

TRACKING THE UNTRACEABLE: THE IMPACT OF PMF AVAILABILITY AND LEGISLATION ON FIREARM CRIME

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ABSTRACT

This paper evaluates the impact of Privately Made Firearm (PMF), or “ghost gun,” availability and legislation on firearm crime in the United States. The use of PMFs in crime expanded significantly in the 2010s, primarily due to the sale of “ghost gun kits,” which include the necessary component parts to build a fully functioning firearm (Brady, n.d.). These kits were intentionally marketed as an unregulated and untraceable means of assembling a working firearm (Brady, n.d.). Through a descriptive study of PMF recoveries and firearm homicide rates in California and nationwide, I analyze the relationship between PMF availability and firearm homicide rates, using PMF recoveries as a percentage of all crime gun recoveries (referred to in this paper as “Percentage PMF Recoveries,” or “PPRs”) as a proxy for PMF availability. I then conduct a panel regression analysis focused on states with existing restrictive PMF laws, and analyze changes in firearm homicide rates among the same populations before and after policy implementation. The results indicate a potential positive relationship between PPRs and firearm homicide rates, and a large and statistically significant decrease in total annual firearm homicide rates and male annual firearm homicide rates after the enactment of a PMF policy. The latter finding suggests strong evidence for a causal effect of PMF policies on firearm homicide rates in the states in which these policies are implemented.

Policy Recommendations

To pursue firearm crime and violence reduction in the United States, I recommend that the Johns Hopkins Center for Gun Violence Solutions (CGVS):

- I. **Advocate** with local, state, and federal lawmakers for **PMF policies** that require **serial numbers and background checks** for component parts of firearms.

- II. Consider including **PMF tracing and reduction** in **CGVS's priority-based gun violence prevention policies**, based on the significant reductions in total firearm homicide after implementation at the state level.
- III. **Advocate** with local, state, and federal lawmakers, as well as **local and state police departments**, for **policies requiring firearms tracing**, to improve the identification and reporting of PMFs.
- IV. **Replicate** this causal study in future research as more data on PPRs and firearm homicide rates become available, to obtain more accurate results.
- V. Conduct **future research** exploring the impact of **differences in state PMF regulations** on firearm homicide rates, to determine the most effective PMF policies.

INTRODUCTION

Wednesday, April 23rd, is the 113th day of 2025. Three days earlier, on April 20th, the United States saw its 102nd mass shooting of the year (Mass Shooting Tracker, 2025).

The U.S. currently has the 28th-highest rate of deaths from gun violence in the world, and the 7th-highest firearm homicide rate out of 65 developed nations (Nurith, 2023; Leach-Kemon et al., 2023). Gun violence in the United States also creates substantial costs to the public at large. According to a recent estimate, American households would be willing to pay an average of \$744 annually for a 20% reduction in gun violence, totaling \$97.6 billion nationwide (Cook et al., 2025). This estimate reflects the significant perceived economic burden gun violence places on individuals and communities.

Playing an increasingly significant role in these high levels of gun violence are Privately Made Firearms (PMFs), colloquially referred to as ghost guns. PMFs are fully functional firearms without serial numbers, and are constructed with components that can be purchased as separate pieces or kits (Brady, n.d.). While not the only source of PMFs, these kits have been the main method by which these firearms are fabricated (Everytown for Gun Safety, 2024). Polymer80, a company that manufactured and sold PMF kits, was responsible for producing over 88 percent of the identifiable ghost guns that were recovered at crime scenes nationwide from 2017 to 2021 (Everytown for Gun Safety, 2024).

Many local law enforcement agencies throughout the United States submit suspected PMFs recovered from crime incidents to the U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) National Tracing Center (ATF, 2023). However, because these guns are unserialized, ATF can usually identify them but not identify the first retail buyer, as they do for other types of firearms. Based on the information received from local law enforcement, ATF found that recoveries of these firearms had increased significantly in recent years, rising by a factor of 10 between 2017 and 2021 (ATF, 2023). These numbers began decreasing again in 2022, the same year in which a new rule from the Biden Administration - 87 FR 24652 - took effect, allowing ATF to regulate PMFs (Brownlee, 2024). Even with this reduction, the rapid rise in recoveries from 2017 to 2021 suggests that within that time frame, there was an increasing number of PMFs in circulation, making these firearms more available to the general public.

This paper aims to answer two related questions: what is the effect of PMF availability and PMF regulation on firearm crime? To answer these questions, I draw on much of the existing literature on firearm violence, which has indicated that higher levels of gun prevalence result in

increased rates of both homicide (Duggan, 2001; Cook & Ludwig, 2006; Johnson & Robinson, 2024) and violent crime more generally (Billings, 2023; Donohue et al., 2024). These findings imply that the increased availability of PMFs may result in higher rates of violent crime with guns, and thus increase the firearm homicide rate. Heightened PMF availability might also lead to some reduction in non-firearm homicide, as perpetrators may substitute PMFs for other weapons, consistent with substitution effects documented in gun-involved robberies (Cook, 1979). As a result, to gauge the relationship between PMF availability and firearm crime, I observe trends in PMF availability and firearm homicide rates in California and the United States as a whole. Additionally, to determine the impact of PMF legislation on firearm crime, I document trends in firearm homicide rates, non-firearm homicide rates, and total homicide rates in states in which PMF regulations¹ have been implemented.

Additionally, there are particular demographic groups that may be disproportionately impacted by PMFs. For instance, not only has gun availability in general been found to be positively related to juvenile crime (Mocan & Tekin, 2006), but these juveniles may also specifically take advantage of increasing PMF availability. Because youth under the age of 21 are barred by federal law from acquiring a handgun from a licensed firearms dealer, they may be drawn to firearms that allow them to evade federal age restrictions (Gun Control Act of 1968, 1968). This assumption is supported by preliminary analyses of PMF use in Baltimore, MD. These data indicate that between January 2023 and April 2024, 41% of individuals arrested

¹ For the purposes of this paper, a “PMF regulation” “PMF legislation,” and/or “PMF policy” refers to a policy that aims to restrict PMF access and use.

with PMFs were either under 21 years old themselves, or were arrested in connection with a case involving someone under 21 charged with PMF possession (Webster, 2024).

There may also be some types of firearm homicide that are more impacted by PMF availability and regulation than others. For instance, gang-related homicide may be more affected by PMF availability and regulation than domestic homicide. As many gang members have criminal records and are therefore prohibited from owning a gun, they may attempt to acquire a firearm through illegal means, such as building or obtaining a PMF (Roberto et. al, 2018). As victims of gang-related firearm homicide tend to be male, and victims of domestic homicide are more likely to be female, it is reasonable to assume that male firearm homicide rates will be more heavily affected by PMF availability and regulation than female firearm homicide rates (Decker & Curry, 2002; Rowh, 2024).

Due to the likely sensitivity of youth and gang members to PMF availability, in addition to the total population, I also observe firearm homicide outcomes among youth ages 12 to 20, and for males and females separately. Because “gun homicide” as an outcome measure is highly variable, focusing on the ratio of age and gender-specific firearm homicide rates to the rate for the population as a whole helps to isolate the impact of PMF availability from other sources of variation in gun violence rates. In fact I do not find evidence that firearms homicide rates of youths or of males are especially sensitive to PMF availability. But the analysis does suggest a positive relationship between PMF availability and firearm homicide rates, and that the implementation of PMF regulations is associated with reductions in firearm homicide rates, both among the total population and males specifically.

This paper is organized as follows: the second section provides a justification for the use of PPRs as a proxy for PMF availability. The third section contains a literature review highlighting the current research on PMFs, and the gaps in that research filled by this paper. The fourth section reviews the data that will be analyzed. The fifth section uses ATF and California Department of Justice (DOJ) data to explore the relationship between PPRs and firearm homicide rates among youth, males, females, and the general population in California and nationwide. The sixth section uses data from the CDC's Web-based Injury Statistics Query and Reporting System (WISQARS) to determine the relationship between the enactment of a PMF regulation and firearm homicide rates in the states where these laws were implemented. The seventh section presents conclusions, and provides policy and research recommendations to the Johns Hopkins Center for Gun Violence Solutions based on the paper's findings.

PPRs AS A PROXY FOR PMF AVAILABILITY

Throughout this paper, I use PMF recoveries as a percentage of all crime gun recoveries (referred to in this paper as "Percentage PMF Recoveries," or "PPRs") as a proxy for PMF availability. Due to the difficulty of tracking PMFs and the fact that not all law enforcement agencies track or report these firearms, PPRs likely underestimate the true prevalence of PMFs used in firearm crimes (ATF, 2023). However, for the purposes of this study, PPRs are the best available proxy for PMF availability. Monitoring PPRs and PMF recovery rates is currently the sole method of tracking the existence of PMFs in the United States. While this measure has serious problems of under reporting, the authors of existing literature on PMFs utilize these measures in their research (Braga et al. 2022; Jackson et al., 2023; Laqueur et al., 2023; Wintemute, 2021).

In addition, Firearm Suicides divided by Suicides (FSS), a typical proxy for gun prevalence, could serve as a valid proxy in this case. However, PPRs are more sensitive to the availability of PMFs in particular to criminals, making PPRs a more appealing proxy given my focus.

LITERATURE REVIEW

National PMFs

PPRs have increased significantly nationwide over the past decade. In 2023, PPRs were over ten times higher than they were in 2017, the year in which ATF first published PPR data (ATF, 2023). This upward trend is likely influenced both by an increase in criminal use of these firearms, as well as an increase in law enforcement reporting of PMFs to ATF (ATF, 2025). These higher levels of reporting reflect the training programs that ATF implemented in 2020, which teach law enforcement agents how to identify and trace PMFs (ATF, 2025).

State-Level PMFs

California

Much of the existing information, research, and literature on PMFs is focused on California, due to the state's unique experience with PMFs. According to the California DOJ's Office of Gun Violence Prevention October 2024 Report, California's influx of PMFs occurred earlier than the influx at the national level (California Department of Justice, 2024). PPRs in California spiked in 2017, with known recoveries jumping 87% from the previous year (California Department of Justice, 2024). PPRs then rapidly accelerated, hitting their highest peak in 2021, when they increased by a factor of 32 from 2017 (California Department of Justice, 2024). Unlike national PPRs, PPRs in California began to decrease in 2022, although they still remained higher than their pre-2017 levels (California Department of Justice, 2024).

These differences between national and California PPR trends can be seen below in Figure 1, and are likely due to California’s uniquely early influx of PMFs, along with reporting differences at the state and national level. California law enforcement agencies have been tracking and reporting PPRs since at least 2013, whereas ATF data is relying on participation from all states, many of which do not have formal reporting processes (California Department of Justice, 2024, Taniguchi, 2021).

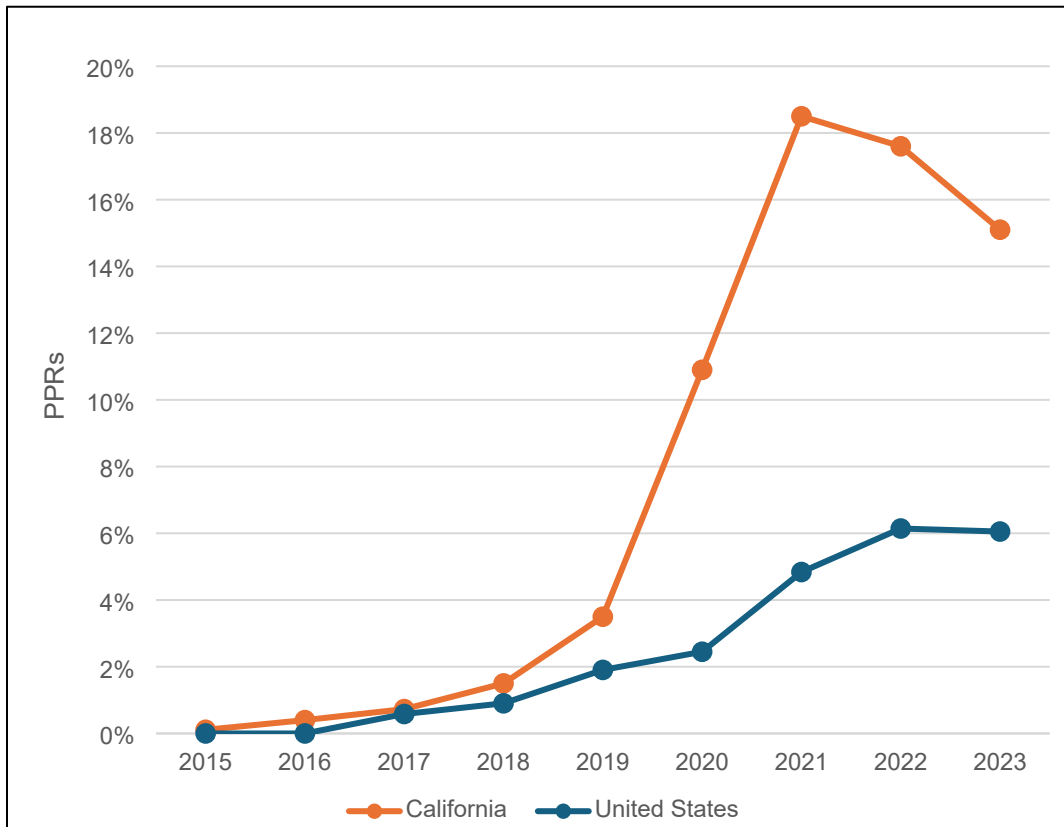


Figure 1. Percentage of all crime guns recovered and identified as PMFs in California and U.S., by year

Source: California Department of Justice Office of Gun Violence Prevention; U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives
 Note: California data adapted from “California’s Fight Against the Ghost Gun Crisis: *Progress and New Challenges*” by the California Department of Justice Office of Gun Violence Prevention, 2024, California Department of Justice. Copyright 2024 by California Department of Justice
 U.S. data adapted from “National Firearms Commerce and Trafficking Assessment (NFCTA): Crime Guns - Volume Two, Part III: Crime Guns Recovered and Traced Within the United States and Its Territories” by the U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives, 2023, U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives. Copyright 2023 by the U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives.

Existing literature on PMF trends in California have noted similar patterns to those presented in the California DOJ report. Braga et al. (2022) found that the percentage of PMFs

among recovered crime guns in Oakland, CA increased from 1.4% in 2017 to 24% in 2021. While Jackson et al. (2023) note that PMF recoveries in Hayward, CA actually decreased from 2016 to 2017, they found an upward trend in recoveries from 2017-2021. Similarly, Laqueur et al. (2023) tracked PMF recoveries in multiple California cities from 2010-2021, and found that beginning in 2017, many of the sample cities experienced and maintained an upward trend in PMF recoveries.

Due to the clear PMF crisis in the state, California legislators have implemented multiple policies regulating PMFs. First, Assembly Bill (AB) 1621 went into effect on June 30th, 2022, and the goal of this legislation was to strengthen regulations of the sale, transfer, and manufacture of completed and unfinished² firearm frames³ and receivers⁴ (a.k.a. “precursor parts”) (Giffords, 2024). Specifically, the law ensured that all frames and receivers were regulated under the same laws as fully assembled firearms, and thus required to be sold by licensed dealers and subject to background checks and waiting periods (Assembly Bill No. 1621, 2022). Purchasers of these precursor parts were also required to meet the same eligibility requirements that apply to buying a fully assembled gun (Assembly Bill No. 1621, 2022). Most of AB 1621’s provisions went into effect on June 30th, 2022, but a select few, such as the requirement that unfinished precursor parts have serial numbers, did not take effect until January 1st, 2023 (Giffords, 2024).

Similarly, California enacted four more PMF regulations that did not go into effect until January 1st, 2023. AB 2156, for instance, required all firearms manufacturers in California to

² Unfinished frame or receiver: a frame or receiver that not fully assembled (U.S. Department of Justice, 2022)

³ Frame: the part of a gun that gives the firearm its shape and structure (U.S. Department of Justice, 2022)

⁴ Receiver: a specific part inside the frame containing the key components needed for the gun to fire (US Department of Justice, 2022)

have a state license, regardless of any existing federal licensure (Assembly Bill No. 2156, 2022). The law also prohibited anyone without a federal firearms manufacturing license from using 3D printers or CNC milling machines⁵ to manufacture guns (Assembly Bill No. 2156, 2022). Senate Bill (SB) 1327 and AB 1594 focused on PMF litigation, with the former giving private individuals the power to sue people engaging in illegal firearm activities (Giffords, 2024). The latter regulation permitted people to do the same against gun manufacturers who violate certain firearm safety laws (Giffords, 2024). Finally, AB 2552 mandated that all unfinished frames and receivers be affixed with serial numbers prior to being sold to the general public (Assembly Bill No. 2552, 2022). Each of these regulations were meant to further restrict PMF assembly and proliferation within the state.

However, these regulatory shifts were not always received positively; in August 2022, Defense Distributed, a company selling products and software for the private manufacture of firearms, challenged the legality of AB 1621 and SB 1327 under the Second Amendment (Willinger, 2022). A federal judge in the Central District of California denied Defense Distributed's preliminary injunction, ruling that the plain-text of the Second Amendment does not apply to the self-manufacture of firearms (Willinger, 2022).

Additional state-level PMF legislation

While California's PMF crisis began comparatively early, its laws regulating these firearms were implemented around the same time that other states began enacting PMF regulations. Between 2018 and 2024, 15 U.S. states implemented laws regulating PMFs more

⁵ CNC milling machines: machines that utilize computer numerical control (CNC) technology to shape and cut metal components to create firearms (SYIL, 2024).

strictly (Everytown for Gun Safety, 2023; Giffords, 2024). These regulations tended to focus on expanding the definitions of firearms to include unfinished frames and receivers, and restricting the sale, transfer, and possession of unserialized frames and receivers, unserialized firearms, and undetectable firearms (Everytown for Gun Safety, 2023). In my panel regression analysis, I focus on PMF policies in nine of these 15 states. Below are brief, non-exhaustive summaries of each state's regulations:

New Jersey was one of the first states to pass PMF legislation, enacting its first PMF law in 2018 (Giffords, 2024). The policy prohibits anyone other than licensed manufacturers from purchasing any unserialized frames, receivers, or firearm parts, or to produce a firearm or firearm components using a 3D printer (Giffords, 2024). The law also disallows the manufacture or sale of any firearm that is undetectable by security screening devices (Giffords, 2024). The law was strengthened in 2019, illegalizing the possession, transfer, or sale of a firearm assembled using an unserialized frame or receiver (Giffords, 2024). Additionally, New Jersey passed legislation in 2022 to increase the penalties for various violations of the state's PMF law (Giffords, 2024).

Connecticut passed its first PMF regulation in 2019, restricting the sale or receipt of an unfinished frame, receiver, or firearm (Giffords, 2023). The state passed another law in 2024, prohibiting the possession of unserialized firearms and banning their distribution, sale, and importation into Connecticut (Giffords, 2023).

Washington also enacted PMF legislation in both 2019 and in 2022 (Giffords, 2024). The laws prohibit the manufacture, sale, transfer, purchase, and possession of unserialized firearms, with specific provisions against providing unserialized guns to people federally barred from

possessing firearms (Giffords, 2024). The regulations apply similar restrictions to unfinished and unserialized frames and receivers, as well as undetectable firearms (Giffords, 2024).

Washington law enforcement officers are also required to seize all illegal undetectable firearms, regardless of where they are found (Giffords, 2024).

Delaware enacted a strong PMF law in 2021, prohibiting untraceable and undetectable firearms (Giffords, 2023). This law also requires that unfinished frames and receivers have serial numbers, and prevents these unfinished firearm components from being sold by anyone without a federal license (Giffords, 2023).

New York enacted two PMF laws in 2021, which took effect in 2022 (Giffords, 2024). These regulations illegalize the sale, intended sale, exchange, giving, disposing, and possession of an unserialized completed or unfinished frame or receiver (Giffords, 2024). The laws also ensure that people prohibited by federal law from owning a firearm are also barred from possessing major firearm components, including a barrel, slide or cylinder, frame, or receiver (Giffords, 2024).

Nevada made its PMF legislation effective as of 2022, regulating unserialized assembled firearms as well as unfinished frames and receivers (Giffords, 2023). This regulation prohibits the manufacture, assembly, possession, sale, transfer, purchase, transport, and receipt of unserialized firearms, and applies similar restrictions to unfinished and unserialized frames and receivers (Giffords, 2023).

In Illinois, a PMF regulation was implemented in 2022 (Giffords, 2024). This law prohibits the sale, transfer, possession, transportation, and receipt of unserialized firearms, frames, or

receivers to any buyers other than federally licensed manufacturers, dealers, or importers (Giffords, 2024).

Maryland also enacted PMF legislation in 2022, clarifying the definition of a firearm so that it also included certain unfinished frames and receivers (Giffords, 2024). The law also includes several provisions prohibiting the sale or transfer of unserialized firearms, along with completed and unfinished frames or receivers, unless the frames and receivers have been imprinted with a federally-compliant serial number (Giffords, 2024). A year later, in 2023, Maryland applied many of these same restrictions and prohibitions to possession, as opposed to solely sale and transfer (Giffords, 2024).

Table 1. PMF regulation implementation dates

State	PMF Regulation Implementation Month/Year
California	June 2022, January 2023
Connecticut	October 2019
Delaware	October 2021
Illinois	May 2022
Maryland	June 2022, March 2023
Nevada	January 2022
New Jersey	November 2018, July 2019, July 2022
New York	April 2022
Washington	July 2019, March 2023

Implications of Federal Legislation

A regulation similar to that of various states was enacted at the federal level in 2022. That year, the Biden Administration’s Department of Justice (DOJ) announced a new rule allowing ATF to regulate PMFs, which went into effect in August 2022 (U.S. Department of Justice, 2022). The rule, 87 FR 24652, permits ATF to classify these guns as functional firearms, explicitly stating that ghost gun kits and some unfinished frames and receivers fall under the

federal definition of a “firearm” (U.S. Department of Justice, 2022). This new classification thus requires all firearm construction kits and some parts to be serialized, sold initially by a licensed dealer, and subjected to a Brady Background Check (U.S. Department of Justice, 2022). 87 FR 24652 was recently upheld by the Supreme Court (*Bondi v. VanDerStork*), indicating support for PMF regulations at the federal level of the judiciary (*Everytown for Gun Safety*, 2025).

Taken together, it seems that both the state and federal laws surrounding PMFs aim to reduce the number of these firearms in circulation, and thus their use in crime, by restricting their manufacturing, assembly, sale, and possession. 87 FR 24652 not only supports this goal by regulating PMFs in states without PMF legislation, but also further strengthens restrictions in states with existing laws. By subjugating PMF dealers to the same rules as fully assembled firearms manufacturers, 87 FR 24652 regulates the national supply chain for PMFs, and prevents individuals from circumventing state-level bans by ordering kits and parts online from dealers in other states (*Everytown for Gun Safety*, 2023).

Now with the advent of the Trump administration, the future of 87 FR 24652 is uncertain. While the Supreme Court has upheld the regulation for now, should the Trump Administration nullify the rule, the efficacy of state regulations become more important. Without regulation of the national supply chain for PMFs, state-level regulations will not only control PMF proliferation within a state’s own borders, but also whether out-of-state purchasers can access PMFs from other state’s markets.

This analysis fills an important gap in the existing literature. While PPRs experienced significant spikes between 2019 and 2021, and various restrictive PMF policies have since gone into effect, there is very little research studying the impact of these regulations on firearm

crime. The literature discussed earlier in this paper notes the importance of policy intervention and discusses the potential for PMF regulations to reduce PMF availability. However, this research does not engage in any further exploration of the impact or effectiveness of PMF regulations. These are especially critical considerations during the Trump Administration, with the possibility that 87 FR 24652 may be revoked. It is crucial to determine whether state PMF regulations are effective in reducing firearm crime such as homicide, so that if the rule is rescinded, state legislators are aware of the most effective mechanisms for regulating PMFs without restrictions at the federal level.

DATA

Descriptive Research: Impact of PMF Prevalence on Firearm Homicide Rates

The data for the descriptive research is derived from Volume II, Part III of ATF's National Firearms Commerce and Trafficking Assessment (NFCTA), along with the California Department of Justice's Office of Gun Violence Prevention October 2024 Report: "California's Fight Against the Ghost Gun Crisis: *Progress and New Challenges*." Data on youth firearm homicides, male and female firearm homicides, and total homicides for both the nation and California are taken from the CDC WISQARS. Additionally, youth, female, male, and total populations for California and the nation are taken from CDC WISQARS.

Panel Regression Analysis: Multi-State Analysis of PMF Regulations on Homicide

The estimates presented are based on panel data for nine states that met the study's qualifications for inclusion. To ensure that the regulations being compared were sufficiently uniform for the purposes of the analysis and coding, I selected states with PMF regulations that specifically required serial numbers and/or background checks for component parts of firearms.

I then restricted this sample to states for which there is at least one year of data on the outcome measures following the regulation's effective date. These restrictions filtered out states with other types of PMF policies and policies that went into effect in 2023, as 2024 WISQARS data is currently unavailable. I then removed states that had years in which homicide rates were 0 to avoid skewing the results.

These restrictions produced a list of 9 states that met the criteria, which I used to conduct the analysis: California, Connecticut, Delaware, Illinois, Maryland, Nevada, New Jersey, New York, and Washington. I also present estimates based on only 8 of the 9 states, excluding Nevada due to significant fluctuations in its outcome variables over time. States are derived from a list of states with PMF regulations provided by the advocacy organizations Giffords and Everytown for Gun Safety (Giffords, 2025; Everytown for Gun Safety, 2023). All firearm homicide rates (youth, total, male, and female) are taken from CDC WISQARS, along with non-firearm homicide rates and total homicide rates. While other sources, such as the FBI's Supplementary Homicide Reports and Uniform Crime Reports, provide similar data, CDC WISQARS data are generally considered to be more reliable. Additionally, youth, female, male, and total populations for each state are taken from CDC WISQARS. When building the panel dataset, multiple years for various states were suppressed by CDC WISQARS. A discussion of how I supplemented this data is included in Appendix A.

EMPIRICAL STRATEGY

Descriptive Research: Impact of PMF Prevalence on Firearm Homicide Rates

To understand the potential relationship between PMF availability and firearm homicide rates, I conduct a descriptive study to explore how trends in firearm homicide rates may relate

to the rise, fall, and regulation of PMFs. I first demonstrate California's leadership in PMF recoveries through a comparison of PPRs in California and the rest of the nation. I then conduct a preliminary examination of whether this leadership translated into distinct firearm homicide trends. Specifically, I assess whether changes in California and national firearm homicide rates correspond with shifts in PMF availability, and whether California's trend diverged from that of other states. Within California, I evaluate whether youth and male firearm homicide rates increased more than those for older individuals and females, as the former groups are expected to be more sensitive to PMF availability.

Panel Regression Analysis: Multi-State Analysis of PMF Regulations on Homicide

To estimate the effect of state-level PMF policies on firearm homicide rates, I conduct a panel regression analysis. The dataset includes nine states and eleven years of data (2013-2023), with outcome variables measured annually for each state. The two-way fixed effects model used in the analysis includes a treatment variable that equals 0 in the years prior to the policy's implementation, 1 in the years after the implementation, and a fraction in the year of implementation, where the fraction is equal to the portion of the year in which the regulation was in effect. The purpose of the fraction is to ensure that any potential effects of the policy are attributed only to the months and years following the policy's implementation.

Several states in the panel enacted multiple relevant regulations at different points in time. To ensure sufficient post-policy outcome data, I used the implementation month and year of the regulation that went into effect prior to 2023. This approach provided at least one full year of firearm homicide data following the law's enactment. In the case of New Jersey, where all applicable regulations were enacted before 2023, I used the implementation month and

year of the earliest policy that specifically mandated serial numbers and/or background checks for firearm component parts.

To account for any other state characteristics that affect homicide, the regression model includes year and state fixed effects. I control for heteroskedasticity in the regression by clustering standard errors at the state level.

RESULTS: IMPACT OF PMF PREVALENCE ON FIREARM HOMICIDE RATES

In this section, I first demonstrate California's leadership in PMFs by comparing PPRs in California with PPRs nationwide. I then conduct a preliminary exploration of the consequences of this leadership for homicide patterns in California. Specifically, I determine whether changes in the California and U.S. firearm homicide rates corresponded with shifts in PPRs, and whether California's firearm homicide rate rose more sharply than the firearm homicide rate trend observed across all other U.S. states.

I then determine whether within California, the homicide rate increased more for youth than for older victims, and whether the rate increased more for males than for females. I observe these demographic groups specifically because I assume that youth and males are more sensitive to PMF availability, due to legal restrictions on firearm possession due to age for the former and gang association for the latter.

Figure 2 presents data on the PPRs in California and nationwide between 2015 and 2023. PPRs in California increase significantly between 2017 and 2021, and while national PPRs also rise, this increase is much less dramatic than in California, highlighting California's leadership in PMFs in comparison to other states.

California PPRs begin to decline in 2021, and continue to do so through 2023. Notably, PPRs are at 17.6% in 2022, the same year that both 87 FR 24652 and AB 1621, California’s first PMF law, went into effect. PPRs subsequently drop to 15.1% in 2023. This decrease indicates a potential relationship between the implementation of both regulations and reduced PMF availability in California, although it is difficult to disentangle the effects of the state regulation from the federal regulation, since they were implemented in the same year.

National PPRs, on the other hand, continue increasing until 2022, when they decline very slightly through 2023. While it is a small decrease, the reduction highlights the possibility of a relationship between the implementation of 87 FR 24652 and reduced PMF availability across the U.S.

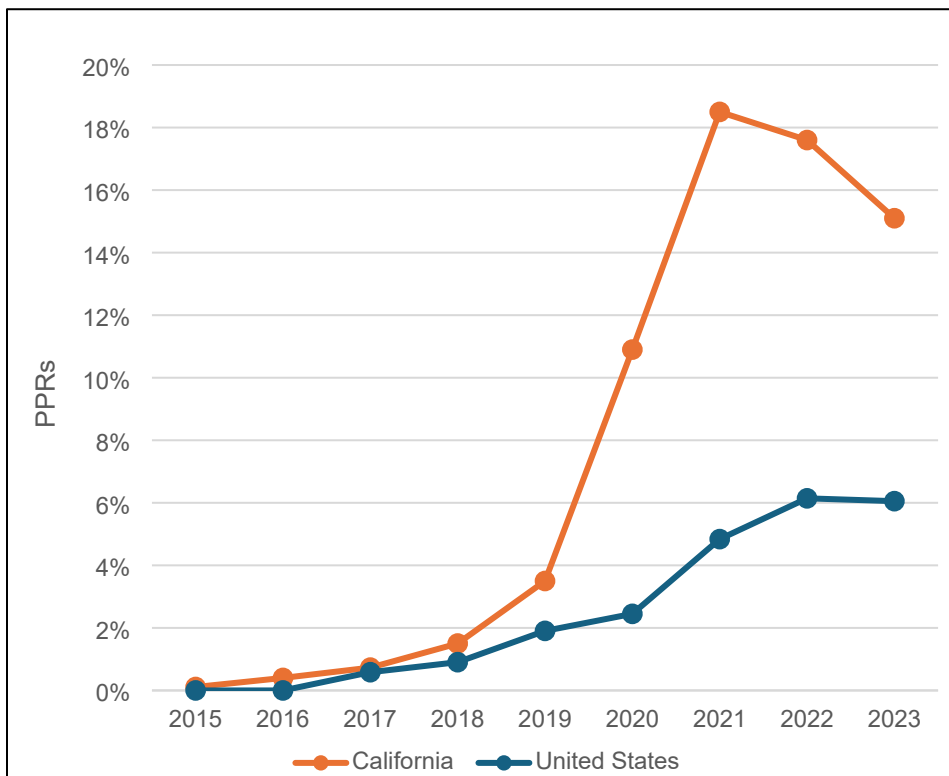


Figure 2. PPRs in California and the United States from 2015-2023, by year

Homicide rate trends are influenced by a variety of factors, most notably (in recent years) by COVID-19 in 2020. To a large extent, the forces that move homicide rates are national, and state rates are highly correlated as a result. The national rate therefore serves as a control for California. If PMFs were uniquely important in California from 2017 to 2021, I would expect that the firearms homicide rate would increase more in California than nationwide. Figure 3 indicates that firearm homicide rates do not follow this expected pattern, decreasing between 2017 and 2019. These results indicate that during this time, there were likely other California-specific factors playing an important role in the state’s firearm homicide rate.

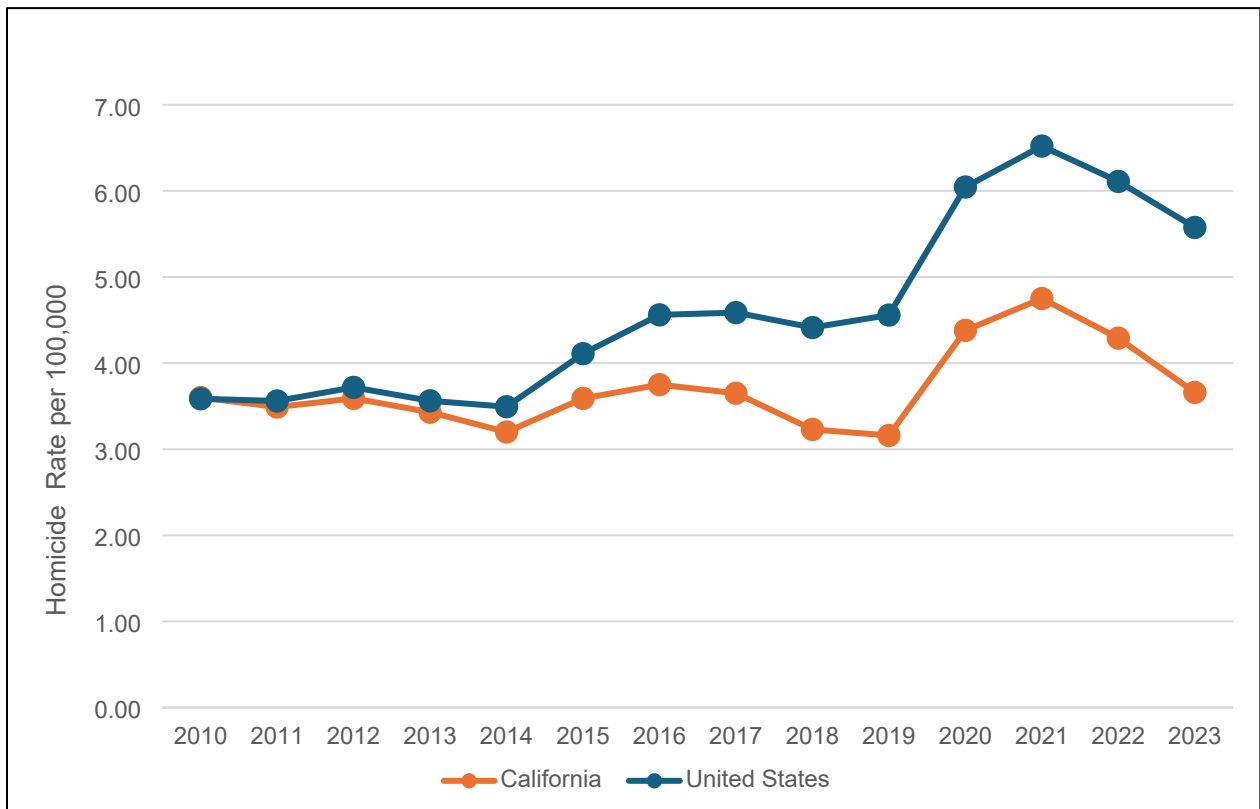


Figure 3: Firearm Homicide Rates in California and the United States, by year

Similarly, Figure 4 indicates that the ratio of California firearm homicide rates to national firearm homicide rates declines between 2017 and 2019, and increases slightly between 2019 and 2021. These findings do not point to a relationship between increasing PMF availability and increasing firearm homicide rates, for if this relationship existed, I would expect to see an increase in this ratio between 2017 and 2021. Figure 4 also shows a reduction in the ratio between 2022 and 2023. While this decrease coincides with the implementation of both state and federal PMF regulations, the effect of 87 FR 24652 cannot be inferred from California's relative decline in firearm homicide rates alone, because the regulation applies to all states. It is also difficult to determine whether the state policy had an impact on this ratio, because it went into effect the same year as the federal rule, making it challenging to disentangle the effects of each individual policy.

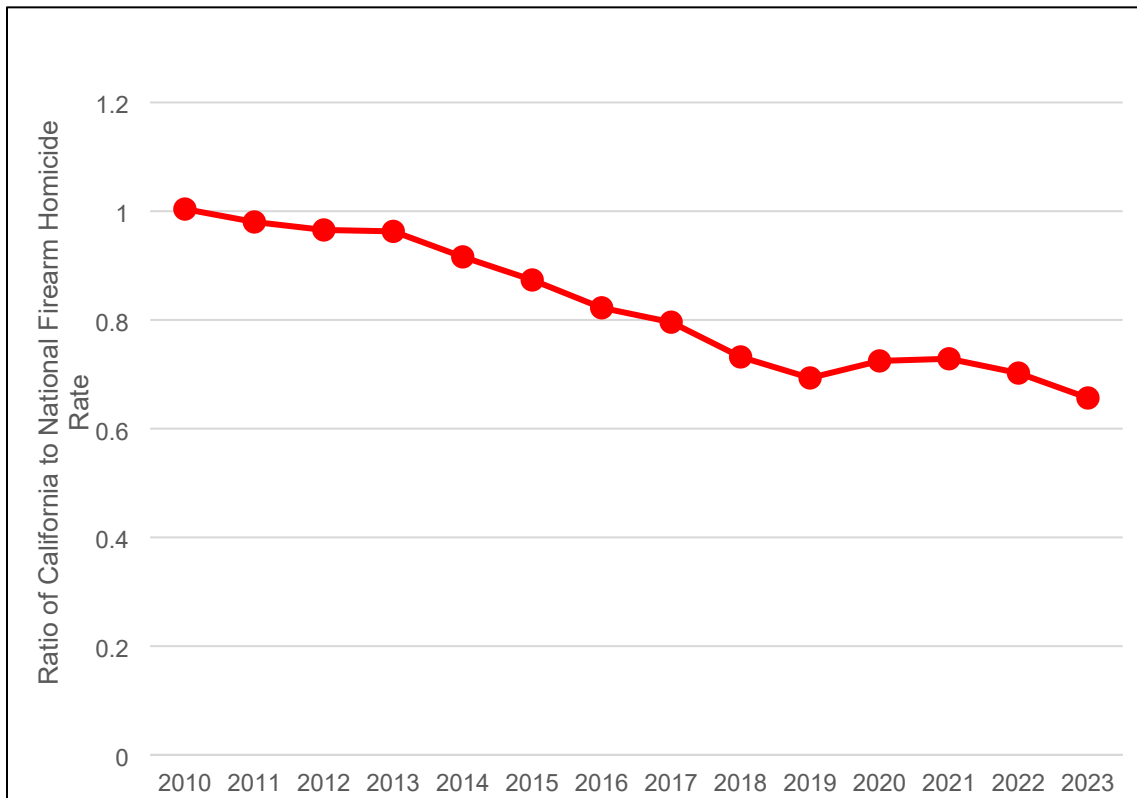


Figure 4: Ratio of California Homicide Rate to U.S. Homicide Rate, by year

Figures 5 and 6 explore the possibility that certain demographic groups are more sensitive to changes in PMF availability. I would expect to see increases in ratio of the youth firearm homicide rate to the adult firearm homicide rate, and the ratio of the male firearm homicide rate to the female firearm homicide rate, between 2017 and 2021. This increase would indicate that these sensitive groups are responding to California’s increasing PMF availability during those years. I would also expect to see a decrease in the ratio from 2022 to 2023, because 87 FR 24652 and AB 1621 took effect in 2022, likely reducing PMF availability.

Figure 5 shows that while the ratio of the youth firearm homicide rate to the adult firearm homicide rate in California increases slightly from 2017 to 2019, it falls between 2019 and 2021. The ratio then increases again from 2021 through 2023. These findings do not follow the pattern that we would expect if PMF availability had larger effects on youth than on adults.

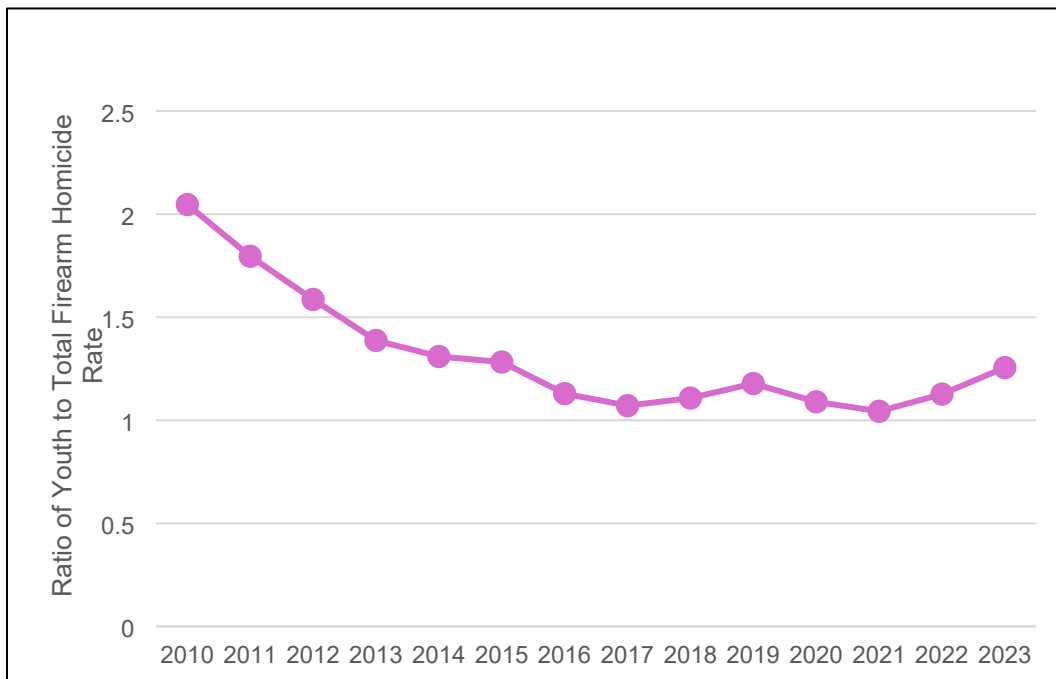


Figure 5. Ratio of Youth Firearm Homicide Rate to Total Firearm Homicide Rate in California, by year

Figure 6 indicates that the ratio of the male firearm homicide rate to the female firearm homicide rate in California increases from 2017 to 2021, and then declines from 2021 through 2023. These findings follow the trends expected if the male firearm homicide rate is more sensitive to PMF availability than the female firearm homicide rate. However, Figure 6 also shows a sharp decline in the ratio from 2016 to 2017. There is no clear explanation for this reduction; it resembles the type of discontinuity that might occur if definitions or data collection methods changed, although there is no evidence that such a change occurred. This unexplained drop introduces uncertainty about how to interpret trends across the entire period.

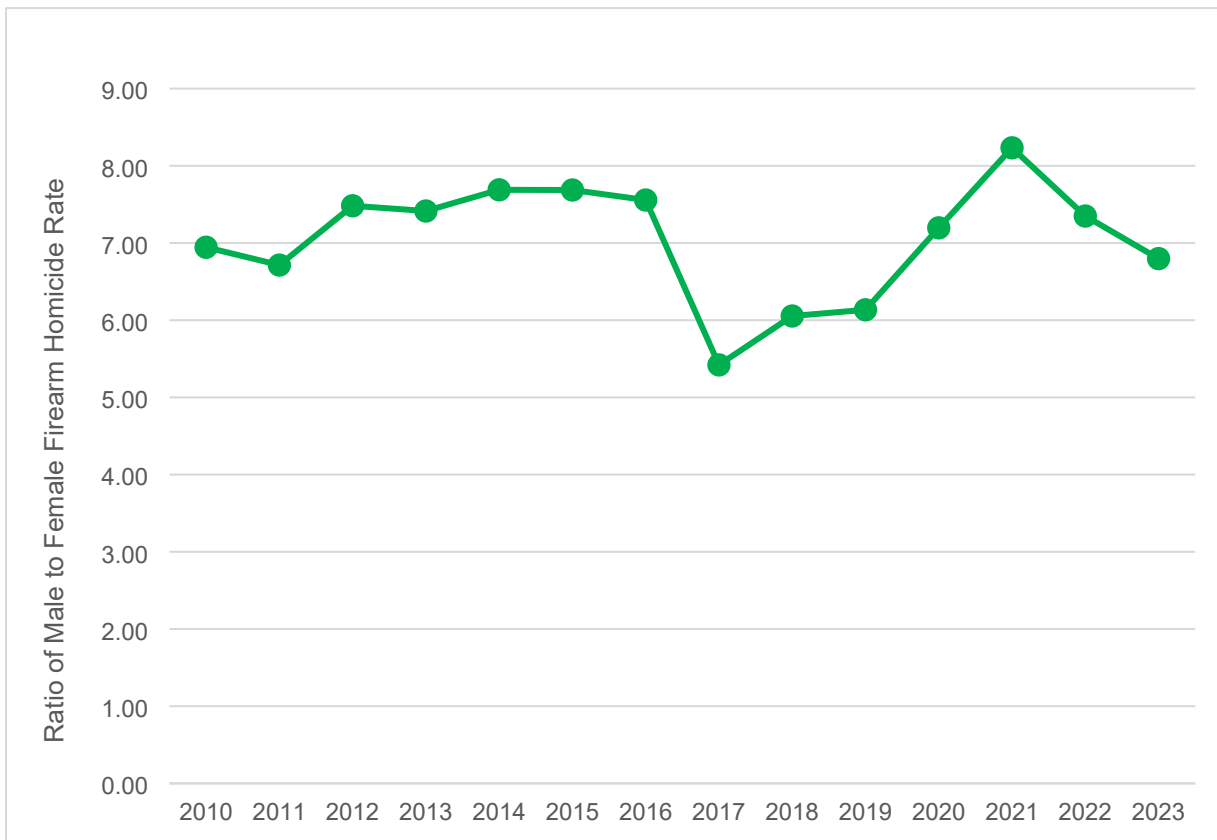


Figure 6. Ratio of Male Firearm Homicide Rate to Female Firearm Homicide Rate in California, by year

Overall, Figure 3 highlights a reduction in firearm homicide rates between 2022 and 2023, indicating a potential impact of 87 FR 24562 on national firearm homicides, and the federal regulation and AB 1621 on firearm homicides in California. Figure 6 also indicates an increase in the ratio of the male firearm homicide rate to the female firearm homicide in California from 2017-2021, highlighting the possibility that males are more sensitive than females to PMF availability. However, the results do not provide any clear indication that the increased availability of firearms associated with the growth of PMFs had an impact on the firearms homicide rate, or firearm homicide rates with respect to age or sex. These results, along with the fact that the controls in these analyses are very weak, necessitate further exploration of this data through a casual analysis.

RESULTS: MULTI-STATE ANALYSIS OF PMF REGULATIONS ON HOMICIDE

To determine the impact of PMF regulations on firearm homicide, I conduct a panel regression analysis of nine states with existing PMF regulations from 2013 to 2023. The regression model includes fixed effects for year and state to isolate the effect of the state regulations on the outcome variables.

Table 2 presents an estimate for annual firearm homicide rates in the years following the enactment of a state's PMF policy. There is a statistically significant decrease in firearm homicides of 1.28 per 100,000 people per year (-2.404, -0.152), implying a 29.9% reduction compared to the pre-policy average firearm homicide rate within the same states. A detailed explanation of this magnitude calculation is included in Appendix B.

These results show a clear temporal association between the implementation of PMF policies and subsequent reductions in firearm homicide rates in the states that adopted them, providing strong evidence of a causal effect of PMF regulations on firearm homicide rates.

Table 2 also presents estimates for the effect of the policy on non-firearm and total annual homicide rates. The goal of observing these outcome measures is to determine whether a substitution effect, in which perpetrators use a different weapon to commit homicide if guns are less available, is present. Column 2 indicates that some substitution may exist, as there is a significant increase in non-firearm homicides of 0.22 per 100,000 people per year (0.033, 0.398), implying a 13.8% increase. However, any substitution effect is likely small given the size of the coefficient. The probability of any substitution effect being minimal is further supported by the fact that there is still a marginally significant reduction in total annual homicides of 1.07 per 100,000 people per year (-2.14, 0.002), implying a 18.3% reduction, as shown in Column 3.

Each of these reductions are quite large in magnitude, implying that many lives were saved by the states' regulations. However, existing trace data indicates that PMFs account for a very small percentage of crime guns recovered, threatening the notion that such large reductions in firearm homicide are a result of the elimination of firearm homicides with PMFs. Even so, it is likely that police are only submitting a fraction of recovered PMFs for tracing, and that the prevalence of PMFs in homicide may be larger than the statistics from the trace data. Trace data are dominated by guns confiscated by the police because they are being carried illegally, and it is possible that the use of PMFs in shootings may be substantially more prevalent (ATF, 2023). While either way, the size of the reductions may not be entirely

accurate, the lower ranges of the 95% confidence intervals in Table 2 likely provide a more credible estimate of the true reduction in firearm homicides.

Table 2.
Effect of PMF policy on homicide rates

	Annual Homicide Rate		
	Firearm (1)	Non-Firearm (2)	Total (3)
Enactment of Policy	-1.278** (0.488)	0.215** (0.079)	-1.069* (0.464)
95% CI	[-2.404, -0.152] [0.033, 0.398] [-2.14, 0.002]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	99	99	99
R ²	0.907	0.768	0.913
Adjusted R ²	0.884	0.713	0.892
Residual Std. Error (df = 79)	0.736	0.225	0.787
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			

Table 3 provides estimates for youth, male, and female annual firearm homicide rates. Column 2 indicates a statistically significant decrease in male firearm homicides of 2.27 per 100,000 people per year (-4.081, -0.453), implying a 29.9% reduction. These results suggest strong evidence for a causal relationship between PMF regulations and reduced male firearm homicide rates. The effect on youth and female annual firearm homicides rates is not significant. Still, both groups experience a decline in firearm homicide rates after the PMF policy's implementation, and there is a reduction in female annual firearm homicides of 28.8%.

While as in Table 2, the large decreases in male and female firearm homicide rates are questionable, the lower end of the distribution of the 95% confidence intervals for each outcome measure in Table 3 provide more credible estimates of the reductions.

Table 3
Effect of PMF policy on firearm homicide rates

	Annual Firearm Homicide Rate		
	Youth (1)	Male (2)	Female (3)
Enactment of Policy	-0.983 (0.723)	-2.267** (0.787)	-0.314 (0.224)
95% CI	[-2.65, 0.684] [-4.081, -0.453] [-0.832, 0.203]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	99	99	99
R ²	0.852	0.907	0.783
Adjusted R ²	0.816	0.885	0.730
Residual Std. Error (df = 79)	1.692	1.342	0.320
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			

Additionally, Table 4 estimates the PMF policy's effect on the ratio of youth to total annual firearm homicide rates, the ratio of male to female annual firearm homicide rates, and the ratio of female to male annual firearm homicide rates. The table indicates that the policy enactment has no statistically significant effect on either outcome variable. Column 1 shows an increase in the ratio of the youth firearm homicide rate to the total firearm homicide rate of 0.21 per 100,000 people (-0.086, 0.514), implying a 14.7% increase. Focusing on gender ratios, Column 2 indicates an increase in the ratio of the male firearm homicide rate to the female

firearm homicide rate of 0.01 per 100,000 people (-0.056, 0.075), implying a 0.12% increase. Similarly, Column 3 shows a decrease in the ratio of the female firearm homicide to the male firearm homicide rate of 0.01 per 100,000 people (-0.051, 0.041), implying a 3.2% reduction. These results are not significant, and do not provide enough evidence to determine whether these trends are a result of PMF policies.

Table 4
Effect of PMF policy on firearm homicide rate ratios

	Annual Firearm Homicide Rate Ratios		
	Youth:Total (1)	Male:Female (2)	Female:Male (3)
Enactment of Policy	0.214 (0.130)	0.009 (0.028)	-0.005 (0.020)
95% CI	[-0.086, 0.514] [-0.056, 0.075] [-0.051, 0.041]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	99	99	99
R ²	0.565	0.712	0.681
Adjusted R ²	0.461	0.643	0.604
Residual Std. Error (df = 79)	0.253	0.067	0.043
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			

Prior to conducting the regression analysis, I plotted the outcome variables for each state from 2013-2023 to determine whether any state had significant fluctuations in its data that might skew the estimates. These graphs are included in Appendix C. I found that Nevada did have some large fluctuations year-to-year, so I ran a second panel regression analysis excluding Nevada. The results are quite similar, with a statistically significant reduction in firearm homicides of 1.52 per 100,000 people per year, implying a 36.1% reduction, and a

statistically significant reduction in male firearm homicides of 2.61 per 100,000 people per year, implying 34.2% reduction. There is still an increase in non-firearm homicides and thus evidence of a substitution effect. However, the coefficient is smaller and the effect less significant compared to the original analysis, and there is a statistically significant decrease in total homicides of 1.33 per 100,000 people per year, indicating that any substitution effect is minimal. Tables containing the results of this analysis are included in Appendix D.

The results of this panel regression analysis are limited by the fact that the panel consists of a small number of states, and includes only a few years outcome variable data following the implementation of a PMF policy. Because there are only 15 total states with PMF policies and CDC WISQARS firearm homicide data is only available through 2023, these limitations are unavoidable, but still may impact the results.

Despite the limitations, the panel regression analysis results provide strong evidence for a causal effect of PMF policies on firearm homicide rates in the states in which these policies are implemented, both among the overall population and for males in particular. While there is some evidence of substitution, any substitution effect is likely small. Additionally, although the substantial reductions in firearm homicide for many of the outcome variables are not entirely plausible, the lower bounds of the 95% confidence intervals provide more credible estimates of the effect size of the implementation of a PMF policy.

CONCLUSION AND RECOMMENDATIONS

The goal of this paper was to determine the impact of PMF availability and legislation on firearm crime. To do so, I conducted both a descriptive study and a panel regression analysis focused on firearm homicide outcomes. The descriptive study compared PPRs in California to

PPRs nationally from 2015-2023, as well as the changes in youth, male, female, and total firearm homicide rates, both in California and nationwide, from 2010-2023. While the results show the possibility of a relationship between PMF availability/legislation and a reduction in firearm homicide rates, they also indicated that despite California's leading role in the adoption of PMFs in crime, the state's firearm homicide rate did not increase relative to the rest of the country; in fact, the rate decreased. While there may have been other California-specific factors during the state's PMF influx period that mitigated firearm homicides in the state, the results of the descriptive study do not provide evidence for any causal relationship between PMF availability and firearm homicides.

The panel regression analyzed firearm homicide rates across the observed demographic groups in nine states with existing PMF policies, before and after the policy's implementation. The results of the analysis show statistically significant and large reductions in total annual firearm homicide rates and male annual firearm homicide rates after the implementation of the PMF policy. Additionally, the results indicate a small statistically significant effect on non-firearm annual homicide rates, indicating some substitution of homicide weapons in the absence of PMFs. However, the coefficient was small and accompanied by a marginally significant reduction in total annual homicide rates, indicating that any substitution effect is likely small. These results provide strong evidence for a causal effect of PMF policies on firearm homicide rates in the states in which these policies are implemented.

Based on these conclusions, I present the following recommendations to the Johns Hopkins Center for Gun Violence Solutions:

- I. **Advocate** with local, state, and federal lawmakers for **PMF policies** that require **serial numbers and/or background checks** for component parts of firearms.
- II. Consider including **PMF tracing and reduction** in **CGVS's priority-based gun violence prevention policies**, based on the significant reductions in total firearm homicide after implementation at the state level.
- III. **Advocate** with local, state, and federal lawmakers, as well as **local and state police departments**, for **policies requiring firearms tracing**, to improve the identification and reporting of PMFs.
- IV. **Replicate** this causal study in future research as more data on PPRs and firearm homicide rates become available, to obtain more accurate results.
- V. Conduct **future research** exploring the impact of **differences in state PMF regulations** on firearm homicide rates, to determine the more effective PMF policies.

These recommendations have the potential to improve research on PMF availability and impacts, as well as reduce the number of overall firearm deaths across the United States.

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Appendix A

Missing CDC WISQARS Data

CDC WISQARS suppresses homicide data in a given year if there were fewer than 10 homicides in that year and state. However, CDC WISQARS still provided the total number of homicides for the 2013-2023 period, so I was able to estimate the number of deaths in the missing years. For example, for youth firearm homicides in Connecticut from 2013 to 2023, CDC WISQARS generated the following table:

Table A1.
Connecticut youth firearm homicide data 2013-2023, by year

Year	Deaths	Population	Crude Rate	Age-Adjusted Rate	Years of Potential Life Lost
2023	15**	416,884	3.60**	--	710
2022	20**	420,997	4.75**	--	946
2021	21	425,218	4.94	--	991
2020	16**	419,406	3.82**	--	753
2019	--	421,891	--	--	--
2018	--	426,528	--	--	--
2017	10**	430,927	2.32**	--	478
2016	--	435,128	--	--	--
2015	11**	439,938	2.50**	--	520
2014	12**	446,335	2.69**	--	569
2013	--	451,075	--	--	--
Total	133	4,734,327	2.81	--	6,290

Note. Taken from the Center for Disease Control Web-based Injury Statistics Query and Reporting System (WISQARS). Copyright 2025 by the Center for Disease Control.

Source: Center for Disease Control Web-based Injury Statistics Query and Reporting System (WISQARS).

To calculate the missing values, I performed the following calculations:

1. Add known values
 - $15+20+21+16+10+11+12 = 105$
2. Subtract the sum of the known values from the total
 - $133 - 105 = 28$
3. Divide the remaining amount by the number of suppressed values
 - $28 / 4 = 7$

Because CDC WISQARS notes that all suppressed values are between 1-9, it is reasonable to assign the number 7 to all suppressed values in this specific case. I followed these same steps for all other tables with suppressed values.

APPENDIX B

Effect Magnitude Calculations

To determine the magnitude of the effect of the PMF policy enactment in the panel regression analysis, I calculated the percentage change in the outcome variables relative to the pre-policy baseline. This was done using the following formula:

$$\text{Percent Change}_i = \frac{\beta_i}{\bar{x}_i} * 100$$

Where:

- β_i is the regression coefficient for group i , (e.g. Youth, Total, Female, Male),
- \bar{x} is the pre-policy average for group i , and
- Percent Change_i is the calculated percent change for group i .

I also utilized the pre-policy averages to calculate the size of the effect using confidence intervals. This was done using the following formula:

$$\text{Percent Change}_i = \left(\frac{\beta_{i\text{lower}}}{\bar{x}_i}, \frac{\beta_{i\text{upper}}}{\bar{x}_i} \right) * 100$$

Where:

- $\beta_{i\text{lower}}$ and $\beta_{i\text{upper}}$ are the lower and upper bounds of the confidence interval for the coefficient β_i ,
- \bar{x} is the pre-policy average for group i ,
- The result is a range representing the confidence interval for the percent change.

Table 1 includes the pre-policy averages for all observed firearm homicide outcome measures, for all 9 states in the first panel regression analysis.

Table B1.

Pre-policy averages for main panel regression analysis

	avg_Youth	avg_Total	avg_Female	avg_Male	avg_Female_Male	avg_Male_Female	avg_NonFirearm	avg_TotalHomicide	avg_Youth_Total
1	6.38	4.27	1.09	7.58	0.16	7.51	1.56	5.83	1.46

Variables:

- Youth: Youth firearm homicide rate
- Total: Firearm homicide rate
- Female: Female homicide rate
- Male: Male homicide rate
- Female_Male: Ratio of female firearm homicide rate to male firearm homicide rate
- Male_Female: Ratio of male firearm homicide rate to female firearm homicide rate
- NonFirearm: Non-firearm homicide rate
- Total homicide: Homicide rate
- Youth_Total: Ratio of youth firearm homicide rate to total firearm homicide rate

Table B2 includes the pre-policy averages for all observed firearm homicide outcome measures, for all states in the first panel regression analysis excluding Nevada.

Table B2.

Pre-policy averages for panel regression analysis without Nevada

	avg_Youth	avg_Total	avg_Female	avg_Male	avg_Youth_Total	avg_Female_Male	avg_Male_Female	avg_NonFirearm	avg_TotalHomicide
1	6.38	4.22	0.97	7.61	1.47	0.14	8.03	1.47	5.69

APPENDIX C

Panel Regression Analysis State Selection

When observing state-level trends, I was originally looking at an outcome variable that I do not discuss at length in the paper: youth:total firearm homicide trends. When looking at these trends, there are large swings in Nevada (Figure B1), which prompted me to remove this state from the second round of the analysis in case the state was skewing any of the results.

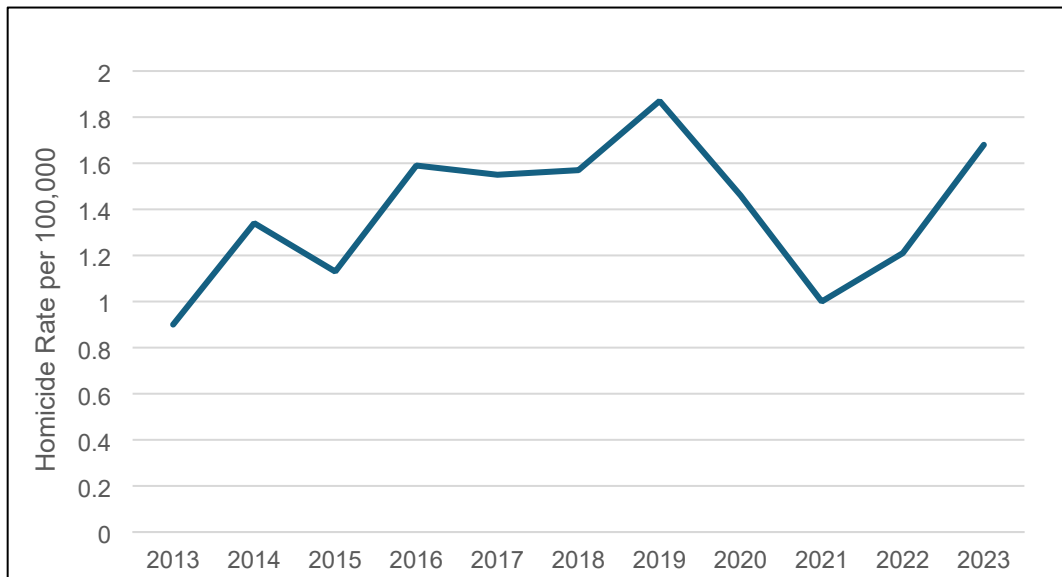


Figure C1. Nevada youth firearm homicide rate: total firearm homicide rate from 2013-2023, by year

As a comparison point, ratio trends for other states in the panel are plotted below:

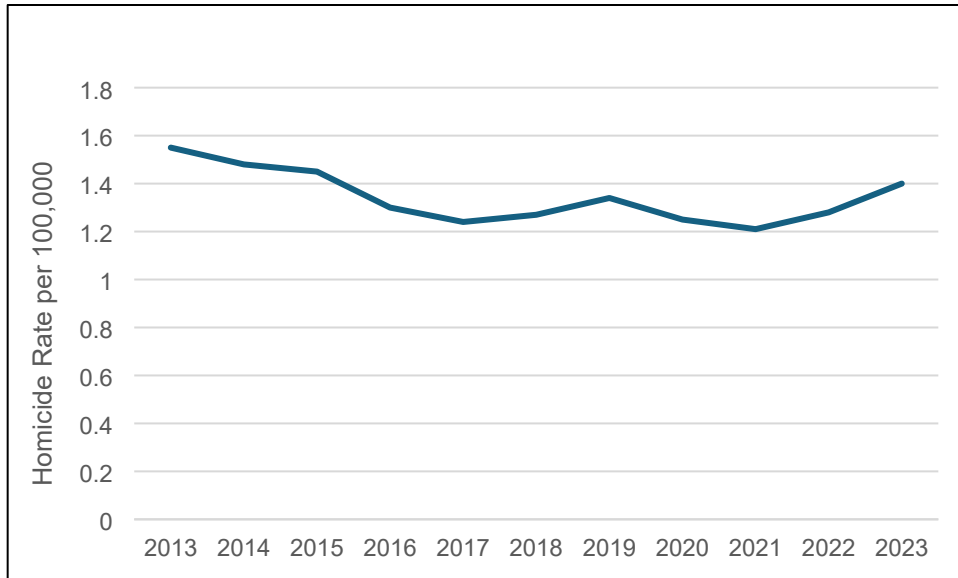


Figure C2. Ratio of California youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

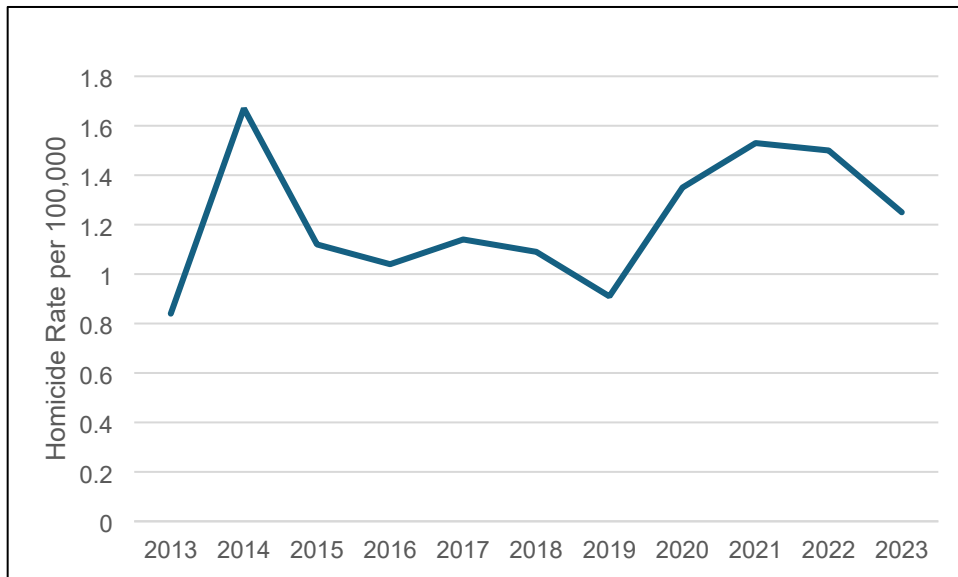


Figure C3. Ratio of Connecticut youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

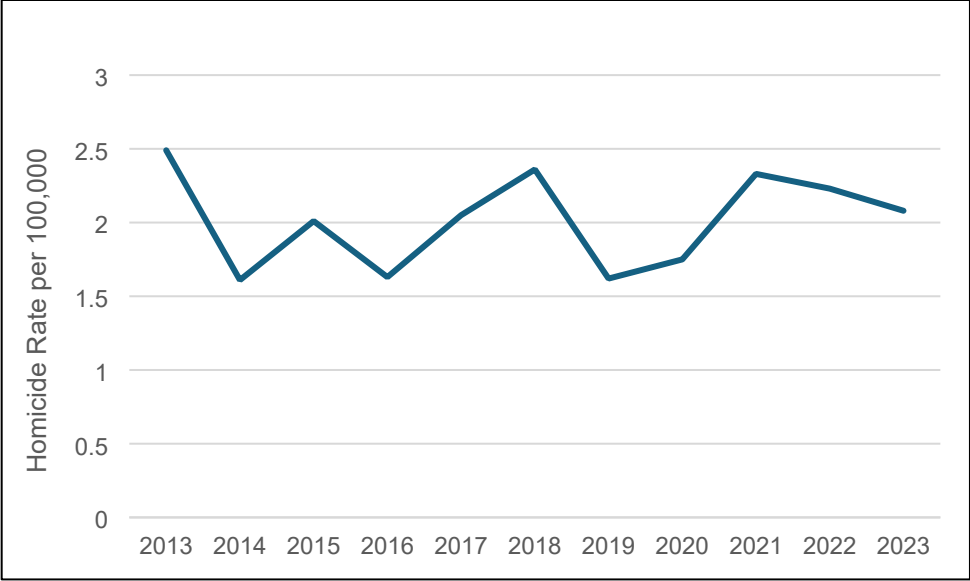


Figure C4. Ratio of Delaware youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

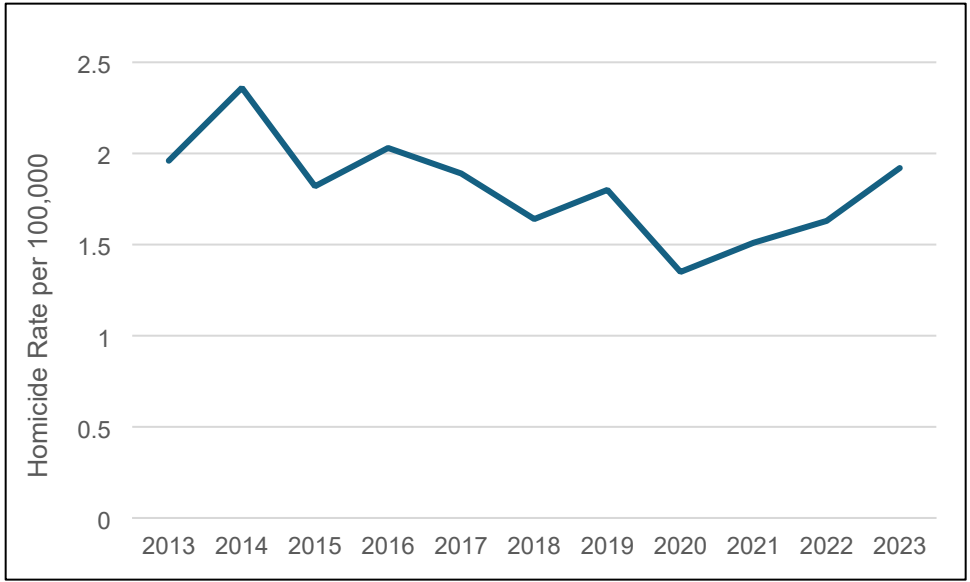


Figure C5. Ratio of Illinois youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

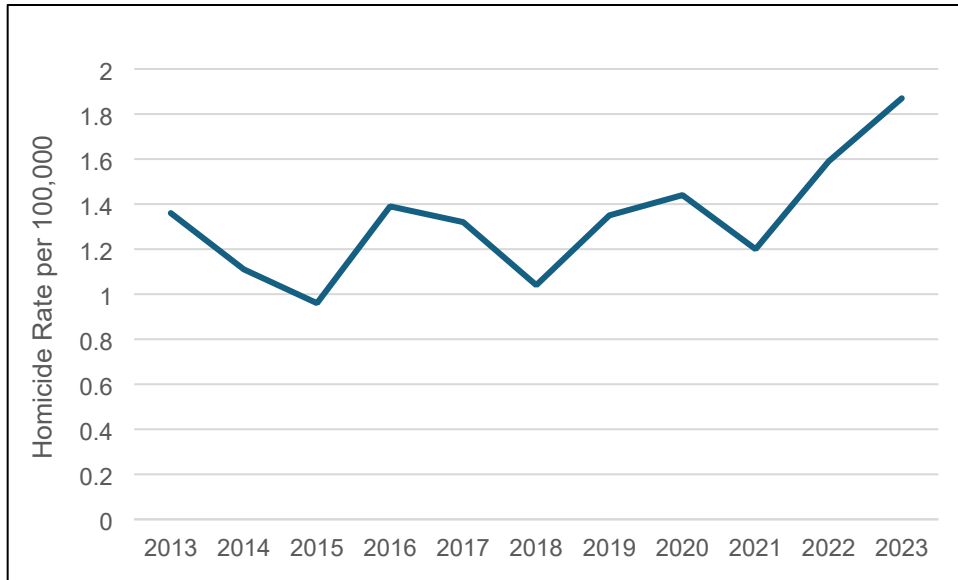


Figure C6. Ratio of Maryland youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

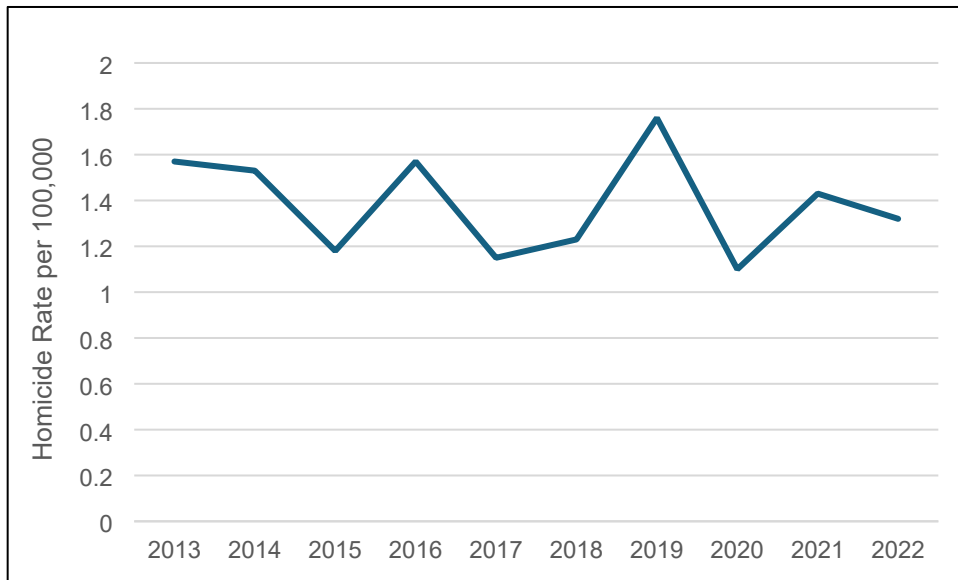


Figure C7. Ratio of New Jersey youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

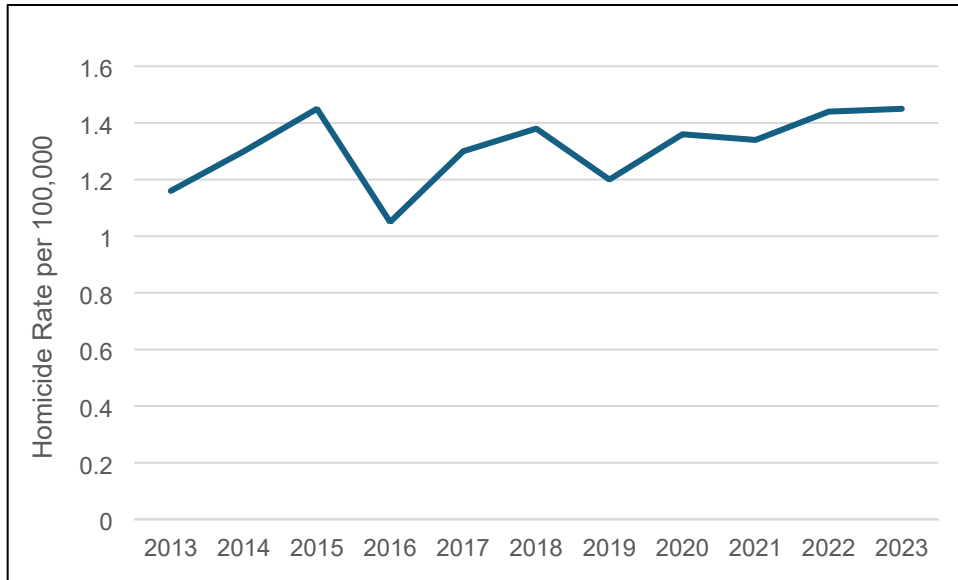


Figure C8. Ratio of New York youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

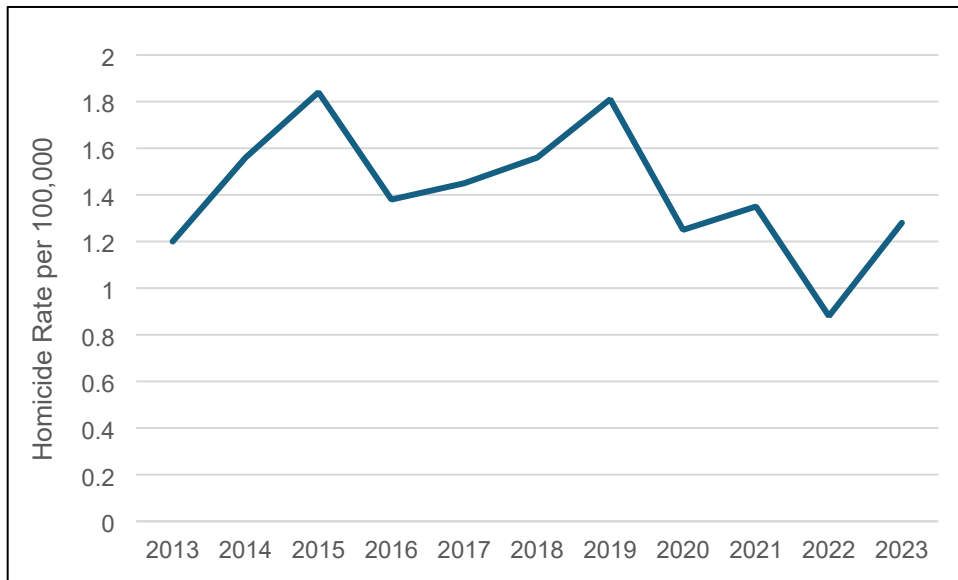


Figure C9. Ratio of Washington youth firearm homicide rate to total firearm homicide rate from 2013-2023, by year

Appendix D

Nevada Regression Results

As shown by Table D1, without Nevada, results for firearm homicide rates and total homicide rates were significant at the 5% level. There was a statistically significant decrease in firearm homicides of 1.52 per 100,000 people per year (-2.718, -0.328) implying a 36.1% reduction.

Table D1 also presents estimates for the effect of the policy on non-firearm and total annual homicide rates. The goal of observing these outcome measures is to determine whether a substitution effect, in which perpetrators will use a different weapon to commit homicide if guns are less available, is present. Column 2 indicates that some substitution may exist, as there is a non-significant increase in non-firearm homicides of 0.20 per 100,000 people per year (-0.013, 0.411), implying a 13.5% increase. However, any substitution effect is likely small given the size of the coefficient. The probability of any substitution effect being minimal is further supported by the fact that there is still a marginally significant reduction in total homicides of 1.33 per 100,000 people per year (-2.43, -0.234), implying a 23.4% reduction, as shown in Column 3.

Each of these reductions are quite large in magnitude, implying that many lives were saved by the states' regulations. However, existing trace data indicates that PMFs account for a very small percentage of crime guns recovered, threatening the notion that such large reductions in firearm homicide are a result of the elimination of firearm homicides with PMFs. Even so, it is likely that police are only submitting a fraction of recovered PMFs for tracing, and that the prevalence of PMFs in homicide may be larger than the statistics from the trace data. Trace data are dominated by guns confiscated by the police because they are being carried

illegally, and it is possible that the use of PMFs in shootings may be substantially more prevalent (ATF, 2023). While either way, the size of the reductions may not be entirely accurate, the lower ranges of the 95% confidence intervals in Table D1 likely provide a more credible estimate of the true reduction in firearm homicides.

Table D1
Effect of PMF policy on homicide rates, without Nevada

	Annual Homicide Rate		
	Firearm (1)	Non-Firearm (2)	Total (3)
Enactment of Policy	-1.523** (0.505)	0.199* (0.090)	-1.332** (0.464)
95% CI	[-2.718, -0.328] [-0.013, 0.411] [-2.43, -0.234]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	88	88	88
R ²	0.915	0.691	0.920
Adjusted R ²	0.893	0.611	0.899
Residual Std. Error (df = 69)	0.738	0.230	0.788
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			

Table D2 provides estimates for youth, male, and female annual firearm homicide rates. Column 2 indicates a statistically significant decrease in male firearm homicides of 2.61 per 100,000 people per year (-4.594, -0.619), implying a 34.2% reduction. Column 3 shows a marginally significant decrease in female firearm homicides of 0.47 per 100,000 people per year (-0.961, 0.01), implying a 48.4% reduction, and a non-significant decrease in youth firearm homicides of 1.29 per 100,000 people per year (-3.099, 0.522), implying a 20.2% reduction. As previously mentioned, the large estimates lack credibility, and the 95% confidence intervals for

each outcome measure in Table D2 provide a likely more accurate range of potential reductions in firearm homicide.

Table D2

Effect of PMF policy on firearm homicide rates, without Nevada

	Annual Firearm Homicide Rate		
	Youth (1)	Male (2)	Female (3)
Enactment of Policy	-1.288 (0.766)	-2.607** (0.841)	-0.472* (0.207)
95% CI	[-3.099, 0.522] [-4.594, -0.619] [-0.961, 0.017]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	88	88	88
R ²	0.870	0.915	0.768
Adjusted R ²	0.836	0.892	0.708
Residual Std. Error (df = 69)	1.678	1.364	0.300
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			

While Table D3 implies that there is an 16.8% increase in the ratio of youth firearm homicides to the ratio of total firearm homicides per year, a 0.35% increase in the ratio of male firearm homicides to female firearm homicides per year, and a 12.9% decrease in the ratio of female firearm homicides to male firearm homicides per year, there is no statistically significant change in either outcome.

Table D3.

Effect of PMF policy on firearm homicide rate ratios, without Nevada

	Annual Firearm Homicide Rate Ratios		
	Youth:Total	Male:Female	Female:Male
	(1)	(2)	(3)
Enactment of Policy	0.246 (0.139)	0.028 (0.026)	-0.018 (0.017)
95% CI	[-0.082, 0.575] [-0.033, 0.089] [-0.059, 0.023]		
State FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	88	88	88
R ²	0.613	0.648	0.619
Adjusted R ²	0.513	0.556	0.520
Residual Std. Error (df = 69)	0.244	0.064	0.039
* p<0.1; ** p<0.05; *** p<0.01			
Robust Standard Errors clustered at the state level			