

A Time Series Analysis of Periodic Heavy Vehicle Inspections and Road Safety Outcomes in Queensland

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Abstract

Heavy vehicle crashes cause significant economic and social costs. Although most crashes are considered to be related to driver errors, the impact of vehicle defects is evident in many crashes (Blower et al., 2010). Hence, different vehicle inspection schemes, including Queensland's certificate of inspection (COI), have been implemented around the world to more effectively manage the safety of heavy vehicles (Keall and Newstead, 2013). This study investigates the trends in and potential impact of COI on heavy vehicle crashes, relying on longitudinal data provided by Queensland's Department of Transport and Main Roads for the period of 2009-2014.

Background and Objective

In a twelve-month period ending December 2016, heavy vehicles were involved in 191 fatal crashes with 213 deaths across Australia (BITRE, 2017). These figures mean heavy vehicles are involved in almost 16% of fatal crashes, while they represent only 2.4% of the total number of registered vehicles and 7% of the total vehicle kilometres travelled (BITRE, 2016). To reduce these damages especially by decreasing defect-related crashes, the COI scheme requires any heavy vehicle registered in Queensland to undergo a periodic inspection every 6 or 12 months, depending on the vehicle type. While a few studies (e.g., Elvik, 2002) have found associations between inspections of heavy vehicles and decline in vehicle defects as well as the total number of heavy vehicle crashes, a recent review of the existing literature shows that there is little empirical research about such impacts (Mooren et al., 2014). Accordingly, this research investigates the efficacy and effectiveness of periodic heavy vehicle inspections by examining the impact of the COI scheme on heavy vehicle crashes in Queensland. In particular, this research explores the overall trends in periodic heavy vehicle inspection results and the number of heavy vehicle crashes, especially to reveal potential relationships between inspections and crashes over a five-year period.

Method

Time series analysis is used to address the proposed research objective. Initially both periodic inspection results and crashes are investigated, following an exploratory approach to reveal potential trends, seasonal components and irregularities from different perspectives. Then, an autoregressive integrated moving average (ARIMA) model is fit to the time series data. The model indicates cross-correlations and any potential impact of periodic inspections on crashes. Finally, Holt-Winters' double exponential smoothing (Metcalf and Cowpertwait, 2009) is applied to forecast changes in heavy vehicle crashes, which are then, compared with the actual observations.

Results and Conclusions

A preliminary investigation shows that: a) the mean inspection failure rate, the total number of crashes and the number of crashes caused by a vehicle defect have decreased, while the vehicles' average age has increased over the five years under investigation, as shown in Figure 1. A regression model fitted to the time series data also shows that the inspection failure rate with a two-month lag, along with the vehicle age, can explain around 39.1 per cent of variation in the number of crashes caused by a vehicle defect, while the estimates for both predictors are statistically significant.

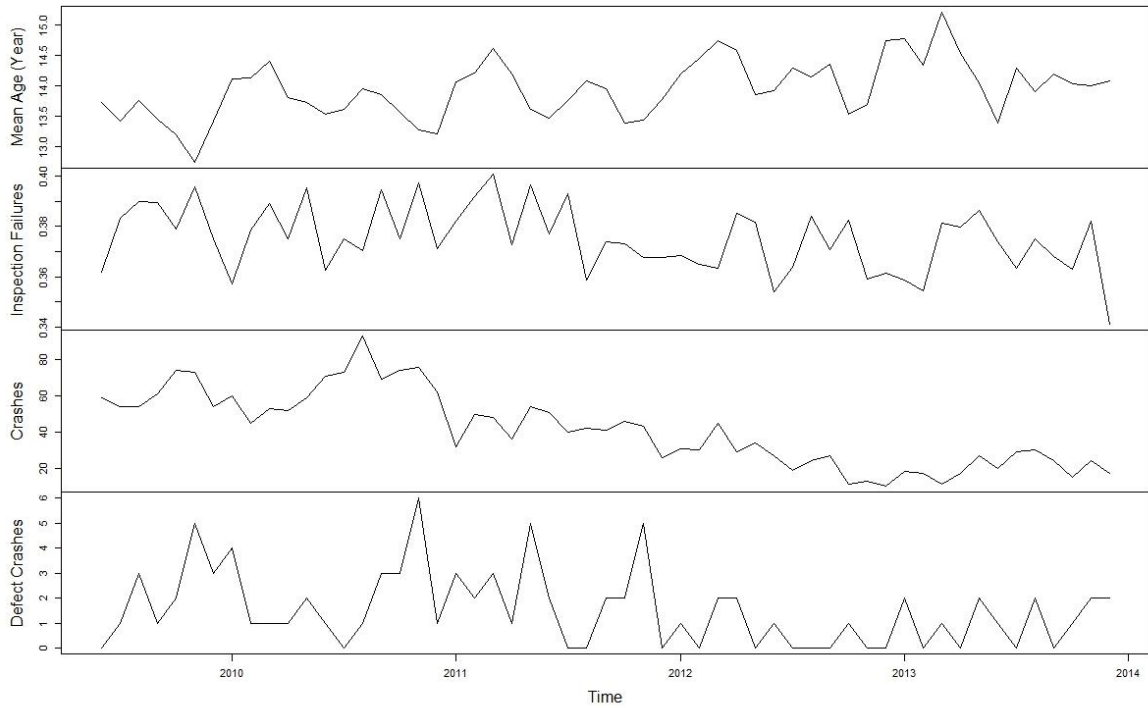


Figure 1. Vehicle age, inspection results and crashes time series

Finally, the results of Holt-Winters double exponential smoothing suggest that the decline of inspection failures and defect-caused crashes (shown in Figure 2) should remain steady for the one-year period after our data set (i.e. 2014-2015), which is comparable to actual observations. These findings have both theoretical and practical implications regarding the effectiveness of vehicle inspection protocols on road safety: inspections do result in reductions in defect-related crashes, and these safety effects are related to the time since the last inspection.

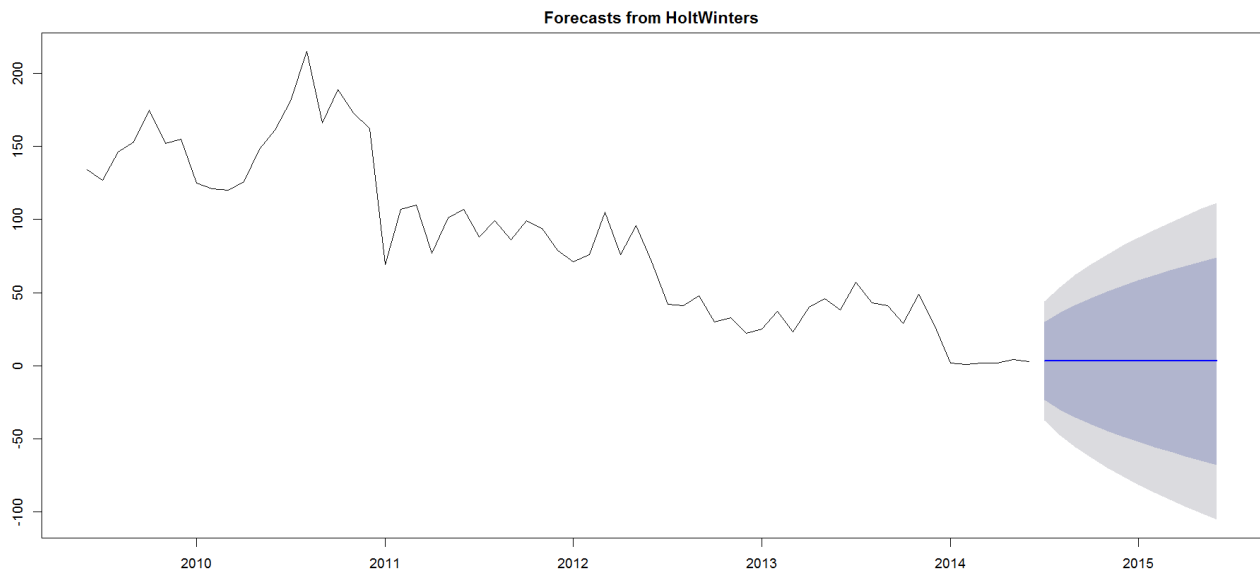


Figure 2. Defect-caused heavy vehicle crash forecasts

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