Effectiveness of Red-Light Cameras for Reducing the Number of Crashes at Intersections in the City of Lafayette

Submitted to:

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Summary

This study analyzes crash data at six intersections in the city of Lafayette, LA, before and after the installation of red-light cameras at each identified intersection. The data show that the total number of crashes occurring at the six intersections declined by 12.6%, from the12 months prior to the installation of the cameras to the12 months after installation. The analysis also showed that the number of angle crashes declined by 33.3%, while the number of all other crash types, including rear-end crashes, remained about the same. This finding for angle crashes is statistically significant and it is consistent with conclusions from other published studies. A crash cost analysis for each of the six intersections indicated that two of the intersections which had a high number of angle crashes in 2007 also had a considerable cost crash reduction where the reductions exceeded the revenue from the red-light cameras in the 12-months period after the cameras were installed. The analysis further indentified two of the six intersections as having no net cost reduction due to the fact that revenues from the cameras far exceeded any crash cost reduction, if any existed. However, this decrease is not conclusive evidence that the red-light cameras were the cause of the entire decline in crashes for the following reasons. First, from 2007 to 2008 there was a significant decline in total crashes statewide and intersection crashes specifically. For instance, Caddo and Calcasieu had intersection crash totals fall by 9% from 2007 to 2008 without having cameras installed. Second, since the intersections may have been selected for camera installation because of their high number of crashes in 2007, the regression to the mean may have resulted in a lower number of crashes in 2008.

Guidelines for the installation of red-light cameras should be developed by the Louisiana DOTD to take into account the current research findings which show red-light cameras as being most effective at intersections with a high number of angle crashes and a high ratio of angle crashes to rear-end crashes. These guidelines should also include recommendations for a cost benefit analysis, including crash cost reduction and revenue comparisons from red-light cameras for each potential intersection under consideration. This analysis will help prevent public perceptions that red-light cameras are revenue generators, rather than safety measures.

Background

Red light cameras that automatically photograph vehicles violating traffic signal laws have been used in many communities over the past decade. The popularity of these cameras has continued to grow despite complaints that the cameras are often installed for generating revenue rather than safety. According to the Insurance Institute, about 250 communities around the USA used red light cameras in 2007, while only New York and San Francisco began utilizing this technology just 12 years ago.

The National Highway Traffic Safety Administration reported in 2007 that, on average, more than 850 people die and about 170,000 are injured each year in crashes caused by drivers running red lights. This accounts for 2% of fatalities in fatal crashes and 6.8% of injuries in injury crashes. Louisiana's crash statistics show similar figures for 2008; 19 of the 818 (2.3%) fatal crashes involved red-light running.

Red light cameras at intersections have had supporters and critics from the beginning and despite the research conducted and the large number of articles written about the subject, red-light cameras are still controversial. Supporters state that red-light cameras save lives and prevent injuries, while critics focus on the revenue generated and question the validity of the published research. This report will briefly review both points of view to provide a baseline for the conclusions of the effect of the six red-light cameras in Lafayette. The following review of literature reflects the findings of the most comprehensive studies and articles written about the subject and represents the latest information on the effectiveness of red-light cameras and its critics.

The premise for installing cameras at intersections is that the cameras reduce the occurrence of red light running and thereby reduce the likelihood of related crashes. Thus, some studies have focused on the number of violations before and after the installment of cameras. For instance, a 2007 study [1] conducted by the Insurance Institute for Highway Safety (IIHS), which is an industry group, examined red-light violations using a two-step approach. The study evaluates the effectiveness of red-light cameras at two intersections along Philadelphia's busy Roosevelt Boulevard by separating the effects of cameras from the effects of extending yellow lights to give approaching motorists more warning that signals were about to turn red. The study reports that both measures reduce signal violations, but the cameras provide the largest impact. Extending the timing of the yellow signal reduced signal violations by 36 percent, whereas, the cameras reduced the remaining 64% violations by 96 percent. At the same time, violations didn't change significantly at intersections without cameras in Atlantic County, New Jersey, two cities only about 50 miles away from Philadelphia.

Although the number of violations may be an indicator of safety at intersections, the true safety measure involves the number of crashes and their severity. The most obvious crash type reduced by installing red-light cameras is the angle crash, a crash involving a red-light running vehicle with an adjacent vehicle proceeding through the intersection legally on a green signal display. Another, less obvious, crash type is a vehicle turning left colliding with a vehicle moving through the intersection from the opposite approaching direction. However, some crash types may increase due to the cameras. There is a concern that rear-end collisions will increase because drivers who become aware of these cameras may stop more abruptly causing the following driver, who may not anticipate the stop, to crash into the vehicle from behind. There were two major national studies conducted to investigate the effect of red-light cameras on the number and type of crashes at intersections.

A 2003 study published by the Transportation Research Board [2] synthesized several international and national studies concerning the effectiveness of red-light cameras. The study reports that "there is a preponderance of evidence, albeit not conclusive, indicating that red light running camera systems improve the overall safety of intersections where they are used. As expected, angle crashes are usually reduced and, in some situations, rear-end crashes increase, but to a lesser extent. There is also evidence, also not conclusive, that there is a "spillover" effect to other signalized intersections within a jurisdiction." It should be noted that the researchers point out that nearly every study and crash analysis reviewed had some experimental design or analysis flaws. Nevertheless, the researchers conclude that "from the information that has been acquired and reviewed, it appears that automated enforcement of red light running can be an effective safety countermeasure. However, there is not enough empirical evidence based on a statistically rigorous experimental design to state that conclusively."

In a comprehensive 2005 study of the Federal Highway Administration [3], researchers investigated the effectiveness of red-light-camera (RLC) systems in reducing crashes. The study involved the empirical Bayes (EB) method using crash numbers from before and after red-light cameras installment. The research included data at 132 treatment sites from seven jurisdictions across the United States to estimate the crash and associated economic effects of RLC systems. The study's findings of the crash analysis were consistent with those found in many previous studies, namely <u>decreased right-angle</u> crashes and <u>increased rear end</u> crashes. The researchers also performed an economic analysis which examined the extent to which increases in rear-end crashes negate the benefits of decreased right-angle crashes. The report concludes that there was a <u>modest aggregate crash cost benefit</u> of RLC systems. The research also shows that red-light cameras are more effective at intersections that have a high frequency of right-angle crashes and a lower frequency of rear end crashes. The research findings report a 24.6% decline in right-angle crashes and a 15.7% decline in injuries in right-angle crashes. There was also a 14.9% increase in rear-end crashes with an increase of 24% in injuries in these crashes. "A disaggregate analysis found that greatest economic benefits are associated with the highest total average annual daily traffic (AADT), with the largest ratios of right-angle to rear end crashes, and with the presence of protected left-turn phases." It should be noted that the economic analysis provided in the report does not reflect a true cost benefit analysis because the cost of installing and maintaining the red-light cameras was omitted.

A smaller study that was designed to estimate the safety impact of RLCs on traffic crashes at signalized intersections in the State of Arizona was prepared by the Arizona DOT [4] in 2005. The objective of the study was to compare and contrast the impact of the RLC on safety at approaches with installed cameras and the impact of the RLC on safety at all approaches, testing for the spillover effect of the RLCs on non-camera approaches. The study draws the same conclusion as the FHWA study, namely, that the right-angle crashes declined and the rear-end crashes increased.

To summarize, observational studies of several intersections throughout the United States indicate that red-light cameras increase safety at intersections by reducing right-angle crashes, however they also increase rear-end crashes. Although all of the studies are not statistically significant at a 0.05 error level or have some design flaws, the available evidence points towards a true safety benefit of red-light cameras. Also, a modest cost benefit is reported when the cost of red-light cameras to the citizens is not included. Some researchers [5] have noted the lack of "conclusive" evidence provided by the reports and subsequently concluded that there is insufficient evidence of safety benefits to warrant installation of red-light cameras as a safety device. However, it should be observed that statistics theory sets a high bar for "significant" results, namely less than a 5% error rate when concluding that a measure is effective if it is really not. Observational studies have inherent weaknesses, such as a low sample size, and often extraneous factors, such as changing traffic patterns, that influence the results. Statistically inconclusive results often mean that there was not enough data to perform a powerful statistical test that would be able to detect a modest reduction in crash numbers or the safety effect was too small relative to the variation in traffic crashes over time. If safety benefits of red-light cameras are ignored because of a lack of statistical significant evidence, we may potentially forgo valuable countermeasures. Whether or not a safety measure such as the red-light camera should be implemented is a question of costs and benefits rather than a question of statistical significance alone. For instance, if a safety measure has no costs associated with its implementation or maintenance and no costs to the citizens as a whole, then few would argue against the implementation of this measure even if the benefits are small. Conversely, if the costs associated with a safety measure are extremely high, it might not be worthwhile to implement the measure even if it provided a statistically significant effect on reducing crashes and injuries. The following short review of the critics of red-light cameras will focus on the cost benefit issues.

Despite demonstrated benefits evident through comprehensive published studies, criticism of the red-light cameras continues to grow. Most articles critical of the use of red-light cameras appear in the news media which often focus on the monies they generate for cities and vendors which install the cameras. For instance, a July 2009 article in the Chicago Tribune by Jason George and Bob Secter best describes the unease of citizens and the press with red-light cameras. Goerge and Secter report that one device in a suburb of Chicago “generates $60,000 to $70,000 a month in revenue from traffic fines for the western suburb.” The Bellwood Comptroller Roy McCampbell declared as he likened the camera to lotto or casino type operations; “that intersection is a guaranteed amount of money, it just keeps popping.” The reason is simple, writes Goerge and Secter, “the camera guards an entrance path to the Eisenhower Expressway and snaps away as cars and trucks make rolling right turns on red with astounding frequency. Such maneuvers are illegal, of course, but experts say they are among the least likely to cause serious damage or injuries. And that gets to the heart of a vigorous debate: Do red-light cameras truly make roads safer, as many towns claim? Or are they merely a high-tech variation on the old moneymaking speed trap?”

Researchers at the University Of South Florida College Of Public Health [5] claim that rather than improving motorist safety, red-light cameras significantly increase crashes and are a ticket to higher auto insurance premiums. The effective remedy for red-light running uses engineering solutions to improve intersection safety, which is particularly important to Florida’s elderly drivers, the researchers recommend. The researchers also argue that “traffic fatalities caused by red-light running are not increasing in Florida and account for less than 4 percent of the state’s yearly traffic deaths. In contrast, more than 22 percent of the state’s traffic fatalities occur at intersections for reasons other than red-light running.” Also, they note that “the injury rate from red-light running crashes has dropped by a third in less than a decade, indicating red-light running crashes have been continually declining in Florida without the use of cameras.”

It would be simplistic to reject the voices against red-light cameras as unscientific and biased as some of the letters in response to the article of the researchers from the University of Florida do. It should be noted that all objective studies point out that although there is likely a reduction in right-angle crashes associated with red-light cameras, it is accompanied with an increase of rear-end crashes and thus the crash cost reduction is only modest, if the cost of the cameras and citations are ignored. Thus, red-light cameras are not a solution for increasing safety at all intersections. A cost benefit analysis should be undertaken before red-light cameras are installed at an intersection, and this analysis must take into account the costs associated with cameras including the revenue from red-light running violations. Most of the criticism in the press stems from the often perceived notion that red-light cameras are used for revenue generating rather than for improving public safety. It should also be noted that the widespread use of RLC enforcement could have a measurable impact on the economy of the state of Louisiana because most of this money collected through tickets goes to these out-of-state vendors. Decision makers must assure the public that they are following established guidelines to perform a true cost-benefit analysis at every intersection before installing red-light cameras.

The following section reviews the data issues confronting a rigorous analysis of the effectiveness of red-light cameras in reducing crashes.

Louisiana Crash Data

There are some limitations to the study of the City of Lafayette intersection which are similar to problems reported in other studies. First, the information available is limited to only one year of data available for the "after period". Secondly, in 2008, Louisiana experienced a significant reduction in fatal crashes (8.2%) and in injury crashes (3.5%). To highlight the difficulty of assessing any change in crashes in Lafayette, Table 1 compares the percentage change of intersection crashes from 2007 to 2008 for the ten largest parishes in Louisiana. Four of the ten parishes had a significant decline in intersection crashes ranging from -1% to -9%. Lafayette parish had a relatively modest decline of -1% from 2007 to 2008. Seven of the parishes experienced a decline in side impact crashes ranging from -1% to -13%. Again, Lafayette parish had a modest decline of -3%. Since none of the other parishes installed red-light cameras before 2008, much of the decline in crashes is likely due to the overall decline in crashes statewide. We are unaware of any other city or community in other parishes that installed red-light cameras during the period of this study, except for the City of Baton Rouge where cameras were installed during the year 2008.

Table 1: Percent Change in Intersection Crashes from 2007 to 2008

	All Intersection Crashes			Side Impact Crashes at Intersections		
Parish	Crashes	Fatalities	Injuries	Crashes	Fatalities	Injuries
EAST BATON ROUGE	3%	-7%	1%	-1%	-27%	-5%
ORLEANS	8%	6%	6%	8%	18%	6%
CADDO	-9%	-50%	-12%	-13%	-72%	-12%
JEFFERSON	-6%	-41%	-7%	-8%	-57%	-10%
LAFAYETTE	-1%	-7%	-6%	-3%	0%	-6%
CALCASIEU	-9%	-18%	-2%	-5%	0%	0%
RAPIDES	-7%	33%	11%	-10%	100%	19%
ST. TAMMANY	-4%	-50%	0%	0%	-50%	2%
OUACHITA	-4%	50%	7%	-2%	150%	9%
BOSSIER	-1%	-67%	8%	0%	0%	17%

Taking into consideration the overall decline of crashes statewide, and specifically the decline of intersection crashes in most of the larger parishes, it will be very difficult to determine if any reduction of intersection crashes in the city of Lafayette was due to a decline in overall crashes or due to the installation of red-light cameras. On the average, one would expect a similar 3% decline in intersection and side impact crashes at intersections in Lafayette due to the overall reduction in crashes in Louisiana. Any additional decreases may be due to the installation of red-light cameras.

Ideally an empirical Bayesian analysis should be performed to test the effectiveness of the cameras. However, due to the limited number of locations with cameras and the relatively short time period that the cameras have been operational, this type of analysis is impossible. It is generally accepted practice that a time frame of 3 years before and after a treatment is required to conduct an appropriate (empirical) Bayesian before and after study. Also, the average daily travel (AADT) for the secondary roads was not available to compute EB estimates. Due to these limitations, an analysis was performed that compares the associated Poisson distributions between the two time periods (before and after the installation of the cameras) including a breakdown of the specific manner in which the cars collided.

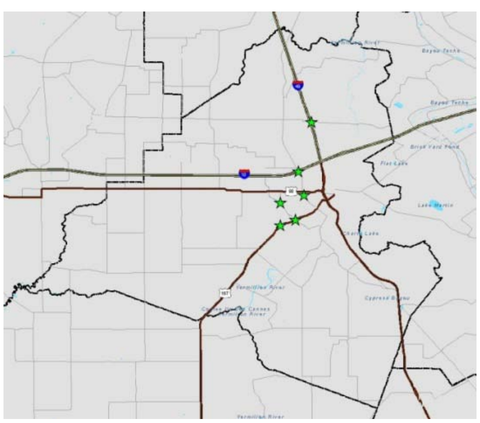
Furthermore, a close look at the data revealed that crash reporting information has a high error rate in reporting locations. This could have an impact on the conclusion of this type of studies if not corrected. Many of the past studies may have relied on police crash reports with missing or incorrect GPS coordinates and needed manual verification to locate the exact crash. A high proportion of crash reports reported crashes at intersections even when they did not occur at an intersection and vice versa. Thus, a careful review of all crashes was conducted to obtain reliable crash locations information.

Another issue that needs to be taken into consideration when analyzing crash data is regression towards the mean. In statistics, regression towards the mean refers to the phenomenon that a variable which is extreme during its first measurement will tend to be closer to the center of the distribution at a later time. This could be of importance in this study, especially if the intersections were not randomly selected. For instance, if the intersections were selected based on a high crash volume in 2007, one would expect the crash count for these intersections to be lower in 2008 due to this phenomenon. To avoid drawing false conclusions due to regression towards the mean**,** experiments would have to be designed based on sound principles of designed experimentation. We did not have any information regarding the selection process for the chosen intersections, but a review of all intersection crashes in Lafayette confirms that these six intersections had some of the highest number of crashes in 2007. Thus, regression to the mean may be a factor affecting the decrease in crashes at the intersections for 2008.

Data Description and Summary

This report studies crash data and tickets issued at six intersections where red light cameras were installed during the time period of December 2007 to March 2008. These intersections include:

Figure 1: Selected Intersections



- Johnston St / S College Rd
- NE Evangeline Throughway / E Gloria Switch
- Johnston St / Woodvale Ave
- Bertrand Dr / Dulles Dr
- W Simcoe St / Agness St / University Ave
- N University Ave / I-10 EB On-Ramp

The `before' period is considered to be the time from January 1, 2007, to December 31, 2007. In order to obtain an acceptable sample size it was necessary to aggregate the different locations together. Since using January 1, 2008, as the starting period would contaminate the before and after periods for some of the locations, all the first three months of 2008 were entirely excluded. Note that the periods compared are still of identical length and contain the same months out of the year. Therefore, any monthly or seasonal effect will still be equally captured. The `after' period is defined as the time between April 1, 2008, and March 31, 2009.

Table 2 shows the latitude & longitude, camera activation date, and milepost information for the selected intersections.

Table 2: Lafayette City Intersections

Intersections	Latitude	Longitude	Activation Date	Milepost
S College Rd (LA 3025) at Johnston St (US 167)	30.207271	-92.038364	Red Light Notices 1-1-08	18.394
E Gloria Switch Rd (LA 98) at I-49 Frontage Rd	30.295499	-92.023611	Red Light Notices 1-1-08	43.517
Johnson St (US 167) at Woodvale Ave	30.202339	-92.052114	2-23-08 Midnight	17.467
Bertrand Dr (LA 3025) at Dulles Dr	30.22256	-92.052199	2-23-08 Midnight	1.443
Agness St / Simcoe St at University Ave (LA 182)	30.229311	-92.030451	2-23-08 Midnight	0.235
University Ave (LA 182) at I-10 East Ramp	30.250707	-92.035713	3-30-08 Midnight	74.303

The law enforcement agency in Lafayette uses the LACRASH software, developed by the Highway Safety Research Group at LSU, to report crash information electronically to the state. These crash reports include GPS information, as well as an indicator regarding whether the crash occurred at an intersection. Although the guidelines to determine an intersection crash established by LADOTD is within 100 feet of an intersection, this guideline is not practiced among all police agencies and reports vary accordingly from agency to agency and officer to officer. The first step in the data quality assessment was to define an intersection crash for this study. For this analysis, all crashes occurring within 150 feet from the center of the intersection were included. 150 feet from the center of the intersection was chosen to account for the width of the intersection. Furthermore, to assure that the analysis would not be sensitive to the intersection definition used, the same analysis using a radius of 200 feet was performed and no significant difference was concluded. The quality check conducted reviewed the crash drawing and officer’s narrative information on the crash report for accuracy in determining the accuracy of the GPS coordinates reported. Close inspection of this data revealed the following data issues and conclusions that may have implications for this and other studies:

1) The intersection variable is not a reliable indicator for intersection crashes within 150 feet. For instance, 80 crashes that were identified as within 100 feet of an intersection were not coded as intersection crashes by the officer.
2) Raw GPS coordinates are not accurate enough for analyzing intersection crashes. Police officers often complete crash reports not in the spot where the accident occurred, but where they parked their patrol car. Moreover, sometimes officers fill out reports later in locations quite far from the exact location of the accident (gas station parking lots in the neighborhood where the crash occurred seem to be popular for this). The GPS coordinates in the report reflect the officer's location, not the crash's actual location.
3) The distance from the intersection (if provided) contained in the report is very often just a rough estimate by the officer. Many times these estimates are inconsistent or the distance measured was chosen incorrectly (i.e. indicated 0.5 feet, but meant 0.5 miles).

In order to remedy these problems, the narrative of the accident, along with the diagram drawn by the officer, was used in conjunction with the street information to manually determine the correct GPS location of the crash. Using map-spotting software, the exact location where the crash occurred was identified and the precise coordinates for the location were obtained. Also, using the narrative and the diagram allowed the elimination of the crashes that were not related to the intersection. For example, accidents within the radius of interest that occurred in parking lots adjacent to the intersections in question were excluded. Although scratching another vehicle while maneuvering into a parking spot might have occurred close to an intersection of interest, for obvious reasons such reports are excluded from the data.

Using the correct coordinates for all crashes is crucial. There is very detailed information available in each report which can be used properly only when examining each report individually. For this purpose we manually examined over 700 crash reports in the city of Lafayette to ensure all crashes that were intersection related were included, and all others were excluded. After the correct coordinates were established, the distance of the crash location to the center of the intersection in question was calculated for each crash located within the six intersection locations.

Data Analysis

We identified 127 crashes at the six intersections in the 12 months before (January 2007-December 2007) and 111 crashes in the 12 months after (April 2008 to March 2009) the installation of the red-light cameras. Table 3 shows the number of crashes by manner of collision aggregated over the six intersections in the before and after period. The average over all six intersections was 10.6 crashes per month before and 9.3 crashes per month after the installation of the red-light cameras. Table 3 also indicates that there was a 33.3% decline in angle crashes while the number of “other” crash types did not change and the number of rear-end collisions decreased by only 1.5%.

Table 3: Number of Crashes in the “before” and “after” periods

	Number of	Missing	Angle	Other	Rear End
Before	127	1	45	15	66
	100%	0.8%	35.4%	11.8%	52.0%
After	111	1	30	15	65
	100%	0.9%	27.0%	13.5%	58.6%
Difference	-12.6%	0.0%	-33.3%	0.0%	-1.5%
	Average per Month				
Before	10.6	0.1	3.8	1.3	5.5
After	9.3	0.1	2.5	1.3	5.4

Table 4 provides an overview of the average number of crashes per month in the “before” and “after” periods for each of the six intersections. None of the intersections indicated a statistically significant decrease or increase in crashes from the “before” and “after” periods at the 0.05 level of significance.

Table 4: Crashes by Intersection

Site	**Mean Before**	**Mean After**	**Difference**	**p-value**
Betrand Dr & Dulles Dr / Billeaud Ln	1.333	0.667	-0.67	0.05
Johnston St & Woodvale Ave / Forman Dr	1.083	1.167	0.08	0.58
College Rd & Johnston St	5.17	4.75	-0.42	0.33
E Gloria Switch Rd & I-49 N Frontage Rd	0.167	0.250	0.08	0.69
N University Ave & I-10 EB Ramp	2.167	2.083	-0.08	0.45
W University Ave & Agnes St / Simcoe St	0.667	0.333	-0.33	0.13

As the background information indicates, the literature suggests that red-light cameras may reduce the number of right-angle crashes while increasing the number of rear-end crashes. Using data from Table 3, one can test these two hypotheses. Categories of crash types include `Rear End’, ` Angle’, and `Other’. Left turn crashes, right turn crashes, and right angle crashes were aggregated into the `Angle’ category, and `Other’ includes head on collisions as well as side swipes.

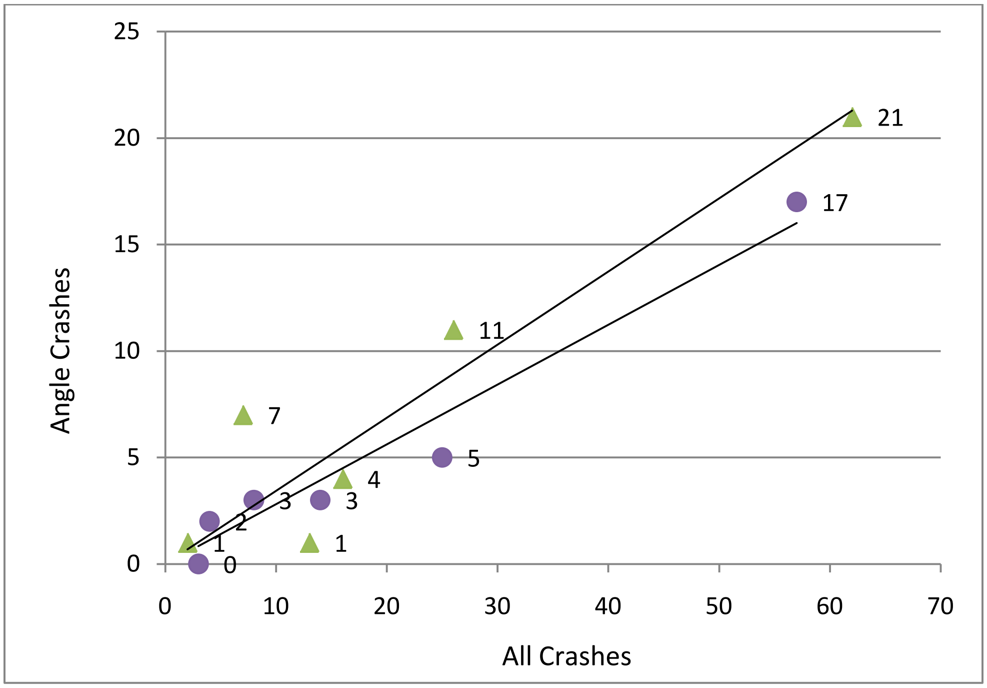
Table 5 shows three hypotheses formulated as Null Hypotheses. To state the objective in more practical terms we use the alternative hypotheses which are of greater interest to us. They can be described as: (1) the red-light cameras reduce the number of “angle” crashes, (2) red-light cameras increase the number of “rear-end” crashes and (3) the red-light cameras increase the number of “other” crashes. The combined data of the six intersections suggests that there is evidence at the 0.05 level of significance that there was a decrease in angle crashes from the before period to the after period, although the significance p=0.0419 level is only slightly below 5%. There was no significant change in other and rear-end crashes. It should be recognized that these results are in line with other results reported in the literature.

Table 5: Mean by Manner of Collision

Manner of Collision	Null Hypothesis	Mean Before	Mean After	Difference	p-value
Angle	$\lambda_{\text{before}} \leq \lambda_{\text{after}}$	3.75	2.5	-1.25	0.0419
Rear End	$\lambda_{before} \geq \lambda_{after}$	5.5	5.42	-0.08	0.5352
Other	$\lambda_{before} \geq \lambda_{after}$	1.25	1.25	0	0.5366

There are also some interesting observations which are noteworthy when judging the effectiveness of the cameras. While there were no fatalities in either period, there was a decline in 14 injury crashes (1 severe, 2 moderate, and 11 minor) and 2 property-damage-only (PDO) crashes. Figure 1 shows the before and after period angle crashes versus all crashes. The triangle represents the before period and the dot represents the after period. It is apparent that the ratio of angle crashes to all crashes is smaller for the after period; this indicates that intersections with red-light cameras tend to have a lower percentage of angle crashes; however, the figure also shows that for intersections with a small number of crashes the benefits of red-light cameras in reducing angle crashes are not as clear.

Figure 1: Number of Angle Crashes versus Total Crashes



Red-Light Tickets

Table 6 provides an overview of the number of tickets issued at each of the six intersections for the 12 months of the "after" period. It can be seen that during the 12 months, 4,122 tickets were issued at the six intersections in which some of the intersections had an increase in the number of tickets issued, while others showed a decrease over the 12 months.

Table 6: Number of Tickets at Intersections

Month	Betrand Dr & Dulles Dr / Billeaud Ln	Johnston St & Woodvale Ave / Forman Dr	College Rd & Johnston St	E Gloria Switch Rd & I-49 N Frontage Rd	N University Ave & I-10 EB Ramp	W University Ave & Agnes St / Simcoe St	Total	Cumulative
April	66	51	14	40	56	89	316	316
May	59	38	11	47	70	87	312	628
June	49	38	10	32	56	71	256	884
July	43	47	22	27	46	58	243	1127
August	66	30	26	43	46	73	284	1411
September	92	36	63	25	63	92	371	1782
October	77	51	54	71	55	137	445	2227
November	69	32	60	34	70	115	380	2607
December	24	47	53	36	47	109	316	2923
January	39	38	45	26	47	133	328	3251
February	44	37	59	46	40	111	337	3588
March	238	35	63	33	38	127	534	4122

Figure 2: Number of Tickets by Month

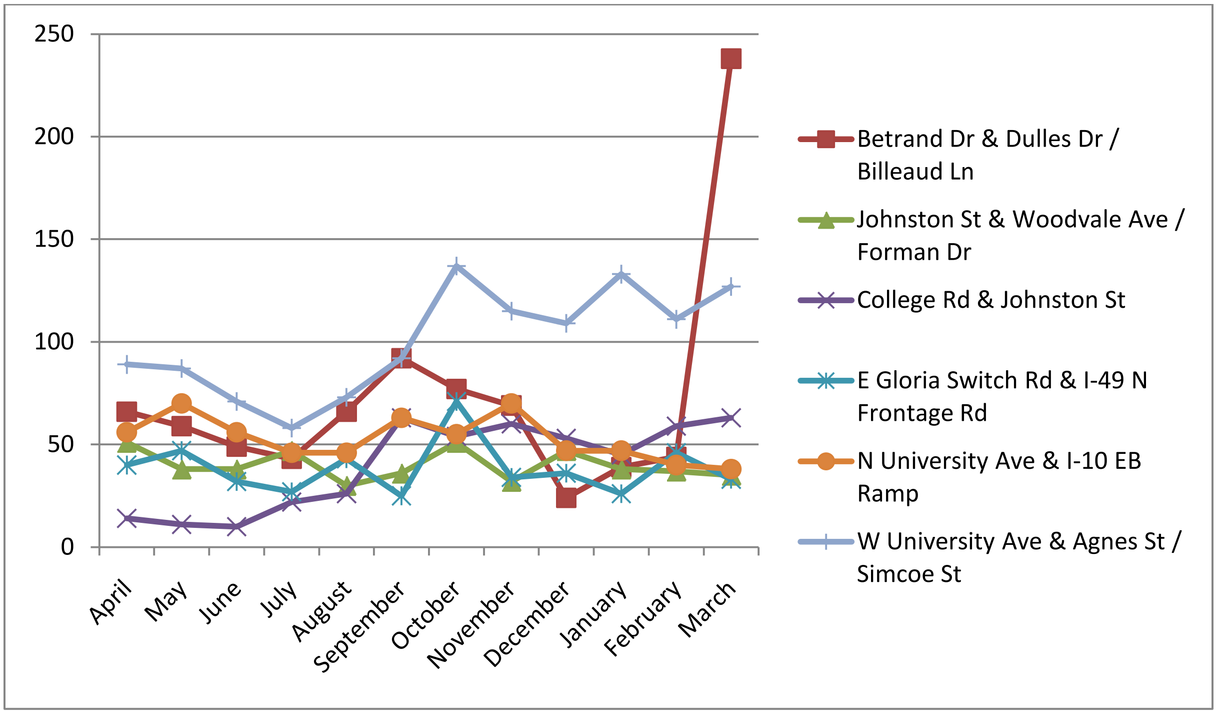


Figure 2 depicts the number of tickets over the 12 month period and shows that while three of the six intersections had a relatively steady or moderate decline in the number of tickets issued, the remaining three intersections had an increase in tickets that ranged from 43% for University/Simcoe to 350% for College and Johnston. There was a spike in tickets for Betrand/Billeaud in March of 2009 which amounts to a 441% change from February 2009. This change was most likely due to the introduction of "rolling right turn" tickets on red at this intersection. Overall, the number of tickets by month does not indicate the red-light cameras have reduced the number of red-light running incidents; noticeably, this is contrary to the findings of the IINS study that reported a decline in violations following the installation of cameras.

Cost Benefits Analysis

Although the reduction in crashes is statistically significant for angle crashes only, it is worthwhile to conduct a cost benefit analysis based on the average reductions and increases in crashes to assess the potential savings and to better understand how a cost benefit analysis could be conducted before a red-light camera is installed. Using cost estimates developed by the HSRG at

LSU, one can assess the potential savings due to red-light cameras. The unit cost estimates for fatal, injury, and PDO crashes are based on a study conducted in 2000 by the US Department of Transportation. The calculations, shown in Table 6, indicate that the reduction in costs of crashes for the 12 months "after" period was over 1.2 million dollars. Red-light cameras should be judged like any other safety measure, whether it involves fixing a road, installing traffic signals, building guard rails, striping highways, building crossover fences at interstates, or issuing citations, since all of these projects have costs associated with them. The purpose of these measures is not to generate revenue but to improve highway safety. In order to obtain a net figure of savings, the revenues for operating the cameras need to be subtracted. If we use $125 for the cost of a ticket, then the revenue for the 4,122 tickets over the 12 months was $515,250. Hence, the net savings in crash costs for the six intersections is estimated at $693,926.

Table 7: Estimated Crash Costs and Net Savings

	Fatal	Injury	PDO	Total
Change in Number of Crashes	0	-14	-2	
Cost per crash	$1,545,134	$85,180	$8,328	
Cost savings	$	($1,192,520)	($16,656)	($1,209,176)
Revenue				$515,250
Total savings				($693,926)

As Table 9 shows, the crash costs savings were not evenly distributed among the six intersections. The cost analysis at each of the six intersections reinforces the findings of the major national studies, namely, that red-light cameras are most effective at intersections with a high number of angle crashes. The two intersections, College&Johnston and University&I-10, which had the highest number of angle crashes in 2007 (see Table 8) also had the highest net cost reduction, shown in Table 9, of all six intersections.

Table 8: Crashes in the Before and after Period by Intersection

	Before					After				
	Angle	Other	Rear End	UNK	Grand Total	Angle	Other	Rear End	UNK	Grand Total
Betrand Dr & Dulles Dr / Billeaud Ln	4	2	10		16	3	3	2		8
Johnston St & Woodvale Ave / Forman Dr	1	1	11		13	3	1	10		14
College Rd & Johnston St	21	11	30		62	17	7	32	1	57
E Gloria Switch Rd & I-49 N Frontage Rd	1		1		2	0	1	2		3
N University Ave & I-10 EB Ramp	11	1	14		26	5	2	18		25
W University Ave & Agnes St / Simcoe St	7			1	7	2	1	1		4
Total	45	15	66	1	126	30	15	65	1	111

For two of the six intersections, the cost benefit analysis showed that the revenues from the tickets exceeded the reduction in crashes costs. Although the Betrand Dr & Dulles Dr / Billeaud Ln intersection had a crash cost reduction which was higher than the revenues from the tickets, this intersection is not a good candidate for red-light cameras since the crash cost reduction resulted from the decline in rear-end collisions which is not considered a benefit of red-light cameras according to published research. One should keep in mind that the reduction in rear-end collisions for this particular intersection could have been part of the overall decline in crashes in Louisiana over these 12 months.

Table 9: Crash Costs and Net Savings by Intersection

	PDO	Injury	Total	Revenue	Net saving
Betrand Dr & Dulles Dr / Billeaud Ln	-$24,984	-$425,900	-$450,884	$108,250	-$342,634
Johnston St & Woodvale Ave / Forman Dr	-$8,328	$170,360	$162,032	$60,000	$222,032
College Rd & Johnston St	$0	-$425,900	-$425,900	$60,000	-$365,900
E Gloria Switch Rd & I-49 N Frontage Rd	$8,328	$0	$8,328	$57,500	$65,828
N University Ave & I-10 EB Ramp	$16,656	-$511,080	-$494,424	$79,250	-$415,174
W University Ave & Agnes St / Simcoe St	-$8,328	$0	-$8,328	$150,250	$141,922
Total	-$16,656	-$1,192,520	-$1,209,176	$515,250	-$693,926

Two of the intersections had a positive net savings; this implies that the revenues from tickets exceeded the crash cost reduction.

Discussion

The analysis of the crash data from the six intersections in the city of Lafayette, LA, suggest that there was a moderate reduction of angle crashes in the 12-month period following the installation of the red-light cameras. This result is in line with studies in other states which have found a reduction in angle crashes after the installation of red-light cameras. The overall decrease of angle crashes at the six intersections coupled with findings from other studies supports the hypothesis that the reduction of angle crashes was likely not entirely due to the overall decline in crashes from 2007 to 2008, but to the installment of the cameras.

The use of red-light cameras for traffic enforcement poses a dilemma. On one hand, there seems to be considerable evidence suggesting that they impact safety at intersections and thus help to reduce angle crashes. On the other hand, there is considerable anxiety among the public regarding the use of private vendors who have a profit motive to install and maintain cameras.

While cameras likely have safety benefits at intersections that have a high percentage of angle crashes and where engineering solutions are ineffective, the return on investment goal provides incentives to install cameras at intersections that have a high percentage of red-light running incidents regardless of crash occurrences.

Viewing the drivers who are running red lights as violators who need to be punished ignores the fact that often these incidents of red-light running are split-second violations visible only to the camera lens and would not all be visible to an officer at the intersection. There are many reasons for observing higher frequencies of red-light running at some intersections than at others. If driver behavior were the only factor, all intersections should have a number of red-light running incidents proportional to the daily traffic only. Elements of the red light running safety issue may be resolved through inexpensive engineering remedies that address infractions in the first second after the light changes (such as lengthening the all-red-light interval) because these remedies permit traffic to clear the intersection prior to releasing cross traffic.

To improve public acceptance of cameras at intersections as safety measures, guidelines need to be established by the Louisiana DOTD to assure the public that red-light cameras are being deployed to increase safety rather than generate revenue. A cost benefit analysis should be part of these guidelines. The analysis in this study supports findings from other studies that suggest that red-light cameras are most beneficial and cost effective at intersections with a high percentage of angle crashes and a relatively high total number of angle crashes. For instance, E Gloria Switch Rd & I-49 N Frontage Rd had 50% angle crashes in 2007, but there were only two crashes in the before period and three crashes in the after period while 460 tickets were issued in the 12 months. While there was no safety benefit expressed in crash cost (actually the cost increased by $8,386), the cameras generated $57,500 in revenue at this intersection.

Conclusions

The red-light running crashes should be placed in perspective to other crashes. To better judge the severity of the problem, we note that in 2008, Louisiana had 19 fatal crashes which had a violation of red-light running, 12 fatal crashes involving cell phone usage, and 56 fatal crashes occurred at intersections with a stop sign that had a violation including “failure to yield” and “disregard traffic control”. Of the 818 fatal crashes, 49% were alcohol related, and the 25% of the drivers who did not buckle up made up 64% of the 593 drivers killed. This suggests that an increase in fines for seat belt violations might have a higher safety benefit than red-light cameras.

Although there is evidence that red-light cameras have a safety benefit, the appearance of a conflict of interest could be detrimental to the many efforts by law enforcement agencies, engineers at the DOTD, and other safety professionals. The public acceptance of safety measures may suffer if safety measures are intertwined with profit or revenue-generating motives. If citations are purely seen as a hidden tax that communities impose to obtain revenue, especially during times of looming budget crises, the implementation of other safety measures where support of the citizens is needed may suffer. The availability of technology and revenue considerations should not be the determining factors for the deployment of safety measures.

The conflict of interest issue has been raised in other states also. For instance, a bill approved in 2008 by the Florida Senate Committee on Transportation intended to resolve this dilemma.

- It requires the Florida Department of Transportation to develop minimum specifications and required compliance with these specifications.
- It restricts the regulation and use of camera enforcement to the state, not to private companies for profit.
- It requires other engineering measures to be used prior to camera use.
- It prohibits payment and profit of camera vendors based on the number of tickets issued.
- It requires the removal of cameras if crashes increase by 10% within one year.
- It requires that the distribution of fine revenues adhere to the formula for other traffic citation fines, meaning local governments receive only a portion of each fine.

Appendix:

Methodology

The most reliable method that guards, to some extent, against the regression to mean effect is the empirical Bayes method. Regression to mean with respect to the study of crashes at intersections refers to the following phenomenon. Suppose we select 100 intersections and count the number of crashes that occur at each intersection. Because of natural variation due to multiple causes, the number of crashes at each intersection will vary from year to year. Now, suppose the number of crashes is normally distributed over the 100 intersections with a mean of 50. If we were to select six intersections with the largest number of crashes, for instance, let's say they had 95, 89, and 82 crashes (and this may often be done when red-light cameras are installed), then we could expect their counts in the preceding year to move closer to the mean of 50. This phenomenon is due to the regression to the mean effect. This reduction occurs regardless of any measures taken. To protect against this natural occurring regression to mean, well designed studies are needed that account for this and other spurious factors. However, most data available are not taken from well-designed studies. An observational study, as presented here, has many drawbacks and care must be taken to avoid the influence of other factors such as changes in the vehicle miles traveled, etc. Unfortunately, the number of vehicles passing through the intersection during the 12 months period before and after the installation of the cameras is unknown. Therefore, this study used a different approach based on a test developed by Krishnamoorthy and Thomson (2004). It should be noted that this test does not eliminate the regression to mean problem, due to the selection bias of the intersections. However, since the findings did not identify any significant differences, this regression to mean does not pose a problem. The following section describes the method.

Assuming Poisson counts, we are interested in whether the mean of the number of crashes per time unit in the "after" period is less that the mean of the number of crashes per time unit in the "before" period. To compare the Poisson means, we used the 'E-test' developed by Krishnamoorthy and Thomson (2004), which is more powerful[1] than the commonly used conditional test of Przyborowski and Wilenski (1940)[2]. In general, we are interested in testing

$$H_0: \lambda_1 - \lambda_2 \leq d \quad vs. \quad H_1: \lambda_1 - \lambda_2 > d$$

The E-test uses an unbiased estimate of the variance of the difference in the rates (means) taken from the two samples to standardize that difference such that

$$T_{k_1,k_2} = (\frac{k_1}{n_1} - \frac{k_2}{n_2} - d)/\sqrt{\widehat{var}_k}$$

where

$$\widehat{var}_k = \frac{k_1}{n_1^2} + \frac{k_2}{n_2^2}$$

Here k_i denotes the observed counts in the sample, and n_i denotes the "time at risk". Note that in this study we will be testing whether the mean in the after period is less that the mean of the before period, and therefore $d = 0$. Note also that the choice of n_i is somewhat arbitrary; however, only the estimate of the actual rate parameter will be influenced by it and the p-values (which we are ultimately interested in) will be numerically identical so long as $n_1 \propto n_2$. We chose $n_1 = n_2 \equiv 12$, which corresponds to an interpretation of comparing crashes per month at each selected site.

Since the p-value $P[T_{X_1,X_2} \geq T_{k_1,k_2} | H_0]$ requires λ_2, the quantity is estimated by

$$\hat{\lambda}_2 = \frac{k_1 + k_2}{n_1 + n_2} - \frac{dn_1}{n_1 + n_2}$$

which allows us to estimate the p-values as

$$\hat{P}\left[T_{X_1,X_2} \geq T_{k_1,k_2} \middle| H_0\right] = \sum_{x_1=0}^{\infty} \sum_{x_2=0}^{\infty} \frac{\exp\{-n_1(\hat{\lambda}_2 + d)\}\left(n_1(\hat{\lambda}_2 + d)\right)^{x_1}}{x_1!} \frac{\exp\{-n_2\hat{\lambda}_2\}\left(n_2\hat{\lambda}_2\right)^{x_2}}{x_2!} I\{T_{x_1,x_2} \geq T_{k_1,k_2}\}$$

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[1] In the context of statistical tests "Power" refers to the probability that a test will reject a null hypothesis when the corresponding alternative is true. A more powerful test has a smaller chance of making a Type II error.

[2] All hypotheses in this study were tested using both methods. In all cases the results are qualitatively identical, and quantitatively very similar. Due to the E-test being more powerful, I chose to report those results in the text.

where $I\{.\}$ is the indicator function.

All of the p-values reported in this study were calculated using the above-described method.

Method for Computing the distance to the Intersection

The distance calculation from the coordinates was derived using the spherical law of cosines, such that the distance between intersection i and crash location j is

$$Distance_{ij} = R * acos\left(\left(sin(lat_i) * sin(lat_j)\right) + \left(cos(lat_i) * cos(lat_j) * cos(long_i - long_j)\right)\right)$$

where R is the radius of the earth in feet. Given that today's computers numerical precision is quite high, this method of calculating distance performs well, even for very close points.

Reference

1. Effectiveness of Red Light Camera Enforcement in Philadelphia (**http://www.govtech.com/gt/103676**).
2. Transportation Research Board, "Impact of red Light camera Enforcement on Crash Experience", NCHRP Synthesis 310, 2003.
3. Safety Evaluation of Red-Light Cameras—Executive Summary, Publication No. FHWA-HRT-05-049 http://www.tfhrc.gov/safety/pubs/05049/index.htm
4. In Arizona, red light cameras reduced the occurrence of severe right-angle and left-turn crashes while the number of rear-end crashes increased. http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/EE86C322456D5328852573DA004EA1C1?OpenDocument&Query=BApp
5. Langland-Orban, B, E. E. Pracht and J. T. Large, "Red Light Cameras: Would Crashes, Injuries and Automobile Insurance Rates Increase If They Are Used in Florida?, Florida Public Health Review, 2008; 5:1-7.
6. Krishnamoorthy, K. and Thomson, J. (2002). A more powerful test for comparing two Poisson means. Journal of Statistical Planning and Inference Vol 119, pp 23-35.
7. Przyborowski, J. and Wilenski, H. (1940). Homogeneity of results in testing samples from Poisson series. Biometrika Vol 31, pp 313-323.