Analyzing the Impact of Reporting Periods on Law Enforcement Officer Behavior

Stakeholder Report

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Executive Summary

This report examines the behavior of local law enforcement officers in response to the approaching end of a fiscal reporting period. Specifically, we seek to explore whether the ticketing behavior of officers changes in response to possible financial pressures or incentives to generate revenue. To accomplish this, the number of citations issued in a city was examined over time. When investigating month-end, quarter-end, or fiscal year-end changes, we find little to no evidence that officers increased ticketing activity in response to an approaching deadline, regardless of the legal status of quotas in the state. There are two noteworthy exceptions to this conclusion, however. The city of Cincinnati, Ohio, displayed several interesting trends during our analysis of monthly aggregated data that points to the probable existence of policing quotas in several years. Additionally, Aurora, Colorado, showed upward trends at the end of all three periods in our analysis.

Introduction

The discussion about policing or ticketing quotas has been a fixture of the American consciousness for decades. Most people who grew up in the United States can recall a parent, grandparent, friend, or other person advising them to be extra cautious with their speed while driving close to the end of the month. “Watch out, they give extra tickets when the month is about to end,” is a cliche many have heard. This myth has carried into journalism as well, with most investigations focusing on the impact of “policing for profit,” as the alleged practice of using citations to boost local government revenue has become known.[1] Whether or not the approach is even effective at raising revenue is an even trickier concept that has come to the surface as police behavior has become more closely examined in recent years.[2]

One such mechanism that could indicate the presence of policing practices designed to raise revenue is a ticket quota. Background research suggests that there are at minimum 26 states that currently forbid the practice of establishing police quotas.[3] Upon reviewing these various laws, it is worth pointing

[1] Keller, Michael H. “The Demand for Money Behind Many Police Traffic Stops (Published 2021).” *The New York Times*, 2 November 2021, https://www.nytimes.com/2021/10/31/us/police-ticket-quotas-money-funding.html

[2] Menendez, Matthew, et al. “The Steep Costs of Criminal Justice Fees and Fines.” *Brennan Center for Justice*, 21 November 2019, https://www.brennancenter.org/our-work/research-reports/steep-costs-criminal-justice-fees-and-fines

[3] Fielding, Jackie. “Outlawing Police Quotas.” *Brennan Center for Justice*, 13 July 2022, https://www.brennancenter.org/our-work/analysis-opinion/outlawing-police-quotas

out that there is a disparity that exists between some.[4] For instance, some states forbid police quotas *as a means to evaluate officer performance (California),* while others simply outlaw the practice altogether (North Carolina). Some states relied on legislative bills (Colorado), while others included these provisions in the state's legal code (Wisconsin). These differences are noteworthy when evaluating the effectiveness of legal attempts to stop the practice, although we find little practical impact when analyzing those approaches.

There is an additional consideration regarding the actual construct of police quotas. As noted in some recent reporting, even in states that explicitly outlaw the use of quotas, there exist other ways for departments to influence officer behavior informally.[5] These implicit methods could range from seemingly innocuous practices such as ticket leaderboards in public places to using citation counts as a discriminator for selecting officers for preferred assignments. These practices may evade legal statutes, but we still expect to observe their impact when analyzing ticketing behavior over time.

Data

This analysis relied on data from the Stanford Open Policing Project.[6] The Stanford Open Policing Project is one of the definitive sources of information on policing activity in the United States, with data available for many states and cities. The span of coverage for each city or state varies, but the general range is from roughly 2000 to 2019. Specifically, we collected data for cities in the Project that reported granular data about police incidents and, critically, the outcome (citation issued or not). We downselect to the city level to gain the most granular data possible before processing it into a final dataset. In the final format, we also chose to exclude the month of December, as we observed a significant alteration to the activity of law enforcement officers during that period, likely caused by the significant holiday period that month. Appendix A (Summary of Cities Examined) and Appendix B (Timeline of Examined Cities) present the final cities used in the analysis.

Analysis

After an initial exploration of available data, we truncated our study to the fifteen cities with the best available data. We then utilized the same techniques in each city to determine where we could detect evidence of practices that amounted to explicit or implicit policing for profit. Appendix C (Summary of Analytical Techniques) provides an overview of the analytical techniques employed. Table 1 (below) provides a graphical summary of the analysis findings, namely that three cities showed a significant, positive movement in the number of citations issued as a reporting cut-off approached. When we examined further, we determined that the observations in two cities were practically significant and chose to disregard the third.

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[4] Ossei-Owusu, Shaun. "Police Quotas." *New York University Law Review*, vol. 96, no. 529, 2021, pp. 529-605. *Perma.cc*, https://perma.cc/NR59-FDUK

[5] SafeMotorist.org. "Do Traffic Ticket Quotas Really Exist?" *SafeMotorist.com*, https://www.safemotorist.com/articles/traffic-ticket-quotas/

[6] Stanford Open Policing Project. "Data." *The Stanford Open Policing Project*, 2023, https://openpolicing.stanford.edu/data/

Table 1. Summary of Analysis Findings

City	Quota Legality	End of Month	End of Quarter	End of Year
Bakersfield, CA	Illegal	—	—	⇩
San Francisco, CA	Illegal	⇩	⇩	⬇
Aurora, CO	Illegal	⇧	⇧	⬆
Denver, CO	Illegal	—	—	—
New Orleans, LA	Uncertain	—	—	—
Baltimore, MD	Uncertain	—	—	—
Durham, NC	Illegal	⇩	—	⇧
Greensboro, NC	Illegal	—	—	—
Winston-Salem, NC	Illegal	⇩	⇩	—
Cincinnati, OH	Legal	⬆	—	—
Oklahoma City, OK	Legal	—	—	—
Houston, TX	Uncertain	—	—	—
San Antonio, TX	Uncertain	⇩	—	—
Seattle, WA	Legal	—	—	⇩
Madison, WI	Uncertain	—	⇩	—

⬆ - *Practically Significant Increase Observed*
⬇ - *Practically Significant Decrease Observed*
⇧ - *Statistically Significant Increase Observed*
⇩ - *Statistically Significant Decrease Observed*
— - *No Significant Effect Observed*

Cincinnati, OH is the only city in our group that showed a positive increase in citations as the end of the month approached. Aurora, CO, showed a positive result across all three periods, but we only assessed the fiscal year cut-off as practically significant. These trends indicate the presence of some sort of implicit or explicit influence on officers' behavior in those jurisdictions. However, we do not assess that this shows a widespread phenomenon that could be generalized to multiple jurisdictions. Furthermore, the practicality of the observed effect in all cities is not always significant, as discussed below.

Contrary to our expectations, nearly half of the cities had at least one permutation where there was negative movement in citations before the end of a period. However, we assessed that these effects were practically insignificant when we analyzed the results further. The most notable exception is San Francisco, which will be presented below. The remaining results are available in Appendix G (Additional Analysis Results)

Cincinnati, OH

Cincinnati is the most noteworthy city in the study. In 2010, 2011, 2014, 2015, 2017 (pictured), and 2018 we observed significant and noticeable increases in the number of citations issued as the end of a month drew near (Appendix D). The later years in that span showed the most apparent increases, with the trendline for 2017 showing roughly a 50% increase in ticketing behavior over the last five days of a month. The number of years where we observed this trend and the magnitude of the change makes a strong argument that, at least in the city of Cincinnati, law enforcement officers were likely under pressure to increase ticketing activity as reporting periods approached.

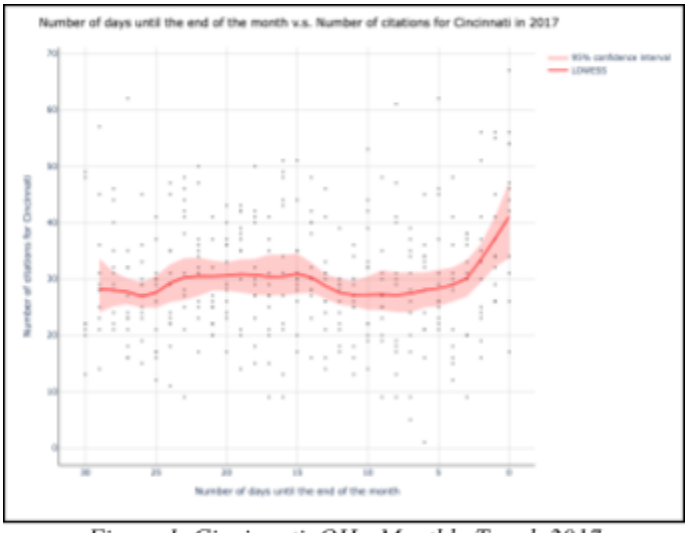


Figure 1. Cincinnati, OH - Monthly Trend, 2017

When we investigated the city of Cincinnati further, we found circumstantial evidence that points to the prospect that officers could have been under pressure to generate revenue through ticketing. The city's 2017 Budget Book explicitly mentions budget deficits and methods the city was undertaking to mitigate those shortfalls.[7] One such tool was an increase in the fine per parking ticket issued. The city's financial documents never specifically call out revenues from parking fines or any other form of citation. However, we believe this points to a strong possibility that officers were pressured to meet monthly quotas for the city. The trends observed support this conclusion.

Aurora, CO

Figure 2 (right) displays a general pattern that is approximate for Aurora throughout the time covered in our analysis. When visualized at the annual level with days to the end of the fiscal year as the independent variable, we observed a noticeable rise in the number of citations issued as the fiscal year approached. However, the trend begins almost two months before the end of the year, and the confidence interval does widen somewhat. We still consider this a practically significant result but cannot find potential causes when investigating the city further, and therefore

Figure 2. Aurora, CO - Annual Trend, All Years

[7] City of Cincinnati. "City of Cincinnati Budget Book - Biennial Recommended.book." *City of Cincinnati*, 24 May 2017, https://www.cincinnati-oh.gov/sites/budget/assets/File/FINAL%205-24-17%20Biennial%20Recommended.pdf.

assume that it reflects the natural behavior of officers and the city's population.

When we interrogate the Aurora, CO data for month-end and quarter-end trends, we can observe the region where there may be a statistically significant effect (see Appendix E - Aurora, CO analysis). However, the data visualized longitudinally clearly communicates different results. We conclude that the significant effect detected in Aurora for month and quarter-end is an artifact of the regression and not likely caused by any intentional change in the behavior of the law enforcement officers there.

An additional consideration for dismissing the findings in Aurora is its proximity to the city of Denver. Aurora is technically an independent constituency; however, it is essentially a suburb of the more prominent Denver immediately to the west. Both cities have different demographics and leadership, but we would expect some similarity in their societies' behavior based on proximity alone. In Denver, we find no significant effects on any time horizon, lending support to the conclusion that Aurora is also likely not experiencing a practical change in the behavior of its law enforcement officers.

San Francisco, CA

San Francisco presented the most puzzling of the fifteen cities analyzed in this study. The city showed significant negative trends across all three periods, with the end-of-fiscal-year cut-off being the most intriguing. As seen in Figure 3 (right), a very well-defined negative slope to the regression curve begins approximately 40 days before the end of the fiscal year. It continues with a reasonably tight confidence interval. This follows a generally flat trajectory through the preceding ten months of the fiscal year. We found little to no explanation for this phenomenon and point out that California has had statutes in place for many years that expressly prohibit policing quotas as an evaluation tool for officers. Whether or not this provision prohibits the use of the practice in generating revenue is a debate we do not address here.

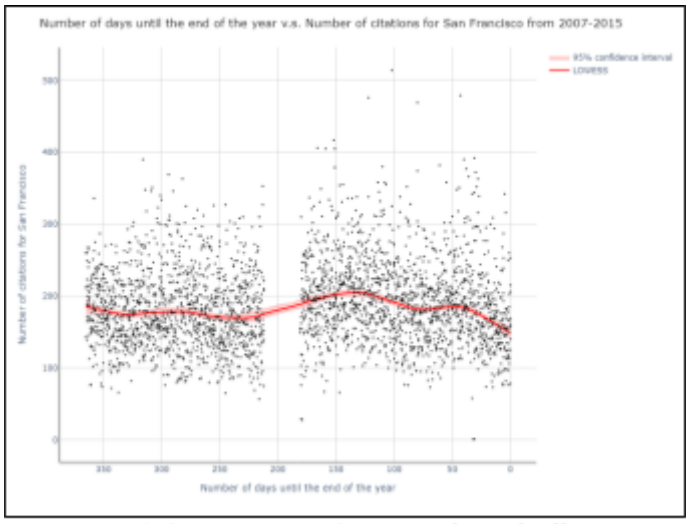


Figure 3. San Francisco, CA - Annual Trend, All Years

We also looked further into California's month-end and quarter-end results and found no significant results for either period. Both periods were consistent throughout and slightly decreased towards the end. The monthly and quarterly analysis for San Francisco is available in Appendix F (San Francisco, CA Analysis).

Limitations

The team identified several areas worth noting when evaluating the validity of this analysis. We are primarily concerned with the murky nature surrounding the disparate legal statuses of policing quotas and the associated timelines. There are at least 26 states that do not allow quotas presently, but when those statutes came into effect, has proved to be less than an exact science. This makes our analysis largely observational.

A second area that requires additional investigation is the impact of local budgetary practices that might affect policing practices. This topic was the primary focus of some recent journalistic investigations.[8] Upon examining the financial disclosures of Durham, NC, we found no mention of revenues generated from police or court activity; however, this does not mean that other constituencies we explored adhere to the same practice. It is certainly possible that officers' behavior might be influenced if the department at least partially relies on that revenue stream. Investigating this effect requires significant research and a robust methodology to quantify these approaches. This is outside the scope of our analysis presented here.

Conclusion

We evaluated this effect as the month, quarter, and fiscal year ended for 15 U.S. cities spanning 20 years. The outcome of our analysis is that we do not detect a response from law enforcement officers to the approaching end of a reporting period. The legitimacy of departmental quotas does not appear to influence behavior. There were effects detected in most of the cities analyzed; however, we dismissed many findings as not practically significant when investigated further. The most noteworthy observations were in select years in Cincinnati, OH, where there was a clear influence on law enforcement officer behavior as the end of the month approached. While we could not find direct evidence of a ticket quota in the city for those years, this behavioral pattern implies that a quota existed at at least an informal level.

San Francisco, CA, showed a puzzling trend when its annual data were analyzed, with a noticeable decrease in citations as the fiscal year drew close. We have little explanation for this trend other than to offer theories that might attribute the effect to a combination of environmental changes around the city each summer. This trend is certainly worth investigating by itself outside the bounds of this research project. Beyond these two cities, we are left with little evidence that the behavior of local law enforcement officers is impacted by financially-motivated incentives to generate revenue for the city government or is being impacted by explicit or implicit citation quotas.

[8] Menendez, 2019

Appendix A - Summary of Cities Examined

Table 2. Summary of Cities Examined

City	State	Time Period[9]	Quota Legality[10]	Notes
Bakersfield	California	2010 - 2017	Illegal - 2020 (Statute)	Updated in 2020, existed in forms prior
San Francisco	California	2007 - 2015	Illegal - 2020 (Statute)	Updated in 2020, existed in forms prior
Aurora	Colorado	2012 - 2019	Illegal - 2010 (Bill)	
Denver	Colorado	2011 - 2017	Illegal - 2010 (Bill)	
New Orleans	Louisiana	2012 - 2017	Illegal - 2020 (Statute)	Prior legality uncertain
Baltimore	Maryland	2011 - 2017	Illegal - 2020 (Statute)	Prior legality uncertain
Durham	North Carolina	2002 - 2015	Illegal - 2020 (Statute)	Updated in 2020, existed in forms prior
Greensboro	North Carolina	2002 - 2013	Illegal - 2020 (Statute)	Updated in 2020, existed in forms prior
Winston-Salem	North Carolina	2002 - 2013	Illegal - 2020 (Statute)	Updated in 2020, existed in forms prior
Cincinnati	Ohio	2009 - 2017	Legal	
Oklahoma City	Oklahoma	2011 - 2019	Legal	
Houston	Texas	2014 - 2019	Illegal - 2019 (Statute)	Prior legality uncertain
San Antonio	Texas	2012 - 2019	Illegal - 2019 (Statute)	Prior legality uncertain
Seattle	Washington	2006 - 2015	Legal	Became illegal in 2020 (Bill)
Madison	Wisconsin	2008 - 2016	Illegal - 2019 (Statute)	Prior legality unceratin

[9] Stanford Open Policing Project, 2023
[10] Ossei-Owusu, 2021

Appendix B - Timeline of Examined Cities

Table 3. Timeline of Examined Cities

City	Data Begin	Data End	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bakersfield	2010	2017																					
San Francisco	2007	2015																					
Aurora	2012	2019																					
Denver	2011	2017																					
New Orleans	2012	2017																					
Baltimore	2011	2017																					
Durham	2002	2015																					
Greensboro	2002	2013																					
Winston-Salem	2002	2013																					
Cincinnati	2009	2017																					
Oklahoma City	2011	2019																					
Houston	2014	2019																					
San Antonio	2012	2019																					
Seattle	2006	2015																					
Madison	2008	2016																					

Appendix C - Summary of Analytical Techniques

The analytical approach utilized in this project is three-pronged. We begin with an exploratory data analysis to narrow the cities and time horizons of interest. Next, we used a fixed effects regression to estimate the statistical effect of the end of a month, quarter, or fiscal year and evaluate for statistical significance. Finally, a LOESS curve was used to gain further insight into the trends observed, with smoothing applied to make the curve more robust to fluctuations in the data.

Our methodology necessitated identifying a cut-off value for the end of the month, quarter, and year. To this end, we selected dates within five days of the end of the month, ten days of the end of the quarter, or 15 days of the end of the fiscal year as meeting our indicator criteria. These variables are critical to the fixed effects regression discussed below.

Exploratory Analysis

The data exploration focused on finding a pattern in citations issued by the local police force in selected cities during different periods. We made a sliding time window to define the best cutoff number of days leading to the end of each fiscal year, quarter, and month. We grouped analysis of month and quarter ends by the calendar year and grouped all fiscal years, and then explored the mean values of each subset. We hope that finding a pattern will allow us to focus more on the cities with potential alignment with our interests.

Fixed Effects Regression

A fixed effects model is a statistical approach used to analyze panel data, which accounts for unobserved heterogeneity by controlling for entity-specific characteristics that do not vary over time. By including these fixed effects, the model isolates the impact of the independent variables of interest while reducing the potential for omitted variable bias.

In this analysis, a fixed effects regression is conducted to investigate the relationship between the issuance of citations and time-related factors, such as the end of the month, end of the quarter, and end of the year, across different cities. The fixed effects regression accounts for unobserved heterogeneity by considering city-specific and time-specific effects. City-specific effects represent the unique characteristics of each city, while time-specific effects capture trends and changes over time that are common across cities. This approach allows for a more accurate understanding of the underlying relationships and helps inform policy decisions and resource allocation for citation enforcement.

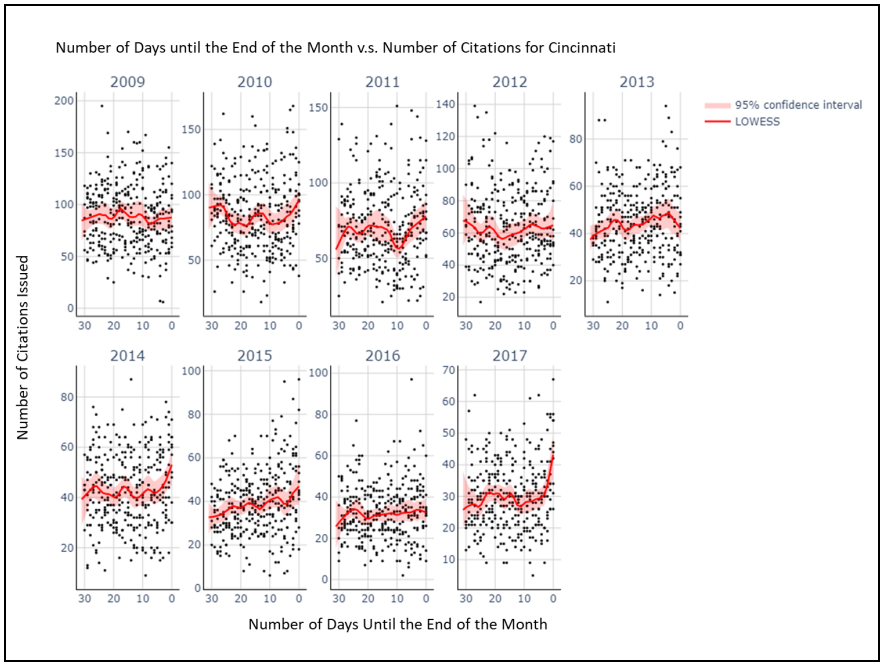
LOESS

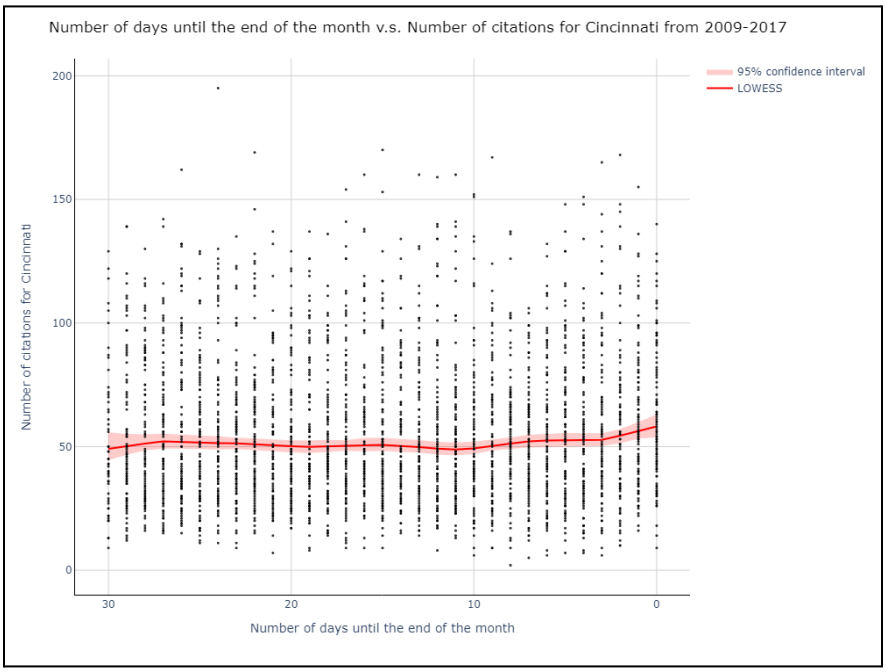
LOESS (Locally Estimated Scatterplot Smoothing) is a regression analysis technique used to investigate the relationship between two variables displayed in a scatterplot. Instead of relying on assumptions about the data distribution and linearity, LOESS estimates a smooth curve by calculating weighted averages of nearby data points. As a result, it is more flexible, robust, and capable of modeling non-linear relationships and handling outliers.

In our study, we explored the relationship between the number of citations issued and the number of days until the end of the month. By applying LOESS to the scatterplot, we could visualize any patterns

or trends and investigate the existence of policing-for-profit practices, such as ticket quotas. To fine-tune the curve fitting process, we controlled the smoothing parameter, α, which determines the number of data points used in each local fit. After testing different values, we found that using $\alpha=0.2$ provided the best fit for modeling the two variables across different cities and years.

Appendix D - Cincinnati, OH Analysis





The figures to the left display results from our investigation for Cincinnati. In 2010, 2011, 2014, 2015, 2017, and 2018 there was a noticeable uptick in the number of citations issued as the end of the month approached. In 2010 the effect was more muted because of the curve's bow shape, but the remaining years clearly point to the existence of either an implicit or explicit quota at the local police department level. The magnitude of the increases over the final five days of the month is shocking, reaching almost 50% in 2017.

The figure below-left shows the aggregated data. The confidence interval remains fairly consistent throughout, with a defined uptick as the end of the month approaches. In the regression summary (Table 4, next page), we can observe that there is indeed a significant result associated with an end-of-month indicator (<5 days to month-end). The upper and lower range values are also comfortably above zero, such that Cincinnati has produced a practically, statistically, significant result in this case.

Table 4. Fixed Effects Regression Summary for Cincinnati, OH (End of Month)

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0056
Estimator:	PanelOLS	R-squared (Between):	0.0217
No. Observations:	3008	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	0.0217
Time:	18:01:10	Log-likelihood	-1.333e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	16.790
Entities:	3008	P-value	0.0000
Avg Obs:	1.0000	Distribution:	F(1,2998)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	16.790
		P-value	0.0000
Time periods:	9	Distribution:	F(1,2998)
Avg Obs:	334.22		
Min Obs:	334.00		
Max Obs:	335.00		

Parameter Estimates

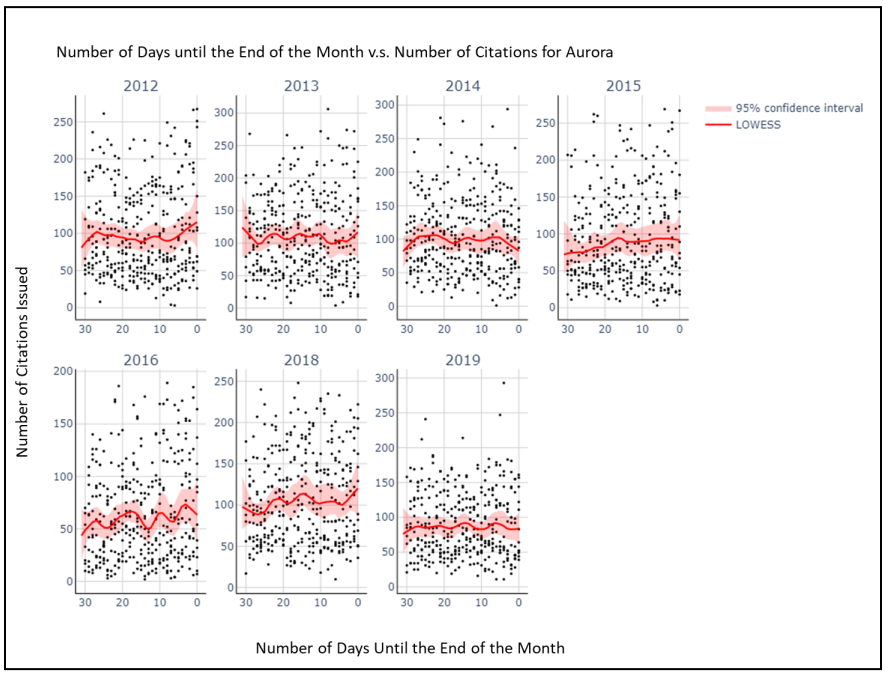
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_month	3.8193	0.9321	4.0976	0.0000	1.9917	5.6469

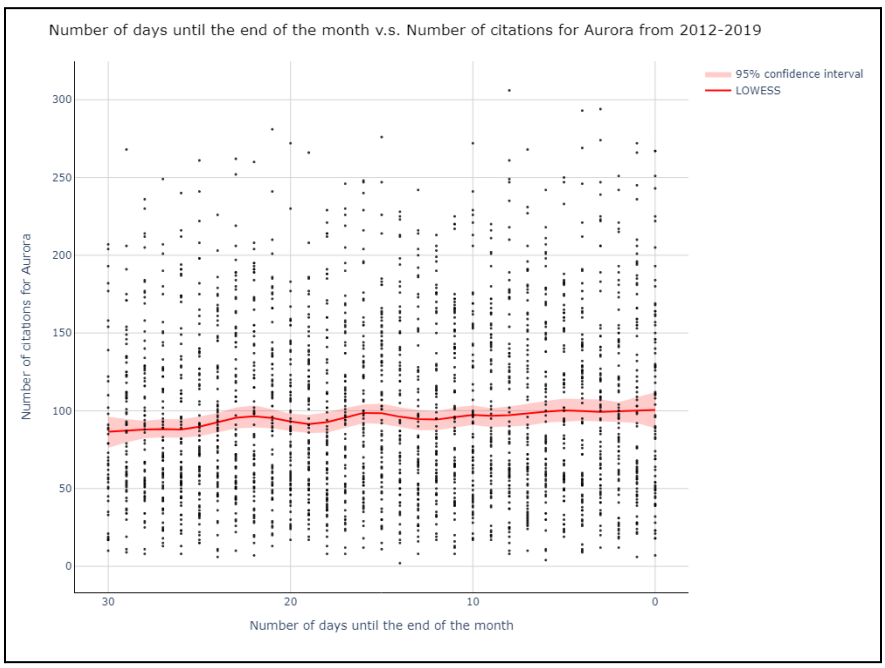
F-test for Poolability: 400.44
P-value: 0.0000
Distribution: F(8,2998)

The parameter estimate of 3.8193 indicates that, on average, there is an increase of 3.8193 citations issued per day within the last five days of the month, holding all other variables constant. The p-value of 0.0000 suggests that this positive effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a truly positive relationship between citation issued and the end of the month. In summary, the results suggest a statistically significant increase in the number of citations issued at the end of the month compared to other times in Cincinnati, OH, after accounting for time fixed effects.

Appendix E - Aurora, CO Analysis

Monthly Trends





As discussed in the main body of the report, we observed several instances where there were possible cases of heightened ticketing activity by law enforcement officers. The most notable instances were in 2012 and 2018. However, the remaining years presented very little evidence to support a conclusion of systematic and consistent influence on the officers' behavior. The chart below-left agrees with this conclusion: there is a steady trend throughout the entire month, with a widening confidence interval as the end approaches. Table 5 on the next page points to a similar phenomenon. The coefficient for the end-of-month indicator is positive, but the confidence interval is quite broad and, in its lower range, is barely, if at all, practically significant.

Table 5. Fixed Effects Regression Summary for Aurora, CO (End of Month)

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0027
Estimator:	PanelOLS	R-squared (Between):	0.0218
No. Observations:	2340	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	0.0218
Time:	18:01:14	Log-likelihood	-1.27e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	6.2163
Entities:	2340	P-value	0.0127
Avg Obs:	1.0000	Distribution:	F(1,2332)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	6.2163
		P-value	0.0127
Time periods:	7	Distribution:	F(1,2332)
Avg Obs:	334.29		
Min Obs:	334.00		
Max Obs:	335.00		

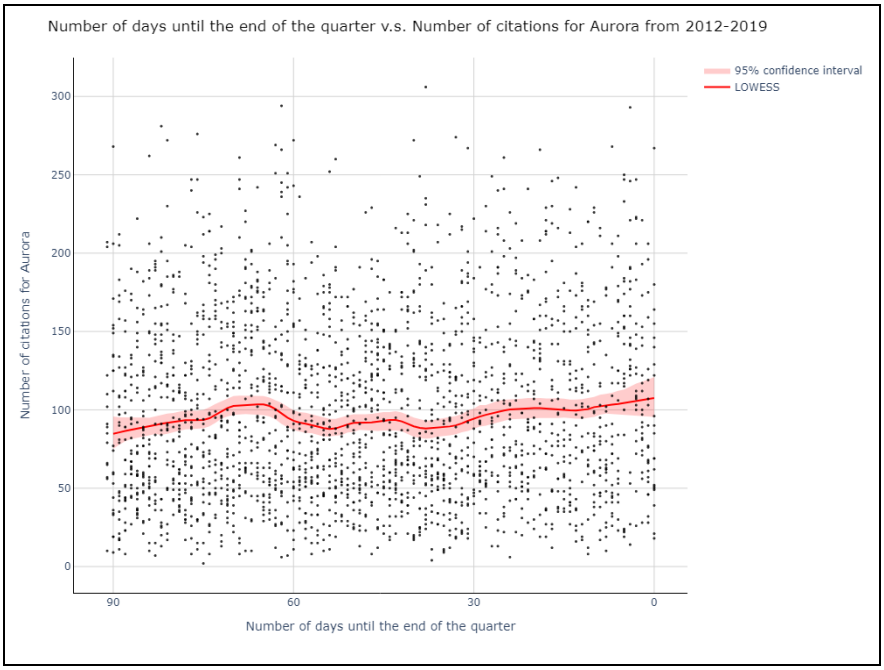
Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_month	7.1386	2.8632	2.4932	0.0127	1.5240	12.753

F-test for Poolability: 28.291
P-value: 0.0000
Distribution: F(6,2332)

The parameter estimate of 7.1386 indicates that, on average, there is an increase of 7.1386 citations issued per day within the last five days of a month, holding all other variables constant. The p-value of 0.0127 suggests that this positive effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true positive relationship between citation issued and the end of the month. In summary, the results suggest that there is a statistically significant increase in the number of citations issued at the end of the month compared to other times in Aurora, CO, after accounting for time fixed effects.

Quarterly Trends



The end-of-quarter data for Aurora is similar to the end-of-month movement, with the noted exception that the quarter seems to have a little more variation throughout, punctuated by a slight increase at the end of the quarter. The rise is mainly due to a significant widening in the confidence interval, reflected in the bottom-left regression table. The parameter value is certainly positive; however, the lower reaches of the interval dip down to the point that we question the practical significance of this finding.

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0022
Estimator:	PanelOLS	R-squared (Between):	0.0133
No. Observations:	2340	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	0.0133
Time:	18:01:14	Log-likelihood	-1.27e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	5.0943
Entities:	2340	P-value	0.0241
Avg Obs:	1.0000	Distribution:	F(1,2332)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	5.0943
		P-value	0.0241
Time periods:	7	Distribution:	F(1,2332)
Avg Obs:	334.29		
Min Obs:	334.00		
Max Obs:	335.00		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_quarter	8.6262	3.8219	2.2571	0.0241	1.1316	16.121

F-test for Poolability: 28.279
P-value: 0.0000
Distribution: F(6,2332)

The parameter estimate of 8.6262 indicates that, on average, there is an increase of 8.6262 citations issued per day approaching the end of the quarter, holding all other variables constant. The p-value of 0.0241 suggests that this positive effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true positive relationship between citation issued and the end of the quarter. In summary, the results suggest that there is a statistically significant increase in the number of citations issued at the end of the quarter compared to other times in Aurora, CO, after accounting for time fixed effects.

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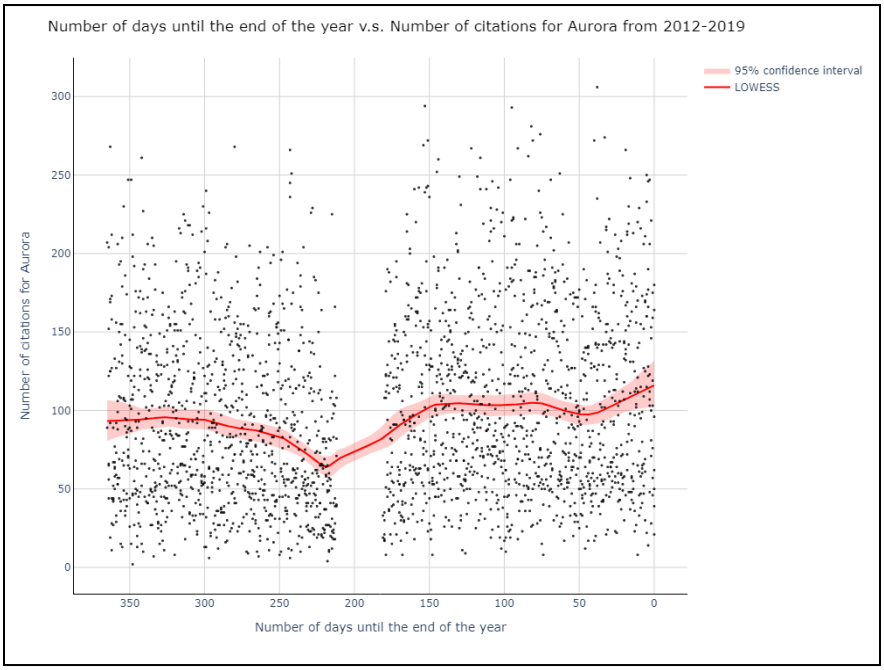
Annual Trends



The annual analysis of Aurora is the most noteworthy of the time horizons for this city. In the top-left plot, we can clearly observe the increase in citations issued as the fiscal year draws close. This is supported by the regression summary, bottom-left, which details the strong parameter value, p-value, and confidence interval for the end-of-year indicator.

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0026
Estimator:	PanelOLS	R-squared (Between):	0.0102
No. Observations:	2340	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	0.0102
Time:	18:01:14	Log-likelihood	-1.27e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	6.1382
Entities:	2340	P-value	0.0133
Avg Obs:	1.0000	Distribution:	F(1,2332)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	6.1382
		P-value	0.0133
Time periods:	7	Distribution:	F(1,2332)
Avg Obs:	334.29		
Min Obs:	334.00		
Max Obs:	335.00		

Parameter Estimates

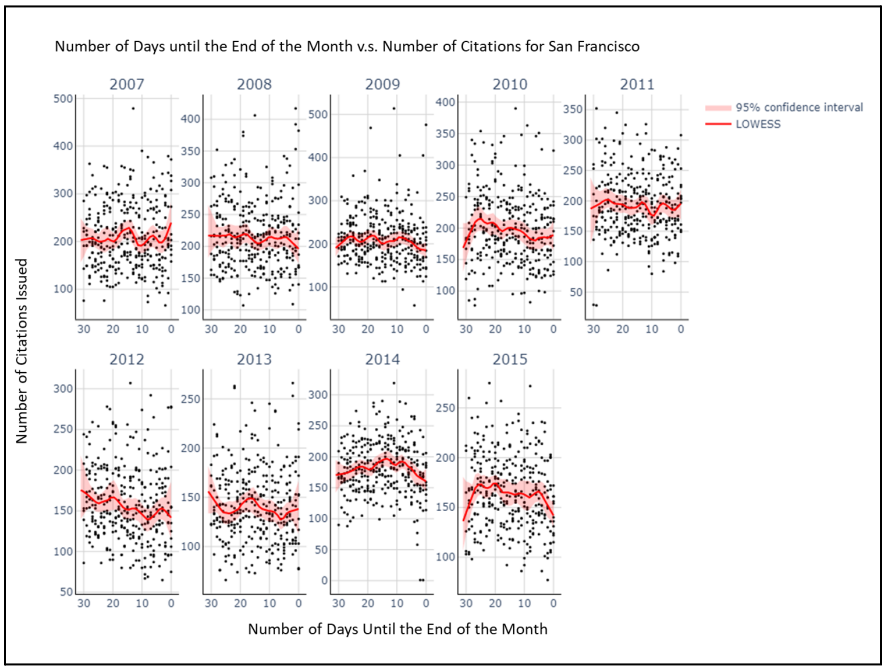
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_year	13.228	5.3390	2.4775	0.0133	2.7579	23.697

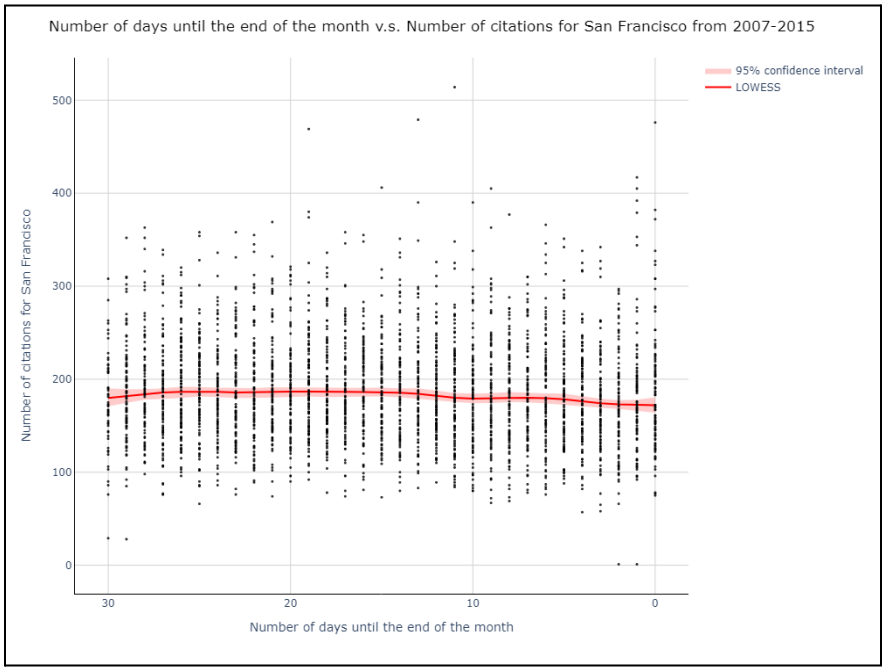
F-test for Poolability: 28.293
P-value: 0.0000
Distribution: F(6,2332)

The parameter estimate of 13.228 indicates that, on average, there is an increase of 13.228 citations issued per day as the end of the year nears, holding all other variables constant. The p-value of 0.0133 suggests that this positive effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true positive relationship between citation issued and the end of the year. In summary, the results suggest that there is a statistically significant increase in the number of citations issued at the end of the year compared to other times in Aurora, CO, after accounting for time fixed effects.

Appendix F - San Francisco, CA Analysis

Monthly Trends





Monthly trends in San Francisco paint an interesting story, but ultimately lead to very little by way of a definitive or practical conclusion. There are many years with a great deal of variance or movement in the number of citations issued throughout a given month. When aggregated, however, the trend is very obviously consistent and generally flat across the study timeline.

An interesting effect was observed when Table 8, the regression findings on the next page, were examined. The parameter value and its confidence interval appear to be statistically and practically significant until the scale of the number of citations was factored into our opinion. San Francisco gives a lot of citations on an average day, so issuing between 3 and 12 less as a month draws to a close is really not a small difference.

Table 8. Fixed Effects Regression Summary for San Francisco, CA (End of Month)

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0038
Estimator:	PanelOLS	R-squared (Between):	-0.0150
No. Observations:	3007	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	-0.0150
Time:	18:01:10	Log-likelihood	-1.609e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	11.381
Entities:	3007	P-value	0.0008
Avg Obs:	1.0000	Distribution:	F(1,2997)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	11.381
		P-value	0.0008
Time periods:	9	Distribution:	F(1,2997)
Avg Obs:	334.11		
Min Obs:	333.00		
Max Obs:	335.00		

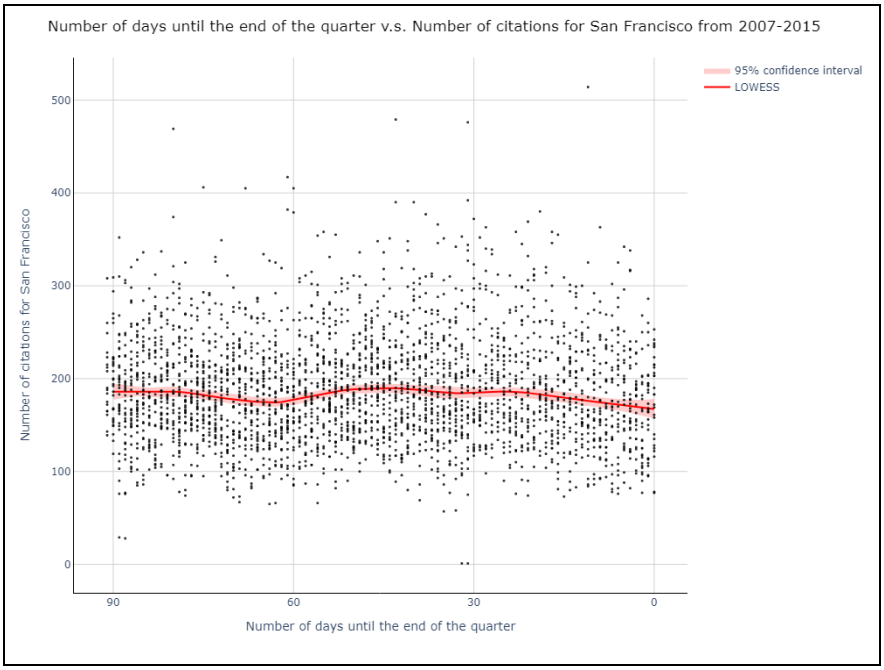
Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_month	-7.8866	2.3378	-3.3736	0.0008	-12.470	-3.3028

F-test for Poolability: 93.516
P-value: 0.0000
Distribution: F(8,2997)

The parameter estimate of -7.8866 indicates an average decrease of 7.8866 citations issued near the end of the month, holding all other variables constant. The p-value of 0.0008 suggests that this negative effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true negative relationship between citation issued and the end of month. In summary, the results suggest that there is a statistically significant decrease in the number of citations issued at the end of the month compared to other times in San Francisco, CA, after accounting for time fixed effects.

Quarterly Trends



Quarterly trends in San Francisco tell a similar story as the monthly data. There is a very slight but detectable decline in the trend of citations issued as the quarter draws to a close. When the regression results (below-left) are factored, we do not see a result that points to a practically significant movement in the volume of citations.

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0073
Estimator:	PanelOLS	R-squared (Between):	-0.0137
No. Observations:	3007	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	-0.0137
Time:	18:01:10	Log-likelihood	-1.608e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	22.089
Entities:	3007	P-value	0.0000
Avg Obs:	1.0000	Distribution:	F(1,2997)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	22.089
		P-value	0.0000
Time periods:	9	Distribution:	F(1,2997)
Avg Obs:	334.11		
Min Obs:	333.00		
Max Obs:	335.00		

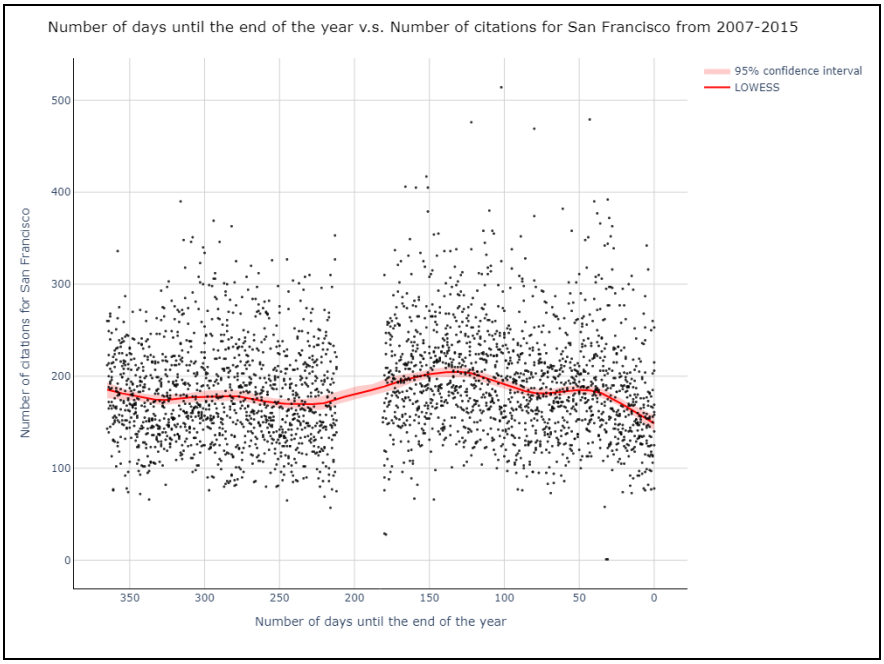
Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_quarter	-14.627	3.1122	-4.6999	0.0000	-20.729	-8.5245

F-test for Poolability: 93.845
P-value: 0.0000
Distribution: F(8,2997)

The parameter estimate of -14.627 indicates that, on average, there is a decrease of 14.627 citations issued per day approaching the end of the quarter, holding all other variables constant. The p-value of 0.0000 suggests that this negative effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true negative relationship between citation issued and the end of the quarter. In summary, the results suggest that there is a statistically significant decrease in the number of citations issued at the end of the quarter compared to other times in San Francisco, CA, after accounting for time fixed effects.

Annual Trends



The annual data for San Francisco are discussed in the main body of the report and presented here. In this case, we have little compelling choice except to acknowledge the significant decrease in the trend of citations issued as the fiscal year draws to a close. The regression summary agrees, with each day inside our 15-day cut-off yielding an expected return of 20-36 fewer citations than the day before.

PanelOLS Estimation Summary

Dep. Variable:	citation_issued	R-squared:	0.0134
Estimator:	PanelOLS	R-squared (Between):	-0.0121
No. Observations:	3007	R-squared (Within):	0.0000
Date:	Mon, May 01 2023	R-squared (Overall):	-0.0121
Time:	18:01:10	Log-likelihood	-1.607e+04
Cov. Estimator:	Unadjusted		
		F-statistic:	40.814
Entities:	3007	P-value	0.0000
Avg Obs:	1.0000	Distribution:	F(1,2997)
Min Obs:	1.0000		
Max Obs:	1.0000	F-statistic (robust):	40.814
		P-value	0.0000
Time periods:	9	Distribution:	F(1,2997)
Avg Obs:	334.11		
Min Obs:	333.00		
Max Obs:	335.00		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
end_of_year	-27.695	4.3350	-6.3886	0.0000	-36.194	-19.195

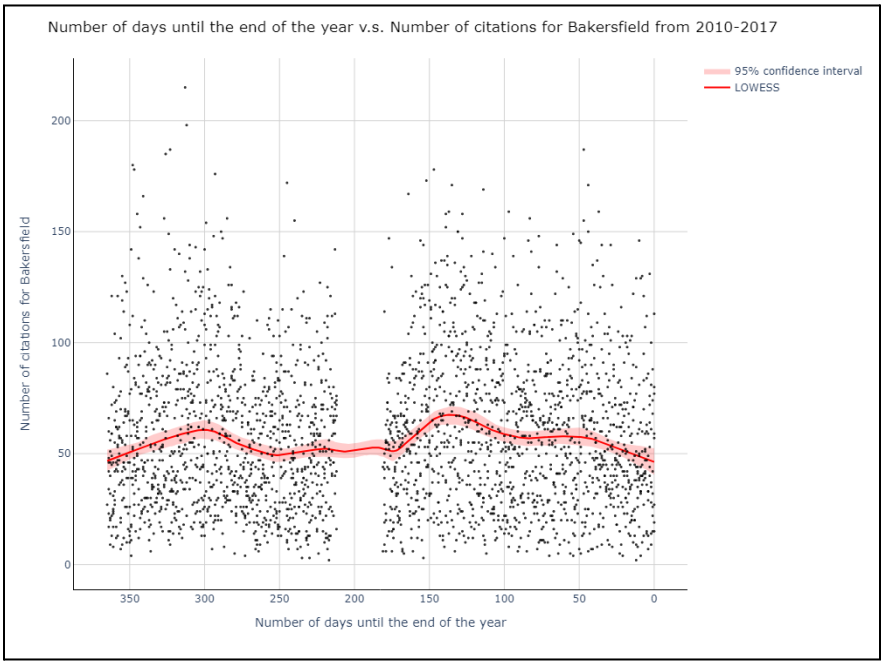
F-test for Poolability: 94.427
P-value: 0.0000
Distribution: F(8,2997)

The parameter estimate of -27.695 indicates an average decrease of 27.695 citations issued per day approaching the end of the year, holding all other variables constant. The p-value of 0.0000 suggests that this negative effect is statistically significant at a 0.05 significance level, meaning that there is strong evidence to conclude that there is a true negative relationship between citation issued and the end of the year. In summary, the results suggest that there is a statistically significant decrease in the number of citations issued at the end of the year compared to other times in San Francisco, CA, after accounting for time fixed effects.

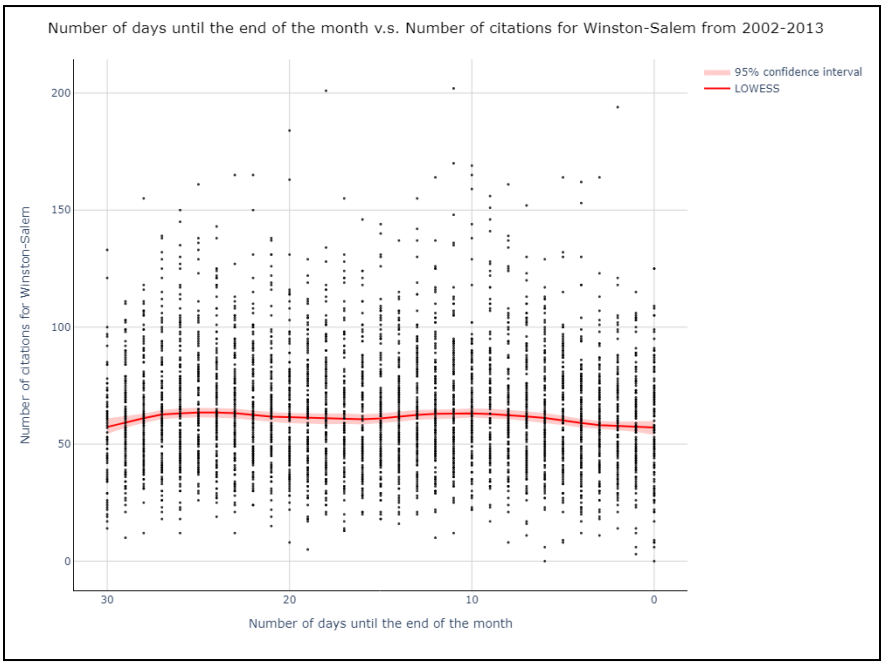
Appendix G - Additional Analysis Results

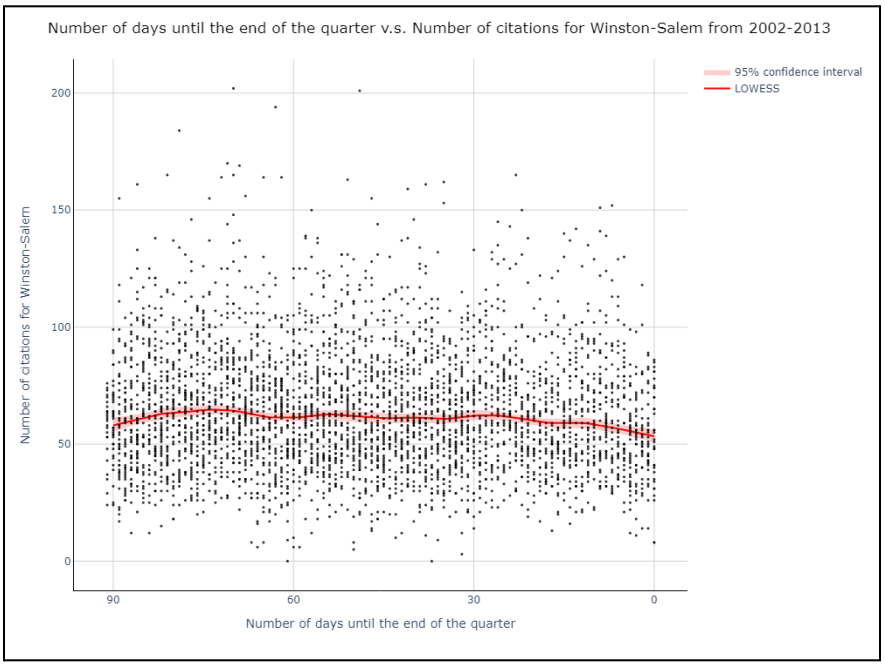
This appendix contains additional visualizations for the city/time combinations where our methods identified a statistically significant positive or negative effect, but we did not determine whether a practical effect was present. Many of the visualizations speak for themselves as to why these instances were disqualified from inclusion in the main summary of our findings. The first result, Bakersfield, CA, is one instance where there is room for debate. However, we determined that the decrease in citations observed was a trend that began well before the end of the fiscal year drew near and was, therefore, not indicative of an effect such as the one we are investigating for.

Bakersfield, CA

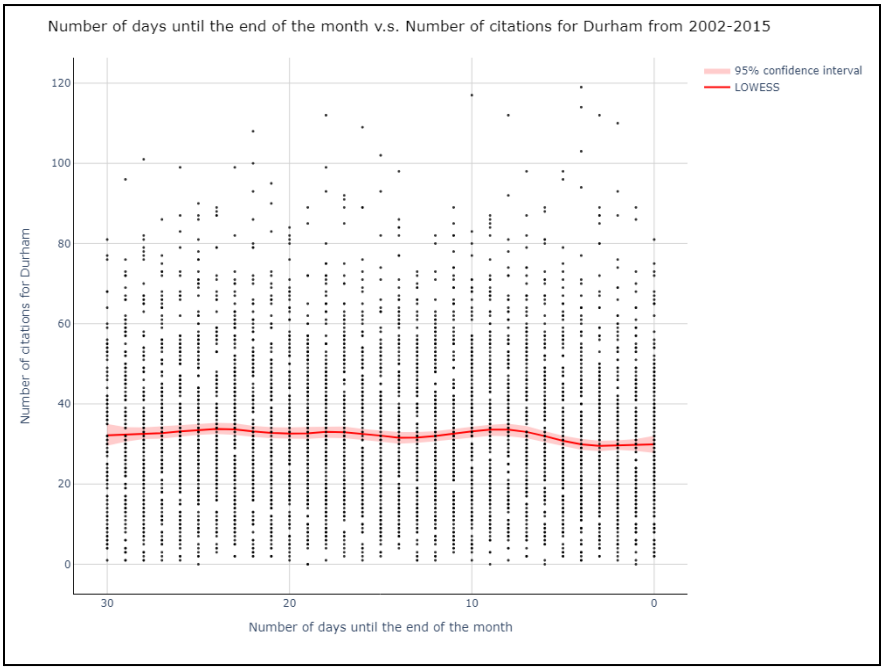


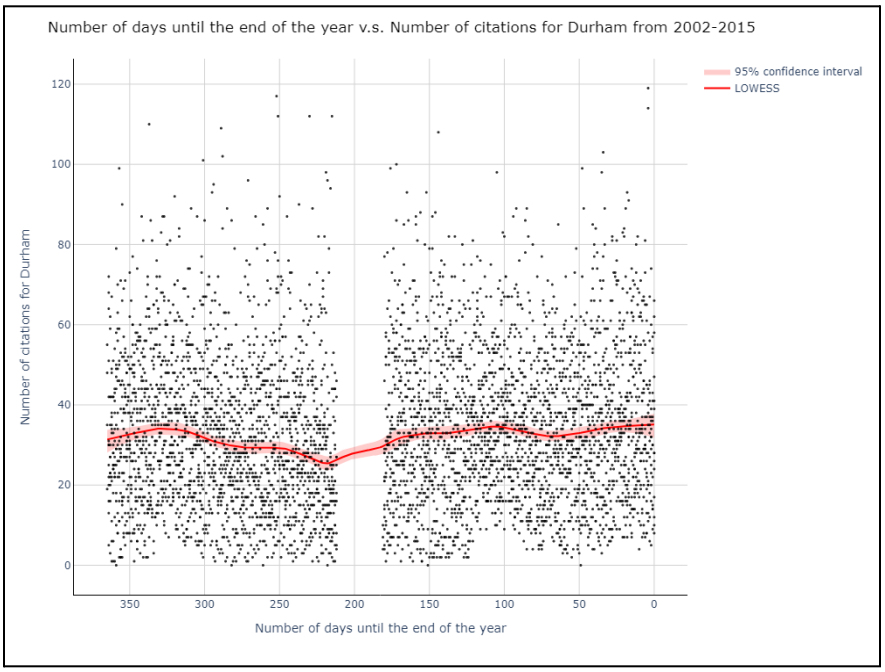
Winston-Salem, NC



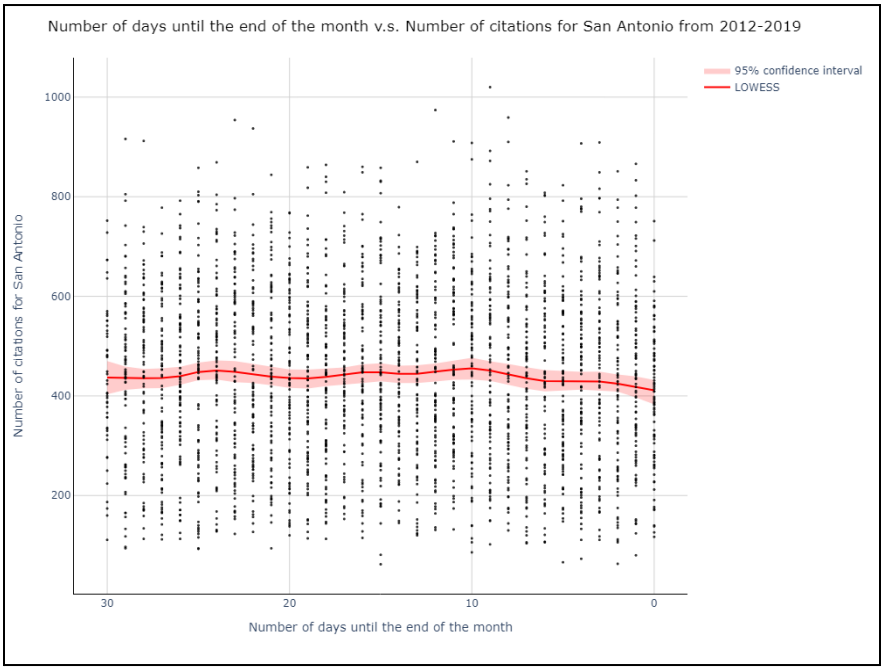


Durham, NC

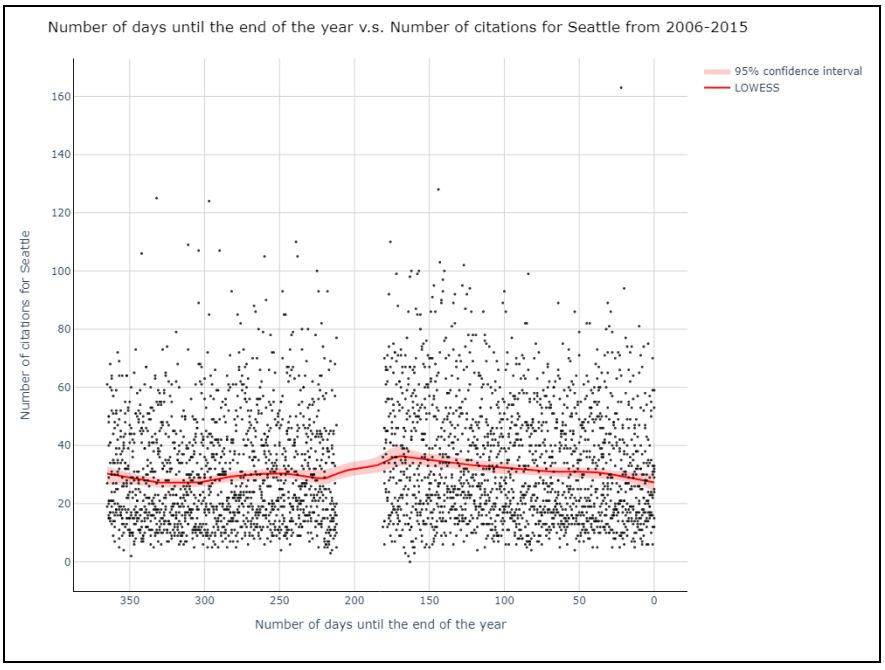

Number of days until the end of the month v.s. Number of citations for Durham from 2002-2015
95% confidence interval
LOWESS
Number of citations for Durham
120
100
80
60
40
20
0
30
20
10
0
Number of days until the end of the month


Number of days until the end of the year v.s. Number of citations for Durham from 2002-2015
95% confidence interval
LOWESS
Number of citations for Durham
120
100
80
60
40
20
0
350
300
250
200
150
100
50
0
Number of days until the end of the year

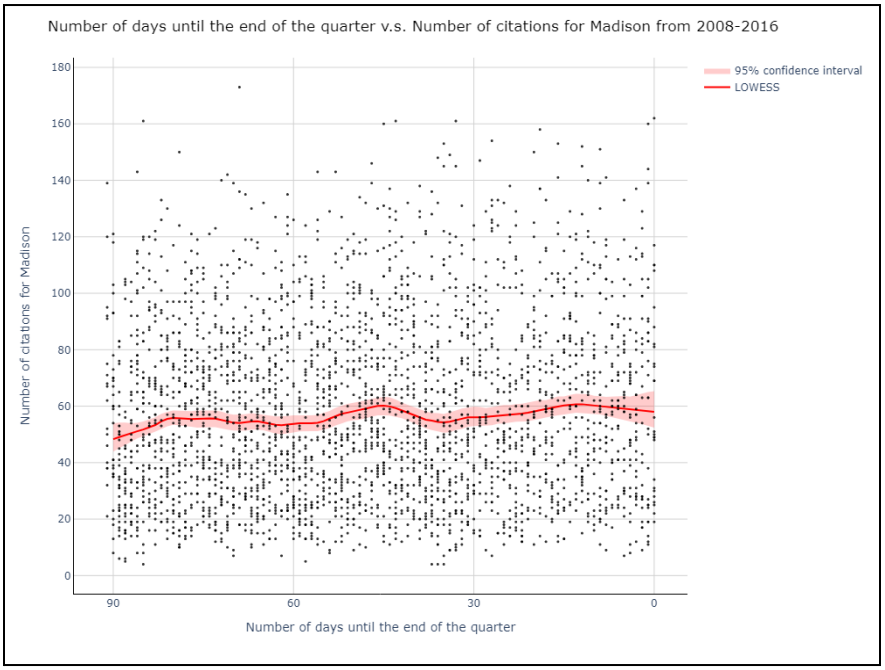
San Antonio, TX



Seattle, WA



Madison, WI


Number of days until the end of the quarter v.s. Number of citations for Madison from 2008-2016
95% confidence interval
LOWESS
Number of citations for Madison
180
160
140
120
100
80
60
40
20
0
90
60
30
0
Number of days until the end of the quarter

Appendix H - References

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