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Accident Analysis and Prevention 38 (2006) 1087–1093

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

The economic costs of road traffic crashes: Australia, states and territories

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Received 2 November 2005; received in revised form 8 December 2005; accepted 8 April 2006

Abstract

In this paper, we obtain detailed data on road traffic crash (RTC) casualties, by severity, for each of the eight state and territory jurisdictions for Australia and use these to estimate and compare the economic impact of RTCs across these regions. We show that the annual cost of RTCs in Australia, in 2003, was approximately $17b, which is approximately 2.3% of the Gross Domestic Product (GDP). Importantly, though, there is remarkable intra-national variation in the incident rates of RTCs in Australia and costs range from approximately 0.62 to 3.63% of Gross State Product (GSP). The paper makes two fundamental contributions: (i) it provides a detailed breakdown of estimated RTC casualties, by state and territory regions in Australia, and (ii) it presents the first sub-national breakdown of RTC costs for Australia. We trust that these contributions will assist policy-makers to understand sub-national variations in the road toll better and will encourage further research on the causes of the marked differences between RTC outcomes across the states and territories of Australia.

Keywords: Australia; Economic cost; Road traffic crashes; States and territories

1. Introduction

This paper is concerned with the economic costs imposed by road traffic crashes (RTCs) in Australia and, in particular, their distribution across the eight Australian states and territories. The paper is motivated, at a fundamental level, by two obvious lacunae in the Australian literature on RTCs. First, although recent national data on RTC fatalities are readily available (e.g., via the International Road Traffic and Accident Database (IRTAD)), data on non-fatal RTC casualties, even at the national level, are not. Second, although the Bureau of Transport Economics (BTE, 2000) has estimated of the annual national cost of RTCs as at 1996, no state- and territory-level disaggregation of RTC costs exists. In this paper, we bridge these gaps using 2003 RTC data disaggregated by casualty type, and obtained from each of the eight Australian jurisdictions. We use these data to estimate the distribution of RTC costs across these eight regions of Australia using the BTE (2000) approach, with Consumer Price Index (CPI) adjustment. In addition we quantify the economic burden on each jurisdiction as a proportion of that region's Gross State Product (GSP), i.e. as a proportion of the total market value of all final goods and services produced by each state and territory in the 2003 calendar year. Thus, our work contributes to the literature by bridging the gap between national (Andreassen, 1992; BTE, 2000) and single-state estimates (Giles, 1990; Hendrie and Rosman, 1994) of the impact of RTCs in Australia.

There are several reasons to be interested about how RTC casualties and costs are distributed across regional space. First, and most obviously, national statistical aggregates can mask important intra-national variations in RTC activity. In fact, in this paper, we demonstrate that the casualty distributions and costs vary quite remarkably between the Australian jurisdictions. Second, the readily available data on fatalities are imperfect proxies—even at the national level—for the real costs imposed by RTCs. This is especially true because the available time-series data on non-fatal crashes show that hospitalisations due to RTCs, for example, have increased quite substantially in recent years (see, e.g., Queensland Transport, 2003) even though fatalities have either fallen or, more recently, plateaued. A consideration of sub-national trends in fatal and non-fatal RTCs may provide some basic insights into not only the comparative success of each jurisdiction in reducing the total costs of RTCs, but also the extent to which secondary prevention has led to a reduction in deaths but, perhaps, a concomitant increase in the number or proportion of non-fatal crashes. Third, and following from

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0001-4575/$ – see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2006.04.015

the preceding points, information about the spatial distribution of RTC trauma and costs may provide policy-relevant insights about an appropriate national approach to further attempts to ameliorate RTC costs.

There are several obvious limitations to the work we present here. One is that the results depend, by necessity, on state- and territory-level aggregates. The second limitation is that the data at our disposal do not permit, at this point, a detailed analysis of the causal factors that explain the substantial variations that exist. The attendant problems are that, although there are obvious differences in geography, population density, road traffic conditions, and so on, between the states and territories, these clearly are not perfectly distinguished by the geographic state-territory boundaries. The final and most important caveat concerns the policy use to which these results may reasonably be put. The relative costs of RTCs in the states and territories of Australia are not, in and of, the relevant criteria upon which to base decisions on the distribution of resources (e.g., of the distribution of preventive expenditures across the states and territories). From an economic point of view, it is the estimated marginal costs and benefits of the available interventions, in each state and territory that is the pertinent consideration. So, in this sense, the total burden imposed by RTCs in a given state or territory does not provide any definitive answer to the critical question of how resources ought to be distributed across the states and territories.[1] Thus, the results presented here would need to be combined with information about causal factors, and the levels of intervention in each jurisdiction, in order to produce clear policy conclusions.

Notwithstanding the foregoing limitations, this work sheds new light on a substantial gap in the existing literature. Our results for the states and territories of Australia reveal that there are indeed remarkable differences in the profiles of RTC costs between these regions. The differences that are rendered transparent in this paper raise a number of research questions and policy issues that, we hope, will stimulate discussion and further research.

The work we present shows that, in 2003, the annual cost of RTCs to Australia was more than $17 billion per annum, or approximately 2.3% of the Gross Domestic Product (GDP). This finding accords with those of the recent international reviews of the costs of RTCs in developed countries (Elvik, 2000; Jacobs et al., 2000) in which the mean costs of RTCs have commonly been found to be of the order of 2–3% of GDP. It also shows that there is substantial variation in the state- and territory-level casualties and costs due to RTCs. Indeed, our cost estimates fall within a range of approximately 0.62–3.63% of GSP. Our work is presented as follows: Section 2 commences with a brief discussion of the conceptual basis of economic costing exercises; Section 3 presents our methods and results and Section 4 concludes.

2. Empirical approaches for estimating the cost of RTCs

Estimates of the costs of RTCs vary considerably between and within countries, for several reasons. In this section of the paper, we provide an overview of some of the most important of these reasons, with a view to characterising the BTE methods to be employed in this paper. Given our purpose, our treatment of the key theoretical and methodological issues is not encyclopaedic; rather, it illuminates some key points of disagreement in the unresolved debate on computing the costs of RTCs to provide a context within which our methods and results may be considered.

The most obvious source of variation in the published cost estimates of RTCs is attributable to real differences in the frequency, distribution, severity, and so on, of RTCs. In addition to this 'true' source of variation, though, estimates vary due to differences in measurement, or measurement error. These two sources of difference in cost estimates are not necessarily the same. Specifically, disagreement about precisely what opportunity costs are imposed by RTCs will lead to divergent cost estimates of RTCs, even if the conceptual cost items are measured without error. Conversely, when there is agreement about those cost concepts that are to be measured, but those costs are measured with error, the resulting cost estimates may diverge. Both types of measurement problems affect the literature on RTCs.

Broadly, economic approaches to computing the costs of RTCs can be viewed as applications of conventional welfare economics (see, e.g., Cullis and Jones, 1998). Although the parlance of "perspectives" (e.g., a "consumer perspective" or a "government perspective") around such exercises is now commonplace, a full economic evaluation takes account of all of the costs and benefits that are associated with the phenomenon of interest "to whomsoever they may accrue" (Mishan, 1988).[2] This approach extends to those costs and consequences (e.g., reductions in the quality and quantity of life) to which no market value is commonly attached.[3]

While, in the spirit of welfare economics, economists generally agree that all of the opportunity costs due to RTCs are relevant in a cost computation exercise, there is no consensus about the appropriate approach for computing RTC costs (Alfaro et al., 1994; Elvik, 2000). The most controversial questions pertain to the problems of computing lost productivity and the lost quality of life. Several approaches, with different conceptual bases, exist. Although it is beyond the scope of this paper to provide a detailed account of them, it is useful to outline some of the central issues, since these are important sources of variation in the existing literature.

First, in relation to the productivity losses caused by RTCs one of two general approaches is typically employed: the human capital approach (HCA), or the friction cost method (FCM).

[1] While a discussion of the economic debate over so-called "burden of disease" studies is beyond the scope of this paper, interested readers are referred to the discussion between Williams (1999, 2000) and Murray and Lopez (2000), as well as the critique by Mooney and Wiseman (2000).

[2] The latter phrase dates to the US Flood Control Act (1939) (Mishan, 1988).

[3] Traditionally, alternative approaches in which attention is restricted exclusively to market values and financial outlays (or to a particular party's perspective) have been labelled "financial" evaluations.

Briefly, the HCA involves estimating the (present value) lifetime earnings foregone as the result of a productivity-reducing disability. The application of this approach involves an implicit assumption that the value of lost production (output, income, value added) to the economy, is equal to the sum of such losses to the individuals whose productivity is lowered by RTCs. Conceptually, this essentially means that an individual's lost productive value is irrecoverable from the point of view of the economy at large.

Proponents of the FCM (e.g., Koopmanschap and van Ineveld, 1992; Koopmanschap et al., 1995), on the other hand, argue that the HCA tends to overestimate the true productivity losses to the economy. They argue that that the loss of an individual worker from the workforce creates only transitory or "frictional" productivity losses that arise only until another worker is found to take the place of the injured/disabled worker. In the limit, when the labour supply is perfectly elastic, the loss of labour due to RTCs approaches zero when the FCM is applied.

Second, numerous approaches have been invoked to value the quality of life lost as a result of illness and injury. Concepts such as the quality-adjusted life-year (QALY), disability-adjusted life-year (DALY), healthy years equivalent (HYE), and so on, are examples of non-monetised measures of lost health-related quality of life (HRQOL). These measures are useful when a given end has been deemed worthwhile (e.g., a reduction in RTC deaths) and the remaining question is how to achieve that end (e.g., via primary prevention programs, safer road furniture, and so on) in the most cost-effective manner. The monetisation of health outcomes is, however, necessary for costing exercises of the kind to be conducted in this paper and also for the purposes of cost–benefit analysis (CBA).

In economics, revealed or stated preference data are typically used to impute the monetary values or "shadow prices" that individuals place on their own health and well-being. Revealed preference (RP) studies involve an estimation of the values individuals appear to place on their well-being based on observations of their actual decisions. In the RP literature, individuals' willingness to pay (WTP) for health risk-reducing products (e.g., airbags in motor vehicles) and willingness to accept (WTA) compensation for risk-increasing behaviour (e.g., higher payment for a riskier job) are sometimes used to impute the value of life. See, for example, Viscusi (1992). Stated preference (SP) methods, on the other hand, are survey techniques that are designed to elicit WTP and/or WTA values and are usually invoked when revealed preference data are unavailable.[4] For an example of a (contingent valuation) study of this kind, see the article by Kartman et al. (1996) on WTP for reductions in angina pectoris attacks.

It is worthwhile to point out that WTP/WTA studies typically produce larger values for lost quality of life than do studies that are based entirely on the HCA. That is because the former approaches measure all non-income-related losses that are caused by a disability and its associated handicaps. The argument can be recast using a distinction recently invoked by Sen (2004). Sen argues that the effects of disability may usefully be viewed by considering two types of handicaps that tend to accompany disability: namely "earning" handicaps and "conversion" handicaps. Earning handicaps involve reductions in income. It is this aspect of disability that is generally captured by the HCA. Conversion handicaps, on the other hand, pertain to a reduction in the enjoyment of life that arises due to the disability, so that, e.g., the same level of income does not provide the same level of utility (i.e., satisfaction) as it would have in the absence of the disability. The HCA arguably misses this source of loss entirely, while the WTP/WTA approaches can be used to estimate (a monetised measure of) the entire utility loss.

Finally, an alternative to the RP and SP methods is the use of court-based compensation awards to measure of the value of lost HRQOL. While some have questioned the veracity of doing so based on, for example, the alleged vagaries of the legal system, Viscusi's (1988) and Cohen's (1988) work on US court-based awards suggests that court awards may in fact be a reasonable alternative to the methods discussed above. See BTE (2000) for a more detailed discussion of this issue.

3. Methods and results

The analytical approach we employ in this paper is based on the comprehensive work of the Australian BTE (2000). Using crash data for 1996, the BTE invoked a HCA-based methodology to compute the "economic losses" (the actuarial term for lost earnings, only) associated with RTCs. In addition, the Bureau used actuarial data from three compulsory third-party personal insurance schemes to produce estimates of the "non-economic losses" associated with lost quality of life (specifically, these estimates pertain to actuarial heads of damages such as "pain and suffering" and "general damages").[5] The BTE estimates the effects of injuries and deaths caused by RTCs are thus higher than those that would be produced by a strict application of HCA, but may be presumed to be lower than those that would be produced using the SP or RP approaches.

In addition to these costs, the BTE produced detailed property damage estimates and estimates of other important categories of cost (e.g., emergency services) that are associated with RTCs. Table 1 presents the cost categories that were measured by the BTE (2000) in its national estimates of road crash costs and their relative magnitudes. Note that the costs of RTCs are disaggregated by the BTE into three broad categories: "Human costs", "Vehicle costs" and "General costs". Columns 2 and 3 of Table 1 indicate the proportion each cost item accounts for within its cost category, and as a proportion of total costs, respectively. Note that, notwithstanding their conservative measurement, the BTE (2000) estimates that "Human costs" account for more than 55% of the total costs of RTCs in Australia.

[4] As a rule, economists tend to place more store in what individuals actually do, rather than what they say they will do.

[5] The term "heads of damages" is used by actuaries to refer to the taxonomy via which payments, under insurance, may be made. These include lost earnings ("economic loss"), compensation for pain and suffering ("general damages"), reimbursement for medical services, and so on.

Table 1
Categories of costs measured by the Bureau of Transport Economics to estimate the cost of road crashes in Australia

Cost category	Percentage of cost category	Percentage of total costs
Human costs		
Medical, ambulance and rehabilitation	4.31	2.41
Long-term care	23.73	13.28
Labour in the workplace	19.38	10.85
Labour in the household	17.81	9.97
Quality of life	21.10	11.81
Legal	9.70	5.43
Correctional services	0.20	0.11
Workplace disruption and staff replacement	3.73	2.09
Funeral	0.04	0.02
Coroner	0.01	0.01
Total human costs	100.00	55.97
Vehicle costs		
Vehicle repairs	94.53	25.93
Unavailability of vehicles	4.43	1.21
Towing	1.05	0.29
Total vehicle costs	100.00	27.44
General costs		
Travel delays	58.15	9.65
Insurance administration	37.26	6.18
Police	2.98	0.49
Non-vehicle property damage	1.21	0.20
Fire and emergency services	0.40	0.07
Total general costs	100.00	16.59

Source: Derived from BTE (2000, p. xi). *Note*: Percentages have been rounded to two decimal places.

The BTE (2000) also produced two sets of average cost estimates, one set of which is based on crash type: (i) average cost per fatal crash; (ii) average cost per serious injury crash; (iii) average cost per minor injury crash; and (iv) average cost per property damage only (PDO) crash. The second set of cost estimates is based on the costs per fatality and injury, viz.: (v) average cost per fatality; (vi) average cost per serious injury; and (vii) average cost per minor injury. In other words, the denominator in the case of categories (i) to (iv) is the number of crashes; while the denominators for categories (v) to (vii) are the numbers of fatalities, serious injuries and minor injuries. The injury severity distinction—as between serious and minor—deserves further comment. In the context of the BTE's taxonomy, serious injury is distinguished from minor injury by a hospital admission for 24 h or more, i.e., an injury is considered serious (ii) if an individual involved in the RTC was admitted to hospital, and minor (iii) if first aid was given at the scene of the crash and/or medical treatment, including a hospital admission less than 24 h, was given.[6] We favour the BTE method as both the most comprehensive and recently produced detailed cost estimates for RTCs in the Australian context.[7]

The BTE estimates of average costs by casualty/crash type, expressed in 2003 Australian dollar values, are as follows:

- Fatality: $1,832,310
- Serious injury: $397,000
- Minor injury: $14,183
- Property damage only crash: $7329.[8]

Note that the first three of these average cost measures employ the number of fatalities, serious injuries, and minor injuries in the denominator. The final average cost measure employs the number of crashes as the denominator. We emphasise the latter BTE estimates in this paper because the crash data that made available to us, at the level of the Australian states and territories, are the frequencies of fatalities, serious injuries and minor injuries. Disaggregated data on the numbers of crashes per se were unavailable.

In order to estimate the costs of RTCs at the level of the Australian states and territories we requested 2003 calendar year data from the state/territory transport authorities of each state and territory in Australia, disaggregated by the BTE categories (fatalities, serious injuries, minor injuries).

Each of the agencies approached supplied RTC data and all but three jurisdictions were able to provide these precisely in accord with our request for "fatalities, serious injuries and minor injuries" data (as defined above). For the Australian Capital Territory, minor injuries only included medically treated patients, as first aid data were not collected in that jurisdiction. For Victoria and New South Wales, though, some imputation or derivation was required in order to invoke the BTE taxonomy. For Victoria, the Transport Accident Commission (TAC) supplied us with data on fatalities and serious injuries. We used data on total injuries, supplied to us by Victoria Police, to derive the number of minor injuries in that state (i.e., we subtracted serious from total injuries). The injury data supplied for New South Wales were not disaggregated according to the serious/minor dichotomy. After considering a variety of alternatives, we applied the Queensland distribution of injuries across these two categories to the New South Wales totals, thereby deriving the numbers of serious and minor injuries in the State of New South Wales.[9] The casualty frequencies are presented in Table 2. For a variety of reasons, the number of injuries (particularly

[6] It is worth emphasising that these descriptors bear no relation to measures of injury severity such as the Injury Severity Score (ISS), New Injury Severity Score (NISS), and so on (see, e.g., Stevenson et al., 2001, for a discussion of these measures).

[7] A detailed statement of the quantitative methods of the BTE is available in BTE (2000) and which is available at the following URL: http://www.btre.gov.au/docs/reports/r102/r102.pdf.

[8] We converted the BTE (2000) estimates, which are expressed in $A1996 to $A2003 values using the annual geometric mean of the Australian Consumer Price Index for the intervening period.

[9] We chose Queensland on the basis of several considerations, including the geographical characteristics and the fatalities-to-(total)-injuries ratios of comparable states. Queensland's fatalities comprised 1.73% of total casualties compared with NSW's 1.94% and this proportion was closest between NSW and Queensland. Queensland's GSP and population are also closer to those of NSW than of other available states, excluding Victoria. (Recall that, for Victoria, distributional imputations for non-fatal injuries were necessary).

Table 2
Numbers and types of road traffic crash casualties: Australia, States and Territories (2003)

Region	Number of serious injuries	Number of minor injuries	Total number of injuries	Number of fatalities
NSW	8874[a]	18395[a]	27269	539
Vic.	6683	15115[b]	21798	330
Qld	5735	11867	17602	310
WA	2837	11209	14046	180
SA	1468	7605	9073	156
NT	434	679	1113	53
Tas.	393	2011	2404	41
ACT	138	238[c]	376	11
Total (Australia)	26562	67119	93681	1620

Sources:

(i) New South Wales (NSW) data provided by the NSW Roads and Traffic Authority;
(ii) Victorian (Vic.) data provided by the Transport Accident Commission and Victoria Police;
(iii) Queensland (Qld) data provided by Queensland Transport;
(iv) Western Australia (WA) data provided by the Office of Road Safety, WA;
(v) South Australia (SA) data provided by Transport South Australia;
(vi) Northern Territory (NT) data provided by the Department of Infrastructure Planning and Environment, NT;
(vii) Tasmania (Tas.) data provided by the Department of Infrastructure, Energy and Resources, Tasmania;
(viii) Australian Capital Territory (ACT) data provided by Roads ACT.

Notes:

[a] Imputed data: using total number of injuries reported for NSW, the distribution between minor and serious injuries was imputed using the Queensland distribution between these categories of severity.
[b] Derived data: this datum was computed as the difference between total injuries (supplied by Victoria Police) and serious injuries (supplied by the Transport Accident Commission).
[c] Incomplete data: only medically treated patients are included in the "minor injuries" category, as first aid data at the scene were not collected by Roads ACT.

minor injuries) is likely to be an underestimate of the true number due to under-reporting. The magnitude of under-reporting is not known.

It is straightforward to estimate the total costs by casualty type given the data in Table 2 and the current price estimates of BTE (2000) average cost per casualty type presented above. As was previously mentioned, data on the number of crashes per se, by region, were not available for all jurisdictions. Rather than ignore this cost category, we chose to compute the proportion that PDO RTCs comprised of the BTE total cost estimate and assumed this proportion (i.e., 16.2%) to be indicative of the economic cost of PDO RTCs in each state and territory. In the absence of better data this admittedly crude approach was deemed to be the best of the feasible options.

In order to provide a further conceptual anchor for the analysis, and to facilitate the comparison of our results with those of other countries, we also retrieved data on the annual Gross State Product (GSP) of each of the states and territories for 2003 and expressed the total costs of RTCs as proportions of them. Table 3 presents our total cost results for each casualty type and for PDO RTCs, for Australia and its states and territories, along with the proportions of GSP and GDP these represent.

Table 3
Estimated costs of road traffic crashes (RTCs): Australia, States and Territories (2003)

Region	Estimated cost (AUD 2003, millions)					Estimated cost of RTCs as a proportion of GSP or GDP (%)
	Fatalities	Serious injuries	Minor injuries	Property damage only RTCs	Total cost of RTCs	
NSW	987.61	3522.98	260.90	925.60	5697.10	2.15
Vic.	604.66	2653.15	214.38	673.55	4145.75	2.14
Qld	568.02	2276.80	168.31	584.50	3597.63	2.80
WA	329.82	1126.29	158.98	313.30	1928.39	2.33
SA	285.84	582.80	107.86	189.43	1165.93	2.32
NT	97.11	172.30	9.63	54.13	333.17	3.63
Tas.	75.12	156.02	28.52	50.37	310.04	2.37
ACT	20.16	54.79	3.38	15.19	93.51	0.62
Total (Australia)	2968.34	10545.13	951.97	2806.07	17271.51	2.28

Source: Computed from Table 2, BTE (2003), Australian Bureau of Statistics (2005a,b), and Reserve Bank of Australia (2005). *Note*: The average 2003 exchange rate was AUD 1 = USD 0.6524.

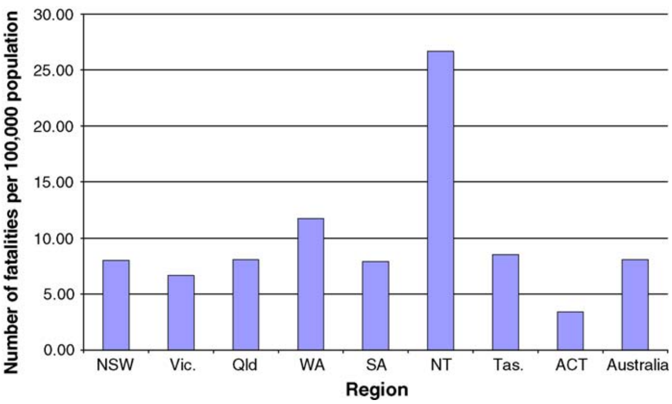

Fig. 1. Number of road traffic crash fatalities per 100000 population: Australia, states and territories, 2003.

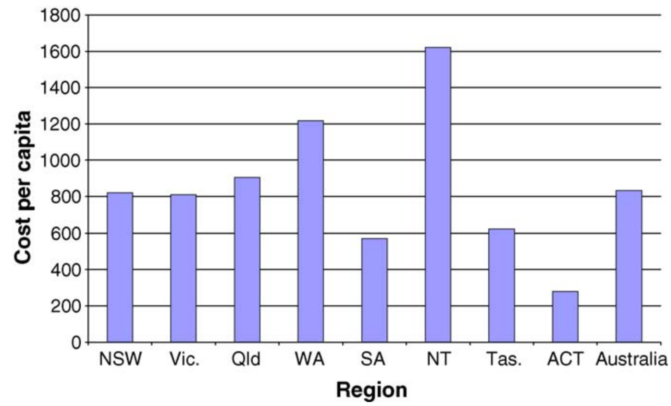

Fig. 2. Total cost per capita (AUD, 2003) of road traffic crashes: Australia, states and territories.

The data in Table 3 provide an indication of the magnitude and spatial distribution of the costs of RTCs in Australia. The total estimates for Australia, presented in the final row of Table 3 are, as one would expect, of the same order of magnitude as the estimates produced by the BTE (2000) for 1996.[10] This sum provides a measure of confidence in the region-specific estimates. In absolute terms, the relative magnitudes of the costs of RTCs are perhaps unsurprising and are increasing in the populations of the states and territories. The largest absolute economic burden of RTCs occurs in New South Wales, at approximately \$5.7b per annum, closely followed by Victoria (approximately \$4.1b per annum) and Queensland (approximately \$3.6b per annum).

In relative terms, the costs of RTCs account for 2.28% of the national GDP and between 0.62% (Australian Capital Territory) and 3.63% (Northern Territory) of GSP.[11] The mean proportion of RTC costs to GSP is 2.30% (with a standard deviation of 0.84%). In fact, the measures of state RTC costs only (i.e., leaving aside the territories), expressed as proportions of GSP, are quite tightly clustered with a range of 2.14% (New South Wales) to 2.80% (Queensland). The territories are outliers for reasons that are clear when one considers the number of fatalities per 100,000 population, presented in Fig. 1. The figure shows that the RTC fatality rate per 100,000 in the Northern Territory is more than three times that of the three most populous states (i.e., New South Wales, Victoria, Queensland), while the rate for the Australian Capital Territory is less than half of the national average. Similar spatial differences arise for injury data, especially with respect to serious injuries. State and territory differences in the casualty rates associated with RTCs are likely attributable to a number of phenomena including the quality of roads, safety of road traffic furniture (e.g., guard rails, lamp posts), distance from crash sites to "definitive care" (i.e., specialist trauma care facilities), emergency response times, law enforcement practices and coverage, road hazards posed by wildlife, and differences in regulations. In relation to the NT, in particular, there is substantive evidence (Treacy et al., 2002) that it is an outlier in relation to RTCs. The Northern Territory has no speed limits on roads outside urban areas and is characterised by an unusually high frequency of single vehicle rollover (SVRO) crashes. In their retrospective analysis of all SVRO crashes that were reported to police, resulted in a death, or in a hospital admission, Treacy et al. (2002) found that high rates of alcohol use and low rates of seatbelt use (38% of people in SVRO accidents were unrestrained) in the "top end" of the Northern Territory contributed to the high fatality and serious injury rates in that region.[12] Notably, the fatality rates reported by Treacy et al. (2002) for the Northern Territory for 1996–1997 are of the same order of magnitude as, although slightly higher than, those for 2003.[13] While it is beyond the scope of this paper to examine the causal effects that lie behind these data, these remarkable differences between the states and territories nevertheless bear further investigation in future work.

Fig. 2 provides a final description of the differences in RTC costs for Australia and its states and territories. Note that the differences witnessed in Fig. 1 are again broadly evident in Fig. 2: the highest per capita costs of RTCs occur in the Northern Territory and the lowest in the Australian Capital Territory. The per capita cost of RTCs in Western Australia and Queensland are also substantially above the national mean; those of South Australia and Tasmania are substantially below the national mean, and those of Victoria and New South Wales are, not surprisingly (due to their influence on the national average), close to the mean.

[10] The BTE's (2000) estimate of the total costs of RTCs in Australia in 1996 was \$14.98b.

[11] Note that, by definition, the (national) GDP is the sum of the state GSPs.

[12] The "top end" of the Northern Territory includes the Darwin, East Arnhem and Katherine Districts.

[13] Other characteristics of the road traffic may also have some bearing on RTC rates and their outcomes. Consider the following advice to travellers from the Katherine Region Tourist Association (KRTA): "The Northern Territory is renowned for it's (sic.) road trains, some of which can be three trailers (50+ metres) long. They need plenty of room and if you contemplate overtaking them, ensure you have at least one kilometre of clear road ahead" (KRTA, 2005, http://www.krta.com.au/Katherine_Region_travel_tips.htm).

4. Discussion

Our estimates of the costs of RTCs are conservative in numerous respects, including the known problems of under-reporting (Giles, 2001) and the inherently conservative nature of the BTE costing approach we employ here. Notwithstanding these measurement issues, this paper makes an important empirical contribution by measuring and comparing the distribution of RTC casualties and the costs of RTCs across the states and territories of Australia. This constitutes first disaggregated view of the costs of RTCs for every jurisdiction in Australia, and sheds light on regional differences in RTC activity that previously were opaque. We hope that this work will stimulate others to examine the causal effects that underlie some of the quite substantial spatial variations in RTCs in Australia. In addition, we hope that the results presented here will help policy-makers to examine effective RTC prevention and post-RTC treatment, rehabilitation and support systems at the national level.

Acknowledgements

We wish to thank the Australian state and territory authorities referred to herein for providing RTC data. We also thank Shahriar Shafiee for his useful comments on an earlier draft of this paper.

References

Alfaro, J.-L., Chapuis, M., Fabre, F. (Eds.), 1994. Socioeconomic cost of road accidents. Report EUR 15464 EN, Commission of the European Communities, Brussels.

Andreassen, D.C., 1992. Preliminary costs for accident-types. Australian Road Research Board, Report ARR-217, ARRB, Victoria, Australia.

Australian Bureau of Statistics, 2005a. Consumer Price Index, Australia. ABS, Canberra, Australia.

Australian Bureau of Statistics, 2005b. Australian National Accounts: State Accounts. ABS, Canberra, Australia.

Bureau of Transport Economics, 2000. Road Crash Costs in Australia. BTE Report 102, BTE, Canberra, Australia, http://www.btre.gov.au/docs/reports/r102/r102.pdf.

Cohen, M.A., 1988. Pain, suffering and jury awards: a study of the cost of crime. Law Soc. Rev. 22 (3), 537–555.

Cullis, J.G., Jones, P., 1998. Public Finance and Public Choice, second ed. Oxford University Press, Oxford.

Elvik, R., 2000. How much do road accidents cost the national economy? Accid. Anal. Prev. 32 (6), 849–851.

Giles, M.J., 1990. Hospital inpatient accident costs for road traffic accident casualties in Western Australia, 1988. In: Smith, D.I. (Ed.), Proceedings of Inaugural Annual Conference. Road Accident Prevention Research Unit, University of Western Australia, Perth, Australia, pp. 159–180.

Giles, M.J., 2001. Data for the study of road crashes in Australia. Aust. Econ. Rev. 34 (2), 222–230.

Hendrie, D., Rosman, D., 1994. Hospital inpatient costs resulting from road crashes in Western Australia. Aust. J. Public Health 18 (4), 369–379.

Jacobs, G., Aeron-Thomas, A., Astrop, A., 2000. Estimating global road fatalities. Transport Research Laboratory Report 445, TRL, Crowthorne, United Kingdom.

Kartman, B., Andersson, F., Johannesson, M., 1996. Willingness to pay for reductions in angina pectoris attacks. Med. Decis. Making 16 (3), 248–253.

Katherine Region Tourist Association, 2005, Northern Territory, Australia. http://www.krta.com.au/Katherine_Region_travel_tips.htm.

Koopmanschap, M.A., van Ineveld, B.M., 1992. Towards a new approach for estimating indirect costs of disease. Soc. Sci. Med. 34 (9), 1005–1010.

Koopmanschap, M.A., Rutten, F.F.H., van Ineveld, B.M., van Roijen, L., 1995. The friction cost method for measuring indirect costs of disease. J. Health Econ. 14 (2), 171–189.

Mishan, E.J., 1988. Cost-Benefit Analysis: An Informal Introduction, fourth ed. Unwin Hyman, London.

Mooney, G., Wiseman, V., 2000. Burden of disease and priority setting. Health Econ. 9 (5), 369–372.

Murray, C.J.L., Lopez, A.D., 2000. Progress and directions in refining the global burden of disease approach: a response to Williams. Health Econ. 9 (1), 69–82.

Queensland Transport, 2003. Queensland Road Safety Strategy, 2004–2011. QT, Queensland, Australia.

Reserve Bank of Australia, 2005. Exchange Rate, Australia. RBA, Sydney, Australia.

Sen, A., 2004. Disability and Justice. The World Bank, Washington D.C.

Stevenson, M., Segui-Gomez, M., Lescohier, I., Di Scala, C., McDonald-Smith, G., 2001. An overview of the injury severity score and the new injury severity score. Inj. Prev. 7 (1), 10–13.

Treacy, P.J., Jones, K., Mansfield, C., 2002. Flipped out of control: single-vehicle roll-over accidents in the Northern Territory. Med. J. Aust. 176 (6), 260–263.

Viscusi, K.W., 1988. Pain and suffering in product liability cases: systematic compensation or capricious awards. Int. Rev. Law Econ. 8 (2), 203–220.

Viscusi, K.W., 1992. Fatal Tradeoffs: Public and Private Responsibilities for Risk. Oxford University Press, New York.

Williams, A., 1999. Calculating the global burden of disease: time for a strategic reappraisal? Health Econ. 8 (1), 1–8.

Williams, A., 2000. Comments on the response by Murray and Lopez. Health Econ. 9 (1), 83–86.