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Attributes affecting preferences for traffic safety camera programs

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ABSTRACT

With just a few notable exceptions, research supports the concept that red light cameras (RLCs) improve safety. However, many communities that have implemented RLC programs have faced a firestorm of public opinion associated with the use of RLCS, with many communities having to remove the cameras. What makes or breaks a red light camera program? Because of the experimental design process, stated choice is recognized as a tool that can resemble a laboratory experiment for the public policy arena. In this research, a stated choice model was developed and used to explore public preferences for a RLC program through an internet survey and a convenience sample drawn from a typical college town. The results suggest while independently the opposite is true, that when there is an increase in both the fine for violators and the number of cameras together (i.e., the interaction of these two) there is a perceived public safety gain. The interacted variable positively increases utility from the selected RLCS program we analyzed and could be key in generating public support for RLC programs. The results suggest some important deterrence theory implications for improving accident prevention through the use of RLC programs that are designed to avoid unnecessary public scrutiny.

1. Introduction

In this manuscript we present results from a stated choice model (SCM) of public preferences for a Red Light Camera (RLC) program. In 2008, more than 5 million traffic accidents occurred. Forty percent of those accidents were intersection related crashes (Choi, 2010). That same year, there were more than 34,000 fatal car accidents in the US, with approximately 8% of those accidents occurring at a traffic light (National Highway Traffic Safety Administration, 2010). With a primary safety-related goal of reducing the number of people who run the light, RLC programs are used in more than 480 communities (as of October 2010) across the U.S. (Retting et al., 1999; IIHS, 2010).

RLC programs typically involve videos or photographs taken of automobiles running red lights and the registered owner of the vehicle is sent a fine. Though the cost effectiveness of speed and RLCs might be questioned (Chen and Warburton, 2006), the U.S. Federal Highway Administration reports that national data support reductions in red-light violations and collisions through the use of cameras. However, red light cameras may increase minor rear-end accidents, a function of off-setting behavior (Connell, 2008; Obeng and Burkey, 2008). A study of seven communities by the Federal Highway Administration suggests that dangerous broadside collisions were reduced by 25% at intersections with traffic cameras, while rear-end collisions increased by15%, potentially caused by motorists who stop suddenly to avoid running a light at an automatically enforced intersection (Hernandez, 2010). Additional research suggests that internationally, RLCs may reduce red light violations by 40–50 percent (Retting et al., 2003).

The primary objective of this research is to identify, using experimental design, the factors that contribute to a public acceptance of RLC programs. To our knowledge, though some safety issues have been examined using a SCM (e.g., Rizzi and de Dios Ortúzar, 2003; Iragüen and de Dios Ortúzar, 2004), no one has examined preferences for RLCs using the SCM approach. From our results, implications for the impact of RLC programs on driver behavior and the controllable features of RLC programs are offered. This type of research is fundamental to linking the accident reduction properties of RLCs and public acceptance of RLC programs. In the remainder of the manuscript we first provide a brief review of related literature, then present the theoretical model underlying the stated choice model (SCM). Next, SCMs require careful experimental design, so this is discussed, followed by a description of the sample and survey. The data are then described, leading to the empirical model results and discussion of these. We offer some conclusions in the final section.

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2. Background literature

Several researchers have now considered whether RCLs can be effective in reducing mortality, or at least crashes at intersections. Of particular concern are side-impact crashes from a vehicle running through an intersection, but rear-end collisions are also considered. By in large, the peer-reviewed literature suggests that red light cameras do, in fact, improve traffic safety (Aeron-Thomas and Hess, 2005; Lund et al., 2009).

Initially it seems that the public would be in favor of automated, unbiased enforcement programs because of enhanced safety. Nevertheless, a number of RLC programs across the U.S. have faced community complaints due to objections to paying a fine without due process, privacy invasion, and false accusation. In addition, concerns that the cameras are ineffective and that communities' are using the programs to simply generate revenue have led to increased public scrutiny with regard to red light camera programs. There have been highly publicized accuracy issues associated with RLC in Arizona, Maryland, Missouri, Oregon, Texas, Italy, and the UK. And RLC programs in New Mexico, Washington, Texas, Florida, and California have been put up to a public vote, resulting in a number of cities removing their RLC programs.

Arizona, as one of the first to adopt traffic-safety cameras, became the first to ban them, in response to activists who felt they invaded privacy, and were installed mainly as a revenue generating device. The state's department of public safety reported a 19% drop in fatal collisions in the first nine months of operation (Archibold, 2010). The controversy in Arizona unfortunately also involves the murder of a mobile speed camera van operator. The state actually collected payments on less than one third of the 1.2 million tickets which were issued, adding $78 million to revenue. More than 400 local governments in the U.S. use traffic cameras, but fifteen states and 11 cities have now banned or restricted their use in response to controversy and the topic has made its way into political campaigns in several regions (Hernandez, 2010). This poses a real problem from a safety perspective; a tool has been identified to reduce both the number and severity of accidents associated with an inherently risky portion of our roadways, yet public pressures have worked against the use of this tool.

In designing a RLC program that has the ability to withstand public scrutiny and impact intersection safety, it is important to understand the role of controllable factors (including camera location, number of cameras, and penalties for infractions) on driver behavior and driver perspectives of camera programs. The existing body of literature focuses largely on the effectiveness of the RLCs at reducing accidents and safety considerations associated with RLCs. Only a few studies delve into understanding how policy makers can effectively adopt automated enforcement programs (Martinez and Porter, 2006).

Red light camera effectiveness in 26 communities in Texas was studied by Walden (2008). With data from 56 traffic intersections, Walden (2008) found a 30% decrease in crashes after installation of the cameras. The author makes an important causality point about and does not claim that his findings prove that cameras reduce crashes at intersections, as he does not control for external factors that may have contributed to the reduction in crashes after cameras were installed. In another study, through the use of a nationwide survey, Porter and Berry (2001) obtained self-reported red light running behaviors and attempted to gauge opinion of red light running from drivers. Porter and Berry (2001) found that drivers often perceived the consequences of running a red light to be very low and suggested that the use of legal initiatives would help deter the behavior. While the results of the Porter and Berry (2001) survey are interesting, the full complexities associated with driver behavior cannot be captured with a typical "public opinion" survey (Louviere et al., 2000).

Stated choice and stated preference methods, using careful experimental design like ours here, attempt to overcome some of these challenges and reflect a more accurate assessment of human behavior. Wong et al. (2007) use a stated preference approach to deciphering the impact of the impact of various, controllable RLC enforcement criteria on driver behavior among a group of Hong Kong drivers with a high propensity to be involved in crashes. The researchers found that, in the presence of red light cameras, both the penalty and the infractions on the driver's record were successful at deterring red light violations.

3. Theoretical model[1]

Stated choice models (SCMs) are increasingly used in modeling outcomes related to transportation, health, and environmental policies and are based on strong underlying economic theory of individual behavior. We do not review the vast amount of literature on SCMs here, referring the reader to two books on SCMs: Louviere et al. (2000) and a book focused on SCM design, edited by Kanninen (2006); there are other books as well.

In an SCM, an individual is offered a choice between two or more alternatives that consist of several key attributes and asked to choose between them. The alternatives might perfectly mimic actual alternatives that the individual faces in real life, such as two existing and frequently traveled transportation routes, or they might be hypothetical, such as two solar or electrically powered automobiles, neither of which is currently available on the market. SCMs are of great potential in situations where policy makers wish to gauge responses and public support to newly proposed transportation routes or facilities that may affect the demand for them.

SCMs are based on the random utility models (RUMs), which in turn are derived on the assumption that individuals are utility maximizers (Marschak, 1960). Within a RUM, attributes of the alternative or choice i are faced by the decision maker n during choice situation t, all denoted by x_{nit}. The modeler specifies a utility function that contains attributes (x) as arguments that are relevant to the individual's decision regarding possible choices.

McFadden (1974) demonstrated that if random errors are independent and identically distributed ($i.i.d$) and follow a type I extreme value distribution, then the probability P_{nit} has a closed form known as conditional logit distribution that can expressed as:

$$P_{nit}(\beta) = \frac{e^{V_{nit}}}{\sum_j e^{V_{njt}}} \equiv \frac{e^{\beta x_{nit}}}{\sum_j e^{\beta x_{njt}}} \quad (1)$$

The conditional logit model, defined by Eq. (1), typically involves a linear utility function and is probably the most used specification by researchers in environmental economics, transportation economics, and marketing. As popular as it is, the conditional logit model has a fairly restrictive substitution pattern that corresponds to the independence of irrelevance alternative (IIA) property. IIA is not always a desirable property to impose on choices. Relaxing the IIA, as well as allowing for some heterogeneity in tastes across choice makers, leads to popular modern variants on the basic conditional logit model known as mixed logit or random parameters logit (RPL) models.

Recent research has shown that an individual respondent's ability to make choices between alternatives diminishes as the number of alternatives increases (Siikamaki and Layton, 2007). Rather than exposing respondents to the full combination of all factors and factor levels, the goal of experimental design is to determine the subset of alternatives given to respondents while maintaining desirable

[1] A brief overview of the theoretical model is provided here. For a more thorough description of SCM modeling and experimental design the reader is referred to Egbendewe-Mondzozo et al. (2010).