Report on effects of Houston-area red light monitoring cameras

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Executive summary

This report tracks the impact of red light monitoring cameras on the frequency of traffic accidents in Houston, Texas. We use data collected over seven years to simulate the effects of camera installation and to estimate their impact. The results show that cameras are associated with a long-lasting reduction in the number of collisions at Houston intersections that averages almost 30% for single cameras. We find that intersections with one camera benefit from reduced collisions only on the approach with the camera, whereas those with two or more see reduced collisions from all approaches. From September 2006 to December 2009, we estimate that camera-controlled intersections prevented about 792 collisions in total.

Introduction and Description of the Data

This report tracks the effect of red-light monitoring cameras on the number of collisions occurring at 50 intersections in Houston, Texas while dealing with several factors that affect the frequency of traffic accidents. We examine both the direct effect of cameras on preventing collisions and the spillover effect of having multiple cameras at one intersection. The standard procedure in most cities is to camera multiple approaches at each intersection. However, in Houston the practice was to camera a single approach and add additional cameras later. This allowed us to track the effect of adding additional cameras.

Taking into account other factors that affect collisions, we find that both direct and spillover effects are strong. Interestingly, we only find spillover effects in intersections with two or more cameras. When one camera is installed at an intersection, it reduces collisions from its approach without affecting other approaches. When a second camera is added on another approach in the same intersection, it reduces collisions not only on its approach but on all others as well. The reason for this requires further study, but we will show that the effect is strong and persistent.

We acquired collision data by intersection and approach from the Crash Record Information

Table 1: Basic summary statistics

Total collisions	11,294
Full period of analysis	January 2003 - December 2009
Number of collisions at all intersections in August 2006 (the month before cameras were installed)	187
Number of collisions at all intersections in August 2009 (three years later)	115

System (CRIS) data base[1] compiled by the Texas Department of Transportation (TxDOT). CRIS is compiled from paper collision reports from all local public safety agencies in the state of Texas. Public safety agencies are required by law to submit these reports to TxDOT within 10 days of a motor vehicle crash[2]. Information was collected between January 2003 and December 2009 and the first cameras were installed in September 2006. We filtered the CRIS data to include only collisions occurring within 500 ft. of a DARLEP[3] intersection[4].

Table 1 provides some basic information. Please see table 3 in appendix for a full list of intersections and average monthly collisions. Cameras were installed on at least one approaching street in each of the fifty intersections by May 2007. An additional twenty cameras were installed in August 2007,[5] so a grand total of 70 red-light surveillance cameras were installed during our period of study. The data we use were collected on the number of accidents at each of the four "approaches" to these intersections. This makes for a total of 200 individual "intersection approaches".

How to measure the effect of cameras

Cameras were installed on approaches that experienced more accidents. Between January 2003 and September 2006, before any cameras were installed, the average number of collisions per month was significantly higher on approaches that eventually received a camera than on those which never did.[6] This strongly suggests that the approaches which received camera control were not selected at random.

Of course, cameras are not an unlimited resource, so this practice makes sense. However, it does make it complicated to measure what effect cameras have on collisions. It is not enough to simply compare collisions before and after camera installation as we do in table 1. For

[1]We gratefully acknowledge the assistance of Houston-Galveston Area Council of Governments and Jeff Kaufman for their assistance in providing us with access to the CRIS data base.

[2]Texas Transportation Code, Section 550.061

[3]Digital Automated Red Light Enforcement Program

[4]See http://www.txdot.gov/drivers vehicles/crash records/reports.htm

[5]Eighteen intersections received one additional camera and one intersection received two additional cameras.

[6]This is an average of .84 collisions per month at approaches that eventually received cameras, compared to .68 collisions per month on average at approaches which never got a camera. The difference is large and statistically significant at the .05 level, meaning that if there really is no difference between the two groups then a difference this large is so rare it would happen fewer than five times out of 100.

example, if high-risk approaches got cameras and low-risk approaches did not get cameras then we can only compare high-risk approaches with cameras to low-risk approaches without cameras. We could compare high-risk approaches before and after camera installation, but this will only help if traffic accidents are basically constant over time. Since there are trends over time, for example due to weather variation or changes in automobile technology, then this is also a problem.

If the Houston program were an experiment, the cameras would have been installed at intersections chosen at random. However, the six years of data we have is the nearest thing to an experiment available. To get around the problems with making simple comparisons, we chose to use all of the data available to us to build a statistical model of traffic accidents. We use this model to simulate the number of collisions at an average intersection approach with or without cameras installed. The simulation approach solves our problem because it provides a baseline for comparison that is built from the information collected at all 50 intersections and 200 intersection approaches and incorporates everything we can measure about what causes traffic accidents.

If our simulated intersection shows a drop in collisions when a camera is installed, then we can conclude with confidence that cameras had a positive effect in Houston. In order to get the best model of collisions, we include information in our model that addresses these key issues:

Time: Between January 2003 and December 2009, there was a natural decline in the number of accidents across all intersections in Houston. We account for this effect.

Weather: There are a variety of ways Houston weather affects traffic. We account for the amount of rain each month, the number of rainy days, and the monthly average temperature. We also address the effects of the two major storms during this period: Ike and Rita.

Geography: The intersections (and their different approaches) we studied are located across the Houston area. Traffic volume, nearness to the freeways and a variety of other factors make these locations very different from one another and affect the number of monthly collisions.

Calendar Month: Months vary in collision frequency due to seasonal differences in weather and traffic patterns. These include differences from the holiday season, the summer school vacation period, etc.

There are dozens of factors that might affect collisions. Some of them, like weather, we can measure easily. Others, like traffic volume, we do not have measures for. To get around this, we can account for all those unmeasured details indirectly by treating each intersection and each approach as unique[7] Filtering out these unique geographical features, time trends and seasonal patterns lets us focus in on the effect of cameras, and it also ensures our model is highly accurate. In a test of the model, it correctly predicted all but 25 collisions out of 1,413 collisions between September 2006 and December 2009.

[7]In statistical terms, we employ fixed effects by intersection approach and calendar month.

The baseline for comparison

Accounting for all the factors described above, our model[8] predicts the baseline number of collisions for an average high-risk approach shown in figure 1. The area between each set of ticks at the bottom of the graph denotes one calendar year. This is *not* a plot of actual data, but rather the best prediction from the model as to how many collisions would happen at a simulated high-risk approach each month. Notice that there is a small trend toward fewer monthly collisions as time passes and that the number of collisions varies month-to-month. This will serve as the basis for comparison in the rest of the report.

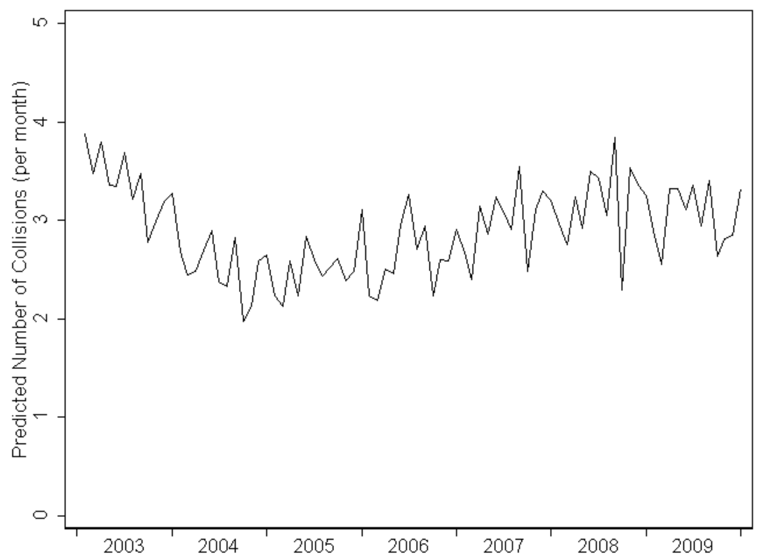

Figure 1: Baseline prediction for a high-risk approach
Based on 50 intersections in the Houston-area, 2003-2009

The effect of camera installation

Statistical tests showed that camera installation does reduce collisions, but the size of the effect depends on **how many** cameras are installed, **which approach** we study, and **how long** the camera is in place. A single approach with a camera sees a reduction in collisions, but approaches without cameras tend to see reductions only when there is *more than one* camera installed at the same intersection. In every case, the benefits of having cameras on an intersection grow with time, perhaps as drivers learn to watch for the cameras. The pictures below tell this story in more detail.

In each figure, the thick blue line tracks the predicted reduction in collisions at an approach that gets a camera. The black, dotted lines are the high and low boundaries of a 95% confidence range. Since these are simulated values, this range tracks how sure we can be

[8]We employ a negative binomial regression with the control variables described above and fixed effects by intersection, approach, direction and month. Each of the 84 individual predicted monthly collision counts is calculated from 1,000 sets of simulated model parameters.

about the predictions. The dashed red line denotes zero change from the baseline. When all three lines are below the dashed red line, the change in collisions is statistically significant and we can be confident that the presence of the camera reduces collisions.

The effect of one camera

Within twelve months of installing one camera at a high-risk intersection, we estimate there will be about one less collision every month and this drop will be permanent. This can be seen in figure 2.

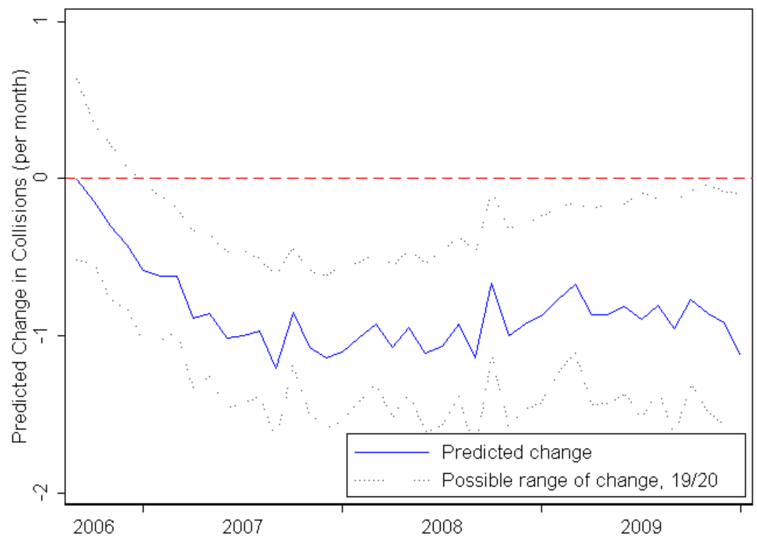

Figure 2: Predicted Reduction in Collisions Per Month
camera installed in 09/2006

The data indicate that the effect of one camera on the other three approaches in the intersection is virtually nil. In figure 3 you can see the predicted number of collisions at a simulated intersection approach that never receives a camera, but which shares an intersection with one approach that *does* have a camera. There is no apparent spillover effect from one camera.

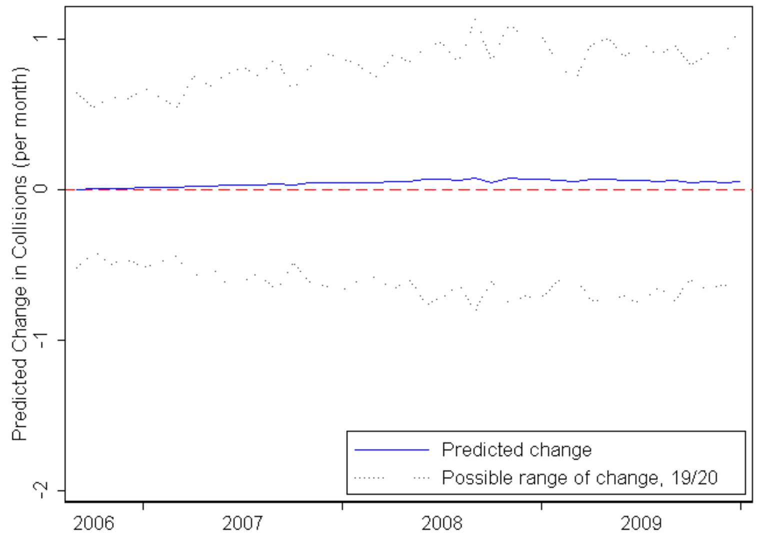

Figure 3: Predicted Reduction in Collisions Per Month
camera installed on a different approach in 09/2006

The effect of two cameras

Our data suggest that two cameras at the same intersection bring down the number of collisions substantially more than one camera alone. Figure 4 shows our prediction for an approach that does not receive a camera at first, but then later has a camera installed. The first camera, again, has almost no impact on the approach without a camera.

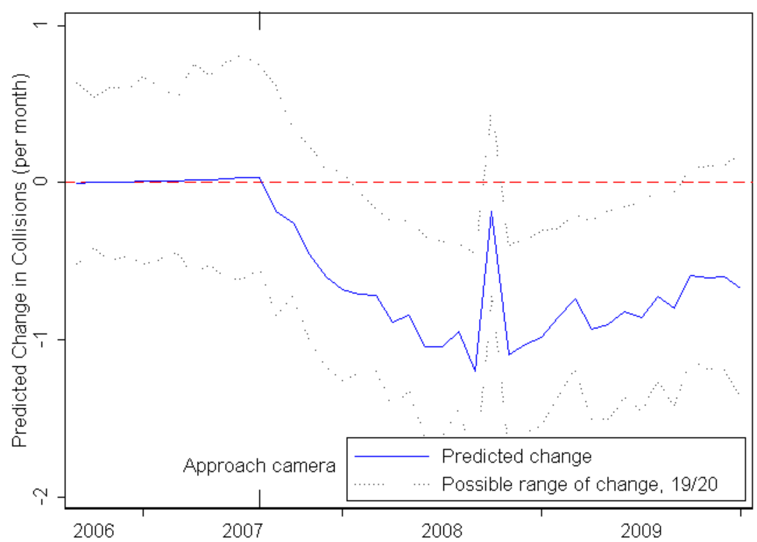

Figure 4: Predicted Reduction in Collisions Per Month
camera on different approach in 09/2006 then on this approach in 08/2007

Table 2: Estimated average reduction in monthly collisions for high-risk intersections

Intersection approach	**Percent Change**
One-camera intersection	
Approach with camera	-27.7%
Approach without camera	+1.4%*
Two-camera intersection	
Approach with first camera	-25.5%
Approach with second camera (after installation)	-23.2%
Approach without camera (after both cameras are installed)	-24.0%

* *This number is not statistically significant.*

The effects are basically a combination of the previous two pictures. After the first camera is installed, we see no change in the approach without a camera. However, once the approach we simulate gets a camera there is a clear reduction in accidents. With two cameras in the intersection, there is also a strong spillover reduction in collisions *even on the two approaches without any camera* as you see in figure 5.

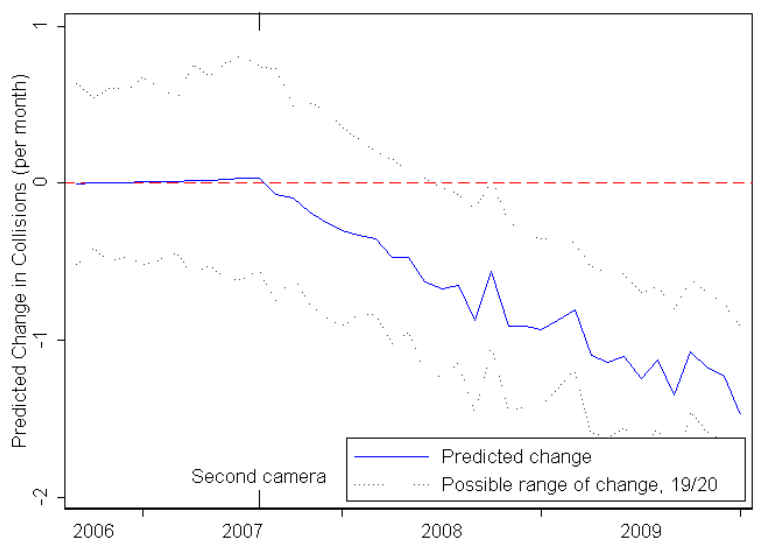

Figure 5: Predicted Reduction in Collisions Per Month
camera on two other approaches installed in 09/2006 and in 08/2007

Table 2 lists the expected reduction in collisions compared to the baseline for various situations.

A real-life example of spillover effects: FM 1960 West at Tomball Parkway

Consider the example of FM 1960 West at Tomball Parkway. As table 3 shows, this intersection was the most prone to collisions before cameras were installed. There was more than a 50% reduction in collisions after cameras were installed. We used our model to simulate what would have happened without cameras at this intersection. Simulations suggest that these reductions were primarily due to the spillover effect from this intersection receiving *two* cameras.

In the first figure, number 6, shows the actual timeline of monthly collisions at the intersection. In figure 7, we predict the number of collisions would have been much larger with no cameras or only one camera at the intersection in the same period.

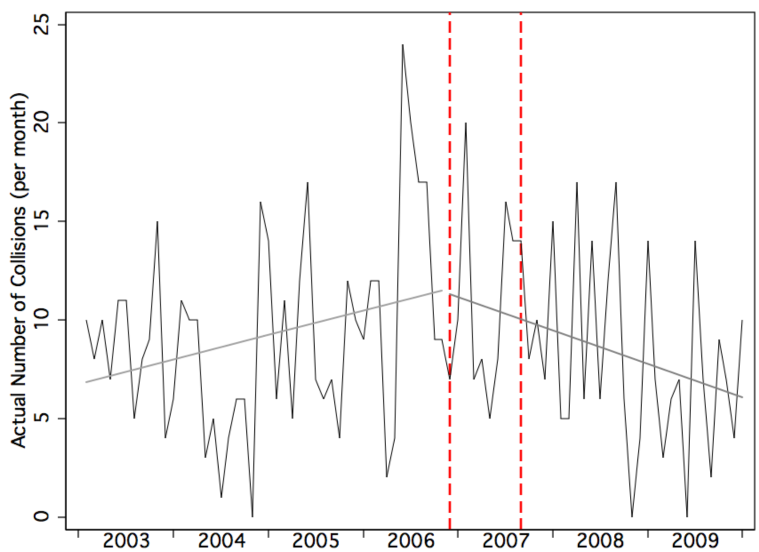

Figure 6: Actual Collisions at FM 1960 at Tomball Parkway
2003-2009, cameras installed Nov 06 and Aug 07

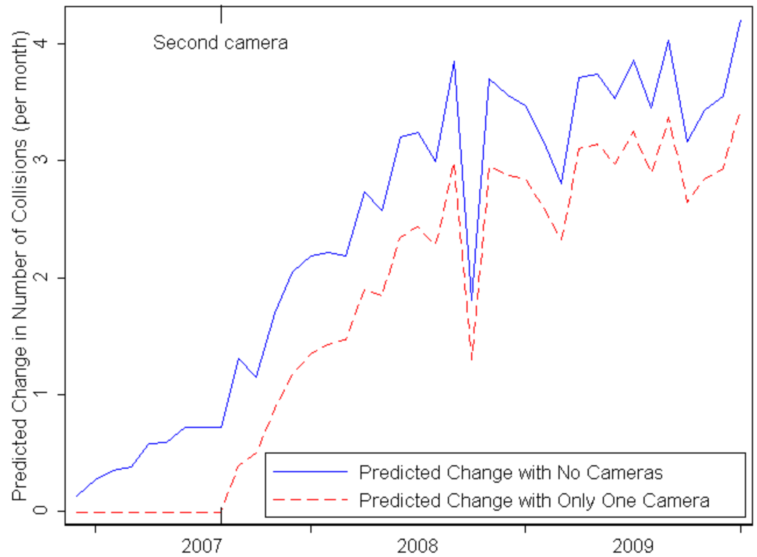

Figure 7: Predicted Increase in Collisions Compared to Two Cameras
FM 1960 W at Tomball Pkwy

Conclusion

Intersection approaches with cameras experienced 1,413 collisions between September 2006 and December 2009. Our findings suggest that this is not a fluke. Simulated re-creations of this period estimate that we should expect about 1,438[9] collisions at these approaches with cameras. If we simulate what this number would have been without cameras installed, we would expect about 2,230[10] - an increase of almost 800 collisions.

The evidence suggests that even once we account for other factors that contribute to traffic accidents, cameras appear to reduce the number of wrecks. An approach with a camera for the full three years of our data tended to have about 28% fewer collisions than the baseline expectation, and intersections with more than one camera saw stronger benefits once the second camera was installed.

The most surprising trend we uncovered is that intersections with one camera only benefit from reductions in accidents at the approach with the camera. Adding a second camera, however, brings reductions in the number of collisions not only on the newly monitored approach but also on the other two approaches *without* cameras.

[9] The 95% confidence interval for this estimate is between 1,061 and 1,913

[10] The 95% confidence interval for this estimate is between 1,518 and 3,167

Appendix

Table 3: Full list of intersections and actual average monthly collisions before and after camera installation - not controlled for number of cameras or timing of installation

	Intersection	**Before**	**After**	**Difference**
1	Harwin at Hillcroft	0.81	0.07	-0.73
2	Milam at Elgin	3.35	0.15	-3.20
3	Richmond at Dunvale	1.42	0.62	-0.79
4	Bellaire at Wilcrest	1.19	0.25	-0.94
5	Richmond at Hillcroft	0.82	0.35	-0.47
6	Brazos at Elgin	1.54	0.12	-1.41
7	Travis at Webster	4.04	1.02	-3.01
8	John F. Kennedy at Greens Rd.	2.11	1.12	-0.99
9	Bay Area Blvd at El Camino Real	2.18	0.12	-2.05
10	Pease at La Branch	1.41	0.30	-1.11
11	Hillcroft at Southwest Fwy	3.30	1.87	-1.43
12	Bissonnet at West Sam Houston S	5.32	2.51	-2.82
13	FM 1960 W at Tomball Pkwy	7.97	3.79	-4.18
14	Chimney Rock at Southwest Fwy	2.74	1.48	-1.26
15	Westpark at Southwest Fwy	1.90	0.79	-1.11
16	Westheimer at West Loop S	2.44	0.74	-1.70
17	West Sam Houston S at Beechnut	2.90	1.00	-1.90
18	Gessner at Beechnut	2.46	1.21	-1.25
19	East Fwy at Uvalde	0.95	0.76	-0.19
20	Southwest Fwy at Fountain View	2.80	0.53	-2.28
21	West Loop S at San Felipe	2.07	0.25	-1.83
22	Southwest Fwy at Bellaire	3.78	1.31	-2.47
23	El Dorado at Gulf Fwy	0.17	0.00	-0.17
24	West Rd at North Fwy	3.80	1.72	-2.08
25	Hollister at Northwest Fwy	2.70	1.23	-1.47
26	North Wayside at East Fwy	4.55	1.62	-2.93
27	Chartres at St. Joeseph Pkwy	4.93	0.86	-4.07
28	Southwest Fwy at Beechnut	2.41	0.42	-2.00
29	Southwest Fwy at Fondren	1.54	1.25	-0.29
30	Bissonnet at Southwest Fwy	1.80	0.75	-1.05
31	West Sam Houston S at Bellaire	4.01	0.53	-3.48
32	Greens Road at North Fwy	3.40	0.74	-2.66
33	North Shepherd at North Loop W	3.23	0.85	-2.38
34	Southwest Fwy at Wilcrest	3.37	1.46	-1.91
35	Main St at South Loop 'N	4.15	1.65	-2.51
36	North Fwy at Rankin	4.60	1.35	-3.25
37	East Fwy at Normandy	1.46	0.38	-1.07
38	Monroe at Gulf Fwy	1.82	0.32	-1.50
39	Scott at South Loop E	1.96	0.35	-1.60
40	Antoine at Northwest Fwy	2.01	0.47	-1.54
41	Gulf Fwy at South Wayside	2.31	0.38	-1.93
42	Gulf Fwy at Woodridge	2.36	0.67	-1.68
43	West Bellfort at Southwest Fwy	2.71	0.38	-2.34
44	Northwest Fwy at Fairbanks N. Houston	2.68	0.44	-2.24
45	Westpark at West Sam Houston S	1.27	0.43	-0.85
46	Gulf Fwy at FM 2351	1.05	0.34	-0.71
47	West Loop S at Post Oak Blvd	0.86	0.12	-0.73
48	Northwest Fwy at Mangum	1.14	0.19	-0.95
49	South Sam Houston Fwy at Telephone	1.50	0.34	-1.16
50	South Loop West at Stella Link	0.74	0.28	-0.46