Does Greater Police Funding Help Catch More Murderers?

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Abstract:

This paper examines the impact of police funding on the fraction of homicides that are cleared by arrest. Using data covering homicides in approximately fifty of the largest U.S. cities from 2007-2017, I find no evidence that greater police funding resulted in higher homicide clearance rates. This finding is robust to linear regression and instrumental variables approaches, different ways to measure police budgets, and across all races of victims. In summary, the way large city police departments have historically used their funds, more funding has not helped catch more murderers.

Key words: Police funding; homicide; clearance rates; arrests; murder victims; defund police; instrumental variables;

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I - Introduction

After the killing of George Floyd by Minneapolis Police Officer Derek Chauvin in May 2020, large protests erupted in many American cities. These protests were the culmination of many years of concern and outrage regarding a view that law-enforcement officers have been overly violent and aggressive in policing small infractions of Black and Latino individuals.[1] But there has also been another voice of concern about something arguably just problematic, though less often expressed, which is the perception law-enforcement under-performs when it comes to holding perpetrators responsible for violent crimes such as murder, particularly when the victims are Black and Latino men. In her book *Ghettoside*, the journalist Jill Leovy states:

> "Forty years after the civil rights movement, impunity for the murder of black men remained America's great, though mostly invisible race problem. The institution of criminal justice, so remorseless in other ways in an era of get-tough sentencing and `preventative' policing, remained feeble when it came to answering for the lives of black murder victims." (Leovy 2015, p 7)

This study takes a detailed look at this issue in urban America, examining how the fraction of homicides for which an arrest is made (hereafter referred to as the homicide *clearance rate*) not only varies by the characteristics of the victim, but also how such rates vary across cities conditional on the characteristics of the victim. Of specific interest will be to assess the extent to which city police budgets impact homicide clearance rates. This latter issue is of particular import given one of the most visible calls for action coming from protests in the summer of 2020 was to "Defund the Police." While it was not always well-specified what was meant by defunding the police, many city leaders responded to these calls by saying they would cut their police budgets. Over the course of the 2020, numerous prominent cities as Austin, New York City, San Francisco, Portland, Philadelphia, Baltimore, and Washington D.C. all

[1] There are also a variety of studies reflecting some truth behind these views, including Anwar and Fang (2006), Antonovics and Knight (2009), Gelman, Fagan, and Kiss (2007), Fagan, Davies, and Carlis (2012), Horace and Rohlin (2016), Coviello and Persico (2015), Gonclaves and Mello (2021), and Hoekstra and Sloan (forthcoming), just to name a few.

suggested they would make significant cuts to their police budgets. This study hopes to shed some light on the potential consequences of such budget moves when it comes to solving homicides.

To look at these issues I employ a dataset collected by the Washington Post (Washington Post 2018), which contains information regarding all homicides that took place in fifty of the largest American cities between 2007 and 2017. These data generally include age, race, and sex of the victim, along with the city and place within the city where the victim was found. I supplement the Washington Post homicide data with city and neighborhood economic and demographic data from the American Community Survey (as well as crime data from the FBI and unemployment data from the BLS) to further assess how homicide clearance rates vary by city and neighborhood characteristics. Moreover, I additionally use city budget data to assess the impact of police budgets on homicide clearance rates.

My general results are as follows. First, in the large American cities between 2007 and 2017, the mean homicide clearance rate across large American cities hovered around 60 percent. Second, almost two-thirds of homicides in these large cities over this time period comprised minority adult males murdered in a heavily minority neighborhood, and moreover, the clearance rate for homicides for such homicides are generally 15 to 30 percentage points lower than they are for adult White male victims, adult female victims of all races, and child and elderly victims of all races and gender. Third, there is substantial variation in homicide clearance rates across cities, with the top five cities clearing over 75 percent of homicides over this time period, while in the bottom five cities clear less than 45 percent of homicides. Fourth and finally, while per capita police budgets vary quite widely across cities, and across years within cities, I find no evidence that such variation has any significant empirical relationship with homicide clearance rates.

With respect to this null finding regarding the impact of police budgets and homicide clearance rates, this result is quite precisely estimated, and is robust to controlling for city level, neighborhood level, and victim level characteristics, as well as city fixed-effects. Moreover, to control for the potential endogeneity between police budgets and current and expected crime conditions, which could also impact clearance rates, I employ an instrumental variables (IV) approach, where I instrument for city police budgets with contemporaneous city fire protection budgets, as well the amount of money each city receives from the State or Federal governments. These IV results further reveal no evidence that greater police budgets increase homicide clearance rates.

Overall, while this study is not able to directly determine what would happen to homicide clearance rates if large U.S. cities were to dramatically cut or increase their police budgets, the results reveal that over the last decade, variation in police budgets across and within large American cities have had no discernable impact on homicide clearance rates.

II – Related Literature

One of the concerns raised about "Defund the Police" movement is the extent to which taking such actions might harm public safety. A variety of studies provide data regarding this concern indirectly by examining the causal impact of more police officers on crime rates (Levitt 2002; Evans and Owens 2007; DiTella and Schargrodsky 2004; Klick and Tabarrok 2005; Draca, Machin, and Witt 2011; Chalfin and McCrary 2018, Mellow 2019). Overall, these studies have found pretty consistent evidence that, all else equal, increasing the number of police officers lowers crime, particularly violent crime. Arguably, to the extent to which lowering police budgets will lessen the number of police officers, this is also at least suggestive that lowering police budgets will lead to more crime.

A separate, but arguably just as important concern however, is how lowering police funding may impact homicide clearance rates. Clearance rates, and homicide clearance rates in particular, are a key metric of policing for a couple of reasons. First, effective deterrence requires that those who are considering breaking a law to expect that there will be a reasonable chance that they will face significant consequences if they do so (Becker 1968; Erlich 1973; Lee and McCrary 2017). Detecting and charging a large fraction of individuals who break a law is obviously a key component of this. Given the egregious and irreversible nature of homicide, deterring this particular crime is of foremost interest. Second, almost any notion of justice requires those who break societal rules and harm others are held accountable in some manner. Finding and arresting those responsible for killing others is therefore a necessary component of a just society. Third, as alluded to in the introduction, several journalists have expressed concerns that homicide clearance rates are particularly low when the victims are Black and Latino men. For example, Jill Leovy states “(i)n Jim Crow Mississippi, killers of black people were convicted at a rate that was only a little lower than the rate that prevailed half a century later in L.A.---30 percent then versus 36 percent in Los Angeles County in the early 1990s” (Leovy 2015).

While to my knowledge there haven’t been any studies formally looking at the impact of police budgets and crime clearance rates, there does exist a relatively robust discussion of clearance rates more generally in the criminology literature. One of the most notable trends this literature has documented has been how homicide clearance rates have been declining in the United States over time, from roughly 90 percent in 1960 to about 60 percent in the 2000s (FBI 2007; Ousey and Lee 2010; Riedel and Jarvis 2009).

Not surprisingly however, such clearance rates differ substantially across cities (Borg and Parker 2001; Horvath, Messig, and Hyeock Lee 2003; Keel, Jarvis, and Muirhead 2009; Roberts 2015), across neighborhoods within cities (Petersen 2017; Mancik, Parker, Williams 2018), and across different types of crimes, victims, and circumstances (Lee 2005; Addington 2006; Roberts 2007; Welford and Cronin 1999; Litwin and Xu 2007; Cook et al. 2019; Regoeczi, Jarvis, and Mancik 2020).

One of the biggest constraints to clearing homicides is the willingness of witnesses to come forward. Such resistance is generally more prevalent in neighborhoods characterized by high levels of social disadvantage (low income, low employment, low education), where residents are often less willing to cooperate with police due to lack of engagement with the community (Regoeczi and Jarvis, 2013), distrust in police (Puckett and Lundman 2003; Litwin, 2004; Tyler and Fagan 2008; Tyler, Fagan, and Geller 2014; Desmond, Papachristos, and Kirk 2016; Brunson and Wade 2019), and possibly a sociological structure the discourages reliance on formal institutions to punish violations (Anderson 1999). Neighborhoods with these characteristics also generally correspond to those with more violence.

Racial differences in homicide clearance rates have also been looked at somewhat extensively, with mixed results (Bachman 1994; Welford and Cronin 1999; Lee 2003). Part of the reason for these mixed results may be related to the issues discussed above, in the sense that it is not clear which other neighborhood, crime, and context variables should be controlled for when looking at racial disparities in homicide clearance rates. Indeed, in one of the most comprehensive studies of racial variation in homicide clearance rates to date, Fagan and Geller (2018) use data from the FBI's Supplementary Homicide Reports to look at all homicides in the United States between 1976 and 2009. They find that homicides with White victims are significantly more likely to be cleared by arrest than homicides with Black victims, but a substantial portion of this disparity can be accounted for by the racial and socio-economic characteristics of the county where the homicide took place.

III – Methodology

The primary question of interest of this study is whether the likelihood a homicide is cleared by arrest is impacted by the monetary resources available to the investigating police department? Police department resources can potentially impact homicide clearance rates through a couple of channels. Maybe most obviously, greater police resources may facilitate hiring more officers, whether this be patrolmen or investigators, allowing for more manpower on each homicide case, which could help identify and find murderers (Liska et al. 1985). Similarly, more resources could allow for the purchase of more technology and/or paying confidential informants, both of which could also help identify and find more murderers. Indeed, Braga and Dusseault (2016) and Braga, Turchan, and Barao (2019) analyze the impact of a specific intervention in Boston in 2012 which increased the number of homicide detectives, added a civilian crime analyst position and an additional Victim-Witness Resource Officer, engaged in additional training and ordered protocols for the Crime Scene Response Unit, and convened monthly peer review sessions for open homicide investigations. These studies found that the collection of these initiatives involved in this intervention notably increased homicide clearance rates in a city which had historically lagged on this dimension.

There is also a potential indirect impact. Namely, increased police budgets may allow for hiring more police or other types of investments that reduce the number of homicides, which in turn means the homicide detectives and others involved in homicide policing are less capacity constrained, which in turn raises homicide clearance rates.

On the other hand, it has also been argued that while hiring more officers indeed lowers crime, it also increases arrests for low-level crimes, particularly among Black residents (Chalfin et al. 2020). This in turn can create tensions and distrust between community members and police, potentially making community members more hesitant to cooperate and assist with homicide investigations, lessening the ability of police to identify and find murderers. Furthermore, it is by no means clear that additional police resources go to the types of initiatives included in the Boston intervention discussed earlier. Rather, they may far more often be to be used for things that have little relation to solving homicides, such as new cars, better protective equipment, updated facilities, higher salaries, or initiatives to deal with other issues such as homelessness or auto theft.

So how to evaluate whether greater policing resources systematically helps increase homicide clearance rates? In a perfect world (at least for researchers), there would be quasi-random variation in the treatment of interest (per capita police budget) within and across otherwise comparable cities. Under this thought experiment, then, we could use OLS to estimate a regression equation of the following form:

$$Clearance\ Rate_{c,t} = \alpha + \beta_1 Police\ Budget_{c,t} + \tau_t + \varepsilon_{c,t} \qquad (1)$$

where $Clearance\ Rate_{c,t}$ is the homicide clearance rate in city c in year t, $Police\ Budget_{c,t}$ is the per capita police budget in city c in year t, τ_t capture year fixed-effects (which may capture things like changing technology), and $\varepsilon_{c,t}$ is idiosyncratic error. The coefficient β_1 would obviously be our coefficient of interest and capture any causal impact of police budget size on homicide clearance rates.

Even in this “perfect” world, however, a couple of issues arise. First, measuring police budgets for a city isn’t necessarily straightforward. While most large cities have their own police department, there are often others also operating within city boundaries simultaneously, notably county sheriffs. More broadly, as stated by the Lincoln Institute website:

> "…the responsibility for providing local public services is often divided among multiple governments, including the municipal government (referred to in this document as a city government) and overlying county governments, independent school districts, and special districts. Fiscal comparisons across city governments alone can thus be highly misleading."

To deal with this, the Lincoln institute constructs Fiscally Standardized Cities (FiSCs) by adding up revenues and expenditures for each city government along with the appropriate share (based on population distribution) of revenue and expenditures from overlying counties, school districts, and other forms of shared government resources. While I will primarily use budget data for these FiSCs, I will check robustness of my results to simply using city only budget data as well.

A bigger issue with equation (1) and the preceding discussion is that the world is certainly not equivalent to that little thought experiment presented above. Cities are not homogenous, and their heterogeneities may impact their police budgets and potentially their homicide clearance rates. For example, cities with higher recent homicide rates might increase their police budgets in response, but also see their homicide investigation resources more constrained. Or some cities may be facing harder economic conditions, which could constrain their ability to increase police budgets despite having lots of homicides to solve. More broadly, cities might differ in the composition of homicides that occur, and some homicides are harder to solve than others. For example, some cities might have a larger number of homicides of children or women, which are far more likely to be done by close acquaintances or family members than homicides of adult males, which may make them easier to solve all else equal. Or, some cities might have a higher number of homicides of Black men that take place in poor primarily Black neighborhoods, which may in turn be harder to solve than those involving White men that take place in richer or less minority heavy neighborhoods due to better cooperation of witnesses with police. Given this, one might worry that such variation in circumstances could make any relation between police budgets and clearance rates hard to pick up, or even worse, cities with harder to solve homicides may actually be investing more in policing in an attempt to solve them, which would negatively bias β_1 estimated from equation (1).

One solution would be to try to control for as many such characteristics as possible, via estimating a regression of the form:

$$Clearance\ Rate_{c,t} = \alpha + \beta_1 Police\ Budget_{c,t} + Case_{c,t}\varphi + \gamma Homicides_{c,t} + \sigma Unemployment_{c,t} + X_c\theta + \tau_t + \varepsilon_{c,t} \quad (2)$$

where new control variables include $Case_{c,t}$ which is a vector of homicide case characteristics in each city *c* in year *t*, $Homicides_{c,t}$ which capture the homicide rate in city *c* in year *t*, $Unemployment_{c,t}$, which captures unemployment rates in city *c* in year *t*, and X_C which is a vector of other city-wide characteristics including racial demographics, median income, percent poor, measures of racial segregation, population, and region indicators. The estimate of β_1 coming from (2) would then tell you the empirical relationship between police budgets on homicide clearance rates holding constant some of the key characteristics of the homicides, as well as the recent homicide and unemployment rates, and other city level economic and demographic characteristics.

The issue that remains in equation (2) is that that there still may be omitted variables that influence both homicide clearance rates and police budgets. Given this, another possible strategy would be to estimate equation (2) with city-level fixed-effects instead of city-level time invariant characteristics, or

$$Clearance\ Rate_{c,t} = \alpha + \beta_1 Police\ Budget_{c,t} + Case_{c,t}\varphi + \gamma Homicides_{c,t} + \sigma Unemployment_{c,t} + \mu_c + \tau_t + \varepsilon_{c,t} \quad (3)$$

where μ_c is a vector of indicator variables for each city. The coefficient on police budgets β_1 would now be primarily identified from variation in police budgets within cities over time, conditional on case characteristics and time varying city characteristics.

Even with the city fixed-effects and the homicide case controls, one might still be worried about an omitted variable bias with respect to the relationship between police budgets and homicide clearance rates. One example might be something like rising gang violence. This gang problem might not only lead to more murders, but might make these murders more difficult to clear due to reluctance to cooperate due to gang affiliation and/or intimidation, as well as cause cities to increase their police budgets. Similarly, policing scandals may reduce police budgets, but also be reflective of poor policing cultures which impact homicide clearance rates.

The above issues suggest that the β_1 estimated from the simple “selection on observables” model and even city fixed-effect model of the forms outlined above might not actually identify the impact of police budgets on homicide clearance rates. An oft-used way to overcome such an endogeneity issue is via an Instrumental Variables (IV) approach. As is well known, key to such an approach is to find a variable that is strongly correlated with the causal variable of interest (in this case city police funding), but conditional on the other included control variables, such a variable can credibly be excluded from having any direct relationship with the outcome of interest (homicide clearance rates). In other words, it must be plausible to assume that any correlation between the instrumental variable and the outcome of interest must only come through the correlation between the instrument and the causal variable of interest. Given such an instrument or instruments, one can then unbiasedly estimate the parameter β_1 in equation (1) via Two-Stage Least Squares (2SLS).

The primary instrument for city police funding that I employ is city funding for fire protection. This instrument is similar to that used by Levitt (2002) in his well-known re-analysis of the impact of police officers on crime, the difference being he instruments for the number of police officers (per capita) with the number of fire fighters (per capita). The motivation is identical however, which is that while city fire department budgets should not be influenced by local crime conditions, or even more notably conditions impacting homicide clearance rates, they might be related to city police budgets due to local public sector union power and contracting, as well as local citizen and political support for government services, particularly those perceived to be furthering public safety.

As a further robustness check, however, I will employ an additional instrument, which is the (natural log of) money in the city budget that comes from the State and/or Federal governments. The motivation for this second instrument is that the amount of money coming into a city from State and/or Federal governments is not likely to be related to current crime conditions in a given city, but might increase the budget for a variety of city budget line items including policing. [2] In some ways, this is similar in spirit to approach taken by Evans and Owens (2007), where they use federal grants to cities for police officers via the COPS program as an exogenous source of variation to look at the impact of more police officers on crime. However, the instrument I use here is much broader than that used by Evans and Owens, in that this money isn't necessarily directed toward policing, and therefore it also may not be a very strong instrument due to this lack of specific direction.

IV – Data

The key data for this project come from the Washington Post Homicides dataset (Washington Post 2018). This dataset contains information on all homicides that occurred in fifty of America's largest cities from 2007 through 2017. This data was collected directly from city police departments. In cases when departments did not provide complete information, the data were supplemented with public records (including death certificates), court records, and medical examiners reports.

In the Washington post data, as well as for this study, a homicide refers to murder and non-negligent manslaughter, but does not include suicides, accidents, justifiable homicides, and deaths by negligence. I also exclude the mass shooting events that appear in the data that I can identify.[3] A homicide is considered "cleared" if the police reported that an arrest was made

[2] Again, like with the police funding measure, for each homicide, both of these instruments are measured per capita and calculated to be the average in the city of the homicide in the year of the homicide and the year prior.
[3] I obtained mass shooting information from https://en.wikipedia.org/wiki/List_of_mass_shootings_in_the_United_States

with respect to that homicide, or if the case was closed because police determined there was sufficient evidence to make an arrest but an arrest was not possible due to death of suspect.

In addition to clearance rate information, for most of the homicides in the dataset there is information on race, sex, and age of victim, the date of the homicide, as well as the city where the homicide took place, and the latitude and longitude of the location where the victim was found.[4] This information was used to map each homicide to a census tract. This allowed me to use data from the Census Bureau's American Community Survey to map racial demographic, income, and poverty data at the city and census tract levels in the year of the homicide to each homicide. However, given the ACS city information for any given year is estimated using sampled data encompassing several different years, I worry that any variation in city level characteristics across years is prone to quite a bit of measurement error. Hence, I use only 2014 ACS data (the middle of the time window for the homicide data) for measuring city and neighborhood characteristics. This means I don't try to separately control for any city level economic and demographic characteristics when I estimate specifications using city fixed-effects, as these characteristics are fixed within city over time.

As alluded to in the previous section, for city budget information, I obtained yearly city budget data from the Fiscally Standardized Cities (FiSC) database developed by the Lincoln Institute using data from the U.S. Census Bureau's Annual Surveys of State and Local Governments. This dataset contains annual information on a variety of city budget line items including the amount of city expenditures on Police Protection, Fire Protection, and the amount of money received from the State or Federal government. All of these are measured on a per capita basis for each city. Given the fact that money spent on policing may take time to impact policing practices, I measure the police expenditure associated with each homicide as the average per capita police expenditure in the city in which that homicide took place in the year in which the homicide took place and the year preceding. Fire Protection expenditures and money received from the State and Federal government are treated analogously.

[4] Given both the Washington Post data and the Census/American Community Survey use the term "Hispanic" when describing ethnicity of Latin American origin, I will subsequently use that term as well.

As also discussed in the previous section, it is not unambiguously clear whether the correct measure of these budget items is taken at just the city level, or the Fiscally Standardized Cities (FiSCs) as developed by the Lincoln Institute. The Lincoln Institute developed these measures to "provide a full picture of revenues raised from city residents and businesses and spending on their behalf, whether done by the city government or separate overlying governments." [5] These FiSC budgets are based on U.S. Census Bureau data from the quinquennial Census of Government Finance and the Annual Surveys of State and Local Government Finance. This data is available yearly from 1977 to 2017 for over 200 of the America's largest cities, including forty-nine of the fifty included in the Washington Post homicide data (the one missing city is San Bernardino CA). Most relevant for this study is that in addition to city level budget data, the FiSC data allots county level measures on things like policing and fire safety spending, as well as state and Federal government disbursements to each city, based on the city's share of the county population.

Given the differences in the way police forces are funded in different cities, it seems arguably correct to use these Fiscally Standardized budgets as the correct measure. However, one could potentially argue that police funding from county and separate overlying governments have little to do with homicide policing in most larger American cities, or even if they do somewhat, allocating those budgets based on the city's share of the county population might overstate the amount of that money actually available to the city. The Lincoln Institute's FiSC data also contains information on just each city's budget separate from the county and other overlying government's contributions. As discussed in the previous section, in the analysis that follows, such city only budget information will be used to assess the robustness of the results that use the Fiscally Standardized budget information.

Higher recent homicide clearance rates could plausibly impact with the citywide homicide clearance rate through congestion and over-taxing a fixed set of detectives. Therefore, I also obtained homicide rates from the FBI's Uniform Crime Reports "Offenses Known to Law Enforcement" series for each city for each year. Like the budget variables, I

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[5] See https://www.lincolninst.edu/research-data/data-toolkits/fiscally-standardized-cities/explanation-fiscally-standardized-cities for full details.

create a "homicide rate" associated with each homicide that is the average of the homicide rate (homicides per 100K population) in the year of the given homicide and the year prior. Similarly, local economic conditions could potentially impact homicide clearance rates, so I use Bureau of Labor Statistics to obtain unemployment rates by city and year and assign these to each homicide.[6]

Finally, to measure the level of segregation in each city, I obtained *isolation indices* for each race/ethnicity for each city from the American Communities Project, which in turn uses United States Census data.[7] For a given race/ethnic group, the *isolation index* measures the percentage of same-group population in the census tract where the average member of that group lives. Very low values of this measure for a give race/ethnic group in a given city suggest that members of that group live near many non-members of their group, or little segregation of that group from others in that city. By contrast, very high values of this measure for a given group in a given city suggest that most members of this group live in neighborhoods comprised primarily of other members of the same group, or high segregation of this group from others in that city.

After combining these data sets, I was able to assign police budget data for homicides in forty-nine of the fifty cities in the Washington Post dataset. The Washington Post data contained latitude/longitude coordinates for the homicides in forty-eight of the cities, allowing me to attach tract level information for homicides in forty-eight of the cities. The Washington Post data also contained age of the victim for forty-seven of the cities, and race and gender of the victim for most victims in forty-six of the cities.

Table 1 summarizes many of the key variables at the city level. As the top row shows, on average, cities had a little over one-thousand homicides between 2007 and 2017, but with quite a bit of variation across cities. The second row shows that, when averaged over these years, the mean clearance rate for homicides in the forty-nine cities included in this sample was

[6] Technically, I use county level unemployment rates for each year and assign cities an unemployment rate for each year based on the county they are in.

[7] See https://www.brown.edu/academics/spatial-structures-in-social-sciences/diversity-and-disparities for full details.

about 60 percent. Though again, there is quite a bit of variation across cities, with some clearing over 75 percent, with others clearing less than 45 percent.

Another thing to note on Table 1 is how citywide demographics differ from the tract level demographics where the homicides occur. The tracts where homicides occur have a higher fraction of Black and Hispanic residents, higher poverty rates, and lower median income than the cities as a whole. Finally, the fraction of victims who are Black is double the fraction of Black residents in the cities as a whole.

The bottom of Table 1 shows that, when measured at the FiSC level (and averaged over 2007 – 2017), cities spent a mean of $465 per city resident per year on policing over this time period. Again though, there was substantial variation across cities. Figure 1 describes the distribution of police spending across cities in more detail. As can be seen, the modal amount spent on policing per capita on average over this time period is in the $300-$400 range, but several FiSCs spent in the $500-$700 range. As can also be seen in Figure 1, if using city only spending, this distribution shifts left a bit, but still exhibits a good deal of variation across cities. Figure 1 also reveals one outlier which spends and average over $1000 per capita on policing per year. This observation corresponds to Washington D.C. Given the uniqueness of policing in the Nation's capital, homicides that take place in Washington D.C. will be excluded from subsequent analyses.[8]

Figure 2 summarizes the variation in police spending *within* cities between 2007 and 2017. While the modal difference between the maximum and minimum amount spent on per capita policing during this time period within any given city is less than $100, there is again some heterogeneity across cities, with some cities spending a couple hundred dollars more on policing per capita in some years than in others. This is a significant amount given the median FiSC city averages $421 on per capita police spending in total.

In terms of homicide clearance rates, Table 2 highlights this issue at a granular level, showing the cities with the five lowest and five highest homicide clearance rates over the time period analyzed here. As can be seen, at the bottom end, some cities clear well less than half of

[8] The mean homicide clearance rate in Washington D.C. between 2007 and 2017 was 0.62, or essentially right at the median across all cities in this dataset over this time period. All of the subsequent results are robust to including homicides in Washington D.C.

their homicides. On the top end, we see that other cities have been able to clear more than three-quarters of their homicides. The second column of numbers in Table 2 shows the per capita (FiSC) police budgets for each of these cities. At a glance, no discernable relationship exists between police budgets and being at the top or the bottom of the homicide clearance rate distribution across cities.

Table 3 summarizes the number of homicides and clearance rates by age, race, and sex, of victim, and neighborhood racial demographics. The first thing to notice is that almost two-thirds of murder cases in these cities involve minority adult males in census tracts that are over two-thirds minority. The second thing to notice in Table 3 is that barring a couple of groups with an extremely small number of observations, the clearance rate for these homicides that involve minority adult males in census tracts that are over two-thirds minority is far lower than it is for any other category, at just 0.47. Notably, by comparison, the clearance rate for minority adult males in census tracts that are less than two-thirds minority is 0.62, and the clearance rate for non-minority adult males in heavily minority census tracts is 0.65.

It should also be noted that there is a notable gap in the homicide clearance rate for minority women in heavily minority tracts relative to non-minority females. However, this gap is smaller than it is with respect to males, and clearance rates for females are higher than they are for males across the board. But overall, these findings are certainly consistent with the sentiments expressed in the quote by Jill Leovy shown at the outset of this paper.

Motivated by Table 3, I will categorize homicides into eleven groups: (1) minority adult males in heavily minority (i..e, > 2/3 minority) census tracts, (2) minority adult males in not heavily minority (i.e., < 2/3 minority) census tracts, (3) non-minority adult males, (4) adult minority females, (5) adult non-minority females, (6) elderly minority males, (7) elderly non-minority males, (8) elderly minority females, (9) elderly non-minority females, (10) male children, (11) female children. As can be seen in Table 2, each of these categories has a reasonable number of observations, and pretty consistent clearance rates within each category. In the regressions that follow, when I say I am controlling for victim/tract composition, I am including separate variables capturing the fraction of homicides that land in each of these eleven categories.

V – Evaluating the Relationship Between Police Budgets and Homicide Clearance Rates

Figure 3 takes a first look at the relationship between homicide clearance rates and police budgets. Specifically, it shows a basic scatterplot of the relationship between average citywide average homicide clearance rates between 2007 and 2017 and average FiSC per capita police budgets over this time period. The graph also shows a simple least squares trend line fitted to the data. As can be seen, in this most basic presentation, there is little observable correlation between (per capita) police budgets and homicide clearance rates. Indeed, the (unconditional) correlation coefficient between these two variables is actually -0.3. The following subsections analyze this relationship in a more rigorous fashion.

V(a) – OLS Regression Analysis

Table 4 shows the results of the basic OLS regressions using homicide data aggregated to the city-year level and FiSC level budget data as described by equations (1) – (3). Column (1) shows the results with no other controls, column (2) show the results when adding all city-level controls, adding tract and victim controls in addition to city controls, and region fixed-effects, while column (3) shows the results when using tract and victim controls, time varying city-level controls (homicide rates, unemployment), and city fixed-effects.

Looking at the top row of coefficients corresponding to the relationship between per capita police budgets and the likelihood a homicide is cleared, we see that in all cases these coefficients are close to zero in magnitude and never statistically significant at any standard level of significance. The largest of these coefficients (specification (1)) suggests that an increase of police spending per capita of $300 (roughly moving from the 25th percentile to the 75th percentile) would be associated with an increase in homicide clearance rates by less than 3 percentage points. But again, even this largest coefficient is not statistically significant at any standard level of significance.

Looking at the other coefficients in specification (2), it is not surprising to see that higher recent homicide rates are negatively correlated with homicide clearance rates. It is less clear what to make of the fact that higher citywide poverty rates are correlated with higher clearance rates, and the more White citizens are segregated from citizens of other races, the lower the clearance rates. It should be noted, however, that these are conditional correlations, meaning they arise conditional on controlling for racial demographics of the city, median citywide income, and victim level controls (including racial composition of the neighborhood of the homicide). In terms of comparing the results from including city fixed-effects in column (3) relative to city-level controls in column (2), the results are quite similar with respect to the coefficient on Per Capita Police Spending, though as should be expected, the standard error is substantially bigger when including city fixed-effects.

Table 5 presents some further robustness checks of these basic OLS results. The top two rows simply show again the coefficients on Per Capita Police Spending from columns (2) and (3) from Table 3. The next two rows show the coefficients on Per Capita Police Spending from analogous regressions to those in columns (2) and (3) from Table 4, but using city only measures of police spending rather than the FiSC measures used in Table 4. The bottom panel present analogous coefficients to those in the top panel, but use the natural log of police spending as rather than the level of police spending. In all cases, the coefficients are small in magnitude and never statistically significant at any standard level.

V(b) – 2SLS Regression Analysis

As described in Section III, there is a notable endogeneity concern. Police budgets in a given city might be reacting to current or expected future crime issues, which may themselves impact clearance rates. Hence, simple OLS type analysis, even with city fixed-effects, may not accurately identify the impact of police budgets on homicide clearance rates. An arguably superior approach to the OLS specifications discussed above is to exploit variation in police budgets due to factors that have nothing to do with current or expected crime conditions, and see if such variation is correlated with homicide clearance rates. In other words, as discussed in Section III, in this subsection I take an instrumental variables approach, using Two-stage Least Squares (2SLS) to analyze the impact of police budgets on the likelihood a homicide is cleared.

Obviously, key to this approach is to find an instrument that is correlated with city police budgets, but should have no direct relationship with homicide clearance rates other than through how they correlate with police budgets. As discussed previously, the primary instrument I employ here are the amount of money (per capita) each city budgets for fire protection as motivated by Levitt (2002).

Figure 4 uses a simple scatterplot to show the basic first-stage relationship (i.e., unconditional correlations) between this instrument and (per capita) FiSC police budgets. This figure shows just the cross-sectional relationship, where each dot represents one city and police and fire budgets are averaged across all years for each city (the actual instrument will vary both across cities but also within cities over time). Again, I include a simple fitted line in each graph. Looking at Figure 4, we can see a strong positive correlation between FiSC police budgets and FiSC fire protection budgets across cities. Indeed, the correlation coefficient between these variables is 0.59 and the fitted line suggests that $100 more in per capita fire spending correlates with just under $100 more in per capita police spending.

Table 6 presents the 2SLS results. Column (1) shows the first-stage results when using per capita expenditures on fire protection as the instrument for per capita police spending, both measured at the FiSC level, and controlling for only city-level characteristics and region fixed-effects. As can be seen, the coefficient on hundreds of dollars of per capita fire spending is statistically significant at the one-percent level and the F-stat on the significance of this excluded instrument is 21, which is also significant at the one-percent level. The coefficient value of 0.86 suggests that conditional on all the other included control variables, an additional $100 of per capita fire protection spending in associated with about $86 higher per capita police spending.

Column (2) shows the 2SLS results regarding the impact of police budgets on the likelihood a homicide is cleared when using per capita expenditures on fire protection as in instrument for per capita police budgets and controlling for city-level characteristics and region fixed-effects. As can be seen, the 2SLS coefficient on (per capita) police spending (in $100s) is effectively zero and is not statistically significant at any standard levels of significance.

Columns (3) and (4) show analogous results to those discussed above, but where I use city-fixed effects in lieu of time fixed city-level control variables. Intuitively, this specification is exploiting variation of police and fire protection budgets within cities over time to estimate β_1.

Column (3) shows the first-stage, which shows again that the instrument is significantly and positively related to police budgets even with city fixed-effects. However, when including city fixed-effects, the F-stat on the excluded instrument falls to 10.28. While this still rejects the null hypothesis at well below the one-percent level, one does start to worry about a weak instrument bias. Column (4) shows the 2SLS results when using city-fixed effects. As can be seen, the coefficient on police budgets is still negative in sign and not statistically significant. Not surprisingly, the standard error on the police budget coefficient when using city fixed-effects in column (6) is substantially bigger than when using just region fixed-effects and all the city characteristics in columns (2) and (4). Again though, this specification presents no evidence that greater police budgets are associated with higher homicide clearance rates.

One might wonder if the results are robust to alternative instruments. As discussed earlier, another candidate instrument is the amount of money the city receives from the Federal or State government in the year of and just previous to each homicide. Figure 5 shows a simple cross-sectional scatterplot of average annual per capita state/federal aid per city and average annual per capita police spending. As can be seen, once again, there is a notably positive correlation, suggesting more state/federal aid is correlated with greater police spending, but arguably should not be related to anything impacting homicide clearance rates directly.

Table 7 shows robustness results with respect to the 2SLS results. The top two rows simply show again the coefficient on police spending from columns (2) and (4) of Table 5, where per capita fire spending was used as the instrument for per capita police spending. The next two rows show the analogous 2SLS results but when using the natural log of per capita state/federal as the instrument for per capita police spending. As can be seen in the third and fourth row of Table 6, using this alternative instrument reveals a similarly insignificant impact of police spending on homicide clearance rates. Though it should be noted that after conditioning on victim/tract characteristics, and city-characteristics (or when controlling for city-fixed effects), in the first stage, the F-stat on the log of state/federal grants is below 10, suggesting this is a pretty weak instrument.

The lower four rows of Table 7 shows analogous results to those in the top four rows, but using city-only budget information, rather than the broader FiSC measures used for the specifications in the top four rows. But, as can be seen, all of these coefficients are relatively small in magnitude, mostly negative in sign, and never statistically significant at standard levels. In other words, they continue to reveal no impact of greater police budgets on homicide clearance rates.

V(c) – Results by Race

Table 8 presents the key results separated by race of the victim. We can look first at the top panel, which limits the analysis to only Black or Hispanic victims. The first two rows show the OLS coefficients on police spending as measured under the FiSC definition for specifications using victim/tract characteristics, and either city-level controls (first row) or city fixed-effects (second row). As can be seen, the coefficients are small in magnitude and not statistically significant. The third and fourth rows shows the 2SLS results for Black and Hispanic victims, when using per capita fire spending as the instrument for per capita police spending. Again, the coefficients are relatively small in magnitude, actually negative in sign, and not statistically significant.

The lower panel of Table 8 shows the analogous results when limited to only non-Black/non-Hispanic victims. Interestingly, the coefficients for this subset of homicides are now quite a bit larger in magnitude, and indeed statistically different than zero under both OLS and 2SLS approaches when using city-level controls. However, they are negative in sign, suggesting more police resources actually lower the homicide clearance rate of non-minority victims. Given that these results are not statistically significant under the city fixed-effects specifications, however, I do not put too much confidence in this result. I would say the overall impression of these results continues to be that more police resources do not appear to appreciably impact homicide clearance rates for victims of any race.

VI – Conclusions

This paper examined homicide clearance rates in large United States cities over the 2007-2017 period. In doing so, I find that such clearance rates vary significantly both across cities, and within cities based on the neighborhood of the murder and the age and race of the victim. Consistent with previous studies, I find that the likelihood a homicide is cleared by arrest is notably lower when the victim is a Black or Hispanic adult male and the homicide occurred in a more heavily minority neighborhood.

The unique finding to this study, however, is that I find no evidence that greater police budgets increase homicide clearance rates. This finding is robust across a wide variety of regression specifications, including simple OLS regression specifications, Two-stage least squares specifications, and different ways to measure police budgets. Moreover, this finding is also not simply due to lack of precision, as coefficient estimates are generally very small in magnitude and often negative in sign.

It should be clear, however, that these results do not necessarily imply that more police funding is not required to increase homicide clearance rates. Indeed, the 2012 Boston initiative discussed earlier suggests that more resources can be quite effective for catching more murderers. Rather, the results from this paper simply suggest that the way police departments have generally been using their funding over the last decade plus, more funding has not systematically helped police better find and arrest those responsible for murdering others.

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Table 1 - Summary of Data Across Cities (2007 - 2017)

	Mean	10th %ile	50th %ile	90th %ile	No. Cities
No. of Homicides	1059	366	694	2519	49
Avg. Clearance Rate	0.59	0.42	0.61	0.75	49
Population (000s)	899	240	598	1,547	49
Population Percent Black	29.4	6.5	24.5	59.2	49
Population Percent Hispanic	20.8	3.7	13.9	47.3	49
Population Median HH Income	$45,551	$34,002	$45,728	$53,274	49
Population Poverty Percent	23	17.7	22.3	30.6	49
City Isolation Index (White)	58.9	43.2	62	70.5	49
City Isolation Index (Black)	50.6	14.9	52.1	80	49
City Isolation Index (Hispanic)	32.9	5.9	29.3	60.5	49
Avg. Unemployment Rate	0.068	0.049	0.066	0.089	49
Tract of Homicide Percent Black	46.4	10.7	49.1	80.5	48
Tract of Homicide Percent Hispanic	22.6	2.3	16.9	52.9	48
Tract of Homicide Median HH Income	$34,898	$25,587	$33,655	$45,658	48
Tract of Homicide Poverty Percent	32.7	27.1	32.8	39.2	48
Percent of Victims Children	5	2.8	4.9	7.7	47
Percent of Victims Elderly	5.3	3.1	5.1	8.1	47
Percent of Victims Female	16	11	16	21	46
Percent of Victims Black	64	33	69	89	46
Percent of Victims Hispanic	14	1	7	35	46
(Per Capita) Police Spending (FiSC)	$465	$294	$421	$659	49
(Per Capita) Police Spending (City Only)	$402	$241	$367	$587	49

Fig 1: Mean Annual Per Capita Police Spending Across Cities

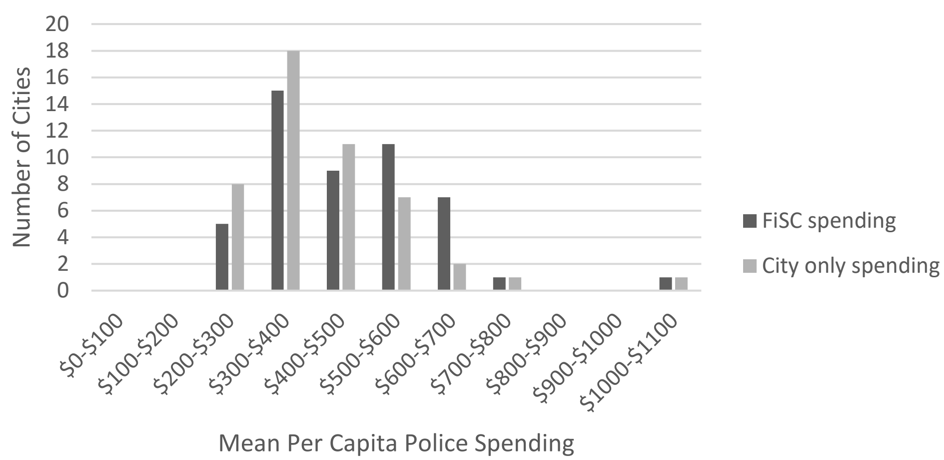

Fig 2: Maximum Difference Within City in Annual Per Capita Police Spending Across Cities

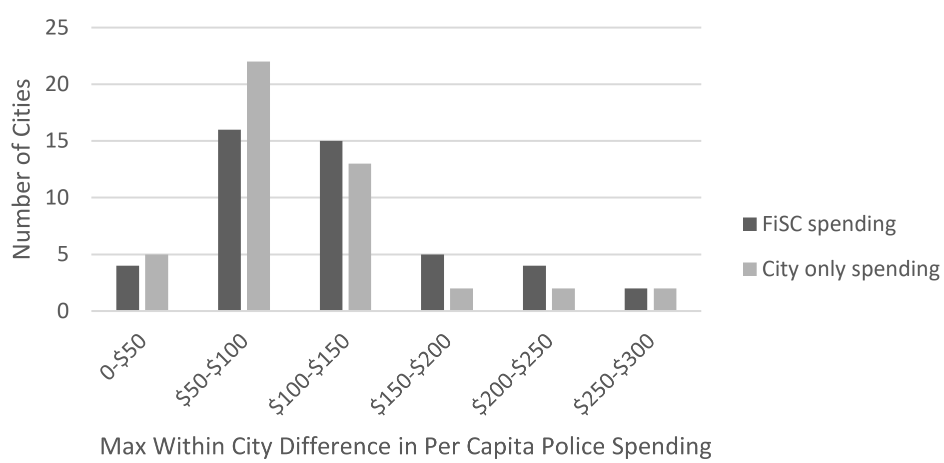

Table 2: Homicide Clearance Rates and Police Budgets (2007-2017)

	City	Homicide Clearance Rt.	Avg. FiSC Police Budget
Bottom Five			
	Chicago	0.33	$547
	Buffalo	0.40	$366
	Baltimore	0.41	$710
	Detroit	0.42	$543
	New Orleans	0.42	$410
Top Five			
	Albuquerque	0.75	$390
	San Diego	0.76	$374
	Tulsa	0.76	$264
	Charlotte	0.76	$374
	Richmond	0.78	$526

Table 3: Number of Homicides and Clearance Rates by Age, Race, Neighborhood Type, and Sex

			Males			Females		
Age Group	**Race**	**Neighborhood**	**Number**	**%**	**Clear Rate**	**Number**	**%**	**Clear Rate**
Adult	Black/Hisp	> 2/3 Black/Hisp	32,025	65.5	0.47	3,948	8.1	0.67
Adult	Black/Hisp	< 2/3 Black/hisp	582	1.2	0.62	116	0.2	0.74
Adult	Not Black/Hisp	> 2/3 Black/Hisp	5,913	12.1	0.65	1,540	3.1	0.77
Adult	Not Black/Hisp	< 2/3 Black/hisp	146	0.3	0.61	45	0.1	0.80
Elderly	Black/Hisp	> 2/3 Black/Hisp	974	2.0	0.60	294	0.6	0.77
Elderly	Black/Hisp	< 2/3 Black/hisp	17	0.0	0.47	4	0.0	0.75
Elderly	Not Black/Hisp	> 2/3 Black/Hisp	685	1.4	0.70	362	0.7	0.86
Elderly	Not Black/Hisp	< 2/3 Black/hisp	20	0.0	0.55	6	0.0	0.50
Child	Black/Hisp	> 2/3 Black/Hisp	1,141	2.3	0.72	586	1.2	0.83
Child	Black/Hisp	< 2/3 Black/hisp	32	0.1	0.84	18	0.0	0.78
Child	Not Black/Hisp	> 2/3 Black/Hisp	281	0.6	0.79	154	0.3	0.90
Child	Not Black/Hisp	< 2/3 Black/hisp	10	0.0	0.70	5	0.0	0.80

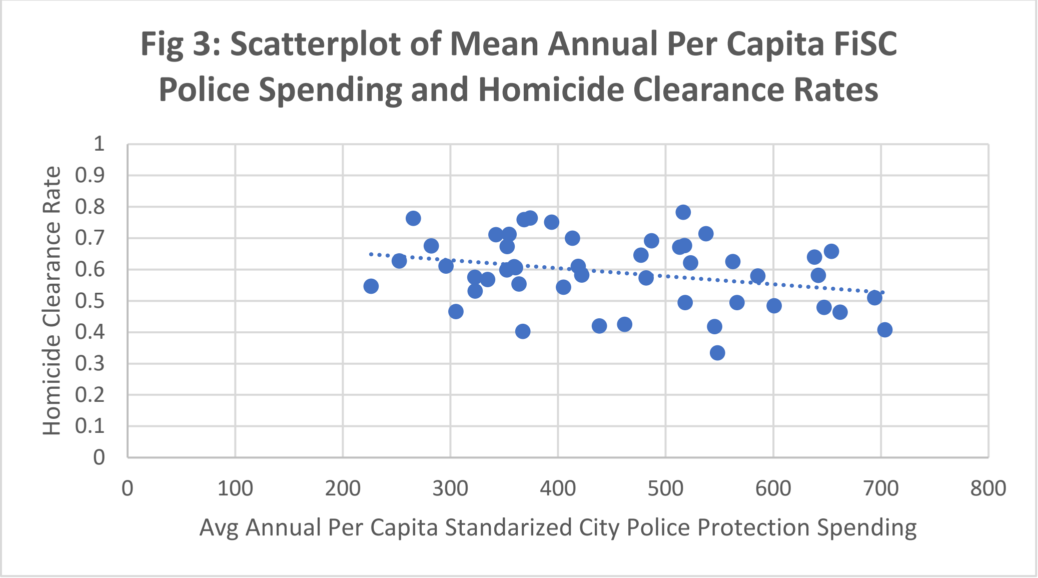
Fig 3: Scatterplot of Mean Annual Per Capita FiSC Police Spending and Homicide Clearance Rates
Homicide Clearance Rate
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
500
600
700
800
Avg Annual Per Capita Standarized City Police Protection Spending

Table 4: OLS Regression Results - Using FiSC Budget Measures

	(1)	(2)	(3)
Per Capita Police Spending FiSC ($100s)	-0.0244**	0.0055	0.0079
	(0.0107)	(0.0088)	(0.0150)
City Recent Homicide Rate per 100,000		-0.0065***	-0.0039**
		(0.0014)	(0.0018)
Percent Unemployed		-0.0039	-0.0099
		(0.0070)	(0.0084)
City Percent Black		0.0022	
		(0.0023)	
City Percent Hispanic		-0.0013	
		(0.0028)	
City Median HH Income ($1000s)		0.0011	
		(0.0053)	
City Percent Poor		0.0051***	
		(0.0018)	
City White Isolation Index		-0.0043***	
		(0.0012)	
City Black Isolation Index		-0.0003	
		(0.0013)	
City Hispanic Isolation Index		-0.0002	
		(0.0016)	
City Population (in hundreds of thousands)		-0.0002	
		(0.0016)	
Victim/Tract Composition Controls		yes	yes
Region Indicators		yes	
City Fixed Effects			yes
Year Fixed Effects	yes	yes	yes
Observations	459	459	459
R-squared	0.1732	0.5474	0.7689

*Heteroskedastic robust standard errors clustered at city level.

Table 5: Robustness of OLS Results

Outcome Speification	City Budget Measure	Control Variables	Coefficient on Per Capita Police Budget ($100s)	Std Error
Clear. Rt.	FiSC	Victim/Tract Char. City Char., Region F.E.	0.0055	(0.0088)
Clear. Rt.	FiSC	Victim/Tract Char., City F.E.	0.0079	(0.0150)
Clear. Rt.	City Only	Victim/Tract Char. City Char., Region F.E.	0.0033	(0.0090)
Clear. Rt.	City Only	Victim/Tract Char., City F.E.	0.0078	(0.0163)
Outcome Speification	**City Budget Measure**	**Control Variables**	**Coefficient on Ln[Per Capita Police Budget ($100s)]**	**Std Error**
ln(Clear. Rt.)	ln(FiSC)	Victim/Tract Char. City Char., Region F.E.	0.0678	(0.0766)
ln(Clear. Rt.)	ln(FiSC)	Victim/Tract Char., City F.E.	0.0592	(0.1397)
ln(Clear. Rt.)	ln(City Only)	Victim/Tract Char. City Char., Region F.E.	0.0013	(0.0244)
ln(Clear. Rt.)	ln(City Only)	Victim/Tract Char., City F.E.	0.0109	(0.1323)

*Heteroskedastic robust standard errors clustered at city level.

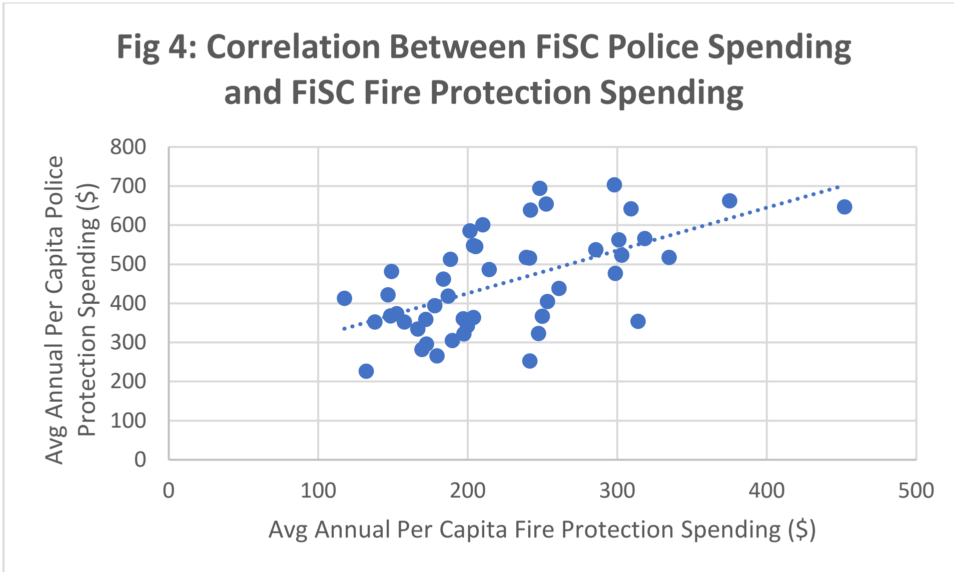
Fig 4: Correlation Between FiSC Police Spending and FiSC Fire Protection Spending
Avg Annual Per Capita Police Protection Spending ($)
0
100
200
300
400
500
600
700
800
0
100
200
300
400
500
Avg Annual Per Capita Fire Protection Spending ($)

Table 6: 2SLS Regression Results - Instrument FiSC Fire Spending

	First-Stage (1)	2SLS (2)	First-Stage (3)	2SLS (4)
Per Capita Fire Spending FiSC ($100s)	0.8647***		0.6407***	
	(0.1887)		(0.1999)	
Per Capita Police Spending FiSC ($100s)		-0.0001		-0.0046
		(0.0150)		(0.0324)
City Recent Homicide Rate per 100,000	0.0131	-0.0064***	0.0093	-0.0038**
	(0.0208)	(0.0013)	(0.0138)	(0.0017)
Percent Unemployed	0.0915	-0.0040	0.0165	-0.0098
	(0.0739)	(0.0066)	(0.0368)	(0.0077)
City Percent Black	0.0130	0.0082***		
	(0.0214)	(0.0020)		
City Percent Hispanic	0.0220	0.0025		
	(0.0202)	(0.0023)		
City Median HH Income ($1000s)	0.0717**	-0.0009		
	(0.0340)	(0.0028)		
City Percent Poor	0.1115*	0.0016		
	(0.0639)	(0.0049)		
City White Isolation Index	0.0117	0.0050***		
	(0.0206)	(0.0018)		
City Black Isolation Index	0.0089	-0.0040***		
	(0.0177)	(0.0013)		
City Hispanic Isolation Index	-0.0027	-0.0004		
	(0.0131)	(0.0013)		
City Population (in hundreds of thousands)	0.0216	-0.0002		
	(0.0144)	(0.0015)		
Victim/Tract Composition Controls	yes	yes	yes	yes
Region Fixed Effects	yes	yes		
City Fixed Effects			yes	yes
Year Fixed Effects	yes	yes	yes	yes
F-stat on Excluded Instrument	21.00***		10.28***	
Observations	459	459	459	459
R-squared	0.6328	0.5461	0.9370	0.7680

*Heteroskedastic robust standard errors clustered at city level.

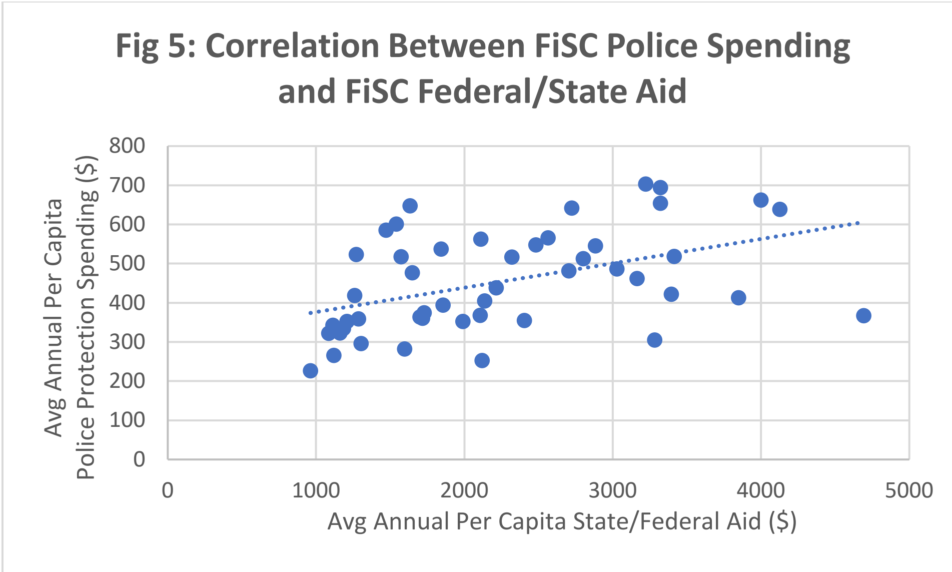
Fig 5: Correlation Between FiSC Police Spending and FiSC Federal/State Aid
Avg Annual Per Capita Police Protection Spending ($)
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
Avg Annual Per Capita State/Federal Aid ($)

Table 7: Robustness of 2SLS Estimates

Instrument	City Budget Measure	Control Variables	Coefficient on Per Capita Police Budget ($100s)	Std Error
Fire Spending	FiSC	Victim/Tract Char. City Char., Region F.E.	-0.0001	(0.0150)
Fire Spending	FiSC	Victim/Tract Char., City F.E.	-0.0046	(0.0324)
State/Fed. Grants	FiSC	Victim/Tract Char. City Char., Region F.E.	-0.0476	(0.0429)
State/Fed. Grants	FiSC	Victim/Tract Char., City F.E.	0.0007	(0.1068)
Fire Spending	City Only	Victim/Tract Char. City Char., Region F.E.	-0.0132	(0.0283)
Fire Spending	City Only	Victim/Tract Char., City F.E.	-0.0133	(0.0402)
State/Fed. Grants	City Only	Victim/Tract Char. City Char., Region F.E.	0.0149	(0.0804)
State/Fed. Grants	City Only	Victim/Tract Char., City F.E.	-0.0045	(0.0754)

*Heteroskedastic robust standard errors clustered at city level.

Table 8: Robustness of Results by Race of Victim

City Budget Measure	Estimation Method	Control Variables	Coefficient on Per Capita Police Budget ($100s)	Standard Error
Black/Hispanic Victims				
FiSC	OLS	Victim/Tract Char. City Char., Region F.E.	-0.0008	(0.0094)
FiSC	OLS	Victim/Tract Char., City F.E.	0.0001	(0.0169)
FiSC	2SLS - Fire Spending	Victim/Tract Char. City Char., Region F.E.	-0.0114	(0.0189)
FiSC	2SLS - Fire Spending	Victim/Tract Char., City F.E.	-0.0255	(0.0395)
Non-Black/Non-Hispanic Victims				
FiSC	OLS	Victim/Tract Char. City Char., Region F.E.	-0.0498**	(0.0226)
FiSC	OLS	Victim/Tract Char., City F.E.	0.0587	(0.0409)
FiSC	2SLS - Fire Spending	Victim/Tract Char. City Char., Region F.E.	-0.0864**	(0.0422)
FiSC	2SLS - Fire Spending	Victim/Tract Char., City F.E.	-0.0229	(0.0869)

*Heteroskedastic robust standard errors clustered at city level.