Parking Meter Violations in Eugene, Oregon

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Abstract: Parking meter citations in the city of Eugene, Oregon from 2007-2012 are examined. The relative effects of events, parking officers, location and time variables are determined on the number of citations received on a given block on a given day. A Tobit model is used to account for issues in the data, which is left-censored at zero. The results indicate that athletic events on the University of Oregon campus, Saturdays, zone and season interactions, and block effects are some of the most impactful. Possible avenues for further research are explored.

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1. Introduction

The management of public parking options is a perhaps mundane, if fundamental, aspect of local government. Many policies are centered on the governance of parking, from the creation of rules ordaining who can park where to the implementation and enforcement of these rules. There are numerous types of parking violations in the city of Eugene, Oregon; one can be cited for parking in a bike lane, parking on the wrong side of the street, or overstaying the allotted time in that space, among many other reasons. In recent years, Eugene has issued over 200 citations every day, approximately 65,000 annually. Over half of these citations are simple meter violations and the vast majority have been issued in the area surrounding the University of Oregon campus.

A fair amount of scholarly work has been done on the broad subject of the economic modeling of parking demand. Many studies have examined individuals' parking behavior in various contexts, and many others have attempted to discern optimal fines and levels of enforcement. The commonly-accepted opinion is that illegal parking behavior is a function of an individual's risk-aversion, enforcement levels, and the associated fines. Our research is intended to further expand on this understanding by examining other factors that influence parking violations. Although we are unable to discern the effect of various factors on the probability of the receipt of a parking citation, our work enlightens on the significance of these factors in the total number of citations received in Eugene, Oregon.

We have three research questions: 1. Which blocks in Eugene receive the most citations? 2. When do the most citations occur? 3. How do local events affect the number of citations handed out?

We begin our examination with an analysis of dense and abundant data on parking citations in the city of Eugene. Jeff Petry, the Parking Director for the City of Eugene, has courteously supplied this data for our use. We focus our study on meter violations that have been aggregated by the block. We conduct a Tobit regression analysis while controlling for time-fixed and zone-fixed effects to isolate the relative importance of local events and on-duty officers on the volume of citations. Our findings indicate that athletic events, Saturdays, block-specific effects, and seasonal changes are the most relevant variables for understanding citations in Eugene.

2. Background

Possibly the most notable aspect of Eugene, Oregon is the University of Oregon campus. A large public university, it pulls approximately 25,000 students and faculty to Eugene every year. Although not a highly urban area the city of Eugene has a busy downtown center as well as multiple residential neighborhoods. Parking, both on and off street, is in high demand for students, faculty, visitors, and residents alike.

The city has implemented various strategies to attempt to control its citizens' parking habits: residential paid parking zones, free parking areas downtown, electronic meters throughout the most visited sectors of town. Efforts have been made in recent years to make street parking even more accessible by introducing electronic credit card meters, with the ability to refill your meter from your smartphone, and through the creation of the ePark mobile map smartphone app.

The price of parking has remained relatively low through the years, with only one minimal increase in parking meter prices in 2012 from $0.75 an hour to $1.00. Parking

tickets for meter violations were $12.00 until 2010, when the fine raised to $16.00. Tickets double if not paid after 30 days.

3. Literature Review

Goodling and Olson (2010) provide a good overview of the literature on examining "the economic incentives that lead to crime" (p. 3), focusing on Becker's seminal 1968 analysis of crime. The decision to park illegally, when considered as fundamentally the same as any other crime, can be analyzed in terms of economic incentives. Decisions are viewed as a result of a consumer's rational cost-benefit analysis, wherein she compares the perceived utility gain from parking illegally against the perceived costs (measured by the probability of getting caught and the fine she would receive). Parking behavior is seen as responsive to policy incentives, where a change in the levels of enforcement and fines does alter an individual's decisions.

Numerous studies have attempted to model parking behavior through varied methods. Habib, Morency, and Trepanier (2012) investigated the correlation between parking choices and activity scheduling—particularly with regards to start-time and duration. Using an Origin-Destination survey from 2003 the authors analyzed the probability that one would choose a specific type of parking (free, charged fee, etc) or leave at a certain time based on a variety of factors, specifically the destination activity. The authors found that activity type and duration, as well as the proportion of types of spaces available, impacted parking choices (p. 165). Hess and Polak (2009) used a mixed multinomial logit regression on data obtained via street survey in the United Kingdom to examine parking choices. The authors were especially concerned with testing and

controlling for taste variation (p. 78). Analysis showed that there was great taste heterogeneity across respondents, meaning that the important variables (willingness to take risks, relevance of search time) varied across locations (p. 95). Another group researched parking issues at the University of Coimbra campus and determined that excess demand for campus parking led to welfare losses (Barata, Cruz, and Ferreira, 2011, p. 410). Willingness to pay for reserved spots was higher among certain groups, implying that parking behavior varies across socio-economic categories (p. 411).

Studies that focus instead on the effectiveness of enforcement on parking violations include those by Calthrop and Proost (2006), Fisman and Miguel (2007), and Calthrop (2001). Calthrop and Proost (2006) found that "a simple time restriction…is welfare inferior to an optimal meter fee" (p. 31) and that the positive search costs associated with relatively cheaper on-street parking were bad for welfare. Calthrop (2001) investigated the relationship between meter fees and enforcement levels in terms of welfare maximization. He discerned that the "peak-load pricing" (often cited as an ideal) was not always optimal if enforcement costs were high, and that the optimal meter fee was above the optimal fine (p. 16). One of the main conclusions from Fisman and Miguel's 2007 analysis of diplomatic parking tickets in New York City was that even though enforcement had a large positive effect on behavior, "norms related to corruption are apparently deeply ingrained, and factors other than legal enforcement are important determinants of corruption behavior" (p. 1045). This is an important indication that we should include factors other than simple enforcement levels and fines in our analysis.

Some attempts have been made to better understand illegal traffic behavior. Havarneanu and Havarneanu (2012) studied the traffic behavior of 605 Romanian drivers.

They discerned that often traffic laws are "perverse" in that "the driver perceives it as inadequate for the current situation, and fears no real danger but only being sanctioned by the police" (p. 146) and are therefore often broken. They characterized a specific type of driver who was more likely to commit traffic violations as someone who "perceive the rules as inadequate for safety, who have a low respect for the laws and a low level of subjective risk" (p.148). In 2007 Fukuda and Morichi investigated illegal bicycle parking at rail stations in Tokyo. They used conformity and social interaction theory and the idea that "in a situation of social dilemma, an individual tends to conform to the actions of the majority" (p. 314) to analyze this issue. The authors found that, although individual differences in personality contributed to one's choice, there was a strong tendency to conform to the majority (p. 321). In places where many illegally parked bicycles were visible others were more likely to park illegally as well.

Beyond these two studies, Spiliopoulou and Antoniou (2012) analyzed the (often illegal) parking habits of Greek drivers in big and small cities. Illegal behavior was found to change between urban and rural cities, implying that illegal parking happens for different reasons under different circumstances (p. 1626-7). The astounding lack of enforcement of traffic laws encouraged citizens in small cities to park illegally; the importance of establishing consistent regulations was stressed (p. 1630). Finally, Ander (2008) wrote a short analysis of parking tickets at the University of Virginia campus, and concluded that illegal parking was a function of fine costs, permit prices, and weather (p. 131). He believed crime to be a simple relationship between "the probability of being caught, benefit of committing the crime, and penalty of the crime" (p. 130).

4. Data

We based our analysis on raw parking citations data collected by the city of Eugene. The data was manually compiled into multiple sets by Jeff Petry and granted to us for use. Each dataset contains every citation given within city boundaries from July 2006 to March 2013, approximately the point at which the data was given to us. In total, 400,715 citations were written during this time span, between 50-70,00 per year. As a general rule, no citations are given out on Sundays or federal holidays.

Each entry in the original spreadsheets contained an assortment of variables. The included variables are the date; license plate number, make, color, and state of origin of the offending car; the officer's badge number; the specific citation number; the fine amount still due; the type of violation; the specific location, beat, and meter; as well as any comments from the citing officer. Of particular relevance to our investigation are the date, officer's badge number, violation type, and meter number variables.

The citations data was supplemented with a variety of other relevant variable from diverse sources. Block-specific data was obtained from the city of Eugene. Information on major events in the city was found online at official websites.

In order to make the data usable for our purposes, many restrictions were necessary. Observations from 2006 and 2013 were dropped because only full year data was desired. Any citation that was not listed as a meter violation was left out. We chose to only include meter violations because they constituted the bulk of the citations, are consistent, narrow our focus, and allow us to easily examine meter-specific variables. Numerous other observations had to be removed because of incongruity in the meter numbers. Some entries were so inconsistently formatted that we could not discern their

true meaning; others allegedly occurred in city blocks that do not exist. Five blocks for which we did not have block-specific data were still included because they received enough citations to be notable. We believe these blocks once had parking meters that no longer exist. Accounting for all of the above left us with 183,572 observations.

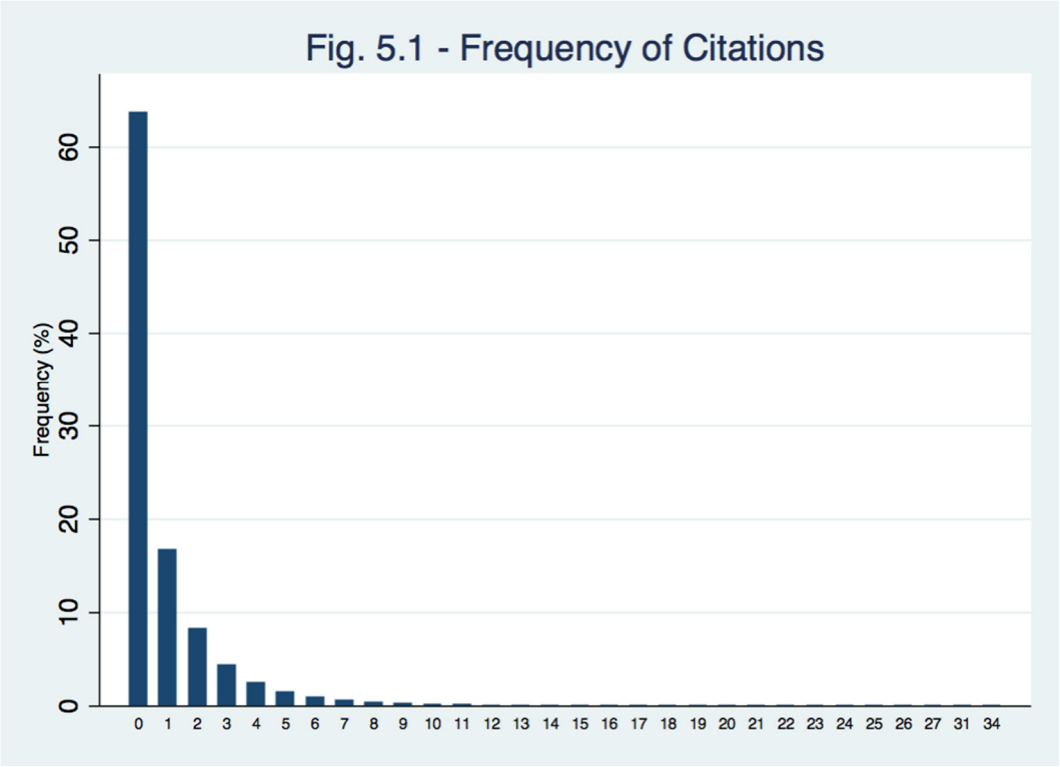
After cleaning the dataset of individual citations, we aggregated the number of individual citations to the block level to create a dependent variable that could be explained by other independent variables. The dependent variable that was created by this aggregation was **citations**, the total number of meter violations issued on a block in one day. As a result of this aggregation, our data is panel data; the group dimension is blocks and time dimension is days. In the data, there are a total of 155 blocks and 1803 days, from Jan 2, 2007 through Dec 26, 2012 excluding Sundays and holidays. This creates our panel dataset with 207,345 total observations.

The block-level aggregation also created an interesting quirk in our dependent variable: over 60% of the observations are zero. This means that, on a given day, there will be numerous blocks that do not see any citations. This is a primary motivator in our regression model choice.

5. Methodology

Due to the nature of our dependent variable, we will use a Tobit model. The large amount of zeros in the data indicates that there is likely some latent variable that is being left-censored at zero. Figure 5.1, a histogram of **citations**, clearly demonstrates this property. An Ordinary Least Squares regression on this type of data would result in biased

coefficient estimates, thus we will use the Tobit regression, which is designed for censoring of this type.



Given the panel data structure, we will be using block fixed-effects dummy variables. These block fixed-effects control for variables that remain constant over each block during each time period, for example, proximity to major locations in Eugene, the number of meters on that block, and the overall demand for parking on that block. Meters located on blocks in a more residential area will have much lower traffic and enforcement levels than a block in the middle of downtown or right off of the University of Oregon campus. Similarly, we use yearly, monthly and day-of-week dummy variables to control for factors that should be correlated with parking violations but are held constant over the course of a year or over a specific month. Examples of these types of factors include population in

Eugene, enrollment at the University of Oregon, the prices of meters and the cost of a meter violation.

Our empirical specification is as follows:

$$Citations_{i,t} = ß_0 + ß_1 fbevent + ß_2 bbevent + ß_3 satmark + ß_4 movein + ß_5 olympic + ß_6 tf + ß_7 officers + ß^* X_{i,t} + \varepsilon_{i,t}$$

$ß^*$ is a vector of coefficients for the control variables contained in X, which contains day of week dummies, month dummies, year dummies, block dummies, and interactions between day of week & month, and month & zone.

We have also allowed for systematic variation in $ß_1 - ß_6$, the coefficients on the event dummies, by interacting them with dummy variables for **zone**. Each $ß_1 - ß_6$ is comprised of several coefficients for each zone (minus one reference category). For example,

$$ß_1 fbevent = (ß_{11} + ß_{12} Zone2 + ß_{13} Zone3 + ß_{14} Zone4 + ß_{15} Zone5)*fbevent$$

where Zone5 is 1 if the block is in zone 5 and 0 otherwise. Thus the marginal effect of a football game on citations per block in zone 5 is $ß_{11} + ß_{15}$.

In addition, we have allowed for systematic variation in $ß_7$, the coefficient on officers, by interacting it with day-of-week dummy variables. $ß_7$ is comprised of several coefficients for each day of the week. The reference category is Monday. Thus, the full equation for officers is as follows:

$$ß_7 Officers = (ß_{70} + ß_{71} Tues + ß_{72} Wed + ß_{73} Thurs + ß_{74} Fri + ß_{75} Sat)*Officers$$

The marginal effect of an additional officer on Monday is $ß_{70}$ and the marginal effect of an additional officer on the other days is $ß_{70} + ß_{7\#}$ where $ß_{7\#}$ is the coefficient corresponding to the day-of-week dummy.

6. Variable Descriptions

Twenty variables in total were used in our final analysis. There are three key variables for our study: date, block, and citations. The date and block variables simply tell the time and location of the violation, and set up the panel structure of our data. Citations, our dependent variable, expresses the number of meter citations given out on a specific block and day. The independent variables included are year, month, and day of week; police officers on duty; neighborhood zone; different events around the city; and a few interaction terms.

6.1 Block and Zone

The block tells where the citation was given. Every block has been previously numbered by the city. Metered blocks in Eugene contain anywhere between two and fifty-eight parking meters, typically around sixteen. Block information was obtained from the meter number variable in the original dataset. The meter number is expressed as "XX-YY" where the first number, XX, represents the city block on which the violation occurred and the second, YY, shows the specific meter pole. From this we were able to generate the block variable.

The zone variable gives a broader categorization of location. There are five zones for parking designated by the city. Zone 3 has the fewest blocks within its boundaries at eleven blocks; zone 5 has the most with forty-one. The two major areas of interest, downtown Eugene and the University of Oregon campus, are located in zones 1 and 2 (for downtown) and zone 5 (campus).

6.2 Year, Month, and DOW

These are straightforward time variables for each observation. DOW tells the day of the week on which the violation occurred, with a dummy variable for each day, Monday through Saturday. As parking is not metered on Sundays in Eugene, no 0 values were recorded. Month and year dummy variables were also created to represent every month and the years 2007 through 2012.

6.3 fbevent, bbevent, olympictrials and tf

This set of variables represent major athletic events at the University. Each is a dummy variable, taking a value of one only if a specific type of sporting event occurred on a day with metered parking. Football games, men's basketball games, and state track and field championships for all years were included. The Olympic Track and Field Trials, which took place in Eugene from June 21 through July 1, 2012, were included as well. In recent years the University of Oregon athletic program has received widespread attention; many home-field football games, for example, have seen upwards of 50,000 attendees. These athletic events draw an influx of visitors and are believed to increase the demand for street parking in Eugene.

6.4 movein and satmark

Movein and satmark are dummy variables for specific recurring events in Eugene. The first, movein, takes a positive value for the days in the weekend before fall term classes begin at the University. The majority of freshmen students are invited to move in to their dormitories during this period, and many older students return to campus during this time as well. Satmark is a variable created to designate the Saturdays during which the Eugene Saturday Market or Holiday Market happened. The Saturday and Holiday Markets are

located in downtown Eugene and take place every year on Saturdays and Sundays from April through December.

6.5 Officers

Officers is the number of parking officers who were on duty each day. This number was obtained by counting the number of distinct badge identifiers per day found in the officer variable in the original citation datasets. It is assumed that if an officer was working, he or she gave out at least one citation that day.

6.6 Interaction terms

We also incorporated several interactions between our established variables in the regression. The interaction terms are designed to isolate the effect of a variable in a specific situation and are obtained by multiplying the designated variables together. The included interactions were: each event and zone; day of week and month; month and zone; and officers and day of week.

7. Analysis

7.1 Descriptive Analysis

To give a basic understanding of trends of meter violations in Eugene, we will provide some descriptive charts and graphs of various trends.

7.1.1 Blocks

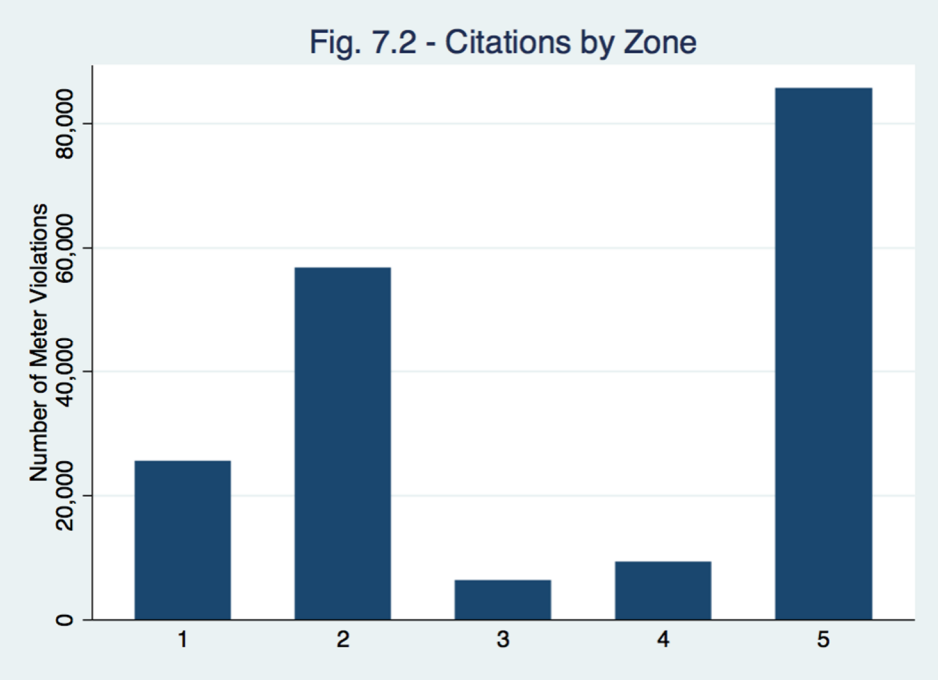
Figure 7.1 shows the total number of citations per block for 2007-2012. As the chart shows, blocks 214 (the block surrounding the shopping area that includes the Duck Store) and block 43 (the block right next to Saturday Market) have the most meter violations. Blocks received at most thirty-four citations per day, but many received only one or zero citations. The average number of meter citations per block is .8839. A map of the most and least cited blocks is in Appendix 9.2.

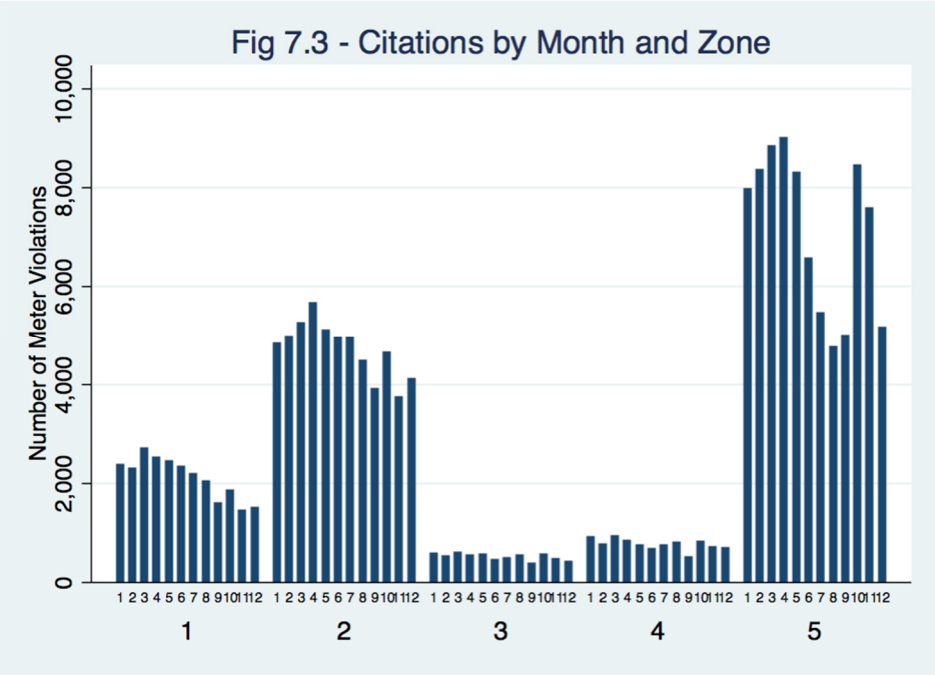
Fig. 7.1: Total Number of Citations (over 5 year period) by block

Block	Citations	Block	Citations	Block	Citations	Block	Citations	Block	Citations
214	12197	250	1876	48	1381	274	769	121	288
43	11834	60	1809	18	1352	235	745	69	259
239	7621	58	1794	39	1337	57	737	111	257
42	7585	238	1757	208	1336	38	706	63	254
226	7204	35	1727	275	1297	277	698	29	247
209	5982	271	1658	224	1272	91	688	54	238
17	5656	5	1646	25	1257	20	672	12	223
227	5399	16	1624	289	1182	73	616	36	210
33	5121	2	1609	30	1153	120	603	72	209
256	4120	34	1603	276	1050	101	556	119	205
234	3605	50	1576	288	1035	273	524	258	191
15	3067	79	1568	272	1020	210	511	78	189
225	2847	53	1561	246	1008	402	497	82	176
222	2793	49	1560	257	989	109	489	270	170
240	2746	71	1556	212	928	99	425	301	142
52	2718	6	1539	401	891	22	414	56	127
205	2412	51	1519	90	866	300	403	8	117
41	2393	213	1505	32	857	59	396	7	77
40	2390	44	1491	110	839	47	376	62	54
70	2345	80	1471	249	823	68	353	67	47
14	2162	4	1426	81	823	89	322	45	38
255	2116	13	1418	400	808	46	308	66	21
31	1989	245	1391	61	796	100	301	403	14

7.1.2 Zones

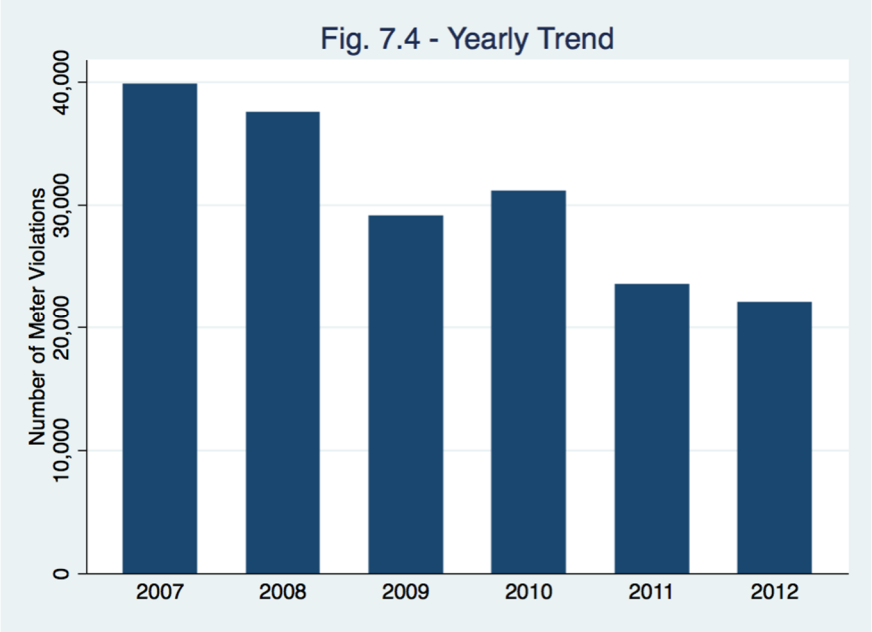
Figure 7.2 shows the trend in meter violations for each zone, and figure 3 breaks each zone down by month. Figure 7.3 clearly demonstrates that zone 5, the campus zone, is significantly impacted by the school year, relative to the other zones. Zones 3 and 4 appear to have no significant seasonal variation.

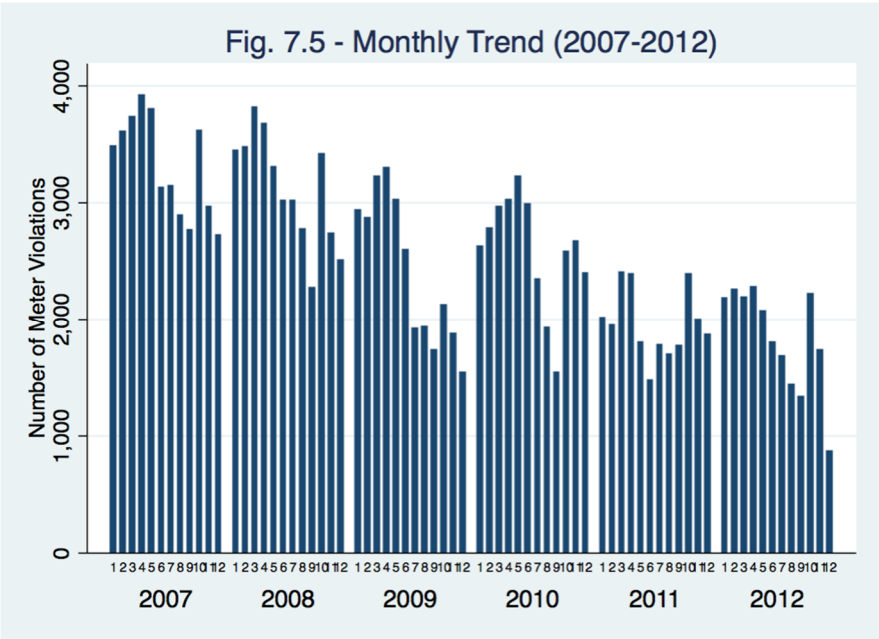




7.1.3 Time Trend

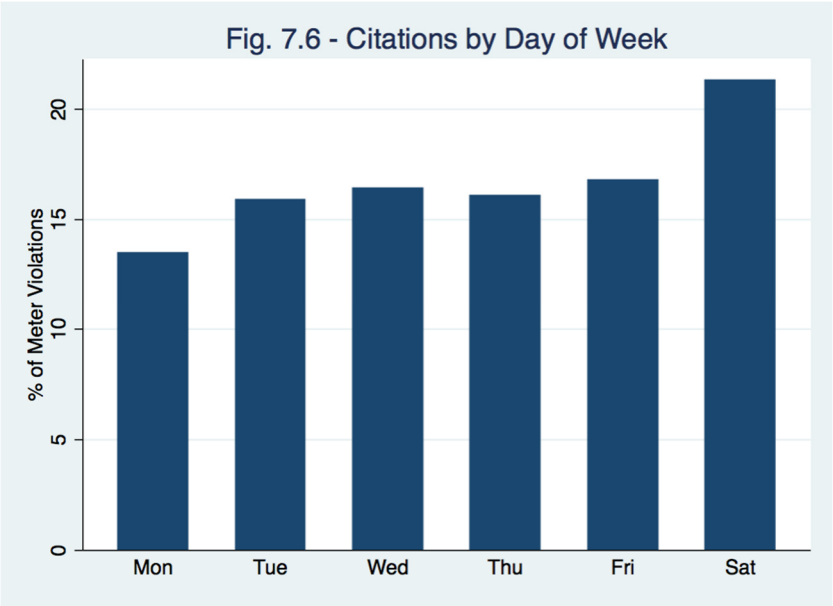
Figure 7.4 shows the trend in meter violations for each year, and figure 5 breaks each year down by months. Figure 7.5 demonstrates the general trend of higher citations during the school year, with total citations dropping drastically during the summer months and climaxing again in October.

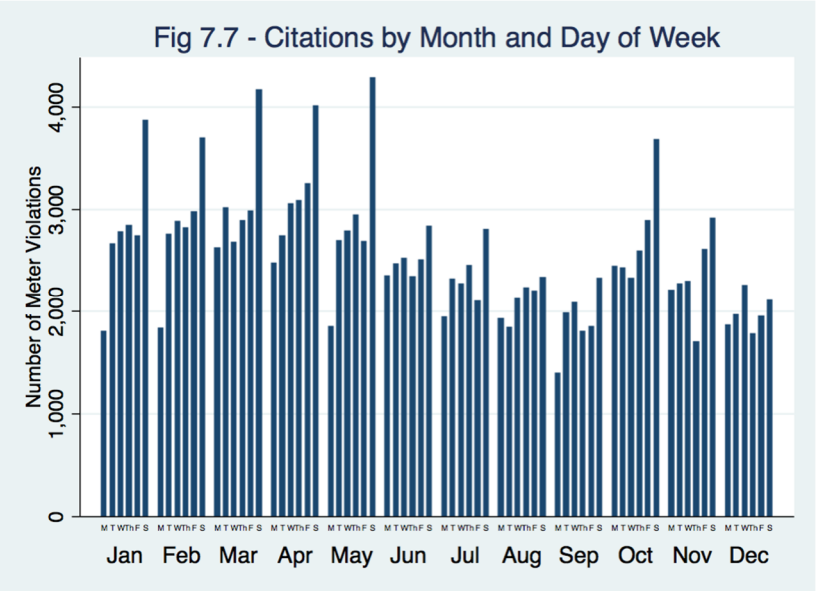




7.1.4 Day of Week

In general, Saturday has the highest volume of violations, while Monday has the lowest. Figure 7.6 shows this overall trend. Figure 7.7 shows an interesting characteristic of this trend: that Saturdays have a higher difference from the weekly average during the school year than over the summer, that is, Saturdays have a higher impact on meter violations during the school year.





7.2 Econometric Analysis

In this portion of the thesis, we will examine the results from the regression and discuss their implications. It is important to note that for the interaction terms, the excluded dummy, i.e. the control group for zones, is zone 1. When determining the marginal effect of, for example, a football game, the coefficient on "fbevent" is switched on when there is a football game on that day, and the coefficients for "zone#*fbevent" are also switched on for zones 2-5. Thus, the marginal effect of a football game on citations, is the sum of the coefficient for "fbevent" and the coefficient for "zone#*fbevent" in zones 2-5.

The full regression output is included in Appendix part 9.1.

7.2.1 Football Games

From the regression results, the presence of a football game is positively correlated with citations in zone 5, meaning that football games are associated with an increase of 1 citations per block in zone 5. All of the other coefficients are not statistically significant.

Fig 7.8 – Regression Output for Football Games

	Coef.	Std. Error	P-Value	95% Conf. Interval	
fbevent	-0.246*	0.125	0.049	-0.491	-0.001
Zone2*fbevent	0.104	0.16	0.516	-0.21	0.419
Zone3*fbevent	-0.123	0.24	0.609	-0.593	0.347
Zone4*fbevent	0.317	0.198	0.109	-0.071	0.706
Zone5*fbevent	**1.245*** **	**0.144**	**0**	**0.962**	**1.528**

7.2.2 Basketball Games

The regression results for basketball games show a similar result to football games. The presence of a basketball game is associated with an increase of 0.29 citations per block in zone 5. All other coefficients for basketball games are not statistically significant.

Fig. 7.9 – Regression Results for Basketball Games

	Coef.	Std. Error	P-Value	95% Conf. Interval	
bbevent	-0.024	0.082	0.765	-0.184	0.135
Zone2*bbevent	0.03	0.106	0.774	-0.178	0.239
Zone3*bbevent	-0.016	0.157	0.917	-0.323	0.291
Zone4*bbevent	-0.114	0.133	0.389	-0.374	0.146
Zone5*bbevent	**0.316****	**0.097**	**0.001**	**0.126**	**0.505**

7.2.3 Olympic Trials

The results from the regression indicate a negative correlation between the presence of the Olympic Trials and citations in zone 1. Relative to zone 1, all other zones have significant positive coefficients for the Olympic Trials; however, since the coefficient for zone 1 is strongly negative, this simply means that the effect in zones 2, 4, and 5 is less strongly negative. Zone 3 has a small positive coefficient.

Fig 7.10 – Regression Output for Olympic Trials

	Coef.	Std. Error	P-Value	95% Conf. Interval	
olympictrials	**-1.923*****	**0.312**	**0**	**-2.535**	**-1.311**
Zone2*olympic	**1.462*****	**0.382**	**0**	**0.714**	**2.211**
Zone3*olympic	**1.970*****	**0.546**	**0**	**0.9**	**3.039**
Zone4*olympic	**1.532****	**0.483**	**0.002**	**0.586**	**2.478**
Zone5*olympic	**1.820*****	**0.359**	**0**	**1.117**	**2.523**

7.2.4 OSAA Track and Field Championships

The results from the regression show that this track and field event has a negative correlation with citations in zone 4. All other results are insignificant. As this is an on-campus event, we expected to find an increase in citations during this time period in zone 5; although the regression did indicate a positive relationship between the two, it was not statistically significant.

Fig 7.11 – Regression Output for OSAA Championships

	Coef.	Std. Error	P-Value	95% Conf. Interval	
tf	0.006	0.172	0.972	-0.331	0.343
Zone2*tf	0.084	0.227	0.711	-0.361	0.529
Zone3*tf	-0.445	0.345	0.198	-1.122	0.232
Zone4*tf	**-0.661***	**0.305**	**0.03**	**-1.258**	**-0.063**
Zone5*tf	0.156	0.206	0.45	-0.248	0.56

7.2.5 Move-In Week

The regression results show a result similar to the results to the other campus events. There are non-significant coefficients for zones 1-4, and a significant and positive coefficient for zone 5. As there is a large influx of people in zone 5 during this time period, and the environment is generally chaotic with hundreds of students trying to move in, it makes sense that more citations would be given out.

Fig. 7. 12 – Regression Output for Move-In Week

	Coef.	Std. Error	P-Value	95% Conf. Interval	
movein	-0.247	0.167	0.139	-0.575	0.081
Zone2*movein	0.08	0.218	0.712	-0.347	0.508
Zone3*movein	-0.004	0.335	0.99	-0.661	0.653
Zone4*movein	0.261	0.281	0.354	-0.29	0.812
Zone5*movein	**0.647****	**0.2**	**0.001**	**0.255**	**1.04**

7.2.6 Saturday Market

The regression results indicate a significant and positive effect of Saturday Markets on citations in zone 1, the zone in which the Saturday Market occurs. Coefficients in zones 2, 4, and 5 are also significant and positive. Zone 2 only has a small positive coefficient. As the Saturday Market is primarily located in zone 2, but is very near to zone 1, it seems that most people choose to park in zone 1 and conduct their business in zone 2.

Fig. 7.13 – Regression Output for Saturday Market

	Coef.	Std. Error	P-Value	95% Conf. Interval	
satmark	**0.591*** **	**0.139**	**0**	**0.319**	**0.863**
Zone2*satmark	**-0.528*** **	**0.073**	**0**	**-0.67**	**-0.385**
Zone3*satmark	-0.174	0.107	0.103	-0.384	0.035
Zone4*satmark	**-0.281** **	**0.091**	**0.002**	**-0.46**	**-0.103**
Zone5*satmark	**-0.271*** **	**0.067**	**0**	**-0.401**	**-0.14**

7.2.7 Officers

The interaction between officers and day of week dummies was significant and positive for the reference category, Mondays. Relative to Mondays, the rest of the day of week coefficients were not significant, except for the Saturday interaction coefficient. The results show that the marginal effect of an officer is around 0.2 citations per block during the weekdays, and more than twice that on Saturdays. This is likely because fewer officers are employed on Saturdays. The average number of officers during the week is 4.9 and the average number of officers on Saturdays is 1.8. These results indicate that an effective way to increase revenue would be to increase the number of officers on Saturdays.

Fig. 7.14– Regression Results for Officers

	Coef.	Std. Error	P-Value	95% Conf. Interval	
Officers	**0.212*** **	**0.021**	**0**	**0.17**	**0.253**
Tues*officers	-0.015	0.027	0.585	-0.068	0.038
Wed*officers	0.002	0.026	0.933	-0.049	0.053
Thurs*officers	0.021	0.027	0.447	-0.032	0.074
Fri*officers	-0.047	0.027	0.082	-0.099	0.006
Sat*officers	**0.237*** **	**0.04**	**0**	**0.159**	**0.316**

7.2.8 Blocks

The results indicate that the majority of the fixed-effect block coefficients are significant, in both the positive and negative directions. Four blocks were omitted from the regression due to collinearity. The coefficients on this variable range widely from 13.457 at block 214 to -5.298 at block 45. Zone 5 is the only zone with a consistent significant sign (positive) for all of its blocks. Eleven of the 111 regressed blocks were not statistically significant at any level. Figure 7.15 shows the results for the blocks with the highest and lowest significant coefficients.

Fig. 7.15 – Regression Output for Blocks

	Coef.	Std. Error	P-Value	95% Conf. Interval	
7	**-4.497**	**0.157**	**0**	**-4.804**	**-4.19**
45	**-5.298**	**0.192**	**0**	**-5.675**	**-4.92**
62	**-4.858**	**0.171**	**0**	**-5.193**	**-4.523**
214	**13.457**	**0.283**	**0**	**12.902**	**14.011**
226	**10.59**	**0.283**	**0**	**10.036**	**11.145**
239	**10.898**	**0.283**	**0**	**10.344**	**11.453**

7.2.9 Time

As expected from the preponderance of citations on Saturday, it is the only day of the week with a statistically significant result and a magnitude of 1.845. When interacted with month, the Saturday coefficients were significantly negative in almost every month. Because this is an interaction term, the results show the difference from the first interaction created – here, Saturdays in January. This means that the effect of Saturdays in January on parking citations is higher than in any other month.

Zones 2, 3, and 5 had statistically significant coefficients. The campus zone surprisingly has a large negative coefficient, implying that proximity to campus is less important, all other variables considered, than proximity to downtown on citations. Monthly effects were only significant for September through December, all with small

negative magnitudes. Zone and month interactions were generally significant for zones 2, 4, and 5. October, November, and December, the months in which we see a resurgence in citations, was significantly positive for all zones (relative to these months in zone 1).

The year variable shows an increasingly negative significant coefficient. This variable is designed to pick up broad changes in Eugene over time. As the number of citations per year has fallen since 2007, the negative sign confirms expectations.

8. Conclusion

In this paper we aimed to examine the effects of various variables on the number of parking meter citations handed out in Eugene, Oregon. Parking citations data from Jeff Petry with the City of Eugene was trimmed and aggregated into a panel with total number of citations grouped by block and day. Using this dataset with over 180,000 distinct observations and twenty variables we performed a Tobit regression analysis with location and time fixed effects. A Tobit model was chosen over the standard OLS regression model because of the highly clustered nature of the data.

The results show that some of the most salient gauges of meter violations in Eugene are certain events; specific months and days; and block effects. The variables that are positively correlated with an increase in meter citations in all of Eugene are Saturdays and the months of January, October, and November. Around campus the positive indicators are football and basketball games and move-in week at the University; in downtown, the Saturday Market appears to have a positive effect as well. The importance of the block fixed effects cannot be stressed enough, as these variables are some of the strongest indicators of

meter violations. This implies that it is largely location specific traits, such as traffic flow in the neighborhood, that determine the volume of citations given out.

We have some ideas for further research. The first is to take a behavioral approach to the cause of citations. Rather than aggregating the total number of citations, it would be interesting to determine the chances of each individual to commit a violation, and also the chances of them getting a citation. With this approach, new data would have to be collected on not only citations, but also on cars that park legally, and cars that park illegally but do not get a citation.

Although we examined the effects of the number of officers active on a given day, those results were the aggregate effects, without knowledge of how many hours each officer worked, or where they patrolled. It would be insightful to conduct research by experimenting with the total number of officers and the routes they patrol, to determine the most efficient method of employing officers.

9. Appendices

9.1 Tobit Regression Output

	Coef.	Std. Error	P-Value	95% Conf. Interval	
Officers	0.212***	0.021	0	0.17	0.253
Tues*officers	-0.015	0.027	0.585	-0.068	0.038
Wed*officers	0.002	0.026	0.933	-0.049	0.053
Thurs*officers	0.021	0.027	0.447	-0.032	0.074
Fri*officers	-0.047	0.027	0.082	-0.099	0.006
Sat*officers	0.237***	0.04	0	0.159	0.316
Zone2	2.282***	0.135	0	2.018	2.547
Zone3	-0.887***	0.176	0	-1.231	-0.543
Zone4	-0.232	0.159	0.145	-0.544	0.08
Zone5	-3.982***	0.297	0	-4.565	-3.399
fbevent	-0.246*	0.125	0.049	-0.491	-0.001
Zone2*fbevent	0.104	0.16	0.516	-0.21	0.419
Zone3*fbevent	-0.123	0.24	0.609	-0.593	0.347
Zone4*fbevent	0.317	0.198	0.109	-0.071	0.706
Zone5*fbevent	1.245***	0.144	0	0.962	1.528
bbevent	-0.024	0.082	0.765	-0.184	0.135
Zone2*bbevent	0.03	0.106	0.774	-0.178	0.239
Zone3*bbevent	-0.016	0.157	0.917	-0.323	0.291
Zone4*bbevent	-0.114	0.133	0.389	-0.374	0.146
Zone5*bbevent	0.316**	0.097	0.001	0.126	0.505
satmark	0.591***	0.139	0	0.319	0.863
Zone2*satmark	-0.528***	0.073	0	-0.67	-0.385
Zone3*satmark	-0.174	0.107	0.103	-0.384	0.035
Zone4*satmark	-0.281**	0.091	0.002	-0.46	-0.103
Zone5*satmark	-0.271***	0.067	0	-0.401	-0.14
movein	-0.247	0.167	0.139	-0.575	0.081

Zone2*movein	0.08	0.218	0.712	-0.347	0.508
Zone3*movein	-0.004	0.335	0.99	-0.661	0.653
Zone4*movein	0.261	0.281	0.354	-0.29	0.812
Zone5*movein	0.647**	0.2	0.001	0.255	1.04
tf	0.006	0.172	0.972	-0.331	0.343
Zone2*tf	0.084	0.227	0.711	-0.361	0.529
Zone3*tf	-0.445	0.345	0.198	-1.122	0.232
Zone4*tf	-0.661*	0.305	0.03	-1.258	-0.063
Zone5*tf	0.156	0.206	0.45	-0.248	0.56
olympictrials	-1.923***	0.312	0	-2.535	-1.311
Zone2*olympic	1.462***	0.382	0	0.714	2.211
Zone3*olympic	1.970***	0.546	0	0.9	3.039
Zone4*olympic	1.532**	0.483	0.002	0.586	2.478
Zone5*olympic	1.820***	0.359	0	1.117	2.523
Feb	-0.071	0.125	0.57	-0.316	0.174
Mar	0.106	0.116	0.361	-0.122	0.334
Apr	-0.108	0.118	0.361	-0.339	0.123
May	-0.147	0.125	0.239	-0.391	0.098
Jun	0.111	0.119	0.352	-0.123	0.344
Jul	-0.052	0.121	0.666	-0.29	0.185
Aug	-0.113	0.12	0.346	-0.348	0.122
Sep	-0.378**	0.132	0.004	-0.637	-0.118
Oct	-0.435***	0.119	0	-0.668	-0.202
Nov	-0.649***	0.123	0	-0.89	-0.408
Dec	-0.514***	0.125	0	-0.759	-0.269
Zone2*Feb	0.194	0.108	0.072	-0.017	0.406
Zone2*Mar	-0.073	0.105	0.483	-0.278	0.132
Zone2*Apr	0.297**	0.106	0.005	0.088	0.505
Zone2*May	0.138	0.111	0.213	-0.079	0.355
Zone2*Jun	0.112	0.109	0.304	-0.101	0.324
Zone2*Jul	0.266*	0.108	0.014	0.055	0.477
Zone2*Aug	0.184	0.108	0.087	-0.027	0.395
Zone2*Sep	0.245*	0.117	0.037	0.015	0.474
Zone2*Oct	0.379***	0.108	0	0.167	0.592

Zone2*Nov	0.440***	0.112	0	0.219	0.66
Zone2*Dec	0.569***	0.112	0	0.349	0.788
Zone3*Feb	-0.198	0.16	0.215	-0.511	0.115
Zone3*Mar	-0.221	0.154	0.15	-0.522	0.08
Zone3*Apr	-0.227	0.158	0.149	-0.536	0.081
Zone3*May	-0.029	0.163	0.861	-0.348	0.291
Zone3*Jun	-0.494**	0.163	0.003	-0.814	-0.173
Zone3*Jul	-0.217	0.161	0.177	-0.532	0.098
Zone3*Aug	0.163	0.158	0.304	-0.147	0.473
Zone3*Sep	-0.016	0.175	0.926	-0.36	0.328
Zone3*Oct	0.368*	0.159	0.02	0.057	0.679
Zone3*Nov	0.511**	0.164	0.002	0.19	0.832
Zone3*Dec	0.332*	0.165	0.044	0.008	0.655
Zone4*Feb	-0.212	0.134	0.114	-0.476	0.051
Zone4*Mar	-0.217	0.129	0.093	-0.471	0.036
Zone4*Apr	-0.298*	0.133	0.025	-0.559	-0.037
Zone4*May	-0.358*	0.139	0.01	-0.631	-0.085
Zone4*Jun	-0.463***	0.137	0.001	-0.73	-0.195
Zone4*Jul	-0.237	0.135	0.079	-0.502	0.028
Zone4*Aug	0.045	0.134	0.739	-0.218	0.307
Zone4*Sep	-0.302*	0.149	0.043	-0.594	-0.009
Zone4*Oct	0.302*	0.134	0.024	0.04	0.564
Zone4*Nov	0.433**	0.139	0.002	0.16	0.705
Zone4*Dec	0.365**	0.139	0.009	0.092	0.637
Zone5*Feb	0.212*	0.098	0.031	0.019	0.405
Zone5*Mar	-0.101	0.095	0.288	-0.288	0.085
Zone5*Apr	0.200*	0.097	0.039	0.01	0.39
Zone5*May	0.079	0.101	0.432	-0.119	0.277
Zone5*Jun	-0.563***	0.1	0	-0.759	-0.368
Zone5*Jul	-0.888***	0.1	0	-1.083	-0.692
Zone5*Aug	-1.057***	0.1	0	-1.253	-0.861
Zone5*Sep	-0.657***	0.108	0	-0.869	-0.445
Zone5*Oct	0.483***	0.099	0	0.289	0.676
Zone5*Nov	0.738***	0.102	0	0.538	0.939
Zone5*Dec	-0.211*	0.103	0.041	-0.414	-0.009

Tues	0.016	0.157	0.921	-0.292	0.323
Wed	0.011	0.153	0.945	-0.29	0.311
Thurs	0.023	0.159	0.885	-0.29	0.336
Fri	0.346*	0.159	0.03	0.034	0.657
Sat	1.230***	0.143	0	0.95	1.51
Tues*Feb	0.119	0.133	0.371	-0.142	0.381
Tues*Mar	0.126	0.125	0.313	-0.119	0.37
Tues*Apr	0.118	0.126	0.351	-0.13	0.365
Tues*May	0.154	0.13	0.237	-0.101	0.409
Tues*Jun	0.089	0.127	0.484	-0.16	0.337
Tues*Jul	0.04	0.13	0.756	-0.214	0.294
Tues*Aug	-0.117	0.13	0.366	-0.372	0.137
Tues*Sep	0.121	0.138	0.378	-0.148	0.391
Tues*Oct	-0.025	0.126	0.843	-0.272	0.222
Tues*Nov	0.122	0.129	0.346	-0.131	0.374
Tues*Dec	0.115	0.134	0.39	-0.147	0.377
Wed*Feb	0.174	0.132	0.187	-0.085	0.432
Wed*Mar	-0.043	0.125	0.733	-0.288	0.203
Wed*Apr	0.213	0.125	0.088	-0.031	0.457
Wed*May	0.125	0.13	0.335	-0.13	0.38
Wed*Jun	0.059	0.127	0.643	-0.189	0.307
Wed*Jul	0.086	0.13	0.507	-0.168	0.34
Wed*Aug	-0.034	0.128	0.792	-0.284	0.217
Wed*Sep	0.176	0.137	0.198	-0.092	0.445
Wed*Oct	-0.263*	0.125	0.036	-0.509	-0.017
Wed*Nov	0.034	0.129	0.79	-0.218	0.287
Wed*Dec	0.006	0.131	0.966	-0.251	0.262
Thurs*Feb	-0.065	0.133	0.625	-0.325	0.196
Thurs*Mar	-0.171	0.125	0.171	-0.416	0.074
Thurs*Apr	0.032	0.126	0.801	-0.215	0.279
Thurs*May	0.11	0.132	0.406	-0.149	0.368
Thurs*Jun	-0.176	0.128	0.169	-0.427	0.075
Thurs*Jul	-0.099	0.129	0.445	-0.352	0.154
Thurs*Aug	-0.014	0.129	0.916	-0.267	0.24
Thurs*Sep	-0.24	0.137	0.079	-0.508	0.028
Thurs*Oct	-0.149	0.126	0.238	-0.397	0.099
Thurs*Nov	-0.226	0.134	0.093	-0.489	0.037
Thurs*Dec	-0.327*	0.134	0.015	-0.59	-0.063
Fri*Feb	0.052	0.132	0.692	-0.207	0.312

Fri*Mar	0.063	0.125	0.614	-0.182	0.307
Fri*Apr	0.321*	0.125	0.01	0.076	0.567
Fri*May	0.016	0.132	0.906	-0.243	0.274
Fri*Jun	0.003	0.127	0.978	-0.246	0.253
Fri*Jul	-0.106	0.13	0.418	-0.361	0.15
Fri*Aug	-0.059	0.129	0.648	-0.312	0.194
Fri*Sep	-0.106	0.137	0.44	-0.374	0.163
Fri*Oct	0.029	0.125	0.818	-0.216	0.273
Fri*Nov	0.237	0.13	0.068	-0.017	0.491
Fri*Dec	0.008	0.134	0.952	-0.255	0.271
Sat*Feb	-0.091	0.13	0.483	-0.346	0.164
Sat*Mar	-0.11	0.122	0.365	-0.349	0.128
Sat*Apr	-0.325*	0.166	0.05	-0.65	-0.001
Sat*May	-0.214	0.183	0.24	-0.573	0.144
Sat*Jun	-1.147***	0.181	0	-1.501	-0.793
Sat*Jul	-0.688***	0.182	0	-1.046	-0.331
Sat*Aug	-1.047***	0.182	0	-1.404	-0.69
Sat*Sep	-0.931***	0.191	0	-1.305	-0.556
Sat*Oct	-0.743***	0.18	0	-1.096	-0.391
Sat*Nov	-0.893***	0.183	0	-1.251	-0.536
Sat*Dec	-0.645***	0.177	0	-0.991	-0.299
2b.block	0	.	.	0	0
4.block	2.235***	0.114	0	2.011	2.458
5.block	2.562***	0.113	0	2.34	2.783
6.block	0.001	0.097	0.989	-0.188	0.191
7.block	-4.497***	0.157	0	-4.803	-4.19
8.block	-3.981***	0.141	0	-4.257	-3.704
12.block	-0.840***	0.138	0	-1.111	-0.568
13.block	2.174***	0.114	0	1.95	2.398
14.block	3.059***	0.112	0	2.84	3.279
15.block	1.397***	0.094	0	1.213	1.581
16.block	0.075	0.097	0.435	-0.114	0.265
17.block	3.121***	0.093	0	2.939	3.303
18.block	-0.296**	0.098	0.003	-0.487	-0.104
20.block	0.909***	0.12	0	0.674	1.144
22.block	0.199	0.125	0.112	-0.047	0.445

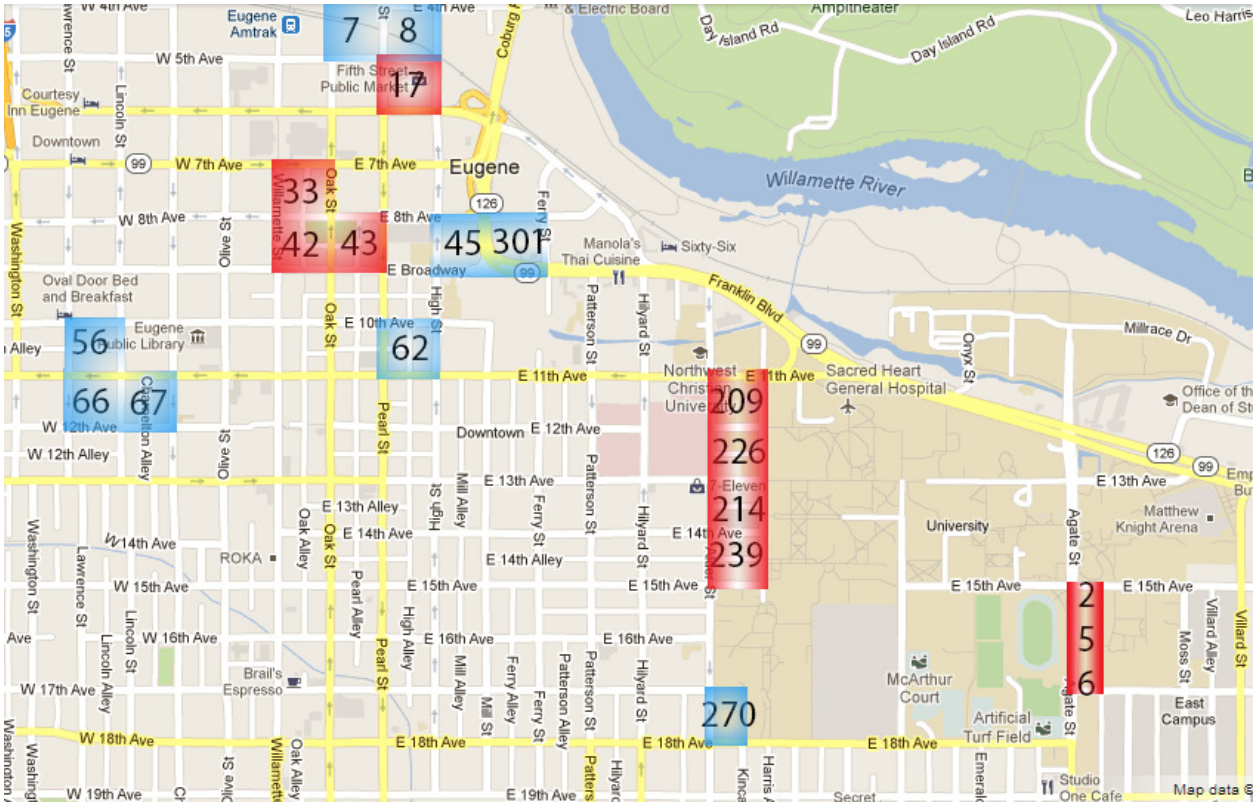
25.block	-0.488***	0.099	0	-0.681	-0.294
29.block	-0.741***	0.137	0	-1.009	-0.472
30.block	1.511***	0.117	0	1.281	1.741
31.block	2.462***	0.114	0	2.238	2.687
32.block	1.116***	0.119	0	0.883	1.35
33.block	2.788***	0.093	0	2.606	2.97
34.block	0.049	0.097	0.614	-0.141	0.238
35.block	0.196*	0.096	0.041	0.008	0.385
36.block	-3.195***	0.124	0	-3.437	-2.952
38.block	0.755***	0.121	0	0.517	0.993
39.block	1.861***	0.116	0	1.634	2.087
40.block	2.910***	0.113	0	2.688	3.131
41.block	2.917***	0.113	0	2.695	3.139
42.block	4.296***	0.093	0	4.115	4.478
43.block	6.727***	0.092	0	6.546	6.908
44.block	-0.146	0.097	0.134	-0.337	0.045
45.block	-5.298***	0.192	0	-5.676	-4.921
46.block	-2.781***	0.118	0	-3.011	-2.551
47.block	-0.195	0.13	0.133	-0.449	0.06
48.block	1.833***	0.116	0	1.605	2.06
49.block	2.066***	0.115	0	1.84	2.292
50.block	-0.19	0.098	0.052	-0.382	0.002
51.block	-0.076	0.097	0.434	-0.266	0.114
52.block	1.083***	0.095	0	0.897	1.268
53.block	-0.037	0.097	0.704	-0.227	0.153
54.block	-3.128***	0.123	0	-3.369	-2.887
56.block	-1.659***	0.156	0	-1.964	-1.354
57.block	0.789***	0.121	0	0.551	1.026
58.block	2.283***	0.115	0	2.058	2.507
59o.block	0	.	.	0	0
60.block	0.124	0.097	0.201	-0.066	0.314
61.block	-1.207***	0.102	0	-1.407	-1.006
62.block	-4.859***	0.171	0	-5.194	-4.523
63.block	-2.977***	0.12	0	-3.213	-2.741
66.block	-2.721***	0.263	0	-3.236	-2.206

67.block	-1.903***	0.208	0	-2.31	-1.496
68.block	0.765***	0.141	0	0.488	1.042
69.block	0.274	0.147	0.062	-0.014	0.563
70.block	4.106***	0.126	0	3.859	4.353
71.block	2.781***	0.118	0	2.551	3.012
72.block	-0.457**	0.141	0.001	-0.734	-0.18
73.block	0.995***	0.126	0	0.748	1.242
78.block	-0.057	0.152	0.706	-0.356	0.241
79.block	3.285***	0.128	0	3.035	3.535
80.block	2.579***	0.118	0	2.347	2.811
81.block	1.582***	0.122	0	1.343	1.822
82.block	-0.614***	0.144	0	-0.895	-0.332
89.block	0.747***	0.141	0	0.469	1.024
90.block	1.619***	0.122	0	1.38	1.858
91.block	1.183***	0.125	0	0.939	1.427
99.block	1.086***	0.138	0	0.815	1.357
100.block	0.044	0.134	0.743	-0.219	0.308
101.block	0.924***	0.126	0	0.676	1.171
109.block	1.228***	0.137	0	0.96	1.497
110.block	1.553***	0.122	0	1.313	1.792
111.block	-0.108	0.136	0.428	-0.375	0.159
119o.block	0	.	.	0	0
120.block	1.048***	0.125	0	0.802	1.293
121o.block	0	.	.	0	0
205.block	7.292***	0.284	0	6.736	7.848
208.block	5.975***	0.285	0	5.416	6.533
209.block	9.872***	0.283	0	9.318	10.427
210.block	4.589***	0.288	0	4.025	5.153
212.block	5.404***	0.286	0	4.844	5.965
213.block	6.250***	0.285	0	5.692	6.808
214.block	13.454***	0.283	0	12.9	14.009
222.block	7.476***	0.284	0	6.92	8.032
224.block	5.960***	0.285	0	5.402	6.518
225.block	7.769***	0.283	0	7.214	8.325
226.block	10.588***	0.283	0	10.034	11.143

227.block	9.495***	0.283	0	8.94	10.049
234.block	8.249***	0.283	0	7.694	8.804
235.block	5.051***	0.287	0	4.489	5.613
238.block	6.187***	0.285	0	5.629	6.746
239.block	10.896***	0.283	0	10.342	11.45
240.block	7.695***	0.283	0	7.14	8.25
245.block	6.191***	0.285	0	5.634	6.749
246.block	5.489***	0.286	0	4.929	6.049
249.block	5.010***	0.287	0	4.448	5.572
250.block	6.929***	0.284	0	6.373	7.485
255.block	6.908***	0.284	0	6.351	7.464
256.block	8.606***	0.283	0	8.051	9.161
257.block	5.432***	0.286	0	4.871	5.992
258.block	3.004***	0.297	0	2.422	3.586
270.block	2.932***	0.297	0	2.349	3.514
271.block	6.534***	0.284	0	5.977	7.091
272.block	5.579***	0.286	0	5.02	6.139
273.block	4.383***	0.289	0	3.818	4.949
274.block	4.967***	0.287	0	4.404	5.529
275.block	5.845***	0.285	0	5.286	6.404
276.block	5.484***	0.286	0	4.924	6.044
277.block	4.807***	0.287	0	4.244	5.37
288.block	5.522***	0.286	0	4.962	6.082
289.block	5.756***	0.285	0	5.197	6.316
300.block	4.110***	0.29	0	3.542	4.677
301.block	2.735***	0.299	0	2.148	3.322
400.block	4.957***	0.287	0	4.395	5.52
401.block	4.977***	0.287	0	4.414	5.539
402.block	4.177***	0.29	0	3.609	4.744
403o.block	0	.	.	0	0
2007b.year	0	.	.	0	0
2008.year	-0.128***	0.024	0	-0.175	-0.081
2009.year	-0.443***	0.025	0	-0.492	-0.393
2010.year	-0.516***	0.025	0	-0.564	-0.467

2011.year	-0.991***	0.026	0	-1.041	-0.94
2012.year	-0.952***	0.027	0	-1.005	-0.898
Constant	-3.170***	0.155	0	-3.473	-2.867

9.2 Map of Most and Least Cited Blocks



10. References

Ander, S. (2008). Ticketed by the Invisible Hand: The economics of parking tickets. *Kennedy School Review, 8*, 129-131.

Barata, E., Cruz, L., & Ferreira J. P. (2011) Parking at the UC campus: Problems and solutions. *Cities, 28*, 406-413.

Calthrop, E. (2001) When consumers can decide not to pay a tax: enforcing and pricing urban on-street parking space (ETE Working Paper Series No. 2001-10).

Calthrop, E., & Proost, S. (2006). Regulating on-street parking. *Regional Science and Urban Economics, 36,* 29-48.

Fisman, R. & Miguel, E. (2007). Corruption, Norms, and Legal Enforcement: Evidence from Diplomatic Parking Tickets. *Journal of Political Economy, 115*(6), 1020-1048.

Fukuda, D., & Morichi, S. (2007) Incorporating aggregate behavior in an individual's discrete choice: An application to analyzing illegal bicycle parking behavior. *Transportation Research Part A, 41*, 313-325.

Goodling, W., & Olson, S. (2010) An Econometric Analysis of Parking Citation Payment in Eugene, Oregon. Unpublished manuscript, University of Oregon, Eugene, OR.

Habib, K. M. N., Morency, C., & Trepanier, M. (2012) Integrating parking behavior in activity-based travel demand modeling: Investigation of the relationship between parking type choice and activity scheduling process. *Transportation Research Part A, 46*, 154-166.

Havarneanu, G. M., & Havarneanu, C. E. (2012) When norms turn perverse: Contextual irrationality vs rational traffic violations. *Transportation Research Part F, 15,* 144-151.

Hess, S. & Polak, J.W. (2009) Mixed Logit Modelling of Parking Type Choice Behaviour. In B. Sloboda (Ed.), *Transportation Statistics* (77-102). J.D. Ross Publishing.

Spiliopoulou, C., & Antoniou C. (2012) Analysis of illegal parking behavior in Greece. *Procedia – Social and Behavioral Sciences, 48*, 1622-1631.