Gun Dealer Density and its Effect on Homicide

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Abstract

We explore the relationship between gun prevalence and homicides in the United States from 2003–2019. We create a novel measure of guns density in a narrow geographic area using an underutilized metric: gun dealers. We find an increase in gun dealer density is significantly and positively associated with increased homicides in subsequent years. We compare estimates from our preferred measure, the number of dealers per 100 square miles in a local area, to those found using other gun prevalence measures. We additionally show the effect of gun dealer density is limited mostly to counties that have a high percent of Black residents and metropolitan areas. We propose that the so-called "Ferguson Effect"—a sharp increase in violent crime in urban and Black communities after 2014—might be largely explained by an influx of gun dealers in and near Black communities, rather than a change in the propensity of Black residents to call the police or changes in police behavior.

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1 Introduction

The declining trend of gun violence in the United States throughout the 1990s sharply changed course at the turn of the century. Although the gun violence discussion in the United States is often dominated by mass shootings, the increase in gun deaths over the past 20 years is an order of magnitude larger than what can be explained by mass shooting incidents. Comparing gun-related deaths from the trough in 2000 to 2019, gun-related deaths have increased by more than an additional Sandy Hook shooting, on average, per day.[1] More than a third of gun deaths are due to homicide, which has continued to increase proportionally with all gun deaths. This is despite the fact that non-gun-related homicides have continued to decline over the same period. This disturbing trend makes the study of the relationship between firearm availability and homicide more important than ever. However, the literature on the connection between gun homicides and firearms availability shows different results when using different proxy measures of gun availability. There are many possible explanations for this, and among them is the possibility that existing gun proxies may not be fully capturing important variation in gun availability. We propose a simple, but powerful, alternative measure: gun dealer density, as measured by the number of gun dealers per 100 square miles in a county and in a small region around a county.

Using publicly available data from the Centers for Disease Control and Prevention (CDC), the United States Census Bureau (USCB), the Federal Bureau of Investigation (FBI), and data from the ATF, we construct a seventeen-year panel running from 2003 to 2019. Our panel tracks each US county's homicides, demographics, criminal activity, and Federal Firearm Licenses (FFLs)—focused on licenses issued to dealers selling firearms to the public—and contains over 50,000 county-years. For each county-year, we also construct a measure of gun density based on the number of FFLs, the land area of the county, and the land area of the surrounding counties. With these data, we estimate the effect of gun density on homicides using Poisson regression with county-level fixed effects to account for unobserved time-invariant heterogeneity.

Our main results show that a one-unit increase in the number of gun dealers per 100 square miles increases homicides by 4.9 percent. These results are robust to multiple specifications and data sources. We also find that gun density has no effect on non-gun homicides—which suggests there are no unobserved variables driving up both the number of FFLs and the murder rate independently—and that the relationship is not caused by changes in business activity (as measured using business establishments per 100 square miles). Last, we explore whether or not gun dealer density interacts with local characteristics. We find that our results are driven primarily by the relationship between our measure of gun density and the homicide rate in urban counties and/or counties with a relatively high percentage of Black residents. We show this is due to a larger variation in gun availability in these county areas and propose that the so-called "Ferguson Effect"—an explanation for the increase in violent crime in Black communities after the death of Michael Brown—may be largely attributed to a massive spike in gun availability around Black communities shortly before 2014.[2] Additionally, we provide evidence that the composition of gun dealers in these communities changed, such that large, corporate dealers left and were replaced by independent "defense" oriented dealers.

Our study makes several significant contributions. Unlike the majority of past work involving gun deaths, we use county-level data. We do so because there is substantial heterogeneity in terms

[1]There were 11,044 more gun-related deaths in 2019 than in 2000, which equates to 30.3 additional gun-related deaths on average per day.

[2]The Ferguson Effect is a term coined by the chief of the St. Louis police to suggest that the spike in homicides and other violent crime was due to an increased hesitancy of police officers to enforce the law due to media and legal scrutiny after the shooting of Michael Brown in Ferguson, MO. The term is also used to describe a decreased willingness of individuals in these communities to call or cooperate with the police.

of county characteristics (e.g., population, income, racial demographics, and gun availability) within states. This approach allows for more precise estimates of the effect of guns due to the increase in the number of observations, improved demographic controls, and a greater ability to capture unobserved heterogeneity within states, which makes the conditional invariance assumptions (pointed out by Manski and Pepper (2018)) more plausible. Second, as we will discuss shortly, our gun density measure has several advantageous properties compared to previously used gun prevalence measures—primarily that it appears to measure more gun variation around metropolitan areas and can be constructed to cover any geographic area rather than only states.

2 Background

In 2019, there were nearly 40,000 deaths involving firearms in the United States. Of these deaths, over 60 percent were suicides; about one-third were assaults/homicides, and the remaining share were other causes (e.g., accidents). Firearms play a particularly important role in the occurrence of violent deaths because of how effectively they cause mortal damage.[3] Thus, variation in the costs associated with locating and acquiring a gun through primary or secondary markets may predict differential levels of violent death. However, it is theoretically possible that a high prevalence of guns would deter individuals from engaging in activities that may become violent, so it remains an empirical question whether reducing gun prevalence would reduce murders. While there is a general consensus of research demonstrating a strong relationship between gun prevalence and suicides (e.g. Anglemyer et al., 2014; Lang, 2013; Briggs and Tabarrok, 2014; Miller et al., 2013; Phillips, 2013), the effect of greater gun availability on homicides continues to spur some debate (e.g. Lott and Mustard, 1997; Ayres and Donohue III, 2002; Duggan, 2001; Moody and Marvell, 2005; Siegel et al., 2013; Lang, 2016).

The primary difficulty with answering this question is the lack of an accurate measure of the stock/flow of guns in the United States. We can be certain that the United States, as a whole, has a large stock of firearms.[4] However, there is no direct data to indicate how this stock of weapons is distributed throughout US states and counties. As an alternative, researchers often try to use proxy measures of the flow of guns in (and out) of communities and rely on statistical methods, like area-level fixed effects, to control for the existing stock of guns. Notable proxies include the percentage of suicides committed with a firearm (e.g., Azrael et al., 2004; Siegel et al., 2013), subscriptions to gun interest magazines (e.g., Duggan, 2001), self-reported survey data (e.g., Mocan and Tekin, 2006), queries to the National Instant Criminal Background Check System (NICS) (e.g., Lang, 2016), and hunting permits (e.g., Siegel et al., 2014).

Researchers can debate the trade-offs associated with each of the proxies, but we cannot know with certainty which measure best captures the true variation in gun availability. Each of these measures likely capture a different part of that variation based on other correlated characteristics, like demographics or geography. Johnson et al. (2022) have recently made progress in assessing what kind of variation different gun proxies capture by collecting data on gun sales in several US states. In other recent work, Chalak et al. (2022) attempts to correct for proxy bias in the gun suicide ratio, finding an association between gun availability and homicides much larger than previous literature using the same proxy. However, while papers utilizing this proxy tend to all show

[3] For instance, Band et al. (2014) finds that 33 percent of those admitted to trauma centers in Philadelphia for gunshot wounds died compared to only 7.7 percent who died after suffering a stab wound.

[4] The Small Arms Survey estimates that there are nearly 400 million privately-held firearms in the US, and that the US has more than double the number of firearms per person than any other nation. See http://www.smallarmssurvey.org/fileadmin/docs/T-Briefing-Papers/SAS-BP-Civilian-Firearms-Numbers.pdf (accessed September 11, 2021).

positive relationships between gun availability and homicides (e.g., Cook and Ludwig, 2006; Siegel et al., 2013; Chalak et al., 2022), there are some mixed results associated with other proxy measures. Siegel et al. (2014), using hunting permits, and Duggan (2001), using magazine subscriptions, both find the same positive association as the literature using the gun suicide proxy. In contrast, using an imputed measure of gun availability based on the General Social Survey, Moody and Marvell (2005) find that handguns have no significant effect on crime. Similarly, Lang (2016) finds a small and insignificant effect of gun availability—measured by NICS checks—on homicide.

To add to our understanding of this relationship, we propose a new gun availability proxy based on an arguably underutilized measure: federal firearms licenses (FFLs).

2.1 Federal Firearms Licenses

FFLs are licenses issued by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). These licenses permit individuals and companies to engage in firearm-related business. Currently, there are nine different types of FFLs. A description of each type along with the current cost is found in Table 1. FFLs are valid for three years and can be renewed.[5] In February of 2019, there were 79,405 FFLs—not including Type 3s—in the United States.[6] The two types of FFL licenses considered to be "dealer" (i.e. able to buy and sell from the public and receive shipments of firearms) licenses are the Type 1 license (for dealers and gunsmiths) and the Type 2 license (for pawnbrokers).[7] For additional information regarding how we acquired the data, how the licenses themselves are structured, and how one obtains an FFL, see the Appendix A.1.

We focus our attention on Type 1 and Type 2 licenses (dealer and pawnbroker). These represent the number of establishments conducting retail sales of firearms to the public, so the number of establishments in business serves as a reasonable proxy for the flow of firearms. Furthermore, online sales of firearms require the firearm to be shipped to an FFL holder before the transfer is completed. These activities would capture the same variation as NICS checks, but we are able to obtain the street address of every FFL in the United States, which allows us to measure the heterogeneity of gun availability within each state. Additionally, firearms require repair and maintenance (gunsmithing), which requires a Type 1 license. Moreover, guns are routinely sold or traded locally, and it is common for gun dealers and pawn brokers to buy and sell used guns and sell guns on commission. Further, firearms components, accessories, and ammunition are also typically sold at FFL establishments, despite not requiring an FFL license. Thus, the number of businesses with these license types also serves as a proxy for the stock of firearms in an area, even the presence of firearms that would not require a NICS check and firearms transferred to individuals without a NICS check for either accidental or negligent reasons.[8]

[5] In most cases, renewal fees are the same as the initial license costs, the only exceptions being Type 1 and Type 2—both of which cost $90 to renew.

[6] Type 3 licenses are for firearm collectors acquiring firearms for non-commercial purposes (see Appendix A.1)

[7] A pawnbroker license is in every way identical to a dealer license, but additionally allows the licensee to engage in the pawning of firearms (i.e., receiving a firearm as collateral for a loan). The licensee also must demonstrate compliance with local laws about pawn establishments, which are often different than other types of businesses.

[8] Recent investigative reporting has shown that violations of background check requirements by FFL dealers are surprisingly common and that ATF officials rarely impose serious penalties for violations. A recent investigative report published in USA Today and the Trace found that, on average, only about 12.3 percent of FFLs are inspected by the ATF. Among the inspected, 33.5 percent were cited for violations. The vast majority of those cited are only issued warnings. Only about 3 percent of violators are recommended to have their license revoked, and nearly 60 percent of those recommendations are overruled, with a warning issued instead. See `https://www.usatoday.com/in-depth/news/investigations/2021/05/26/gun-dealers-let-off-hook-when-atf-inspections-find-violations/7210266002/` (accessed on June 12, 2021). According to ATF records, nearly 84,000 guns were reported lost or stolen from FFLs from 2015-2019, nearly 17,000 per year. Thus, FFLs may

Table 1: FFL Types

Type	Cost	Description
Type 1	$200	Dealer in firearms / Gunsmithing (firearms repair)
Type 2	$200	Pawnbroker
Type 3	$30	Collector of curios and relics
Type 6	$30	Manufacturer of ammunition for firearms
Type 7	$150	Manufacturer of firearms & ammunition
Type 8	$150	Importer of firearms & ammunition
Type 9	$3,000	Dealer in destructive devices
Type 10	$3,000	Manufacturer of destructive devices, ammunition for destructive devices, or armor piercing ammunition
Type 11	$3,000	Importer of destructive devices, ammunition for destructive devices, or armor piercing ammunition

While, to our knowledge, this is the first study in the economics literature to use FFLs as a proxy for gun availability, the idea has been previously explored in sociology/criminology and public health.[9] These papers all use single-year or pooled data with cross-sectional statistical methods that cannot be interpreted causally. Furthermore, each paper standardizes the number of FFLs into the number of FFLs per capita, which, as we discuss in Section 2.2, may underestimate gun prevalence in large population centers. Nonetheless, there are several interesting methods and results from this literature worth noting. Most of these papers find no association between the number of FFLs per capita and homicide (e.g., Chao et al., 2019; Wiebe et al., 2009; Semenza et al., 2020). However, Semenza et al. (2020) finds that gun dealer prevalence is associated with increased homicides for white victims only, and Stansfield and Semenza (2019) and Stansfield et al. (2021) find that an increase in gun dealers is associated with a greater number of intimate partner homicides. Steidley et al. (2017) is the only paper that finds that increased gun dealer prevalence is associated with increases in the overall homicide rate. Their approach is unique in that they focus their study on major cities only and differentiate between different types of gun dealers, like pawn brokers and "big box" retailers—a concept that we explore to some extent as well in Section 4.2. Steidley et al. (2017), Wiebe et al. (2009), and Semenza et al. (2020) are also unique in that they recognize that gun prevalence in the entire local region around the county or city matters, which we discuss in the next section. Matthay et al. (2021) is an exception in this literature for being the first to use FFLs as a measure of gun availability in a quasi-experimental framework. They combine monthly data on self-harm injuries with FFL data in California and use a difference-in-differences

capture variations in illicit gun activity missed by NICS checks.

[9] We came up with our concept independent of this literature. Despite this, many of the same ideas and logic from this section and the next section for using FFLs as a gun prevalence proxy are found in these papers as well, which we take as validation of the concept.

approach—comparing incidents of self-harm in counties that had a new FFL dealer to matched counties with no change in FFLs in the month before the new FFL opening and the month after. They find no statistically discernible effect of FFL openings on self-harm.

2.2 Gun Density

Our hypothesis is variation in the cost of locating and acquiring guns relative to other weapons should be a cogent predictor of gun-related deaths. Thus, we choose to focus on *gun density*—a measure of the distribution of firearms in a region using FFL data—as the relevant explanatory factor in gun deaths rather than FFLs per person. We do this for two reasons: first, the concentration of gun dealers in an area will strongly correlate with the price of the firearm on the margin, due to competition, and the search costs of finding a particular gun. Retail gun sales will also be correlated with secondary/gray markets.[10] Second, FFLs per person are highest in areas with low population density and known for sport shooting and hunting tourism, like Montana, which would not necessarily correlate with a high volume of weapons, per se, nor necessarily sell the types of weapons typically used in crime, like handguns.[11]

As a "first pass" measure of gun density (Equation 1), we take the total number of dealer and pawnbroker licenses in county i in year t and divide it by county i's land area (100s of square miles).

$$GD_{i,t} = \frac{(D_{i,t} + PW_{i,t})}{A_i} \tag{1}$$

where $D_{i,t}$ and $PW_{i,t}$ are the number of Dealer and Pawnbroker licenses issued, and A_i is the county's area in square miles (100s).

This naive measure of gun density ignores two qualities of firearms: namely, firearms are durable and expensive. These two qualities suggest individuals will shop around for a firearm and not limit their purchase to stores within their county's borders. Instead, gun buyers might travel to a neighboring county to purchase a firearm that is on sale or seek out a used gun in a nearby geographic area. Consequently, the area of interest may not only be the gun density in county i in a particular year, but also the gun density in county i *and* the gun density in the counties surrounding county i:

$$GD_{i,t} = \frac{\Big(D_{i,t} + PW_{i,t} + \sum_{j=1}^{m}(D_{j,t} + PW_{j,t})\Big)}{A_i + \sum_{j=1}^{m}(A_j)} \tag{2}$$

where $D_{i,t}$ and $PW_{i,t}$ are the number of Dealer and Pawnbroker licenses issued in county i in year t, $\sum_{j=1}^{m}(D_{j,t} + PW_{j,t})$ is the total number of Dealer and Pawnbroker licenses issued in the m counties surrounding county i in year t, A_i is the county's area in square miles (100s) and $\sum_{j=1}^{m}(A_j)$ is the total land area in the counties surrounding county i. We refer to this as the *halo* of county i.

We chose to normalize our FFL measure by land area rather than a more direct distance measure—like the population weighted distance to county centroids used by Wiebe et al. (2009)—for two reasons: first, it is not clear how to best measure distance in this context.[12] Second,

[10] Guns from retailers and guns from secondary markets are substitutable. For example, the presence of a highly competitive retail market may reduce buyers in the secondary market, which would reduce prices, all else equal. Similarly, individuals may partially finance the purchase of new guns by selling used guns on secondary markets.

[11] It would be prudent for a business focused on hunting expeditions, for example, to have an FFL in order to accept firearm transfers by mail, sell small volumes of firearms and equipment, and provide gunsmithing services.

[12] Measuring from each county's geographic center is one approach, but it is often the case that population centers in a county are not near the center of the county. Measuring from a population weighted center could potentially solve this, but can often result in placing the county's center in an area that is not close to geographical center and

we believe it is also likely that individuals living in larger rural counties think about distances differently than individuals living in and around metropolitan areas: traveling longer distances is both expected and normalized when living in rural areas. Of course, it is unclear whether this attitude toward distance would fully cancel out the effect of having to travel longer distances to the nearest gun store. However, we believe this is enough of a reason to not normalize our halo measure directly by distance, which would assume rural and urban individuals think of distance in the same way. Our approach, normalizing by land area, is arguably simpler and still accounts for the effect of county size.

To get a better understanding of the importance of the halo measure, consider individuals who wish to purchase a firearm and live in Cook County, Illinois (home of the city of Chicago and represented by the darkest region in Figure 1 on the left). The right side of Figure 1 shows the heat map of the number of FFLs at the zip-code-level across Cook County and the counties sharing a border with Cook County. While it may seem as though these individuals would have a difficult time locating a firearm for purchase in Cook County due to the lack of gun dealers, they are only a short distance away from some of the country's most gun-dealer-dense zip codes (many above the 90th percentile) in neighboring counties, like DuPage County. Consequently, one could reasonably assume that there is a halo of counties around their home county that they would be willing to travel to purchase a firearm (i.e., the shaded counties surrounding Cook County on the left of Figure 1).

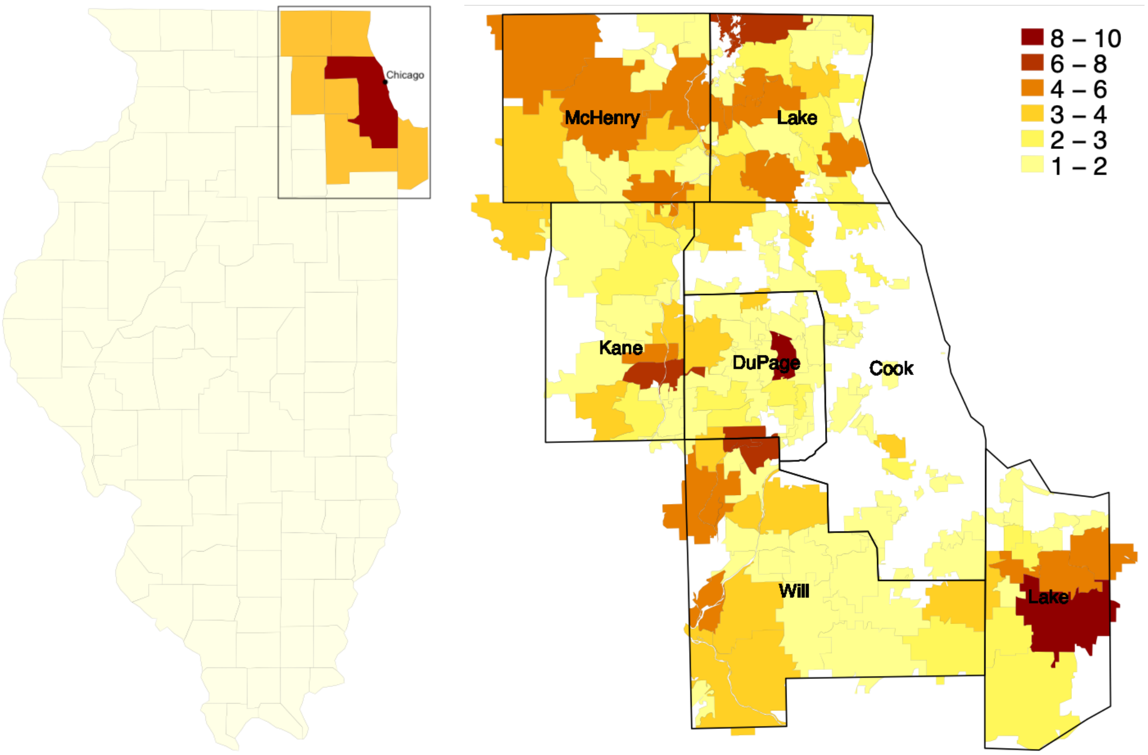
In the case of Chicago, there is substantial evidence of guns spilling over into Cook County—particularly, Chicago—through secondary gun markets (i.e., private sales, trades, and illicit activity). For example, many of the guns recovered between 2013 and 2016 by the Chicago Police Department come from dealers located just outside of Cook County (Office of the Mayor, 2017).[13] It is worth noting that while Chicago's strict gun laws appear to work in terms of limiting traditional gun markets in the city itself, it is clear that these traditional gun markets can simply locate just outside of the jurisdiction of those laws, which creates the opportunity for secondary markets as well. Additionally, we allow for halos to cross state lines for adjacent counties, as shown by the inclusion of Lake County, Indiana in the Cook County halo. Although federal law prevents residents from one state from purchasing handguns in a different state through FFLs, most state laws still allow long gun purchases in traditional markets, and secondary markets are not necessarily limited in this way.

Figure 2 presents the practical effect of using a halo measure of gun density from a national view. Essentially, looking at the halo gun density smooths out the "topography" of firearms in an area. This adjustment also prevents the under-counting of firearms in a location with few FFLs (e.g., due to local ordinances preventing gun dealers from setting up shop within a city/county and small populations) but with a high prevalence of FFLs nearby. Figure 2 also visually demonstrates the primary difference between using FFLs per mile as a measure of gun density, as opposed to the percent of suicides committed with a gun or FFLs per capita. The percentage of suicides committed with a gun, when examined at the county level appears to be the highest in rural areas. FFLs per capita (as well as almost any per capita measure) even more heavily favors rural areas, especially those with a lot of hunting and wilderness tourism (e.g., such as Idaho, Wyoming, and Montana), and completely misses large population centers. Thus FFLs PM may be a useful alternative to capture the variation in gun availability around urban areas that are potentially missed by other gun proxy measures.

often not in a highly populous area (imagine a county with two larger cities on opposite ends of the county).

[13] Data reporting the last dealer of a recovered gun is rare. Regardless, a similar figure to the one presented on page 5 of (Office of the Mayor, 2017) can be created for Philadelphia County, Pennsylvania using data hosted by the Pennsylvania Attorney General (Office of the Attorney General, 2021).

Figure 1: Example of a Halo of Counties

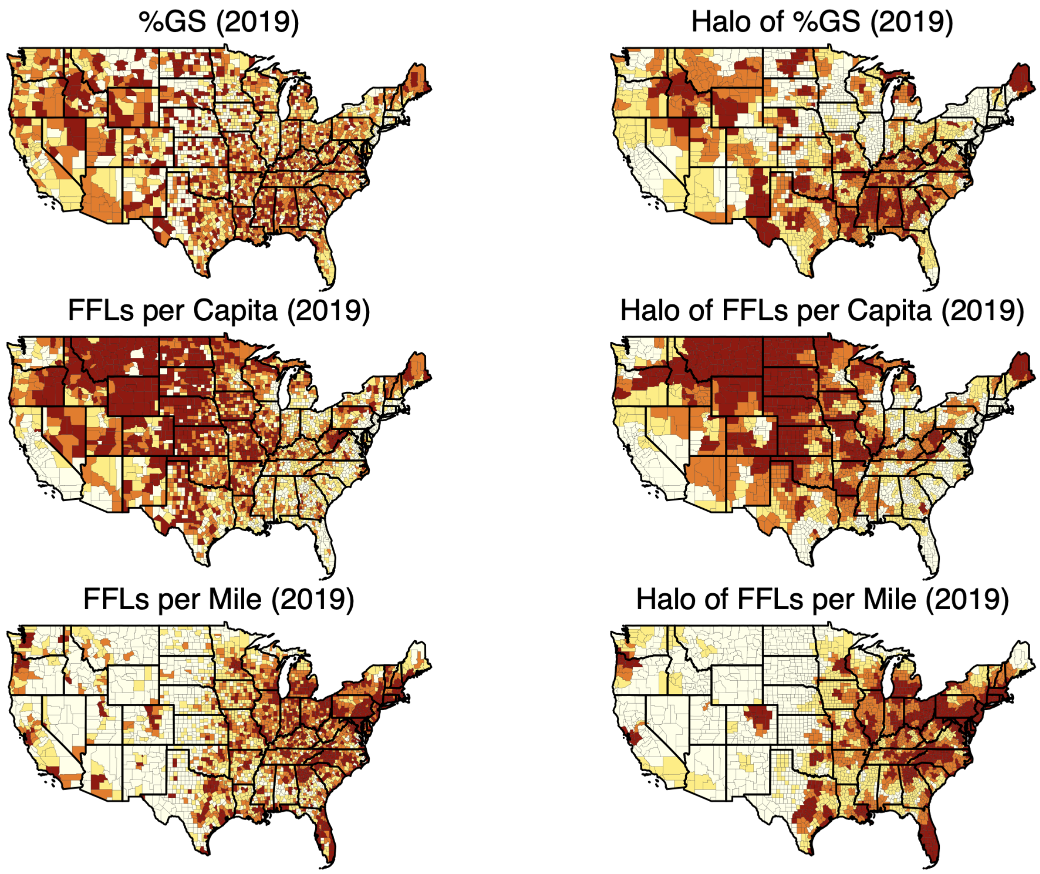


Notes: Halo county example for Cook County, IL. On the figure on the left, the dark-shaded county represents the county where the gun buyer lives, and lightly shaded counties represent counties that the buyer may be willing to drive to in order to purchase a gun (halo). The figure on the right shows the detail of the halo of Cook County with zip code level FFLs shown by the heat map. Despite there not many guns being available (as measured by FFLs) in Cook County, there is significant gun density in the surrounding counties. White space indicates zero.

Using FFLs per 100 square miles in the halo region (our preferred measure) shifts gun availability back toward population centers, but not exclusively so (notice the high concentration of gun density in the southeast and midwest regions). For example, the two other gun availability measures (% GS and FFLs per capita) indicate the regions around Chicago, Los Angeles, New York, and Detroit have a curious lack of firearm availability, while our FFLs per 100 square miles measure shows a high concentration of guns in these areas. Perhaps the most striking example is that of north-central Colorado, which contains cities infamous for mass shootings (Boulder, Aurora, Columbine, etc.). The percent of suicides committed with a gun and the per capita measure suggest this area has very low gun availability. On the contrary, our gun density measure suggests this area has the highest concentration of guns in the western United States. Since we do not know the true pattern of gun availability, we cannot say for sure which metric is "best." However, it clearly indicates that the halo gun density measure captures a unique variation in gun availability around metropolitan areas not captured by population-based metrics.

Figure 3 shows in detail the significant amount of within-state variation in FFL density for two dramatically different states: Texas and California. Texas has relatively lax gun laws relative to California, and most people would assume that Texas has a lot more guns overall. It is true that parts of east Texas appear to have a high concentration of guns; however, in much of the state, the FFL density is in the lowest quintile nationally. Likewise, there are areas of north-central California—particularly around the Bay Area—in which FFL density is on par with east Texas.

Figure 2: Gun Density by Individual Counties (Left) & By County Halo (Right)



Notes: Gun density by competing measures: percent gun suicides (%GS), Federal Firearm Licenses per 1,000 residents (FFLs Per Capita), and Federal Firearm Licenses per 100 miles (FFLs per Mile), which is our preferred measure.

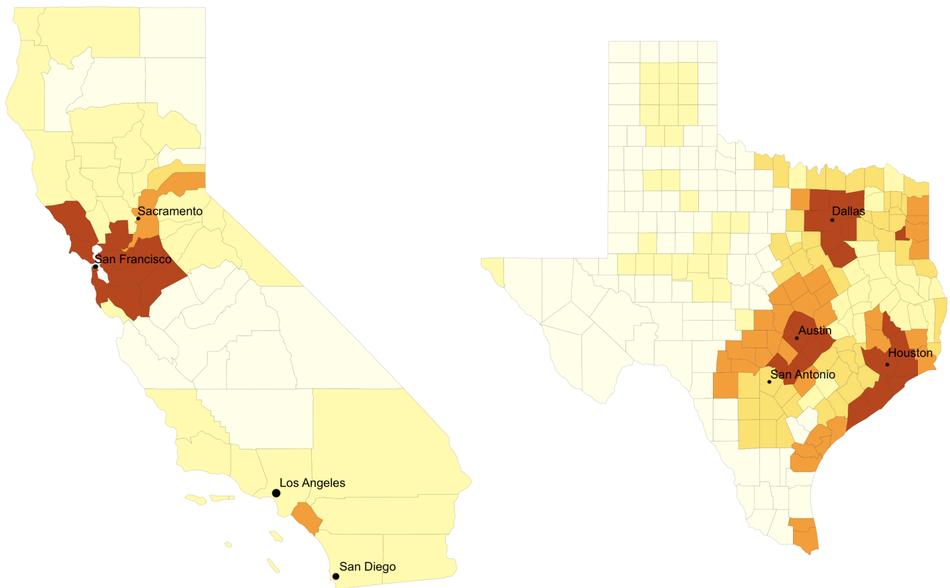
Notice again that FFL density does not merely mimic population density. Los Angeles County is the nation's most populous county, containing more than a quarter of the people living in California, yet it is only in the second quintile of FFL density. This pattern is mimicked nationally: there is substantial geographic and inter-temporal variation in the number of FFLs. From 2003 to 2009 the number of FFLs dropped by about 10,000 and then increased steadily until 2018. Given the time and spatial variation and its unique properties compared with existing gun proxies, we believe FFL density is an interesting alternative to other measures of gun prevalence.[14]

3 Data and Methodology

Our analysis uses data from only the contiguous United States. Mortality and some demographic data (e.g., county population, age, and racial demographics) come from the CDC Wonder database. We primarily focus on CDC death certificate data rather than local law enforcement data from the

[14] To contrast this with the most popular gun proxy measure, we show the same figure but using the percentage of gun suicides in place of FFLs per 100 square miles in Figure A1 in Appendix A.2. Consistent with Figure 2, the heat map of the percent of gun suicides is nearly the inverse of gun dealer density, suggesting these two proxies are picking up very different types of variation in gun prevalence.

Figure 3: Within State Variation in FFL Density (2003)



Notes: Darker regions represent a higher quintile of FFLs per square mile.

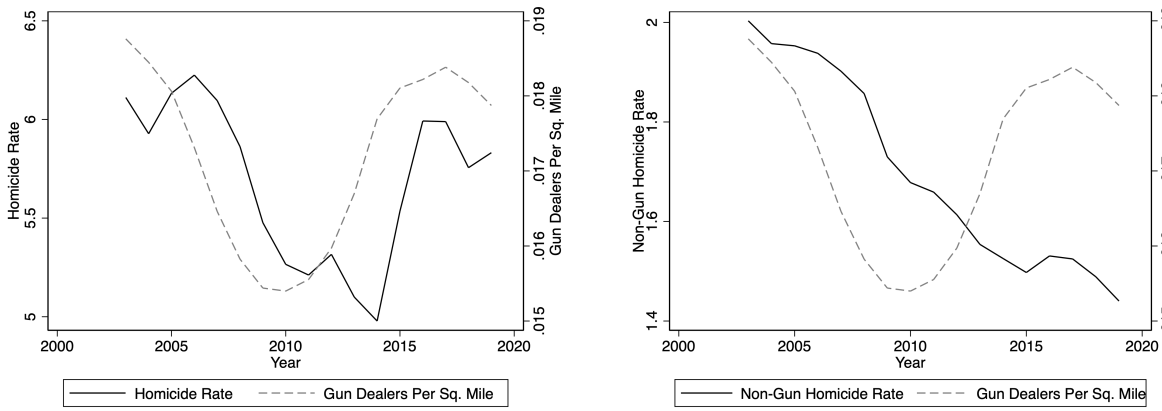
Federal Bureau of Investigation (FBI) due to the FBI data being based on voluntarily reported crime counts, which undercounts the total number of homicides.[15] We focus on both gun homicides and non-gun-related homicides. Non-gun-related homicides serve as a kind of "placebo check" to test that our homicide results are not being spuriously driven by the kinds of homicides least affected by gun prevalence.[16] That is, an unobserved factor—like social unrest in a community—could drive up both gun demand and violent actions. In this case, we would expect to see an increase in non-gun-related homicides as well. A graph of these death rates (per 100,000) across time is found in Figure 4. In each of these figures, we also include the number of gun dealers per 100 square miles (right-hand axis). Analogous figures for each state are found in Figures A2 and A3 found in the appendix.

To account for some of the socioeconomic and demographic differences between counties that may affect mortality rates, we use Census data on population, race, and gender composition and the median income from the Bureau of Labor Statistics (BLS). We do not combine rural counties into large rural county groups because even in counties with small populations and in the same state there is substantial heterogeneity in terms of demographics, gun dealers, and income. For instance, counties with the highest percentage of Black residents are not urban counties but rural

[15]However, given that these data are commonly used in the literature on crime, it is worth exploring if our results change when using law enforcement data. We present results using FBI homicide data in Appendix A.7. Although we prefer the CDC homicide data, it is important to note that the CDC data is not without its problems. County death counts are based on the victim's county of residence rather than—and in contrast to the FBI data—where the death occurred, and these CDC data cannot inform any questions related to how gun prevalence can affect crime rates other than homicide.

[16]As a robustness check, we estimate results using total homicides in Table A2 of Appendix A.5 using the fixed effects Poisson and linear approaches.

Figure 4: Changes in Homicide Rates Relative to Gun Density



Notes: Yearly death rates (dark gray line) versus yearly gun dealers per 100 miles (light gray line).

ones in the deep south (e.g., over 80 percent of residents in Jefferson County, Mississippi identify as Black). Summary statistics for the dependent and control variables are found in Table 2. Table 2 also includes the summary statistics of the number of federal firearms licenses issued to dealers and pawnbrokers (which make up nearly 90 percent of all FFL licenses in our data), the number of these FFLs per 100 square miles, and other measures of gun availability.[17]

As a point of comparison, we contrast our results with another common measure of gun prevalence that is available at the local level: the proportion of gun suicides to total suicides. However, this introduces a complication, as there are many county-years with no reported suicides. In these cases, we replace the undefined proportion of gun suicides with 0. There are roughly 6,800 observations that are impacted by this replacement, which is roughly 350 counties per year.

Homicide is a count variable with a significant number of zeros. Consequently, we estimate Equation 3 using a Poisson regression with county fixed-effects and cluster-robust standard errors to account for over-dispersion. We use county population as the exposure variable to account for the fact that places with more people will have more "opportunities" for homicides. The independent variables, $X_{i,t}$, include a vector of county characteristics (natural log of the population, natural log of median income, percent male, and percent Black) in county i in year t, county fixed effects, ψ, and county-specific time trends, $\psi_i * \tau$. Finally, the variable of interest, G, is one of six measures of county gun availability—all of which are lagged two years.

$$E[y_{i,t}|x] = \exp\{\beta_0 + \beta_1 G_{i,t-2} + \beta_j X_{i,t} + \psi_i + \psi_i * \tau\} \tag{3}$$

We lag the gun density measures for two reasons. First, lagging the measure reduces concerns about reverse causality (see Lang, 2016; Duggan, 2001; Cook and Ludwig, 2006; Moody and Marvell, 2005; Chalak et al., 2022). Second, a new gun dealer will likely receive an FFL from the ATF before they begin selling to the public, as the FFL will be necessary to have inventory shipped to the point of sale. To this point, it is common in the ATF data to see a new FFL granted to a person and address with no business name associated with the license, but for a business name to be registered to the same individual and address upon renewal of the license, which suggests the FFL is often acquired before a business opens to the public. Finally, a longer lag takes into account the time it takes for guns to move to people who are likely to commit crime or to actually be used in a crime

[17]Histograms for the deaths and explanatory variables are found in Figures A4 and A5 in Appendix A.4.

Table 2: Summary Statistics

	Mean	Std. Dev.	Min	Max
Ln Pop.	10.3	1.46	4.01	16.1
% Male	0.50	0.021	0.43	0.73
% Black	0.095	0.15	0	0.87
Ln Income	10.7	0.26	9.73	11.9
Homicides	5.73	28.2	0	1070
Gun Homicides	4.03	21.6	0	874
Non-Gun Homicides	1.70	7.20	0	249
FFLs PC (H)	4.16	2.82	0.11	25.2
FFLs PC	5.26	5.10	0	163.9
FFLs PM(H)	2.90	2.36	0.082	22.5
FFLs PM	3.12	4.43	0	140.8
% GS (H)	0.58	0.14	0	1
% GS	0.53	0.34	0	1
Observations	52207			

Notes: Summary statistics of the main variables of interest. (H) indicates that the variable is a local area measure (e.g., Figure 1).

once acquired.

According to (Alper and Glaze, 2019), among prisoners (state and federal) who possessed a firearm during the offense that led to them serving time, only 10 percent obtained the weapon from a retail store. On the other hand, 25 percent obtained the weapon from an individual (e.g., a friend/family member), 43 percent purchased the weapon through the black/gray market, and another 6 percent stole the weapon. What this means is that it takes time for a gun to move from a lawful owner to a criminal. Therefore, it is unrealistic to expect the existence of a new FFL to change the homicide rate in the first year of its existence. Critics of a two-year lag might note that the average age of a firearm used to commit a crime is between 10–15 years old (Braga et al., 2020), but this statistic is somewhat misleading in this context as gun dealers regularly sell used guns.[18] However, all of the results that follow are robust to using one-year or three-year lags instead of a two-year lag. A plot of these different lags is found in Appendix Figure A7 along with the first, second, and third lead of gun dealer density.

We cluster standard errors at the county level. Our main assumption in doing so is that the error terms across counties are uncorrelated—meaning that a change in the homicide rate in one county does not change the homicide rate in an adjacent county—except through a change in the number of FFLs in an adjacent county. That is, county homicides are assumed to only be related by a common gun market. Given that most crime occurs between neighbors, acquaintances, and family members, this is plausibly true.

The county-level fixed effects eliminate any effects of the persistent stock of firearms in the beginning period of the study. Thus, β_1 will measure only how changes in firearm stock—that is, the flow of firearms—influence changes in homicides.

As robustness checks, we perform the inverse hyperbolic sine (IHS) transformation on the homicide rates and use that as the dependent variable to obtain point estimates using standard OLS with county fixed effects and using an Anderson-Hsaio dynamic panel estimation—to ensure serial correlation in the errors is not biasing our result. Those results are found in Tables A3 and

[18]For example, one of the authors sold a 9mm Browning High Power that was roughly 20 years old to a local pawn shop when his twins were born.

A4 in Appendix A.6.

4 Results

4.1 Gun Density and Homicides

Our main results are presented in Table 3. There are two panels—showing gun homicides (top) and non-gun homicides (bottom)—and six columns in each panel—each showing a different measure of gun availability—for a total of 12 sets of results. Each column in the panels is labeled by one of the six gun density measures available at the county level. From left to right, they are the percentage of suicides involving a firearm (%GS), the number of FFLs per 1,000 people (FFLs PC), and the number of FFLs per 100 square miles (FFLs PM). The last three columns, designated with "(H)", indicate models using a gun prevalence measure calculated using the halo of counties surrounding county i. The halo measure of FFLs per 100 square miles, FFLs PM (H), is our preferred measure of gun prevalence. As all these estimators are log-linear, all coefficients are comparable and can be interpreted approximately as semi-elasticities.

One of the first results of note is that the most common measure of gun availability in the scientific literature, the percent of suicides committed with a gun—measured at both the county level and county halo level—has a small, negative, and statistically insignificant association with gun homicides. This is in contrast to past work, such as Cook and Ludwig (2006); Siegel et al. (2013); Chalak et al. (2022), who all find a positive and significant relationship between the percentage of gun suicides and homicides. This may be due to our use of a full panel of counties and gun suicide ratio being high in rural areas with low populations.[19] However, the point estimates obtained from using gun dealers per capita suggest a large and statistically significant association between gun availability, despite the measure also tending to emphasize rural gun ownership, suggesting that these measures capture different types of variation in guns. The point estimates suggest that an increase of one FFL per 10,000 people increases homicides 5.8 percent or 19.7 percent for the halo measure.[20] While our estimates are largely consistent with Wiebe et al. (2009), they were only able to find significant results when restricting their sample to only urban counties.

Our preferred measure of gun density, FFL PM(H), shows a one-unit change in FFLs per 100 square miles in the halo of counties is associated with a 4.9 percent increase in gun homicides.[21] When gun density is measured at the county level (FFL PM), rather than the county halo, the coefficients are about half as large—one-unit change in FFLs per 100 square miles is associated with a 2.4 percent increase in gun homicides. Though it is not entirely clear what is causing the attenuation of these estimates relative to the halo estimates, it is consistent with our concerns discussed in Section 2.2. Many counties are relatively small, and individuals in many places are likely prone to buying goods (particularly expensive, durable goods, like firearms) across county lines.[22] Thus, our halo measure of gun density is more likely to represent the relevant purchasing area for the average consumer.

To contextualize our main result, a one-unit change in FFLs per 100 square miles is very large—more than a 40 percent increase from the median value. This translates into approximately 48 additional gun dealers in the median county halo. In contrast, a 4.9 percent increase in homicides

[19] Cook and Ludwig (2006) have specifications with county-level data, but they limit their sample to the 200 largest counties, and their elasticity estimates were nearly a full order of magnitude smaller in this specification.

[20] Coefficients exponentiated for precision: $e^{0.056} - 1 = 0.0576$ and $e^{0.18} - 1 = 0.197$

[21] Coefficient exponentiated for precision: $e^{0.048} - 1 = 0.049$

[22] Likelihood to purchase a firearm from a dealer outside one's county is also likely determined by local gun dealer ordinances.

Table 3: The Effect of Guns Density on Gun Homicides

	Gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.019	0.056***	0.024***	-0.051	0.18***	0.048***
	(0.024)	(0.013)	(0.0035)	(0.071)	(0.025)	(0.011)
% Male	-4.91	-4.64	-2.48	-4.90	-1.90	-3.93
	(3.16)	(3.07)	(2.94)	(3.16)	(3.08)	(2.81)
% Black	5.00*	5.06**	6.70***	4.99*	5.37**	5.71***
	(2.63)	(2.22)	(2.29)	(2.63)	(2.24)	(1.98)
Ln Income	0.79***	0.72***	0.57***	0.79***	0.63***	0.58***
	(0.12)	(0.10)	(0.10)	(0.12)	(0.098)	(0.10)
Ln Pop.	-1.22***	-1.08***	-1.31***	-1.21***	-0.99***	-1.24***
	(0.32)	(0.26)	(0.27)	(0.32)	(0.23)	(0.28)
Pse. R^2	0.88	0.88	0.88	0.88	0.88	0.88
LL	-51459.8	-54974.0	-54883.8	-51455.4	-54905.9	-54903.0
Counties	2757	2768	2768	2756	2768	2768
Observations	41355	44288	44288	41331	44288	44288
	Non-gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.033	-0.026*	0.0055	-0.095	-0.055**	0.00086
	(0.030)	(0.013)	(0.0033)	(0.084)	(0.022)	(0.0083)
% Male	3.49	2.32	2.88	3.42	1.99	2.65
	(3.09)	(2.91)	(2.97)	(3.09)	(2.90)	(2.96)
% Black	2.44	0.80	1.30	2.41	0.71	0.86
	(1.98)	(1.73)	(1.83)	(1.99)	(1.70)	(1.77)
Ln Income	0.25***	0.32***	0.28***	0.25***	0.34***	0.31***
	(0.082)	(0.074)	(0.077)	(0.082)	(0.074)	(0.078)
Ln Pop.	-0.39	-0.25	-0.19	-0.39	-0.30	-0.17
	(0.28)	(0.26)	(0.27)	(0.28)	(0.25)	(0.27)
Pse. R^2	0.74	0.74	0.74	0.74	0.74	0.74
LL	-40939.6	-44007.2	-44008.5	-40935.1	-44005.2	-44009.5
Counties	2716	2731	2731	2716	2731	2731
Observations	40740	43696	43696	40727	43696	43696

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 1,00 square miles (halo). Dependent variables are gun and non-gun homicide counts, and models are estimated using poisson regression with county fixed effects, county-specific linear time trends, and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

is relatively small—the median county has only 0 gun homicides per year and the mean value is just over 4 per year. For the entire United States, a 4.9 percent increase would translate to approximately 706 additional gun homicides per year based on 2019 figures. While this may seem high, the equivalent increase in FFL dealers to generate that change (in 2019) would be nearly 26,000. In 2019, each gun dealer was responsible for over 180 background check inquiries for handgun and long gun purchases to the FBI. While every background check does not result in a purchase, if we assume the number of new firearms in the US is approximately equal to the total number of manufactured firearms plus imported firearms minus exported firearms, then there are approximately 93 new guns for every 100 background checks for potential handgun and long gun purchases. This would translate to about 4.3 million new guns per year or approximately 6,091 guns per gun homicide.

We can loosely compare our results to papers using other gun proxies by estimating a constant elasticity model, which can be estimated by modifying our main specification to use the natural log of each gun density measure (Silva and Tenreyro, 2006).[23] Those results are found in Table 4 and imply an elasticity estimate between 0.24 and 0.45 depending on which FFL density measure is used. Our preferred measure implies a 10 percent increase in FFLs per 100 square miles increases homicide by approximately 4.43 percent. Interestingly, these results are very close to elasticity estimates by Duggan (2001) (elasticity of 0.214 using magazine subscriptions), Cook and Ludwig (2006) (elasticity of 0.645 using the percentage of gun suicides), and Chalak et al. (2022) (elasticity of 0.411 before measurement error adjustment using the percentage of gun suicides). However, our results are quite different than Lang (2016) (elasticity of 0.01 and insignificant using NICS checks).[24]

Table 4: The Effect of Guns Density on Gun Homicides (Constant Elasticity)

	Gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
ln(Gun Dens.)	-0.0022	0.24***	0.24***	-0.0068	0.45***	0.44***
	(0.017)	(0.040)	(0.041)	(0.040)	(0.063)	(0.066)
% Male	-8.55**	-7.34**	-7.06**	-8.07**	-5.86**	-6.13**
	(3.78)	(2.98)	(2.94)	(3.28)	(2.80)	(2.82)
% Black	10.2***	9.53***	9.61***	9.87***	9.44***	9.64***
	(2.79)	(2.48)	(2.45)	(2.66)	(2.16)	(2.17)
Ln Income	1.11***	0.91***	0.92***	1.10***	0.84***	0.85***
	(0.12)	(0.097)	(0.096)	(0.11)	(0.096)	(0.097)
Ln Pop.	-2.00***	-1.62***	-1.79***	-1.97***	-1.64***	-1.77***
	(0.48)	(0.37)	(0.38)	(0.48)	(0.33)	(0.35)
Pse. R^2	0.88	0.88	0.88	0.88	0.88	0.88
LL	-51764.4	-59403.0	-59405.9	-56128.8	-59563.9	-59580.5
Counties	2613	2782	2782	2788	2799	2799
Observations	36734	47048	47048	44538	47582	47582

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 1,00 square miles (halo). The dependent variable is gun-related homicide counts, and models are estimated using poisson regression with county fixed effects, county-specific linear time trends, and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

One potential threat to our identification is reverse causality. It is likely that changes in the homicide rate may change gun purchasing behavior of individuals in that area. Consistent with this, Depew and Swensen (2018) show that increased homicides in an area will increase the number of concealed carry permit applications. While we cannot eliminate the possibility of reverse causality, due to the lagged structure of our gun density measure, in our case, reverse causality would imply that individuals can anticipate increases in homicides many years in the future when deciding to buy a gun (see Lang, 2016; Duggan, 2001; Cook and Ludwig, 2006; Moody and Marvell, 2005; Chalak et al., 2022). Furthermore, entrepreneurs would have to anticipate the that people in a given locality would be able to accurately forecast crime years in advance and capitalize on this by moving to open a gun store in advance of population's beliefs changing. This reasonably unlikely.

A more likely threat to causal identification is that some underlying variable (e.g., an increase

[23] It is important to note that this specification implies different assumptions about the relationship between gun dealers and homicide. Specifically, it implies that the effect of an additional gun dealer diminishes as the number of gun dealers increases, which may not be true.

[24] We also tried including both our preferred measure of FFLs per 100 square miles and the percent of gun suicides in the same regression, since the summary analysis suggested they were picking up very different types of variation in gun prevalence. This did not change the interpretation of the elasticities for either measure. Those results are found in Appendix Table A9.

in social unrest) is causing more FFLs to open in a given area as well as leading to an increase in the murder rate through a pathway that does not involve an increase in the availability of guns, which would lead to spurious correlation. To test this, we estimate the relationship between lagged gun dealer density and homicides not involving a gun. The assumption here is that if a variable like social unrest is driving the relationship then we should expect to observe a significant relationship between non-gun homicides *and* gun dealers.

Estimates for the relationship between our measures of gun density and non-gun homicides are found in the bottom panel of Table 3. Point estimates for our preferred gun density measure, FFLs PM(H), are an order of magnitude smaller than the total homicide estimates and statistically insignificant. Both gun suicide measures and FFLs PM are also statistically unrelated to non-gun homicide. The FFLs per capita measure are statistically significant, but with a flipped sign. These results taken together show that when our preferred measure of gun density, FFLs PM (H), increases we see a small increase in the gun homicide rate, but we see no discernible effect on the non-gun homicide rate. This suggests three points: i) the geographic gun density measures are not measuring an unobserved local propensity to murder or underlying trend in homicides, ii) it shows that reductions in geographic gun density is not causing individuals to substitute into other methods of murder, and iii) our estimates presented in Table 3 are plausibly causal.[25] It is also worth noting—as we discuss in Section 4.2—that other types of crimes are still generally on a downward trend during this period, which makes the possibility of a spurious correlation even less likely. As an additional robustness check, we show our results are not driven by local economic changes.[26]

4.2 Gun Dealer Density with an Application to the "Ferguson Effect"

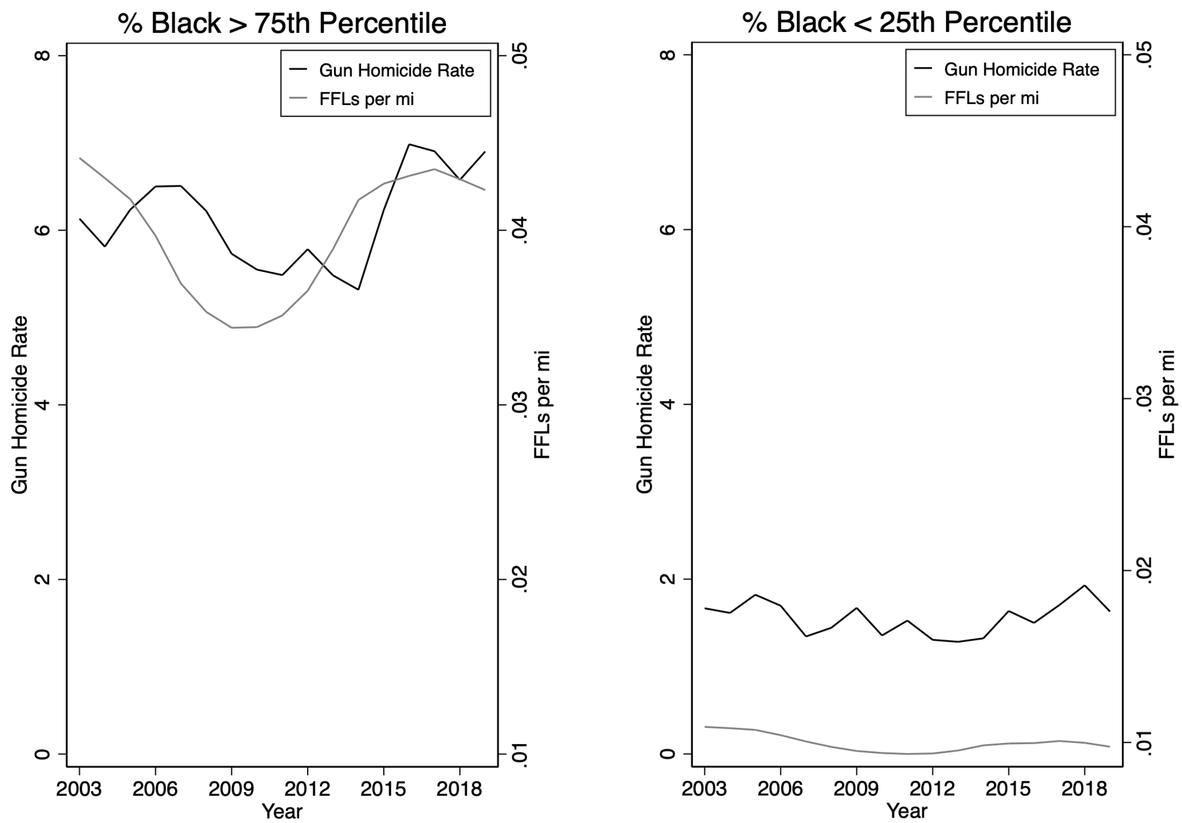
In Section 4.1 we demonstrated increases in gun dealer density increase the homicide rate on average. In this section, we investigate potential heterogeneity in this effect. Such heterogeneity could result from gun dealers specializing in specific firearm types. Some firearms are easy to hide and consequently more useful in committing crime (e.g., handguns) others are probably less useful (e.g., bolt-action rifles) due to their more cumbersome nature. So if a gun dealer locates in an area that has a lot of interest in hunting, it is likely they will specialize in long-guns—which are less useful in committing crime—resulting in a weaker link between gun dealer density and homicide. On the other hand, dealers located near urban and suburban populations will have more customers interested in purchasing a gun for personal protection and will, thus, carry more handguns.

An interesting avenue for investigating the heterogeneity in the gun/homicide relationship is the so-called "Ferguson Effect". Beginning in 2014, there was a large, rapid increase in homicides that were particularly pronounced for urban areas and areas with a higher percentage of Black residents. The Ferguson Effect is a term coined by the chief of the St. Louis police to suggest that the spike in homicides and other violent crime was due to an increased hesitancy of police officers to enforce the law due to media and legal scrutiny after the shooting of Michael Brown in Ferguson, MO in 2014. Edwards and Rushin (2017) investigated this hypothesis and found that there is a small, but significant, increase in crime in cities in which the local police department received increased scrutiny from the US Department of Justice. Yet, there is debate. Morgan and Pally (2016)

[25] Figure A7 of Appendix A.8 also demonstrates that this non-result is not due to the chosen lag/lead of FFLs PM.

[26] Gun dealers are businesses, and fluctuations in economic conditions can be correlated with many unobserved variables. To test this, we replace our gun density measure with a measure of business density—the number of business establishments per 100 square miles in the county and surrounding county halo—and estimate the same models found in Tables 3. These estimates are found in Appendix Table A10. Estimates are statistically significant; however, they are several orders of magnitude smaller and in the opposite direction (negative association) than our gun density estimates. We interpret these coefficients as precisely estimated zeros.

Figure 5: Relationship Between Guns & Homicide by Racial Composition



Notes: Total homicides and Gun Dealers in communities with the percent of Black residents in the top quartile (right) and communities with the percent of Black residents in the bottom quartile (left).

and Shjarback et al. (2017) find very little evidence of changing police behavior after Ferguson; however, each only investigates a narrow area and time window. Interestingly, Desmond et al. (2016) finds that one of the effects of high-profile cases of police violence against Black individuals is an increased hesitancy to call the police in Black neighborhoods. This suggests that crime may be under-reported. However, one type of criminal activity is unlikely to be under-reported: homicides.

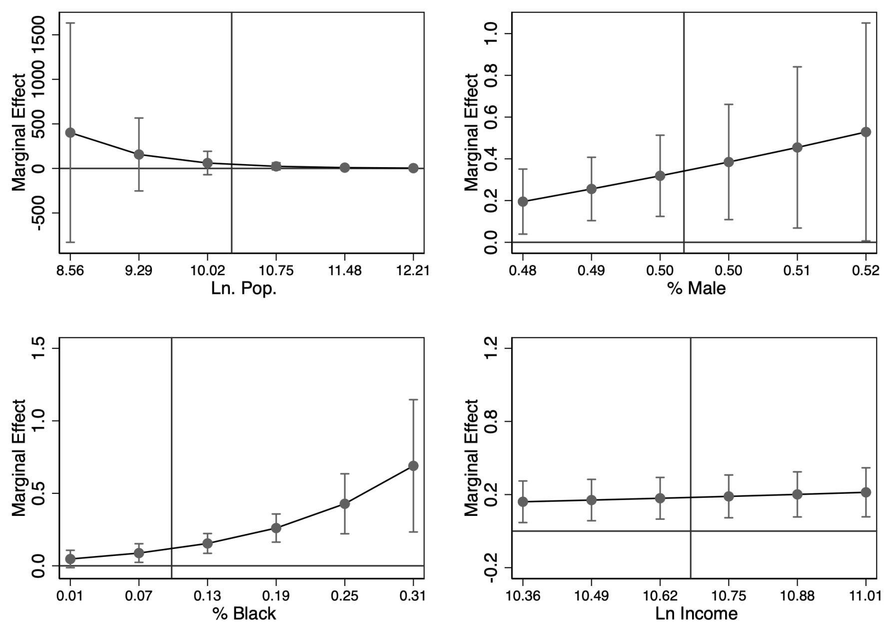
The left side of Figure 5 shows that gun homicide rates, indeed, rise quickly and remain high in counties with a high percentage of Black residents after 2014.[27] While this could be due to increased hesitancy among police to make arrests or a decreased willingness to call police among individuals in these counties, we offer a third possible explanation: an increase in the availability of guns in Black communities. Figure 5 also shows that counties in the highest quartile of Black residents, the number of FFLs per 100 square miles—our gun density measure—falls steadily from 2003 to 2010, and that is followed by a declining homicide rate from 2006 to 2014. In 2011, gun density began to sharply increase in predominantly Black counties, with roughly 800 gun dealers added in these areas. This is followed by a sharp increase in homicides beginning in 2015. Although these are unconditional time series plots, a strong relationship between gun density and homicides is apparent. No such clear relationship can be seen in counties within the lowest quartile of Black

[27]We note that there is also an increase in homicides in counties with a low percentage of Black residents (right side of Figure 5); however, the increase is much smaller, far more gradual (happening over a 4 year period), and sharply falls by 2019.

residents (right side of Figure 5), where there is comparatively almost no variation in gun density and, perhaps consequently, far less variation in homicide.[28]

We explore the heterogeneity in the effect of gun dealer density on homicide more formally by interacting gun dealer density with several county characteristics. The plotted marginal effects are presented in Figure 6.[29] This model suggests that the negative consequences of gun dealers are primarily suffered in communities with a high percentage of Black residents, with gun dealers having almost no effect on homicides in counties with even the average percent of Black residents and increasing significantly as the percent of Black resident approaches the higher percentiles. The other characteristics investigated, median personal income, and population have no significant effect on the gun dealer density-homicide relationship. The marginal effect more than doubles as the proportion of male residents increases from the 10th to the 90th percentile of the distribution, which is unsurprising given that approximately 85 percent of gun homicides are perpetrated by a man.[30] However, the standard errors are too large to reliably distinguish between these estimates.

Figure 6: Marginal Effect of Gun Dealer Density



Notes: Estimated marginal effects of gun density on homicides across the domain of controls variables. Each graph is scaled independently. Error bars indicate 95% confidence intervals. The solid vertical line is the variable's mean.

To investigate this observed relationship further, we also obtain separate results for counties that are in the highest quartile of Black residents (> 11 percent of the population) and for counties in the lowest quartile of Black residents (< .9 percent of the population), on average over the 2003–2019 time period. These results are found in the first and second columns of Table 5. The third and

[28]It is important to note that no such relationship can be identified if gun prevalence is measured by the ratio of gun suicides to total suicides. A figure similar to Figure 5 is presented in the Appendix in Figure A8, which uses the gun-suicide ratio rather than FFL density as the measure for gun prevalence. Given the lack of variation in the gun-suicide ratio in counties with a high percentage of Black residents, there is no discernible relationship present in the figure.

[29]Coefficient estimates are found in Figure A8 in the appendix

[30]Bureau of Justice Statistics report: `https://bjs.ojp.gov/content/pub/pdf/tpfv9318.pdf` (last accessed January 30, 2022).

Table 5: Gun Dealer Density and County Characteristics

	Black Population		Metro Status	
	% Black>75^{th}	% Black<25^{th}	Metro	Non-Metro
FFL PM (H)	0.047***	-0.054	0.049***	-0.023
	(4.17)	(-0.36)	(4.38)	(-0.61)
Ln. Pop.	-1.23***	-3.80	-1.36***	-0.93
	(-4.28)	(-1.13)	(-4.30)	(-1.44)
% Male	-6.39**	37.4**	-5.79	-0.43
	(-1.99)	(2.03)	(-1.33)	(-0.12)
% Black	5.48***	-49.6	6.59***	-3.15
	(2.59)	(-1.08)	(2.92)	(-0.94)
Ln Income	0.67***	0.22	0.62***	0.20
	(6.15)	(0.38)	(5.54)	(1.14)
Pse. R^2	0.90	0.37	0.90	0.38
LL	-33568.9	-3901.0	-31554.7	-23334.8
Counties	1277	614	1106	1662
Observations	19402	6008	17696	26592

Notes: All models are estimated via fixed effects Poisson regressions and include county-specific linear time trends, county fixed effects, and have standard errors clustered at the county level. Column one uses the sample of counties that have a proportion of Black residents in the top quartile; column two uses the sample of counties in the bottom quartile. Columns three and four split the sample into metro and non-metro counties based on the NCHS urban-rural classification scheme. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

fourth columns show the effect broken down by metropolitan and non-metropolitan areas.[31] We find that the average effect of gun density on homicide found in Section 4.1 is entirely concentrated in communities with a high percentage of Black residents.

Our result echoes that of Williams (2017) who finds the repeal of Missouri's Permit to Purchase law, which required handgun buyers to have a permit and submit to a background check, led to a significant increase in the Black homicide rate while having no effect on the White homicide rate. We emphasize, however, that we cannot say with certainty that increased gun density would have had no effect in communities with low Black populations, as the lack of effect in counties with low Black populations is likely driven by the fact that gun density remains relatively stable (low variance) in these counties during this time frame. We also find that our main results are driven by metropolitan counties and no discernible effects are found in non-metropolitan counties.

Our data do not allow us to directly observe what types of guns are being sold by dealers, but we can infer some information based on the name of the dealer. To that end, we use the business names listed in the FFL data to examine how the composition of gun dealers changes over time in different types of counties. We classify the license holders' business names into one of eight categories: Pawn, Outdoors, Defense, Big-box, Gun Smith, Patriotism, X-Guns, and Multiple Categories. Pawn indicates the FFL is a pawn-type license, Outdoors FFLs have business names suggesting the store specializes in outdoor equipment, Defense indicates a business name containing words associated with personal/home defense, Big-box indicates the business is a large chain store, Gunsmith FFLs have a name that suggests the store is a gun repair shop, Patriot are stores with names containing a "patriotic" word, X-Guns have business names containing a common name for a person followed by guns/firearms (e.g. Bob's Guns), and Mixed Categories indicates a business

[31] We use the National Center for Health Statistics Urban-Rural Classification Scheme. We classify large, large-fringe, medium, and small metropolitan counties as "metropolitan" and micropolitan and non-core counties as "non-metropolitan."

name that could be classified in more than one category. A full list of the words/names for each classification is found in the Appendix A.13. Our classification covers roughly 50 percent of FFLs with a business license.

We calculate a rough measure of gun dealer type density (Equation 4) by taking the total number of FFLs of classification z (e.g., Pawn, Outdoors, Defense...) county type b (e.g., % Black≥11), in year t and dividing it by the total land area of counties of type b (which is 886,766 square miles for counties with less than .9 percent of their residents identifying as Black and is 444,815 square miles for counties with more 10 percent of their residents identifying as Black.)

$$GD_{z,b,t} = \frac{\sum_{j=1}^{n} FFL_{z,b,t}}{A_b} \tag{4}$$

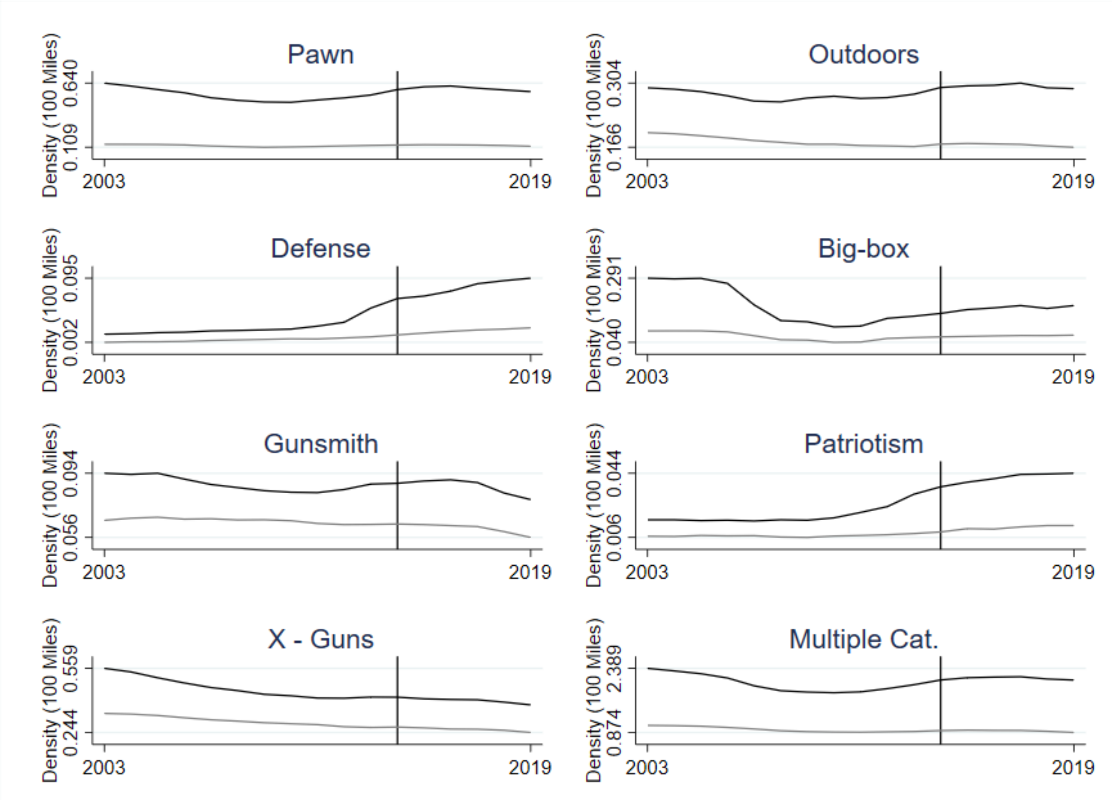
In Figure 7 we illustrate how FFL density by business classification varies across time and location type. Three stylized facts emerge from Figure 7: First, dealer density, regardless of location type, is greater in counties with a higher percentage of Black residents. Second, there seems to be little change in the density of dealer types in areas with a low percentage of Black residents, which is somewhat surprising considering the greater land area. Third, the decrease and subsequent increase in gun dealer density is not caused by one dealer type exiting the market and then reentering later. Rather, it seems that Big-box FFLs exited Black communities around 2007 only to be heavily replaced by Defense and Patriot-type dealers beginning in 2011 and with sharp increases in 2014 and 2015. That is, there is a large decrease in corporate businesses selling guns in Black communities, and the homicide rate in these communities hits a trough a few years later. This loss of gun density is rapidly filled by an influx of dealers with names suggesting a specialization in self-defense weapons, like handguns, in the years following Michael Brown's shooting.

With this observational result in mind, we replicate our main specification from Table 3, except we split the gun density measure into four categories based on Figure 7: Big Box, Defense or Patriot, Pawn, and Other. Results are found in Table 6. Overall, it is clear that the gun density-homicide connection is primarily driven by Defense and Patriot dealers and to a lesser extent Pawnshops (first column).[32] It is also clear that this pattern is being driven by the presence of these types of dealers in metro areas (second column). Finally, Defense and Patriot dealers also appear to be driving the connection we are seeing in areas with higher Black populations. It is important to note that we cannot rule out the role of other dealer types because they all show large, positive coefficients, despite the imprecision of the estimates.

The results presented above strongly suggest that a major factor contributing to the increase in violent crime in Black communities in the years after Michael Brown's death—the Ferguson Effect—is the differential increase in gun density in the short time before and after this event. To our knowledge, we are the first to demonstrate the potential role of gun availability in explaining this trend. Definitely separating other potential causes of the Ferguson Effect from the "gun dealer effect" we identify here is outside the scope of the present work. However, the effectiveness of guns as a lethal instrument combined with the correlated fluctuation of gun density suggests that increases in gun dealer density likely explain a significant portion of the increase in violent crime that has been identified as the Ferguson Effect. If this was not the case—and the effect was purely due to changes in police behavior or the willingness of citizens to contact the police—we would expect to see fluctuations in other crimes. This is not the case. In Figure 8, we present various crime counts in counties with Black residents in top quartile (percent of Black residents greater than 11%) and the same crime rates in counties with a percent of Black residents in the bottom

[32]Note that identified Defense and Patriot dealers are a small percent of total FFLs, so the increased size of the coefficients is partially due to the proportionally larger change implied by a one-unit increase.

Figure 7: Changes in Gun Dealer Density Type



Notes: Gun dealer density by classification type for counties in the top and bottom quartile in terms of percent of Black residents. The black (gray) line corresponds to counties in the top (bottom) quartile of Black residents. Vertical line corresponds to 2014, the year of Michael Brown's death.

quartile (percent of Black less than .9%). Unlike homicides in the Black community, which ebbs and flows with gun dealer density (Figure 5), changes in the crime counts look nothing like changes in the number of gun dealers and had no noticeable change (in terms of trend) post 2014.[33] A similar result is observed when relying on victimization survey data from the National Crime Victimization Survey (NCVS) and is discussed in Appendix A.15.[34]

The only type of crime for which we see a major change in trend, homicides, is the one most likely to change when it becomes easier to obtain a gun. It seems likely, therefore, that the propensity to call the police is not the primary mechanism of increased homicides in these communities, but rather that the availability of guns increased, which gave people an increased ability to commit homicide. Since guns are not as differentially useful in committing other types of crime, the trend of other crime rates did not change much.[35]

[33] With the exception of aggravated assault which is hardly surprising considering a firearm would not be an uncommon piece of capital equipment to be brandished (or used) in the commission of this type of crime.

[34] We thank Jacob Kaplan for this suggestion.

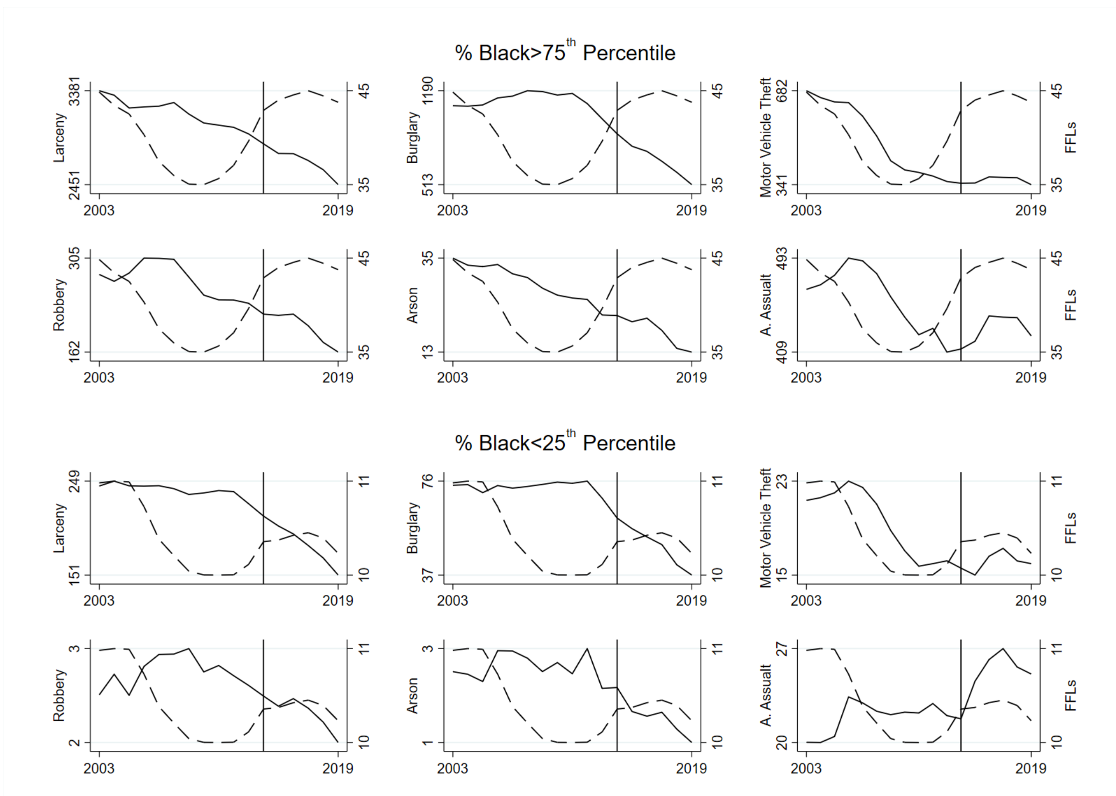
[35] In Table A11 in the Appendix we report the p-values for a series of known structural break tests using the crime data that has been collapsed by county type (top and bottom quartile in terms of % Black) and year. The dependent variable in each of these models is one of the eight crime rates and is explained using the lagged crime rate. Here we find some evidence that there may have been some changes in reporting that would be consistent with a decrease in the willingness to call the police (e.g., a significant structural break occurring with burglary and motor vehicle theft in 2015) but overall the changes are marginally significant or are likely reflective of sharp change in the trend occurring years before the death of Michael Brown. However, due to the limited number of observations and data

Table 6: Effects of Different Types of Gun Dealers on Homicides

	All Counties	Metro Counties	Non-Metro Counties	% Black>75^{th}	% Black<25^{th}
Big Box Gun Dens. (H)	0.076	0.081	-0.33*	0.100	0.36
	(0.074)	(0.075)	(0.20)	(0.082)	(0.58)
Defense & Patriot Gun Dens. (H)	0.32***	0.35***	-0.13	0.28**	-1.83
	(0.12)	(0.12)	(0.41)	(0.13)	(1.24)
Pawn Gun Dens. (H)	0.11*	0.12**	-0.093	0.084	-0.96**
	(0.059)	(0.062)	(0.15)	(0.064)	(0.41)
Other Gun Dens. (H)	0.013	0.010	0.074	0.011	0.29*
	(0.015)	(0.016)	(0.064)	(0.017)	(0.16)
Ln Pop.	-1.27***	-1.40***	-1.04	-1.35***	-0.24
	(0.28)	(0.32)	(0.65)	(0.30)	(1.93)
% Male	-3.73	-5.40	-0.15	-9.48***	9.65
	(2.79)	(4.32)	(3.73)	(3.15)	(12.4)
% Black	5.98***	6.94***	-3.38	5.62**	-26.2
	(2.00)	(2.28)	(3.36)	(2.25)	(23.4)
Ln Income	0.58***	0.61***	0.24	0.57***	-0.45
	(0.099)	(0.11)	(0.18)	(0.11)	(0.45)
Pse. R^2	0.88	0.90	0.38	0.90	0.37
LL	-54885.9	-31534.5	-23333.7	-22716.0	-5789.7
Counties	2768	1106	1662	762	570
Observations	44288	17696	26592	12192	9120

Notes: Models estimated with fixed effect Poisson using gun homicides counts as the dependent variable. All models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

Figure 8: Crime Trends by County Racial Demographics



Notes: Yearly crime rates (per 1,000 people) and gun dealers (per 1,000 miles) in counties with more than 11 % Black residents (top panel) and crime counts and gun dealers in counties with fewer than .9 % Black residents (bottom panel). Vertical line corresponds to 2014, the year of Michael Brown's death.

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quality, these results should be treated with skepticism.

5 Discussion and Conclusion

We examine the effect of gun dealer density on county homicide rates. We compare different measures of gun density and find that a halo measure that includes the county of interest, as well as surrounding counties, counties has many compelling properties relative to existing measures. Our results indicate that homicide rates increase in the years following an increase in gun density. Additionally, gun density itself has no significant relationship with homicides not involving a gun. Overall, however, the effect of gun density on homicides is small in magnitude.

We propose the small effect is due to gun dealer heterogeneity that is driven by multiple factors but among them are differences in the of types guns sold by gun dealers and the ebbs and flows of the market. To explore this possibility we interact gun dealer density with a number of county characteristics. Of the characteristics explored, we find the percentage of Black residents significantly increases the effect of gun dealer density on homicides. We show suggestive evidence that indicates that the composition of gun dealers in these counties shifts toward smaller gun dealers that likely specialize in selling weapons designed for self-defense (i.e. handguns) and that these types are dealers are driving the association between FFL density and homicide. In doing so we demonstrate the first evidence that the increase in violent crime in Black communities after 2014—known as the "Ferguson Effect"—was at least partially due to a sharp increase in gun density in those communities in the years just prior to and after Michael Brown's death. It is possible that the increase in gun availability plays a more important role in the increase in violent crime than previously explored causes, like changes in police behavior and decreased willingness of citizens to report crime. Future research could use our gun density measure to decompose the contributing factors of the Ferguson Effect in a more systematic fashion.

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A Appendix

A.1 FFL Details

Most of the FFL data was obtained from the ATF through a Freedom of Information Act request submitted in May of 2019. In the request, we asked for the number of FFLs issued by county, year, and type going back to 1987. The ATF filled our request by sending us a list of FFLs (usually from January and not including Type 3 FFLs) for each year from 2003 to 2013 along with the name, address, and (when applicable) business name of the FFL holder. Type 3 Licenses—issued to firearm collectors—were not included presumably because Type 3 firearms are not used like a typical firearm.[36] Regrettably, the ATF was unable to locate any FFL data older than 2001.[37] FFL data for the years 2014 - 2018 was found on the ATF's website.[38]

The ATF assigns a fifteen-digit FFL number to each approved applicant. An example of a typical (but fictional) FFL is provided in Table A1. As can be seen in Table A1, each license can be broken into six sections and these sections identify the state and county of the license holder as well as the license type. State (technically Internal Revenue Service district number – which maps to a state) and county of the license holder are identified by the second and third section of the license number while the fourth section identifies the license type. The fifth and sixth sections give the license expiration date and a unique identifier, respectively.[39] So in the example FFL provided in Table A1, one can infer the license holder is in Los Angeles County California, and is an importer of Firearms/Ammunition. Last, the license expired in January of 2016.

Table A1: Example FFL

Division	IRS District	County	Type	Expiration Date	Unique
9	33	037	08	6A	75309

Notes: Fictional FFL number broken up by section.

FFLs are common in the United States, and obtaining one takes about 60 days from application to approval. Applicants must first submit the application form along with the correct application fee. After the fee is processed, the applicant's information is entered into the Federal Firearms Licensing Center's (FFLC) database. For all license types, except for the Type 3 license, the ATF reviews substantial supporting material which includes fingerprints and photographs. The FFLC then conducts an electronic background check on all of the "responsible persons" identified in the application.[40] While the background checks are being completed, a local Industry Operations Investigator (IOI) is sent to conduct an in-person interview with the applicant. Upon completion

[36] Specifically, Type 3 licenses are issued to individuals who are buying firearms that are considered to be "of special interest to collectors by reason of some quality other than is associated with firearms intended for sporting use or as offensive or defensive weapons." To qualify as a Curio or Relic (C&R) firearm, one of three qualifications must be met: i) the firearm must have been manufactured 50 years from the current date, ii) the firearm must have been certified as a C&R by the curator of a museum which exhibits firearms, or iii) derive a substantial portion of its monetary value from its novelty, rarity, or relationship to some historical event.

[37] The ATF did send data from 2001 but was unable to locate any data from 2002. We do not use the 2001 data because it was not as detailed as what was provided in the other years.

[38] The data provided online does not include any information relating to the Type 3 licensees.

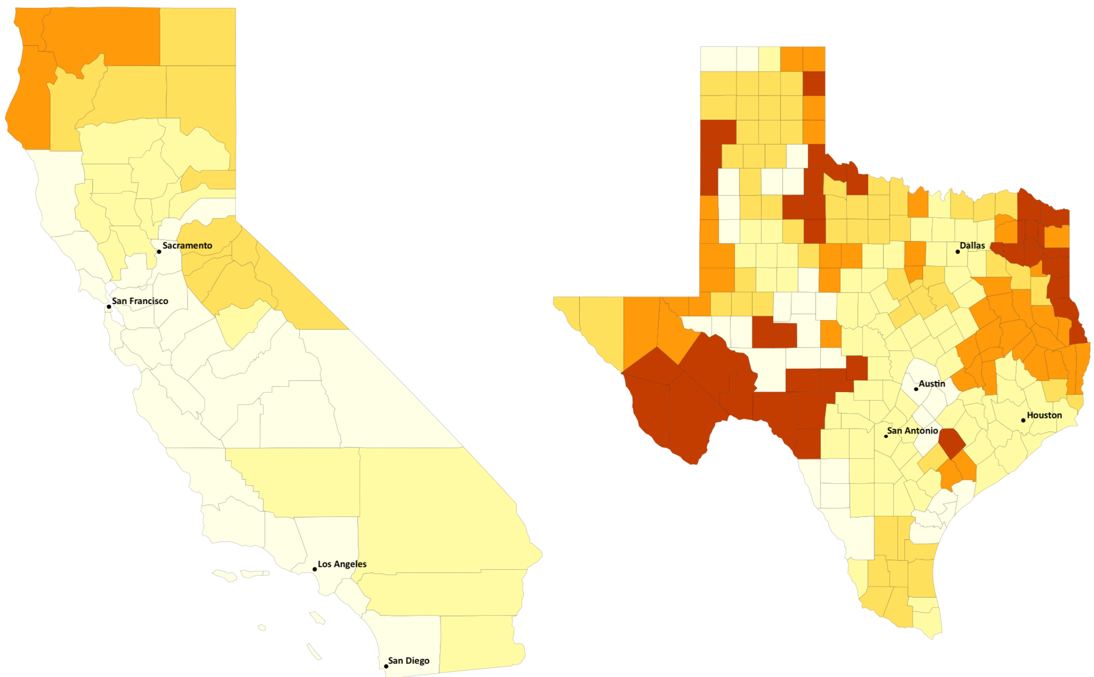
[39] The numerical digit in the fifth section gives the expiration year while the letter corresponds to the month. Because licenses are valid for 3 years, only a single digit is needed to determine if the FFL is expired.

[40] The ATF defines a responsible person as "a sole proprietor, partner, or anyone having the power to direct the management, policies, and practices of the business or activity as it pertains to firearms."

of the interview, the IOI makes a recommendation regarding the outcome of the application. The license is issued once the background check(s) have been completed and the applicant demonstrates that all business operations comply with state and local law.

A.2 Figure 3 but for the Percentage of Gun Suicides

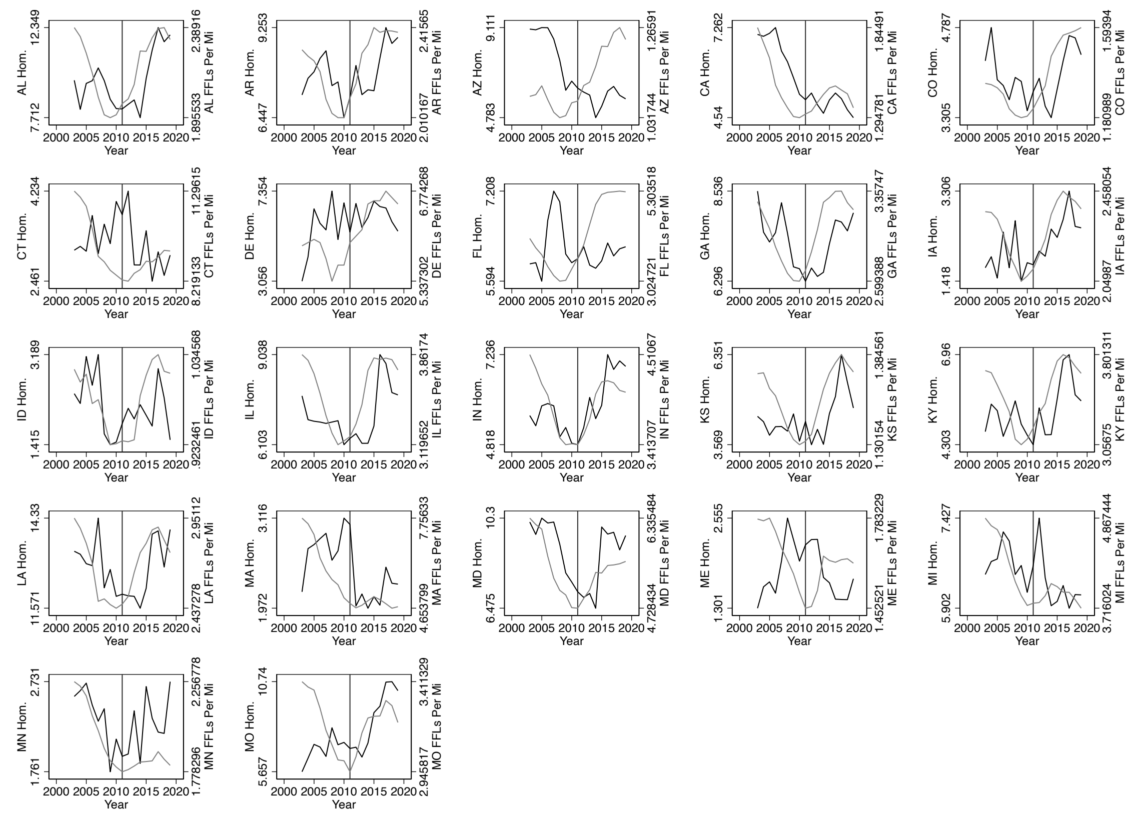
Figure A1: Within State Variation in Percent Gun Suicides (2003)



Notes: Darker regions represent a higher quintile of the percentage of gun suicides committed with a gun.

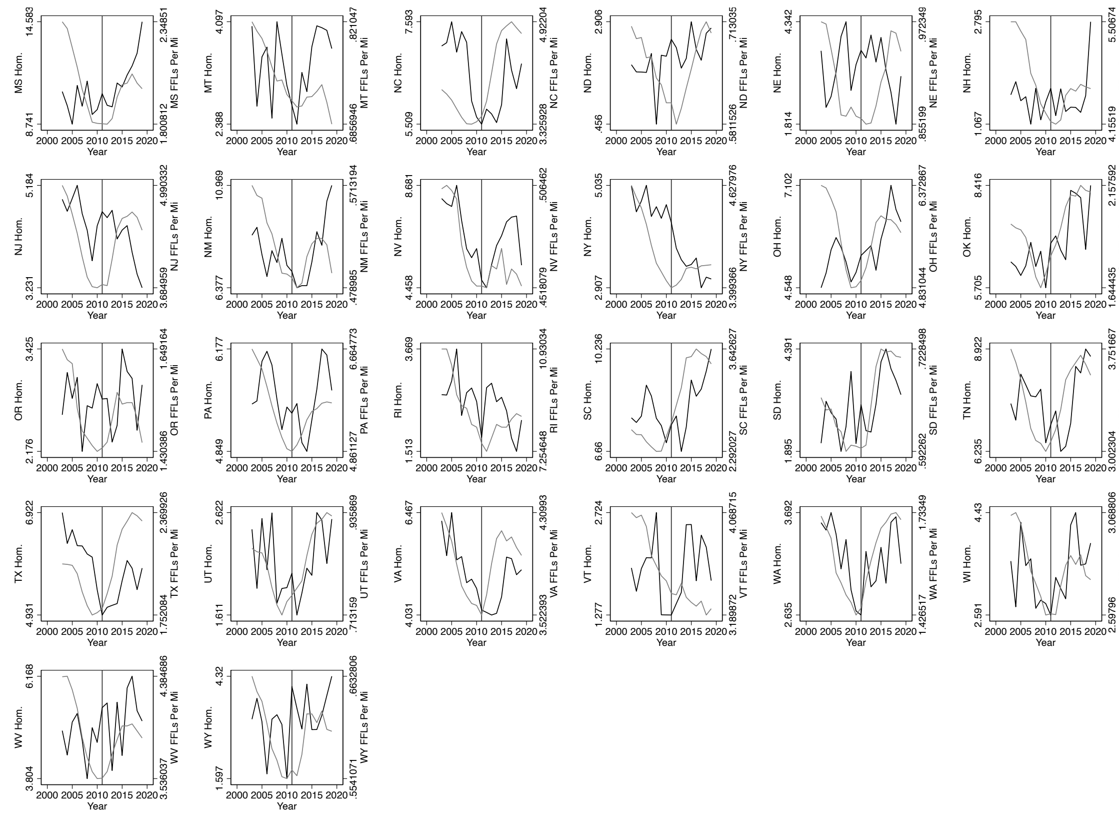
A.3 Gun Death Trends by US State

Figure A2: Homicide Rate and Gun Density by Year and State (AL - MO)



Notes: Homicide Rates (per 100 thousand people) and FFLs per 1,000 people by state and year. Solid line corresponds to a simple non-linear time trend. From top left to bottom right: Alabama, Arkansas, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Iowa, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, and Missouri.

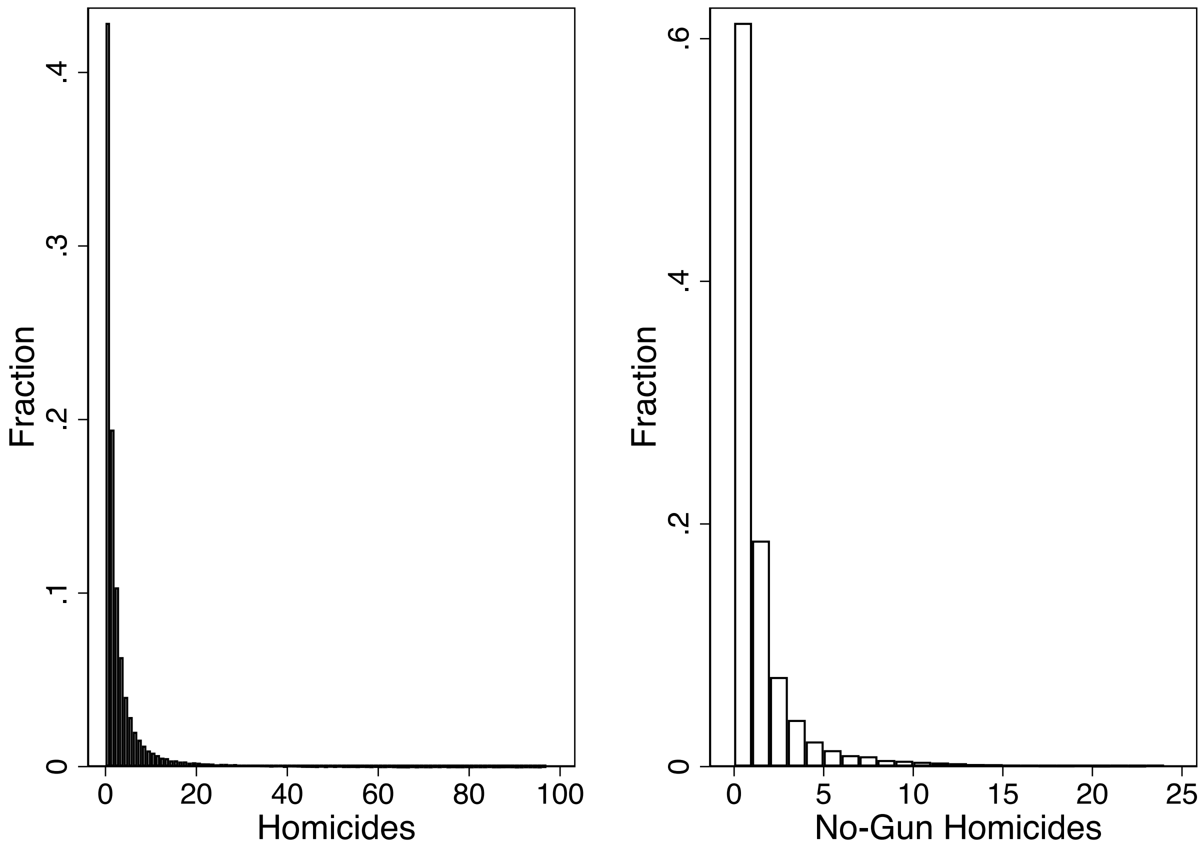
Figure A3: Homicide Rate and Gun Density by Year and State (MS - WY)



Notes: Homicide Rates (per 100 thousand people) and FFLs per 1,000 people people by state and year. Solid line corresponds to a simple non-linear time trend. From top left to bottom right: Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, New Mexico, Nevada, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Vermont, Washington, Wisconsin, West Virginia, and Wyoming.

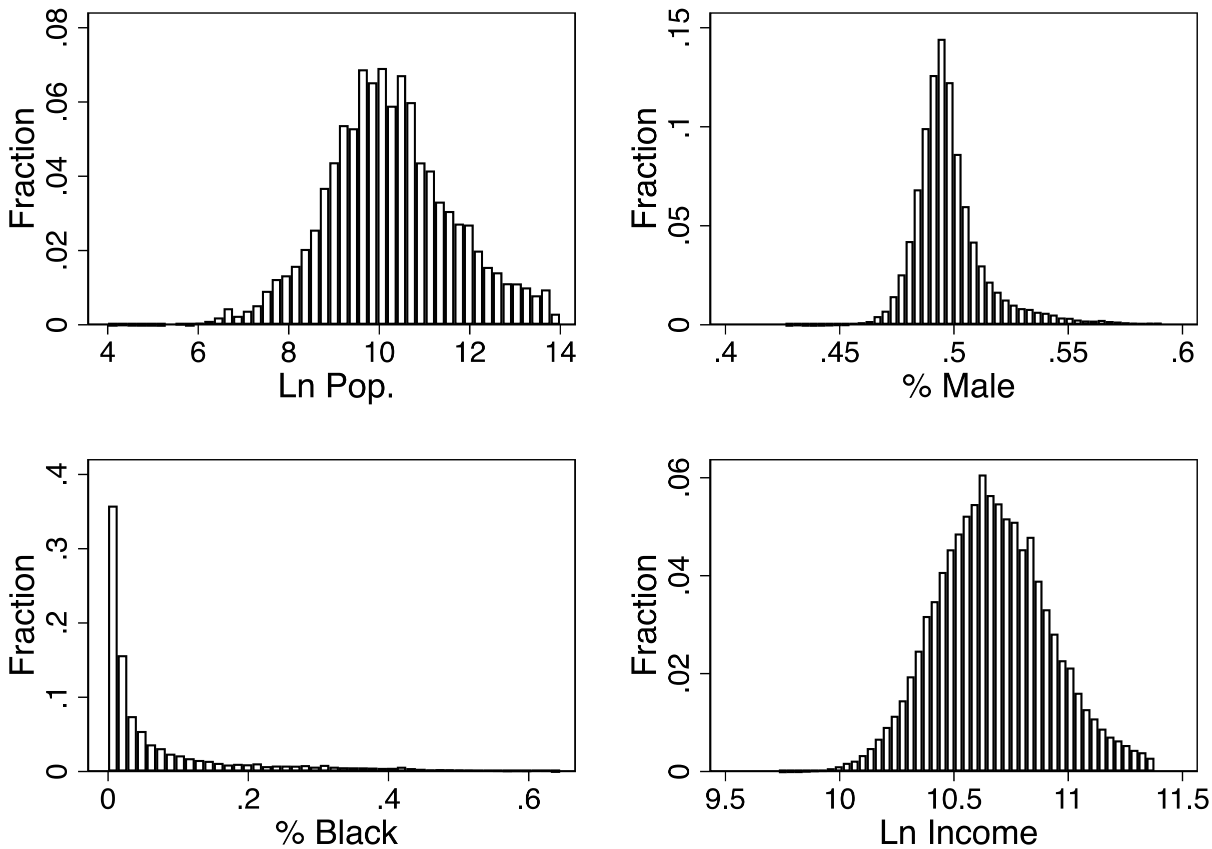
A.4 Histograms of Variables of Interest

Figure A4: Histograms of Deaths



Notes: Distribution of deaths per county per year. Left-hand panel: Homicides; Right-hand panel: homicides not involving a firearm. Both figures use data compiled by the CDC.

Figure A5: Histograms of Explanatory Variables



Notes: Distribution of the explanatory variables. From top left to bottom right: i) natural log of county population, ii) percentage of the population identifying as male, iii) percent of the county population identifying as Black, and iv) the natural log of median county income.

A.5 Results Estimating Total Homicides

Table A2: The Effect of Guns Density on Total Homicides

	Fixed Effects Poisson					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.023	0.044***	0.021***	-0.054	0.14***	0.040***
	(0.019)	(0.0093)	(0.0029)	(0.056)	(0.019)	(0.0094)
% Male	-3.20	-3.31	-1.93	-3.22	-1.48	-2.91
	(2.34)	(2.31)	(2.21)	(2.34)	(2.32)	(2.14)
% Black	4.72**	4.16**	5.60***	4.71**	4.32**	4.69***
	(2.06)	(1.74)	(1.80)	(2.06)	(1.76)	(1.54)
Ln Income	0.70***	0.65***	0.53***	0.70***	0.58***	0.54***
	(0.093)	(0.079)	(0.079)	(0.093)	(0.077)	(0.079)
Ln Pop.	-1.15***	-0.96***	-1.16***	-1.15***	-0.87***	-1.09***
	(0.26)	(0.21)	(0.21)	(0.26)	(0.18)	(0.21)
Pse. R^2	0.89	0.89	0.89	0.89	0.89	0.89
LL	-62495.9	-66840.1	-66744.2	-62487.6	-66779.3	-66770.7
Counties	2900	2908	2908	2899	2908	2908
Observations	43500	46528	46528	43470	46528	46528

	Linear Fixed Effects					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.0081	0.00044	0.0089***	-0.022	0.017***	0.021***
	(0.0075)	(0.0011)	(0.0017)	(0.023)	(0.0059)	(0.0038)
Ln Pop.	-0.48***	-0.42***	-0.39***	-0.48***	-0.34**	-0.34***
	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
% Male	0.27	-0.31	-0.33	0.32	-0.23	-0.34
	(0.90)	(0.89)	(0.89)	(0.90)	(0.88)	(0.89)
% Black	1.44	0.71	0.77	1.41	0.57	0.71
	(1.04)	(0.95)	(0.95)	(1.05)	(0.95)	(0.95)
Ln Income	0.22***	0.20***	0.19***	0.22***	0.19***	0.18***
	(0.039)	(0.038)	(0.039)	(0.039)	(0.038)	(0.039)
R^2	0.34	0.34	0.34	0.35	0.34	0.34
LL	-15712.7	-17008.0	-17001.6	-15665.3	-17001.0	-16998.7
Counties	3071	3071	3071	3071	3071	3071
Observations	46065	49136	49136	46025	49136	49136

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 1,00 square miles (halo). Top panel estimated is a fixed effect Poisson regression, and the bottom panel estimated linear fixed effects regression. The dependent variable is the inverse hyperbolic sine of the homicide rate in the bottom panel. Poisson estimates use homicides counts. All models include county-specific linear time trends and county-fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.6 Results using OLS and Anderson-Hsaio

Table A3: The Effect of Guns Density on Gun Homicides (OLS)

	Gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.0020	0.0014	0.0074***	-0.0079	0.018***	0.020***
	(0.0061)	(0.0011)	(0.0019)	(0.018)	(0.0047)	(0.0034)
Ln Pop.	-0.44***	-0.41***	-0.40***	-0.44***	-0.34***	-0.36***
	(0.10)	(0.093)	(0.093)	(0.10)	(0.097)	(0.095)
% Male	-0.25	-0.57	-0.60	-0.18	-0.50	-0.61
	(0.68)	(0.70)	(0.70)	(0.68)	(0.69)	(0.69)
% Black	1.01	0.67	0.71	1.00	0.52	0.66
	(0.90)	(0.83)	(0.83)	(0.90)	(0.83)	(0.83)
Ln Income	0.17***	0.16***	0.14***	0.17***	0.15***	0.13***
	(0.033)	(0.032)	(0.032)	(0.033)	(0.032)	(0.033)
R^2	0.36	0.35	0.35	0.36	0.35	0.35
LL	-6946.2	-7601.0	-7595.5	-6899.8	-7590.9	-7589.9
Counties	3071	3071	3071	3071	3071	3071
Observations	46065	49136	49136	46025	49136	49136
	Non-Gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.0071	-0.00089	0.0026*	-0.015	0.0015	0.0033
	(0.0050)	(0.00089)	(0.0015)	(0.017)	(0.0040)	(0.0024)
Ln Pop.	-0.12	-0.071	-0.053	-0.12	-0.054	-0.050
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
% Male	0.41	0.14	0.13	0.39	0.15	0.14
	(0.58)	(0.56)	(0.56)	(0.58)	(0.56)	(0.56)
% Black	0.76	0.31	0.33	0.74	0.30	0.31
	(0.71)	(0.67)	(0.67)	(0.71)	(0.67)	(0.67)
Ln Income	0.081***	0.078***	0.074***	0.081***	0.077***	0.074***
	(0.027)	(0.026)	(0.027)	(0.027)	(0.027)	(0.027)
R^2	0.12	0.12	0.12	0.11	0.12	0.12
LL	2010.9	1698.0	1698.5	2014.4	1697.5	1697.9
Counties	3071	3071	3071	3071	3071	3071
Observations	46065	49136	49136	46025	49136	49136

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 1,00 square miles (halo). Dependent variable is the inverse hyperbolic sine of the homicide rate. All models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

Crimes, like homicide, can be very persistent across time. If past homicides are correlated with future homicides and gun prevalence, our results may be biased. We control for this bias with the Anderson-Hsaio first-difference dynamic panel data method. This involves using the first difference estimator and including a lag of the dependent variable while instrumenting for that lagged difference with further lags of the dependent variable to avoid endogeneity. We found virtually no difference in coefficients (or statistical significance) between the standard linear model and the Anderson-Hsiao dynamic model (0.020 vs. 0.018) which suggests that autocorrelation in the error is not biasing our results.

Table A4: The Effect of Guns Density on Gun Homicides (Anderson-Hsaio)

	Gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	0.0031	0.0015	0.0058**	-0.0011	0.0055	0.018***
	(0.0070)	(0.0013)	(0.0026)	(0.020)	(0.0081)	(0.0065)
Ln Pop.	-0.25	-0.26*	-0.26	-0.26	-0.25	-0.25
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
% Male	0.61	0.59	0.62	0.60	0.61	0.61
	(0.83)	(0.83)	(0.83)	(0.84)	(0.83)	(0.83)
% Black	1.16	1.17	1.17	1.19	1.15	1.17
	(1.16)	(1.16)	(1.16)	(1.16)	(1.16)	(1.16)
Ln Income	0.017	0.018	0.017	0.019	0.017	0.016
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
LD.Hom.	-0.0038	-0.0041	-0.0040	-0.0038	-0.0040	-0.0040
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
R^2	0.0037	0.0039	0.0039	0.0037	0.0038	0.0039
LL	-24350.5	-24345.2	-24346.4	-24256.3	-24347.5	-24345.4
Counties	3071	3071	3071	3071	3071	3071
Observations	42994	42994	42994	42915	42994	42994

	Non-gun Homicides					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.0069	-0.00078	0.0057*	-0.010	0.00039	0.0066
	(0.0055)	(0.0012)	(0.0030)	(0.018)	(0.0071)	(0.0046)
Ln Pop.	-0.18	-0.18	-0.19	-0.19	-0.18	-0.18
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
% Male	0.38	0.38	0.39	0.41	0.38	0.38
	(0.77)	(0.77)	(0.77)	(0.78)	(0.77)	(0.77)
% Black	0.15	0.14	0.15	0.14	0.15	0.15
	(0.82)	(0.82)	(0.82)	(0.82)	(0.82)	(0.82)
Ln Income	0.052	0.051	0.051	0.053	0.051	0.051
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
LD.Hom. (NG)	-0.011	-0.011	-0.011	-0.011	-0.011	-0.011
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
R^2	0.011	0.011	0.011	0.011	0.011	0.011
LL	-15775.8	-15780.0	-15776.8	-15744.5	-15779.3	-15778.4
Counties	3071	3071	3071	3071	3071	3071
Observations	42994	42994	42994	42915	42994	42994

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 1,00 square miles (halo). Dependent variable in each of the models is the inverse hyperbolic sine of the homicide rate. All models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.7 Results using FBI Crime Report Data

As a robustness check, we explore how estimates using CDC data compare to estimates using FBI data. To make the FBI and CDC data more comparable, we collapse the five boroughs of New York (Bronx, Brooklyn, Manhattan, Queens and Staten Island) into one "New York" county, Broomfield county Colorado is combined with Boulder county, and the independent cities of Virginia are combined with their nearest neighbor. All county adjacencies were adjusted to account for these changes. We also drop observations where the entry was possibly an error (i.e., a difference of more than 3 standard deviations from the county's mean). Estimates with these counties included results in no notable difference (though the correlation between the CDC and FBI homicide counts falls slightly, roughly .94). Summary statistics for the new variables of interest are found in Table A5. Crime data comes from the FBI Crime Data API.[41] This data is reported by local law enforcement agencies using the Summary Reporting System (SRS), or the National Incident Based Reporting System (NIBRS) and was accessed using the FBI's public API. County crime rates are identified using Originating Agency Identifier (ORI) of the reporting agency, which is matched to a county using the 2012 Law Enforcement Agency Crosswalk. As previously discussed, the crime data is of lower quality than the CDC data for two main reasons: i) law enforcement agencies voluntarily report their crime data, and ii) the location of the crime is based on the address of the law enforcement agency reporting, which could lead to accounting issues for agencies covering large areas (e.g., state-wide or multiple counties). These two bugs lead to an inconsistent number of law enforcement agencies reporting each year within a given county. We are not the first to highlight these types of problems and emphasize that results discussed using the FBI data should be taken only as a robustness check of our main result.

Table A5: Summary Statistics (FBI)

	Mean	Std. Dev.	Min	Max
Homicide (FBI)	5.76	28.8	0	1069
Officers Per Capita	0.0020	0.00089	0	0.011
% Reporting	0.82	0.22	0.0071	1
Observations	45488			

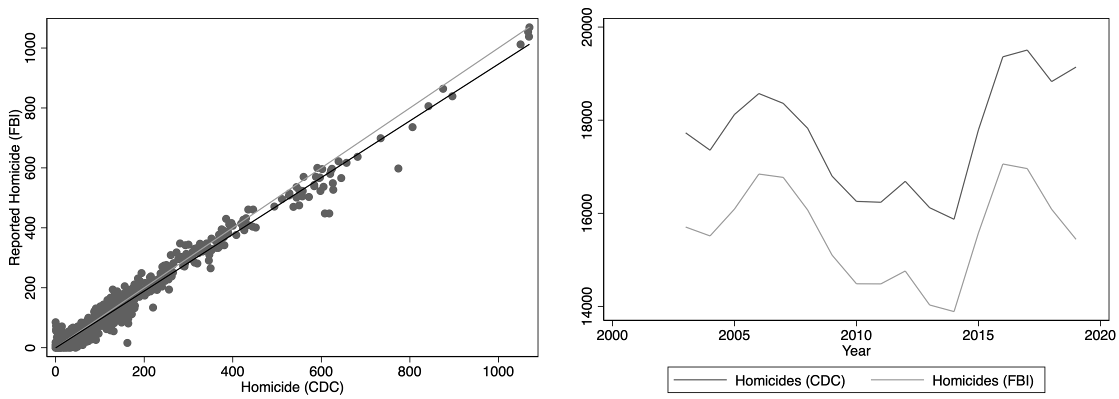
Notes: Summary statistics from 2003-2019. All variables come from the FBI and are based off of voluntary reports from local law enforcement agencies.

Despite potential problems, the county-collapsed local law enforcement homicide data is very similar to the CDC homicide counts. The overall correlation between the *county* homicide counts from 2003 to 2019 collected by the CDC and its FBI's counterpart is 0.991. To give an idea of how similar the two data sources are, a scatter plot depicting the correlation between the CDC's homicide count against the FBI's along with a 45° line (gray) and a simple estimated linear regression (black) is presented in Figure A6 (left panel). Overall 1,933 county years are missing over the 17-year FBI panel or roughly 113 counties per year. Many of these missing observations are likely zeros. Of the 1,933 observations missing in the FBI data, 1,264 had no reported homicides by the CDC. We also present the number of homicides by year, measured by the CDC and FBI, in the right-hand panel of Figure A6. Overall, they match up fairly well but, in more recent years, there is a dramatic drop in homicides reported by the FBI data. This drop is not present in the CDC data.

Table A6 contains estimates of the effect of gun density on homicide using the homicide rate as measured by FBI. Table A6 presents 12 regression results varying by the measure of gun density

[41] Available online at https://crime-data-explorer.app.cloud.gov/api (last accessed August 1, 2021).

Figure A6: FBI and CDC Homicide Counts



Notes: (Left) Scatter plot of county homicides measured by the Centers of Disease Control from 2003 to 2019 versus the number of reported homicides by local law enforcement agencies collapsed to the county-level. Gray line indicates the 45 degree line (or 1 to 1 matching); black line is the fitted regression line. (Right) Total number of homicides in the United States from 2003 - 2019 from the FBI (black Line) and CDC (gray line).

and estimator (linear fixed effects and fixed effects poisson). The primary difference between these estimates and those presented in the previous section is that we include variables that control for the number of police officers per capita (Off. Per Cap), the percent of the agencies that report to the FBI (% Report), and the interaction of the percent of the agencies that report and the natural log of the county's population (% Rep. X Ln Pop).

The relationship between gun dealer density and homicides using FBI data is similar to that found when using CDC data; however, the estimated coefficients are slightly smaller across all estimation methods. For our preferred gun density measure, FFL PM(H), a one-unit increase in FFLs per 100 square miles is associated with a 1.6 percent increase in the homicide rate (3.1 percent when using the poisson estimator). This could be due to attenuation bias from the known measurement error in the FBI data, but the ultimate source of the difference in magnitude is unclear.[42] Like the results presented in Table 3, the coefficients on %GS and %GS(H) are in the opposite direction than we would expect.

Table A7 shows the association between our gun density measure—specifically the number of FFLs in a county and the surrounding county halo divided by the total land area of these counties in hundreds of squared miles—and other categories of crime. The top panel shows results for all law enforcement agencies (LEAs) that report to the FBI, and the bottom panel shows results for only those LEAs that report every month. These results broadly show that an increase in gun density increases aggravated assaults and aggravated assaults using a gun. Interestingly, gun density is *negatively* associated with other categories of crime, like burglary, theft, arson, and robbery. This could be because a high percentage of resident gun owners may deter would-be criminals from committing property crime.

We caution against considering these results causal, however. There is a persistent autocorrelation in the error term of these regressions—that is correlated with gun density—that is not present in the homicide regressions. That is, these models appear to have a dynamic component to them. Attempting to remedy this issue with dynamic panel data methods, such as the Anderson-Hsaio dynamic panel estimation method, did not alleviate the serial correlation problem, which could

[42]We note that the difference in magnitude is not due to the inclusion of the additional regressors, police officers per capita and the number of reporting agencies. The coefficients are nearly identical when these variables are removed from the regressions.

Table A6: Guns Density and FBI-Measured Homicide Rates

	Linear Fixed Effects					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.017**	-0.0015	0.0050**	-0.036	0.0038	0.016***
	(0.0074)	(0.0023)	(0.0021)	(0.023)	(0.0057)	(0.0038)
Ln Pop.	-0.29**	-0.25*	-0.21	-0.29**	-0.21	-0.16
	(0.14)	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)
% Male	1.38	0.82	0.79	1.41*	0.83	0.76
	(0.84)	(0.77)	(0.77)	(0.85)	(0.77)	(0.78)
% Black	1.51	1.04	1.08	1.53	1.01	1.05
	(0.97)	(0.86)	(0.86)	(0.97)	(0.86)	(0.86)
Ln Income	0.071**	0.078**	0.068*	0.070*	0.074**	0.053
	(0.036)	(0.035)	(0.035)	(0.036)	(0.035)	(0.036)
Officers Per Capita	1.07	3.24	4.07	0.95	3.89	5.20
	(6.69)	(6.50)	(6.52)	(6.69)	(6.56)	(6.52)
% Reporting	0.27*	0.32**	0.31**	0.28*	0.32**	0.30**
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
% Rep. X Ln(Pop)	-0.013	-0.018	-0.018	-0.014	-0.018	-0.016
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
R^2	0.39	0.39	0.39	0.39	0.39	0.39
LL	-5968.3	-6646.7	-6644.2	-5972.4	-6646.7	-6639.3
Counties	2760	2764	2764	2760	2764	2764
Observations	39402	42106	42106	39390	42106	42106

	Fixed Effects Poisson					
	%GS	FFL PC	FFL PM	%GS(H)	FFL PC(H)	FFL PM(H)
Gun Dens.	-0.053*	0.034**	0.018***	-0.089	0.11***	0.031***
	(0.028)	(0.014)	(0.0038)	(0.078)	(0.026)	(0.011)
% Male	5.44	5.31	7.86*	5.44	7.01	6.34
	(4.91)	(4.23)	(4.34)	(4.90)	(4.28)	(4.18)
% Black	-0.50	0.74	1.23	-0.47	1.24	0.53
	(4.59)	(3.52)	(3.83)	(4.58)	(3.68)	(3.56)
Ln Income	0.62***	0.61***	0.51***	0.62***	0.55***	0.53***
	(0.11)	(0.092)	(0.091)	(0.11)	(0.088)	(0.089)
Officers Per Capita	-41.1***	-36.2**	-26.3*	-41.4***	-26.9*	-31.6**
	(15.9)	(15.1)	(14.6)	(15.9)	(14.4)	(15.2)
% Reporting	2.15***	2.16***	2.08***	2.15***	2.15***	1.90***
	(0.38)	(0.39)	(0.43)	(0.38)	(0.40)	(0.46)
% Rep. X Ln(Pop)	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***	-0.13***
	(0.031)	(0.032)	(0.035)	(0.030)	(0.032)	(0.038)
Pse. R^2	0.89	0.89	0.89	0.89	0.89	0.89
LL	-53131.9	-56832.1	-56766.5	-53132.2	-56799.7	-56792.9
Counties	2474	2484	2484	2474	2484	2484
Observations	35961	38511	38511	35952	38511	38511

Notes: Each column corresponds to a different measure of gun density. From left to right: percent of gun suicides as a share of total suicides, FFLs per 1000 county residents, FFLs per 100 square miles, percent of gun suicides in the local area over the total suicides in the local area (halo), FFLs in the local area per 1,000 local area residents (halo), and FFLs in the local area per 100 square miles (halo). Top panel estimated with linear fixed effects regression, and bottom panel estimated with fixed effect Poisson. Dependent variable is the inverse hyperbolic sine of the homicide rate in the top panel, and Poisson estimates use homicides counts. All models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

mean that these coefficient estimates are biased. It is unclear whether this persistent correlation is due to national trends in crimes that we have failed to model appropriately or trends in reporting errors or lack of reporting that are common across many LEAs. In light of this, we consider this results to be suggestive, at best, and leave the exercise of finding more plausibly causal estimates for future work.

Table A7: Gun Dealer Density and Other Crimes

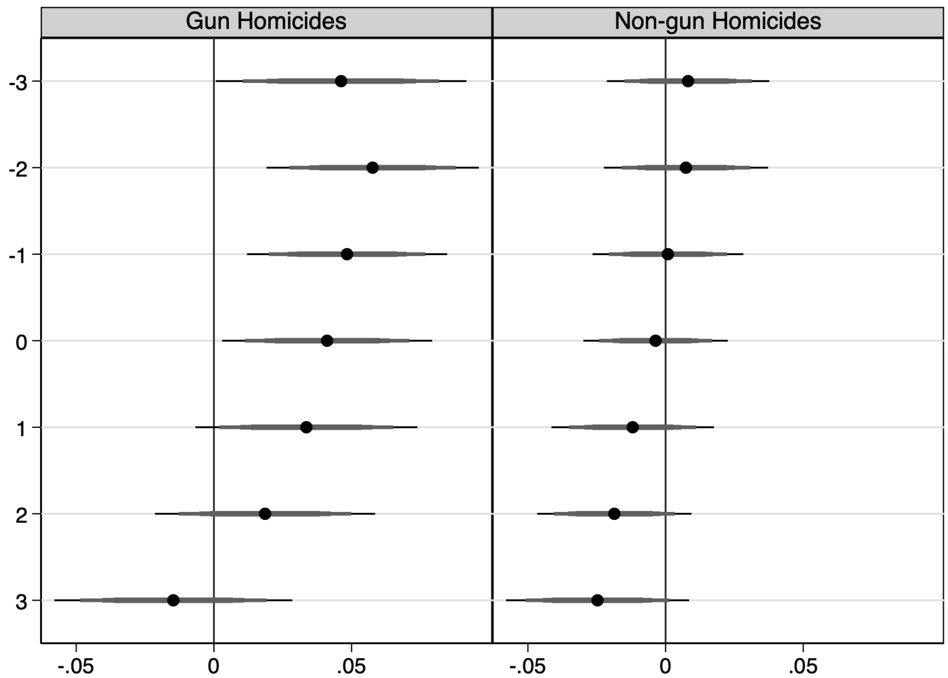
	Fixed Effects Poisson (All LEAs)						
	Burglary	Theft	Arson	A. Assault	Robbery	Robbery (w/G)	Assault (w/G)
Gun Dens.	-0.15***	-0.034***	-0.055***	0.013	-0.052***	-0.076***	0.052***
	(0.012)	(0.0057)	(0.014)	(0.0080)	(0.011)	(0.020)	(0.016)
% Male	7.55**	3.49**	4.18	2.39	4.70	10.4	2.07
	(3.74)	(1.73)	(4.53)	(2.12)	(4.27)	(7.61)	(4.01)
% Black	4.73*	2.07*	9.41***	5.93***	5.61**	3.75	6.50***
	(2.55)	(1.06)	(2.97)	(1.36)	(2.48)	(3.53)	(2.45)
Ln Income	-0.56***	-0.11**	0.38**	0.42***	0.57***	0.63***	0.65***
	(0.062)	(0.048)	(0.19)	(0.073)	(0.12)	(0.20)	(0.13)
Ln Pop.	0.24	-0.098	1.69**	-0.60**	-0.14	0.48	-1.13***
	(0.67)	(0.17)	(0.75)	(0.28)	(0.33)	(0.79)	(0.42)
Pse. R^2	0.99	0.99	0.92	0.98	0.99	0.98	0.97
LL	-621366.4	-1134090.9	-127396.8	-358518.0	-160928.9	-133415.6	-176928.9
Counties	3059	3061	2952	3051	2891	2607	2880
Observations	48944	48976	47232	48816	46256	41712	46080

	Fixed Effects Poisson (Fully Reporting)						
	Burglary	Theft	Arson	A. Assault	Robbery	Robbery (w/G)	Assault (w/G)
Gun Dens.	-0.13***	-0.019***	-0.030*	0.024***	-0.043***	-0.073***	0.057***
	(0.010)	(0.0039)	(0.017)	(0.0090)	(0.011)	(0.023)	(0.017)
% Male	3.10	3.62*	5.51	2.38	3.38	4.52	1.59
	(3.20)	(1.98)	(4.75)	(2.77)	(5.48)	(8.37)	(5.19)
% Black	8.31***	1.21	7.67**	5.13***	6.24*	5.81	4.41
	(1.77)	(1.32)	(3.59)	(1.76)	(3.27)	(3.96)	(3.00)
Ln Income	-0.57***	-0.054	0.54***	0.43***	0.63***	0.74***	0.68***
	(0.065)	(0.054)	(0.20)	(0.087)	(0.13)	(0.21)	(0.14)
Ln Pop.	0.82***	-0.73***	-0.69	-0.84**	-0.14	2.00	-0.91
	(0.32)	(0.26)	(0.68)	(0.37)	(0.49)	(1.29)	(0.90)
Pse. R^2	0.99	1.00	0.93	0.99	0.99	0.98	0.97
LL	-329545.0	-569775.3	-83088.7	-212521.3	-108197.0	-101174.2	-126973.0
Counties	2020	2020	1992	2020	1961	1832	1993
Observations	32320	32320	31872	32320	31376	29312	31888

Notes: Each model is estimated with fixed effect Poisson regression with county crime counts as the dependent variable. The dependent variable for each set of results is indicated by the column title. All models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.8 Robustness Check: Different Leads and Lags of Gun Density

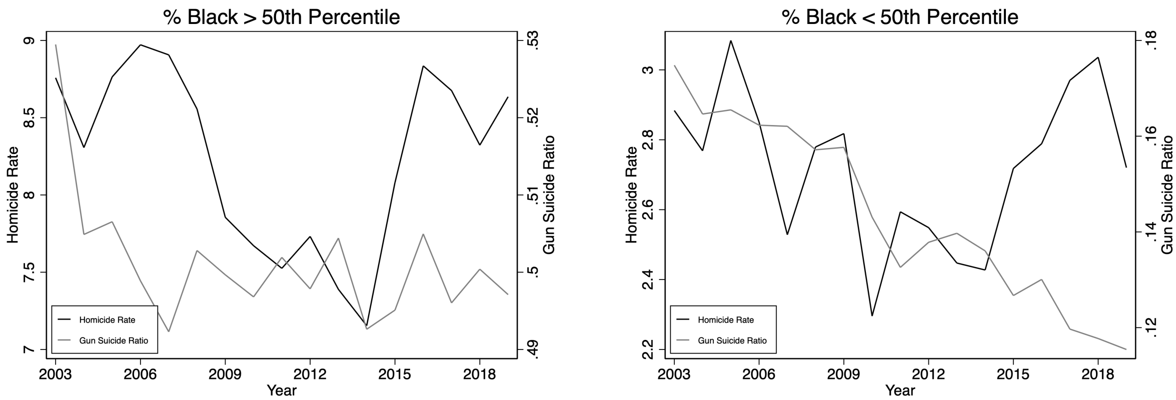
Figure A7: Different Lags and Leads of Gun Density



Notes: Estimates of Equation 3 using various lags and leads of our preferred measure of gun density FFLs PM(H). Other variables included in each of these models: the natural log of the county's population, the percent of the county identifying as male, the percent of the county identifying as Black, and the natural log of the county's median income. Error bars show 90, 95, 99, and 99.9 percent confidence levels.

A.9 Gun Prevalence as Measured by the Percent of Suicides Committed with a Gun

Figure A8: Gun Density (using GS/TS) and Homicide



Notes: Total homicides and Gun Dealers in highly Black communities (left) and communities with percentage of Black residents below the median (right).

A.10 Interaction Coefficients from Figure 6

Table A8: Gun Dealer Density and County Characteristics

	Homicides			Non-Gun Homicides		
	% Black>75^{th}	% Black<25^{th}	Interactions	% Black>75^{th}	% Black<25^{th}	Interactions
Ln. Pop.	-1.80***	-0.89	-1.80***	-0.86***	0.73	-0.63***
	(-4.53)	(-0.57)	(-4.54)	(-2.88)	(0.45)	(-2.82)
% Male	-14.4***	11.1	-9.49**	0.56	-10.9	7.07**
	(-4.56)	(0.93)	(-2.47)	(0.15)	(-1.00)	(2.09)
% Black	8.14***	-20.8	8.76***	3.19*	-16.4	2.93*
	(3.51)	(-0.94)	(4.21)	(1.84)	(-1.00)	(1.72)
Ln Income	0.90***	-0.062	0.90***	0.45***	0.52	0.38***
	(7.91)	(-0.17)	(5.24)	(4.45)	(1.26)	(3.46)
FFL PM (H)	0.050***	0.022	0.051*	0.0088	-0.24***	-0.018
	(4.21)	(0.24)	(1.72)	(0.97)	(-2.89)	(-0.69)
FFL PM (H) X Ln. Pop.			-0.0044			0.0027
			(-0.56)			(0.31)
FFL PM (H) X % Male			0.80			-1.50**
			(0.80)			(-2.22)
FFL PM (H) X % Black			0.11			-0.0086
			(1.27)			(-0.18)
FFL PM (H) X Ln Income			-0.0020			-0.0021
			(-0.09)			(-0.12)
Pse. R^2	0.90	0.37	0.88	0.78	0.32	0.74
LL	-24993.7	-6571.6	-59617.6	-17529.7	-5418.8	-47044.7
Counties	770	605	2799	754	578	2740
Observations	13090	10284	47582	12818	9825	46579

Notes: Estimated relationship between gun dealer density and Homicides (left three columns) and Non-Gun Homicides (right three columns). All models are fixed effects Poisson regressions and include county-specific linear time trends, county fixed effects, and have standard errors clustered at the county level. Columns one and four use the sample of counties that have a proportion of Black residents in the top quartile; columns two and five use the sample of counties in the bottom quartile. Columns three and six use the full sample but include the interaction of gun dealer density and county characteristics. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.11 Using Multiple Gun Density Measures

Table A9: Gun Dealer Density and %Gun Suicides on Gun Homicides

	Gun Homicides	
	Regular	Halo
ln(FFLs Per Mile)	0.25^{***}	0.47^{***}
	(0.045)	(0.069)
ln(% Gun Suic.)	-0.0085	-0.043
	(0.017)	(0.042)
Ln Pop.	-0.97^{**}	-0.93^{**}
	(0.46)	(0.43)
% Male	-6.16^{*}	-4.93^{*}
	(3.55)	(2.99)
% Black	10.4^{***}	9.95^{***}
	(2.88)	(2.47)
Ln Income	0.94^{***}	0.85^{***}
	(0.11)	(0.10)
Pse. R^2	0.88	0.88
LL	-51605.8	-55987.7
Counties	2603	2788
Observations	36586	44538

Notes: Both models are estimated with fixed effect Poisson regression with county gun homicide counts as the dependent variable. The left column shows both FFLs per mile and the percentage of gun suicides jointly serving as the gun proxy. The column on the right uses the halo measures of FFLs per mile and percentage of gun suicides. Both models include county-specific linear time trends and county fixed effects and have standard errors clustered at the county level. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.12 Business Establishments per Mile

Table A10: Gun Dealer Density and Business Establishments per Mile

	Homicides			Non-Gun Homicides		
	Linear FE	A-H	Poisson FE	Linear FE	A-H	Poisson FE
Business Density	0.000064	0.000016	-0.00020***	-0.000010	-0.0000074	-0.000055*
	(1.64)	(0.50)	(-5.01)	(-0.54)	(-0.42)	(-1.67)
% Male	-0.38	0.24	-8.38***	0.33	0.22	3.64
	(-0.90)	(0.50)	(-2.60)	(0.95)	(0.50)	(1.25)
% Black	1.16	1.33	10.3***	1.12*	0.38	5.46***
	(1.38)	(1.14)	(4.12)	(1.72)	(0.48)	(2.76)
Ln Income	0.23***	0.013	1.19***	0.084***	0.045	0.36***
	(7.17)	(0.31)	(10.64)	(3.33)	(1.31)	(4.43)
Ln Pop.	-0.53***	-0.28*	-2.03***	-0.10	-0.19	-0.84***
	(-5.32)	(-1.89)	(-4.13)	(-1.12)	(-1.59)	(-2.81)
Observations	49135	46064	44639	49135	46064	43631

Notes: Estimated relationship between business establishment density and Homicides (left three columns) and Non-Gun Homicides (right three columns). Columns correspond to the estimation method: linear fixed effects with IHS transformed dependent variables, Anderson-Hsaio dynamic estimator with IHS transformed dependent variables, and fixed effects poisson, respectively. Stars correspond to statistical significance: *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$.

A.13 Classifying FFLs by Name

Below are the classification keywords. To create the classifications, we first dropped all non-alphanumeric characters and spaces in the business name and capitalized each letter (e.g., Dick's was changed to DICKS). We then searched for the following strings. The strings we searched for were selected based on popularity. Future work will examine this in a more formal manner.

- **Outdoors**: CAMP, HUNT, OUTFIT, GAME, FISH, SUPPLY, OUTDOOR, SPORT.
- **Defense**: TACTICAL, DEFENSE, DOUBLETAP, LAWENFOR, GUARDIAN.
- **Big-box**: WALMART, BASS, SPORTSAU, CABELAS, DICKS, DUNHAMS, BIMART, BIG5, GANDER, ACEHARD, RURALKI, ATWOODS, KMART.
- **Gunsmith**: GUNSMITH, REPAIR.
- **Patriot**: 2A, SECONDA, AMERICAN, PATRIOT, 2ND, LIBERTY, HERITAGE, FREEDOM, EAGLE.
- **Name**: DAVE, BILL, BOB, RAY, JIM, JOHN, MIKE, STEVE, GARY, FRED, WILL, TOM, RICK, LARRY, JERRY, DON, RON, GREG, JOE, PAUL, TIM, FRANK, DAN, WAYNE, TERRY, PETE, RICHARD, MARK, LEES, KEN, JEFF, JACK, MITCHEL, MICHAEL, ROGER, SCOTT, THOMPSON, MARSHAL, GENE, GEORGE, EDSGUN, DOCS, DOUG, CHUCK, CHARLIE, ROBERT, ROBINSON, STEWART, RUSSELLS, RANDY.

A.14 Structural Break Tests

Table A11: Known Structural Break Test Results

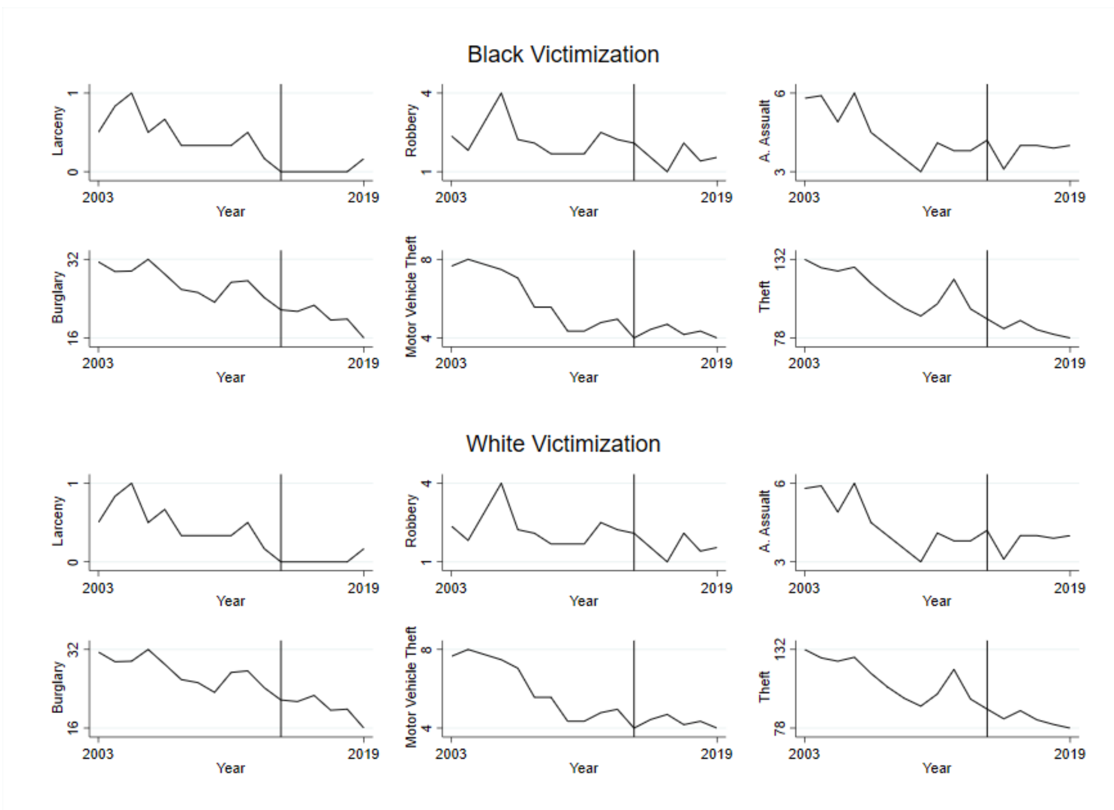
				% Black $< 25^{th}$ Percentile				
	A. Assualt	Arson	Burglary	Larcney	MVT	Robbery	Homic (FBI)	Homic (CDC)
2011	.175	.133	.056	.648	0	0	.366	.715
2012	.152	.269	.05	.156	.001	0	.33	.669
2013	.157	.001	0	0	.08	.002	.431	.669
2014	.069	.039	.047	.412	.157	.103	.536	.49
2015	0	.002	.608	.868	.127	.132	.735	.034
				% Black $> 75^{th}$ Percentile				
	A. Assualt	Arson	Burglary	Larcney	MVT	Robbery	Homic (FBI)	Homic (CDC)
2011	0	.665	.012	.389	.14	.723	.583	.89
2012	0	.973	0	.424	.187	.669	.39	.476
2013	.083	.515	0	.185	.033	.67	.601	.759
2014	.079	.85	.001	.416	.077	.602	.336	.394
2015	.078	.963	.001	.613	.07	.652	0	0

Notes: Structural Break tests results (p-values). Null hypothesis is that there is no structural break in year 2011, 2012,..., 2015. All models use county collapsed crime data that is further collapsed by year and county "type". Counties with incomplete observations are dropped. Type depends on the percent of the county that identifies as Black (top and bottom quartile). Estimates all use the same specification ($E[y_t] = \beta_0 + \beta_1 y_{t-1}$) where y is one of the eight crime rates ($N = 17$).

A.15 Victimization Survey Data

As a final point in support of guns being a primary cause of the increase in homicides and not a change in the propensity of Black Americans to call the police, we present some basic time trends in victimization reported by the National Crime Victimization Survey (NCVS).[43] The central idea here is that if the drop in crime was due to a decrease in the willingness of Black Americans to call the police (or report a crime) and crime was actually increasing in these communities, we should see crime victimization rates found using survey methods in the Black Community increase. A similar argument could be made for a decreased willingness of police to enforce the law. Instead, what we find is that, in general, crime victimization rates are falling or staying the same. This is shown in Figure A9. It is, however, important to note that, unlike crime rates, the survey results are not separated by Black and White communities but rather reported crime by Black and White Americans. As expected, reported victimization is greater than the crime rates reported by the FBI - with the exception of larceny, which is due to the separation of theft and larceny in the NCVS.

Figure A9: Crime Victimization Trends by Racial Demographics



Notes: Yearly crime victimization rates (per 1,000 people). Vertical line corresponds to 2014, the year of Michael Brown's death.

[43]Available online at `https://www.bjs.gov/index.cfm?ty=nvat` (last accessed September 25, 2021).