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Effects of red light camera enforcement on fatal crashes in large US cities

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ABSTRACT

Objective: To estimate the effects of red light camera enforcement on per capita fatal crash rates at intersections with signal lights. *Methods:* From the 99 large U.S. cities with more than 200,000 residents in 2008, 14 cities were identified with red light camera enforcement programs for all of 2004–2008 but not at any time during 1992–1996, and 48 cities were identified without camera programs during either period. Analyses compared the citywide per capita rate of fatal red light running crashes and the citywide per capita rate of all fatal crashes at signalized intersections during the two study periods, and rate changes then were compared for cities with and without cameras programs. Poisson regression was used to model crash rates as a function of red light camera enforcement, land area, and population density. *Results:* The average annual rate of fatal red light running crashes declined for both study groups, but the decline was larger for cities with red light camera enforcement programs than for cities without camera programs (35% vs. 14%). The average annual rate of all fatal crashes at signalized intersections decreased by 14% for cities with camera programs and increased slightly (2%) for cities without cameras. After controlling for population density and land area, the rate of fatal red light running crashes during 2004–2008 for cities with camera programs was an estimated 24% lower than what would have been expected without cameras. The rate of all fatal crashes at signalized intersections during 2004–2008 for cities with camera programs was an estimated 17% lower than what would have been expected without cameras. *Conclusions:* Red light camera enforcement programs were associated with a statistically significant reduction in the citywide rate of fatal red light running crashes and a smaller but still significant reduction in the rate of all fatal crashes at signalized intersections. *Impact on Industry:* The study adds to the large body of evidence that red light camera enforcement can prevent the most serious crashes. Communities seeking to reduce crashes at intersections should consider this evidence.

1. Introduction

More than 2.2 million police-reported motor-vehicle crashes in the United States in 2009 occurred at intersections or were intersection related, accounting for about 41% of all police-reported crashes. These crashes resulted in 81,112 serious nonfatal injuries and 7,358 deaths. About one-third of the deaths occurred at intersections with signal lights (Insurance Institute for Highway Safety, 2010a).

Running a red light is a common traffic violation. A study of traffic at 19 intersections in 4 states reported an average of 3.2 red light running events per hour per intersection (Hill & Lindly, 2003). In a national telephone survey conducted in 2010, 93% of drivers said it is unacceptable to go through a red light if it is possible to stop safely, but one-third reported doing so in the past 30 days (AAA Foundation for Traffic Safety, 2010).

The safety consequences of running red lights are considerable. A study of urban crashes reported that running red lights and other traffic controls was the most common type of crash (22%). Injuries occurred in 39% of crashes in which motorists ran traffic controls (Retting, Williams, Preusser, & Weinstein, 1995). In 2009, 676 people were killed and 130,000 were injured in crashes in which police were able to establish that drivers ran red lights. Sixty-four percent of these deaths were people other than the red light runners, including passengers in the red light running vehicles, occupants of the other vehicles, pedestrians, and bicyclists. Compared with the drivers involved in these crashes who did not violate the signal, red light runners were more likely to be male, to be younger than 30, and to have prior crashes, alcohol-impaired driving convictions, or citations for speeding or other moving violations. Violators also were much more likely to have been speeding or alcohol impaired at the time of the crash, and less likely to have had a valid drivers license (Insurance Institute for Highway Safety, 2010b).

A high likelihood of apprehension helps convince motorists to comply with traffic laws, but many enforcement agencies have insufficient personnel to mount effective enforcement programs using traditional police patrols. Red light cameras can supplement traditional methods of enforcement at intersections, especially at times of the day and on roads where traditional enforcement can be

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difficult or hazardous. Studies have reported reductions in red light violations of 40-96% after the introduction of red light cameras (Retting, Ferguson, & Farmer, 2008; Retting, Williams, Farmer, & Feldman, 1999a, 1999b), and reductions occurred not only at camera-equipped sites but also at signalized intersections without cameras. A study of the impact of red light camera enforcement on crashes in Oxnard, California, one of the first U.S. communities to employ such cameras, reported significant citywide reductions in crashes at intersections with traffic signals, with injury crashes reduced by 29% (Retting & Kyrychenko, 2002). Right-angle collisions, the crash type most closely associated with red light running, at these intersections declined by 32%, and right-angle crashes involving injuries fell by 68%.

Some studies have reported that even though red light cameras reduce front-into-side collisions and overall injury crashes, they can increase rear-end crashes. A study evaluating red light camera programs in seven communities reported a 25% reduction in right-angle crashes, whereas rear-end crashes increased by 15%. Because the types of crashes prevented by red light cameras tend to be more severe and more costly than the additional rear-end crashes that can occur, the study estimated a positive social benefit of more than $18.5 million in the seven communities (Council, Persaud, Eccles, Lyon, & Griffith, 2005). Not all studies have reported increases in rear-end crashes. A review of 10 controlled before-after studies of red light camera effectiveness that adjusted for regression to the mean, spillover effects, or both, reported an estimated 13%-29% reduction in all types of injury crashes, a 24% reduction in right-angle injury crashes, and a nonsignificant 18% reduction in rear-end injury crashes (Aeron-Thomas & Hess, 2005).

Red light cameras have proven to be controversial in some U.S. communities, but the number of communities that implemented camera programs during 1992–2010 has increased dramatically, from no communities in 1992 to 25 communities in 2000 and 501 communities in 2010 (Fig. 1).

Numerous studies have examined the effects of red light camera enforcement on all crashes or crashes involving injury, but few if any studies have examined the effects on fatal crashes. The present study evaluated the effect of camera enforcement on per capita fatal crash rates for large U.S. cities. Changes in per capita rates of fatal red light running crashes were compared for cities with and without camera programs. Because prior research reported citywide effects of red light cameras on all crashes at signalized intersections, the present study also examined changes in the rates of all fatal crashes at signalized intersections in these cities.

2. Method

Large U.S. cities were defined in this study as those with more than 200,000 residents; there were 99 such cities in 2008 (U.S. Census Bureau, 2009). Information on red light camera programs in these 99 cities was obtained from news reports and calls to city police departments or public works departments. For cities with camera enforcement, program start and end dates were obtained. Other historical information was sought but was not available for all cities, including the number of cameras and number of signalized intersections over time.

Calendar years 2004–2008, the latest 5 years for which fatal crash data were available, represented the "after" study period. Calendar years 1992–1996 represented the "before" study period; very few U.S. communities had camera programs during this time (Fig. 1). The 14 cities with camera programs during full 2004–2008 but not during 1992–1996 comprised the camera group. The 48 cities without camera programs during either time period comprised the comparison group. Of the remaining cities, 4 cities implemented camera programs prior to 1997, and 33 cities had camera programs for some but not all of the 2004–2008 period. These 37 cities were excluded from analyses.

Data on fatal crashes at intersections with signal lights were extracted for 1992–1996 and 2004–2008 from the Fatality Analysis Reporting System (FARS), which contains detailed information on all fatal motor-vehicle crashes occurring on U.S. public roads (National Highway Traffic Safety Administration, 1992–1996, 2004–2008). Fatal red light running crashes were defined as the subset of these crashes that involved a driver traveling straight who was assigned the driver level contributing factor of "failure to obey traffic control devices." This definition was developed jointly by the Insurance Institute for Highway Safety and Federal Highway Administration so that consistent estimates of red light running crash losses would be produced (Retting, 2006).

Annual population estimates were obtained for each city from the U.S. Census Bureau (1997, 2009). For each city in each study period and for each crash measure, the average annual per capita fatal crash rate (crashes per million population) was calculated by summing fatal crashes across the 5-year period and then dividing by the sum of the annual population counts. This resulted in two observations (one each for the before and after periods) per city for the rate of fatal red light running crashes and for the rate of all fatal crashes at signalized intersections. To study the citywide effect of camera enforcement on fatal crash rates, the per capita crash rates were computed for each study group for the 2004–2008 period, aggregating crashes and population across the cities in each group, and these rates were compared with those for the 1992–1996 period.

Using the city-specific data, Poisson regression models were used to more rigorously examine the relationship of camera enforcement and other variables with fatal crash rates. The Poisson models accounted for the covariance structure due to repeated measures because each independent unit of analysis (city) had two observations (before and after periods). Separate models were developed for the rate of fatal red light running crashes and the rate of all fatal crashes at signalized intersections. Independent variables in the model were population density (in thousands of people per square mile for each study period), land area (in square miles for each study period), study period (after vs. before), and city group (cities with camera programs during the after period vs. cities without cameras). Land area was included because large area changes potentially could confound the relationship between camera enforcement and fatal crash rates. Census information on cities' land areas is available only from the decennial reports (U.S. Census Bureau, 1990, 2000). Therefore, the 1990 land area data were used for the before period and the 2000 data were used for the after period. The population density during the before period was calculated as the average annual population during 1992–1996 divided by the 1990 land area, and the population density during the after period was calculated as the average annual population during 2004–2008 divided by the 2000 land area. An interaction variable for study period and city group tested whether crash trends were different for cities with and without camera programs. The difference in modeled crash trend between cities with

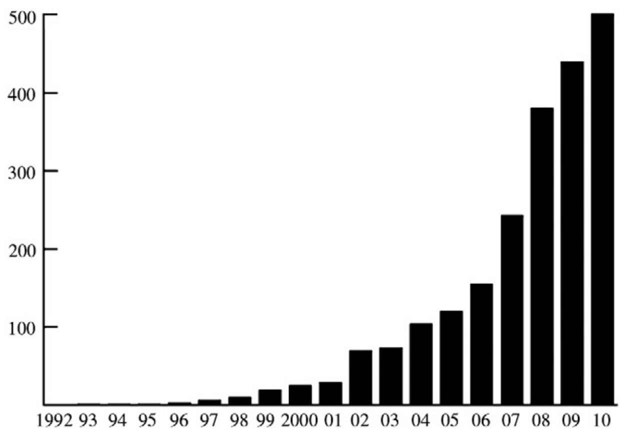

Fig. 1. US communities with red light camera enforcement programs, 1992–2010.

camera program and those without was taken as the primary measure of effectiveness. It was interpreted as the change in fatal crash rate for cities with camera programs beyond what would have been expected absent the programs. Variables with p-values less than 0.05 were taken as statistically significant.

3. Results

The 62 large U.S. cities studied accounted for 10% of the U.S. population, 14% of all fatal red light running crashes, and 15% of all fatal crashes at signalized intersections in 2008.

Figs. 2 and 3 show the percentage changes in average annual per capita fatal crash rates for cities with and without red light camera enforcement programs, respectively. Detailed population and crash data for each city are listed in Appendix A. All but two of the 14 cities with camera programs experienced reductions in the rate of fatal red light running crashes, and all but three experienced reductions in the rate of all fatal crashes at signalized intersections (Fig. 2). Among the cities with camera programs that experienced reductions in both fatal crash rates, all but one city had percentage reductions for fatal red light running crashes that were larger than those for all fatal crashes at signalized intersections. Among the 48 cities without camera programs, the pattern of changes in crash rates was much more variable. About half of the cities experienced reductions in the rate of fatal red light running crashes, and about half experienced increases. More than one-third of the cities experienced reductions in the rate of all fatal crashes at signalized intersections (Fig. 3).

Table 1 lists combined results for the camera and comparison groups. The average annual rate of fatal red light running crashes declined for both study groups, but the decline was larger for cities with camera programs than for cities without cameras (35% vs. 14%). The average annual rate of all fatal crashes at signalized intersections decreased by 14% for cities with camera programs and increased slightly (2%) for cities without cameras. For cities with camera programs, the percentage decline in the annual average rate of fatal red light running crashes was much higher than the decline in the rate of all fatal crashes at signalized intersections (35 vs. 14%).

Table 2 lists results of the Poisson regression model that estimated the effects of red light camera enforcement and other predictors on the per capita rate of fatal red light running crashes. No significant effect was associated with land area. After accounting for the effects of other predictors, an increase in population density (in thousands of people per square mile) reduced the rate of fatal red light running crashes by an estimated 4% ([exp(−0.0371)-1]×100), a marginally significant difference. After accounting for the interaction of study period and city group, the fatal crash rate during the before period was an estimated 65% higher ([exp(0.4998)-1]×100) for cities that later implemented camera programs compared with cities that did not. The rate of fatal red light running crashes between 1992–1996 and 2004–2008 was reduced by an estimated 16% ([exp(−0.1709)-1]×100) for cities without camera programs and by an estimated 36% ([exp(−0.1709-0.2809)-1]×100) for cities with cameras. The estimated effect of camera enforcement on the rate of fatal red light running crashes was obtained by interpreting the interaction term for study period and camera use directly. Based on this parameter, the rate of fatal red light running crashes during 2004–2008 for cities with cameras programs was 24% lower ([exp(−0.2809)-1]×100) than what would have been expected without cameras.

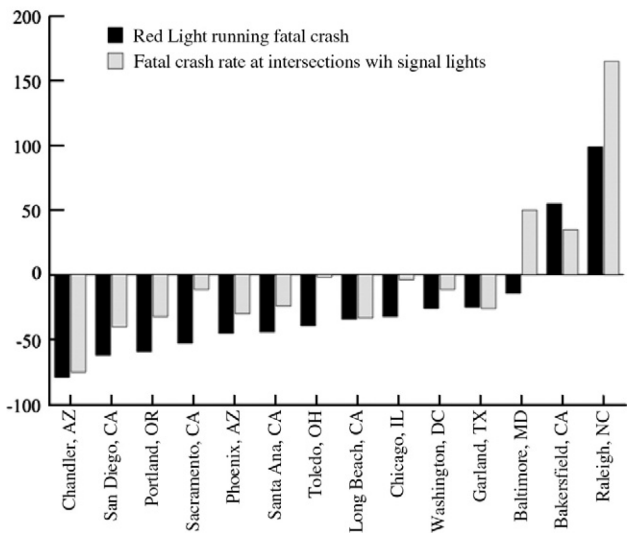

Fig. 2. Percent change in average annual per capita fatal crash rates for 14 large US cities with red light camera enforcement programs, 2004–08 vs. 1992–96.

Table 3 lists results of the Poisson regression model that estimated the effects of red light camera enforcement and other predictors on the per capita rate of all fatal crashes at signalized intersections. After accounting for the effects of other predictors, neither land area nor population density was significantly associated with the crash rate. After accounting for the interaction of study period and city group, the per capita rate of all fatal crashes at signalized intersections during the before period was an estimated 32% higher ([exp(0.2812)-1]×100) for cities that later implemented camera programs compared with cities that did not. The rate of all fatal crashes at signalized intersections between 1992–1996 and 2004–2008 changed only minimally for cities without camera programs and was reduced by an estimated 16% for cities with cameras ([exp(0.0112-0.1822)-1]×100). Based on the interaction term for study period and camera use, the actual per capita rate of all fatal crashes at signalized intersections during 2004–2008 for cities with camera programs was 17% lower ([exp(−0.1822)-1]×100) than what would have been expected without cameras.

Land areas for 19 of the 62 study cities (4 camera cities and 15 comparison cities) increased by more than 10% between 1990 and 2000. Additional Poisson regression models were conducted that excluded these cities, and results changed little.

4. Discussion

Red light running is a frequent traffic violation, and the safety consequences have been established. Enforcing red light laws is important, but many communities do not have the resources for police to patrol intersections as often as would be needed to ticket most motorists who run red lights. Traditional police enforcement also poses special difficulties for police, who in most cases must follow a violating vehicle through a red light to stop it. This can endanger motorists and pedestrians as well as officers.

Before-after studies in communities that have implemented red light camera enforcement programs have reported reductions in red light running, not only at camera-equipped intersections but also at other signalized intersections without cameras (Retting et al., 1999a, 1999b), as well as citywide crash reductions at signalized intersections (Retting & Kyrychenko, 2002). The current study extends this research by examining the effects of camera enforcement on fatal crashes in large U.S. cities. Based on Poisson regression models, camera programs were associated with statistically significant citywide reductions of 24% in the rate of fatal red light running crashes and 17% in the rate of all fatal crashes at signalized intersections, when compared with rates that would have been expected without cameras. The larger effect of camera enforcement on the rate of fatal red light running crashes would be expected because these are the crashes targeted by cameras. The significant reduction in the rate of all types of fatal crashes at signalized intersections indicates that cameras may have a generalized effect on driver behavior at intersections that extends beyond running red lights.

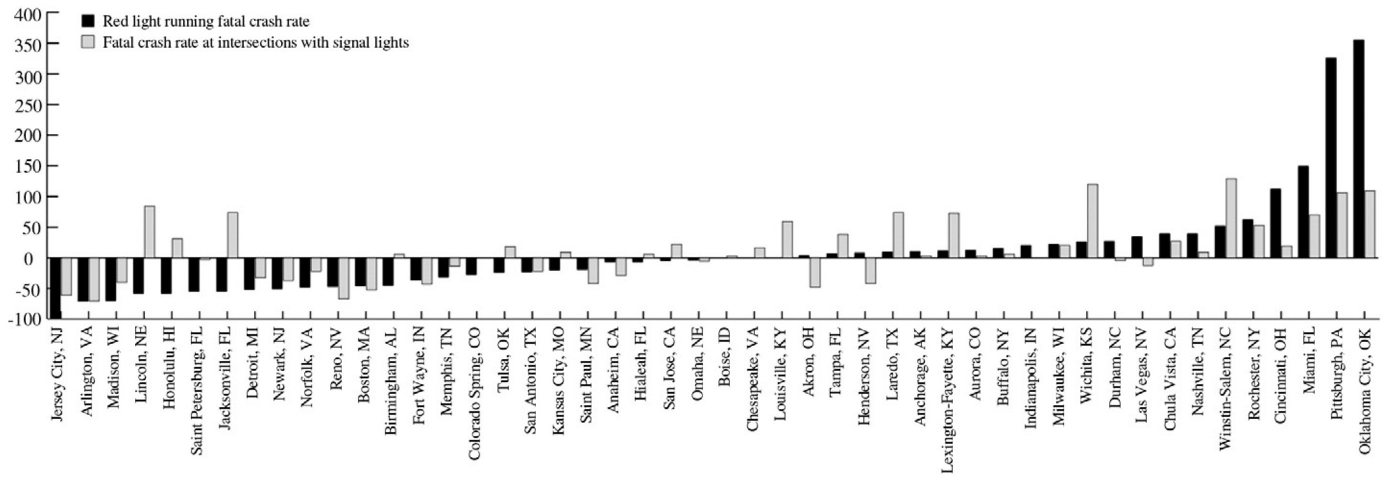

Fig. 3. Percent change in average annual per capita fatal crash rates for 48 large US cities without red light camera enforcement programs, 2004–08 vs. 1992–96.

Other factors also were found to influence fatal crash rates. Higher population densities were associated with lower fatal crash rates. A possible explanation is that denser populations generally lead to lower travel speeds and thus fewer fatal crashes (Cerrelli, 1997). Rates of fatal crashes during the baseline period were higher for cities that subsequently implemented red light camera programs than for cities that did not implement camera programs. It is to be expected that cities with larger red light running problems should have been more likely to implement camera enforcement programs.

Several limitations of the study are worth noting. The definition of red light running crashes excluded some crashes such as those involving a driver making an illegal turn on red. Bias due to regression-to-the-mean or to unobserved confounders is another possible limitation of the study, but the likelihood of this was minimized in the study design. Random variation was greatly reduced by calculating citywide intersection crash rates over 5 years across a large geographic area, when compared, for example, with comparisons of crash rates at individual intersections over a short time period in a relatively small area such as a single city. The models could not entirely control for non-equivalence of the two groups of cities and the different effects of historical events on them. Other factors not included in the study may have influenced fatal crash rates for the camera cities but could not be examined due to limitations in the data. Attempts were made to obtain historical information on the number of red light cameras in the study cities, but information on the scope of red light programs could not be obtained for many of the cities. Historical information also was sought on the number of signalized intersections and the locations of red light cameras but was unavailable in many cities. As a result, crash rates at only those intersections with cameras were not examined in the study. Thus it is unknown how the fatal crash rates changed at signalized intersections with cameras and signalized intersections without cameras in the same city. However, prior research (Retting & Kyrychenko, 2002; Retting et al., 1999a, 1999b) indicates that the effects of red light camera enforcement on red light running violations and on crashes are citywide and not limited to intersections with cameras. Two cities in the study group experienced increases in fatal red light running crash rates from the before to the after study period. It would have been of interest to examine whether features of camera programs might explain the findings in these two cities. However, due to the lack of historical information, further examination of the features of individual camera programs could not be performed.

Red light cameras are not the only countermeasure for reducing crashes at signalized intersections. Converting traditional intersections to roundabouts eliminates the need for traffic signals as well as cameras. It has been reported that conversion of traditional intersections to roundabouts reduces fatal crashes by 81-90%, injury crashes by 25-87%, and overall crashes by 37-61% (Federal Highway Administration, 2000; Persaud, Retting, Garder, & Lord, 2001; Schoon & van Minnen, 1994; Troutbeck, 1993). However, it is not feasible to replace every traffic light with a roundabout, and not every intersection is appropriate for a roundabout. Better enforcement of traffic signals using cameras is a solution that can be implemented quickly on a large scale.

In tallying the costs and benefits of camera enforcement, communities should factor in the considerable social and economic benefits of successfully reducing crashes. Besides foregone medical costs, vehicle repair bills, travel delays, and lost income, citizens in communities with camera enforcement experience direct savings in terms of reduced police time to investigate and report crashes, lessened need for emergency response service, and lower roadway cleanup costs.

National surveys of drivers and surveys conducted in cities with and without red light camera programs have found that a large majority support camera enforcement (Garber et al., 2005; Retting &

Table 1
Average annual per capita rates of fatal red light running crashes and all fatal crashes at signalized intersections for cities with and without red light camera enforcement programs, 1992–96 and 2004-08.

	14 cities with camera programs			48 cities without camera programs		
	1992-96	2004-08	Percent change	1992-96	2004-08	Percent change
Average annual population (million)	9.02	10.08	11.7	17.07	19.08	11.7
Number of fatal red light running crashes	323	235	−27.2	409	391	−4.4
Number of all fatal crashes at signalized intersections	739	707	−4.3	1112	1266	13.8
Average annual rate of fatal red light running crashes per million population	7.16	4.66	−34.9	4.79	4.10	−14.4
Average annual rate of all fatal crashes at signalized intersections per million population	16.38	14.02	−14.4	13.02	13.27	1.9

Table 2
Poisson model of the effects of red light camera enforcement on average annual per capita rate of fatal red light running crashes.

Parameter	Estimate	Standard error	p value
Intercept	1.7050	0.1547	<0.0001
Land area in square miles	0.0001	0.0003	0.6391
Population density (thousands of persons per square mile)	−0.0371	0.0191	0.0527
After period (2004–08) vs. before period (1992–96)	−0.1709	0.0678	0.0117
Cities that implemented red light cameras vs. cities that did not	0.4998	0.1436	0.0005
Interaction of study period and city group	−0.2809	0.1079	0.0092

Table 3
Poisson model of the effects of red light camera enforcement on average annual per capita rates of all fatal crashes at signalized intersections.

Parameter	Estimate	Standard error	p value
Intercept	2.5994	0.1314	<0.0001
Land area in square miles	0.0002	0.0002	0.3805
Population density (thousands of persons per square mile)	−0.0187	0.0160	0.2428
After period (2004–08) vs. before period (1992–96)	0.0112	0.0564	0.8426
Cities that implemented red light cameras vs. cities that did not	0.2812	0.1284	0.0285
Interaction of study period and city group	−0.1822	0.0914	0.0462

Williams, 2000; Royal, 2004). Despite the widespread support and the safety benefits of red light camera enforcement, cameras remain controversial in some communities where opponents raise concerns about “big brother” government tactics and claim that violators are victims of revenue-generating government schemes. In the current study, the cities that implemented red light camera programs had higher baseline crash rates, suggesting that government officials were motivated by safety concerns. Although automated traffic enforcement is not a panacea, the current study adds to the large body of evidence that red light cameras can prevent the most serious crashes. This evidence should be considered by communities seeking to reduce crashes at intersections.

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Appendix A

Population, crash counts, per capita crash rates, and changes in per capita crash rates for each study city for fatal red light running crashes and all fatal crashes at signalized intersections, 2004–2008 vs. 1992-1996

	Average annual population		Fatal red light running crashes				Percent change in crash rate	All fatal crashes at signalized intersections				Percent change in crash rate
			5-year total crash counts		Annual crash rate per 100,000 population			5-year total crash counts		Annual crash rate per 100,000 population		
	1992-96	2004-08	1992-96	2004-08	1992-96	2004-08		1992-96	2004-08	1992-96	2004-08	
Cities with red light camera programs												
Bakersfield, CA	203,797	301,102	7	16	0.69	1.06	55	14	28	1.37	1.86	35
Baltimore, MD	699,943	640,054	14	11	0.40	0.34	−14	32	44	0.91	1.37	50
Chandler, AZ	119,198	241,729	7	3	1.17	0.25	−79	16	8	2.68	0.66	−75
Chicago, IL	2,799,671	2,824,206	69	47	0.49	0.33	−32	175	170	1.25	1.20	−4
Garland, TX	187,241	215,403	7	6	0.75	0.56	−25	13	11	1.39	1.02	−26
Long Beach, CA	430,595	464,451	14	10	0.65	0.43	−34	32	23	1.49	0.99	−33
Phoenix, AZ	1,098,702	1,509,114	100	76	1.82	1.01	−45	197	190	3.59	2.52	−30
Portland, OR	497,777	541,682	18	8	0.72	0.30	−59	42	31	1.69	1.14	−32
Raleigh, NC	241,617	364,026	3	9	0.25	0.49	99	6	24	0.50	1.32	165
Sacramento, CA	400,480	452,320	15	8	0.75	0.35	−53	24	24	1.20	1.06	−11
San Diego, CA	1,161,107	1,291,335	26	11	0.45	0.17	−62	76	51	1.31	0.79	−40
Santa Ana, CA	298,297	336,783	11	7	0.74	0.42	−44	21	18	1.41	1.07	−24
Toledo, OH	322,241	316,835	10	6	0.62	0.38	−39	25	24	1.55	1.51	−2
Washington, DC	563,014	584,461	22	17	0.78	0.58	−26	66	61	2.34	2.09	−11
Cities without red light camera programs												
Akron, OH	218,976	209,668	2	2	0.18	0.19	4	8	4	0.73	0.38	−48
Anaheim, CA	282,074	330,345	12	13	0.85	0.79	−7	24	20	1.70	1.21	−29
Anchorage, AK	249,365	278,125	9	11	0.72	0.79	10	20	23	1.60	1.65	3
Arlington, VA	173,359	202,500	3	1	0.35	0.10	−71	9	3	1.04	0.30	−71
Aurora, CO	242,283	303,791	5	7	0.41	0.46	12	17	22	1.40	1.45	3
Birmingham, AL	256,388	231,578	14	7	1.09	0.60	−45	25	24	1.95	2.07	6
Boise, ID	154,806	201,372	0	1	0.00	0.10	N/A	3	4	0.39	0.40	3
Boston, MA	553,977	617,749	5	3	0.18	0.10	−46	21	11	0.76	0.36	−53
Buffalo, NY	316,662	275,641	4	4	0.25	0.29	15	26	24	1.64	1.74	6
Chesapeake, VA	179,792	217,583	0	2	0.00	0.18	N/A	5	7	0.56	0.64	16
Chula Vista, CA	146,629	211,660	2	4	0.27	0.38	39	6	11	0.82	1.04	27
Cincinnati, OH	352,050	332,341	2	4	0.11	0.24	112	8	9	0.45	0.54	19
Colorado Springs, CO	315,112	395,544	11	10	0.70	0.51	−28	27	34	1.71	1.72	0
Detroit, MI	1,007,094	918,776	46	20	0.91	0.44	−52	111	68	2.20	1.48	−33
Durham, NC	160,985	211,713	3	5	0.37	0.47	27	8	10	0.99	0.94	−5
Fort Wayne, IN	200,085	251,663	5	4	0.50	0.32	−36	14	10	1.40	0.79	−43
Henderson, NV	86,311	239,939	1	3	0.23	0.25	8	5	8	1.16	0.67	−42
Hialeah, FL	204,090	220,141	3	3	0.29	0.27	−7	21	24	2.06	2.18	6
Honolulu, HI	390,745	374,348	5	2	0.26	0.11	−58	27	34	1.38	1.82	31
Indianapolis, IN	745,367	793,282	18	23	0.48	0.58	20	48	51	1.29	1.29	0
Jacksonville, FL	664,626	795,745	13	7	0.39	0.18	−55	38	79	1.14	1.99	74
Jersey City, NJ	229,201	237,973	4	0	0.35	0.00	−100	15	6	1.31	0.50	−61
Kansas City, MO	434,600	469,728	15	13	0.69	0.55	−20	33	39	1.52	1.66	9
Laredo, TX	152,870	210,741	2	3	0.26	0.28	9	5	12	0.65	1.14	74
Las Vegas, NV	334,750	550,914	10	22	0.60	0.80	34	33	47	1.97	1.71	−13
Lexington, Fayette, KY	236,005	283,144	6	8	0.51	0.57	11	13	27	1.10	1.91	73
Lincoln, NE	204,472	244,961	4	2	0.39	0.16	−58	5	11	0.49	0.90	84
Louisville, KY	670,350	706,926	17	18	0.51	0.51	0	28	47	0.84	1.33	59
Madison, WI	204,138	226,575	3	1	0.29	0.09	−70	9	6	0.88	0.53	−40
Memphis, TN	619,267	680,035	36	27	1.16	0.79	−32	73	69	2.36	2.03	−14
Miami, FL	362,845	407,606	5	14	0.28	0.69	149	35	67	1.93	3.29	70
Milwaukee, WI	606,704	602,397	14	17	0.46	0.56	22	37	44	1.22	1.46	20
Nashville, TN	502,398	585,422	8	13	0.32	0.44	39	34	43	1.35	1.47	9
Newark, NJ	271,809	276,721	12	6	0.88	0.43	−51	39	25	2.87	1.81	−37
Norfolk, VA	246,229	237,800	4	2	0.32	0.17	−48	8	6	0.65	0.50	−22
Oklahoma City, OK	459,474	539,146	1	5	0.04	0.19	326	12	29	0.52	1.08	106
Omaha, NE	371,308	437,344	15	17	0.81	0.78	−4	29	32	1.56	1.46	−6
Pittsburgh, PA	358,173	314,869	1	4	0.06	0.25	355	12	22	0.67	1.40	109
Reno, NV	148,367	209,923	4	3	0.54	0.29	−47	19	9	2.56	0.86	−67
Rochester, NY	225,908	209,022	2	3	0.18	0.29	62	12	17	1.06	1.63	53
Saint Paul, MN	262,938	277,799	7	6	0.53	0.43	−19	13	8	0.99	0.58	−42
Saint Petersburg, FL	237,878	246,461	13	6	1.09	0.49	−55	28	28	2.35	2.27	−3
San Antonio, TX	1,068,009	1,292,560	27	25	0.51	0.39	−23	68	64	1.27	0.99	−22
San Jose, CA	813,785	921,760	13	14	0.32	0.30	−5	29	40	0.71	0.87	22
Tampa, FL	283,464	330,769	8	10	0.56	0.60	7	26	42	1.83	2.54	38
Tulsa, OK	376,458	383,293	9	7	0.48	0.37	−24	15	18	0.80	0.94	18
Wichita, KS	322,887	358,229	5	7	0.31	0.39	26	9	22	0.56	1.23	120
Winston, Salem, NC	167,987	220,383	1	2	0.12	0.18	52	2	6	0.24	0.54	129