Gun Violence in Black and White: Evidence from Policy Reform in Missouri

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Abstract

The role of state-level background check requirements for private firearm sales in reducing gun violence remains controversial in both the empirical literature and gun control policy debate. On August 28, 2007 the Missouri General Assembly repealed an 86 year-old "permit-to-purchase" (PTP) law requiring that handgun purchasers possess a permit, and subsequently undergo a background check, for all sales. The vast racial disparities in firearm homicide within Missouri raises important questions concerning the disproportionate impact of the repeal on Black communities throughout the state. Using generalized synthetic control estimation, this study finds that the PTP repeal led to an additional 1,234 handgun background checks by federally licensed dealers and an average seven percentage point county-level increase in the fraction of suicides committed with a firearm. State-level effects suggest that overall Black firearm homicide increases on average by an additional five deaths per 100,000 (17 percent increase) while the same rates for Black victims ages 15-24 rise by 29 deaths per 100,000 (33 percent increase). County-level estimates also show considerable increases in firearm homicide in Black communities within the more urban regions of the state. However, this study finds no evidence of an increase in firearm homicide among White Missourians.

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1 Introduction

Despite experiencing significant declines over the past twenty years, gun violence remains considerably higher in the United States (U.S.) relative to other western countries with significant disparities across racial groups (Grinshteyn and Hemenway (2016)). While constituting less than 13 percent of the population, Black Americans account for roughly half of all U.S. homicide deaths–with nearly 84 percent of Black homicide victims killed with firearms in 2013. In 2008, the Black homicide victimization rate exceeded the corresponding rate for White Americans by six fold with Black homicide offending rates in the same year being seven times greater. Homicide alone contributes nearly a full year to the 4.7 year gap in life expectancy between Black and White U.S. males (Kochanek, Arias, and Anderson (2013)). U.S. gun violence remains particularly concentrated in large urban cities and metropolitan areas across the country (Glaeser and Sacerdote (1999); O'Flaherty and Sethi (2010c)).

Over the course of the twentieth century, the U.S. experienced important changes in gun control laws designed to limit the proliferation of firearms to individuals associated with criminal activity. In particular, the 1993 Brady Handgun Violence Prevention Act set a federal mandate requiring background checks for all federal firearms license (FFL) sales and left regulation of private firearm sales to states. While 34 states essentially leave private firearm sales unregulated, a few states require that both unlicensed and licensed gun dealers perform background checks before making a transaction. Other states mandate that all individuals (i.e., licensed or unlicensed) seeking to make a firearm purchase must possess a permit—also known as permit-to-purchase (PTP) laws. According to the Bureau of Justice Statistics (BJS) 2005 Survey of State Procedures Related to Firearm Sales, only 16 states required some form of background check or licensing for private firearm sales. Despite the existence of significant racial disparities in firearm homicide victimization, the extent to which state-level gun control policies influence racial differences in homicide remains largely unexplored within the gun control literature.

This study examines how the 2007 permit-to-purchase law repeal influenced racial differences in homicide within the state of Missouri.[1] Under the former law, individuals wishing to purchase a handgun were required to apply for a permit for all firearm sales (i.e., licensed and unlicensed). The permit application process included an extensive background check conducted by each local sheriff's office–including information unavailable in federal background checks such as civil proceedings and arrest records. The repeal of the 86 year old PTP law effectively removed any formal screening of private firearm sales within the state.

Ranking among those states leading the nation in firearm homicide, Missouri serves as an interesting case study on the effects of gun control policy on firearm homicide for several reasons. First, the PTP law repeal took place more than 10 years after the national implementation of the Brady Act which led to changes in gun control policies for FFL dealers operating in several states. If any of these policy changes systematically influence patterns in gun trafficking between states, this behavior could influence any interpretation of the consequences of gun control policy reform. Second, Missouri possesses an extensive gun culture with robust primary and secondary markets for firearms throughout the state. The post-repeal period appears to coincide with a considerable increase in a proxies for overall gun prevalence in addition to a rise in the number of recovered Missouri crime guns originally purchased in the state.[2] This paper argues that the removal of legally required background checks led to an exogenous increase in gun proliferation to secondary markets with estimation results mirroring the geographic distribution of recovered crime guns. Figures 1-2 examine Missouri trends in various forms of serious index crime tracked by the FBI compared to similar trends at the national level. Other than murder and nonnegligent manslaughter, other

[1]This study excludes any analysis concerning Hispanic Missourians as they make up roughly four percent of the population, but account for less than three percent of all firearm homicide deaths over the 1999-2013 period.

[2]Unfortunately, Section 571.093 of the Revised Statutes of Missouri precludes the sharing of permit-to-purchase a firearm application data by any Missouri county sheriff's office and states, "If any sheriff retains record of permits to obtain concealable firearms issued under former section 571.090, as repealed by senate bills nos. 62 and 41 of the ninety-fourth general assembly, then such records shall be closed to the public. No such record shall be made available for any purpose whatsoever unless its disclosure is mandated by a valid court order relating to a criminal investigation."

forms of violent and nonviolent index are generally declining during the post-repeal period. Given that the overwhelming majority of murders are committed using firearms, these trends provide some suggestive evidence for a gun proliferation argument. Lastly, gun violence remains heavily concentrated among young Black men within the urban regions of the state such as the City of St. Louis, St. Louis County, and Kansas City (Jackson County)–accounting for nearly 80 percent of all firearm deaths in 2006. Support for stricter gun control policies in cities runs in stark contrast to the widespread support for less restrictive gun laws in rural areas of the state (Edsall (1999)).

Studies evaluating changes in state and federal gun laws provide fairly mixed evidence concerning their protective effects and often disagree on the selection of a suitable control group (Loftin et al. (1991); Kleck and Patterson (1993); Britt, Kleck, and Bordua (1996); Ludwig and Cook (2000); Koper and Roth (2002); Levitt (2004)). Using crime data from 1980 on large cities, Kleck and Patterson (1993) presents two-stage least squares estimates providing no evidence of an association between gun control laws and rates of violence. However, their usage of National Rife Association (NRA) membership and “liberal" voters as instruments remains questionable. Ludwig and Cook (2000) implement a quasi-experimental design based on the 1993 passage of the Brady Act–with the treatment units being the “Brady states" required by the new law to implement background checks on federally licensed sales in addition to enforcing a five day waiting period. The authors find no statistical evidence suggesting that the Brady Act lowered firearm homicide rates for any age group, but do find evidence of a reduction in firearm suicides among adults ages 55 and older. Koper and Roth (2002) find that the 1994 Federal Assault Weapons Ban led to a short-run surge in assault weapons production and decline in prices in the months shortly after the ban’s enactment. Rudolph et al. (2015) find that the 1995 implementation of Connecticut’s permit-to-purchase law led to a 40 percent reduction in firearm homicide 10 years after the law’s implementation, but provide no evidence of the law’s impact on secondary firearm markets and do not address issues of potential donor pool contamination. More recently, Levine and McKnight (2017) present evidence that the December 2012 shooting at Sandy Hook Elementary School in Newton, Connecticut resulted in an

additional 60 overall unintentional shooting deaths with 20 of them occurring among children.

Relevant to this study, Webster, Crifasi, and Vernick (2014) estimate the effect of the Missouri permit-to-purchase law repeal on (overall) state-level firearm homicide and murder rates. Citing concerns over confounding factors such as changes in crack cocaine markets during the 1990s, they specifically focus on a pre-intervention beginning in 1999 and post-intervention period leading up to 2012. The authors report an ordinary least squares estimate of an additional 1.09 firearm homicide deaths per 100,000 or a 23 percent increase, but find no evidence of an effect for nonfirearm homicide rates.

While Webster, Crifasi, and Vernick (2014) provide important insight regarding the impact of the permit-to-purchase law repeal on Missouri gun violence, their empirical approach possesses several limitations. First, the authors provide little direct evidence concerning the mechanism through which the permit-to-purchase law repeal led to an increase in firearm homicide. Understanding whether the impact of the repeal remains attributable to increased gun proliferation or changes in unemployment requires a more nuanced discussion on changes within secondary firearm markets within Missouri. Second, the authors utilize data from all 43 states with fully available vital statistics data on firearm homicide and their analysis implicitly assumes that each control unit should receive equal weight in constructing Missouri's counterfactual firearm homicide trends. The growing popularity of synthetic control estimation in policy evaluation stems from the fact that ad hoc control group selection often leads to conflicting results due to differences in the assumptions behind their constructed counterfactuals. While largely a puzzling omission within the larger empirical gun control literature, the authors also fail to address the extraordinary overrepresentation of young Black Missourians from urban areas in firearm homicide mortality. Focusing exclusively on state-level firearm homicide trends for the entire population also masks important heterogeneity in the impact of the repeal across age groups, racial groups, and geographical locations.

This study addresses a key issue within the empirical literature on gun control policy concerning the selection of control units in constructing counterfactual homicide rates. While finding evidence

of a slightly smaller treatment effect of 0.9716 for overall firearm homicide or a 17 percent increase, this study also re-examines the effects of the PTP law repeal on various Missouri subpopulations utilizing the generalized synthetic control (GSC) estimator introduced in Xu (2017). Building on the Abadie, Diamond, and Hainmueller (2010) synthetic control (SC) methodology and the interactive fixed effects model from Bai (2009), GSC estimation relaxes several assumptions behind SC estimation which assist in constructing valid counterfactual firearm homicide trends in Missouri– namely the inclusion of multiple treatment units and the reweighting of full control group data by accounting for unobservable latent factors. Thus, GSC estimation permits a deeper analysis into the persistently high Black firearm homicide rates in Missouri (relative to other states) and provides evidence of the heterogenous impact of the PTP repeal at the county-level.

This study finds that the Missouri permit-to-purchase law repeal led to significant changes to both primary and secondary firearm markets in Missouri. In particular, Missouri experienced an additional 1,234 handgun background checks per 100,000 residents and an average seven percentage point county-level increase (i.e., Jackson County and the Greater St. Louis area) in the fraction of suicides committed with a firearm over the post-repeal period. These results also suggest that the repeal led to significant increases in Black firearm homicide of five to six additional deaths per 100,000 (17 percent) over the post-repeal period. Firearm homicide among Black victims ages 15-24 increases on average by an additional 29 deaths (33 perecent) over this period with substantial increases in overall Black firearm homicide in the City of St. Louis, St. Louis County, and Jackson County. The greatest impact of the PTP repeal generally takes place within the first few years of the post-repeal period. Given the intense spatial concentration in post-repeal gun violence, these findings remains consistent with theories based on strategic complementarities in the economics of crime literature.

The paper proceeds in the following manner. Section 1.1 examines descriptive evidence concerning post-repeal changes in gun proliferation and the growing number of firearms recovered from crime scenes. Section 1.2 examines racial differences in Missouri firearm homicide trends

and provides context for these trends in urban areas of the state accounting for the majority of gun violence. An immediate discussion follows in Section 2 exploring the theoretical literature on the underlying mechanisms behind racial differences in crime. Section 3 describes the empirical strategy, data sources, and sample restrictions for this study. Section 4 reports the generalized synthetic control estimation results concerning gun proliferation and firearm homicide mortality. The paper concludes in Section 5.

1.1 Gun Ownership and the 2007 Missouri Permit-to-Purchase Law Repeal

In examining the the effects of the 2007 PTP repeal on firearm homicide within Missouri, an important question remains whether or not the repeal also led to an increase in the proliferation of firearms throughout the state. The number of background checks performed by federally licensed dealers provides some information concerning the increase in gun prevalence after the 2007 repeal. Figure 3 shows trends in National Instant Criminal Background Check System (NICS) background checks in Missouri and the U.S. by gun type. Under the former permit-to-purchase law, background checks by FFL dealers supplemented the more extensive checks conducted by local sheriffs' offices throughout the state.[3] While the NICS measure only reflects the rate of background checks in (potential) sales by FFL dealers, these rates provide valuable insight into the proliferation of firearms to secondary markets (legal and illegal). Missouri experiences a sharp post-repeal increase in handgun background checks relative to the national level. Missouri FFL dealers conducted an average 719.95 handgun background checks per 100,000 residents between 1999 and 2006 before rising to 1,381.34 handgun background checks in 2007 and peaking at 3,982.92 in 2013. Similar to national trends, the rate of long gun (e.g., rifles and shotguns) background checks remain fairly flat until undergoing a slight increase after 2010.

[3]The FBI launched NICS in 1998 as mandated by the Brady Handgun Violence Prevention Act of 1993. The FBI requires all FFLs to conduct a background check for all potential firearm or explosives purchases with intrastate private purchases being regulated by state law. NICS background checks generally take only a few minutes, but any check taking longer than three days in duration can proceed legally without further inquiry. For more information see: https://www.fbi.gov/services/cjis/nics

While administrative data providing reliable estimates of gun prevalence largely remain absent in the U.S., the economics of crime literature offers other insightful proxies for gun ownership (Duggan (2001); Cook and Ludwig (2006)). Empirical work below the national and state-level often utilize the fraction of suicides committed with a firearm (FSS) in estimating firearm prevalence in local private markets. Cook and Ludwig (2006) find evidence of a strong (positive) correlation between FSS and gun ownership measured in the General Social Survey relative to the correlation of the latter with *Guns and Ammo* magazine subscriptions. The authors also provide county-level evidence of a 0.173 firearm homicide elasticity with respect to lagged FSS. Moreover, the strong association between FSS and firearm homicide among victims ages 15-19 suggests that local secondary markets play an important role in driving the proliferation of firearms to underground markets.

Figure 4 shows county-level variation in FSS over the 1981-2013 study period for Jackson County, St. Louis County, and the City of St. Louis. Jackson County experiences a slight decline in FSS during the mid-2000s before rising to 43.3 percent in 2009. In St. Louis County, FSS fluctuates between 30 and 40 percent before reaching a high of 44 percent in 2012. However, the largest increase in FSS occurs within the neighboring City of St. Louis with nearly 67 percent of all suicides committed with a firearm in 2011.

This study remains particularly interested in the extent to which firearms become increasingly available among individuals associated with criminal activity. Table 1 provides descriptive evidence concerning the rate at which firearms tend to appear in Missouri crimes scenes relative to their purchase date. Since 2006 the average amount of time before recovery at a Missouri crime scene fell 26 percent from 11.22 years to 8.94 years in 2013 or two years below the national average. The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) also defines unusually short “time-to-crime" rates as crimes guns recovered within two years of original purchase from a FFL dealer and interpret this measure as a sign of gun trafficking. While the Missouri time-to-crime rate stands at 23.44 percent in 2006, this measure reaches a high of 45.3 percent in 2011 before declining

slightly to 39.26 percent in 2013. One interpretation of the significant decline in time-to-crime rates remains the increased value that illegal markets place on new firearms as older weapons possess greater risk of malfunction and links to previous crimes (Levitt and Venkatesh (2000)). The City of St. Louis and Kansas City account for the vast majority of Missouri firearm traces–roughly 40 and 20 percent over the 2007-2013 post-repeal period, respectively. At the height of post-repeal gun violence, the number of traced crime guns rose 28 percent in the City of St. Louis and 39 percent in Kansas City since 2006. Overall, the ATF trace data suggests that the Missouri PTP repeal led to a substantial increase in the domestic proliferation of firearms to illegal secondary markets.

1.2 Race and Homicide in Missouri

A considerable gap exists in the rates of firearm homicide across racial groups in Missouri. Constituting roughly 11 percent of the population, Black Missourians account for approximately 66 percent of all Missouri firearm homicide deaths over the study period. Figure 5 compares Missouri firearm homicide rates to rates at the national level by racial group using vital statistics data. As one might expect, the Black firearm homicide rates in Missouri largely mirror the overall state-level trends due to the significant overrepresentation of Black Missourians in firearm homicide. The Black firearm homicide rate in Missouri peaks at 50.74 per 100,000 in 1993, or roughly twice the national rate, before declining sharply in the late 1990s. The White firearm homicide rates in Missouri slightly exceed the national rates until the late 1990s when both rates fall to less than two deaths per 100,000. Both Black and White firearm homicide rates rise in Missouri during the post-repeal period–although the increase in Black firearm rates remains considerably higher after the PTP repeal.

Mortality data also suggests that an overwhelming number of Missouri firearm homicide deaths occurs among young Black males. In 2006, Black males between the ages of 10 and 30 accounted for nearly 45 percent of *all* firearm homicide deaths in the state. Figure 6 shows racial differences in male firearm homicide within the state of Missouri. While confirming a familiar age gradient

in firearm homicide, these data also show the extent of Black male overrepresentation in firearm homicide victimization across all age groups. Black firearm homicide rates are largely driven by young men ages 15-24 and rise to over 200 deaths per 100,000 in the early years of the post-repeal period. Post-repeal White male firearm homicide remains highest among victims in the intermediate range, but rates for each of these groups never exceeds 10 deaths per 100,000 over the study period.

Table 2 provides descriptive statistics for Jackson County, St. Louis County, and the City of St. Louis which account for the majority of firearm homicide within Missouri. The first four rows show significant changes in average overall firearm homicide and Black firearm homicide in the post-repeal period for all three areas. Black firearm homicide increases roughly 23 percent in the City of St. Louis from an average 40.71 deaths per 100,00 to 49.71 over the 2007-2013 period. Similarly, Jackson County experiences a 16 percent increase in Black firearm homicide and St. Louis County a 26 percent increase. Table 2 shows pronounced socioeconomic disparities among Black and White Missourians in each area. The percentage of female-headed households stands at 20 percent in the City of St. Louis compared to 15.31 percent in Jackson County and 13.64 percent in St. Louis County. Across each of these measures Black-White disparities remain consistently higher within the City of St. Louis which also hosts one of the largest Black populations among U.S. cities. According to U.S. census data, the City of St. Louis also ranks among the top 10 most racially segregated cities in the U.S. with the 2010 isolation index indicating that approximately three quarters of Black residents live in a census tract where the average Black person resides. The last two rows also show a considerably higher law enforcement presence for the City of St. Louis in terms of jail incarceration and law enforcement officers per capita.

2 Theories on Racial Differences in Homicide

Differential responsiveness to gun control policy reform, such as Missouri's permit-to-purchase law repeal, requires a deeper understanding of the various intellectual approaches to the question of race and crime. An extensive interdisciplinary literature exists providing theoretical explanations for racial differences in criminal behavior. The extent to which racial differences in gun violence remain attributable to poverty or cultural norms is a vital question for gun control policy evaluation. Much of the theoretical work on race and crime generally belongs to four different themes spanning disciplines from criminology to economics–social disorganization, cultural norms, gun proliferation, and social interactions.

2.1 Social Disorganization

Social disorganization theory focuses on the importance of certain ecological characteristics and social structures in shaping criminal behavior (Shaw and McKay (1942); Wilson (1987); Sampson and Wilson (1995)). According to this theory, the disproportionate representation of Black Americans in firearm homicide might emerge due to presence of greater socioeconomic disadvantage and the inability of neighborhood members to coordinate on acceptable cultural norms around gun violence. Indeed, Table 2 shows that Jackson County and the Greater St. Louis area exhibit many of the characteristics associated with social disorganization. The spatial distribution of gun violence in Missouri also remains consistent with a story based on social disorganization theory. Rural Missouri is overwhelmingly White with higher levels of poverty and lower levels of educational achievement relative to urban areas such as Kansas City and the Greater St. Louis area (Dyne et al. (2015)). However, firearm homicide almost exclusively takes place within the urban regions of the state. Social disorganization theory would suggest that despite the elevated presence of rural socioeconomic disadvantage, sparse populations and lower levels of residential turnover might allow for these areas to enforce certain cultural norms with respect to crime.

While social disorganization theory provides some insight concerning the pronounced racial differences in Missouri gun violence, the theory remains fairly limited in understanding the temporal variation in firearm homicide. Demographic and socioeconomic variables generally possess limited explanatory power in empirical work on homicide (Rogers et al. (2001); Levitt (2004); O'Flaherty and Sethi (2010a)). Given the significant role of firearms in Missouri homicide trends, social disorganization also offers little direction in understanding the impact of secondary firearm markets on racial differences in homicide.

2.2 Cultural Norms

In contrast to social disorganization theory, theories based on cultural norms place less emphasis on group-level differences in structural disadvantage and suggest a greater role for the social construction of group beliefs concerning crime. Anderson (2000) argues that the participation in activities such as drug markets by "street" people, in addition to a common distrust or lacking presence of institutions to enforce behavior within those markets, often push even "decent" people to pursue firearms in order to navigate the dangers of their environment. This street-decent characterization remains consistent with qualitative research on "code of the street" behavior within the most disadvantaged neighborhoods in the Greater St. Louis area–where lower levels of institutional mistrust allow for members of street families to perturb certain norms concerning the use of violence (Decker and Winkle (1996); Kubrin and Weitzer (2003)).

The lack of established property rights in underground markets and absence of effective institutions to enforce social norms often allow significant participants in criminal behavior to influence social norms surrounding violence (Levitt and Venkatesh (2000)). Akerlof and Yellen (1994) argues that the ability of the government (the principal) to monitor the behavior of criminals (the agent) remains confounded by the level of community cooperation. Disadvantaged neighborhoods in Kansas City and the City of St. Louis historically have been susceptible to street culture such as gang violence and other vice activity (Decker and Winkle (1996); KCPD (2016)). If gun investment

by gangs reduces the expected costs of committing crime, due to a reduction in community cooperation or an increase in government monitoring costs, the Akerlof and Yellen (1994) model predicts higher levels of gun violence similar to the post-repeal trends in Missouri. Thus, Black-White differences in community social norms with respect to crime could explain the differential response to increased secondary firearm market access across both groups.

However, theories based on cultural norms also have several limitations in explaining racial differences in observed post-repeal gun violence. Both anecdotal evidence and police reports suggest that the post-repeal increase in gun violence does not appear to be driven by gang violence–with gangs in places like the City of St. Louis consisting of mainly small scale networks rather than the more well known hierarchical gangs responsible for large scale drug trafficking (Phillips (2015)). Post-repeal firearm homicide trends also appear to be driven by “everyday disputes" instead of gang warfare. More importantly, theories based on cultural norms offer little insight into the determinants of temporal variation in gun violence and generally provide no clear direction in understanding their underlying racial disparities.

2.3 Technological Spillovers and Vice Activity

Other work explaining the racial differences in gun violence focus on the proliferation of illegal firearms associated with vice activity (Blumstein, Rivara, and Rosenfeld (2000)). O'Flaherty and Sethi (2010c) present a model explaining the spatial concentration of street vice (e.g., illegal drug and prostitution markets) in Black neighborhoods within urban areas. In contrast to the “concentration effects" explored in Wilson (1987), the intense concentration of vice activity in (densely populated) urban Black neighborhoods can arise due to the location preferences of sellers and households–with the latter group differing in characteristics such as income and their willingness to be exposed to illegal activity. Within these neighborhoods, lower prices in vice activity influences residential mobility between urban centers and the suburbs resulting in greater exposure for Black residents. If murder serves a strategic role in markets lacking the necessary institutions to resolve

property right issues and disputes, one would also expect to see an increase in gun investment within these neighborhoods. Over the past 40 years, residential mobility and vice activity in the Greater St. Louis area exhibit similar spatial patterns (Swanstrom, Webber, and Metzger (2016)). From 2008-2015, one-third of City of St. Louis neighborhoods account for 80 percent of homicides and these neighborhoods are overwhelmingly located in northern St. Louis (Phillips (2015)).

Another possible explanation for racial disparities in firearm homicide focuses on gun proliferation as a form of technological spillover (Gaviria (2000); Bingenheimer, Brennan, and Earls (2005)). Empirical studies on gun violence lend some support to the importance of gun proliferation as technological spillovers. Post-repeal racial differences in homicide victimization remain almost exclusively attributable to the increasing number of Black firearm homicide deaths relative to homicide by other means. Using vital statistics data, Figure 7 shows trends in the ratio of firearm homicide deaths to nonfirearm homicide deaths among non-Hispanic White and Black Missourians. While this ratio remains very close to one for White Missourians over this period, Black firearm deaths are four times greater during the crime epidemic of the early 1990s before rising to seven during the post-repeal period. These figures suggest that the post-repeal racial differences in homicide within the state of Missouri appear to be driven by a contemporary increase in gun proliferation.

An important limitation of an explanation based on technological spillovers associated with vice activity involves the fact that post-repeal gun violence seems to be driven by everyday disputes rather than large scale gang warfare (Phillips (2015)). Given the extensive racial differences in Missouri firearm homicide trends, any theory explaining these differences must account for the lack of post-repeal increases in firearm homicide in other geographical areas in the state with higher levels of gun ownership yet lower levels of gun violence. In discussing U.S. gun violence, the current literature also requires further work on the importance of access to secondary firearm markets.

2.4 Social Interactions

At the height of post-repeal Missouri gun violence in 2010, nearly 71 percent of reported homicides involved homicide victims killed by someone that they knew with a significant proportion of homicides driven by a dispute (Sugarmann (2013)). The crime literature offers several theories based on the notion that social interactions characterized by disputes can often lead to social multipliers in violence while also explaining the spatial, temporal, and group-level differences in crime (Glaeser, Sacerdote, and Scheinkman (1996); Papachristos (2009); O'Flaherty and Sethi (2010a); O'Flaherty and Sethi (2010b)).

O'Flaherty and Sethi (2010a) provide a theoretical model of strategic complementarities and specifically addresses one of the main concerns of this analysis pertaining to racial differences in homicide. Within their framework, two randomly matched individuals engage in a dispute and belong to one of two groups (i.e., B or W) and must make a binary decision of whether to resolve this dispute using violence. While victimization costs and the interaction-specific distribution of offending costs are commonly known, the offending cost for each individual in the model is private information. The strategic complementarities within their model remain attributable to the pre-emptive motive each individual possesses to strike the other party to the dispute–with population composition, nature of segregation, and offending cost characteristics influencing the type of homicidal interactions driving equilibrium race-specific murder rates. Assuming that lower offending costs are more likely among Blacks relative to Whites, the model provides key predictions explaining the higher equilibrium Black murder rates relative the rates for Whites depending on the characterization of offending costs.

O'Flaherty and Sethi (2010a) also allows for ex-ante investment in firearms before the dispute. In this scenario, each party to the dispute faces a binary investment decision that reduces one's offending costs and requires an upfront payment before the dispute. An interesting comparative statics exercise addresses the question of what happens to equilibrium race-specific murder rates

as the investment costs approach zero. A reduction in firearm investment costs remains consistent with increased competition in underground firearm markets or reduced straw purchasing costs–two possibilities for the Missouri secondary firearm markets after the 2007 permit-to-purchase law repeal (Cook et al. (2007); Levitt and Venkatesh (2000)). Such a reduction in investment costs could lead to an amplification of the Black-White murder rate gap as an expanded range of types with sufficiently low offending costs remains greater for Blacks than Whites.

Theoretical predictions based on models with strategic complementarities are consistent with previous research emphasizing the importance of retaliatory homicides to gun violence in the City of Louis in addition to overall post-repeal firearm homicide trends for the state of Missouri (Kubrin and Weitzer (2003)). Based on data from the St. Louis Metropolitan Police Department, Figure 8 shows the prevalence of homicide in predominately Black and White neighborhoods in the City of St. Louis from 2008 to 2015 (Phillips (2015)). One immediately notices the extraordinary levels of residential segregation with Delmar Boulevard partitioning the predominately Black neighborhoods in the north from the predominately White (and relatively more affluent) neighborhoods in the southernmost neighborhoods in the City of St. Louis. Moreover, post-repeal homicide remains intensely concentrated in the Black neighborhoods in northern St. Louis with these neighborhoods accounting for the overwhelming majority of homicides. These patterns in spatial concentration certainly remain consistent with the social multiplier effects generated by strategic complementarities and offer a compelling explanation for racial differences in post-repeal gun violence in Missouri.

3 Empirical Strategy

3.1 Generalized Synthetic Control Estimation

The empirical strategy for this study closely follows the generalized synthetic control (GSC) methodology introduced in Xu (2017) which incorporates the interactive fixed effects model de-

veloped in Bai (2009) into the synthetic control estimation procedure from Abadie, Diamond, and Hainmueller (2010). The synthetic control estimator remains increasingly popular in the policy evaluation literature and generalizes difference-in-differences estimation in providing a data-driven approach to the weighting of control group data. The ad hoc selection of control units often generated conflicting results within the empirical gun control literature. Using the adjacent metropolitan areas in Maryland and Virginia as a control group, Loftin et al. (1991) finds that the 1976 firearm ban in Washington D.C. reduced firearm homicide mortality by 25 percent and a 23 percent reduction in firearm suicide over the 1968-1987 period. Reevaluating their findings using Baltimore as the relevant counterfactual, Britt, Kleck, and Bordua (1996) no longer find statistical evidence of an increase in either measure. Construction of the correct counterfactual trends remains crucial to drawing the appropriate conclusions concerning the impact of the permit-to-purchase law repeal on gun violence.

The GSC estimator extends the synthetic control methodology in important ways for the identification of the Missouri PTP repeal effects on firearm homicide. First, GSC estimation allows for more than one treatment unit and subsequently an analysis of the heterogenous impact of the PTP repeal at the county-level. Second, synthetic control estimation offers little guidance with respect to model specification. The absence of any guidance on model specification often leads to questions on best practices concerning the inclusion of lagged outcomes and interpretation of the "V-weights." Linking synthetic control methodology with the interactive fixed effects models from Bai (2009), GSC estimation overcomes these concerns by performing dimension reduction before reweighting the control group data and these vectors are smoothed across the control units. This approach also allows for the counterfactual construction to take advantage of negative correlations in data in comparison to the nonnegative control weight assumption imposed by synthetic control estimation.

Third, synthetic control estimation does not allow for the familiar large-sample inference tools. Instead, Abadie, Diamond, and Hainmueller (2010) offers an inference approach based on permu-

tation tests where each unit from the “donor pool" serves as the pseudo-treatment unit and chosen cutoffs (based on corresponding mean squared prediction errors) help in determining the probability of obtaining a dynamic treatment effect similar to the one observed for the (true) treated unit. A second test involves an evaluation of the distribution of the ratios of post-intervention to pre-intervention mean squared prediction errors. An important limitation for either approach again involves issues of model specification as finding the appropriate specification for each pseudo-treatment unit remains analytically cumbersome. GSC estimation addresses these issues in providing a parametric bootstrap procedure for the estimation of standard errors with simulations and resampling based on full control group data.

Lastly, the synthetic control estimator also fails to construct an adequate counterfactual when covariates and factor loadings of the treated unit lie outside of the convex hull of the control units. During the early-1990s, the City of St. Louis often led the nation in both overall and Black firearm homicide–considerably outpacing gun violence in places like Baltimore, Chicago, and Detroit (Kapustin et al. (2017)). These outlier trends subsequently result in a poor pretreatment fit in constructing a synthetic control unit. With the incorporation of intercept shifts through additive fixed effects, the GSC estimator remains less susceptible to these concerns while also taking advantage of the full data on controls.

Similar to SC estimation, implementation of the GSC estimator in this case study involves finding suitable counterfactual firearm homicide trends after the repeal of the permit-to-purchase law with a crucial identifying assumption being parallel trends during pretreatment period. Let H_{st} denote the firearm homicide rate for unit s at time $t = 1, 2, \ldots, T$ with the number of pre-intervention periods given by T_0 such that $1 \leq T_0 \leq T$, X_{st} a $(k \times 1)$ vector of observed covariates, β a $(k \times 1)$ vector of unknown parameters, f_t a $(r \times 1)$ vector of unobserved common factors, λ_s a $(r \times 1)$ vector of unknown factor loadings, and ϵ_{st} unobserved idiosyncratic shocks with zero mean. GSC

estimation assumes a linear factor model given by:

$$H_{st} = \alpha_{st} D_{st} + X'_{st}\beta + \lambda'_s f_t + \epsilon_{st} \tag{1}$$

where D_{st} serves as an indicator taking on a value of one if state s is exposed to the intervention at time t and zero otherwise. If $H_{st}(1)$ and $H_{st}(0)$ denote the potential outcomes, the dynamic average treatment effect on the treated (ATT) units s at time $t > T_0$ is also given by:

$$\alpha_t = \frac{1}{N_{Treated}} \sum_s [H_{st}(1) - H_{st}(0)] \tag{2}$$

Estimating α_t involves the general causal inference exercise of finding the appropriate counterfactual for unobserved $H_{st}(0)$. Xu (2017) offers a three-step procedure in implementing the GSC estimator α_t^{GSC} while imposing a normalization and orthogonality constraints on the factors. The first step involves estimation of an interactive fixed effects model using control group data to obtain $\hat{\beta}, \hat{F}$, and $\hat{\Lambda}_{CO}$:

$$\begin{aligned} (\hat{\beta}, \hat{F}, \hat{\Lambda}_{CO}) = &\underset{\tilde{\beta}, \tilde{F}, \tilde{\Lambda}_{CO}}{\operatorname{argmin}} \sum_{s \in \text{Controls}} (H_s - X_s\tilde{\beta} - \tilde{F}\tilde{\lambda}_s)'(H_s - X_s\tilde{\beta} - \tilde{F}\tilde{\lambda}_s) \\ &s.t. \quad \tilde{F}'\tilde{F}/T = I_r \quad \text{and} \quad \tilde{\lambda_{CO}}'\tilde{\lambda_{CO}} = \text{diagonal} \end{aligned} \tag{3}$$

Using estimates from step one, step two involves minimizing the pretreatment mean squared prediction error (MSPE) in order to obtain factor loadings λ_s for each treatment unit:

$$\hat{\Lambda} = \underset{\hat{\Lambda}}{\operatorname{argmin}} \sum_{s \in \text{Controls}} (H_{s,T_0} - X_{s,T_0}\hat{\beta} - \hat{F}_{T_0}\tilde{\lambda}_s)'(H_{s,T_0} - X_{s,T_0}\hat{\beta} - \hat{F}_{T_0}\tilde{\lambda}_s) \tag{4}$$

The third step computes $\hat{H}_{st}(0)$ using $\hat{\beta}, \hat{F}, \hat{\lambda}_{CO}$ estimates from the first two steps:

$$\hat{H}_{st}(0) = x'_{st}\hat{\beta} + \hat{\lambda}'_s \hat{f}_t \tag{5}$$

An important challenge to estimating the impact of the PTP repeal on firearm homicide involves accounting for unobservable latent factors which could potentially lead to a violation of the parallel trends assumption. For example, empirical research on firearm homicide often points to the role of expanding crack cocaine markets and gang activity during the 1980s and early-1990s (Levitt (2004); Fryer et al. (2013)). Not accounting for such unobservable factors could produce biased estimation results. While previous research offers some a priori guidance in selecting the number of factors, Xu (2017) offers a leave-one-out cross-validation procedure which chooses the number of unobservable factors r that minimizes the MSPE based on the following steps:

- **Step 1:** For a given number of factors r, estimate $\hat{\beta}$ and $\hat{F}$ via interactive fixed effects estimation based on control group data
- **Step 2a:** For every $t \leq T_0$, hold back all treated unit data at time $\tau \in \{1, \ldots, T_0\}$ and conduct OLS estimation using the remaining pretreatment data to obtain for every treated unit:

$$\hat{\lambda}_{-\tau} = (F^{0\prime}_{-\tau} F^{0}_{-\tau})^{-1} F^{0\prime}_{-\tau} (H^{0}_{-\tau} - X^{0\prime}_{-\tau} \hat{\beta})$$

- **Step 2b:** Predict the treated outcomes at time τ using $\hat{H}(0)_\tau = x'_\tau \hat{\beta} + \hat{\lambda}'_{-\tau} \hat{f}_\tau$ and save $e_\tau = H(0)_\tau - \hat{H}(0)_\tau$ for every treated unit
- **Step 3:** Calculate for a given r and every treated unit $s \in$ Treated:

$$\text{MSPE}(r) = \sum_{\tau=1}^{T_0} \sum_{s \in \text{Treated}} e^2_{s\tau} / T_0$$

- **Step 4:** Repeat Steps 1-3 for different values of r to obtain each corresponding MSPE
- **Step 5:** Choose the MSPE-minimizing r^*

As mentioned earlier, GSC estimation also provides a parametric bootstrap procedure allowing for standard inference techniques–in particular “clustered" standard errors and confidence intervals.

The procedure uses the full control group data with draws based on the empirical distribution of the prediction errors. In particular, Xu (2017) suggests the following procedure:

- **Step 1:** Begin a loop running B_1 times

    a. Denote one randomly selected control unit s as the "treated unit" in round $m \in \{1, \ldots, B_1\}$ for $t > T_0$

    b. Resample the remaining controls with replacement size N_{CO} to form a new sample with the pseudo-treatment unit

    c. Conduct GSC estimation on this sample to obtain residuals $\hat{\epsilon}_m^p = H_s - \hat{H}(0)$ and end loop collecting $\hat{\boldsymbol{e}}^{\boldsymbol{p}} = \{\hat{\epsilon}_1^p, \hat{\epsilon}_2^p, \ldots, \hat{\epsilon}_{B_1}^p\}$

- **Step 2:** Conduct GSC estimation on the original data to obtain:

    a. $\widehat{ATT}$

    b. Coefficients $\hat{\beta}, \hat{F}, \hat{\Lambda}_{CO}, and \hat{\lambda}_{s \in \text{Treated}}\}$

    c. Control fitted values $\hat{\boldsymbol{H}}_{\boldsymbol{CO}} = \{\hat{H}_1(0), \hat{H}_2(0), \ldots, \hat{H}_{N_{CO}}(0)\}$

    d. Control residuals $\hat{\boldsymbol{e}} = \{\hat{\epsilon}_1, \hat{\epsilon}_2, \ldots, \hat{\epsilon}_{N_{CO}}\}$

- **Step 3:** Begin a loop running B_2 times

    a. Construct a bootstrapped sample $\boldsymbol{S}^{(k)}$ using:

$$\tilde{H}_i^{(k)}(0) = \hat{H}_i(0) + \tilde{\epsilon}_i^p \quad i \in \text{Treated} \tag{6}$$

$$\tilde{H}_j^{(k)}(0) = \hat{H}_j(0) + \tilde{\epsilon}_j \quad j \in \text{Controls} \tag{7}$$

    where $\tilde{\epsilon}_i$ and $\tilde{\epsilon}_j^p$ are randomly selected from $\boldsymbol{e}$ and $\boldsymbol{e}^p$, respectively and $\hat{H}(0) = X'\hat{\beta} + \hat{F}'\hat{\lambda}$

b. Conduct GSC estimation based on $\boldsymbol{S}^{(k)}$ to obtain a new ATT estimate, and add the previous $\widehat{ATT}$ estimate from Step Two to it, to obtain the bootstrapped $\widehat{ATT}^{k}$. End the bootstrap loop.

- **Step 4:** Compute the variance of ATT:

$$Var(\widehat{ATT}_t|D, X, \Lambda, F) = \frac{1}{B}\sum_{k=1}^{B}(\widehat{ATT}_t^{(k)} - \frac{1}{B}\sum_{j=1}^{B}\widehat{ATT}_t^{(j)})^2$$

GSC estimation results throughout this study are based on boostrapped samples of $N = 2,000$.

3.2 Data and Study Sample Construction

This paper utilizes data from a variety of state-level and county-level sources over the 1981-2013 study period–yielding 26 years of pre-intervention data and roughly seven years of post-intervention data.[4] All state-level age-adjusted firearm homicide, nonfirearm homicide, suicide, and firearm suicide rates (per 100,000) come from death certificate data reported in the United States Centers for Disease Control and Prevention (CDC) Web-Based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Reports while corresponding county-level data come from the CDC WONDER database.[5] State personal income per capita (logged) data comes from the Bureau of Economic Analysis (measured in 2009 dollars using the Bureau of Labor Statistics consumer price index data). Population estimates, percent living in poverty, proportions of the population non-Hispanic Black or White, percent of female-headed households, educational attainment, unemployment rates, and county-level per capita income data come from the Bureau of the Census Current Population Survey. State-level cocaine-related mortality rates (per 100,000)

[4]While additional years of post-repeal data remain available, this analysis extends the study period up until the year 2013 in order avoid concerns regarding any potential effects associated with the events surrounding the Michael Brown shooting on local law enforcement practices in the greater St. Louis area–more broadly known as the "Ferguson Effect" (Rosenfeld (2015)).

[5]The CDC suppresses data for counties and states where low homicide or suicide numbers make certain deaths identifiable. This exclusion leads to changes in the number of available controls for each analysis.

come from the National Center for Health Statistics (NCHS) Mortality Detail Files.[6] Index crime data comes from the Federal Bureau of Investigation (FBI) Uniform Crime Reports (UCR).[7]

In order to avoid potential contamination among the control units, this analysis excludes any states introducing background check requirements during the study period. This restriction leads to the exclusion of California, District of Columbia, Colorado, Indiana, Maryland, Nebraska, Oregon, and Pennsylvania from the study sample. Data limitations also lead to the exclusion of Hawaii, Maine, North Dakota, New Hampshire, South Dakota, Vermont, and Wyoming from the study sample.[8] For the main state-level firearm homicide results, these restrictions lead to a study sample consisting of 33 states. The county-level sample pulls from the 200 largest U.S. counties in 2000 with complete data in estimating each outcome of interest.

[6]Following the work in Fryer et al. (2013), cocaine-related death rates are defined as "accidental poisonings, suicides, and other deaths for which cocaine was coded as a primary or contributing factor." For cocaine-related deaths before 1989, the International Classification of Diseases 9th revision (ICD-9) codes are 8552, 3042, and 3056. ICD-9 codes 8501-8699, 9501-9529, 9620-9629, 972, 9801-9879, 3050-3054, and 3057-3059 with a secondary code of 9685 are also included. For cocaine-related deaths after 1998, the International Classification of Diseases 10th revision (ICD-10) codes are F140-F149, F190-F199, X42, X44, X62, X64, X85, Y12, and Y14 with a secondary code of T405.

[7]The FBI UCR data comes from reports to the FBI from law enforcement agencies across the U.S. The FBI uniform crime index consists of seven crimes: murder and nonnegligent manslaughter, forcible rape, robbery, burglary, larceny theft, aggravated assault, and motor vehicle theft. The FBI defines murder and nonnegligent manslaughter as the willful killing of one human being by another–excluding deaths caused by negligence, suicide, accident, justifiable homicide, attempts to murder, and assaults to murder. This definition will include nearly all homicides as opposed to the more narrow definition for firearm homicide.

[8]One exception remains the 2012 repeal of the "one-handgun-per-month" law repeal in Virginia. However, private handgun sales in Virginia do not require background checks and the results are robust to the exclusion of Virginia from the sample.

4 Evaluating the Impact of the Missouri PTP Repeal

4.1 State-Level Gun Ownership Effects

If an increase in post-repeal gun violence remains attributable to expanded access to Missouri secondary firearm markets, one would expect to observe meaningful changes within the primary firearm markets as well under the assumption of no significant state-level externalities. Table 3 shows the generalized synthetic control estimation results using NICS background checks by gun type as a proxy for potential sales by federally licensed dealers–controlling for poverty, log per capita income, unemployment, and percent of the population with less than a high school degree in addition to state and year fixed effects. Beginning with the first column, these results suggest that the repeal led to an additional 1,234 handgun background checks per 100,000 and reflects a 190 percent increase relative to the baseline mean. However, the results for background checks for long guns show a statistically insignificant average increase of 162.30 per 100,000. Given that the permit-to-purchase law specifically pertained to concealable firearms, these results strongly suggest that the greatest impact of the repeal occurred within the market for handguns.

Figure 9 also shows they dynamic treatment effect evidence corresponding with the handgun background check results provided in Table 3. Figure 9a provides the estimated counterfactual trends in handgun background checks, relative to the actual trends for Missouri, and Figure 9b gives the dynamic treatment effect evidence with estimated 95 percent confidence intervals. The figures confirm the previous results in showing the divergence of Missouri trends in potential handgun sales from the estimated counterfactual after the 2007 permit-to-purchase law repeal. This estimated average treatment effect sharply increases over the first few years of the repeal before reaching a steady state of roughly 1,500 handgun checks through 2011 and rising slightly more heading into the last few years of the post-repeal period. Figure 10 provides similar dynamic treatment effect evidence for potential long gun sales in Missouri and confirms the previous findings that the repeal appears to not greatly impact the market for long guns.

Focusing on the handgun estimation results again in Table 3, cross-validation also leads to the selection of a model with two unobserved factors. Figure 11 shows the two estimated latent factors while Figure 12 provides a plot of the associated estimated factor loadings. While one must exercise some caution in interpreting these factors, the first factor captures a gradual increase in potential handgun sales after 2007 and this factor increases sharply during the latter years of the post-repeal period. Other than observing a decrease in handgun background checks during the early 2000s, interpretation of the second factor remains less clear. Figure 12 sheds some additional insight on these two factors by plotting the corresponding factor loadings for both Missouri and the control group. One immediate observation involves the estimated factor loadings for Missouri residing within the convex hull of the control units and provides some credibility for the generalized synthetic control estimation results. Another interesting observation from the plot points to the fact that states with weaker gun laws (e.g., Arkansas, Oklahoma, and West Virginia) generally have larger factor loadings on the first factor. Altogether, these results provide strong evidence that the Missouri permit-to-purchase law repeal led to a significant increase in potential handgun sales within the primary firearm markets.

4.2 County-Level Gun Ownership Effects

An important question remains whether the PTP repeal led to an increase in gun proliferation across local secondary firearm markets within the state of Missouri. Figure 14 provides county-level dynamic treatment effects for the impact of the PTP repeal on FSS with estimation results in Table 4. This specification controls for total suicide rates, log per capita income, percent of female-headed households, and percent of the population with less than a high school degree in addition to county and year fixed effects. Despite yielding a fairly noisy estimate, Table 4 provides evidence of an average seven percentage point increase in FSS across Jackson County, St. Louis County, and the City of St. Louis with Figure 14 showing increased gun proliferation peaking a few years after the repeal. Cross-validation also leads to a model specification with one estimated

latent factor shown in Figure 15. While interpretation of this factor remains less straightforward, this figure clearly shows a steady increase in FSS trends during the early 1990s before rising again after 2000.

The autonomy possessed by each sheriff's office in screening permit-to-purchase applications could imply important county-level heterogeneity in the effects of the PTP law repeal. Figures 14b-14d show considerable heterogeneity in the effects of the PTP repeal on county-level gun ownership across the three treatment units. However, these results are primarily driven by the sharp increase in FSS within the City of St. Louis. In particular, the dynamic FSS treatment effect shows a large and significant 60 percentage point increase over the 2011-2012 period. While both Jackson County and St. Louis County also experience post-repeal increases in gun prevalence, the statistical evidence remains less conclusive.

The significant expansion of secondary firearm markets within the City of St. Louis remains consistent with the substantial number of crime guns traced back to the area in the ATF firearm trace reports data. While the extent to which an increase in the FSS proxy truly reflects changes in gun ownership among individuals associated with criminal activity remains an open question, previous empirical work suggests that the measure captures both legal gun ownership and some aspects of illicit firearm ownership. The fact that survey measures often find significant racial differences in reported gun ownership and suicide remains substantially higher among White Americans might contribute to the noisy relationship between the PTP repeal and the FSS measure (Parker et al. (2017)).[9]

4.3 State-Level Firearm Homicide Effects

The 2007 permit-to-purchase law led to significant changes in Missouri firearm homicide trends with these effects varying considerably across age groups. Table 5 provides generalized synthetic control estimation results by age group while Figures 16-17 showing the corresponding dynamic

[9]Contrary to homicide trends, White Missourians make up approximately 85 percent of the state while accounting for nearly 93 percent of all suicides (Missouri Institute of Mental Health (2015))

treatment effects associated with the repeal. All state-level specifications control for (race-specific) poverty, (race-specific) unemployment, cocaine-related overdose rates, FSS, state effects, and year effects. GSC estimation yields an average treatment effect of 0.9716 with a standard error of 0.6278. The largest increase in post-repeal firearm homicide occurs among victims ages 15-24 with an additional 2.83 deaths per 100,000 and the average treatment effect decreases with age. The dynamic treatment effect results show that the greatest impact of the PTP repeal on firearm homicide occurs within the first few years of the post-repeal period. Overall firearm homicide peaks in 2008 with a significant and positive increase of 1.73 deaths per 100,000 in 2008. Similarly, firearm homicide among victims ages 15-24 at over six deaths per 100,000 from 2009-2010 and victims older than 45 experience a slight increase of 1.13 additional deaths in 2008.

Focusing on the overall firearm homicide results, the cross-validation procedure within GSC estimation yields a specification with two estimated latent factors. Figure 18 shows the estimated unobserved factors for overall firearm homicide over the study period while Figure 19 plots the estimated factor loadings for Missouri and each control state. While some caution remains necessary in providing a direct interpretation of the estimated factors, one fairly clear observation points to the importance of the crime epidemic during the early 1990s in explaining firearm homicide trends up until the early 2000s when states throughout the U.S. experienced historical declines in crime rates. Indeed, Figure 19 illustrates that states with significant racial disparities in homicide such as Illinois, New York, Louisiana, and Mississippi possess some of the largest factor loadings on the second factor. Interpretation of the first factor remains less clear, but results from both figures suggests an upward trend in firearm homicide among states with either relatively lax gun laws (e.g., Delaware and Ohio) or states with neighbors possessing less restrictive gun control laws (e.g., New Jersey).

Similar to national trends, substantial racial differences in firearm homicide exist within the state of Missouri and estimation across these groups highlight the disparate impact of the PTP repeal. Table 6 provides evidence from generalized synthetic control estimation on the varying impact of

the PTP repeal across race and age groups. The first column suggests that the overall firearm among Black victims increased significantly by an average 5.17 additional deaths per 100,000 over the post-repeal period. However, estimation results by age group also emphasizes the importance of the permit-to-purchase law for Black youth homicide. The large and significant 28.97 treatment effect among young Black firearm homicide victims ages 15-24 suggests that much of the increase in Missouri firearm homicide trends remains attributable to greater illicit access to firearms. Similarly, firearm homicide increases by an average 8.18 deaths per 100,000 for Black victims ages 25-44. White firearm homicide results also suggest a small post-repeal increase of 0.1226 for the overall rate and 0.3477 among White Missourians ages 25-44. However, the corresponding standard errors also present less conclusive statistical evidence concerning the average post-repeal effect for White Missourians.

Figures 20-23 also provide dynamic evidence of the impact of the PTP repeal across race and age groups. These results again show that the greatest impact of the PTP repeal occurs within the first few years of the post-repeal period. A sharp spike in overall Black firearm homicide occurs in 2008 and reflects an additional 12.03 deaths per 100,000. Young Black firearm homicide victims ages 15-24 account for an extensive amount of the early post-repeal gun violence and peaks at an additional 55 deaths per 100,000 by 2010. Similar treatment effect estimates for Black victims ages 25-44 range from 15.30 in 2008 to 12.5 by 2010. Limited dynamic findings for White firearm homicide victims ages 25-44 also show a smaller yet significant increase of 1.89 additional deaths during the first full year of the repeal.

In understanding the importance of unobservable factors violating any parallel trends assumption, Figure 24 shows the estimated latent factors for overall Black firearm homicide while Table 7 shows the estimated factor loadings for each state. Similar to overall trends, the second and third factors capture a strong upward trend in Black firearm homicide during the crime epidemic of the late-1980s and early-1990s. Comparing these trends with the estimated factor loadings in Table 7, the third factor also shows a modest upward trend in Black firearm homicide among states such

as Missouri, Illinois, and Louisiana. While interpretation of the first factor again remains less straightforward, one observes a similar combination of states suffering from less restrictive gun laws and substantial contemporary increases in Black firearm homicide. Overall, state-level results yield strong evidence that the permit-to-purchase law repeal led to a significant increase in firearm homicide with a disproportionate impact felt by young Black Missourians.

4.4 County-Level Heterogeneity in Firearm Homicide

The overwhelming concentration of firearm homicide in urban areas of Missouri, in addition to the autonomy held by sheriffs' offices in screening permit applications before 2007, raises an important question concerning the differential impact of the PTP repeal at the county-level. Given data limitation and the state-level results highlighting the significant impact of the repeal on Black firearm homicide, Table 8 shows county-level estimation results for overall firearm homicide and Black firearm homicide–focusing specifically on Jackson County, St. Louis County, and the City of St. Louis as treatment units. These specifications remain similar to the state-level models with the Black population proportion instead of the cocaine-related mortality rates. County-level estimation reveals a slightly larger average treatment effect of 1.81 deaths per 100,000 for overall homicide. The 6.27 Black firearm homicide estimate remains slightly larger than the corresponding state-level estimate of 5.17 and remains significant–once again providing evidence showing the importance of the PTP law for gun violence in the more urban regions of the state.

The dynamic treatment effects shown in Figures 25-26 also demonstrate the higher levels of gun violence during the early years of the post-repeal period. The 2009-2010 period remains characterized by a large and significant increase of approximately four overall firearm homicide deaths. Overall gun violence within the City of St. Louis grew by nearly 10-11 additional deaths per 100,000 in the early years of the repeal. County-level Black firearm homicide estimates in Figures 27-28 show substantial increases in gun violence across all three areas with average increases of 10-11 deaths over 2008-2010 period. Both Jackson County and St. Louis County show large

early post-repeal increases well over 10 overall firearm deaths while the PTP law repeal led to an additional 17-18 Black firearm homicide deaths per 100,000 from 2008-2009. These results provide conclusive evidence that the burden of less restrictive access to firearms largely falls on urban Black communities within the state of Missouri.

4.5 Robustness Checks and Sensitivity Analyses

A natural question for the identification strategy utilized in this paper involves potential externalities associated with the Missouri PTP repeal. One such externality could involve gun trafficking opportunities for Missouri secondary markets in border states with more stringent gun laws. For example, the Missouri PTP repeal might have led to Missouri becoming a net exporter of firearms to secondary markets in other states–in particular those states bordering Missouri. Such a change might lead to an increase in firearm homicide rates and subsequently a heightened law enforcement presence in those states. In estimating a gravity relationship using the 2009 ATF trace data, Knight (2013) finds evidence suggesting that firearms tend to flow from secondary markets in states with weaker laws to states with tougher ones.

Table 9 examines the flow of firearms originally purchased from a Missouri FFL dealer to crimes scenes within Missouri and its eight border states–with states such as Illinois, Iowa, and Nebraska each having stronger firearm laws than Missouri over the post-repeal period. While Missouri accounts for less than one third of its total firearm traces in the year before the PTP repeal, this number increases to 50.34 percent by 2013. This large increase in the domestic recovery of Missouri firearms suggests that the PTP repeal had important consequences for illegal secondary markets within the state. Moreover, none of the states bordering Missouri experience any significant changes in Missouri firearm traces within their borders over the post-repeal period. The lack of a notable increase in the trafficking of firearms to states outside of Missouri remains consistent with previous findings suggesting that social connections, and subsequently straw purchasing behavior, play a more salient role in the proliferation of firearms into criminal activity than large scale gun

trafficking operations (Cook et al. (2007); Cook, Parker, and Pollack (2015); Cook et al. (2015)).

In order to avoid potential contamination among controls, further analyses based on the state-level samples involve generalized synthetic control estimation excluding any of Missouri's border states from the control group. Carrying out the analysis in this manner leads to some changes in the magnitude of certain estimated coefficients for Black firearm homicide and pre-treatment mean squared prediction errors, but the qualitative conclusions remain the same.[10] In particular, the coefficient on overall Black firearm homicide increases to 7.34 while the corresponding estimate for Black youth ages 15-24 falls to 16.86 with a standard error of 9.47. The estimate for Black firearm homicide for victims ages 25-44 also increases to 10.14 with a standard error of 5.73 and reinforces the conclusion that the repeal's greatest impact occurs among young Black Missourians.

Table 10 assesses whether the PTP law repeal influenced nonfirearm homicide rates or any other forms of criminal activity captured in the FBI UCR data. Based on mortality data, state-level GSC estimation yields a positive estimate of 0.1140 nonfirearm deaths per 100,000 with a standard error of 0.5108. These findings suggest that post-repeal homicide within Missouri remains exclusive to firearm homicide and provides additional evidence that this violence remains attributable to greater gun proliferation within the state. The remaining rows of Table 10 show similar estimation results across the seven index crimes reported to the FBI by local law enforcement agencies. Aggravated assault, forcible rape, robbery, and motor vehicle theft all show positive post-repeal effects although each remain statistically insignificant. Estimates for burglary, larceny theft, and property crime show statistically insignificant negative effects. With an exception for the 1.23 increase in murder and non-negligent manslaughter, this study finds no conclusive statistical evidence suggesting that the PTP repeal led to an increase in any other crime rates.

In the absence of any potential "Ferguson Effect," an extension of the post-repeal period up until 2016 reflects an increase in both gun proliferation and firearm homicide throughout the state of Missouri–with these results being qualitatively similar to the core results presented in previous

[10]Results available upon request to the author.

sections. Based on generalized synthetic control estimation, Table 11 reproduces earlier results in the second column of the table using 2013 as the last post-repeal year and the extended results up until 2016 in the third column. The average treatment effect estimates for both state-level NICS background checks measures and the county-level FSS measure are slightly larger after extending the post-repeal period to 2016. While the effect for long guns remains statistically insignificant, the increase in (potential) handgun background checks continue to serve as an overwhelming presence in the post-repeal primary gun markets in Missouri with an average treatment effect of 1,259 checks per 100,000.

Table 11 also shows an increase in the state-level average treatment effects across all age groups with overall firearm homicide increasing from 0.9716 to 1.51 additional deaths per 100,000 Missourians. More importantly, racial disparities in firearm homicide remain persistent over the 10 year period post-repeal period as Black gun violence continues to dominate the state-level trends for Missouri. Compared to the baseline mean 86.67, the now 36 percent increase in firearm homicide among Black Missourians ages 15-24 continues to highlight the significant contribution of gun violence among Black youth to the state's post-repeal narrative. The average treatment effect for Black Missourians ages 25-44 nearly doubles over the 10 year period to 15.36, and relative to the baseline mean of 52.04, reflects a 30 percent increase within this group. Consistent with earlier findings, the analysis yields no statistical evidence of an increase in state-level White firearm homicide although both average treatment effects are larger after accounting for recent trends.

Lastly, an inspection of the corresponding dynamic treatment effect evidence sheds additional insight regarding the substantial firearm homicide victimization taking place among young Black Missourians. Figure 29 provides the dynamic average treatment effect for state-level Black firearm homicide in Missouri after including three additional years of post-repeal data. While earlier results suggest a consistent decline in Black firearm homicide up until 2013, these trends remain short-lived as gun violence increases sharply to over 40 Black firearm homicides per 100,000 by 2015. In particular, the roughly 20 additional firearm homicide deaths in 2015 reflects a 63 percent increase

increase in gun violence relative to the baseline and remains comparable to the historic peak in Black firearm homicide during the early 1990s. The generalized synthetic control estimation results again show that these trends are driven by the extraordinary levels of gun violence taking place within the City of St. Louis.

5 Conclusion

Using the 2007 repeal of the Missouri permit-to-purchase law as a natural experiment, this paper provides evidence of an increase in the proliferation of firearms and strong evidence of an increase in firearm homicide within Missouri. The repeal led to an increase of 1,234 handgun background checks per 100,000 throughout the state of Missouri. The absence of statistical evidence supporting an increase in long guns suggests that the permit-to-purchase law repeal primarily influenced the primary market for handguns. Results concerning the county-level FSS proxy show an average treatment effect of a seven percentage points across Jackson County, St. Louis County, and the City of St. Louis. The increase in local gun proliferation occurs at a time in which within-state firearms appear at crimes scenes more quickly and the proportion of crime guns from other states remains consistently low throughout the post-repeal period. These results mirror the geographic distribution of crime guns within the ATF firearm trace reports with the City of St. Louis showing the greatest increase in firearm proliferation through local secondary markets.

This paper also finds evidence of a modest increase in overall firearm homicide throughout the state of Missouri with much of the gun violence driven by a disproportionate increase in firearm homicide among young Black Missourians. Statewide non-Hispanic Black firearm homicide increases by an average of 5.17 deaths per 100,000 (17 percent) during the post-repeal period and increases by roughly 29 deaths per 100,000 (33 percent) among Black youth ages 15-24. The average treatment effect for Black firearm homicide in Missouri translates into approximately an additional 260 Black deaths over 2008-2013 period. This analysis yields no statistical evidence of a corresponding increase among non-Hispanic White Missourians. Furthermore, these changes

in firearm homicide occur in the absence of any significant changes in nonfirearm homicide and other reported crimes not involving murder. Thus, this paper provides new evidence concerning the differential impact of state-level gun control laws on firearm homicide across racial groups.

Considerable heterogeneity also exists in the effects of the permit-to-purchase law repeal on firearm homicide across counties and cities in the state of Missouri. Black firearm homicide increases by an average 6.27 deaths per 100,000 (17 percent) across Jackson County, St. Louis County, and City of St. Louis. County-level results suggests that the largest increase occurred within the City of St. Louis with an increase in Black firearm homicide rates of 7.97 deaths followed by 5.92 deaths in Jackson County and 4.91 deaths in St. Louis County. Similar to the state-level findings, these results suggest that the adverse effects of the PTP repeal fall disproportionately on urban Black communities within the state of Missouri.

The heightened levels of Missouri gun violence led to the introduction of several interventions by law enforcement agencies, prosecutors, and other parties interested in reducing firearm homicide. In the absence of any potential Ferguson effect, these short-term interventions could explain the limited post-repeal decline in gun violence within the City of St. Louis from 2010-2013. Mares and Blackburn (2012) assesses the impact of Acoustic Gunshot Location System (AGLS) technology usage on gun violence in northern neighborhoods within the City of St Louis from August 2008 until October 2009. AGLS technology, commonly sold by companies such as Shotspotter, triangulates the sounds of gunshots using GIS software and forward the location information to patrol officers. The police department specifically chose the Wells/Goodfellow and (parts of the) Hamilton Heights neighborhoods given the overwhelming prevalence gun violence within these areas in addition to the costs associated with implementing AGLS technology–nearly $200,000-250,000 per square mile. Using monthly data from the Uniform Crime Reports and “shots fired" reports from residents, the authors find that AGLS technology implementation led to a 49 percent decline in gun shot reports by residents. However, the authors find no statistical evidence of a decrease in gun-related crime within these neighborhoods. While control group selection by the authors remains questionable

(i.e., the authors chose four surrounding neighborhoods as control units based only on comparability in gun violence), the introduction of AGLS technology does not appear to serve as a significant concern for the results from this case study.

An increase in post-repeal gun violence also attracted the attention from the ATF resulting in the establishment of “Operation Hustle City" (DOJ (2016)). Taking place roughly over the first five months in 2013, this undercover storefront operation consisted of running a tattoo parlor in the Jeff Vander Lou neighborhood in northern St. Louis where undercover ATF agents collected information on criminal behavior and purchased illegal firearms. Although yielding no extensive information on gun trafficking operations, this intervention led to 129 illegal firearm purchases and 32 arrests. Reports from local law enforcement also suggests that this short-term “surge" in ATF agents resulted in a temporary reduction in crime within the City of St. Louis. Thus, one explanation for the decline in Missouri gun violence towards latter part of the study period involves the spread of information concerning the increasing federal presence in places like St. Louis.

Efforts to reduce gun violence in the City of St. Louis also took place within the criminal justice system. As a preliminary evaluation of a gun monitoring program integrating information on gun crimes from arrest to sentencing, Rosenfeld et al. (2014) provides descriptive data on 246 gun-related arrests taking place during the first quarter of 2011 in the City of St. Louis. The authors find that 94 percent of arrestees in their sample were Black males with a median age of 23. These individuals generally have extensive arrest records and in total account for 1,753 prior felony arrests. The disproportionate representation of young Black men within this arrest sample confirms the gun offending patterns presented in this study. Moreover, the significant felony arrest records also suggests that the proliferation of illegal firearms serves a particular challenge within the City of St. Louis.

A variety of explanations for racial disparities in crime exists within the literature with different policy implications emerging from each theory. The overwhelming majority of Missouri gun violence takes place within urban disadvantaged neighborhoods in Kansas City and the Greater St.

Louis area. These areas exhibit many of the characteristics outlined in work based on social disorganization theory and cultural norms. However, the disproportionate impact of the permit-to-purchase law repeal on young Black Missourians suggests a greater role for behavior within secondary firearm markets and social interactions. The intense spatial concentration of gun violence within predominately Black neighborhoods in northern St. Louis, an area historically accounting for greater criminal behavior, specifically alters the consequences of disputes in the presence of expanded access to secondary firearm markets. The opening of anonymous hotlines by nongovernmental organizations to settle disputes further emphasizes how the post-repeal increase in gun proliferation influenced social interactions–lending more credibility to a strategic complementarities argument where a reduction in gun investment costs led to an increase in equilibrium danger (McKinstry (2017)). To the extent that the rise in Missouri gun violence remains attributable to an increasing number of disputes being settled with firearms by youths, the implementation of interventions based on cognitive behavioral therapy have shown promise among similar demographics in other parts of the country suffering from intense gun violence (Heller et al. (2017)).

While several aspects of Missouri gun violence exhibits similar characteristics and patterns observed in other states, one must exhibit caution in generalizing the experiences of Missouri to other states. The effects of deregulatory efforts within private firearm markets in other states will depend on the extensiveness of gun culture, the nature of gun trafficking, law enforcement efforts, and other salient determinants of gun violence.

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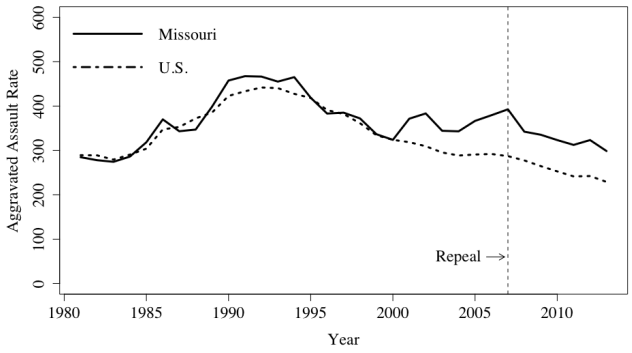
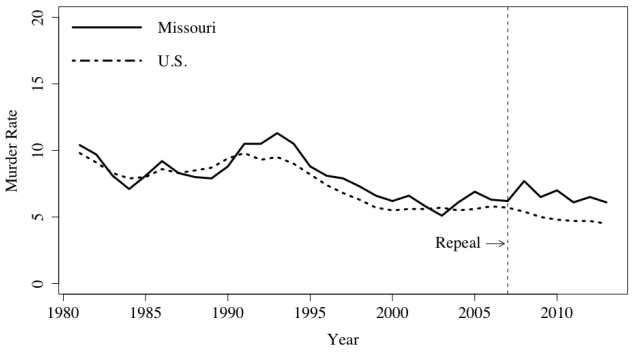
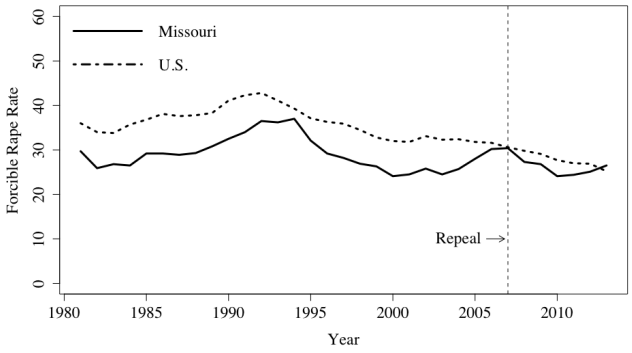
6 Appendix



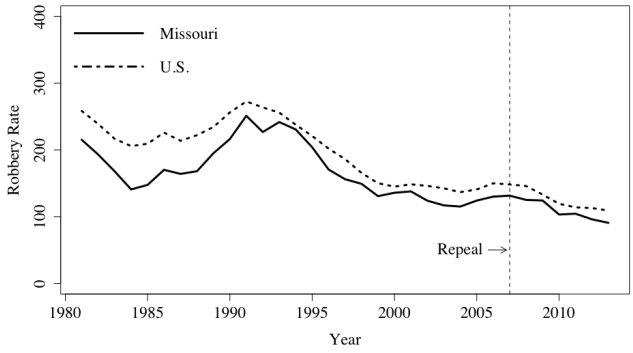
(a) Aggravated Assault



(b) Murder and Nonnegligent Manslaughter

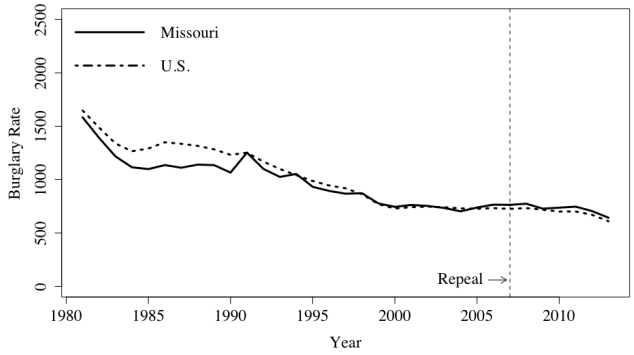


(c) Forcible Rape

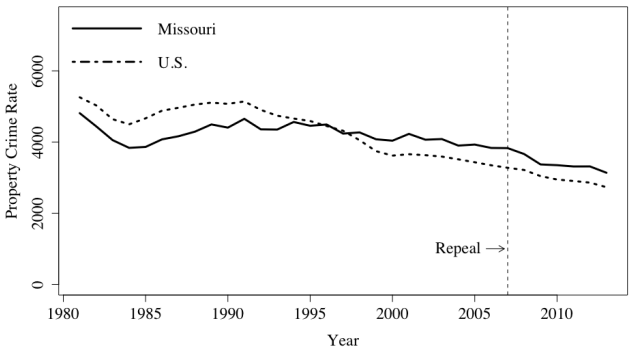


(d) Robbery

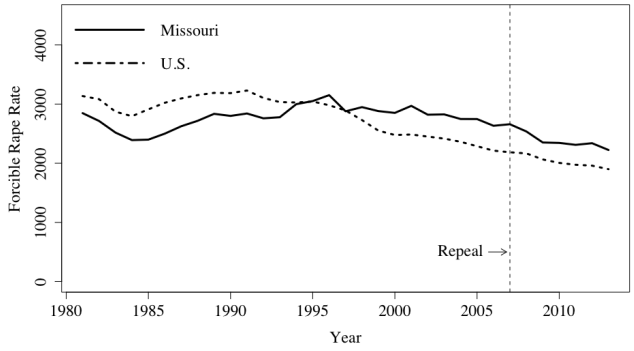
Figure 1: FBI Violent Index Crime: Missouri v. U.S.



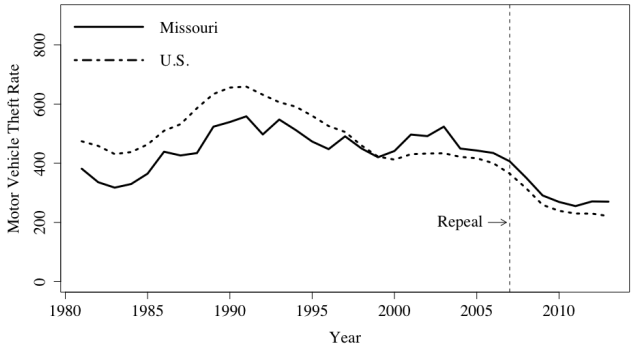
(a) Burglary



(b) Property Crime

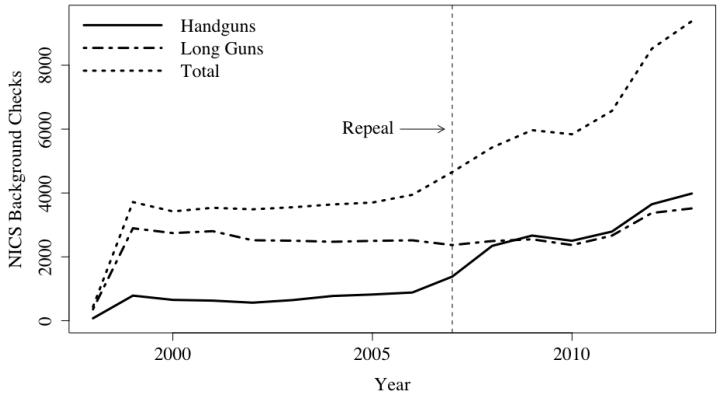


(c) Larceny Theft

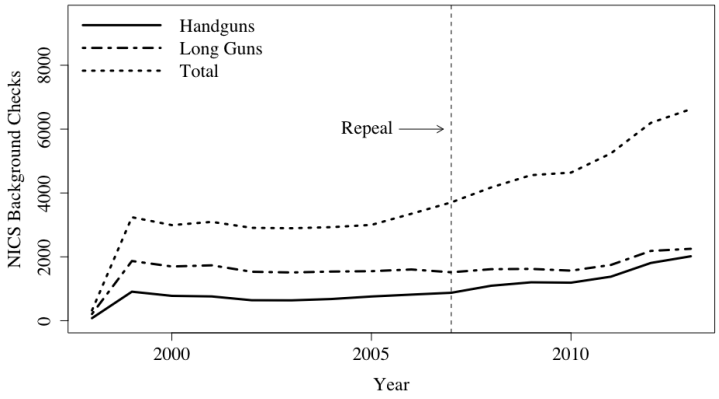


(d) Motor Vehicle Theft

Figure 2: FBI Nonviolent Index Crime: Missouri v. U.S.



(a) Missouri



(b) U.S.

Figure 3: FFL Background Checks Per 100,000 by Gun Type: Missouri v. U.S.

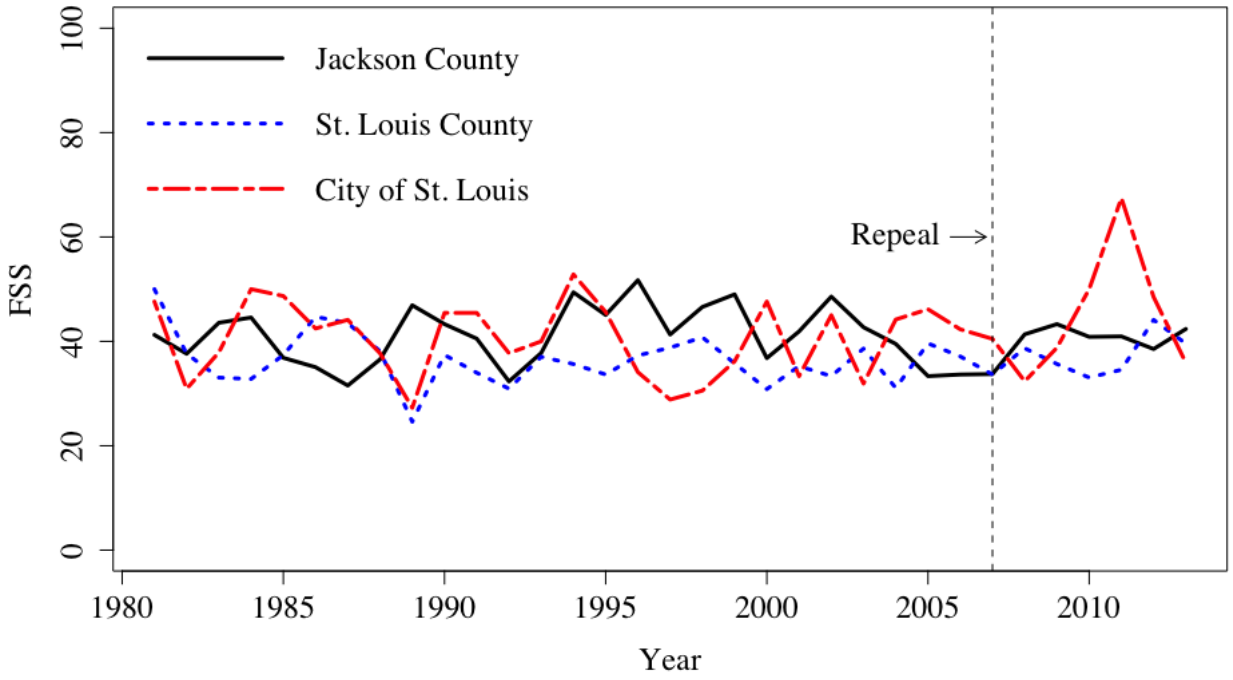
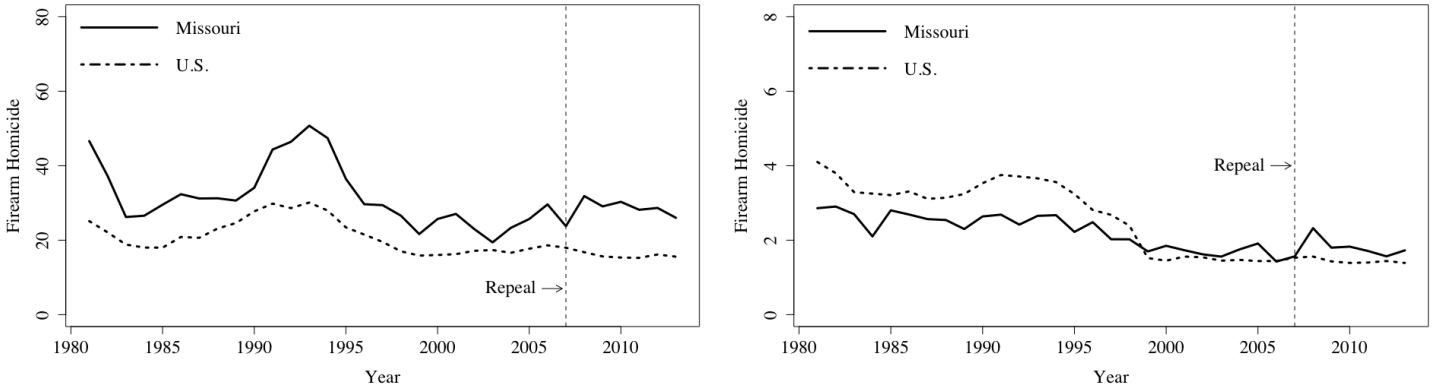


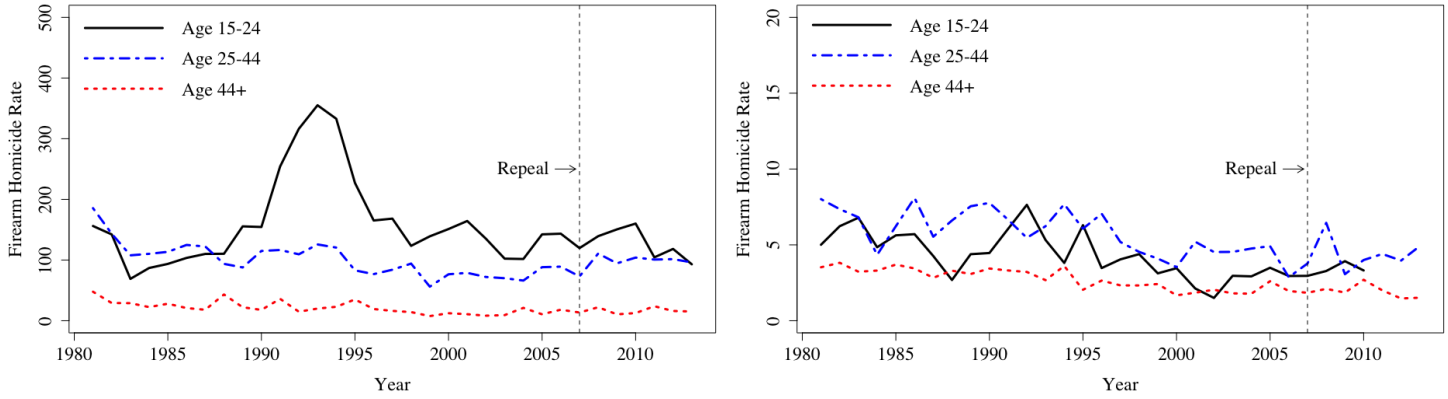
Figure 4: Missouri Fraction of Suicides Committed with a Firearm (FSS): 1981-2013



(a) Black

(b) White

Figure 5: Firearm Homicide Rates Per 100,000 by Race: Missouri v. U.S.



(a) Black Males

(b) White Males

Figure 6: Missouri Male Firearm Homicide Rates by Race and Age-Group

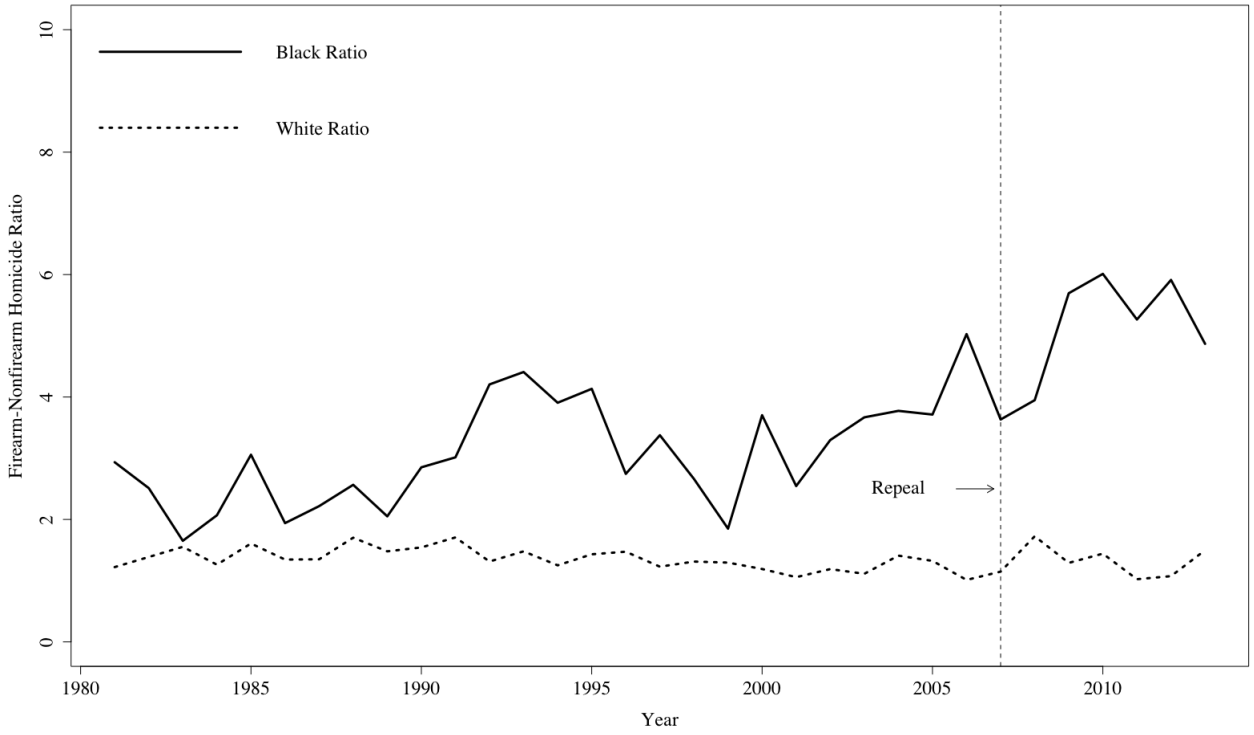
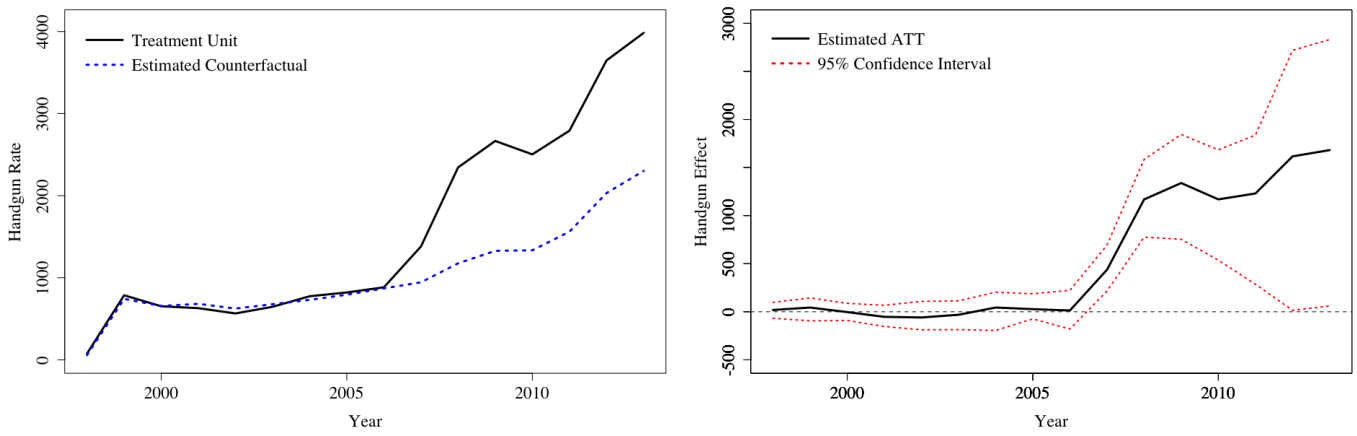


Figure 7: Missouri Firearm-Nonfirearm Homicide Ratios by Race: 1981-2013

Figure 8: City of St. Louis Homicide: 2008-2015, Phillips (2015)

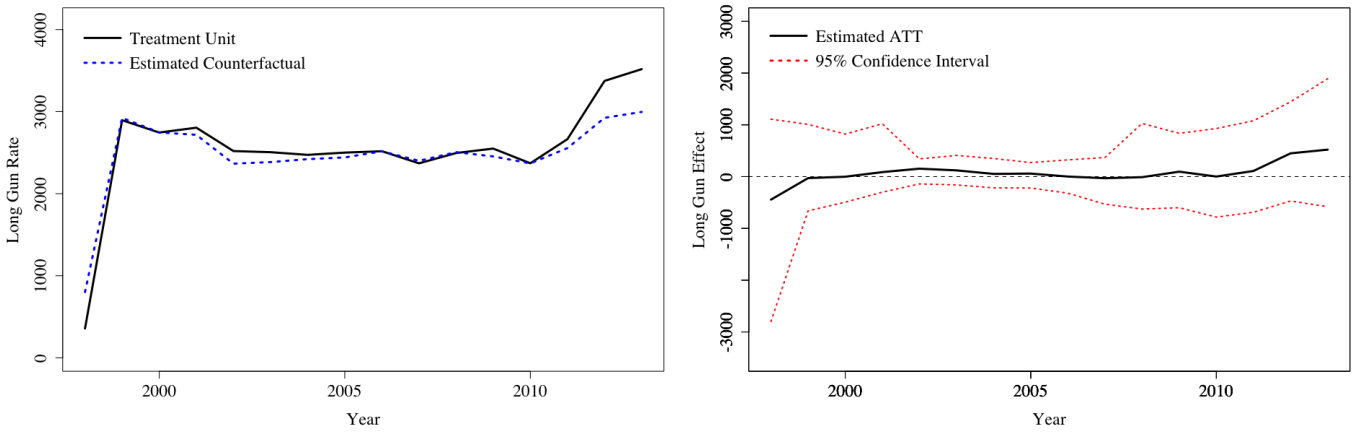


(a) NICS Background Checks

(b) NICS Background Check Effect

Figure 9: Missouri NICS Background Check Results: Handguns

Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for poverty, log per capita income, unemployment, percent of the population with less than a high school degree, state effects, and year fixed effects.



(a) NICS Background Checks

(b) NICS Background Check Effect

Figure 10: Missouri NICS Background Check Results: Long Guns

Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for poverty, log per capita income, unemployment, percent of the population with less than a high school degree, state effects, and year fixed effects.

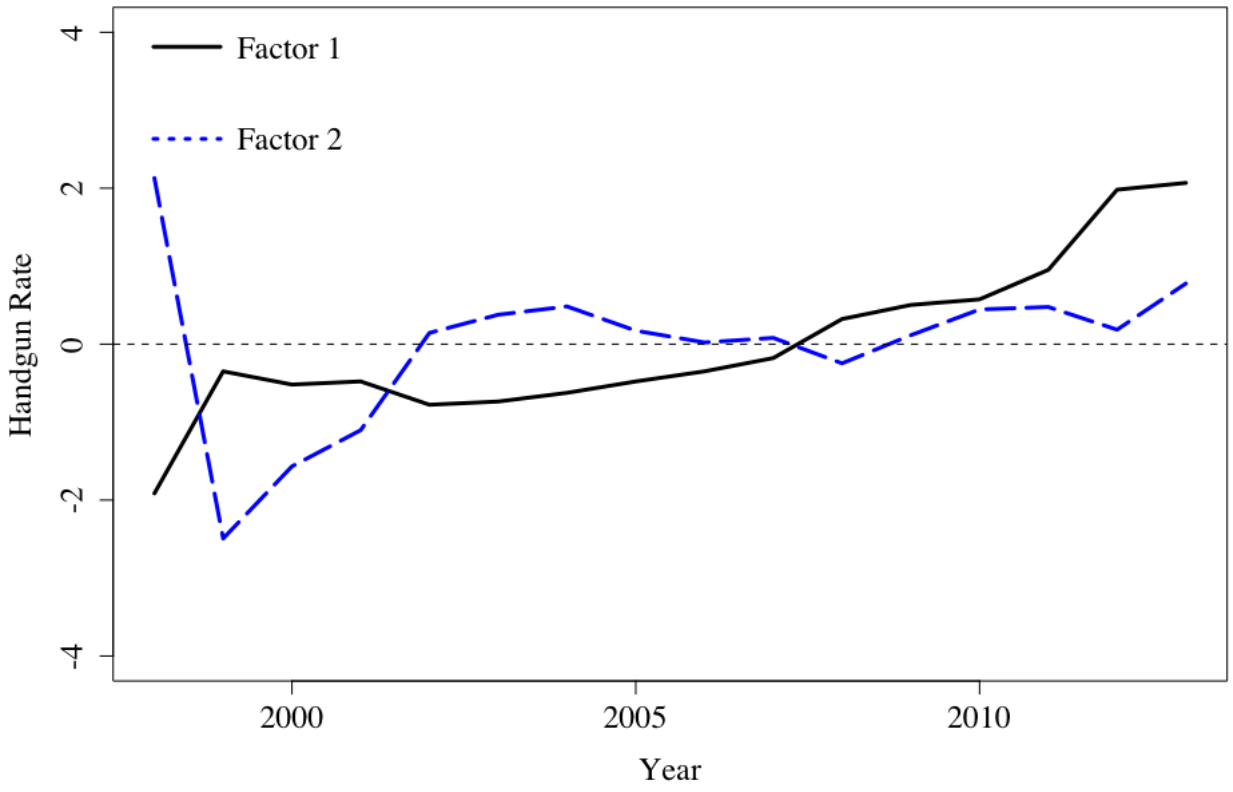


Figure 11: Missouri PTP Repeal and Handgun Background Checks: Estimated Latent Factors

Notes: Estimated latent factor comes from generalized synthetic control estimation controlling for poverty, log per capita income, unemployment, percent of the population with less than a high school degree, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.

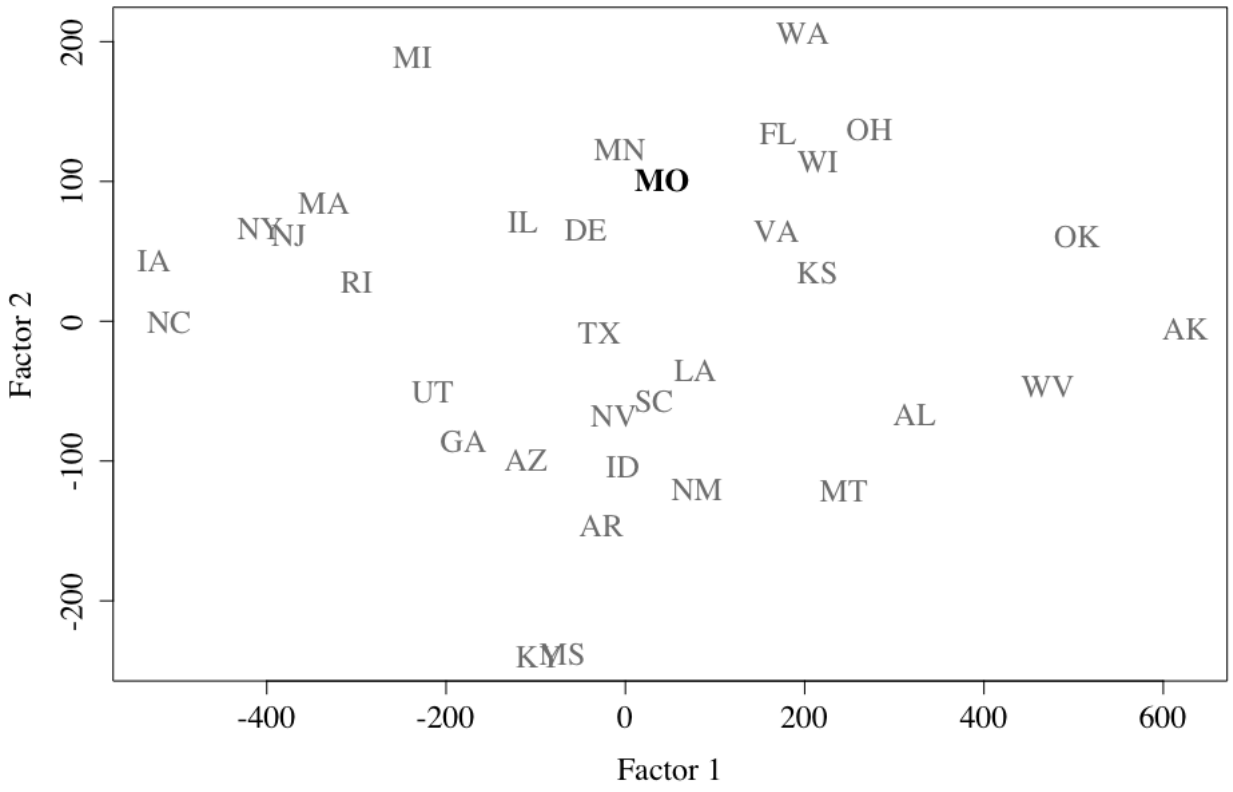
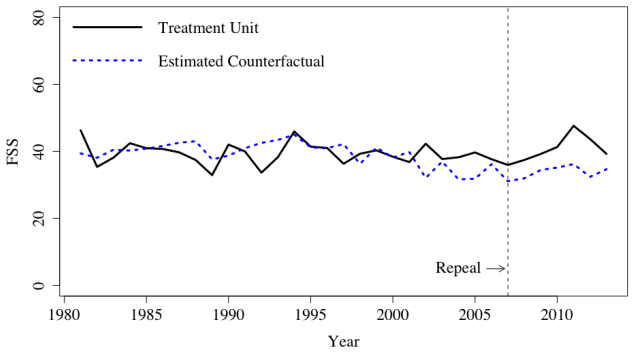
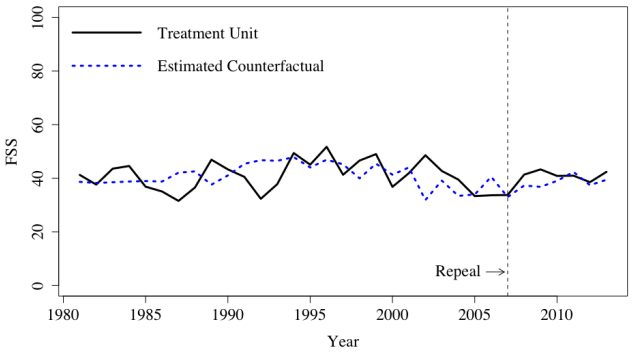


Figure 12: Missouri PTP Repeal and Handgun Background Checks: Factor Loadings

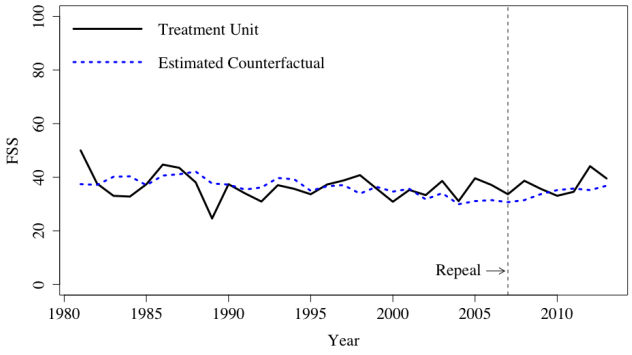
Notes: Estimated factor loadings come from generalized synthetic control estimation controlling for poverty, log per capita income, unemployment, percent of the population with less than a high school degree, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.



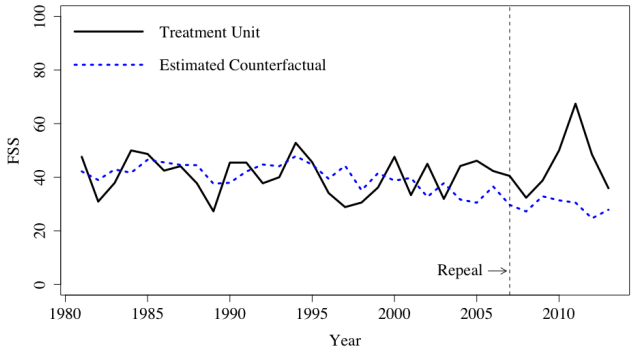
(a) FSS: All Counties



(b) FSS: Jackson County



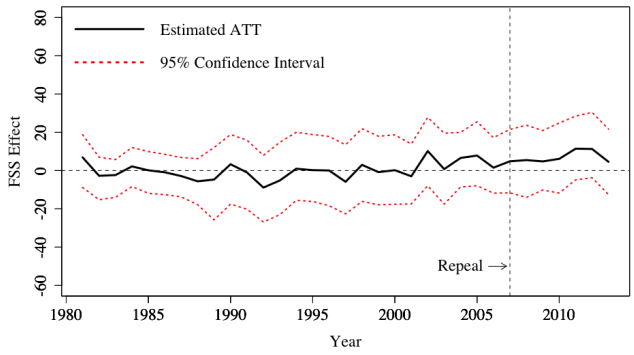
(c) FSS: St. Louis County



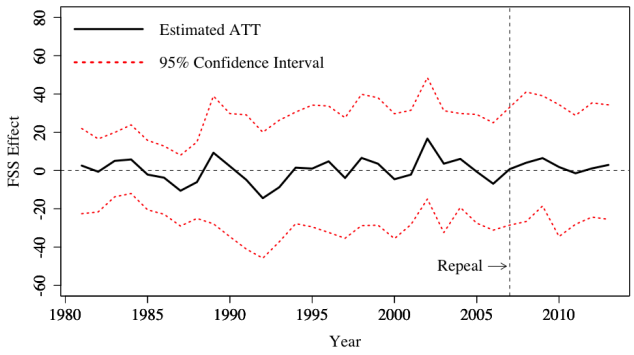
(d) FSS: City of St. Louis

Figure 13: Missouri County-Level FSS Results

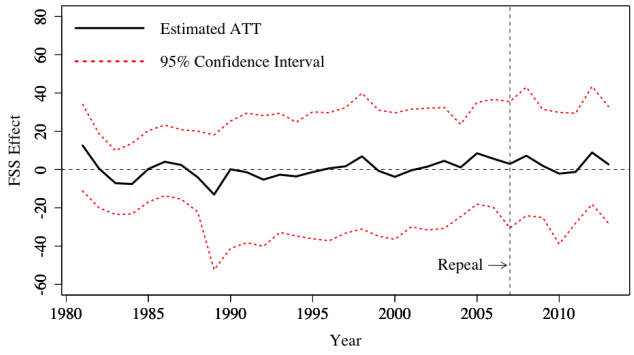
Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for overall suicide rates, log per capita income, percent of female-headed households, educational attainment less than high school, county effects, and year fixed effects.



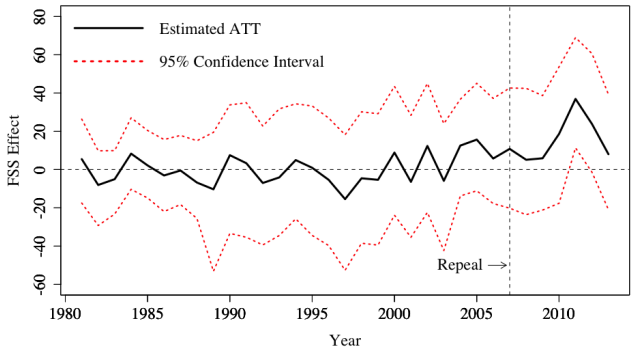
(a) FSS: All Counties



(b) FSS: Jackson County



(c) FSS: St. Louis County



(d) FSS: City of St. Louis

Figure 14: Missouri County-Level FSS Effects

Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for overall suicide rates, log per capita income, percent of female-headed households, educational attainment less than high school, county effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the county-level based on a sample of $N = 2,000$.

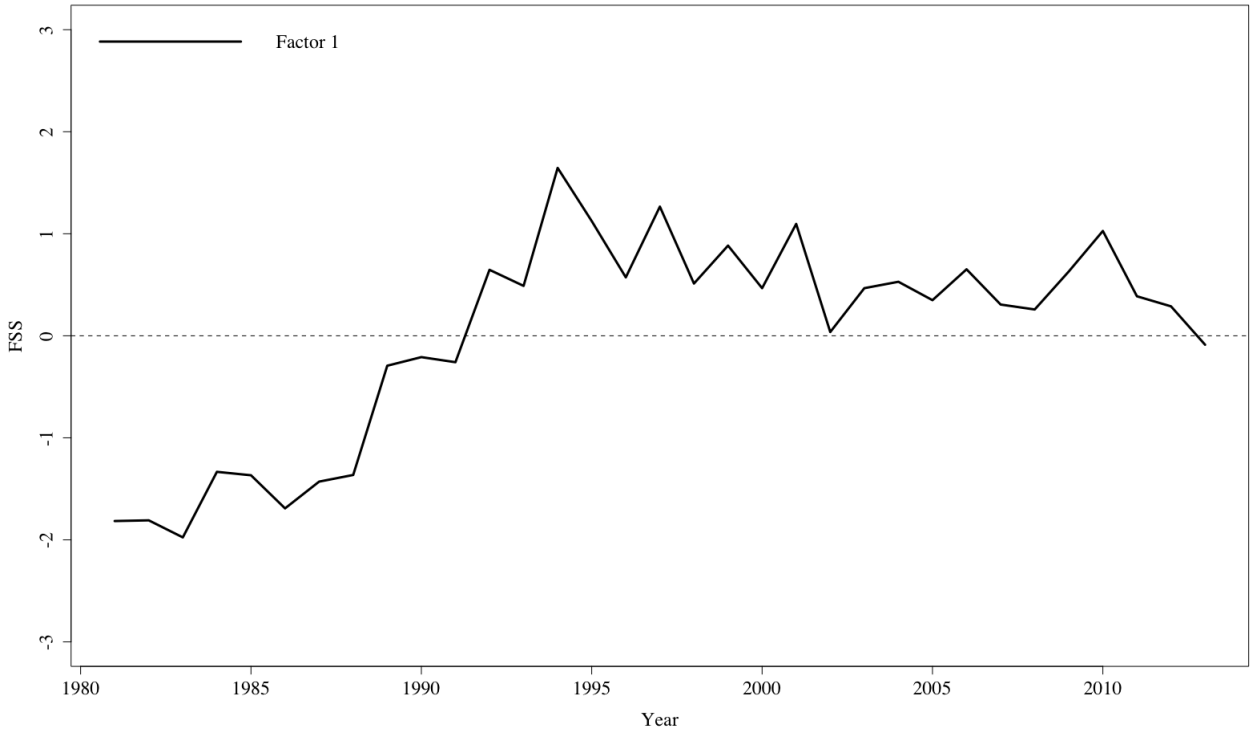
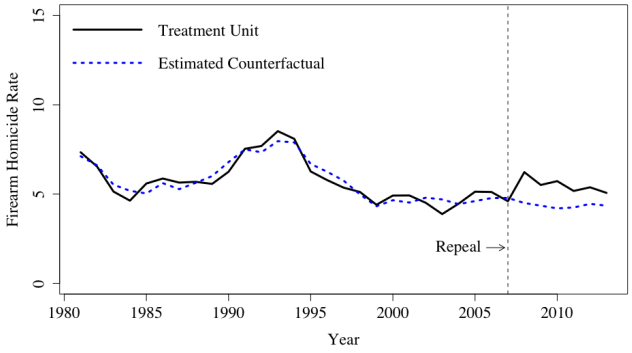
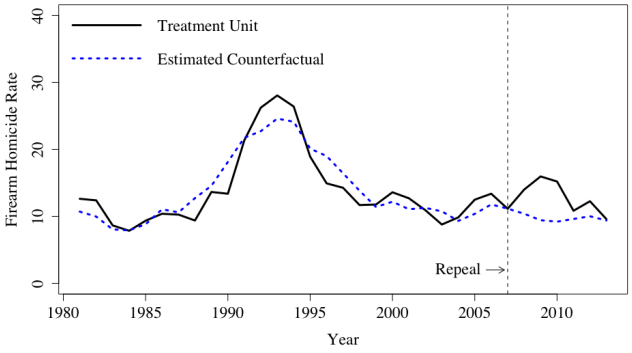


Figure 15: Missouri PTP Repeal and County-Level Gun Ownership: Estimated Latent Factors

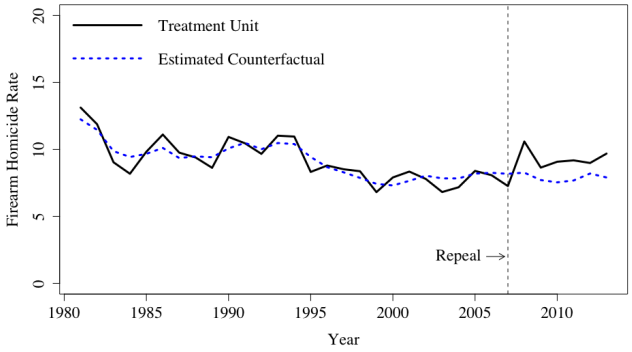
Notes: Estimated latent factor comes from generalized synthetic control estimation controlling for overall suicide rates, log per capita income, percent of female-headed households, educational attainment less than high school, county effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.



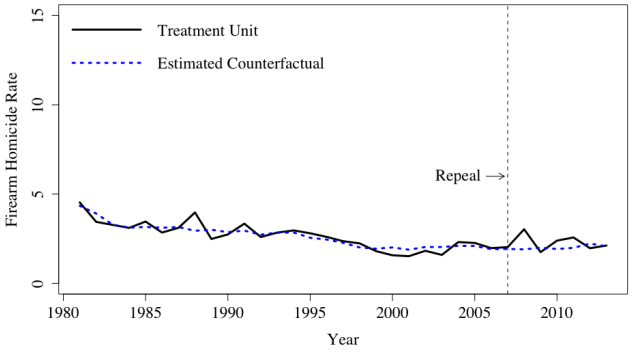
(a) Firearm Homicide: Overall



(b) Firearm Homicide: 15-24



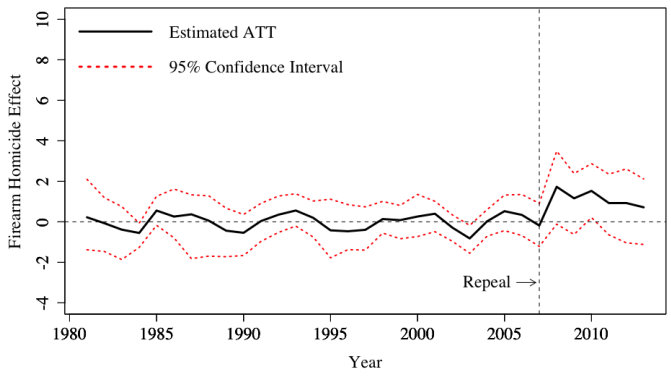
(c) Firearm Homicide: 25-44



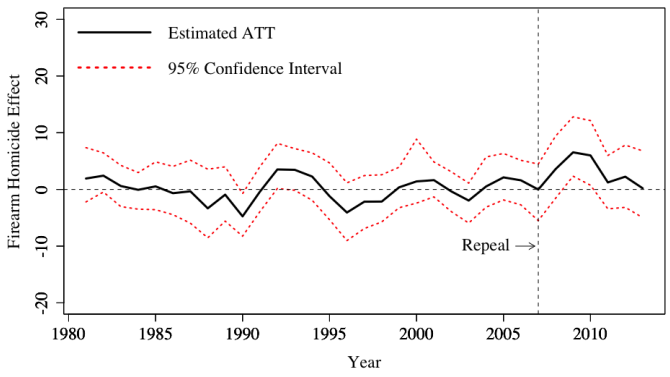
(d) Firearm Homicide: 45 and Older

Figure 16: Missouri Firearm Homicide Results

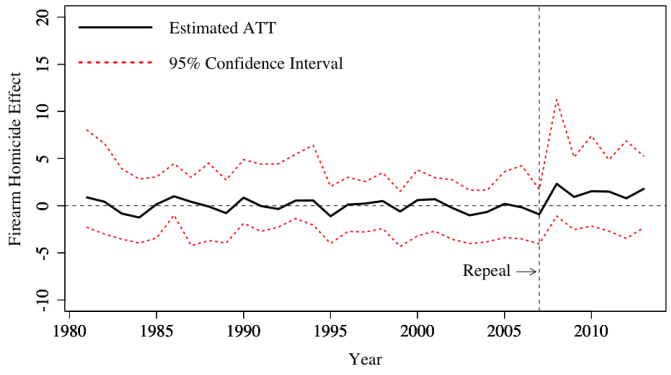
Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for poverty rate, unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects.



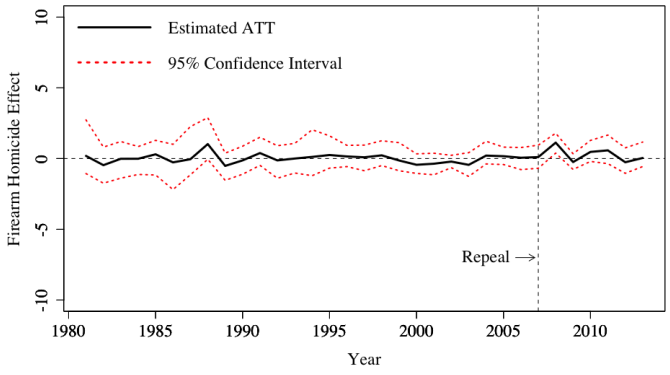
(a) Firearm Homicide: Overall



(b) Firearm Homicide: 15-24



(c) Firearm Homicide: 25-44



(d) Firearm Homicide: 45 and Older

Figure 17: Missouri Firearm Homicide Effects

Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for poverty rate, unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the state-level based on a sample of $N = 2,000$.

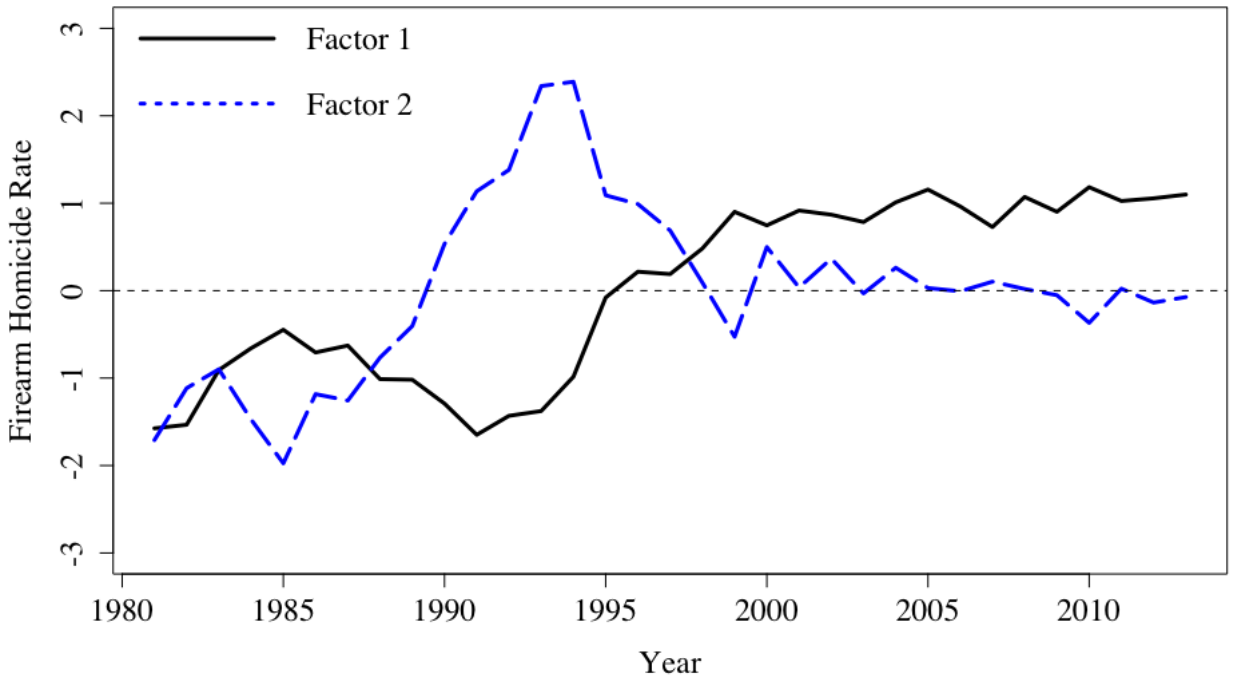


Figure 18: Missouri PTP Repeal and Firearm Homicide: Estimated Latent Factors

Notes: Estimated latent factor comes from generalized synthetic control estimation controlling for poverty rate, unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.

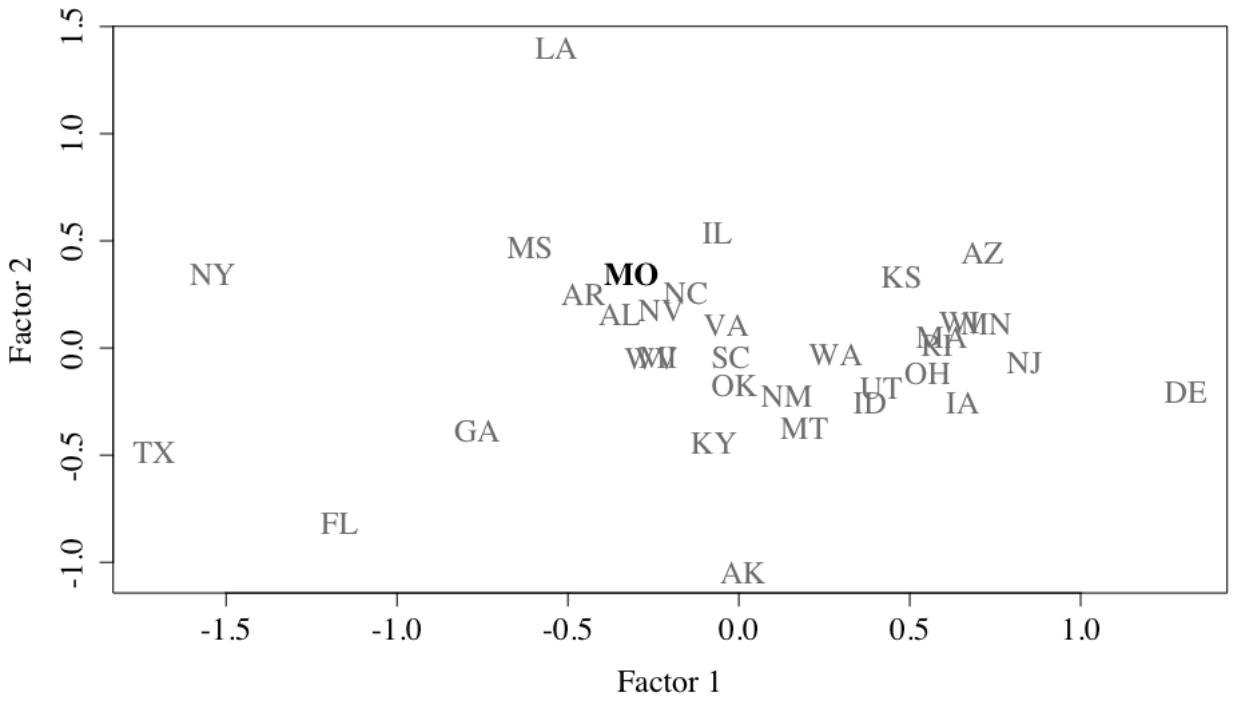
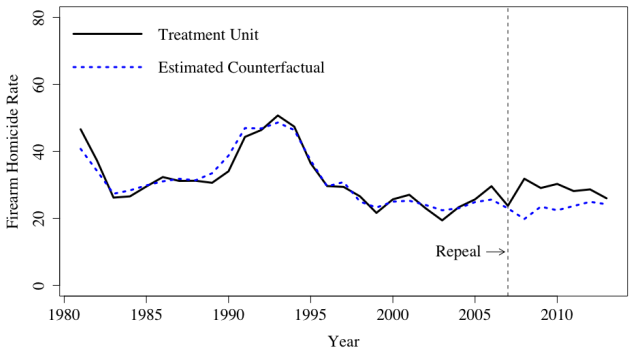
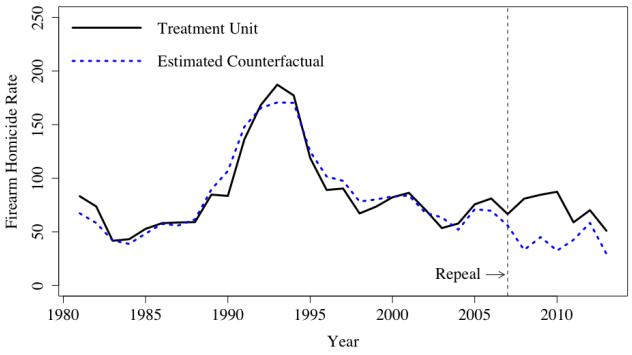


Figure 19: Missouri PTP Repeal and Firearm Homicide: Factor Loadings

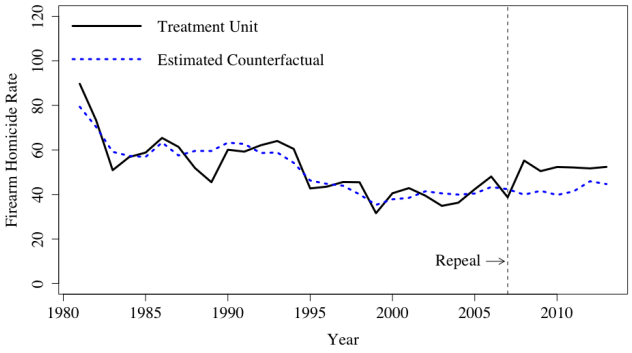
Notes: Estimated factor loadings come from generalized synthetic control estimation controlling for poverty rate, unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.



(a) Black Firearm Homicide: Overall



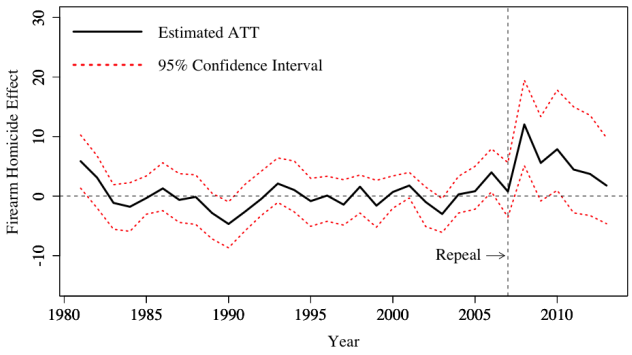
(b) Black Firearm Homicide: 15-24



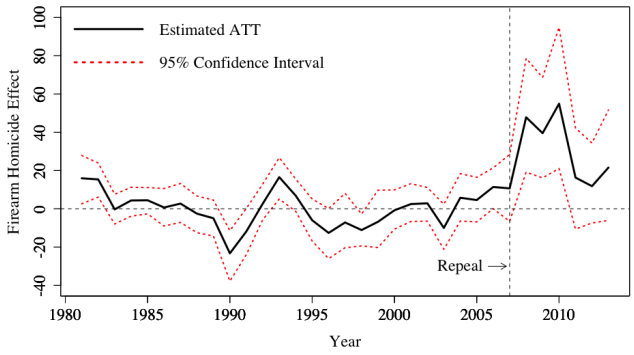
(c) Black Firearm Homicide: 25-44

Figure 20: Missouri Black Firearm Homicide Results

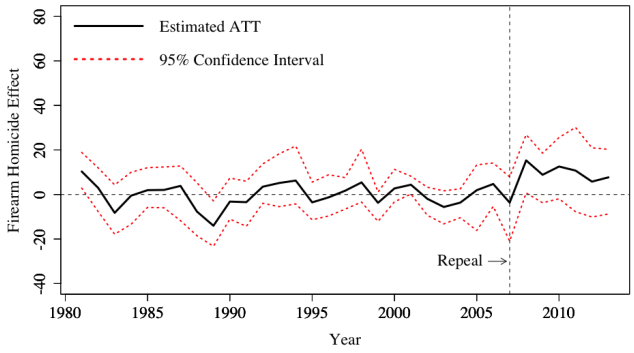
Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects.



(a) Black Firearm Homicide: Overall



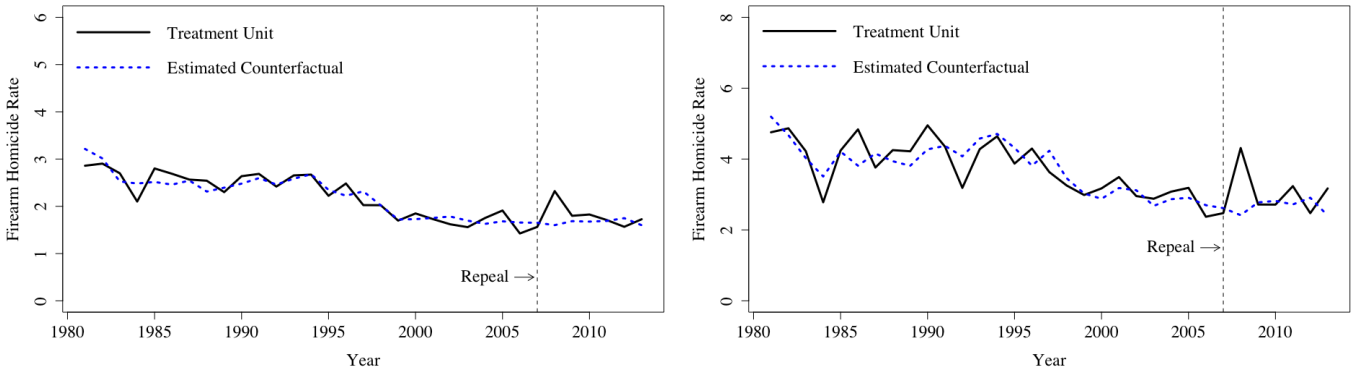
(b) Black Firearm Homicide: 15-24



(c) Black Firearm Homicide: 25-44

Figure 21: Missouri Black Firearm Homicide Effects

Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the state-level based on a sample of $N = 2,000$.

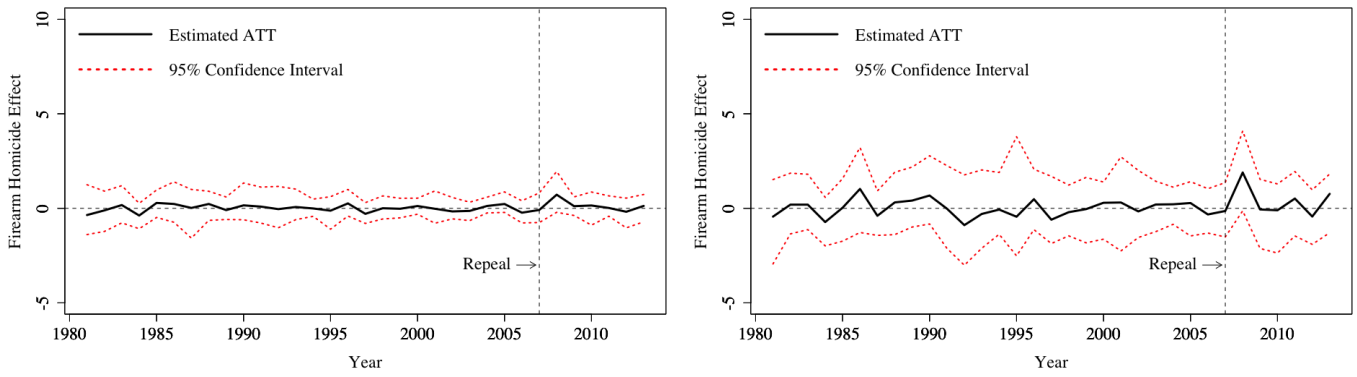


(a) White Firearm Homicide: Overall

(b) White Firearm Homicide: 25-44

Figure 22: Missouri White Firearm Homicide Results

Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for White poverty rate, White unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects.



(a) White Firearm Homicide: Overall

(b) White Firearm Homicide: 25-44

Figure 23: Missouri White Firearm Homicide Effects

Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for White poverty rate, White unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the state-level based on a sample of $N = 2,000$.

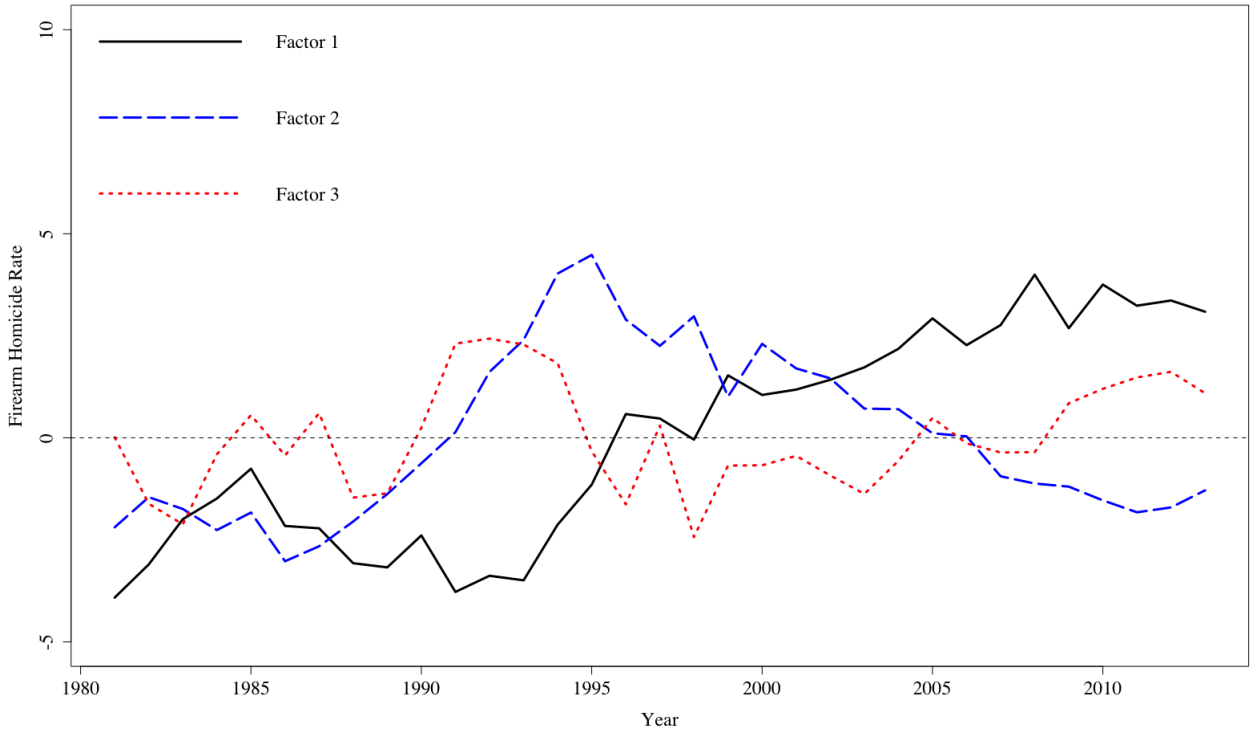
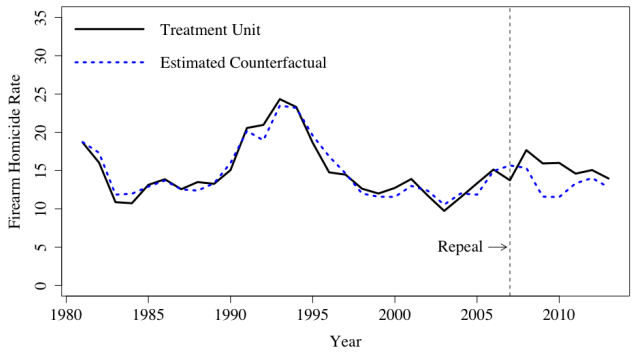
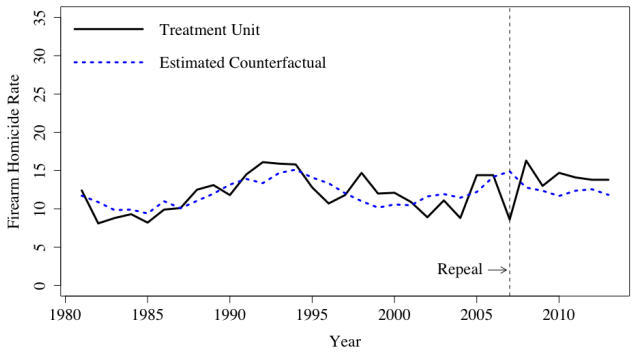


Figure 24: Missouri PTP Repeal and Black Firearm Homicide: Estimated Latent Factors

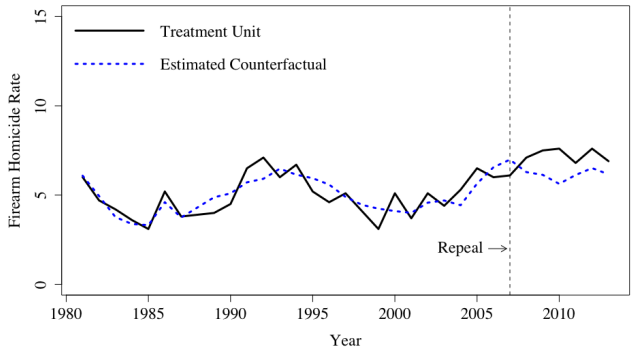
Notes: Estimated latent factors come from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.



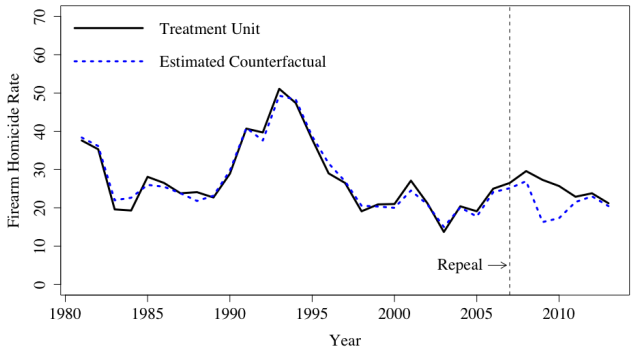
(a) Firearm Homicide: All Counties



(b) Firearm Homicide: Jackson County



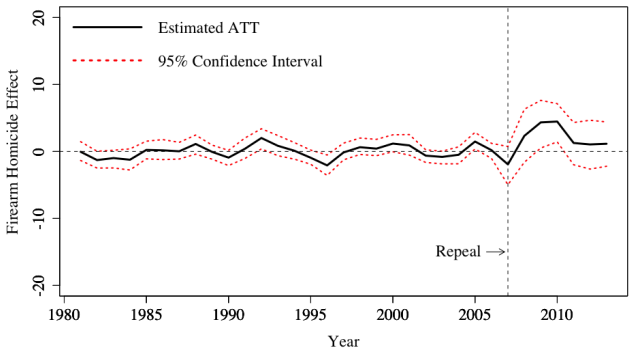
(c) Firearm Homicide: St. Louis County



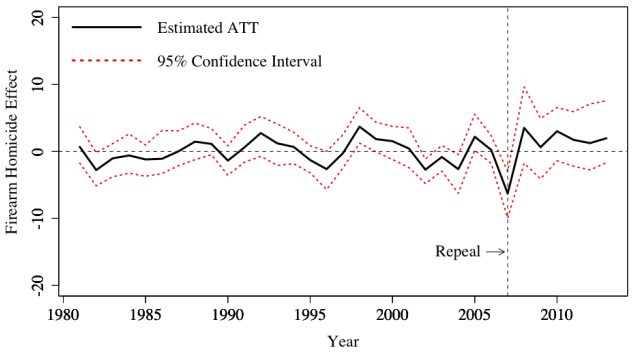
(d) Firearm Homicide: City of St. Louis

Figure 25: Missouri County-Level Firearm Homicide Results

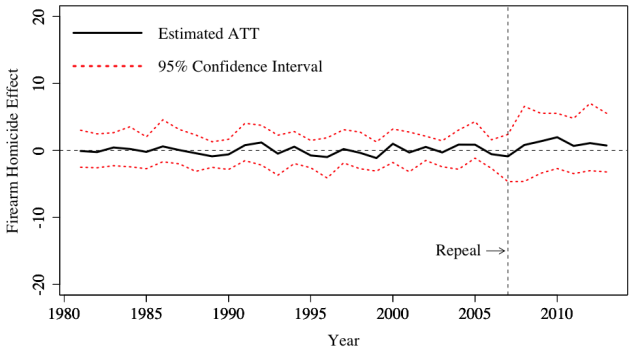
Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for poverty rate, unemployment rate, Black percent of the population, FSS, county effects, and year fixed effects.



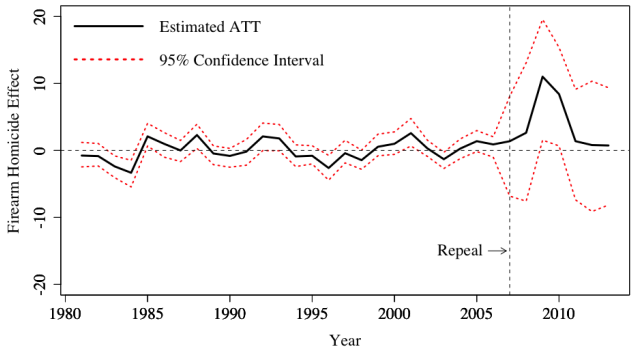
(a) Firearm Homicide: All Counties



(b) Firearm Homicide: Jackson County



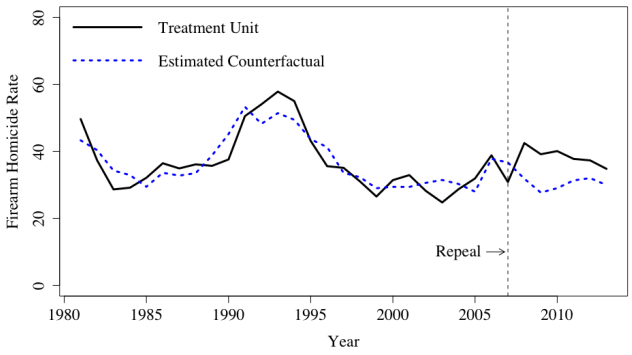
(c) Firearm Homicide: St. Louis County



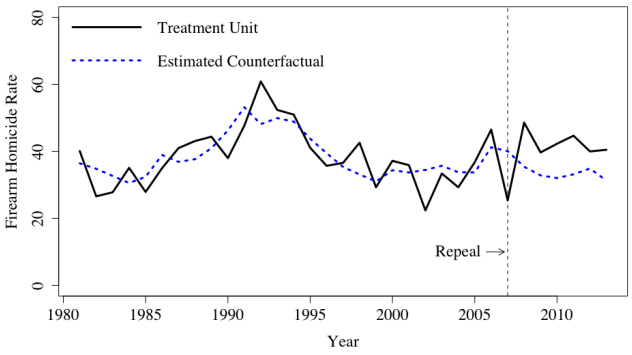
(d) Firearm Homicide: City of St. Louis

Figure 26: Missouri County-Level Firearm Homicide Effects

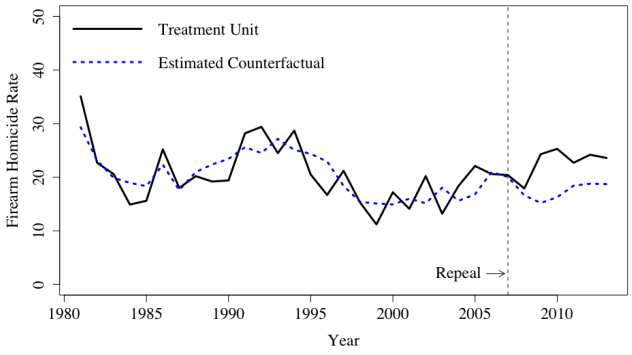
Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for poverty rate, unemployment rate, Black percent of the population, FSS, county effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the county-level based on a sample of $N = 2,000$.



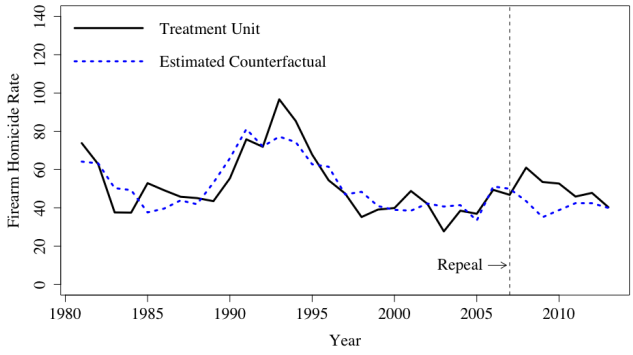
(a) Black Firearm Homicide: All Counties



(b) Black Firearm Homicide: Jackson County



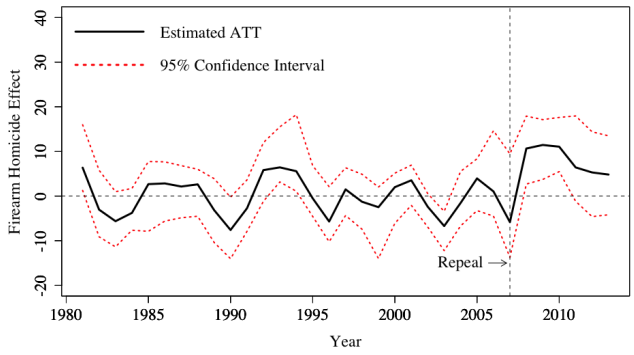
(c) Black Firearm Homicide: St. Louis County



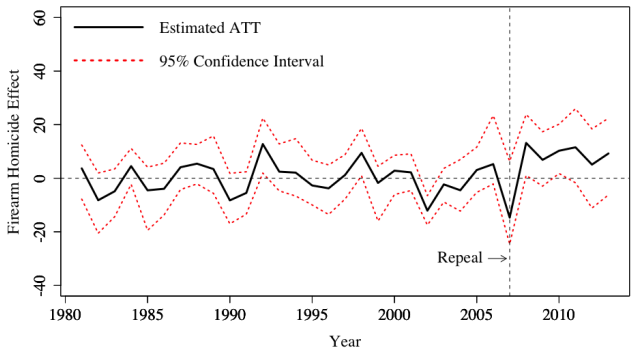
(d) Black Firearm Homicide: City of St. Louis

Figure 27: Missouri County-Level Black Firearm Homicide Results

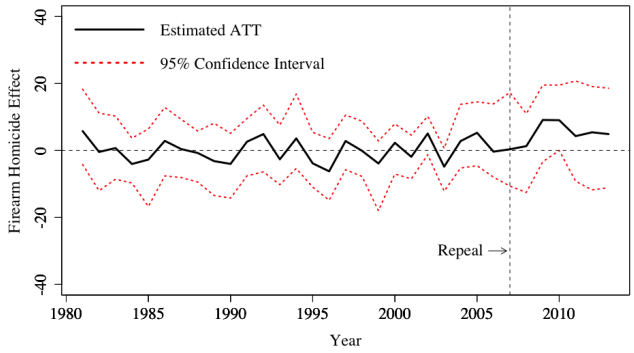
Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, Black percent of the population, FSS, county effects, and year fixed effects.



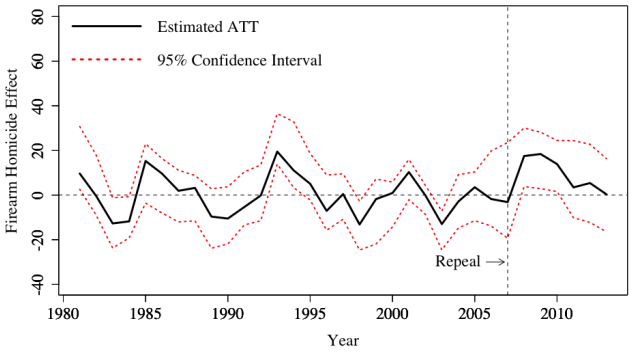
(a) Black Firearm Homicide: All Counties



(b) Black Firearm Homicide: Jackson County



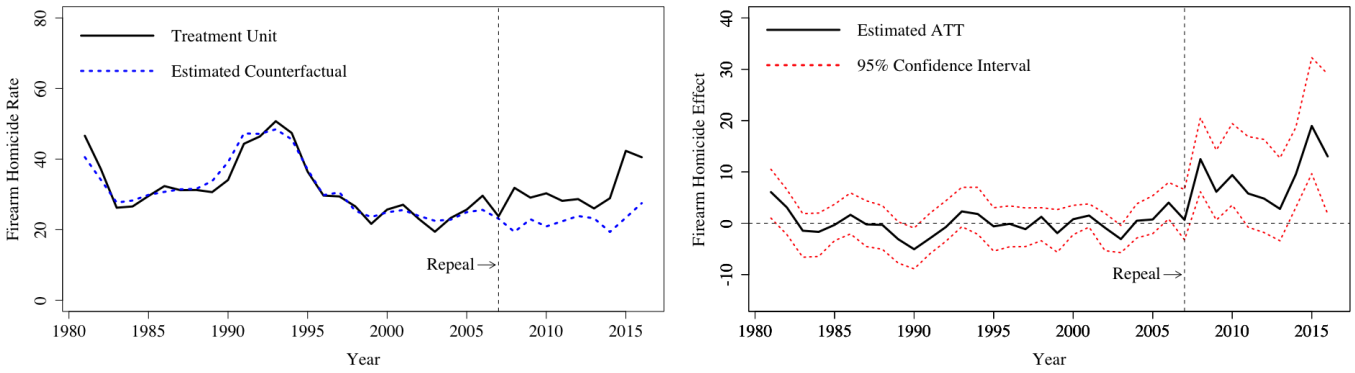
(c) Black Firearm Homicide: St. Louis County



(d) Black Firearm Homicide: City of St. Louis

Figure 28: Missouri County-Level Black Firearm Homicide Effects

Notes: Figure includes treatment effects from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, Black percent of the population, FSS, county effects, and year fixed effects. Dashed lines represent 95 percent confidence intervals with bootstrapped standard errors clustered at the county-level based on a sample of $N = 2,000$.



(a) Black Firearm Homicide

(b) Black Firearm Homicide: Effects

Figure 29: Missouri Black Firearm Homicide Results (1981-2016)

Notes: Figure includes estimated counterfactuals from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects.

Table 1: Missouri Firearm Time-to-Crime Rates: 2006-2013

Year	< 3 Months	3-7 Months	7-12 Months	1-2 Years	2-3 Years	≥ 3 Years	Average	U.S. Average
2006	71	89	78	159	123	1698	11.22	10.17
2007	106	95	88	166	150	1725	10.68	10.33
2008	222	174	125	159	131	1562	10.30	10.39
2009	203	173	204	319	136	1484	9.34	10.77
2010	227	213	194	386	251	1698	9.25	10.94
2011	233	191	201	347	260	1504	8.66	11.20
2012	243	153	190	323	238	1566	8.93	11.12
2013	169	189	229	325	271	1830	8.94	11.08

Source: Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) Firearm Tracing System

Table 2: Missouri County-Level Descriptive Statistics, 2006

Variables	Jackson County	St. Louis County	City of St. Louis
Firearm Homicide Rate (Per 100,000)			
Pre-Repeal (2000-2006)	11.51	5.16	21.07
Post-Repeal (2007-2013)	13.47	7.09	25.29
Black Firearm Homicide Rate (Per 100,000)			
Pre-Repeal (2000-2006)	34.50	17.97	40.47
Post-Repeal (2007-2013)	40.17	22.63	49.71
Unemployment Rate (%)			
Black	10.78	7.69	16.66
White	3.38	3.52	7.05
Poverty (%)			
Black	20.22	17.72	32.06
White	6.91	4.34	13.03
Ln(Income Per Capita)			
Black	9.83	9.91	9.56
White	10.26	10.52	10.18
Black (%)	23.67	21.60	50.01
Female-Headed Households (%)	15.31	13.64	20.14
Jail Incarceration Rate (Per 100,000)	203.20	138.34	752.17
Law Enforcement Officers (Per 100,000)	304.30	258.27	466.37

Notes: Data on firearm homicide are age-adjusted and come from the National Center for Health Statistics (NCHS) mortality detail files. Law enforcement officer data come from the FBI Uniform Crime Reports (UCR). Jail incarceration data come from the Bureau of Justice Statistics (BJS) Annual Survey of Jails and Census of Jails. Other demographic data come from the Bureau of the Census. All descriptive statistics pertain to the year 2006 unless stated otherwise.

Table 3: Missouri PTP Repeal NICS Background Check Results (1998-2013)

Variables	Handguns	Long Guns
PTP Repeal	1234.00	162.30
	(341.20)	(342.40)
Poverty Rate	2.34	13.68
	(5.30)	(14.11)
Unemployment Rate	8.42	-20.17
	(14.80)	(30.73)
Ln(GDP Per Capita)	2754.74	4421.41
	(1336.81)	(1705.18)
Education: Less Than High School	-37.61	30.80
	(28.36)	(46.36)
Treatment Units	1	1
Control Units	33	33
Unobserved Factors	2	0
MSPE	9126.46	35138.13
Mean	648.43	2368.49

Note: All NICS background check rates are presented per 100,000 individuals in the population. Estimation includes state and year fixed effects. Standard errors are presented in parentheses and clustered at the state-level with bootstraps based on a sample of $N = 2,000$.

Table 4: Missouri County-Level PTP Repeal FSS Results

Variables	FSS
PTP Repeal	6.94
	(4.48)
Total Suicide Rate	1.24
	(0.1048)
Ln(Income Per Capita)	8.00
	(5.32)
Female-Headed Households (%)	1.30
	(0.5520)
Education: Less Than High School (%)	0.2602
	(0.2535)
Treatment Units	3
Control Units	163
Unobserved Factors	1
MSPE	50.76
Mean	39.36

Notes: Data on (crude) total suicide rates are presented per 100,000 individuals in the population. Estimation includes county and year fixed effects. Standard errors are presented in parentheses and clustered at the county-level with bootstraps based on a sample of $N = 2,000$.

Table 5: Missouri PTP Repeal Firearm Homicide Results

Variables	All Age	Age 15-24	Age 25-44	Age 45+
PTP Repeal	0.9716	2.83	1.14	0.2599
	(0.6278)	(2.47)	(1.75)	(0.2169)
Poverty Rate	-0.0292	-0.1536	0.0590	-0.0106
	(0.0159)	(0.0887)	(0.0663)	(0.0134)
Unemployment Rate	-0.0390	-0.4834	-0.1223	0.0419
	(0.0372)	(0.1975)	(0.1214)	(0.0285)
Cocaine-Related Overdose Rate	0.0356	0.1597	0.0543	0.0089
	(0.0221)	(0.1219)	(0.0721)	(0.0110)
FSS	0.0122	0.0116	0.1083	0.0094
	(0.0372)	(0.0592)	(0.0417)	(0.0107)
Treatment Units	1	1	1	1
Control Units	33	26	29	25
Unobserved Factors	2	1	0	1
MSPE	0.2497	6.80	0.4841	0.1376
Mean	5.77	13.98	9.21	2.68

Note: Data on cocaine-related overdose and all firearm homicide rates are presented per 100,000 individuals in the population. Estimation includes state and year fixed effects. Standard errors are presented in parentheses and clustered at the state-level with bootstraps based on a sample of $N = 2,000$.

Table 6: Missouri PTP Repeal Firearm Homicide Results by Race and Age

Variables	Black	White	Black (15-24)	Black (25-44)	White (25-44)
PTP Repeal	5.17	0.1226	28.97	8.18	0.3477
	(3.19)	(0.1728)	(11.68)	(5.97)	(0.6255)
Poverty Rate[1]	0.0416	0.0205	0.9003	0.0947	-0.0064
	(0.1508)	(0.0546)	(0.4384)	(0.3605)	(0.1660)
Unemployment Rate[1]	-0.0859	-0.0536	-0.3242	-0.0014	-0.0624
	(0.2162)	(0.0502)	(0.7152)	(0.4923)	(0.1676)
Cocaine-Related Overdose	0.1103	0.0132	-0.0958	0.5267	0.0560
	(0.1163)	(0.0096)	(0.4151)	(0.3052)	(0.0294)
FSS	0.0060	0.0132	0.2233	0.1902	0.0311
	(0.0440)	(0.0063)	(0.1621)	(0.1226)	(0.0185)
Treatment Units	1	1	1	1	1
Control Units	24	28	20	22	21
Unobserved Factors	3	2	2	1	1
MSPE	18.62	0.0500	459.65	50.93	0.2610
Mean	32.00	2.26	86.67	52.04	3.79

Note: Data on cocaine-related overdose and all firearm homicide rates are presented per 100,000 individuals in the population. Estimation includes state and year fixed effects. Standard errors are presented in parentheses and clustered at the state-level with bootstraps based on a sample of $N = 2,000$.

[1] Poverty and unemployment rates are race-specific when appropriate.

Table 7: Missouri PTP Repeal and Black Firearm Homicide: State-Level Factor Loadings

State	Factor 1	State	Factor 2	State	Factor 3
1. Delaware	2.41	1. Kansas	2.45	1. **Missouri**	2.06
2. New Jersey	1.98	2. Wisconsin	1.57	2. Illinois	1.05
3. Kentucky	0.8189	3. Minnesota	1.49	3. Louisiana	0.9978
4. South Carolina	0.8131	4. Arizona	1.13	4. Wisconsin	0.9582
5. Ohio	0.7962	5. Louisiana	0.9941	5. Arkansas	0.6211
6. Massachusetts	0.7316	6. Illinois	0.8459	6. Texas	0.5980
7. Oklahoma	0.6384	7. Nevada	0.8123	7. Oklahoma	0.5444
8. Wisconsin	0.3430	8. **Missouri**	0.5659	8. Ohio	0.4395
9. Virginia	0.2422	9. Virginia	0.2253	9. Massachusetts	0.3921
10. North Carolina	0.1716	10. North Carolina	0.0941	10. Michigan	0.3653
11. Minnesota	0.1194	11. Mississippi	-0.0278	11. New York	0.3630
12. Kansas	0.0809	12. Arkansas	-0.0823	12. New Jersey	0.0894
13. Arizona	0.0087	13. Massachusetts	-0.1619	13. Mississippi	0.0891
14. Illinois	0.0001	14. Kentucky	-0.2145	14. Kansas	-0.0316
15. Mississippi	-0.0300	15. Alabama	-0.3586	15. Minnesota	-0.0770
16. Alabama	-0.0679	16. New York	-0.4922	16. Virginia	-0.1667
17. Louisiana	-0.1266	17. South Carolina	-0.5148	17. Delaware	-0.2527
18. Arkansas	-0.3732	18. Ohio	-0.7548	18. Alabama	-0.2783
19. Georgia	-0.5176	19. Oklahoma	-0.8101	19. North Carolina	-0.3411
20. Michigan	-0.8873	20. New Jersey	-0.8251	20. South Carolina	-0.3443
21. New York	-0.9011	21. Delaware	-0.8341	21. Georgia	-0.5811
22. Florida	-1.23	22. Georgia	-0.9152	22. Florida	-0.5928
23. Nevada	-1.41	23. Michigan	-1.16	23. Kentucky	-1.09
24. **Missouri**	-1.59	24. Texas	-1.19	24. Arizona	-1.37
25. Texas	-2.02	25. Florida	-1.84	25. Nevada	-3.45

Notes: Estimated factor loadings come from generalized synthetic control estimation controlling for Black poverty rate, Black unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. Model specification based on cross-validation results minimizing the mean squared prediction error (MSPE) over the pretreatment period.

Table 8: Missouri County-Level PTP Repeal Firearm Homicide Results

Variables	Firearm Homicide	Black Firearm Homicide
PTP Repeal	1.81	6.27
	(1.47)	(3.22)
Poverty Rate[1]	0.0178	-0.0688
	(0.1735)	(0.5212)
Unemployment Rate[1]	-0.2410	0.4782
	(0.0888)	(0.6485)
Percent Black	0.0775	-0.3047
	(0.1425)	(0.4811)
FSS	0.0070	-0.0709
	(0.0078)	(0.0445)
Treatment Units	3	3
Control Units	33	14
Unobserved Factors	4	4
MSPE	16.56	63.34
Mean	14.90	37.06

Note: All firearm homicide rates are presented per 100,000 individuals in the population. Estimation includes county and year fixed effects. Standard errors are presented in parentheses and clustered at the county-level with bootstraps based on a sample of $N = 2,000$.

[1] Poverty and unemployment rates are race-specific when appropriate.

Table 9: Missouri Firearm Trace Recovery in Border States: 2006-2013 (%)

Year	Missouri	Arkansas	Illinois	Iowa	Kansas	Kentucky	Nebraska	Oklahoma	Tennessee
2006	30.65	1.75	0.63	1.26	7.18	0.00	0.94	0.64	0.00
2007	33.33	0.96	0.84	0.60	7.99	0.00	0.78	0.37	0.00
2008	35.64	0.94	0.86	1.39	6.92	0.00	1.18	1.18	0.00
2009	40.43	0.93	1.08	1.45	6.33	0.00	0.00	0.66	0.00
2010	41.19	1.65	1.00	1.08	8.31	0.00	1.06	0.73	0.00
2011	48.24	0.90	1.43	1.30	6.71	0.00	1.12	1.09	0.00
2012	47.96	0.76	1.37	1.49	6.98	0.36	1.45	0.53	0.00
2013	50.34	1.05	1.69	1.49	6.50	0.00	1.87	1.06	0.00

Source: Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) Firearm Tracing System

Table 10: Missouri PTP Repeal: Robustness Check Results

Outcomes	PTP Repeal
Non-Firearm Homicide Rate: CDC	0.1140
	(0.5108)
Murder Rate and Non-Negligent Homicide: UCR	1.23
	(0.6053)
Aggravated Assault Rate: UCR	34.18
	(38.05)
Forcible Rape Rate: UCR	1.81
	(2.87)
Robbery Rate: UCR	0.9267
	(10.51)
Burglary Rate: UCR	-10.13
	(61.25)
Larceny Theft Rate: UCR	-130.70
	(241.10)
Property Crime Rate: UCR	-211.60
	(312.80)
Motor Vehicle Theft Rate: UCR	0.16
	(138.4)

Note: Specifications include poverty, unemployment rate, cocaine-related overdose rate, and fraction of suicides committed with a firearm. Estimation includes geographic unit (i.e., county-level or state-level) and year fixed effects. Standard errors are presented in parentheses and clustered at the geographic level (i.e., county-level or state-level) with bootstraps based on a sample of $N = 2,000$.

Table 11: Missouri PTP Repeal: 2007-2016 Post-Intervention Period

Outcomes	PTP Repeal 2007-2013	PTP Repeal 2007-2016
NICS Handgun Checks (State-Level)	1234.00	1259 .00
	(341.20)	(434.80)
NICS Long Gun Checks (State-Level)	162.30	208.50
	(342.40)	(364.50)
FSS (County-Level)	6.94	7.24
	(4.48)	(4.02)
Firearm Homicide: Overall (State-level)	0.9716	1.51
	(0.6278)	(0.7139)
Firearm Homicide: Ages 15-24 (State-level)	2.83	4.12
	(2.47)	(2.63)
Firearm Homicide: Ages 25-44 (State-level)	1.14	1.85
	(1.75)	(1.82)
Firearm Homicide: Ages 45 and Older (State-level)	0.2599	0.4463
	(0.2169)	(0.2446)
Black Firearm Homicide: Overall (State-level)	5.17	8.36
	(3.19)	(3.71)
Black Firearm Homicide: Ages 15-24 (State-level)	28.97	30.94
	(11.68)	(10.53)
Black Firearm Homicide: Ages 25-44 (State-level)	8.18	15.36
	(5.97)	(6.69)
White Firearm Homicide: Overall (State-level)	0.1226	0.2906
	(0.1728)	(0.2581)
White Firearm Homicide: Ages 25-44 (State-level)	0.3477	0.5109
	(0.6255)	(0.6505)
Firearm Homicide: Overall (County-level)	1.81	2.06
	(1.47)	(2.25)
Black Firearm Homicide: Overall (County-level)	6.27	9.61
	(3.22)	(3.98)

Note: All NICS background check rates are presented per 100,000 individuals in the population. State-level NICS background check specifications control for poverty, log per capita income, unemployment, percent of the population with less than a high school degree, state effects, and year fixed effects. The county-level FSS specification controls for overall suicide rates, log per capita income, percent of female-headed households, educational attainment less than high school, county effects, and year fixed effects. All state-level firearm homicide specifications control for (race-specific) poverty rate, (race-specific) unemployment rate, cocaine-related overdose rate, FSS, state effects, and year fixed effects. County-level firearm homicide specification control for (race-specific) poverty rate, (race-specific) unemployment rate, Black percent of the population, FSS, county effects, and year fixed effects. Standard errors are presented in parentheses and clustered at the geographic level (i.e., county-level or state-level) with bootstraps based on a sample of $N = 2,000$.