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Ministry of Transport Withheld under section 9(2)(a) of the Official Information Act 1982

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Review of
Qualitative and Quantitative Analysis of the New Zealand Road Toll
(by Deloitte Access Economics)

Dear [redacted] Withheld under section 9(2)(a) of the Official Information Act 1982

Thank you for the opportunity to review the report on the road toll produced by Deloitte Access Economics for the Ministry. The version I have is labelled Draft Final Report and dated 24 February 2017.

As agreed I will address the following issues:

1. Robustness of the modelling, its relative strengths and weaknesses.
2. Approaches taken by the DAE compared to other road toll modelling the Ministry has commissioned and how the Ministry might explain different results to the lay person.
3. The applicability of this piece of work and any caveats or explanation that should be raised in its release.
4. Any areas where further work should be undertaken (noting that this may incur added cost to the Ministry).

I will also offer some other comments and suggestions.

Robustness

The main findings and conclusions from the two core models are reasonably robust, and the recommendations follow logically from the analysis. I agree with them.

I do have some doubts about the reliability of the results for the enforcement and speed variables. There are both conceptual and statistical issues around how they are incorporated into the models, as explained below. It is good that these particular results are not mentioned in the Key Findings.

Also the micro-econometric analysis in Appendix C.2 is incomplete. As it stands it can yield only very tentative inferences.

Comparison of Approaches

DAE use an econometric approach, as did Infometrics (2013a, 2013b) and Keall et al (2012), but the techniques are applied in different ways.

Infometrics (2013a) is more fundamentally different. It looked at the underlying reasons for the long term decline in the road toll whereas DAE puts aside most of the long term factors and looks at how departures from the long term trend can be explained. Further, Infometrics (2013a) works with the annual rate of fatalities per unit travel, not the number of injury crashes or the fatality rate per injury crash (at a weekly level –as DAE does). That is, it addressed the first term on the right hand side of the following equation.

$$F = F/T * T/V * V/P * P$$

- where:

F is fatalities (or serious injuries/crashes)

T is travel (VKT)

V is number of vehicles

P is population

The focus on F/T was because it is the factor that had the largest contribution to the reduction in fatalities and because it is the target of road safety interventions and innovations. It was also the only variable with a long enough time series. The model explained approximately 81% of the decline in F/T between 1900 and 2012, with better roads and safer vehicles being major contributors.

As DAE discuss in Section B.3.1 their set of explanatory variables is small. So while the main model explains about 66% of the variation in casualty crashes, a considerable proportion of what is explained is attributable to the annual (and weekly) dummy variables which in essence capture factors such as trend improvements in vehicle safety and the quality of the road as identified in Infometrics (2013a). Thus there is no inconsistency between the findings.

A key component of vehicle safety identified in Infometrics (2013a) was the change in motorbike use. Essentially a motorbike is a car with very little protection for the driver – no doors, no roof etc. DAE also find a strong motorbike effect on the number of crashes and their severity.

Keall et al (2012) and Infometrics (2013b) are more akin to the DAE approach in that they look at departures from the long term trend, particularly addressing the sharp decline in fatalities in 2011. Keall et al and Infometrics used quarterly data while DAE use weekly data which enables a richer set of variables to be examined. As DAE note in Section 3.3.5, monthly and weekly effects could wash out in a quarter. However, there could also be more noise.

DAE identify motorbikes, VKT, infringements notices, speeding and advertising as the main explanatory variables; a list that is very similar to the variables identified by Keall et al and Infometrics. Their use of VKT as an explanatory variable is partly intended as a proxy for economic activity. Keall et al and Infometrics used more direct measures of economic strength such as the real wage rate. It is possible that VKT has a stronger effect and in that sense is a better variable, but this could be because it is 'closer' to the dependent variable in the sense that it if one wished to understand what explained VKT, one would probably look at variables such as GDP and wage rates.

Applicability and Caveats

As discussed below, I would not emphasise the results for enforcement and speeding as they are probably not robust. The other results for the two main models seem fine.

I am unsure of the use of the analysis in Appendix C.2 on modelling severity. It is more a disaggregation of the composition of crashes by who, where, when, etc, than an explanation of the reasons for them. This is like regressing the price of petrol against the crude oil price, the refining cost, excise taxes and transport costs – interesting but without providing much insight.

The results are also likely to be severely affected by multicollinearity; road type and speed zone, age and licence status, and so on. Thus the individual coefficients and associated effect sizes cannot be relied upon. The largest effect size for the probability of a fatal injury is age=zero. Is this result robust or does it reflect a high number of fatalities in this age group? Nothing can be inferred about why.

One might ask what can be learnt from this report that is new and useful. Three points stand out:

1. The use of VKT as an explanatory variables is revealing, and the accompanying discussion around possible changes in its composition (age, vehicle type, road sharing, location etc) is very valuable. It is definitely an area that merits further research.

2. Previous findings of the effect of motorbike use, petrol prices and some other factors have been confirmed as affecting the number of crashes and their severity.

3. The low number of fatalities in 2013 and the increases in 2014 and 2015 reflect random variation. Keall et al (2012) noted the same finding for the dip in 2011.

Further Work

While there is intrinsic merit in testing the robustness of the enforcement and speeding results in this report, I am not sure how much further it would advance the understanding of their effects on the road toll.

A better understanding of the role, especially at the margin, of all enforcement (whether alcohol, speed, drugs etc) is urgently required, but this is better investigated in a study with that specific objective.

As stated above the micro-econometric analysis in C.2 is incomplete if it is to be useful. Again though, what is the objective here? Is to look for patterns or to guide road safety policy? A unit record analysis could form a very useful complement to aggregate analysis.

The composition of VKT is worth more investigation. It could affect the number of crashes quite independently of other factors. Infometrics (2013a) noted the same point with respect to fatalities per unit travel.

Suggestions and comments

1. Section 2.2.4 regarding the discussion on additional enforcement: It may well have reduced the proportion of vehicles exceeding the speed limit, but one cannot infer anything about its effect on the road toll. Keall et al (2012) noted a negligible if any effect. However, the authors make a good point when stating that education and enforcement interventions need to be well designed to ensure that their potential impacts are realised.

2. Section 3.3.1: The trouble with using enforcement notices as an explanatory variable, is that it is an output not an input; more notices could mean worse behaviour or more enforcement activity. The former would be expected to be associated with more accidents while that latter should lower the number of accidents. Thus the sign is ambiguous. DAE seem to acknowledge this in Section A.2.

   I suspect that the alternate positive and negative signs on enforcement reflect this ambiguity, and also perhaps high correlation between this variable and its lag. Without more testing I would not trust those results.[1]

3. Table 3.2 and Chart C.2: The lag speeding proportion is somewhat arbitrary. It is not robust and lacks a theoretical argument on how it could affect crash rates. I would not place too much emphasis on the estimated relationship.

   A measure of goodness of fit would be useful for Table 3.2.

4. Section 3.3.5 presents a good discussion of reasons for differences between the DAE results and those of Keall et al and Infometrics. The comment on the

[1] Also using lags is not necessarily a way of avoiding simultaneity. See for example Read, W.R. (2014) "On the Practice of Lagging Variables to Avoid Simultaneity". University of Canterbury Department of Economics and Finance *Working Paper 18/2014.*

rate of fatalities and number of vehicle occupants is true, but Infometrics did not use that definition of the fatality rate.

DAE note that the effect of not using VKT (in Keall et al and Infometrics) is indeterminate, but if other economic activity variables are like VKT and act only via the fatality rate (fatalities divided by casualty crashes) as claimed by DAE, then it does not matter which is modelled. Am I missing something here?

Also statistical consideration of 'over dispersion' aside, we are interested in lowering fatalities irrespective of whether they occur in single fatality crashes or multiple fatality crashes. Perhaps some factors such as airbags have different impacts on drivers than on passengers. Thus it is not obvious that fatal crashes is a better metric for analysing contributions to road safety improvements than fatalities.

5. Section 4.2: The last paragraph regarding cost deserves more prominence. I would bring it into the Executive Summary.

6. Section 4.3: While these are worthy aims, even if data on (say) driver distractions was collected, if current CAS reports are anything to go by (refer last paragraph in section A1) the data would be extremely subjective, and may contain more measurement error than reliable signal.

7. Appendix A, around chart A.10: The point about drugs having to be shown to cause impairment, as opposed to alcohol where only a concentration threshold is required, has more weight than the authors perhaps realise. Proxy measures of crash risk may work well over certain ranges. For example someone who is ten times over the alcohol threshold is almost certainly at high risk of crashing. However, as the threshold gets lower the proxy becomes a progressively poorer measure of risk. Similarly for very fine speed tolerances. Thus policy makers should not be surprised if evermore fiddling with blunt proxies for risk fails to have any material impact on serious crashes. To paraphrase DAE (p vii), policymakers need to understand the changing relationship between the strength of the link between risk factors and road trauma.

   I think that point is worth elaborating.

8. Chart A.24: The discussion mentions VKT per capita as a measure of exposure to crash risk, but in section 2.2.5 VKT (not per capita) is used as an exposure measure. Chart A.24 looks less convincing than the associated discussion implies.

9. Section B.2: The interpolations may upset the regression standard errors through the effects of multicollinearity and/or autocorrelation. This is relevant to points 2 and 3 above.

10. Section B.3.1 The general to specific approach is good, but to reduce the risk of discovering spurious associations it is usually best to undertake a bit more testing especially if multicollinearity exists.

11. Section B.3.2: Does DRAG denote the Demand for Road use, Accidents and their Gravity? An explanation would assist the reader.

Minor Points

1. P2: The four main components of the road system are identified as roads & roadsides, speed, vehicles, and road use. Speed and road use should both be under the heading of 'driver'. That would be more consistent with other approaches.

2. Table 2.1: Effect matrices of this type are rarely as simple as they seem. One could for example argue for a tick in the 'vehicle safety' row and 'user' column if the theory of risk compensation applies.

3. Section 2.2.1: The reference to a 19% in Stroombergen (2013) applies to the fatality rate (F/T), not to the number of fatalities.

4. Charts 3.1 and 3.2 are referred to in the text as 3.2 and 3.3.

5. Section 4.1: Repeated text; paragraph below the bullet points and last paragraph

6. Section A.2: Heading should presumably be Independent variables, not Dependent variables

7. Chart A.21: Although a specific expenditure series related to safety does not exist before 2012, the 'safety' label is somewhat arbitrary. Much expenditure that is aimed at reducing journey time also improves safety.

8. Chart A.22: Infometrics found that <u>rate of change</u> in petrol prices has a bigger effect than the level of petrol prices.

The motivation for the study (as stated in the report) is fairly loose and perhaps as a consequence the report is more of a broad-brush exploration and discussion of some factors that influence the road toll, rather than a strong guide to effective (and efficient) intervention. If that is the objective, fine. The report is free of serious error and is easy to read.

The recommendations are solid. I would add the need to support top-down analysis with unit record analysis, as begun by DAE.

Yours faithfully

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