Neighborhood Effects on 911 Call Priority in Baltimore, MD

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Abstract

This papers sets out to determine if the priorities assigned to 911 calls are affected by the demographics of the neighborhood from which the call is placed. I hypothesize that demographics do affect 911 call priority, especially the income of the neighborhoods, although I expect racial characteristics to play a role as well. Existing studies have produced mixed results; some find that demographics play no significant effect on police behavior and those that do find a significant effect often disagree on whether this effect is positive or negative. However, while these studies often examine ‘outcomes’ of police officer behavior - such as response times - my research looks at something that determines police officer behavior, specifically the priority placed on a given 911 call. To address the problem of selection bias, I use both multiple regression and matching. In both strategies, I control for various features of each Census Block Group and for differences between each 911 call, such as day of week and description of the call. After controlling for these factors, I find that in Baltimore city, as a whole, Census Block Groups with higher median household incomes receive higher priority and Census Block Groups with higher percentages of white residents or higher percentages of African American residents receive lower priorities. However, when examining how each precinct determines priority, there is no clear overall pattern, as the significance and direction of the effect of demographics on assigned 911 call priority changes vastly between the different precincts.

I. Introduction

The goal of my research is to understand how demographics and other qualities of neighborhoods affect police behavior. Specifically, I examine if the priority placed on 911 calls depends on the characteristics of the neighborhood from which the call was placed. While there has been a lot of research on how demographics affect police behavior, most of this research focuses on actions such as response times, which come after the priority on the call is already placed and can be affected by external factors such as where a police officer is when the call is placed. 911 call priority, on the other hand, is more likely to be entirely determined by the 911 call operator and understanding how demographics may affect this decision may help to understand the source of any disparities in police actions. To conduct this research, I use a dataset from the Baltimore Police Department which contains information on every 911 call placed in Baltimore from the start of 2015 until September 2017; the dataset includes information on when and where the call was placed from, a brief description of the call, and the priority the call was assigned by the 911 call operator. The data for the Census Block Groups in Baltimore comes from the United States Census Bureau and contains demographic information for 647 Block Groups within Baltimore. The first way I analyze the data is by using multiple regression, where I try to control for factors that may affect priority and then see how income and racial makeup affect assigned priority. In addition, I use matching for each of the nine major precincts in Baltimore, which reveals how demographics affects priority for each precinct. I find that in Baltimore city as a whole there is a significant, positive relationship between income of a Census Block Group and the priority it receives, while there is a significant, negative relationship between the percentage of white residents and priority as well as a significant, negative relationship between the percentage of African American residents and priority. However, when

I examine demographic effects for each of the major precincts, there is no overall trend that emerges, as many of the precincts return results that show that demographics have insignificant effects or show that the precincts vary in how these demographics affect their priority.

The remainder of the thesis is structured as follows. In the next section I provide a literature review. Then, I provide background on how the Baltimore Police Department assigns priority to 911 calls. Next, I describe the data used in the analysis, followed by the empirical strategy. Afterwards, I turn to the main findings and finish with a concluding section.

II. Literature Review

While there is a great deal of literature on how demographics affect government services, existing studies have been, as a whole, inconclusive. Most studies have determined that demographics have a significant effect on response times, although they disagree on whether minorities and high-poverty neighborhoods receive better or worse treatment as a result.

Mladenka and Hill (1978) explored the distribution of police services in Houston by collecting and analyzing response time data. Their paper relied on data from the Houston Police Department and looked at 660 dispatches from nine days in 1973. The calls were separated by the type of incident described; however, calls including serious personal injury or death were excluded. The calls were then located in the 20 police districts of the city of Houston and demographic data for these districts were gathered from the 1970 Census. The variables included percentage of the population that was Mexican-American and African-American, as well as the average value of owner occupied housing units, average contract rent, population density, average education level, mean per capita income, and the percentage of all families earning incomes below the poverty line. Mladenka and Hill used a bivariate correlation matrix and found that the only statistically significant demographic effect on response time was mean per capita income; an increase in this statistic tended to slow response times. Additionally, they found that the police did not respond less quickly to calls from minority or high-poverty areas of the city.

Nearly 35 years later, Cihan, Zhang, and Hoover (2012) examined the relationship between police response time and community characteristics in the same city as Mladenka and Hill. They obtained incident-level data from the Houston Police Department, looking only at the 4,917 911 calls classified as an in-progress burglary. This dataset included the address and geolocation of the incident, the response priority, the source of the call, the type of call, time of call, time of dispatch, time of arrival, time between arrival and closing the issue, and whether an arrest was made. They then used data from the 2000 census to obtain demographic information about Houston's census tracts. To examine how the characteristics of the incident and the qualities of the neighborhood affect police response time, the study applied hierarchical linear models to the data. The results of the study suggested that disadvantaged neighborhoods received a shorter police response, and that rapid response increased the probability of in-progress burglary apprehension.

Cihan later reexamined the relationship between police performance and neighborhood disorganization in 2015. This study used agency-generated calls-for-service data from the Houston Police Department in 2006 and the 2000 US Bureau of Census statistics. The data included information regarding a variety of call characteristics, such as the address and geographic coordinates of the incident, call priority, dispatch and arrival time, and weapon use. The Census Bureau statistics included variables on race, ethnicity, immigration, poverty, unemployment, and residential stability. To determine how call and neighborhood characteristics affected response times, Cihan used hierarchical linear modeling. The results suggested that concentrated disadvantage, immigrant concentration, and residential stability were significantly related to the distribution of the HPD's response time patterns, and that police were quicker to respond to in-progress assault calls in disorganized neighborhoods.

Feigenbaum and Hall (2015) studied the distribution of local government services in Boston. To do this, they used a dataset of requests for local government services for Boston between 2011 and 2015. There were various services included in the data set, such as snow plowing, traffic signal repairs, pothole repairs, and graffiti cleanup. They also used a census dataset with information on localized income and income inequality to see how these demographics affected the allocation local government services. Using a multiple regression that controls for fixed effects, the paper found that higher-income neighborhoods both made more requests for government services and also received faster response times than lower-income neighborhoods, in direct contrast with the earlier papers examining police response time.

Finally, Lee, Lee, and Hoover (2017) evaluated police performance by examining response time to domestic violence incidents. Their study used 10,880 incidents responded to by the Houston Police Department from September 2010 through August 2013. They used information available through the 2010 U.S. Census for characteristics at the neighborhood level. To analyze how both differences in the nature of the call and the characteristics of the neighborhood affected response time, they used hierarchical linear modeling, which performs regression analysis with multilevel data. The study revealed that incidents that occurred on weekends or during the night, as well as those where weapons were present, were responded to more quickly than would otherwise be expected. Similarly, if the caller was Hispanic, response time was predicted to be faster. As far as the neighborhood was concerned, increases in concentrated disadvantage, immigration concentration, and residential mobility led to predicted decreases in the time it took the police to arrive at the incident.

While informative, none of these studies directly examine the question I try to answer. All of these studies look at government services with specific regards to response time. And while response times and the priority placed on a call are related, response times can be affected by a number of outside factors - such as traffic conditions and where the officer was when the call was placed - that do not affect the priority assigned to a 911 call by the call taker. Because this assigned priority sets in motion a chain of law enforcement actions, understanding whether this first police response is inappropriately affected by neighborhood characteristics is critical to understanding the nature of bias in policing.

III. Background

The city of Baltimore's Police Department organizes police calls into five categories of priority: emergency, high, medium, low, and non-emergency. Any 911 call that is placed in Baltimore is received by a call-taker who then puts the information about the call - and the prioritization it receives - into a computer system.[1] The priority assigned to a call determines the order in which police officers will respond to the calls.

IV. Data

My dependent variable is the priority placed on the 911 call by the 911 call operator in Baltimore City. This variable is an ordinal variable that can take on one of five different values. This data is made available online by the Baltimore Police Department (BPD). In addition to the

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[1] While it seems very unlikely that the assignment of priority is entirely at the discretion of the 911 call-taker, I failed to find any information about how call-priority is determined.

priority placed on the call, the dataset reports when the call was received, which district in Baltimore the call was placed from, a description of the call, the call number assigned to the call, and the location of the incident (latitude/longitude). The dataset spans 2 and three-quarter years (going from the beginning of 2015 to September 2017) and contains information on 2,691,733 911 calls.

My independent variables are the income and racial characteristics of the different Census Block Groups.[2] All of these variables are interval variables; the racial variables include the percentage of white residents, black residents and various other minority residents for each Census Block Group and income lists the median household income for the Census Block Groups. The data is made available online via the United States Census Bureau, which contains this information for 647 Census Block Groups within Baltimore city for 2015. This dataset also includes many other demographic variables, which I use as control variables. The control variables which I have decided to include are each Census Block Group's population, its total number of households, its average household size, its proportion of households occupied by families, its proportion of households not receiving public assistance, and the proportion of households that are occupied by the household's owner. Table 1 on the next page displays all of these variables as well as their number of observations, means, standard deviations, minimums and maximums.

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[2] Census Block Groups are the smallest geographical units for which the United States Census Bureau publishes sample data.

Table 1 – Summary Statistics

VARIABLES	N	Mean	S.D.	Min	Max
Priority	2,452,922	2.740791	0.8387999	1	5
Median Household Income (in $10,000)	2,452,922	4.207602	2.424416	0.8281	25
Percentage of White Residents	2,452,922	28.82416	30.31584	0	100
Percentage of African American Residents	2,452,922	64.29914	34.52946	0	100
Percentage of Native American Residents	2,452,922	0.2827958	1.187174	0	20.25547
Percentage of Asian Residents	2,452,922	2.374519	4.708189	0	40.39409
Percentage of Pacific Islander Residents	2,452,922	0.032744	0.36102	0	6.630972
Percentage Multiple Races	2,452,922	2.305608	3.697436	0	30.17752
Total Number of Households	2,452,922	450.8805	262.6711	58	1414
Population	2,452,922	1097.909	549.8676	141	3828
Proportion of Households Owned	2,452,922	0.4075974	0.2404785	0	1
Proportion of Households Not Receiving Public Assistance	2,452,922	0.9264646	0.0717575	0.5481172	1
Average Housheold Size	2,452,922	2.604829	0.9198574	1.089888	25.38514
Proportion of Family Households	2,452,922	0.498353	0.1984267	0.0149813	1

V. Empirical Approach

There is clearly a problem of selection bias here, as income levels and racial composition are not randomly assigned to neighborhoods. Neighborhoods that have lower incomes and/or more nonwhite residents differ from neighborhoods with higher incomes and/or more white residents in a number of ways. These differences could include the nature and frequency of reported crimes, both of which might influence the priorities assigned to similar 911 calls. To address this problem, I use both multiple regression and matching. These methods reduce bias created by confounding variables and allow the findings to approximate the true causal effect.

<u>Multiple Regression</u>

Using multiple regression allows me to see the effect that any individual neighborhood characteristic has on the priority placed on 911 calls, while holding all other measured neighborhood characteristics constant. Also, it has the benefit of allowing me to treat my independent variables as interval variables - something that I cannot do using matching. The formula I use for this regression is:

$$Y_{ij} = \alpha + \beta INCOME_j + \gamma' RACE_j + \delta' DEMOGRAPHICS_j + \lambda' CALLINFO_{ij} + \kappa REASONFORCALL_{ij} + \varepsilon_{ij}$$

The subscript $_i$ refers to each individual phone call, while the subscript $_j$ refers to the Census Black Group from which the call was placed. Y_{ij} is the expected priority that is placed on the call; $INCOME_j$ is the income of the Census Block Group from which the call was placed; $RACE_j$ is a matrix describing the percentage of residents that identify as various races of the Census Block Group from which the call was placed, $DEMOGRAPHICS_j$ is a matrix of various characteristics of the Census Block Group from which the call was placed, $CALLINFO_{ij}$ represents qualities related to each individual 911 call,[3] and $REASONFORCALL_{ij}$ is a variable indicating the description of the emergency, as recorded by the 911 call operator. I expect the coefficient on income (β) to take a positive value because I expect that as income of a Census

[3] This includes fixed effects for year, month, and all other time variables.

Block Group increases, the priority assigned to 911 calls will also increase - in line with the results of Feigenbaum and Hall (2015). I am unsure what value the coefficients on the race variables will take, although I expect the value on the percentage of white residents and the value on the percentage of African American residents to have opposite signs, which would be consistent with many previous studies.

Matching

The point of matching is to control for all possible factors that could affect the priority placed on 911 calls. In order to do this, each 911 call is assigned a propensity score. A propensity score is the probability of treatment assignment conditional on observed baseline characteristics. Propensity scores allow for the design and analysis of an observational study as if it were a randomized controlled trial. For observations with similar propensity scores, the distribution of observed baseline covariates is similar between treated and untreated subjects. Thus, after the units have been matched, any differences between the treated and untreated can be attributed to the treatment (Austin 2011).

After assigning each call a propensity score, they are matched using nearest-neighbor matching. Nearest-neighbor matching groups together each call that received the treatment to a call that did not receive the treatment that has the most similar propensity score. Then the difference in priority between the average pairing is viewed as the treatment effect - where the treatment is either median household income or the proportion of residents in a Census Block Group of a specific race. This difference is the average increase or decrease of expected 911 call priority for calls placed from Census Block Groups with the treatment versus those placed from Census Block Groups without the treatment.

The matching strategy I use matches calls within each of the nine major districts that make up Baltimore city. Each of these districts contains one precinct building which is responsible for taking in and assigning responsibility to each 911 call placed from the district. Thus, matching in this way allows me to see how each precinct's assignment of priority is affected by Census Block Group demographics. To do this, I match calls on year, month, day of the week, hour of the day, and - most importantly - call description. In addition to matching on the qualities of the call, I also match on all qualities of the block group, except for income and race. Matching on these variables, as well as the characteristics of the call, ensures that any differences between the priorities given to calls from two different neighborhoods can be attributed to racial and financial characteristics of the neighborhoods.

After conducting the matching strategy, I expect to find that for Census Block Groups with above average median household income, the priority placed on 911 calls from this Census Block Group will be higher than those with below average median household income. Similarly, I expect that Census Block Groups with an above average percentage of white residents will differ significantly from those with a below average percentage of white residents. I expect the same to be true for the percentage of African American residents, although I expect these two effects to be of opposite direction.

VI. Results

Multiple Regression

VARIABLES	(1) Priority per 10,000 Calls	(2) Priority per 10,000 Calls	(3) Priority per 10,000 Calls	(4) Priority per 10,000 Calls
Median Household Income	-20.9***	21.5***	19.3***	7.27***
	(2.69)	(3.30)	(3.34)	(.950)
Percentage of White Residents	-11.4***	-15.3***	-14.4***	-3.98***
	(1.39)	(1.46)	(1.48)	(.421)
Percentage of African American Residents	.174	-4.53***	-5.75***	-3.45***
	(1.33)	(1.39)	(1.43)	(.405)
Observations	2,452,922	2,452,922	2,452,922	2,452,922
R-squared	0.002	0.003	0.018	0.921
Racial Controls	Yes	Yes	Yes	Yes
Census Block Group Controls		Yes	Yes	Yes
Phone Call Fixed Effects			Yes	Yes
Description Fixed Effects				Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

While median household income - here in units of ten thousand dollars - is initially shown to lead to a lower priority, adding controls shows that an increase in median household income increases expected 911 call priority. When all controls are included, a $10,000 increase in the median household income of a Census Block Group from where the call was placed is associated with an increase in one level of priority for approximately seven calls out of 10,000. This effect is statistically significant at the 99% level. While this effect may seem negligible for small differences in median household income, when looking at the data as a whole, the difference becomes quite substantial. Specifically, the poorest Census Block Group in Baltimore has a median household income of $8,281, while the richest has a median household income of $250,000. Based on these results, the richest Census Block Group could expect over 1% of their calls to be given higher priority than identical calls from the poorest.

While the results for income are in line with my hypothesis, those for the racial variables are not. While I expected the coefficient on the percentage of white residents to be of the opposite magnitude than the coefficient on the percentage of African American residents, this is not the case. Both coefficients are negative, meaning that both Census Block Groups with a higher percentage of African American residents and those with a higher percentage of white residents experience lower expected 911 call priority. I expect that this is a result of more segregated neighborhoods being viewed differently than more integrated ones.

The coefficient on the income variable above is in line with the results found by Feigenbaum and Hall, but are unique when compared to only papers in the literature that examine police behavior. All of them that studied the effects of income disparity found that poorer neighborhoods received faster response times from the police. The findings for my racial variables are also dissimilar from any papers I came across, because none found that both areas with a high concentration of African American residents and those with a high concentration of white residents received slower response times.

Matching

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DISTRICT	NE	CD	SD	SE	SW	ND	NW	ED	WD
VARIABLES	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls	Priority per 10,000 Calls
Median Household Income	-33.1**	-29.5	20.6	91.6***	60.8***	-29.4*	-43.7***	-29.6	25.8
	(13.5)	(33.3)	(15.2)	(15.0)	(16.4)	(17.0)	(15.9)	(24.6)	(18.9)
	[360,073]	[282,162]	[264,595]	[265,412]	[261,910]	[257,657]	[240,154]	[220,318]	[233,117]
Percentage of White Residents	-7.27	-44.9**	64.0***	-132***	-67.5***	-7.03	-1.50	8.20	-41.4
	(11.0)	(19.3)	(18.5)	(20.1)	(20.1)	(14.9)	(48.3)	(16.5)	(39.1)
	[360,032]	[281,549]	[264,131]	[264,796]	[261,792]	[257,469]	[239,618]	[220,212]	[231,167]
Percentage of African American Residents	-2.99	34.3*	-75.3***	131***	46.0***	-24.3*	38.8	-.716	118
	(11.9)	(20.4)	(18.6)	(22.9)	(17.2)	(14.3)	(48.7)	(16.0)	(82.6)
Observations	[359,999]	[281,549]	[264,085]	[264,640]	[261,792]	[257,461]	[239,596]	[220,212]	[229,655]

Standard errors in parentheses
Number of observations in brackets
*** p<0.01, ** p<0.05, * p<0.1

The results of the matching analysis for each individual district are much less straight forward than the results of the regression analysis. (I also did a multiple regression analysis for each of the nine districts; while this produced different results, they were still just as ambiguous.) Starting with the results on median household income - which compared 911 calls from Census Block Groups with a median household income equal to or greater than $37,500 to calls from Census Block Groups with a median household income lower than $37,500 - five of the nine districts do not have significant results at the 95% level. Of the four districts that did have statistically significant results for median household income, two showed a positive effect, while the other two showed a negative effect. Interestingly, the two districts that showed a positive effect are very similar for the racial characteristics, showing a negative effect for Census Block Groups with more than 14.7% white residents (as compared to those with less than 14.7% white residents) and a positive effect for Census Block Groups with more than 79% African Americans residents (as compared to those with less than 79% African American residents). The two districts that showed statistically significant negative effects for income are very similar as well, as both show statistically insignificant coefficients on the two racial variables.

The racial variables in this analysis offer some interesting insights. For example, of the four districts where both of the two racial variables are statistically significant at the 90% level, the two variables take on opposite values; this means that if calls from districts with high percentages of African American residents are given higher priorities, then calls from districts with high percentages of white residents are given lower priorities and vice versa. While I was surprised to see that this effect was not present in the regression analysis, it makes sense that it appears when analyzing the data via matching. Because Baltimore is a city where over 90% of the residents are either African American or white, Census Block Groups usually have a high percentage of white residents or a high percentage of African American residents, but rarely would they have both. Thus, any district where Block Groups with a high proportion of white residents receive preferential treatment must almost always be a district where Block Groups with a high proportion of African American residents receive negative treatment.

Finally, comparing the results of the matching analysis to the regression analysis also leads to some interesting findings. The differences between the relationships seen in the districts and the relationships seen in the city as a whole could be an example of an ecological fallacy, where just because something is true for the whole does not mean it is true for each part that makes up the whole. Also, the fact that each district does not merely mimic the demographic effects that was found in the regression analysis means that it may be possible that only a few of the districts are responsible for the effects we see at the aggregate level, although it is not immediately clear if that is the case in this analysis.

VII. Conclusion

Based on my findings, 911 calls in Baltimore city placed from Census Block Groups with higher incomes receive, on average, a higher priority than identical calls placed from Census Block Group with lower incomes. Specifically, a $10,000 increase in the median household income of a Census Block Group is associated with 7 calls out of 10,000 being viewed as one level higher priority. For both the percentage of white residents and the percentage of African American residents as a one percent increase for either these two races is associated with 3.5 to 4 calls out of 10,000 being viewed as lower priority.

When analyzing each district individually, however, the results are not nearly as clear. For income, many of the results are not statistically significant, while the ones that are significant are split between showing that an increase in median household income increases priority and that it decreases priority. For race, the results show that the effects for the two racial variables are usually of opposite directions - one positive and one negative - although there is no clear indication of which race is associated with a higher expected priority. Given the racial makeup of Baltimore city, I expected to see this result - where an increase in one race increases expected priority, while an increase in the other decreases expected priority - and was surprised that it was not present in the aggregate analysis.

In sum, it appears that demographics have a significant effect on the behavior of police call operators. While this behavior is more substantially affected by income demographics, the effects caused by racial characteristics should be a cause for concern as well. However, it is not nearly as clear as how to ameliorate the problem. No individual precinct in Baltimore can be blamed for the results seen and a few even seem to not be significantly affected by these demographics at all.

Finally, I believe that there are further questions that arise from this analysis. Specifically, given the findings of many other papers that lower income neighborhoods receive faster response times from the police, how are these findings compatible with that idea. For example, is it possible that 911 call operators are giving higher priority to higher income neighborhoods to correct for this effect or are police officers simply ignoring the priority placed on a call? One way to answer this question would be to compare call priority with response times to see the interaction between these two steps of the police-response process; unfortunately, very few cities currently makes both of these pieces of information publicly available.

VIII. References

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