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Red-light running traffic violations: A novel time-based method for determining a fine structure

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ABSTRACT

In 2016, the monetary fine for a red-light running (RLR) traffic violation varies widely in the U.S., with a fine of $50 in North Carolina and as much as $490 in California. Currently, a scientific method for determining the monetary fine based on the safety impacts associated with such violations does not exist, thereby causing disparities in fine structures. This study develops a novel fine structure for RLR traffic violations based upon the estimated economic impact of potential crashes by RLR violations and estimated delays caused by providing all-red intervals to prevent potential conflicts. A physical model is developed to determine the crash probability at a discrete time after the traffic signal turns red. The Highway Capacity Software is also employed to estimate additional delay incurred by road users. Considering that the use of red-light cameras is increasing in the nation, while it is often criticized as a revenue instrument, policymakers need to develop an objective fine structure that closely reflects the risk a RLR vehicle poses to other drivers.

1. Introduction

A red-light running (RLR) crash, by definition, happens when a driver, inadvertently or deliberately, runs a red light at a signalized intersection and crashes into another road user who has the right-of-way (ROW). It is sometimes difficult to obtain and maintain the necessary intensity of law enforcement presence at an intersection to reduce RLR traffic violations. Therefore, considerable interest exists in developing new technologies that will help improve driver compliance with traffic control devices, prevent violations, and reduce crash occurrence (Antonucci et al., 2004; Obeng and Burkey, 2008).

Red-light cameras (RLCs) detect a vehicle that runs a red light and automatically issue a citation for the traffic violation. The first U.S. application of this system was implemented in New York City in 1991, and as of February 2015, an estimated 467 individual communities operate and maintain RLC programs (IIHS, 2015). Past studies also show the benefits of installing RLCs include enhanced enforcement, educating drivers on ways to reduce red-light violations, reduced angle crashes, and socio-economic benefits (i.e., generated revenue, preservation of life, reduced traffic delays, etc.) to the community.

Another facet of RLCs that has yet to be examined is an empirical basis for determining RLR fines. Enforcement countermeasures are intended to encourage drivers to obey traffic laws through the threat of a citation and a possible fine (Egbendewe-Mondzozo et al., 2010). However, the fine associated with RLR has no relationship to its negative impacts and, as a result, may have less of a deterrent effect. The fine is generally predetermined, based on the traffic violation that

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has been committed. The RLR drivers pay a predetermined monetary fine and/or accept a predetermined number of violation points, or challenge the citation by making an appeal (Sharma et al., 2007).

Table 1 lists the RLR fine amounts in six states, which were obtained from the Roadway Information Database (RID) that is maintained by Iowa State University's Center for Transportation Research and Education (CTRE 2015). The table shows that the monetary fine for a RLR traffic violation varies widely in the U.S. From Table 1, it appears that no points are assessed when traffic violations are captured by RLCs. It is because holding the driver of a vehicle accountable for a RLR traffic violation typically requires a frontal photograph to help with driver identification for a trial. Capturing high-quality facial images of the violator is often difficult for many reasons such as angled windshield and sun glare. Besides, the frontal photograph increases privacy concerns that often are raised in opposition to automated traffic law enforcement legislation (Eccles et al., 2012).

The National Highway Traffic Safety Administration (NHTSA) sponsored a national survey in 2002 that showed the majority of drivers in communities with and without cameras support this program (Royal, 2004). In spite of these results, opponents claim that this system is a tool to generate revenue for state, city, and local municipalities. Considering the controversial nature of RLCs and the increased use of cameras, developing a fine structure that closely reflects the risk a RLR vehicle poses to society is needed.

RLCs have the ability to determine the exact time a violation occurs, thus making it possible to quantify the risk imposed on other road users by the violator. The exact time and date of a violation along with vehicle speed and signal timing at the time of the violation are continuously being collected by the company operating and maintaining the RLC system. In this study, a mathematical model is developed to predict the probability that a RLR vehicle may collide with crossing traffic. Next, a method based on the Highway Capacity Manual (HCM) is applied to quantify the cost of traffic delay if the all-red time was not provided. Finally, a novel fine structure is suggested to calculate the dollar value of RLR fines for various intervals based on the expected crash occurrence at an intersection as a result of the RLR traffic violation and estimated delay cost, caused by providing all-red intervals to prevent potential conflicts. The proposed approach is then applied to a case study in Opelika, AL as an example.

2. Literature review

Police enforcement programs are used to alter driver behavior and driver decisions in an effort to enhance road safety (Wong, 2014). As a result, drivers adhere to established traffic laws because they realize the risk of fines and penalties if they are not in compliance. Drivers are more likely to brake sooner during the yellow or all-red intervals when they are aware that their driving is being monitored by cameras (Polders et al., 2015; Baratian-Ghorghi et al., 2015a). Retting et al. (1999) showed that the violation rate is reduced by approximately 40% during the first year after the installation of RLCs. McCartt and Wen (2014) found that there was a statistically significant reduction in the number of violations occurring at 0.5 s (39%) and 1.5 s (86%) after the onset of the red signal. A 17–32% reduction in angle crashes (injury and fatal) was found at intersections where RLCs were installed (Sayed and de Leur, 2007; Retting and Kyrychenko, 2001).

Over the past couple of decades, many studies have sought to measure deterrent effects, in the form of lower recidivism and/or crash rates, due to increases in fines (Walter and Studdert, 2015; Tavares et al., 2008; De Paola et al., 2013; Redelmeier et al., 2003). For instance, Abay (2014) showed that drivers with one or more demerit points reduced a driver's likelihood of committing a traffic violation by 11–20%. However, few studies have considered RLR violations and the effects of penalties (e.g. fines, demerit points) used to sanction those programs (Porter et al., 2013; Pulugurtha and Otturu, 2014). Lu et al. (2012) implemented a randomized experiment in China and showed that informing drivers that they were observed committing traffic violations by automatic detection devices deterred drivers from committing the same traffic violation in the future.

Reeves and Kreiner (2008) invented a new system for assessing a monetary fine based on the number of vehicles that were impacted as a result of the traffic violation. First, a traffic violation is discovered by a violation analyzer. Then, the data (i.e., a traffic violation code number and data representative of the impact of the traffic disturbance from the data collection sensors) are sent to the penalty calculator to determine the associated fine. The data representative of the impact may include the number of vehicles that were present in the resulting traffic congestion. However, the economic value of those impacts was not investigated in an effort to link them to the appropriate amount of the monetary fine.

One measure used in determining the effectiveness of safety programs involves calculating costs associated with various types of crashes (i.e., head on, side swipe, rear end, etc.). Some researchers focused on the aggregate cost based on crash geometry, geography, or other collective characteristics of interest (Blincoe et al., 2002; Miller et al., 1997), while others calculated the cost based on injury reported on crash forms filed by police to determine a cost per injured person (Zaloshnja

Table 1
RLR fine amount in six U.S. states (CTRE 2015).

Enforcement type	Florida	New York	North Carolina	Pennsylvania	Washington	Alabama
RLC	$158	$50	$50	$100 max	$250 max	$100 max
Traditional	$125/3 points	$100/3 points	$100 max/3 points	$25 max/3 points	$250 max	$150 max/3 points