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Analysis of crash data from safety camera intersections in South Australia

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ABSTRACT

There are now many signalised intersections in South Australia that are equipped with safety cameras which photograph vehicles that either travel though a red signal or exceed the posted speed limit. The detection of infringing drivers is intended to reduce speeding and red light running and ultimately reduce the number and severity of crashes at the signalised intersections being monitored. This study analysed the injury crash data for 35 safety camera intersections in South Australia that have been in place for at least five years. By comparing the injury crash numbers for five years before and five years after site commissioning, an attempt was made to determine if the safety cameras are having a beneficial effect on injury crash numbers and to estimate the size of this effect. In an attempt to control for long term trends in injury crash numbers, changes in relevant injury crashes (those involving a vehicle passing a safety camera) were compared with changes in non-relevant injury crashes (those involving only vehicles not passing a safety camera) at the intersections. The analyses carried out suggest that safety cameras, as implemented in South Australia, are reducing injury crashes on the monitored legs of the treated intersections. Estimates of the size of the reduction range up to 21%. This is in general agreement with the literature suggesting a modest but real effect of fixed cameras. As more safety cameras are installed in South Australia, and more time passes to allow crash data to accumulate for newer sites, the current analysis can be extended to provide more precise estimates of the effect of the cameras (although there are limitations with the methods available).

KEYWORDS

Red light camera, Speed camera, Signalised intersection, Accident rate, Data analysis.

Summary

There are now many signalised intersections in South Australia that are equipped with safety cameras which photograph vehicles that either travel though a red signal or exceed the posted speed limit. The registered owners of photographed vehicles are sent an infringement notice that includes a fine and a number of demerit points. The detection of infringing drivers is intended to reduce speeding and red light running and ultimately reduce the number and severity of crashes at the signalised intersections being monitored.

A previous study examined the traffic infringements issued at 21 South Australian safety camera intersections during their first year of operation. It was found that both red light infringements and speeding infringements declined over time. This provided evidence that the safety cameras are effective in terms of their primary functions of reducing red light running and speeding.

This study analysed the injury crash data for 35 safety camera intersections in South Australia that have been in place for at least five years. By comparing the injury crash numbers for five years before and five years after site commissioning, an attempt was made to determine if the safety cameras are having a beneficial effect on injury crash numbers and to estimate the size of this effect.

In an attempt to control for long term trends in injury crash numbers, changes in relevant injury crashes (those involving a vehicle passing a safety camera) were compared with changes in non-relevant injury crashes (those involving only vehicles not passing a safety camera) at the intersections.

The analyses carried out suggest that safety cameras, as implemented in South Australia, are reducing injury crashes on the monitored legs of the treated intersections. Estimates of the size of the reduction range up to 21%. This is in general agreement with the literature suggesting a modest but real effect of fixed cameras.

As more safety cameras are installed in South Australia, and more time passes to allow crash data to accumulate for newer sites, the current analysis can be extended to provide more precise estimates of the effect of the cameras (although there are limitations with the methods available).

Contents

1 Introduction

There are now many signalised intersections in South Australia that are equipped with safety cameras (preceded by a warning sign) which photograph vehicles that either travel though a red signal or exceed the posted speed limit. The registered owners of photographed vehicles are sent an infringement notice that includes a fine and a number of demerit points. The detection of infringing drivers is intended to reduce speeding and red light running and ultimately reduce the number and severity of crashes at the signalised intersections being monitored.

A previous study by Mackenzie et al (2013) examined the traffic infringements issued at 21 South Australian safety camera intersections during their first year of operation. It was found that red light infringements declined slowly over time while speeding infringements declined rapidly during the first few months and then more gradually thereafter, with the decline during the first few months being more rapid for more serious levels of speeding. This provides evidence that the safety cameras are effective in terms of their primary functions of reducing red light running and speeding.

Examining the effect of the safety cameras on crashes is more difficult because the number of crashes at a particular intersection will be relatively low and subject to considerable random variation over time. Only by examining crashes at a large number of intersections over a long period of time can the effect of safety cameras on crashes be discerned.

The purpose of this study is to examine the available data for a set of safety camera intersections in South Australia and determine what evidence is available about their effectiveness in reducing injury crashes.

2 Method

The aim of this study is to examine a set of intersections in South Australia with safety cameras installed in order to determine if there have been any changes in crash numbers at those locations associated with the installation of the cameras.

2.1 Selection of safety camera sites for analysis

It is possible that different camera types and camera locations will have different effects on crashes, so a group of relatively similar sites was chosen based on the following criteria:

- Digital speed and red light cameras installed at a signalised intersection
- Only intersections in the greater Adelaide metropolitan area (rural intersections may be different and generally have fewer crashes)
- Commission date of June 2011 or earlier (to ensure 5 years of post-implementation data was available)
- Currently not decommissioned or decommissioned at least 5 years after commissioning (to ensure 5 years of post-implementation data was available)
- Not previously the site of a camera that was removed (due to effects on historical crash data)
- Camera only installed on one leg of the intersection (to provide control crash data from unaffected legs)

This selection criteria resulted in 35 safety camera intersections being available for analysis. The locations and commissioning dates for the intersections are shown in Table 2.1.

Table 2.1
Safety camera intersection sites meeting the selection criteria

Site ID	Road	Intersecting road	Suburb	Traffic direction monitored	Commissioning date
48	Kensington Road	Portrush Road	Marryatville	W	2006-10-05
49	King William Road	Sir Edwin Smith Avenue	North Adelaide	S	2007-03-26
50	Tapleys Hill Road	West Lakes Boulevard	Seaton	N	2007-03-29
51	Greenhill Road	Hutt Road	Adelaide	E	2007-03-26
56	North East Road	Ascot Avenue	Vale Park	SW	2007-03-26
57	Anzac Highway	Marion Road	Plympton	NE	2007-03-27
61	Lower North East Road	Darley Road	Paradise	NE	2006-02-17
63	Grand Junction Road	Walkleys Road	Walkley Heights	E	2006-10-05
64	The Grove Way	Atlantis Drive	Golden Grove	SE	2006-05-05
65	West Terrace	Hindley Street	Adelaide	N	2007-09-22
66	Grand Junction Road	Main North Road	Enfield	W	2007-04-12
67	Henley Beach Road	Holbrooks Road	Underdale	E	2006-12-06
68	Grand Junction Road	Hanson Road	Ottoway	E	2007-04-12
69	Glover Avenue	West Terrace	Adelaide	E	2007-09-22
70	Grand Junction Road	Addison Road	Pennington	W	2006-10-12
73	South Road	Richmond Road	Mile End South	S	2007-12-19
74	Henley Beach Road	Tapleys Hill Road	Fulham	W	2006-10-05
75	Panalatinga Road	Pimpala Road	Woodcroft	S	2006-05-02
76	Main South Road	Bains Road	Morphett Vale	S	2006-05-09
77	Main South Road	Doctors Road	Morphett Vale	S	2007-03-27
89	Diagonal Road	Oaklands Road	Glengowrie	SE	2007-04-03
91	South Road	Ashwin Parade	Torrensville	N	2007-04-03
92	Payneham Road	Nelson Street	Stepney	SW	2007-04-09
93	Payneham Road	Lower Portrush Road	Marden	NE	2007-04-09
94	Main South Road	Black Road	O'Halloran Hill	N	2008-09-30
95	Anzac Highway	Cross Road	Plympton	SW	2008-11-24
97	Waterloo Corner Road	Bagster Road	Salisbury North	SE	2008-09-25
98	Bridge Road	Montague Road	Ingle Farm	SW	2008-10-23
100	Churchill Road	Regency Road	Prospect	N	2008-09-11
101	Glynburn Road	Kensington Road	Kensington Gardens	S	2009-03-18
102	Sir Donald Bradman Drive	Brooker Terrace	Hilton	W	2008-07-08
103	Montefiore Road	War Memorial Drive	North Adelaide	S	2009-01-20
105	Main North Road	Fairfield Road	Elizabeth Grove	S	2008-08-28
107	Commercial Road	Grand Junction Road	Port Adelaide	SE	2008-10-02
110	Grange Road	Findon Road	Findon	E	2010-09-02

2.2 Extraction of crash data

Crash data for each of the safety camera intersections was extracted from the Traffic Accident Reporting System (TARS) for the five years before the day of commissioning and the five years after. Over the time period examined, the reporting criteria for property damage only crashes have changed so such crashes cannot be used in a before and after analysis of crashes. There have also been changes in the classification of serious injury crashes over the time period examined. Given this, it was decided to count the total number of injury crashes at each intersection (crashes in which at least one person was fatally injured, taken to hospital or treated by a doctor) in the five years before and five years after the date of commissioning. Fatal crash reporting is reliable enough to be considered separately but the numbers were too low for a meaningful analysis.

Crashes that involved at least one vehicle passing through the leg of an intersection monitored by a safety camera were classified as “relevant” crashes as the risk of such crashes could conceivably be directly influenced by the safety camera. Crashes only involving vehicles not passing through the monitored leg were classified as “non-relevant” crashes. The non-relevant crashes provided a rough control group of crashes against which changes in the relevant crashes could be compared.

The relevance of a crash could not be reliably determined from the pre-coded data in TARS so each crash was examined by a CASR researcher with reference to the crash description and other coded direction fields to determine relevance. During this process, two crashes were identified as being incorrectly coded as occurring at a safety camera intersection - these crashes were excluded from the analysis. There were three crashes where the relevance could not be determined from the available data - these crashes were included in the total crash counts but could not be included in the relevant or non-relevant crash counts.

The total number of crashes, and the number of relevant and non-relevant crashes for each site in each of the 5 years before and after the commission date for each site are shown in Tables 2.2-2.4.

Table 2.2
Total number of injury crashes in the years before and after the safety camera commission date

Site ID	Years before and after the safety camera commission date									
	-5	-4	-3	-2	-1	+1	+2	+3	+4	+5
48	3	7	5	1	3	2	4	1	2	2
49	5	8	6	5	2	4	3	7	2	3
50	4	5	2	4	1	3	6	3	6	6
51	3	2	1	4	4	3	1	2	3	5
56	7	8	8	8	8	5	4	8	6	6
57	3	7	10	12	5	3	4	4	7	2
61	2	6	8	3	3	5	4	5	6	6
63	7	4	6	1	3		3	4	2	7
64	3	3	2	6	4	1	1	2	4	2
65	5	3	4	2	3	2	4		6	2
66	11	12	13	14	13	9	4	7	10	12
67	10	9	4	8	3	3	3	2	4	8
68	8	5	5	3	1	7	8	5	2	7
69	7	5	6	4	6	2	4	3	2	4
70	7	5	3	2	2	2	2	5	3	3
73	1	4	6	3	4	6	2	3	7	4
74	6	12	8	5	8	10	2	7	6	8
75	2	7	5	3	1	5		8	2	3
76	5	6	8	6	4	7	3	8	3	3
77	2	4	2	4	1	4	3	4	3	4
89	6	3	3	2	4	5	3	3	3	6
91	2	6	3	5	8	3	3	5	5	5
92	3	6		3	5	5	5	6	13	2
93	7	3	9	3	2	8	6	8	6	1
94	3	1	1	4	3	1	2	2	6	4
95	5	8	5	4	7	4	4	6	1	1
97	4	3	6	6	3	4	1		3	4
98	11	5	6	6	5	1	7	7	5	3
100	6	7	1	3	1	4	4	3	7	7
101	2	3	5	3	2	1	3	3	4	2
102	3	3	3	3	2	2	1	3	2	2
103	9	1	5	6	6	3	4	4	2	4
105	4	1	3	3	4	1	5	4	1	9
107	6	1	1	5	3	1	3	1	2	4
110	5	4	4	2	8	10	9	5	2	4
Total	177	177	167	156	142	136	125	148	148	155

Table 2.3
Number of relevant injury crashes in the years before and after the safety camera commission date

Site ID	Years before and after the safety camera commission date									
	-5	-4	-3	-2	-1	+1	+2	+3	+4	+5
48	2	3	2		1		3		1	2
49	2	2	3			1	1			
50	2	2	2	1		1	5	2	4	3
51				2	3	2			3	3
56	2	3	4	4	5	3	1	5	3	3
57	2	3	3	4	1	1		1	3	1
61	1	2	2	2	2	1	1	2		1
63	1				1			1		2
64	1	1	1	2	3	1		2	2	2
65	1	1	1	1	1	1	1		2	
66	5	6	7	3	2	2		2	3	
67	5	9	3	6	3	2	1		2	1
68	5	3	4	3	1	6	6	3	2	5
69	2	1		1	1					
70	4	2	2	2			1	5	1	2
73	1	2	1	1		4		2	6	2
74	2	6	3	2	2	1			2	1
75		3	1	3		3		2		
76	1	2	7	3	2	4	1	3	2	1
77	1	1	1	3	1	1	1			1
89	1	1	1	2	1		1		1	4
91		3	3	2	1		1	1	2	4
92		1			2	1	2	1	3	
93	3	1	4	2		7	1	6		
94	1			3	2	1		1	3	4
95	4	7	2	2	4	2		2		
97	3	2	4		3	1	1		1	2
98	5	1	4	2	1				1	
100	1			1		1	1		1	2
101	1	2	3	2	2	1	2	2	3	2
102	1	3	1	1	1	1	1			1
103					1		1			
105	1		3	2		1	5			5
107	1			1	2		2		1	
110	2		1	1	4	6	7	2	2	2
Total	64	73	73	64	53	56	47	45	54	56

Table 2.4
Number of non-relevant injury crashes in the years before and after the safety camera commission date

Site ID	Years before and after the safety camera commission date									
	-5	-4	-3	-2	-1	+1	+2	+3	+4	+5
48	1	4	3	1	2	2	1	1	1	
49	3	6	3	5	2	3	2	7	2	3
50	2	3		3	1	2	1	1	2	3
51	3	2	1	2	1	1	1	2		2
56	5	5	4	4	3	2	3	3	3	3
57	1	4	7	8	4	2	4	3	4	1
61	1	4	5	1	1	4	3	3	6	5
63	6	4	6	1	2		3	3	2	5
64	2	2	1	4	1		1		2	
65	4	2	3	1	2	1	3		4	2
66	6	6	6	11	11	7	4	5	7	12
67	5		1	2		1	2	2	2	7
68	3	2	1			1	2	2		2
69	5	4	6	3	5	2	4	3	2	4
70	3	3	1		2	2	1		2	1
73		2	5	2	4	2	2	1	1	2
74	4	6	5	3	6	9	2	7	4	7
75	2	4	4		1	2		6	2	3
76	4	4	1	3	2	3	2	5	1	2
77	1	3	1	1		3	2	4	3	3
89	5	2	2		3	5	2	3	2	2
91	2	3		3	7	3	2	4	3	1
92	3	5		3	3	4	3	5	10	2
93	4	2	5		2	1	5	2	6	1
94	2	1	1	1	1		2	1	3	
95	1	1	3	2	3	2	4	4	1	1
97	1	1	2	6		3			2	2
98	6	4	2	4	4	1	7	7	4	3
100	5	7	1	1	1	3	3	3	6	5
101	1	1	2	1			1	1	1	
102	2		2	2	1	1		3	2	1
103	9	1	5	6	5	3	3	4	2	4
105	3	1		1	4			4	1	4
107	5	1	1	4	1	1	1	1	1	4
110	3	4	3	1	4	4	2	3		2
Total	113	104	93	90	89	80	78	103	94	99

3 Results

The safety camera sites were not selected in such a way as to allow a definitive analysis of their effects to be carried out. Therefore, a number of different analyses were conducted to examine the changes in injury crash numbers from different perspectives.

3.1 Injury crashes at all sites combined

The simplest method of analysis is to add the number of injury crashes occurring at all the sites together and compare the numbers in the five years before the safety camera installation with the five years after. Table 3.1 presents these numbers for relevant and non-relevant injury crashes as well as total injury crashes.

Table 3.1
Changes in injury crash numbers by crash relevance

Crash relevance	5 years before	5 years after	Difference after-before	Ratio after/before	% change	Chi-square p-value
Relevant	327	258	-69	0.789	-21.1	0.004*
Non-relevant	489	454	-35	0.928	-7.2	0.254
Total	819	712	-107	0.869	-13.1	0.006*

* statistically significant using chi-square test at 5% level

The total number of injury crashes at the safety camera intersections was 13.1% less in the five years after the safety cameras were commissioned compared to the five years before. This change was statistically significant which means it is unlikely to be a chance effect.

The number of relevant injury crashes at the safety camera intersections was 21.1% less in the five years after the safety cameras were commissioned compared to the five years before. This change was statistically significant which means it is unlikely to be a chance effect.

The number of non-relevant injury crashes at the safety camera intersections was 7.2% less in the five years after the safety cameras were commissioned compared to the five years before. This change was not statistically significant which means it could well have arisen by chance.

If the change in non-relevant injury crashes is used as a control for the number of expected relevant injury crashes then we would expect 303.6 relevant injury crashes in the five years after the safety cameras were commissioned. There were in fact 258 such injury crashes which represents a 15.0% additional reduction above the reduction seen in the control injury crashes. However, a chi-square test of relevant vs non-relevant injury crashes in the five years before and after was not statistically significant (p=0.124) which means the observed difference between relevant and non-relevant injury crashes could have arisen by chance.

The previous statistical analyses assume that injury crash numbers measured from year to year are only subject to true random variation about a fixed risk of crashing. However, the underlying risk will vary from year to year due to random changes in other risk factors such as the weather and traffic flows. This additional variation means that the analyses could have incorrectly identified some results as being statistically significant when they are not.

3.2 Injury crash changes over time

An alternative to just summing injury crashes in the five years before and five years after the safety cameras were commissioned is to examine the yearly injury crash numbers for both relevant and non-relevant injury crashes (Table 3.2). By fitting a regression model to these numbers, the actual year to year variation can be used to test for statistical significance.

Table 3.2
Relevant and non-relevant crashes injury crashes by year

Year	Period	Relevant crashes	Non-relevant crashes
1	-5	64	113
2	-4	73	104
3	-3	73	93
4	-2	64	90
5	-1	53	89
6	+1	56	80
7	+2	47	78
8	+3	45	103
9	+4	54	94
10	+5	56	99

A regression model was fitted to the log of the relevant injury crash numbers using year and a step function for the years after the cameras were commissioned. The model found:

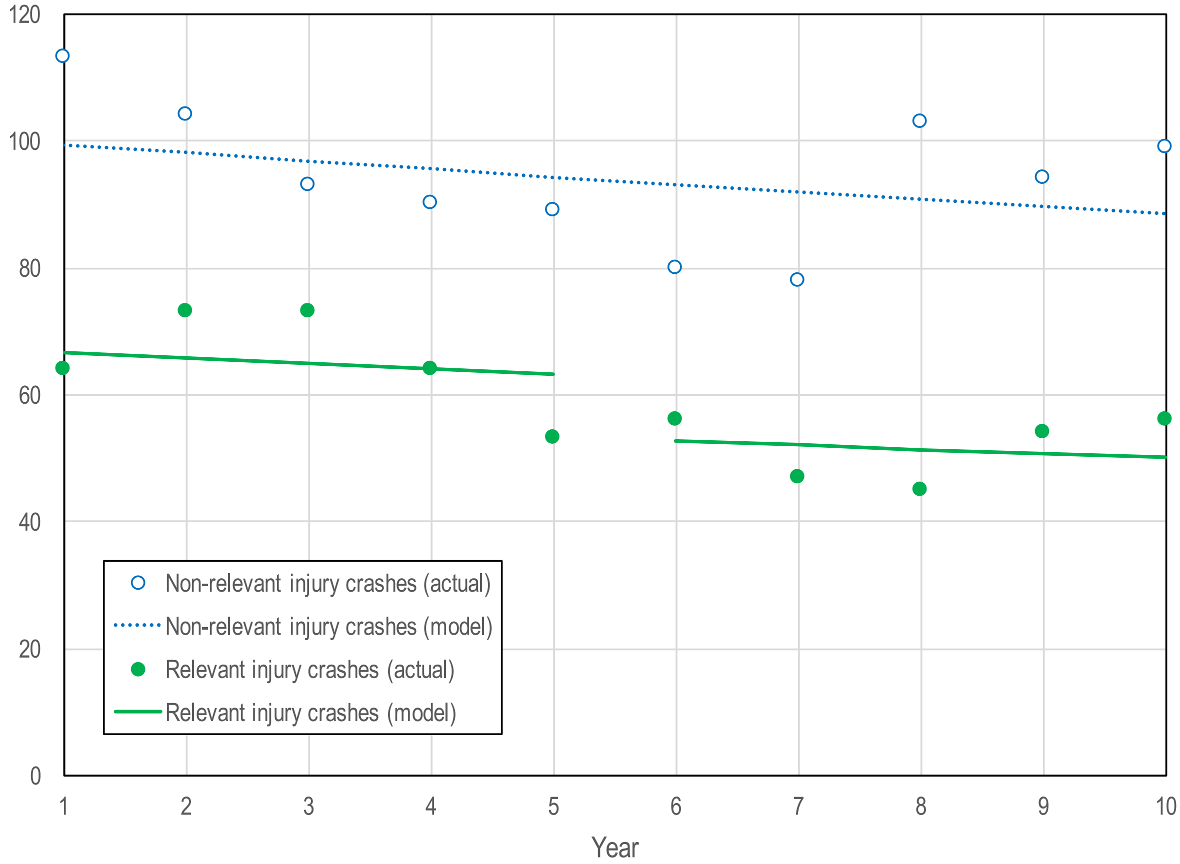
- Relevant injury crashes declined by 1.8% per year but this was not statistically significant (p=0.521)
- The commissioning of the cameras was associated with a 13.2% reduction in relevant injury crashes but this was not statistically significant (p=0.397)

A more detailed model fitted the log of the injury crash numbers (relevant and non-relevant) using year, relevance of crash and a function identifying relevant crashes after the cameras were commissioned. The model found:

- Injury crashes in general declined by 1.3% per year but this was not statistically significant (p=0.274)
- The commissioning of the cameras was associated with a 15.6% reduction in relevant injury crashes but this was not statistically significant (p=0.087)

Figure 3.1 shows the modelled regression lines along with the actual yearly data for both relevant and non-relevant crashes.

Figure 3.1
Actual and modelled yearly injury crash numbers for relevant and non-relevant crashes over time



3.3 Injury crashes at individual sites

The preceding Sections only analysed injury crash numbers summed over all sites. This method is particularly susceptible to a small number of sites with large changes in the number of crashes having a big influence on the resultant observed changes. Since we do not know the full history of other changes made at the intersections, it is possible that other major factors at particular intersections may be skewing the results.

In order to explore the data at an individual site level, the changes in injury crash numbers were examined for each site. In particular, the ratio of injury crashes in the five years after the safety cameras were commissioned to the five years before was determined for each site. The median of this value for all sites represents the typical proportional change among all the sites. Note that these values are much less susceptible to individual site anomalies than those in Section 3.1.

Since the calculated ratio can vary from zero to infinity the log of the ratio was calculated for each site to give numbers below zero for a reduction in injury crashes and numbers greater than zero for an increase in injury crashes. In a purely random system the distribution of the log(ratio) negative numbers should mirror those of the positive numbers. This was tested for using a Wilcoxon Signed Rank test on the log(ratios). A significant result on this test indicates that the observed ratios are unlikely to appear by chance without an underlying effect across the sites.

The changes in total injury crash numbers for the sites are shown in Table 3.3. The median change was a 17.2% reduction in injury crashes and it was statistically significant.

The changes in relevant injury crash numbers for the sites are shown in Table 3.4. The median change was a 16.7% reduction in injury crashes but this was not statistically significant.

The changes in non-relevant injury crash numbers for the sites are shown in Table 3.5. The median change was a 10.5% reduction in injury crashes but this was not statistically significant.

The greater reduction in relevant injury crash numbers compared to non-relevant ones suggests an additional effect of the safety cameras but the lack of statistical significance for either means this could be due to chance alone.

Table 3.3
Total crash changes by site

Site ID	5 years before	5 years after	Difference after-before	Ratio after/before	log(ratio)
69	28	15	-13	0.536	-0.271
57	37	20	-17	0.541	-0.267
97	22	12	-10	0.545	-0.263
95	29	16	-13	0.552	-0.258
64	18	10	-8	0.556	-0.255
48	19	11	-8	0.579	-0.237
67	34	20	-14	0.588	-0.230
103	27	17	-10	0.630	-0.201
66	63	42	-21	0.667	-0.176
107	16	11	-5	0.688	-0.163
98	33	23	-10	0.697	-0.157
102	14	10	-4	0.714	-0.146
49	26	19	-7	0.731	-0.136
56	39	29	-10	0.744	-0.129
63	21	16	-5	0.762	-0.118
70	19	15	-4	0.789	-0.103
65	17	14	-3	0.824	-0.084
76	29	24	-5	0.828	-0.082
74	39	33	-6	0.846	-0.073
101	15	13	-2	0.867	-0.062
91	24	21	-3	0.875	-0.058
51	14	14	0	1.000	0.000
75	18	18	0	1.000	0.000
89	18	20	2	1.111	0.046
61	22	26	4	1.182	0.073
93	24	29	5	1.208	0.082
73	18	22	4	1.222	0.087
94	12	15	3	1.250	0.097
110	23	30	7	1.304	0.115
68	22	29	7	1.318	0.120
105	15	20	5	1.333	0.125
77	13	18	5	1.385	0.141
100	18	25	7	1.389	0.143
50	16	24	8	1.500	0.176
92	17	31	14	1.824	0.261

Median change is 17.2% reduction

p-value for Wilcoxon Signed Rank test on log(ratio) is 0.035 (statistically significant at 5% level)

Table 3.4
Relevant crash changes by site

Site ID	5 years before	5 years after	Difference after-before	Ratio after/before	log(ratio)
69	5	0	-5	0.000	-infinity
98	13	1	-12	0.077	-1.114
49	19	4	-15	0.211	-0.677
95	26	6	-20	0.231	-0.637
74	15	4	-11	0.267	-0.574
66	7	2	-5	0.286	-0.544
67	23	7	-16	0.304	-0.517
97	12	5	-7	0.417	-0.380
102	7	3	-4	0.429	-0.368
64	7	3	-4	0.429	-0.368
89	13	6	-7	0.462	-0.336
77	9	5	-4	0.556	-0.255
48	7	5	-2	0.714	-0.146
61	15	11	-4	0.733	-0.135
76	8	6	-2	0.750	-0.125
107	4	3	-1	0.750	-0.125
65	5	4	-1	0.800	-0.097
92	18	15	-3	0.833	-0.079
70	8	7	-1	0.875	-0.058
91	9	8	-1	0.889	-0.051
57	10	9	-1	0.900	-0.046
101	6	6	0	1.000	0.000
103	10	10	0	1.000	0.000
56	1	1	0	1.000	0.000
93	16	22	6	1.375	0.138
68	10	14	4	1.400	0.146
63	2	3	1	1.500	0.176
75	6	9	3	1.500	0.176
94	5	8	3	1.600	0.204
51	6	11	5	1.833	0.263
105	7	15	8	2.143	0.331
50	3	7	4	2.333	0.368
110	8	19	11	2.375	0.376
100	2	5	3	2.500	0.398
73	5	14	9	2.800	0.447

Median change is 16.7% reduction

p-value for Wilcoxon Signed Rank test on log(ratio) is 0.127 (not statistically significant at 5% level)

Table 3.5
Non-relevant crash changes by site

Site ID	5 years before	5 years after	Difference after-before	Ratio after/before	log(ratio)
64	10	3	-7	0.300	-0.523
48	11	5	-6	0.455	-0.342
57	24	14	-10	0.583	-0.234
101	5	3	-2	0.600	-0.222
73	13	8	-5	0.615	-0.211
103	26	16	-10	0.615	-0.211
69	23	15	-8	0.652	-0.186
51	9	6	-3	0.667	-0.176
56	21	14	-7	0.667	-0.176
70	9	6	-3	0.667	-0.176
107	12	8	-4	0.667	-0.176
63	19	13	-6	0.684	-0.165
97	10	7	-3	0.700	-0.155
110	15	11	-4	0.733	-0.135
65	12	10	-2	0.833	-0.079
91	15	13	-2	0.867	-0.062
66	40	35	-5	0.875	-0.058
49	19	17	-2	0.895	-0.048
76	14	13	-1	0.929	-0.032
50	9	9	0	1.000	0.000
94	6	6	0	1.000	0.000
102	7	7	0	1.000	0.000
105	9	9	0	1.000	0.000
98	20	22	2	1.100	0.041
93	13	15	2	1.154	0.062
68	6	7	1	1.167	0.067
89	12	14	2	1.167	0.067
75	11	13	2	1.182	0.073
95	10	12	2	1.200	0.079
74	24	29	5	1.208	0.082
100	15	20	5	1.333	0.125
92	14	24	10	1.714	0.234
61	12	21	9	1.750	0.243
67	8	14	6	1.750	0.243
77	6	15	9	2.500	0.398

Median change is 10.5% reduction

p-value for Wilcoxon Signed Rank test on log(ratio) is 0.167 (not statistically significant at 5% level)

3.4 Injury crashes at individual sites using non-relevant crashes as a control

The final method involves using the changes in non-relevant injury crashes at each site to correct the observed changes in relevant crashes at each site. This is achieved by dividing the ratio of relevant crashes by the ratio of non-relevant crashes at each site. This gives the effect at each site on relevant crashes over and above the effect seen in non-relevant crashes. As in the previous Section, the log is taken of this ratio of ratios for statistical testing using a Wilcoxon Signed Rank test.

The changes in this ratio for each of the sites are shown in Table 3.6. The median change was a 12.5% increase in injury crashes but this was not statistically significant.

Table 3.6
Ratio of relevant to non-relevant crash ratios by site

Site ID	Relevant ratio	Non-relevant ratio	Ratio of ratios relevant/non-relevant	log(ratio)
69	0.000	0.652	0.000	-infinity
98	0.077	1.100	0.070	-1.155
67	0.231	1.750	0.132	-0.880
77	0.429	2.500	0.171	-0.766
95	0.211	1.200	0.175	-0.756
74	0.267	1.208	0.221	-0.656
61	0.556	1.750	0.317	-0.498
49	0.286	0.895	0.319	-0.496
66	0.304	0.875	0.348	-0.459
102	0.429	1.000	0.429	-0.368
97	0.417	0.700	0.595	-0.225
75	0.714	1.182	0.604	-0.219
76	0.733	0.929	0.790	-0.103
57	0.462	0.583	0.791	-0.102
89	1.000	1.167	0.857	-0.067
65	0.800	0.833	0.960	-0.018
91	0.889	0.867	1.026	0.011
107	0.750	0.667	1.125	0.051
68	1.375	1.167	1.179	0.071
93	1.400	1.154	1.213	0.084
56	0.833	0.667	1.250	0.097
70	0.900	0.667	1.350	0.130
92	2.333	1.714	1.361	0.134
94	1.500	1.000	1.500	0.176
103	1.000	0.615	1.625	0.211
48	0.750	0.455	1.650	0.217
101	1.000	0.600	1.667	0.222
105	1.833	1.000	1.833	0.263
100	2.500	1.333	1.875	0.273
50	2.143	1.000	2.143	0.331
63	1.500	0.684	2.192	0.341
51	1.600	0.667	2.400	0.380
64	0.875	0.300	2.917	0.465
110	2.375	0.733	3.239	0.510
73	2.800	0.615	4.550	0.658

Median change is 12.5% increase

p-value for Wilcoxon Signed Rank test on log(ratio) is 0.589 (not statistically significant at 5% level)

4 Discussion

This study has analysed the injury crash data for 35 safety camera intersections in South Australia that have been in place for at least five years. By comparing the injury crash numbers for five years before and five years after site commissioning at each of the intersections, an attempt was made to determine if the safety cameras are having a beneficial effect on injury crash numbers and to estimate the size of this effect.

In an attempt to control for long term trends in injury crash numbers, changes in relevant injury crashes (those involving a vehicle passing a safety camera) were compared with changes in non-relevant injury crashes (those involving only vehicles not passing a safety camera) at the intersections.

4.1 Apparent effects of safety cameras on crashes

By summing injury crashes across the 35 intersections and comparing the numbers in the five years before commissioning with the five years after, the following was found:

- There was a **13% reduction in injury crashes** at the intersections after the safety cameras were commissioned. This was statistically significant which means that it is likely that there was a real reduction in injury crash risk (however, the statistical test conducted may not be based on valid assumptions).
- There was a **21% reduction in relevant injury crashes** at the intersections after the safety cameras were commissioned. This was statistically significant which means that it is likely that there was a real reduction in injury crash risk for crashes involving vehicles passing the safety cameras (however, the statistical test conducted may not be based on valid assumptions).
- There was a **7% reduction in non-relevant injury crashes** at the intersections after the safety cameras were commissioned. This was not statistically significant which means the reduction could be the result of chance alone.
- By adjusting the expected number of relevant injury crashes by the change in non-relevant crashes it was found that there was a **15% reduction in relevant injury crashes** above that seen for non-relevant injury crashes. This is the estimate for the effect of the safety cameras above any background trend in injury crashes. However, the differential reductions were not statistically significant which means the net reduction could be the result of chance alone.

When fitting regression models to the yearly injury crash numbers the following was found:

- The commissioning of the cameras was associated with a **13.2% reduction in relevant injury crashes** but this was not statistically significant (p=0.397) which means the reduction could be the result of chance alone.
- When the changes in non-relevant crashes were also taken into account, the commissioning of the cameras was associated with a **15.6% reduction in relevant injury crashes** but this was not statistically significant (p=0.087) which means the reduction could be the result of chance alone.

An alternative analysis was carried out that examined the changes in injury crash numbers at each site individually and checked for consistency in the changes across all the sites. The following was found:

- More sites showed reductions in injury crashes than increases. The typical (median) change was a **17% reduction in injury crashes** after the safety cameras were commissioned. This was statistically significant which means that it is likely that there was a real system wide reduction in injury crash risk.
- More sites showed reductions in relevant injury crashes than increases. The typical (median) change was a **17% reduction in relevant injury crashes** after the safety cameras were commissioned. This was not statistically significant which means the reduction could be the result of chance alone.
- More sites showed reductions in non-relevant injury crashes than increases. The typical (median) change was an **11% reduction in non-relevant injury crashes** after the safety cameras were commissioned. This was not statistically significant which means the reduction could be the result of chance alone.

A final analysis was carried out that examined the changes in relevant injury crash numbers at each site corrected by the changes in non-relevant injury crash numbers at the same site and checked for consistency in the resultant changes across all the sites. The following was found:

- Slightly more sites showed corrected increases in relevant injury crashes than reductions. The typical (median) change was a **13% corrected increase in relevant injury crashes** after the safety cameras were commissioned. This was not statistically significant which means the increase could be the result of chance alone.

4.2 Study limitations

While this study has found some general reductions in injury crashes to be associated with safety camera installation, there are a number of limitations in the methodology used.

The selection of sites for installation of a safety camera was based, at least in part, on the crash history of those sites. This means that sites where there was a random increase in crashes in the years before selection would be more likely to be selected and then revert back to their normal level of crashes in the years after. This gives an apparent additional effect of treatment that is not real. This is known as regression to the mean and is exceedingly hard to correct for after the selections have been made.

The selected sites, having high crash rates, may also have other treatments applied. Part of any apparent reduction in crashes could be the result of these additional treatments. It was not feasible in this study to identify the history of other changes to the sites examined and even if it was, it is not clear how a correction could be made.

The long time period of crashes examined (10 years for each site) means that the underlying injury crash rates could be changing. Vehicles are becoming safer due to better construction and more safety features leading to generally fewer injury crashes. Traffic volumes may be increasing leading to more injury crashes in general.

An attempt was made to take these trends into account by using changes in non-relevant injury crashes as a form of control with these changes representing the “background” effects against which the changes in relevant injury crashes could be compared.

However, it is possible that there is a halo effect of the safety cameras on the non-relevant intersection legs whereby they also reduce the risk of non-relevant injury crashes. This means the actual benefits of the safety cameras, when taking in to account the control crashes, may be greater than they appear.

Finally, the small number of sites available for analysis and the low frequency of injury crashes at these sites means that statistical analysis can only hope to identify large effects. Smaller but still meaningful effects will be lost in random variation.

4.3 Conclusion

The analyses carried out suggest that safety cameras, as implemented in South Australia, are reducing injury crashes on the monitored legs of the treated intersections. Estimates of the size of the reduction range up to 21%. This is in general agreement with the literature suggesting a modest but real effect of fixed cameras (eg Wilson et al, 2010).

As more safety cameras are installed in South Australia and more time passes to allow crash data to accumulate for newer sites, the current analysis can be extended to provide more precise estimates of the effect of the cameras (although some of the methodological limitations will still remain).

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