Guns, Germs, and Murders:

Firearms Increased Homicides after the COVID-19 Pandemic

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Abstract

In 2020, the US homicide rate increased by 30%, marking the largest one-year change in the country's history. We attribute this surge in homicides to the "arms' race" occurring at the onset of the COVID-19 pandemic, gun sales doubling in the two weeks following the National Emergency Acts of March 13, 2020, and reaching a peak in June. During the same period, the homicide rate increased by 51 percent – up from 4.5 per 100 thousand inhabitants in February to 6.8 in June – and remained on a similar level during the following years. Using daily data, we show that 80% of the increase took place before the murder of George Floyd (May 25) and the ensuing racial tensions. Estimates of dynamic panels and difference-in-differences between states with more vs. less restrictive gun control policies bolster the causal interpretation of the effect of the arms race on the rise in homicides.

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1 Introduction

In 2020, the homicide rate in the US increased by roughly 30%, the largest ever one-year increase in the country's history – at least, since when consistent data on homicides are available (Panel A of Figure 1). This is also the largest increase in homicides observed in the same year across all (large) countries in the World (Panel C of Figure 1). These diverging paths widened even further the gap in homicide rates between the US and other developed economies. In 2020, the US witnessed 7.5 homicides per 100,000 inhabitants (up from 5.8 in 2019) compared to, e.g,, 1.82 in Canada, 1.32 in France, 0.75 in Germany, and 0.47 in Italy (Panel D of Figure 1). [1]

Not surprisingly, the upsurge in homicides attracted considerable attention (see, e.g., Pew Research Center (2021); New York Times (2022)), but its causes remain unclear. 2020 was the first year of the Covid-19 pandemic, which in principle could have affected homicides through several mechanisms – for instance, soaring unemployment rates and worsening mental health – . However, most other countries that were equally (or more) affected by the pandemic did not experience a similar increase in homicides. Similarly, there was no abnormal increase in other types of crimes in the US. To explain this unprecedented increase in homicides, one must thus look for specific factors that triggered deadly violence in the US.

We attribute the increase in homicide rates in 2020 to the arms race that started immediately after the breakout of the pandemic and has been attributed to the high uncertainty that characterized the onset of the Covid-19 pandemic (CNN, 2020). In particular, daily data on background checks and Google searches (see Figure A.1 and Figure B.1 in the online appendix) show that firearm purchases soared immediately after President Trump enacted the State of Emergency for COVID-19 on March 13, 2020, and remained sustained over the following months. Overall, gun sales increased by an unprecedented 94% between March and June 2020 (compared to the same months in 2019). Following the arms race, the number of homicides rapidly started rising starting from May 2020, when the majority of US states started lifting stay-at-home orders leading to the infamous 30% increase in the homicide rate. Our estimates imply that the arms race that followed the Covid-19 pandemic can explain roughly 40% of the increase in the homicide rate.

We establish the causal effect of firearm sales on homicides using two different identification strategies. Firstly, we estimate dynamic panel data models on monthly data across US states for the period 2008-2022, where estimate the effect of the lag of firearm sales on contemporaneous homicide rates – after controlling for a battery of fixed effects and time-varying potential confounders –. Secondly, akin to Koenig & Schindler (2023) we estimate a difference-in-differences model where we compare homicide rates and firearm sales in states with and without a bundle of gun control policies that have been deemed to be effective in reducing

[1] The mortality data is based on information from all death certificates filed in the fifty states and the District of Columbia. This data excludes fatalities of nonresidents and fetal deaths. Each death certificate provides information on up to twenty contributing causes of death. For our analysis, we focus on all instances where "assault (homicide)" is mentioned as a cause of death. This category includes cases such as "assault by discharge of firearms" and "assault by other and unspecified means." Intentional self-harm (suicide) or accidental injuries are not factored into these statistics. When referring to cross-country statistics we refer to data produced by the United Nations Office for Drugs and Crime, which only counts intentional homicides when computing the homicide rate

violent crimes according to a systematic review conducted by RAND (2023). We complement our analysis with Granger causality tests for panel data (Juodis et al., 2021), which show that firearm sales strongly predict homicides but the contrary is not true.

In principle, our results could be driven by common factors affecting both firearm sales and the homicide rate. For example, if Americans bought more guns because of concerns about personal safety and subsequent tensions led to increased violence in the US, it could be argued that the firearms sold in 2020 were not directly responsible for the rise in homicides. We show that firearms bought in 2020 are much more likely to be found at crime scenes than firearms purchased before 2020. In particular, before 2020, *young* firearms were found at just over 10% of crime scenes. Starting in 2020, this figure more than doubles, with almost one-quarter of firearms found at crime scenes being *young* firearms.[2] Moreover, the National Shooting Sports Foundation reports that 40% of the guns purchased in 2020 were bought by first-time buyers, a fact that is also consistent with the hypothesis that more people with guns lead to more homicides.

Several papers in economics and the social sciences investigated crime patterns in the US during the Covid-19 pandemic. Abrams (2021) provides an overview of crime trends in the US before and after the Covid-19 pandemic. The author documents a decline in all types of crime, but homicide and non-residential burglaries using data from 25 large American cities. Some papers – mostly outside economics – focus on the determinants of the 2020 spike in homicides. The two main explanations for the murder spike in the US are: the *arm's race* that followed the beginning of the Covid-19 pandemic and the tensions between the police and the public that followed the murder of George Floyd. Schleimer et al. (2020) use data until July 2020 from the US and consider the association between excess firearms sales and firearm violence, finding that excess firearm purchases are associated with firearm injuries but only weakly associated with non-domestic firearm violence. Cassell (2020) documents a fall in proactive policing and an increase in homicides immediately after the murder of George Floyd for Minneapolis, Chicago, Philadelphia, Milwaukee and, to a lower extent, New York. Ang et al. (2021) provides evidence for a negative effect of the murder of George Floyd on public trust and cooperation with law enforcement. These papers either only analyze data fro a fraction of 2020, or only consider a small fraction of large American cities.

In this paper, we contribute to the literature about the murder spike in the US in 2020 by showing that the *arm's race* that followed the start of the Covid-19 pandemic was the main cause of the largest increase in murders in the US during the last century. We contribute to a long-standing debate on the causal effect of guns on homicides. On the one hand (J. R. Lott, 2013), in his influential and controversial book *More Guns, Less Crime* argues that more guns lead to less violent crime, as guns deter criminals to commit violent crimes. This hypothesis is supported by a strand of the literature that finds either no effect or mixed evidence for the hypothesis that tougher gun laws reduce homicides (eg. see (J. R. Lott Jr & Mustard, 1997; Manski & Pepper, 2018) for the effect or right-to-carry laws and (Duggan et al., 2011) for the regulation of gun shows) . On the other hand, Donohue et al. (2019) argues that right-to-carry laws actually increase violent crime,

[2]We define *young* firearms as those acquired within 7 months before being involved in an incident.

Anderson & Sabia (2018) finds that child-access-prevention (CAP) laws reduce threat and injury reports on school properties. Cheng & Hoekstra (2013) and McClellan & Tekin (2017) show that expanding *Castle Doctrine* laws increases the number of reported murders. Relatedly to our paper, (Koenig & Schindler, 2023) exploit a sharp rise in firearm sales to estimate the effect of mandatory delays on purchasing, finding that delays reduced homicide rates. Finally, Cook & Ludwig (2006) estimate the elasticity of homicide with respect to gun prevalence as between +0.1 and +0.3, supporting the hypothesis that more guns lead to more homicides. Our results support this latter view

2 Data

We utilize multiple data sources to investigate the relationship between firearm sales and homicides in the United States. Our primary dataset is a state-by-month panel dataset, encompassing estimated firearm sales and homicide rates from 2008 to 2022. This core dataset is complemented by additional information, including state-level socio-economic characteristics, detailed mobility data from cellular phone records, comprehensive data on state-level gun control laws, records of political and civil rights protests, and COVID-19 mortality data. In what follows we provide a detailed description of our data sources and provide a rationale for using it.

2.1 Main Outcome and Explanatory Variables

Data on Homicides Our main analysis relies on monthly data on homicides by US state from the Multiple Cause of Death database[3] provided by the Center for Disease Control and Prevention (CDC). Data is based on death certificates for U.S. residents. The main limitation of this data is that it is censored if less than 10 deaths happened in the same month in the same state. Therefore, we only include in our sample data from 36 states for which we can consistently observe non-censored data throughout our sample period. This approach still allows us to account for over 97% of all murders and over 90% of the US population.

We complement the CDC data with data from the FBI's National Incident-Based Reporting System (NIBRS). NIBRS is an incident-level dataset that collects information on reported crimes from local, state, and federal law enforcement agencies. The NIBRS dataset includes rich incident-level information on reported offenses and arrests. Reporting to the NIBRS program is not mandatory and agencies can self select into reporting. For this reason we only use the NIBRS data at the daily level to provide evidence for a non discontinous increase in homicides after the murder of George Floyd. Due to the self reporting nature of the data we can only observe roughly 50% of the total homicides committed in the US in 2020.

Data on Gun Sales We gather estimates of the number of gun sales at the state level from The Trace's firearm sales estimates. These data are derived from the National Instant Criminal Background Check

[3]We include all the cases labeled as *Assault (homicide)* that are defined with codes U01-U02, X85-Y09, Y87.1.

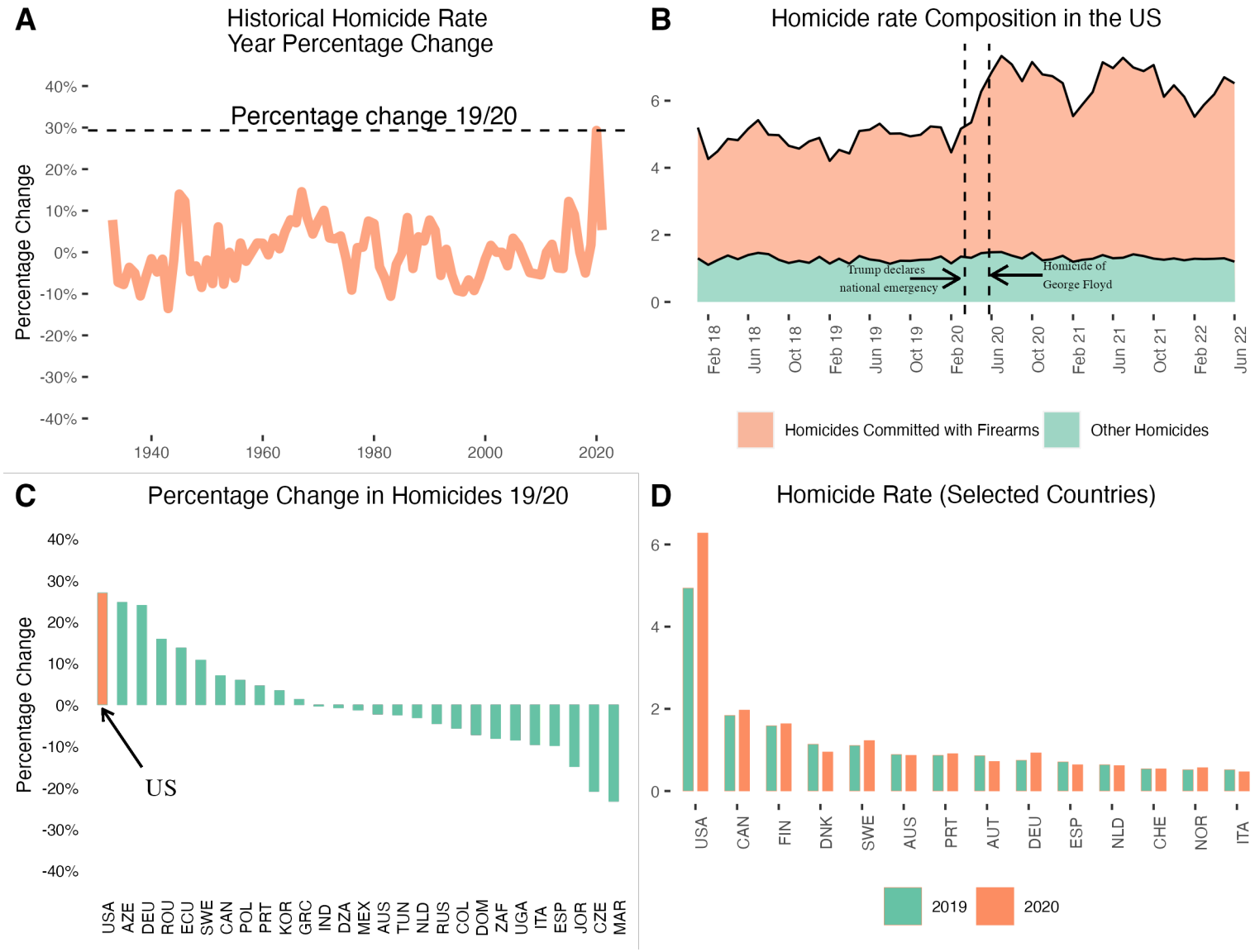


Figure 1: The Spike in Murders

Notes: This figure shows historical year-to-year changes in the homicide rate in the US from 1938 to 2021 in Panel A. Panel B shows a breakdown of homicides (committed with firearms and not committed with firearms) between 2018 and 2022.Panel C shows year-to-year percentage changes in the homicide rate in a sample of selected countries. Panel D shows the homicide rate in the US and in a sample of selected countries in 2019 and 2020.

System (NICS), run by the FBI. In order to take into account that background checks do not correspond one-to-one with sales, the estimates are corrected considering the share of transactions that include multiple guns. Moreover, seasonal adjustments are calculated to account for factors such as cyclical changes in demand, the number of days in a month, and the timing of holidays. This adjustment allows meaningful comparisons to be made between months. Although all federally licensed firearm retailers are required to run a background check before selling a firearm, background checks are not required for private sales in many states. Thus, a potential pitfall of this measure of gun sales is the absence of private sales, which are estimated to make up 13% of all sales (Miller et al., 2017).

We complement these data with Firearms Trace Data provided by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). ATF provides state-by-state reports using trace data to give the public insight into firearms recoveries. Tracing is done upon request from law enforcement agencies involved in genuine criminal investigations where a firearm is suspected to have been used. The firearms contained in the dataset do not constitute a random sample and should not be considered representative of the larger universe of all firearms used by criminals, or any subset of that universe. For this reason we only use the ATF data to provide evidence of a general reduction in the time-to-crime after 2020, defined as the amount of time between the retail sale of a firearm and its recovery by law enforcement.

2.2 Control Variables And Additional Data

Data on Gun Laws We obtain data on gun control policies at the state by year level from State Firearm Laws website maintained by Boston University School of Public Health. They provide a longitudinal gun law database which catalogs the presence or absence of 133 firearm safety laws grouped in 14 categories in each of the 50 states from 1991 to 2016 (updated continually). It is considered as the most extensive panel of longitudinal state firearm laws assembled to date. Based on recent evidence, we will exclusively focus on three key categories. First, Child Access Prevention Laws, that establish rules for firearm safety locks and hold gun owners criminally liable for negligent gun storage. Second, Stand Your Ground Laws, that allow individuals to use deadly force as a first resort for self-defense in any public place where they have a legal right to be. Third, Prohibition after Domestic Violence Laws, that establish conditions under which individuals convicted of domestic violence-related offenses are prohibited from possessing firearms. We will establish a criterion for defining a State with "effective gun laws" as follows: a State will be considered to have effective gun laws if, as of 2019, it has implemented child access prevention laws and prohibition after domestic violence measures while simultaneously not having stand your ground laws in place.

Data on Mobility To assess mobility levels, we utilize smartphone location data from the "Monthly Patterns" Dataset provided by SafeGraph[4]. This dataset offers valuable foot traffic information, including

[4]SafeGraph, a data company that aggregates anonymized location data from various applications to generate insights about physical places, through the SafeGraph Community. To protect privacy, SafeGraph excludes census block group information if there were fewer than five devices that visited a particular establishment in a given month from a specific census block group.

frequency of visits, duration of stays, origin of visitors, other destinations visited, and more. It is derived from GPS data collected from a diverse sample of over 40 million U.S. phones. The dataset is organized into monthly data sets, which encompass visit patterns and related metrics for over 6 million points of interest (POIs) across the United States.To establish our mobility index, we focus on POIs that have visit information throughout the entire sample period (January 2018 to December 2020) for each State and we normalize the number of visitors, setting equal to 1 the value of January 2018. Then, we average by month across POIs to obtain a rough measure of mobility at State-month level.

Firearm Trace Data We source our crime gun trace data from the state-by-state reports provided by Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). More specifically, we got data on "time-to-crime", defined as the length of time that elapses between when a firearm was first purchased and when it was used and confiscated by the police. However, the precise date of firearm purchase isn't available at a daily level. Instead, ATF provides a categorization system consisting of six categories[5] that gives a sense of the firearm's age when used in a crime. When analyzed at an aggregate level, this categorization system offers insights into the average vintage of confiscated firearms each year.

Data on Covid Deaths We gather data on Covid deaths from The COVID Tracking Project. They collect in publicly available datasets COVID-19 data from 56 US states and territories. To assess the COVID-19 impact at the state level, we construct a measure of the severity of the pandemic's impact on a State, by dividing the number of COVID-19 deaths in a specific month by the corresponding State population.

Data on Protests We use data from The Crowd Counting Consortium (CCC) to identify the number of protests against police and racism at US State level starting from 2018. The CCC collects publicly available data on political crowds reported in the United States, including marches, protests, strikes, demonstrations, riots, and other actions. We compute the monthly count of events related to *racism* or *police* at the state level.

Demographic and Economic Characteristics Finally, we gather basic demographic and economic variables at the state level from the Federal Reserve Economic Data and Census Bureau. This includes data on the unemployment rate at the state-by-month level, estimated state population and state-level racial composition.

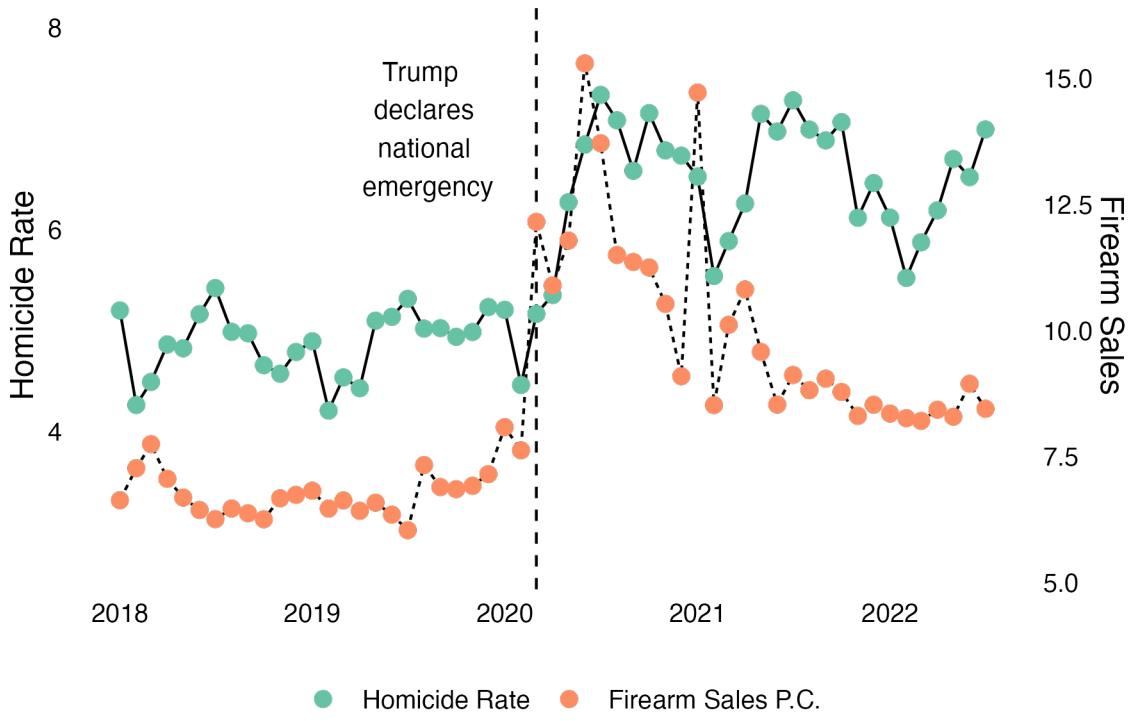


Figure 2: The Arms Race and Homicides

Notes: This figure plots the monthly homicide rate per 100,000 population (left axis) and the number of firearm sales per capita per 1,000 population (right axis) from January 2018 to June 2022.

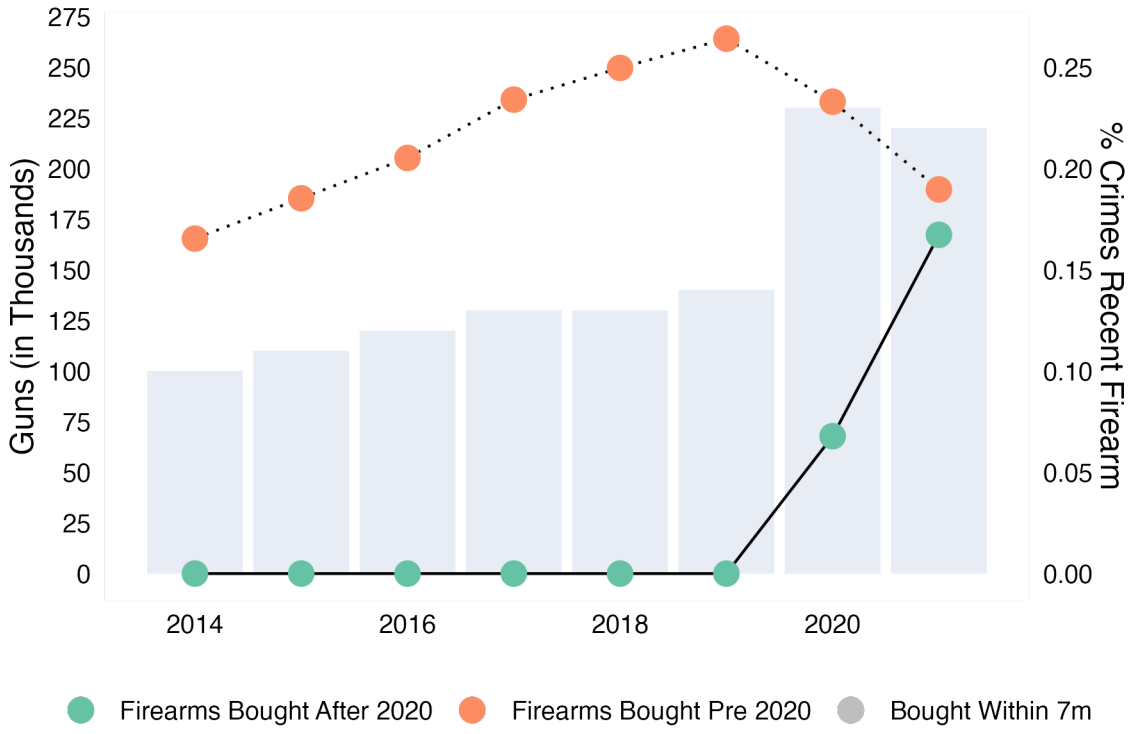


Figure 3: Guns Vintage

Notes: This figure illustrates the time-to-crime of firearms, which is defined as the duration between a gun's most recent legal purchase and its subsequent use in a criminal incident. The lines depict the annual count of firearms recovered at crime scenes, categorized by those acquired after 2020 (green line) and before 2020 (orange line). The grey bars shows the percentage of traced guns with a time-to-crime of less than 6 months.

3 Institutional context and descriptive evidence

3.1 Homicides and Firearms in the US

The US is a clear outlier among developed countries when it comes to homicides. the upsurge of 2020 brought the homicide rate close to 8 per 100,000, back to its level in the mid-90s and very similar to that of much poorer countries. The homicide rate in the US in 2019 ranked between that of Argentina and Tunisia, and it was much higher than that of countries like Canada, Italy, and Albania (United Nations Office on Drugs and Crime, 2023). Turning to firearms, there are almost 400 million civilian-held guns in the US, or 120 per 100 inhabitants, by far the highest rate in the world; for comparison, the rate of firearm holdings equals 34.7 in Canada and lies between 10 and 20 in Western Europe (Karp, 2018).

Not surprisingly, countless papers in different disciplines – criminology, sociology, economics, and health – draw a connection between abnormally high homicide rates and firearm holdings but, as discussed in the previous section, there is no consensus on the direction of causality. We address this issue by focusing on the effect of massive firearm purchases in the months following the outbreak of the COVID-19 pandemic.

3.2 COVID-19 and the arms' race

The US witnessed the first COVID-19 cases in January 2020 and the first deaths in February. The first travel restrictions in the US were imposed on China on February 2 2020 (New York Times, 2020). On March 13th President Trump declared the national emergency status (Trump, 2020). These measures were followed by a rapid spike in gun purchases, with gun sales per capita going from 7.5 estimated firearm sales for every 1000 Americans in February 2020 to 12.2 estimated firearm sales for every 1000 Americans in March 2020, a monthly 59% increase, and an 83% increase with respect to March 2019 (Figure 2).

The surge in firearm sales occurred rapidly following the declaration of a national emergency in March 2020, reaching its zenith in June 2020 (see Figure 2). Subsequently, firearm sales plateaued by the close of 2021, sustaining a heightened level compared to pre-pandemic times. Specifically, in 2019, prior to the Covid-19 pandemic, the average monthly firearm purchases per 1000 Americans stood at 6.7. Post-pandemic, these numbers increased to 11.1 in 2020 , 9.6 in 2021, and have since settled at 8.4 in 2022.[6] Notably, firearm sales spiked again in January 2021, the month of the assault on Capitol Hill.

The significant surge in firearm sales in March 2020 saw a notable influx of new buyers. According to the National Shooting Sports Foundation (NSSF) (**??**), 40% of gun purchases in 2020 were made by individuals acquiring firearms for the first time. The NSSF reported that approximately 5 million Americans became

[5](i)Under 3 Months, (ii) 3 Months to Under 7 Months, (iii) 7 Months to Under 1 Year, (iv) 1 Year to Under 2 Years, (v) 2 Years to Under 3 Years, (vi) 3 Years and Over.

[6]In the data section of the paper we give a thorough description of how we obtain estimates of gun sales. These are based on background checks. As anyone purchasing a gun in the US from a licensed store has to go through criminal background checks, these represent a good proxy for the number of guns sold. However, background checks do not map perfectly to the number of guns sold for several reasons. Firstly, background checks are compulsory in all American states only for licensed gun stores, therefore excluding private sales and gun sales at gun shows. Moreover, only one background check is required even when more than one firearm is purchased. Finally, not everyone going through background checks can buy a firearm, as some people will fail to pass the background check

new gun owners. This increase in first-time buyers is particularly relevant, as it can alter the relationship between firearm sales and homicide rates. In theory, if we were to anticipate a rise in homicides due to increased firearm sales, it would likely be attributed to these first-time buyers.

The significant upsurge in firearm sales during 2020, though considerable in scale, did not come as a complete surprise. Documented evidence indicates that Americans tend to acquire more firearms during periods of heightened uncertainty ((Brookings, 2020)). Previous research, exemplified by Levine & McKnight (2017); Koenig & Schindler (2023), has demonstrated that events like the 2012 Sandy Hook mass shooting led to increased gun sales during times of elevated uncertainty. Additionally, during the presidency of Barack Obama, as outlined in Depetris-Chauvin (2015), concerns related to policy changes fueled fear-based purchases, driving up firearm sales because of restrictions anticipated in the future. In our data, we show that wee observe a second spike in firearm sales, which occured at another time of high uncertainty, political turmoil and perceived risk, the month of the assuault on Capitol Hill.

3.3 The Arms Race and the Increase in Homicides

The rapid surge in firearm sales has coincided with the most substantial year-to-year increase in homicides, as seen in Figure 1, panel A. By May 2020, the homicide rate had reached five homicides per 100,000 Americans, the highest level since the late 1990s (Figure 2). This alignment between increased homicides and surging firearm sales raises the question of whether the latter might be causing the former. However, it is important to note that a direct causal link between gun sales and homicides cannot be established based solely on temporal patterns. Notably, a significant portion of those who purchased firearms in 2020 were new buyers, many of whom may have acquired firearms solely for self-defense purposes and may not have used them in any criminal activity.

We present evidence demonstrating that over 20% of crimes committed in 2020 involved firearms acquired within seven months prior to the offense. As illustrated in Figure 3 (left axis), the chart displays the count of guns discovered at crime scenes that were purchased in 2020 (depicted in green) and the count of guns found at crime scenes that were bought in 2020. Notably, by 2021, nearly half of the firearms recovered at crime scenes, which were purchased in 2020, accounted for almost 50% of all firearms found at such scenes. Furthermore, the grey bars in Figure 3 (right axis) represent the proportion of guns purchased within seven months prior to a crime from 2014 to 2021. Once again, a conspicuous spike (64% year-on-year increase) is visible in 2020, indicating that following the surge in gun sales, firearms acquired during that peak were more likely to be discovered at crime scenes.

This descriptive evidence suggests a robust connection between the surge in firearm sales during the COVID-19 pandemic and the simultaneous increase in homicides in 2020. While panic may account for both an increase in firearm purchases and homicides, our findings demonstrate that firearms acquired in 2020 were more likely to be associated with criminal activity than those acquired before 2020. This reinforces the argument for a causal link between the rise in firearm sales and the increase in homicides.

Significantly, 2020 marked not only the year of the pandemic but also the year of George Floyd's murder and the emergence of movements such as Black Lives Matter and calls to defund the police. Recent studies in the social sciences have emphasized how George Floyd's murder triggered increased violence against the police (**??**), suggesting a possible contribution to the rise in homicides due to heightened racial tension. Surprisingly, the temporal patterns do not reveal an immediate spike in homicides following George Floyd's murder. Specifically, homicides increased by 27% from 2019 to 2020. If homicides had remained at the same level as they reached in May 2020, the year-on-year percentage increase in homicides in the US would still have been 20%, marking the highest ever recorded. [7]

Finally, it is possible that forward-looking individuals bought firearms in expectation of heightened violence. If this would have been the case then it would be homicides that causes violence and not vice-versa. To address this issue we run the (Juodis et al., 2021) Granger non-causality test for Panel Data to check whether homicides Granger cause firearm sales. The test does not reject the null hypothesis of no causality (p-val= 0.5827). On the other hand, the test confirms that firearm sales do Granger cause homicides (p-val = 0.000).

4 The Effect of Firearm Sales on Homicides

Basic Estimates We start by estimating the following simple linear regression models on monthly data at the state level from 2008 to 2022:

$$y_{st} = \beta \text{After February 2020}_t + \text{State}_s + \text{Month}_t + \text{Year}_t + \epsilon_{st}, \tag{1}$$

where β is our coefficient of interest and can be interpreted as the average difference in our outcome variable y_{st} after February 2020 when the emergency status was announced by President Trump. The outcome variable y_{st} can either be the homicide rate – measured in homicides per 100,000 inhabitants – or the gun sales per capita – measured in gun sales per 1000 inhabitants – in state s and month t. We add state, calendar and year fixed effects. This approach allows us to interpret our coefficient of interest β as the within state difference in homicide rate or gun sales per capita between after netting out any seasonal component – by adding calendar month fixed effects –, year specific shocks – by adding year fixed effects –.

Panel A of Table 1, columns (1) and (4) show the estimates of β. On average, for every hundred thousand Americans, we estimate that 1.3 more Americans have been killed since the announcement of the National Emergency Status a sizeable 22% increase with respect to the sample mean. At the same time, since the announcement of the National Emergency, we estimate that 2.3 more guns have been sold every month for every 1000 Americans, a 55 % increase with respect to the sample mean. These estimates are all statistically significant at any conventional level and likely reflect the impact of increased fear and stress of American

[7] In the online appendix, we show, using daily data on homicides, that the number of daily homicides did not exhibit discontinuous variations around the time of George Floyd's assassination.

Citizens during the Covid pandemic, with citizens buying more weapons to defend themselves and then occasionally using them to commit a homicide.

In column (2) of Table 1, panel A, we use the same set of fixed effects as in Equation 1 to estimate the association between gun sales in a specific month and the homicide rate in the same month throughout our sample period (2008-2022). In particular we substitute the dummy variable After February 2020_t with the variable Gun Sales_t, which represents the number of firearms sold in month t. Our estimates show that, on average, if one in one thousand Americans buy a gun, the homicide rate increases by 0.1845 homicides per 100,000 inhabitants. Using our estimates of the average increase in gun purchases after the announce of the National Emergency as a benchmark we estimate that more than 1000 homicides per month after the announcement of the National Emergency would be associated with gun purchases.

Furthermore, in column (3) of Panel A of Table 1, we augment the model with an interaction term between Gun Sales_t and After February 2020_t. This approach allows us to break down the association of gun sales per capita and homicides into the association before and after the announcement of the National Emergency. As shown in column (3) the association between gun sales per capita and homicides is not statistically significant before the announcement of the National Emergency and are positive and statistically significant after that, with an estimated increase of 0.21 homicides per 100,000 inhabitants for every 1000 Americans who buy a new gun.

The Causal Effect of Gun Sales on Homicides While the estimates above are helpful for understanding the basic correlation patterns between homicides and gun sales before, during, and after the Covid pandemic, we can not interpret them as causal for several reasons. Firstly, the temporal correlation between homicides and gun sales could be driven by Covid-related restrictions impacting both variables in the same direction. If individuals are confined to their residences, their ability to acquire firearms may be hindered, as would their capacity to commit murder. Secondly, in a scenario characterized by heightened social tension, an increase in homicides might prompt individuals to purchase firearms for self-defense against potential aggressors. If this circumstance were to hold true, it would be murders that cause gun purchases and not the opposite, in other words, we would have reverse causality.

We address these issues by estimating a dynamic panel data model by OLS:

$$\text{Homicide Rate}_{st} = \pi \text{Gun Sales}_{st-1} + \gamma \text{Homicide Rate}_{st-1} + \text{State}_s + \text{Month}_t + \text{Year}_t + \mathbf{X_{st}} + \epsilon_{\mathbf{st}}, \quad (2)$$

where we regress the homicide rate in month t and state s on per capita firearm purchases and murders in month $t-1$. Furthermore we add the same battery of fixed effects as in the previous model and in some specifications we include time varying potential confounders $\mathbf{X_{st}}$. Our coefficient of interest is π. Under the assumption of sequential exogeneity π represents the causal impact of gun sales on homicides. [8] In other

[8] Econometrically assuming sequential exogeneity amounts to assuming that $\mathbb{E}[\epsilon_{st}|\text{Gun Sales}_{st-1}, \text{Homicide Rate}_{st-1}, \text{State}_s, \text{Month}_t] =$

words, we assume that the lag of the homicide rate captures all relevant shocks that affect gun sales at $t-1$ and the homicide rate at time t.

The lag of the homicide rate summarizes the impact of a range of factors that affect both gun sales and the homicide rate, such as increased social tensions, fear, and violence. These economic factors should have an impact on the future homicide rate, primarily through their influence on the current homicide rate. To account for potential factors that might affect both gun sales and future homicides, we also estimate a version of Equation 2 where we include the percentage of Black individuals by state, unemployment rate, the number of protests against the police, the covid death rate as well as our mobility measure obtained through cell phone mobility data.[9]

Column (1) in panel B of Table 1 shows our estimate of π. We estimate that one more firearm sale per one thousand Americans causes 0.11 more homicides per 100 thousand Americans. The estimate is statistically significant. This estimate implies that if we consider the average increases of gun sales per capita and homicide rate obtained from estimating equation 1, gun sales would be responsible for 27% of the increase in homicides after February 2020.[10] In column (2) we augment Equation 2 with our set of controls. The point estimate increases to 0.15 and is still statistically significant.

Finally, in columns (3) and (4) of panel B, we estimate the same models as in columns (1) and (2) but we estimate different coefficients for the effect of gun sales before and after February 2020. Similarly to the naive OLS estimation, the estimated coefficients are not statistically significant before February 2020 and become, positive, and statistically significant after February 2020.

These results show that firearm sales played a crucial role in the greatest increase in homicides in the recent American history. Our estimates are consistent with a scenario where individuals exprienced stress and fear during the covid 19 pandemic and as a consequence bought more firearms and started using them more often to committ murders. This is confirmed by Figure 3, where we have shown that the share of relatively *young* firearms found on individuals who committed a crime increased by 64% between 2019 and 2020.

The Effect of Gun Control Policies We examine how states with more restrictive gun control policies reacted to the announcement of the National Emergency. Specifically, we draw upon the systematic literature review conducted by RAND (2023), which explores the effectiveness of various gun policies. From this review, we identify a set of gun control policies that have been consistently proven to reduce violent crimes. These policies include Child Access Prevention Laws, laws that require firearms owners to hold permit for carrying concealed firearms (Concealed-Carry Laws), and the absence of Stand Your Ground laws, which remove the obligation to retreat from a threat and allow individuals to use deadly force in self-defense.

We investigate the impact of stricter gun control policies on homicide rates and per capita gun sales using

0. It implies that gun sales and past homicide rates are orthogonal to contemporaneous and future shocks to the homicide rate and that the error term ϵ_{st} is serially uncorrelated.

[9] As we only have cell phone mobility data since 2018 the sample size decreases significantly in our model with controls.

[10] $\beta_{guns} * \pi / \beta_{\text{homicide rate}} = (2.318 * 0.1162)/1.328 = 0.27$

Table 1: The Effect of Gun Sales on Homicide Rate

Panel A: Naive Estimates

Dependent Variables:	Homicide Rate			Gun Sales Per Capita
Mean of Dependent:	6.1 $\times 100k$			4.2 $\times 1k$
	(1)	(2)	(3)	(4)
After Feb 2020	1.33***			2.32***
	(0.217)			(0.187)
Gun Sales Per Capita		0.184**		
		(0.070)		
Gun Sales Per Capita × Before Feb 2020			0.071	
			(0.083)	
Gun Sales Per Capita × After Feb 2020			0.212***	
			(0.070)	
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Calendar Month	Yes	Yes	Yes	Yes
Observations	5,811	5,811	5,811	6,372

Panel B: Dynamic Panel Estimates

	Homicide			
Lag Gun Sales	0.116**	0.150**		
	(0.044)	(0.060)		
Lag Homicide Rate	0.292***	0.227***	0.286***	0.223***
	(0.045)	(0.068)	(0.041)	(0.063)
Lag Gun Sales × Before Feb 2020			-0.010	0.027
			(0.064)	(0.092)
Lag Gun Sales × After Feb 2020			0.151***	0.123**
			(0.045)	(0.060)
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Calendar Month	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Fit statistics				
Observations	5,514	1,251	5,514	1,251

Panel C: DiD Estimates

	Homicide Rate		Gun Sales Per Capita	
Have Effective Gun Laws × After Feb 2020	-1.69***	-0.714**	-1.10***	-1.00***
	(0.402)	(0.413)	(0.311)	(0.387)
State	Yes	Yes	Yes	Yes
Calendar Month X Year	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Observations	5,696	1,262	6,195	1,342

Cluster Bootstrap standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

a difference-in-differences research design. We leverage variations in state-level gun control laws, categorizing states as treated if, in 2019, prior to the COVID-19 pandemic, they had implemented child access prevention laws, making gun owners criminally liable if a child under the age of 18 gains access to a firearm, Stand Your Ground laws were absent and where there were laws either requiring permits for carrying concealed weapons or completely prohibiting concealed carry.

We employ separate difference-in-differences models, comparing the *changes* in homicide rates and gun sales per capita in states with more and less restrictive gun control policies before and after the declaration of the state of emergency by President Trump. We estimate the following difference-in-difference model by OLS:

$$y_{st} = \phi \text{ Strict Bundle}_s \times \text{After February 2020}_t + \text{State}_s + \text{Month}_t \times \text{Year}_t + \mathbf{X_{st}} + \epsilon_{\mathbf{st}}, \tag{3}$$

where we regress the homicide rate and gun sales in month t and state s on an interaction term between a dummy that takes value one if a state s had enacted what we have defined as an "effective" gun control policies bundle (Strict Bundle$_s$) and the After February 2020$_t$ dummy. We include State fixed effects and month by year fixed effects, allowing us to exploit within state variations and to net out any common shock that is affecting all states at the same time. $\mathbf{X_{st}}$ represents a vector that includes the control variables that we employ in the previous models as well.

The coefficient of interest ϕ can be interpreted as the average difference in murders and gun sales between states with and without the effective bundle of gun control policies. We can interpret ϕ as the causal effect of having strict gun control laws on homicides and firerm sales under two assumptions. The first assumption is the parallel trends assumption, which amounts to assuming that in the absence of the arms race that followed the Covid-19 state of emergency, the homicide rate would have followed similar trends in state with and without strict gun control policies. The second assumption is that all other shocks that happened after February 2020 are uncorrelated with the presence of strict gun control policies. While there is no direct way to test these assumptions we address concerns about them not holding in two different ways. Firstly, we estimate a dymamic version of Equation 3, where we investigate whether prior to February 2020 we could detect any differential trends in the homicide rate in states with and without strict gun control policies. Secondly, we control for a battery of time varying control varialbes $\mathbf{X_{st}}$ that act as good proxies for the other relevant shocks that hit the US after February 2020.[11]

Panel C of Table 1 shows our estimate of ϕ. Columns (1) and (2) refer to the estimated impact of effective gun control policies on the homicide rate. Column (1) reports estimates of ϕ – our static DiD coefficient without controls – and column (2) reports the same estimates when we include our set of controls. These

[11] As described in the previous sections these include: he percentage of Black individuals by state, unemployment rate, the number of protests against the police, the covid deathrate as well as our mobility measure obtained through cell phone mobility data (as a proxy for Covid-19-related restriction orders).

results show that on average, we estimate that strict gun control laws reduced the homicide rate by 0.714 to 1.69 homicides for every 100,000 American per month, an estimated reduction between 11% and 27% with respect to the sample mean. Columns (3) and (4) show estimates of similar models, but where the outcome variable is the number of guns sold for every 1,000 Americans. We estimate that stricter gun control laws determined a reduction betwen 1 and 1.1 firearm sales after February 2020. An effect that corresponds to roughly 25% of the sample mean. In all diff-in-diff models our estimates are statistically significant at the 5% level.

Figure 4 shows estimates of a dynamic version of Equation 3 along with state leve wild cluster bootstrapped 95% confidence intervals. Estimates before February 2020 are never statistically different from zero, suggesting that states with stricter gun control policies in place prior to Ferbuary 2020 were not a diverging trend with respect to states with less strict gun control policies. After February 2020, in particular from May 2020 – when restrictions orders started being lifted – the homicide rate for states with stricter gun laws was significantly lower than in states with more permissive gun laws.

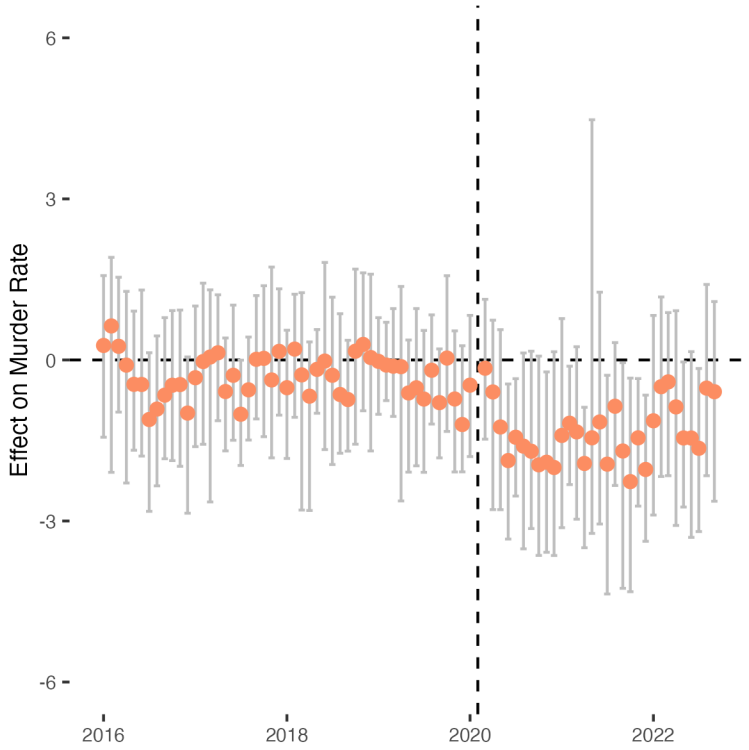


Figure 4: Effect of Gun Control Laws

Notes: This figure plots the dynamic treatment effect estimates for our of gun laws on the homicide rate (×100.000). 95% confidence intervals are obtained through Wild CLuster Bootstrap (MacKinnon & Webb, 2017)

5 Conclusion

The question of whether an increase in the number of guns contributes to a rise in murders has sparked intense debate. This issue has engaged economists and social scientist who struggle to reach an agreement on whether more guns cause more or less crime. Our findings indicate that amidst the 2020 Covid-19 pandemic, more guns led to more homicides.

Using dynamic panel estimation techniques, along with a difference-in-differences estimation strategy, we estimate that during the pandemic one more gun sold for every 1000 Americans in a given month caused 0.12 homicides per 100,000 Americans the month after. A back-of-the-envelope calculation reveals that according to our estimates newly sold guns are able to account for roughly 21% of the homicides committed in the US after February 2020 and for 40% of the total increase in homicides between 2019 and 2020. Crucially, states that had gun control policies that have been shown to be effective in reducing violent crimes experienced significantly less firearm sales and homicides.

Our findings suggest that tighter firearm regulation can help countries to curb with shocks that heighten tentions through multiple mechanism such as a global pandemic.

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A Online Appendix

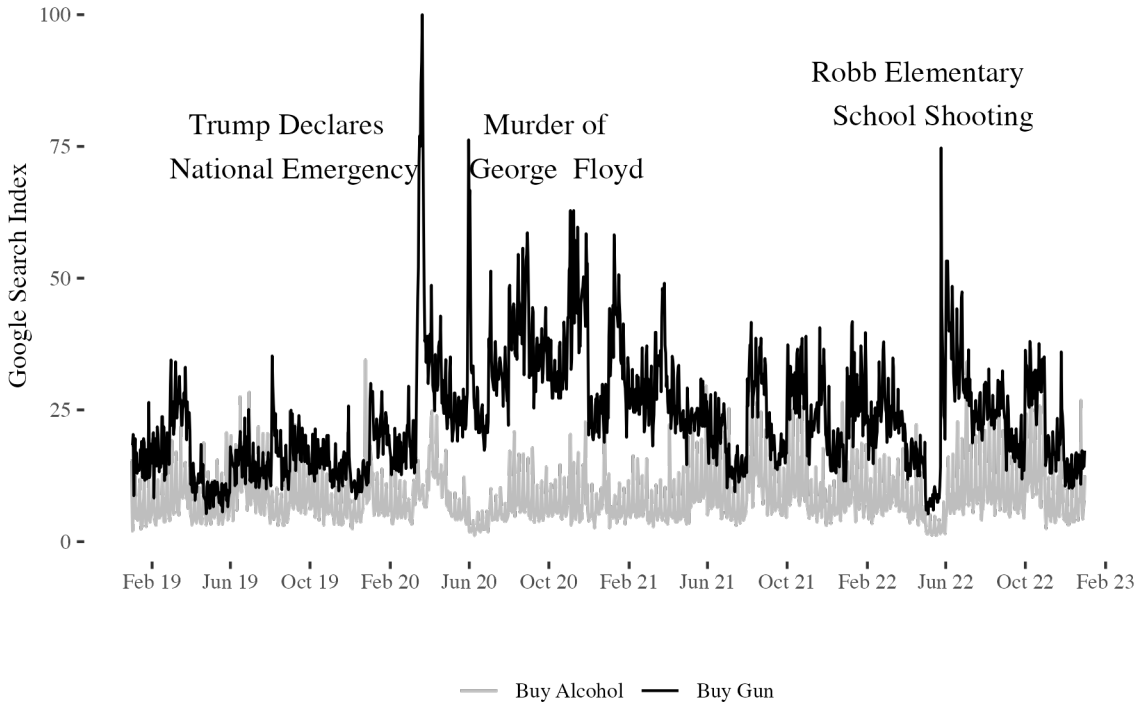


Figure A.1: Google Searches for Buy Alcohol and Buy Gun

Notes: This figure plots daily searches on google for "Buy Gun" and "Buy Alcohol" from January 2019 to February 2023. The index compares the intensity of searches in the US for the two terms over time.

B Firearm Sales, Murders and the Assassination of George Floyd

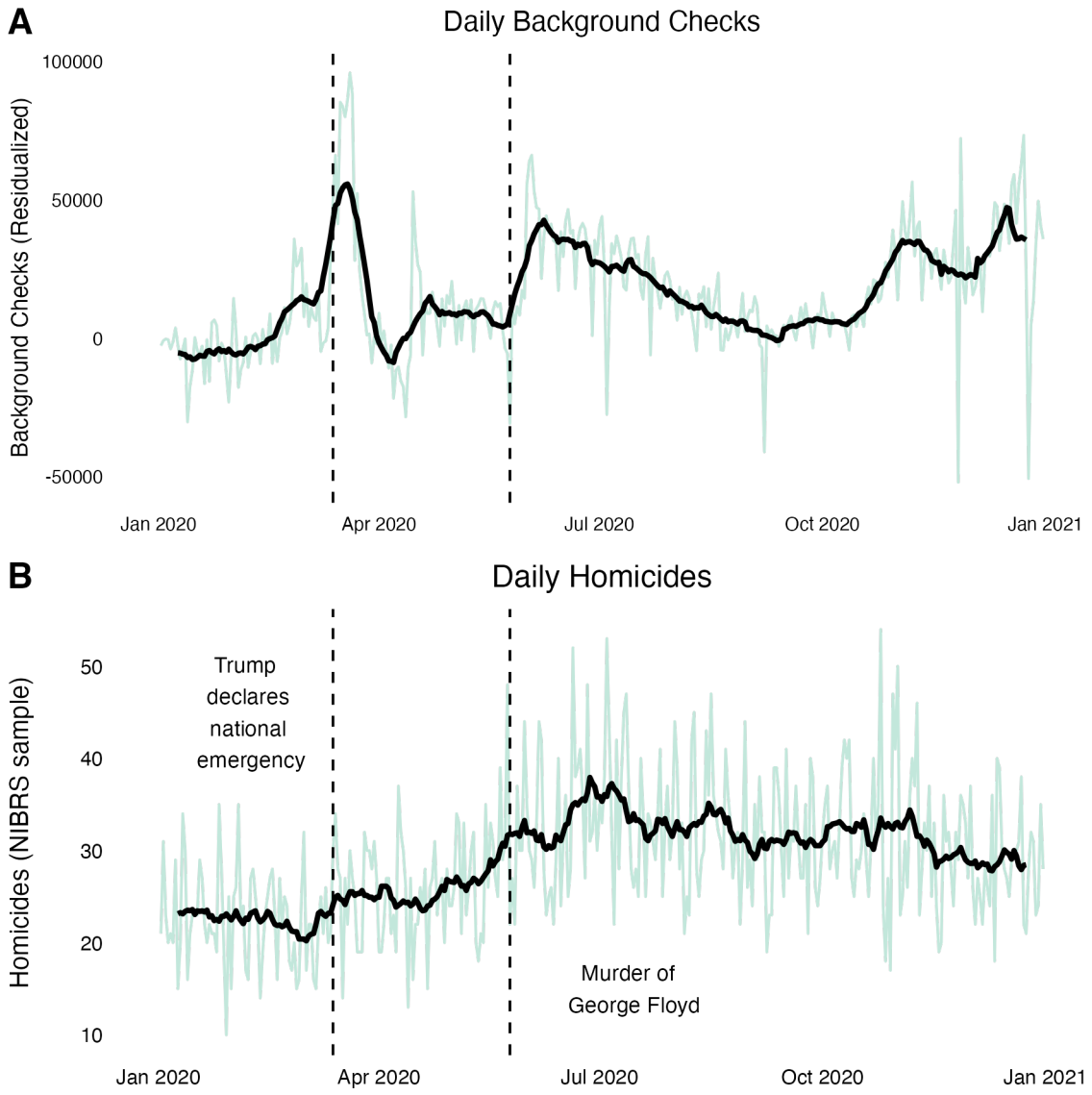


Figure B.1: Daily Gun Sales and Homicides

Notes: This figure plots the number of background checks or purchasing a firearm once fluctuations due to day of the week fixed effects are removed (i.e. the residuals of a regression of background checks on day of the week fixed effects) (Panel A). Panel B