Analysis of Toronto's Red Light Cameras*

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Red light cameras serve a number of purposes for the Municple Governemnt of Toronto. Firstly, they police the roads, creating a safer community for all Torontonians and secondly, they generate revenue for the city. To complete the analysis of the red light camera data provided by opendatatoronto, in this report I use tables and graphs to visualize the information. I also use the data to asist in the analysis of how the COVID-19 pandemic has impacted red light camera tickets.

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*Code and data are available at: https://github.com/Crooksyyy/Toronto-Red-Light-Camera-Analysis-.

1 Introduction

In Toronto the fine for entering an intersection during a red light, and being caught by a red light camera is 325CAD ("Red Light Cameras" 2024). This is a very large fine, which most would like to avoid however, since 2007, the red light cameras across the city have issued thousands of tickets (Gelfand 2022). The total number of tickets issued in 2022 was 129896. This would imply the red light cameras generated over 42 million CAD worth of revenue for the city of Toronto. This may seem like a large amount however, compared to the city of Toronto operating budget of 17 billion CAD ("2024 City Budget" 2024).The red light camera fines relative to the cities budget are not generating a substantial amount of revenue.

Red light cameras are not only designed to increase revenue for the city they serve as additionally, they are intended to aid in making the roads safe for pedestrians, cyclist and vehicle operators. This is very difficult to measure as you would need to analyze the data for accidents at a given intersection before and after the red light camera was installed. This would also have to be applied to a radius around the intersection, not just the intersection itself. This analysis requires an extensive data set, likely combining multiple data sets with methods like multi-level post stratification methods.

The goal of this paper is to focus on neither goal of red light cameras but analyze the trends that occur at a red light camera intersection or red light cameras in general. The reason for this is the city of Toronto continues to install more red light cameras through out the city. A recent CBC news article discusses both red light cameras and speed cameras (Jeffords 2024). I look to answer questions such as why is the number of tickets in a given year more or less than the years prior.

The remainder of this paper is structured as follows. Section 2 and Section 3, both with subsections within. Section 2 focuses on the strength and weaknesses of the raw data and the cleaned data. Section 3 focuses on what further analysis can be done to understand the effectiveness of red light cameras in the city of Toronto.

2 Data

2.1 Data Introduction

The data in this analysis is openly accessible from the Gelfand (2022), a R Core Team (2022) package which allows data sets from the city of Toronto to be easily used in R. The data used in this paper is extremely simple. The data consists of a list of intersections that have had a red light camera since 2007, when the city began installing them, to 2022. For each intersection it lists the number of tickets each camera has issued. This means it is a small to moderately sized data set as it has a row for each year between 2007-2022 and a row for each intersection with a red light camera. Table 1 displays a sample of the data set to illustrate the

simplicity of the data. Unfortunately, the data has not been updated since the end off 2022 (Services 2024). The data is supposed to be updated semi-annually but was last updated in March of 2023, with the complete 2022 data (Services 2024).

Table 1: Sample of the data set, 6 different red light camera locations and the number of ticketes issued each year from 2007-2010

Location	2007	2008	2009	2010
Richmond St. and Parliament St.	46	1208	909	998
Lake Shore Blvd. and York St.	42	635	165	238
Steeles Ave. and Carpenter Rd.	70	1061	1123	835
Steeles Ave. and Hilda Ave.	25	625	527	760
Albion Rd. and Silverstone Dr.	222	1467	1137	1092
Albion Rd. and Finch Ave.*	0	0	93	171

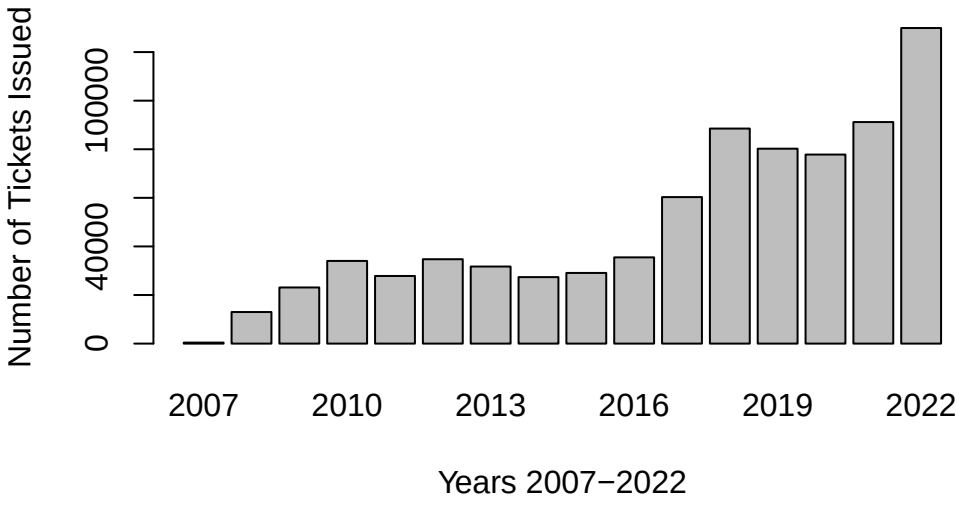

Figure 1: The total number of red light camera tickets issued in Toronto from 2007-2022

Obviously, not all 300 red light cameras were installed in 2007, only 6 red light cameras we installed in 2007. This means for the years the cameras were not yet installed it should show it issued 0 tickets. In the raw data this was true for a number of lights, however not all. This proved to be a challenge when completing statistics or graphs of the data, requiring N/A values to be assigned a value of 0. An example of a red light camera issuing 0 tickets can be seen

in Table 1. Albion Rd. and Finch Ave. issued 0 tickets in 2007 and 2008 because it was not yet installed. In Figure 1 the distribution of tickets issued since the cameras were installed in 2007.

The number of tickets overall trend is an increase year over year. A handful of years issued less tickets than the previous. An obvious example is in 2020 we see a decrease compared to both the previous years, a result of the COVID-19 pandemic, resulting in multiple lockdowns during the year. To truly understand how many tickets are issued each year, the average number of tickets per year is in Table 2.

2.2 Data Insights {sec-datainsights}

Table 2: Mean number of tickets issued by red light cameras in Toronto by year from 2007-2022

Year	Mean
mean_2007	68
mean_2008	317
mean_2009	321
mean_2010	460
mean_2011	366
mean_2012	476
mean_2013	423
mean_2014	360
mean_2015	383
mean_2016	467
mean_2017	413
mean_2018	606
mean_2019	550
mean_2020	548
mean_2021	447
mean_2022	464

This table provides an interesting insight. On average more tickets were issued in 2018 than 2022, which means Figure 1 may be misleading as it clearly shows more tickets being issued in 2022. This is a result of the total number of cameras installed in each year. In 2018 only 146 cameras were installed, however in 2022, 280 cameras were installed. This means the increase in tickets is not a result of the each camera actually issuing more tickets, but more cameras in total issuing tickets. Again a likely cause of the cameras not issuing as many tickets in 2022 as 2018 could be the COVID-19 pandemic. During the year 2022, the economy and society were just returning to their 'normal' or, pre pandemic times Section 2.1. In order to determine

this the data for 2023 would be required as it was the first full year post pandemic. However, mentioned previously the data is currently only available for 2022.

3 Discussion

3.1 Data Positives

There were multiple benefits to this data set. Most obviously was the simplicity of the data, it was originally in an excel file(XSLS). Opening this file directly from the Services (2024) website was extremely insightful. All the variables were extremely simple and easy to understand. The topic in general is also extremely simple making analyzing the topic very straight forward.

3.2 Data Drawbacks

Although the data is simple and easily understandable, it had many drawbacks. Firstly, there was a number of different formats within the data. Specifically, there were a number of different ways the data represented 0 tickets issued such as 0, "N/A" or N/a. This increased the complexity in cleaning the data as having 0 tickets issued is very different from missing data all together. Another drawback was the variable names. All the year variables were not named, when cleaning the data the names were created as the given year. This created a number of problems when trying to analyze the data as a number of functions were difficult to use.

3.3 Next steps

There are multiple ways to continue this analysis. Firstly, obtaining the 2023 data to more accurately determine how the pandemic impacted the number of tickets issued. Another way to continue analyzing red light cameras is to measure how effective red light cameras are at preventing accidents. That is not possible with just this data set. This would require a number of other data sets including geographical data of accidents around red light cameras before and after a red light camera was installed. Then, complete analysis of the number of accidents before and after the red light camera was installed. This type of analysis is outside the scope of this paper but an interesting topic for future studies.

Appendix

.1 Data Cleaning

The first step in cleaning the data was completed when opening the file by removing the formatting issues. These issues were caused by the XSLS file as the column names were filled as N/A. To do this I simply removed the first row when opening the file for cleaning as the next row actually had the titles. The next step was setting any missing value equal to zero. Another formatting mistake is that the column for year 2017 was a character class not numeric. This had to be changed as well. This created a single missing value that was removed from the data. Lastly, more appropriate names for the column were added.

.2 Data

```
Rows: 303
Columns: 17
$ Location  <chr> "Richmond St. and Parliament St.", "Lake Shore Blvd. and Yor~
$ year_2007 <dbl> 46, 42, 70, 25, 222, 0, 0, 0, 0, 5, 0, 0, 0, 0, 0, 0, 0, ~
$ year_2008 <dbl> 1208, 635, 1061, 625, 1467, 0, 160, 34, 0, 223, 436, 54, 0, ~
$ year_2009 <dbl> 909, 165, 1123, 527, 1137, 93, 86, 193, 140, 165, 494, 161, ~
$ year_2010 <dbl> 998, 238, 835, 760, 1092, 171, 75, 181, 189, 117, 454, 74, 9~
$ year_2011 <dbl> 827, 394, 782, 846, 975, 145, 96, 420, 169, 188, 288, 90, 81~
$ year_2012 <dbl> 1100, 592, 999, 1000, 1213, 251, 136, 463, 165, 198, 228, 20~
$ year_2013 <dbl> 812, 249, 834, 906, 1289, 160, 106, 405, 159, 144, 353, 151,~
$ year_2014 <dbl> 721, 310, 747, 632, 1071, 110, 86, 386, 98, 113, 275, 174, 9~
$ year_2015 <dbl> 809, 410, 436, 710, 779, 70, 56, 269, 160, 132, 217, 188, 87~
$ year_2016 <dbl> 829, 271, 601, 786, 797, 143, 123, 452, 155, 131, 193, 168, ~
$ year_2017 <dbl> 3994, 45, 528, 501, 604, 32, 27, 190, 34, 23, 213, 24, 1004,~
$ year_2018 <dbl> 6615, 324, 804, 639, 0, 0, 71, 377, 137, 173, 283, 71, 885, ~
$ year_2019 <dbl> 2937, 321, 623, 455, 1181, 0, 99, 410, 147, 150, 371, 113, 1~
$ year_2020 <dbl> 2106, 1197, 920, 627, 947, 0, 82, 1313, 94, 65, 307, 342, 26~
$ year_2021 <dbl> 1400, 840, 1830, 1314, 912, 0, 30, 430, 90, 179, 458, 176, 2~
$ year_2022 <dbl> 1290, 757, 1794, 1558, 1196, 0, 48, 262, 108, 201, 515, 0, 2~
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