EXPLORING THE SPATIAL DEPENDENCE AND SELECTION BIAS OF DOUBLE PARKING CITATIONS DATA

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Parking violation citations, often used to identify contributing factors to parking violation behaviors, is one of the most valuable datasets for traffic operation research. However, little has been done to examine its spatial dependence caused by location-specific differences in features such as traffic, land use, etc., and potential selection biases resulting from different levels and coverage of traffic enforcement.

This study leveraged extensive data on double parking citations in Manhattan, New York in 2015, along with other datasets including land use, transportation and socio-demographic features to investigate the following:

- Global and Local Moran's I statistics - **Spatially Autocorrelation**
- **Selection Bias** – Investigate the effects of parking ticket density and police precinct distance, when controlling for variables such as commercial area, truck activity, taxi demand, population, hotel and restaurant.

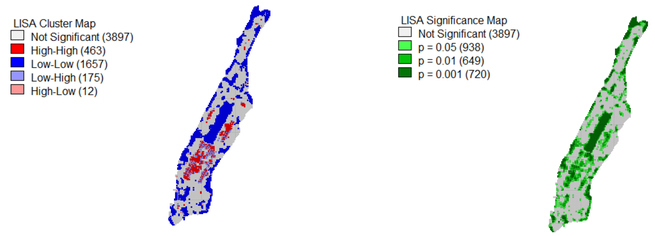
Parking ticket density and police precinct distance were used as indicators of the enforcement levels and coverage and were found to be statistically significant.

	All Parking Violations	Double Parking Violations
Total number of tickets in 2015	10,905,102	695,369
%Commercial vehicle tickets	19.4%	45.2%
%Passenger cars tickets	72.5%	47.3%
%Tickets issued in Manhattan	34.0%	58.8%
%Tickets issued in Brooklyn	20.7%	17.5%
%Tickets issued in Queens	18.3%	7.8%
%Tickets issued in Bronx	10.1%	14.2%
%Tickets issued in Staten Island	0.9%	0.2%
%Tickets issued during Weekday	85.7%	89.9%
%Tickets issued during Weekend	14.3%	11.1%

Global Moran's I Statistics

Weight Matrix	I	E[I]	SD[I]	Z_i	Pseudo p-value
Threshold Distance-300 feet	0.3321	-0.0002	0.0090	36.9521	0.0001
Threshold Distance-800 feet	0.2581	-0.0002	0.0041	62.7201	0.0001
4-nearest neighbor	0.3318	-0.0002	0.0089	37.2234	0.0001
8-nearest neighbor	0.3262	-0.0002	0.0063	51.8185	0.0001

Local Moran's I Statistics - LISA



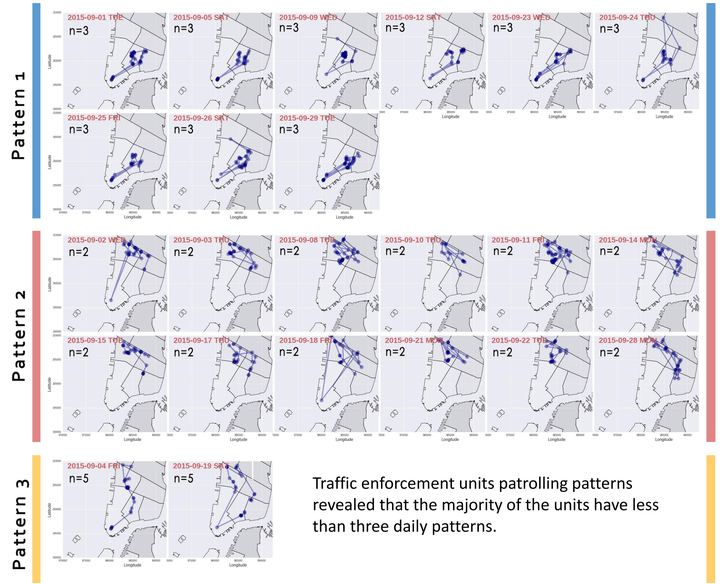
Model Results and Assessment

To investigate whether selection bias exists in issuing parking tickets, the effects of parking ticket density and police precinct distance were estimated while controlling for variables such as commercial area, truck activity, taxi demand, population, hotel and restaurant.

- **Parking ticket density** – Indicator of the level of enforcement – Positive Impact
- **Police Precinct Distance** – Indicator of the enforcement coverage – Negative Impact

Variables	Standard Model		Spatial Lag Model		Spatial Error Model	
	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value
Intercept	-12.712	<0.001	-14.472	<0.001	-11.501	0.006
Experimental variables						
Parking ticket density	5.313	<0.001	3.044	<0.001	5.199	<0.001
Police precinct distance	-18.433	<0.001	-14.665	0.002	-18.112	0.001
Control variables						
Commercial ratio	8.829	0.014	6.630	0.060	10.927	0.004
Hotel distance	6.606	<0.001	6.053	<0.001	6.592	<0.001
Restaurant density	7.316	<0.001	7.204	<0.001	7.311	<0.001
Total population	0.040	<0.001	0.037	<0.001	0.034	<0.001
Truck ratio	1.210	<0.001	1.225	<0.001	1.283	<0.001
Taxi drop-offs	0.886	<0.001	0.825	<0.001	0.862	<0.001
Autoregressive Parameter						
ρ			0.224	<0.001	-	-
λ			-	-	0.245	<0.001
Model Assessment						
R^2	0.225		0.259		0.263	
AIC	73683.300		73486.300		73469.900	
BIC	73743.800		73553.600		73530.500	

Demonstration of patrol patterns of traffic enforcement



Traffic enforcement units patrolling patterns revealed that the majority of the units have less than three daily patterns.

Conclusions

- The global and local Moran's I statistics were in complete agreement that double parking citations were spatially dependent and such spatial dependence should not be neglected when using citation data.
- Both of the experimental variables Parking ticket density & Police Precinct Distance were found to be statistically significant, confirming the assumption that certain selection bias caused by enforcement intensity exists in the parking ticket data.
- These findings can assist proper usage of the citation data by suggesting researchers and agencies to consider spatial dependence as well as selection bias, and provide insights for parking violation management strategies.