Gun Licenses, Restricted Firearms, Deaths and Crime: Results from Administrative Data in Canada*

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Abstract

Civilian ownership of firearms is a contentious political issue. We use national measures of firearm licenses and the total number of registered and restricted firearms collected by the Royal Canadian Mounted Police (RCMP) to revisit the relationships guns may have with homicides, suicides, and crime. Using fixed effects models at different geographic levels, we estimate the impacts of guns on deaths, suicides, and firearms-related crimes. We find that increasing other-restricted guns (neither rifles nor handguns) by about 50 (per 100,000) increases firearms-related deaths by about 0.1 (per 100,000). Other-restricted guns are also increasing firearms-related deaths whose intent are classified as assaults or self-harms. Licenses are generally unrelated to the different firearms-related deaths. Effects of different firearms types and different licenses on firearms-related crimes are heterogeneous based on the different crimes considered. Many of our coefficient estimates are small in magnitude, suggesting large changes in guns or licenses would be necessary to reduce firearms-related deaths.

KEYWORDS: Firearms; Guns; Crime; Homicide.

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1 Introduction

Crime, homicides, and suicides are perpetually linked to guns. In Canada during 2021, firearms were the primary cause of death in 297 homicides (0.78 per 100,000) and were present in violent crime affecting over 8,047 victims (27.4 per 100,000) (Cotter, 2022). At the same time, it was estimated that Canadians had 34.7 civilian firearms per 100 people in 2017 (estimated around 12,708,000 total civilian firearms), fifth highest in the world.[1] The United States has a similarly high relationship between firearms and related harms: over 52% of suicides (24,292 deaths) and more than 78% of homicides (19,384 deaths) involved firearms in the United States during 2020.[2]

Arguments for how and why access to guns may promote or deter violence are found in abundance. Within theoretical models, linking firearms and various outcomes like homicides and suicides can be ambiguous. Giving credence to some theories and arguments for real-world decision making therefore relies on researchers' abilities to understand potential underlying relationships. Yet, the dearth of reliable data on firearms and gun owners leaves the research in this area wanting.

Canada is an example where empirical evidence is particularly relevant. The federal government banned over 1500 "assault-style" rifles following the Nova Scotia attacks which killed 22 people in April 2020 (Allen, 2022). In 2022, the Canadian federal government introduced new firearms legislation (Bill C-21, *An Act to amend certain Acts and to make certain consequential amendments (firearms)*) which imposes many restrictions on licensed firearm owners. Two major features of Bill C-21, as of January 2023, are: (1) a "freeze" on the market for (legal) handguns and; (2) the prohibition and mandatory buyback of many semi-automatic long guns.[3]

Legislation change warrants questions of efficacy if enacted; specifically on how they will impact public safety through the legal firearms channel. If legal firearms owners are the culprits of firearms-related crimes, then restricting access and type of firearms could be appropriate. But this need not be the case, and the relationship between legal firearms and violent crimes remains unanswered. Allen (2022, p. 5) notes the current data gaps related to firearms in Canada:

[1] Canada is behind the United States (120.5 per 100 people), Yemen (52.8 per 100 people), Montenegro (39.1 per 100 people), and Serbia (39.1 per 100 people) (Small Arms Survey, 2020).

[2] For suicides, see: https://www.cdc.gov/nchs/fastats/suicide.htm. For homicides, see: https://www.cdc.gov/nchs/fastats/homicide.htm.

[3] More details can be found here https://pm.gc.ca/en/news/news-releases/2022/05/30/further-strengthening-our-gun-control-laws. The former precludes handguns from being bought, sold, transferred or imported in Canada; effectively freezing the total number of handguns at 2022 levels. The latter would see assault-style firearms bought back at values (in Canadian dollars) between $1,139 (VZ58 and variants) and $6,209 (SG550 and SG551 and variants), with a AR platforms (M16, AR-10, AR-15, M4 carbine and variants) and M14 rifles (and variants) being bought back at $1,337 and $2,612, respectively. See: https://www.publicsafety.gc.ca/cnt/cntrng-crm/frrms/bp-en.aspx

> *It is important to recognize that there are limitations in our knowledge about firearms used in crime. There is little information currently collected about the characteristics of these firearms, such as details about the exact type of gun, who owned it (e.g., accused, victim, or someone else), how it was stored, or whether the owner was licensed.*
>
> *Of particular concern, there is currently little information available to determine the source of firearms used in crime: for example, whether a gun used in a crime was stolen, illegally purchased or smuggled into the country. This information is sometimes not recorded by police services, recorded inconsistently or, in some cases, the information is simply not available. For example, not all firearms are recovered from firearm-related homicides; consequently, only some of these guns are available for tracing.*"

And while police considered 46% of firearm-related homicides to be gang-related (Moreau, 2022, p. 3), it is still uncertain exactly to what extent organized crime is involved with firearm-related violence (Allen, 2022, p. 5).

Our paper uses the annual stocks of firearm licenses and the total number of registered and restricted firearms collected by the Royal Canadian Mounted Police (RCMP) between 2013 and 2019 to investigate the relationships between legal guns variables and homicides, suicides, and crime. All of our analysis is specific to the Canadian context, which has particular laws surrounding firearms which need not exist elsewhere. For example, firearms licenses are mandatory for anyone to legally possess or acquire a firearm in Canada and can be thought of as the extensive margin for legal firearms ownership, since it would give an individual the ability to purchase a firearms. Registered and restricted firearms are a subset of all firearms which can be legally bought in Canada. Although not containing all legal firearms, we have data on counts of all publicly registered handguns. These guns variables improve on previous studies which rely on proxy measures for firearms due to data limitations.

We combine our licenses and guns variables with both publicly available data on deaths, homicides and firearms-related crimes and restricted, administrative data on deaths in Canada. Our main model specifies the prevalence (*i.e.* per $100,000$) of our outcome variables (deaths, crimes, *etc.*) with the prevalence of our guns variables in linear fixed effects model to control for unobserved heterogeneity across time and Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs).[4,5] CMAs and CAs are largely urban parts of Canada and so our analysis currently omits more rural parts of Canada.

It is worth noting that all of the following results are relative to the Canadian context between 2013 and 2019 with a specific focus on the legal firearms markets. Canada during this period heavily regulates firearms in general, and more so regarding handguns. For other periods of Canadian history (which were generally less regulated), and for other contexts, our results do not tell us the implications of additional legal firearms. We reiterate this periodically throughout this paper.

We accessed Statistics Canada's *Canadian Vital Statistics Death (CVSD)* database which

[4]In what follows, *prevalence* indicates values are rates per $100,000$ unless otherwise noted.

[5]A CMA can be thought of as a Metropolitan Statistical Area (MSA); a CA can be thought of as a Core Based Statistical Areas (CBSA).

provides restricted data on individual's leading cause of death. This allows us to aggregate deaths into those involving firearms, as well as the intent of deaths involving firearms and which type of firearms is thought to have caused the death. We further aggregate these deaths to their CMA and CA at the annual level to match our guns dataset.

When modelling the impacts of the prevalence of registered firearms or licenses separately from one another with CMA and CA fixed effects, we fail to detect any effects on firearms-related deaths, firearms-related suicides, firearms-related assaults or any of those deaths where a specific firearm was suspected used in the death in Canada between 2013 and 2019. Modelling the prevalence of licenses and restricted firearms in the same model still yields no effects across all of our dependent variables.

We also estimate a model which regresses our different firearms-related deaths with all of our guns variables. These models break out both types of license types into PALs and RPAls, as well as three categories of restricted firearms, handguns, rifles and a residual category of other guns. All firearms-related deaths are statistically significant and positively related to other guns. The coefficient estimates suggest increasing other guns by about 50 (per $100,000$) would increase the firearms-related deaths by 0.1 (per $100,000$). Both licenses types as well as handguns and rifles are statistically insignificant at all traditional levels. When decomposing total firearms deaths into those whose intents are assaults and self-harm, a similar story emerges. Handguns, PALs and RPALs are unrelated to firearms deaths whose intent are assaults, self-harm or unknown. Coefficient estimates suggest increasing the other guns variable by about 139 (83) per $100,000$ would increase firearms-related assault (self-harm) deaths by 0.1 (per $100,000$). Rifles are marginally significant and negatively related to self-harm deaths, where coefficient estimates suggest increasing rifles by about $3,845$ (per $100,000$) would reduce self-harm related deaths by 0.1 (per $100,000$). There seem to be no effects of firearms on deaths whose intent is unknown, across all of our models in Canada over this time period.

We use the same model but change our outcome variable to firearms-related deaths believed to be caused by a specific type of firearm (rifle, handgun, *etc.*). While we are able to detect effects, the coefficient magnitude are often too small to be of practical economic importance. Coefficient estimates suggest increasing handguns by $5,800$ (per $100,000$) would increase handgun-related deaths 0.1 (per $100,000$). Where the sample mean of handguns approximately $3,200$ (per $100,000$), this seems rather substantial. Increasing the prevalence of rifles by about $22,220$ would decrease the total handgun deaths by about 0.1 (per $100,000$). Again, the sample mean of rifles is approximately 400 (per $100,000$). Rifles and other guns are statistically significant and negatively related to rifle deaths. Coefficient estimates suggest 0.1 (per $100,000$) decrease in deaths associated with approximately $4,350$ rifles and 190 other guns (per $100,000$). Other guns and licenses are statistically significant and positively related firearms deaths with unspecified firearms. Coefficient estimates suggest increasing unspecified firearms deaths by 0.1 (per $100,000$) from increasing other guns by about 40 (per $100,000$). Increasing PALs by about 526 (per $100,000$) would translate to increasing unspecified firearms deaths by about 0.1 (per

100,000). There does not appear to be a relationship between uncategorised firearms deaths and our guns variables across all of our models.

We also estimate the effects of our firearms variables on firearms related crimes. We first standardize our firearms variables to more easily interpret our coefficients. Using the (standardized) prevalence of all licenses and all registered and restricted firearms as independent variables in the same model, we see that licenses appear to be decreasing documentation issues (coefficient equalling -1.56, significant at the 5% level) and also total homicides (coefficient equalling -0.33, significant at the 1% level). Breaking out total homicides into first degree murder, second degree murder and manslaughter, we find positive effects on first degree murders (coefficient equalling -0.53, significant at the 10% level), negative effects on second degree murders (coefficient equalling -0.88, significant at the 5% level), and no effects on manslaughter. There are no effects of total restricted firearms on any of our crime variables.

We then break out both our licenses into PALs and RPALs and our firearms variables into rifles, handguns, and other guns. The results are heterogeneous across types of licenses and types of firearms. Rifles appear to be increasing total firearms violations (through firearms discharge, using firearms and improper storage offences). Handguns have null effects on total firearms violations (decreasing using firearms and improper storage offences but increasing documentation issues).

Total homicides are unrelated to PALs, RPALs, handguns, rifles, and other guns. However, there is heterogeneity amongst the different types of homicides and our guns variables. Handguns and PALs are positively related to first degree murders; rifles and PALs are negatively related to second-degree murders. Rifles, other guns and PALs are positively related to manslaughters but RPALs are decreasing manslaughters.

One possible explanation for our muted, or null, results is that variation in legal gun owners need not affect firearms-related crime and homicides the same way as illicit gun use, as discussed in Appendix Figure A4. If illicit gun use has a stronger association with firearms-related crime and homicides, legal guns may not be the margin policymakers ought to be concerned with. Should it be the case that illicit firearms markets are what reduces public safety, municipal handgun bans and or gun buyback programs need not be associated with improved public safety. In the US, Khalil (2017) finds increasing crimes are associated with lagged values of illegal firearms flows (their proxy being the number of reported stolen firearms in policy jurisdictions) but not associated with lagged values of legal firearms flows (their proxy being percentage of gun suicides). Currently, we do not have a similar measure for illegal firearms and their impacts on crime since data tracking reported stolen or missing firearms is not readily available in Canada. However, historical measures suggest quantities of these variables to be small in magnitude. During the 2019 fiscal year the Canadian Border Services Agency seized 753 firearms.[6] This value pales in comparison to the 1,159,477 total registered and restricted firearms in our dataset as of December 2019, itself a lower-bound on legal firearms in Canada. As another example,

[6]See the statistics on https://www.cbsa-asfc.gc.ca/security-securite/seizure-saisie-eng.html

the ratio of total firearms reported missing or stolen to the cumulative total of unique firearms registered in 2004 was 0.000806 (=5,631/6,984,485) (Hung, 2006).[7] Moreover, the object of this paper is to estimate the impacts of legal gun ownership on firearms-related deaths since these are the policies being considered.

Insufficient data on direct measures of legal firearms leads many researchers to use proxy variables that are likely correlated with the presence of firearms and their owners. Examples of proxies include the sales of gun enthusiast magazines and National Rifle Association (NRA) gun shows (Duggan, 2001), the percentage of gun suicides (Cook and Ludwig, 2006; Khalil, 2017) or the number of background checks (Lang, 2013). While more direct measures of legal firearms supply like the density of gun dealerships (Johnson and Robinson, 2021) and firearms sales in Pennsylvania (Johnson et al., 2022) are beginning to enter the literature, data on gun ownership and total guns data for any region are still hard to come by. Existence of such data represents an improvement on this literature in general, and since our data on license holders and numbers of legally owned firearms is administrative, concerns over attenuation bias due to measurement error in a right-hand side variable ought to be reduced.

Much of the previous research use (proxy) flow measures of firearms and licenses. Our work is able to measure both the annual change (flow) but also the stock since we have the total number of licenses and registered and restricted firearms in the legal market.[8] While we only witness restricted firearms (a subset of the total legal firearms in Canada), we perfectly measure the number of issued licenses. Moreover, since all license owners are subject to a background check when applying for a license and continuously while licenses are valid, we have the stock of all individuals subject to passing a background check.

More recent studies use plausibly exogenous variation to understand important relationships with firearms and to measure the efficacy of various policy changes. Colmer and Doleac (2021) argue that daily temperatures cause higher incidences of homicides and assaults with larger effects for states with less restrictive right-to carry laws. Carr and Doleac (2018) argue that youth curfew laws aimed at reducing crimes, controlling for fired shots, simply shift when crime takes place. This type of variation likely impacts firearms owners and the environment they face and indirectly measuring firearms use.[9]

We additionally contribute directly to the literature focusing on firearms-related harms in Canada. Evidence-based research on firearms in Canada is comparatively small and focusing predominantly on gun-related violence, like homicides and suicides which is due in part to a lack of relevant data.[10] Leenaars and Lester (1994) is an early analysis of the impact of gun control on homicides in Canada while Dandurand (1998) summarizes firearms use and gun-related

[7]The total number of unique firearms is substantially different due to institutional changes regarding which firearms must be registered over time.

[8]Unregistered firearms which are classified as restricted are illegal firearms, be definition.

[9]The nature of our data, being annual and aggregated to a much larger geographic region, does not permit us with a similar research design.

[10]For example, Fergunson and Koziarski (2019) finds only thirteen peer-reviewed publications on firearms-related research in Canada between 2000 and 2019.

violence prior to much of the legislative changes which have come before the mid-90s. Gagné et al. (2010) uses more restrictive firearms legislation in Quebec during 1991 to show a decrease in male suicides involving a firearm. There has been increasing interest in firearms-related research following Canadian federal election campaigns promising improved public safety with regards to firearms. While Langmann (2020) studies the relationship between gun control and homicides and suicides in Canada, they do not use data on the number of firearms or licences as in this study. Finally, research by Schwartz (2021) demonstrates how an emerging social identity through gun ownership is associated with increased political activity.

This paper broadly contributes to the literature asking how guns impact public safety. While research examining the relationship between firearms and gun-related deaths exists internationally, research tends to focus on the United States.[11] Moody (2010) provides an overview of the relationship between handguns and homicide in the US. Brent (2001) offers an early review of the relationship between firearm ownership and suicides, finding the presence of a firearm in the home increases the risk of suicide. Miller et al. (2015) examines the relationship between firearm ownership and suicides at the city level in America. Using survey data on ownership, they find that areas with higher firearm ownerships have higher rates of suicide using a firearm, but no impact on suicides not using a firearm. Anestis and Houtsma (2018) finds a similar relationship at the state level. Knopov et al. (2019) finds that states with higher proportions of gun ownership in households are associated with higher youth suicide rates.

This paper is structured as follows. Section 2 gives a background on gun ownership in Canada. Section 3 describes the environment and channels through which firearms policy can act. Section 4 describes our dataset before discussing our model and estimation strategy in Section 5. Section 6 presents our results and Section 7 concludes.

2 Background: Licensing and Recent Legislation

Regulated firearms in Canada fall into three distinct categories: non-restricted, restricted, and prohibited.[12] Generally speaking, prohibited firearms are fully-automatic firearms, handguns with short barrels, small calibre handguns, and firearms deemed prohibited. Restricted firearms are non-prohibited handguns and rifles which are deemed to be restricted. Non-restricted firearms are firearms which are neither restricted nor prohibited. In effect non-restricted firearms are mostly shotguns and rifles. Generally speaking, the ability to own or purchase different types of firearms is largely dictated by Canadians' licenses.

[11] Killias and Markwalder (2012) provides a European overview of the association between firearm availability and murders.

[12] A detailed discussion of the differences can be found here https://www.rcmp-grc.gc.ca/en/firearms/classes-firearms.

2.1 Gun Licensing in Canada: PALs and RPALs

The Canadian firearm regulatory landscape is complex. Legislation (as of 2022) largely limits the ownership of firearms, carrying firearms in public, using firearms in the commission of crimes, and buying, selling, importing or exporting firearms. The Canadian firearm licensing system is an involved system of training, testing, and constant background-checking which grants and tracks individuals' licenses. Licenses can be regarded as exceptions to the overall prohibition of firearms ownership in Canada.

There are two general types of firearm licenses in Canada: Possession and Acquisition licenses (PALs) and Restricted Possession and Acquisition Licenses (RPALs). These licenses differ in the types of firearms that they allow an individual to acquire. PALs allow for the purchase and acquisition of non-restricted firearms. RPALs allow for the purchase of restricted firearms. The general public is not able to obtain a license that allows for ownership of prohibited firearms.

There are many steps to obtain and maintain a firearms license. Individuals can obtain a PAL by passing the Canadian Firearms Safety Course, which includes in-class instruction, a practical test and written test. Applicants who successfully pass the Canadian Firearms Safety Course (CFSC) are then vetted through the Royal Canadian Mounted Police (RCMP) using a background check and declaration of personal information and personal history. Appendix Figure A1 shows the opening page of the Information Sheet, while the Personal History section, is shown in Appendix Figure A2. The Personal History section requires applicants to answer questions about their previous criminal history, mental health concerns, separation from a partner in the previous two years, or if they've been reported for violent behaviour. Having any of these concerns does not preclude having a PAL but may require additional investigation for the application to be approved. Finally, two references (neither of which can be an applicant's partner) who have known the applicant for at least three years must sign that they **"know of no reason why, in the interest of safety of the applicant or any other person, the applicant should not be given a licence to possess and acquire firearms."** (bold in original document).

RPALs can be obtained only after successively passing the Canadian *Restricted* Firearms Safety Course in addition to the CFSC. RPAL applicants attend in-class sessions, passes practical and written tests, and apply for their upgraded licence through the RCMP in a process akin to the PAL.

Total costs of each course (in-class portion and RCMP application) are less than $200 (Nominal, 2022, Canadian Dollars). The in-class portion is often completed in a weekend, with the processing time for applications ranging from two to six months.[13] Licences must be renewed once every five years at a cost of about $100 (Nominal, 2022, Canadian Dollars).

In addition to the licensing requirements, the Chief Firearms Officer (CFO) of each province has discretion over whether to approve the transfer of a firearm after a sale. In every province

[13]An example of a firearms course can be found here: https://ottawafirearmsafety.ca/pal-application/.

except for Ontario, CFOs also require RPAL holders to have a current membership to an accredited firing range in order to acquire a restricted firearm.[14] Given that transfers need to be approved for every acquisition of a restricted firearm, we have very detailed information about the geographic dispersion of firearms. Similarly, license holders must provide their address when they first apply and update this periodically as they move. Thus, there is also up-to-date and detailed information about the spatial distribution of license holders.

2.2 Recent History of Firearms Legislation in Canada

Canadians have been subject to major legislative changes regarding gun ownership since the early 1990's. Bill C-17 and the *Firearms Act* (Bill C-68) were passed in 1991 and 1995, respectively, each introducing many aspects of the modern licensing program in Canada (Royal Canadian Mounted Police, 2020; The Canadian Encyclopaedia, 2021). The former introduced a more stringent vetting process for licensing such as spousal endorsement and safety training, new and amended legal penalties such as safe storage laws and minimum sentences, and prohibited certain types of guns (Langmann, 2012). Bill C-17 was rolled out through the 1990's (Royal Canadian Mounted Police, 2020) while the *Firearms Act* was being conceived and would ultimately alter aspects of gun legislation in Canada. Although coming into effect in 1998, the former Firearms and Acquisition Certification (FAC) system would be replaced by the Possession and Acquisition Licence system January 1st, 2001 (Royal Canadian Mounted Police, 2020). Two years later, all gun owners needed both a licence to own guns and to register all of their guns.

Most of the major changes from firearms legislation in the 1990's continued to come into effect in the early 2000's. Considerable debate regarding non-restricted firearms registration lead to legislative proposals aimed at removing the registration. This would be proposed as Bills C-21, C-24, and C-19 in 2006, 2007, and 2011 respectively (Royal Canadian Mounted Police, 2020). Where the first two failed, the third succeeded, and came into effect April 5th, 2012. Bill C-19 in 2012 "... eliminate[d] the registration of non-restricted firearms and erase[d] the data from the registry" (The Canadian Encyclopaedia, 2021).[15] The records were thus destroyed by October 2012. Importantly for us, detailed data on the registry of guns is restricted to all years following 2012.

The *Common Sense Firearms Licensing Act*, Bill C-42, was enacted July 31st, 2015 and came fully into force September 2nd of the same year (Government of Canada, 2015a,b). Bill C-42 transitioned all previously grandfathered Possession Only License holders to a PAL license, made in-class training for first-time licence applicants mandatory, and allowed restricted firearms to be transported without seeking authorization for pre-approved locations like fire ranges, gun repair stores, and to an international border, amongst other changes. Our data on licences show a one-time increase between 2015 and 2016 of PALs which we believe are the POLs being

[14] See https://www.rcmp-grc.gc.ca/en/firearms/classes-firearms for additional information.

[15] Quebec challenged this in the supreme court before ultimately losing March 27th, 2015, after which their records were also destroyed.

grandfathered in.

Bill C-71 passed June 21st 2019, furthering precautionary measures like lifetime background checks (up from only the previous five years) and making authorization for transportation required (except for trips to a firing range) (Government of Canada, 2019; Royal Canadian Mounted Police, 2021). As with the previous legislation, there was a delay between when passed and when implemented, with both background checks and transportation changes coming in 2021.

In April 2020, a gunman in Nova Scotia went on a mass killing leading to the death of 22 individuals and the perpetrator. This event, amongst others, lead to the prohibition of 1500 semi-automatic rifle types by the government. Many of these firearms were previously only legally accessible *via* PAL or RPAL licensed holders.[16] The federal government further bolstered their stance on restricting access to firearms in 2021 by proposing legislation that would allow allow municipalities to ban handguns. By September 2022, the semi-automatic assault-style rifles buyback program had classified weapons which they intend to buyback. In October 2022, the Federal government froze the market on handguns, no longer allowing handguns to be bought, sold or transferred, excepting for exempt individuals and businesses.

Handgun freezes and prohibited firearms buybacks apply at the margin to a unique set of individuals. Specifically, handgun freezes impact individuals who have an RPAL (restricted license) so can own a handgun but are yet to purchase a handgun. The handgun freeze is thus quite narrow in scope. People who currently possess legally owned handguns are no longer allowed to sell or transfer any handguns, but may still possess them. While the proposed bill does not limit individuals from applying for RPALs, the benefits of an RPAL over a PAL are significantly diminished. The handgun freeze does not directly target unlicensed (illicit) gun owners since all non-licensed individuals are already prohibited from owning a handgun. Similarly, the buyback affects current legal owners of firearms that are now prohibited but were previously non-restricted, restricted, or in some cases not classified as firearms. The buyback does not apply to people who illegally own these firearms.

2.3 Important Differences between Canada and the US

Much of the past literature on the relationship between gun ownership and homicides has used American data. There are reasons to suspect that past results are not easily transferable to Canada. Table 1 notes the differences between regulating firearms in Canada and the US as of May 2022. The only commonality is that both countries require individuals who own a firearm to be older than 18. In Canada, background checks, training and licensing are mandatory for ownership of firearms and enforced at the national level. In contrast, only some states in the US make these background checks, training and licensing mandatory. In Canada, the following

[16] An amendment to expand the list of prohibited semi-automatic assault rifles was proposed in late 2022. The new list included popular types of hunting rifles. Several groups, including first nations groups, protested and the amendment was withdrawn.

regulations are enforced nationally while none of the regulations are enforced at any level in the US: (1) firearms registration; (2) restricted ownership of handguns; (3) prohibition of most magazine-fed semi-automatic rifles; (4) prohibition of short-barrelled handguns. Additionally, Canadians are generally not able to open- or concealed-carry handguns; some states permit either open- or concealed-carry of handguns. In Canada, there is no Second Amendment ("Right to Bear Arms") as there is in the United States. Firearms in Canada are federally regulated, allowing much swifter changes in the legal landscape with regards to firearms. This also impacts our analysis, since there is no heterogeneity at a sub-national level due to legal changes.[17]

As previously discussed, there is generally a lack of precise data on firearms ownership in the United States, so many studies have used proxies for ownership. Consequently, most studies involve measures that include both legal and illegal firearms. In this study we are able to precisely measure legal (registered and restricted) firearms at the local level. Additionally, the Canadian licensing system is quite different than what is required to legally acquire a firearm in most American States. Finally, while many States allow for concealed- or open-carry of firearms, this is almost universally prohibited in Canada.[18]

3 Conceptual Framework

Appendix Diagram A3 helps explain our conceptual framework. *Nature* randomly assigns individual i their proclivity for firearms ownership (θ). Each individual selects into one of four broad categories given an exogenous regulatory environment (R). Individuals may not want to access firearms at all which we call the "Never" type or θ_0. Otherwise, those wishing to access firearms may only be willing to do so through legal channels ("Legal" type or θ_L); some may be only willing (or able) to access through illicit channels ("Illicit" type or θ_I); and some may be willing to access firearms either legally or illegally ("Either" type or θ_E). Thus, two markets form: the formal market (M_F) for firearms which is regulated and an unregulated, informal market ($M_{\neg F}$) which is subject to legal penalties. The formal market is accessed only by the "Legal" and "Either" types, while the informal market can be accessed by "Illicit" and "Either" types. In the diagram, the dashed lines starting from the "Either" type and entering into both markets signify that the individual can be swayed into either market. Once individual i access firearms through their respective market, they can choose how to use firearms. In many ways, a person's type determines their motivation for use. In this framework, there are three choices: for sport, for self-harm and for crime.[19] While either market may yield any of the uses

[17] There was a campaign pledge to allow municipalities (census subdivisions, which can be thought of as counties) to ban handguns.

[18] Technically, an RPAL holder can apply for an Authorization to Carry (ATC) for personal protection reasons. However, according to one *Access to Information and Privacy* request, only two individuals in Canada have a valid ATC. See https://thegunblog.ca/2018/11/08/two-canadians-have-authorization-to-carry-guns-filing-shows/.

[19] The diagram could include self-defence. In Canada, firearms ownership for self-defence is not generally permitted through legal channels.

of firearms, we show two dashed lines (one from the informal market to sport; the other from the formal market to crime) which we believe to be possible but unlikely. Again, this is due to one's motivation for use.

For many of these linkages there exist potential incentive schemes or policies capable of influencing the regulatory environment, R. For example, those wishing to access through legal channels may be subject to background checks, mandatory training and licensing. That is, the edges entering the formal market can be influenced by the stringency of regulations directed at access. After accessing firearms through the legal market, firearms owners may have their use restricted to sport. In so doing, additional regulations such as safe storage laws or the ability to monitor where firearms are transferred would result in non-increasing self-harm and crimes. Monitoring costs such as these in the formal market may also reduce the likelihood for self-harm since firearms ownership may be stopped by the monitor.

For those owning firearms in the informal market, there may be substantial legal penalties associated with possessing firearms illegally. These penalties influence the edges entering the informal market or the edges entering any of the downstream uses. That is, there may be direct penalties, like illegally possessing a firearm or there may be deterrents for using firearms in crimes which affect the extensive margin decision to possess firearms in the first place. These penalties are likely to compound if one was using firearms in accompanying crimes like robbery, assault or homicide.

In this conceptual framework, policymakers are able to alter the environment described in Appendix Diagram A3 in multiple dimensions. Policymakers could reduce the incentives of owning firearms in the informal sector by increasing penalties for getting caught. This would restrict the number of illicit individuals and may deter "either"-typed individuals into the legal market or choosing not to own. Alternatively, policymakers may increase the monitoring of the formal market, decreasing the likelihood for self-harm and crime at the cost of "legal" or "either" types; they may stop purchasing all together or to substitute towards the informal market.

The usefulness of this conceptual framework is that it clarifies the avenues through which policymakers can influence the firearms landscape. If policymakers would like to reduce the informal market and crime, they can do so directly. Alternatively, if policymakers want to reduce self-harm associated with formal market firearms owners, the can do so there. While different policies can affect both markets, understanding the different channels helps focus the conversation on what ought to be done to affect which market.

The conceptual framework, of course, abstracts away from the many real-life uses and dynamic reasoning for having firearms. A pertinent example in the Canadian context are for those living in rural and remote locations. Hunting for sustenance, managing wild life and self defence from said wild life, may all impact owning a firearm while potentially unrelated to any "type." Restrictions on the legal market, so far as it may be applied broadly, would also impact these individuals.

4 Data

Annual Gun Licenses and Types of Guns

We acquired data on gun ownership in Canada *via* request under the *Access to Information and Privacy (ATIP) Act*. The Royal Canadian Mounted Police (RCMP) provided us with data that characterizes two major aspects of gun ownership in Canada: the number of registered and restricted firearms and the number of valid gun licenses.[20] Throughout this text, any explicit mention of the counts of firearms, like handguns or rifles, should be understood that these are the total *registered and restricted guns*. Importantly, this does not measure unrestricted firearms, like most shotguns or rifles, and any illicit firearms or unlicensed owners. Counts of guns are separated into the following categories: handguns, rifles, shotguns, submachine guns, machine guns, air pistols, combination guns and commercial versions of guns. Handguns and rifles make up the majority of these firearms. We aggregate shotguns, submachine guns, machine guns, air pistols, combination guns and commercial guns into a category we call "other guns." Counts of licensed gun owners fall into one of two major categories: those with a valid possession and acquisition firearm licensed (PAL) and those with valid *restricted* possession and acquisition firearm (RPAL). Both gun owners and types of guns were given at the census subdivision (CSD) level (colloquially thought of as municipalities) and span the years between 2013 and 2019, inclusively. The data provided to us are as of December 31st of each year. These municipalities likely follow the 2011 version of the Standard Geographic Classification (SGC).[21] Not all of the 3753 municipalities are accounted for in our dataset, likely from the amount of census subdivisions without any counts of guns or licenses. In cases where there is no data on the census subdivision, we assume a value of zero for either licenses or registered and restricted firearms. In most of our analysis, we aggregate the licenses and firearms data to a more aggregate geographical area to match the other available data.

Crosswalk between Census Subdivisions and Census Metropolitan Areas, Census Agglomerations and Provinces

Publicly available aggregate data in Canada is often reported at geographical-levels called census metropolitan areas (CMAs) and less frequently at census agglomerations (CAs).[22]

[20] We also requested one dataset about the sellers of guns – counts of licensed *dealers* grouped by postal code – in Canada. Since this data is a cross-section for 2020, it can be used only for descriptive statistics and figures. Moreover, gun dealers are allowed to sell firearms to license holders across the country *via* mail. In this way, the availability of local dealers is not as meaningful as in places like the United States.

[21] The "likely" caveat is a result of our trial-and-error merging between various data sources. It was not made explicit to us the correspondence between the RCMP data and the SGC version. We do our best to crosswalk the data we were given with much of our SGC 2016 data. In most cases, issues are at too fine a level to make a difference when aggregating counts to the appropriate geographic level (*i.e.* provincial, census agglomeration, or census metropolitan area). See our Data Appendix A2 for an extensive discussion.

[22] Census metropolitan areas have at least 100,000 people living in the total area with at least 50,000 living in their "core". Census agglomerations have at least 10,000 in their core. Examples of CMAs include Toronto,

CMAs and CAs are much larger geographic regions than a census subdivision. While census subdivisions do not map perfectly into CMAs and CAs, they do map reasonably well.[23] We use a crosswalk between Provinces, CMAs, CAs, and census subdivisions to leverage our counts of guns and licensed owners with meaningful outcome variables like deaths, homicides, various crime outcomes and covariates like population, employment, median income levels, and common benefits like the Canadian unemployment insurance (known in Canada as *employment* insurance, or EI) and federal child benefits. After matching the guns data to the crosswalk, we aggregate our guns and licenses data up to the CMA/CA level. As a caveat, there are some CSDs which do not fit into any CMA or CA. The sample we are looking at largely contains urban Canada.

Canadian Vital Statistics Death Database (CVSD)

We gained access to the Canadian Vital Statistics Death Database (CVSD), administrative deaths data through Statistics Canada's *Research Data Center*. The dataset includes information on individuals, including the leading cause of death for an individual as well as an approximate location where the individual was residing at the time of death. The CVSD designates which ICD code best corresponds to their death, allowing us to aggregate individuals into types of deaths. The types of deaths we currently have aggregated individuals into include: total firearms-related deaths; firearms deaths whose intent was designated as assaults, self-harm (suicides), or unknown; firearms deaths where the type of firearm used was a handgun, rifle, uncategorised or unknown.

We further aggregate individuals to the year and CMA/CA level in which they died to better match our publicly available tim-varying control variables. To aggregate to the CMA/CA, we used the 2016 *Postal Code Conversion File* (PCCF), designating each individual to be living in the area given by their single link indicator (SLI). This was necessary as the CVSD does not have a uniform definition of census geographies across time. In total, we recover 1015 observations (CMA/CA-by-year) of the 1089 used with the publicly available data, with missing observations coming from CMAs or CAs which were promoted or demoted in 2016 due to changes in their population counts.

Annual Deaths in Canada

Data on the total number of deaths in Canada is gathered from two sources. The first characterizes the leading cause of death at the Provincial level Statistics Canada (2022). We use four large groups which we label as suicides, homicides, accidents, and other causes of death.[24]

Montréal and Vancouver. Examples of CAs include: Sarnia, Cornwall and Sault. Ste. Marie.

[23] This is mainly because they are two different types of ways of splitting up Canada. We describe the process in greater detail in our data appendix A2.

[24] Suicides are described as "intentional self-harm (suicides)" and include International Classification of Diseases (ICD) 10 codes [X60-X84, Y87.0]. Homicides are described as "Assault (homicide)" and include ICD-10 codes [X85 - Y09, Y87.1]. Accidents (unintentional injuries) include ICD-10 codes [V01-X59, Y85-Y86]. Other causes of death are a residual group.

Annual Counts of Incident-Based Crime Statistics

Annual counts of various crimes come from Statistics Canada (2021c) which is an aggregate of the Uniform Crime Reporting (UCR) Survey. The data includes variables related to any violations, homicides, weapons violations, firearms use, and weapons trafficking, to name a few. These variables let us inspect if the distribution of guns across Canada has any correlation with related offences. To our knowledge, only publicly available data on crimes in Canada are at the CMA level for these years.

Aggregate Taxfiler Data

Taxfiler annual aggregate data at the CMA and CA levels comes from Statistics Canada (2021a) and includes useful variables such as: the number of people, the average age, the percent married (excluding common-law), average and median incomes, number of people who are using unemployment insurance, and number of people reporting federal childcare benefits. These variables will act as our controls as well as allow us to compare the distribution of guns and licenses across Canada.

Descriptive Statistics CMA only and CMA/CA Datasets

Tables 2 and 3 show the summary statistics of the variables which are used in our models involving deaths, crimes, guns variables, and additional covariates at the CMA/CA and only CMA levels, respectively. Our control variables show a reasonable variation associated with the continuum of city sizes across Canada: nearly half are female, the average age is about 41, and about 38% of people are married. The average number of employment insurance beneficiaries (known as unemployment insurance in most other places in the world) across CMA/CA for all years is about 125,000 and the average number of persons reporting federal child benefits is about 24,500 across CMA/CA and year.[25] Table 2 shows the average total number of licenses being 10,000 per hundred thousand with approximately four PALs for every one RPAL in CMAs and CAs. The CMAs only Table 3 shows a relationship closer to seven PALs for every two RPALs, implying CAs, with their lower population density, are likely to have a greater concentration of restricted licenses. Similarly, the CMA only sample has a lower concentration of total registered and restricted firearms (2526 per hundred thousand on average) than the CMAs and CAs sample (3658 per hundred thousand on average). In both geographies, handguns make-up the lion's share of the registered and restricted firearms, representing about eight-ninths of the total guns in CMAs and CAs and about 90% in CMAs only. To summarize, our less-urban sample is more likely to have higher concentrations of restricted licenses, restricted firearms, and a greater rifle-to-handgun ratio on average. The remaining registered and restricted firearms in

[25]The number of EI beneficiaries and the number of those collecting federal child benefits is higher on average when taking the subsample of CMAs only as shown in Table 3. This is because CMAs are much larger than CAs.

our data are no greater than two orders of magnitude less than the number of registered and restricted rifles. It is worth reiterating here that these figures do not wholly represent the count of guns at either geography since some guns are not required to be registered and other guns are owned illegally. Finally, Table 3 shows that firearms crimes, homicides, and murders per hundred thousand are quite close to zero.

4.1 Model and Empirical Strategy

We are interested in recovering the causal effect of firearms on outcomes like deaths and crimes. While other papers make use of more modern techniques in causal inference (Card, 2022; Imbens, 2022) such as difference-in-differences in Donohue et al. (2022) and Ferrazares et al. (2022), causal effects in this paper rely on strict exogeneity between our firearms measures and our outcomes after conditioning on unobserved (fixed) effects at the geographic level (Wooldridge, 2010). These assumptions are similar to papers in this literature like Duggan (2001), Cook and Ludwig (2006) and Khalil (2017), who also rely on variation in firearms ownership across time and geography.[26]

There are two reasons for our use of these assumptions. First, firearms are federally regulated in Canada, making heterogeneity in legislation below a national level difficult to find.[27] Second, it would be unethical to answer questions using a conscious form of randomization in firearms assignment, such as in a randomized control trial.

One key concern is that there exist a series of observable factors which affect: (1) the likelihood to purchase firearms and (2) firearms-related deaths. Examples of these variables would include variables like local economic conditions expressed in an unemployment rate or access financial supports as well as the differences in socio-economic variables like the proportion of females who are less likely to own firearms. We use similar variables in our analysis, denoting them by $\mathbf{x}$ to partially address concerns regarding omitted variables.

There also likely exists omitted variables which are not easily observed and cannot be proxied for, including heterogeneity across provinces (π), CMA/CA (ξ) and time (τ). An example for including geography fixed effects would be places' different preferences or their underlying desire to own firearms as well as places' likelihood for firearms to be used in deaths or crimes. In so far as our observed variables only partially correlated with these hard-to-observe variables, we can control for geography-specific unobserved variables using fixed effects. Additionally, differences across time in the landscape for owning firearms and using their associated deaths nationally would want to be controlled for. An example of this would be the implementation of the *Common Sense Firearms Act* in 2015 which grandfathered Possession and Only Licenses

[26]The implicit assumption made in these papers (using Wooldridge (2010)'s naming convention) is akin to sequential exogeneity between firearms measures and outcomes once conditioning on the unobserved (fixed) effect at their geographic level. This allows for lags of both outcomes and covariates to have an effect on the contemporaneous outcomes and firearms measures.

[27]Provinces do regulate their own hunting, however.

(POLs) into Possession and Acquisition Licenses (PALs).

Still, concerns remain regarding the use of firearms for crimes or deaths. We display the typical concern in Appendix Figure A4a which shows a place's proclivity for violence affecting gun ownership (and use) with doing crime in a Direct Acyclic Graph (DAG). Here, we abstract from the time dimension for clarity in our DAG, noting that they can be drawn with our strict exogeneity between outcomes and firearms variables conditional on our fixed effects, as in Cunningham (2021) and Kim and Imai (2019). Ideally (*i.e.* holding constant a place's proclivity for violence) one would be able to recover the causal effect of guns on crimes. If this is relatively unchanging over time, place-specific fixed effects help to reduce this concern. However, the difficulty in measuring this proclivity for violence makes it hard to control for.

We believe the relationship looks more like Appendix Figure A4b. In this diagram, illegal firearms and legal firearms are unconditionally unrelated, with no arrow drawn between the two of them. Proclivity for violence affects illegal market guns and crimes. We draw a dashed red line, with a blue 'X' through it, running from proclivity for violence and into our legal guns variables. We are using a dashed, red line to suggest an unlikely relationship, and a blue 'X' through it to suggests no relationship, between proclivity for violence and legal firearms. Canadians face substantially greater barriers for accessing firearms than Americans, outlined in Section 2.3 and summarized in Table 1. In addition to the background checks and training, licenses holders are subject to daily comparisons against their criminal record. Criminal convictions need to be disclosed when applying for firearms licenses, making their approvals difficult. Finally, firearms are traceable to the people who purchase them, independent of whether the firearms themselves are registered. This suggest that individuals wanting to use firearms with crimes would be best *not* to use legal firearms.

At the same time, the relationship between legal firearms and crimes is not always clear. Khalil (2017) finds crimes are most likely being driven by illicit market guns and not by legally owned firearms in the United States. Also in the United States, Ferrazares et al. (2022) find (modest) volunteer firearms buybacks are unrelated to crimes in a city. On the contrary, Donohue et al. (2022) finds increasing crimes laws due to "Right-to-Carry" laws.

The relationship between firearms and self-harm is depicted in the directed acyclic graph in Appendix Figure A5. Unlike the case for the effects of legal firearms on crimes, we believe depression is more likely to affect the use of legal guns for self-harm. While the licensing procedure attempts to screen out people who have a history of self-harm and provides phone numbers for those worried a legal firearms owner may hurt themselves, the episodic nature of depression makes it hard to completely screen out. Moreover, firearms owners may have been less affected by depression when applying to own a firearm than when they may be susceptible for self harm. Supposing the depiction in Figure Appendix A5, as well as a positive correlation between legal firearms ownership and depression (Perlis et al., 2022), and a positive relationship between firearms and self-harm (Leigh and Neill, 2010), our coefficient estimates would overestimate the true relationship between legal firearms and self-harm. On the one

hand, this would make us more likely finding a positive and statistically significant result. On the other hand, failure to detect an effect is suggestive a relationship may not exist at all.

CMA and CA Analysis

We model the relationship between gun ownership and various outcome variables using equation 1:

$$y_{pct} = \beta \text{ Guns Variables}_{pct} + \mathbf{x}_{pct}^{\mathrm{T}}\gamma + \pi_p + \xi_c + \tau_t + \varepsilon_{pct} \tag{1}$$

Observations are indexed by their province (subscript p), CMA/CA (c), and year (t).

Guns Variables$_{pct}$ represents our variable of interest in all of our models and takes on values such as the number of PALs, the number of RPALs, the total registered guns, and the total type of registered and restricted guns, all per hundred thousand. In some instances, we include multiple guns variables in a given model. The variable y_{pct} represents a generic dependent variable which changes based on the outcome we are modelling. Outcome variables include: the total number of deaths, the total number of crimes, or the total number of a type of crime. $\mathbf{x}_{pct}$ is a vector of covariates that include the: average age, proportions of individuals who are female, the proportion of individuals who are married, the number of individuals claiming employment insurance, and the total number of individuals claiming federal child benefits. Province and CMA/CA fixed effects are represented by coefficients π_p and ξ_c, respectively. Time fixed effects are represented by τ_t.

We interpret β from our model as representing the marginal effect between our Guns Variables$_{it}$ and our dependent variable, conditional on our covariates.

In many scenarios coefficient estimates are small in magnitude. This is partially a function of scaling (everything per $100,000$) but also because of the large values in our guns variables (usually between 10^1 and 10^4) and the small values in our dependent variables (usually 10^1). We often discuss estimates which arise from $\frac{1}{\hat{\beta}_x} = \hat{\beta}_x^{-1}$ which we interpret as how many x would be necessary to increase the outcome variable by 1, *ceteris paribus*. When looking at our crime data by CMA, we have opted to standardize our guns variables for ease of interpretation and due to small coefficient estimates.

Equation 1 uses residual variation from the sample average deviations within CMA/CA-province-years for both outcomes and guns variables. Some of variation in firearms likely comes from people who choose not to renew their licenses and those who are first-time license holders. Additionally, variation may come from changes in the ownership of registered and restricted firearms. Data identifying license renewals versus first-time owners, and changes in legal firearms, represent ideal data which we do not have. Confiscated firearms or deaths to gun-owners may also result in legal supply of firearms fluctuations. What we hope to identify is how many additional firearms deaths results from above-average deviations in license holders and legal firearms.

We now discuss the source of residual variation in the models that we analyze. In many

cases, the true number of deaths from firearms (less so for crimes) are quite small within any CMA/CA annually. Taking the deviations from that trend (CMA/CA fixed effects) further reduces the residual variation in deaths or crimes. The trade-off is using the between- versus within-variation to try and identify these effects. The former fails to control for unobserved heterogeneity, likely biasing estimates, while the latter has few observations for any CMA/CA, making it hard to detect true effects. The previous literature chooses the latter with less of a concern due to more observations for any one region. Recognizing our setting, we present both of these results. We ultimately continue using the regressions containing geographic fixed effects to better align ourselves with previous literatures.[28]

5 Results

5.1 National and Provincial Trends

Figure 1 and Figure 2 show the trends in national prevalence of restricted guns and licenses, respectively. The data provided to us are as of December 31st of each year, which we correspond to the successive year. Figure 1 shows the total restricted firearms which is the sum of three components: handguns, rifles, and other guns. The prevalence of restricted guns has been increasing between 2013 and 2019 primarily as a result of handguns. The prevalence of handguns has risen from just under $2,000$ at the end of 2013 to about $2,500$ at the end 2019. Rifles and other guns have remained relatively stable of our time period, and are significantly fewer than handguns. While there are hundreds of restricted rifles, the prevalence of other guns is near zero.

Figure 2 shows the breakdown of Canadian licenses over time. The prevalence of firearms licenses has increased steadily over time, with a marked increase between 2015 and 2016 from about $5,000$ licenses to about $7,000$ licenses. After 2016, the relationship stabilizes to about $7,000$ licenses with only small increases across our time period. The *Common Sense Firearms Licensing Act* converted all Possession Only Licenses (POLs) from the previous licensing system to Possession and Acquisition Licenses in September 2016, which we believe is the result of the one-time increase in total licenses, as driven by PALs.

Figure 3 shows national time series of suicides, homicides, total registered restricted firearms, and firearms licenses per hundred thousand population between 2014 and 2020. Our homicide and suicide deaths data at the national level are relatively stable: suicides lie between 10 deaths per hundred thousand and just above 12 deaths per hundred thousand, while homicides are

[28] Future work can take advantage of the firearms data given to us at the census subdivision. Doing so would give us smaller regions of Canada which may better divide urban and rural Canada. This may sufficiently allow us to control for common unobserved heterogeneity at the CMA, CA, or non-CMA/CA while having variation *within* each region. This would simultaneously help with issues associated with power as there are many CSDs in any one CMA, CA or non-CMA/CA. Even without controlling for region fixed effects, finer geographies would likely reduce coefficient estimate because so few firearms deaths happen in small places, but small places typically have many firearms.

consistently less than 2 per hundred thousand. The total number of gun licenses and registered and restricted firearms are generally increasing over this period.

We further characterize our data through choropleth maps which describe the Canadian spatial distribution of guns, licenses, homicides and suicides. The maps demonstrate a ranking of the provinces by their rate per hundred thousand for these variables. All Figures 4a through 6b are constructed in the same manner for 2019 and each represent a different variable. The deeper blue represents provinces and territories with fewer counts of the variable we are plotting while deeper red represents greater amounts of the same variable; white represents the middle group.

Figure 4 shows the spatial variation across provinces in 2019 for firearms licenses per hundred thousand population (Figure 4a) and the total registered restricted firearms per hundred thousand (Figure 4b). In general, these two figures show differences in the rankings for licenses and registered and restricted firearms. Nova Scotia, Prince Edward Island, Quebec, Ontario, Manitoba and British Columbia have fewer licenses than New Brunswick or Alberta who have between $9,560$ and $10,550$ licenses (per hundred thousand). Newfoundland and Labrador, Saskatchewan, Nunavut, Northwest Territories and Yukon all have greater than $10,550$ amounts of license holders per hundred thousand. The total amount of registered and restricted firearms are greater than 2800 per hundred thousand for provinces Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia and for the territories of Yukon and Northwest Territories. Quebec, Newfoundland and Labrador, New Brunswick, Prince Edward Island, and Nunavut all have fewer than about 2800 registered and restricted firearms.

Figure 5 shows the spatial variation across provinces in 2019 for total registered restricted rifles per hundred thousand (Figure 5a) and the total registered restricted handguns per hundred thousand (Figure 5b). Since these two figures represent a breakdown of the total registered and restricted firearms, they closely match Figure 4b. For Newfoundland and Labrador, Prince Edward Island, New Brunswick, Quebec, Nunavut, Manitoba and British Columbia, the number of handguns and rifles, are similar within their region across both maps. Ontario, Saskatchewan and Alberta have relatively more registered and restricted rifles (have a greater ranking) compared to handguns in the same region. Nova Scotia, Yukon and Northwest Territories all have comparatively more handguns than restricted rifles in the same region.

Figure 6 shows the spatial variation across provinces in 2019 for homicides (Figure 6a) and the total suicides per hundred thousand (Figure 6b). In general, the rankings between these two variables are quite different. Homicides are relatively more concentrated in Nova Scotia, New Brunswick, Ontario, Manitoba and Nunavut. Suicides are more concentrated New Brunswick, Manitoba, Saskatchewan, Nunavut and Northwest Territories.

Next we explore the relationship within provinces across time. Table 4 shows the coefficient estimates when modelling provincial level gun crimes as a linear function of licenses (or total registered firearms) per hundred thousand and that variable's annual percentage change.[29] Eight

[29]We model the relationship between various outcomes variables and our guns variables (total firearms licenses

columns of gun crimes are considered in Table 4 including total firearms violations, discharging a firearm, using a firearm with intent, firearms documentation and administration (labelled as "documentation issue" in the table), improper storage of firearms, homicides, first-degree murder, second-degree murder, and manslaughter. The top panel shows when our main independent variable is total licenses (PALs plus RPALs). Excepting firearms documentation issues and first-degree murders which show a negative and no relationship with total licenses respectively, the remaining crime outcomes have a positive relationship with total licenses with most of these estimates being small in magnitude. For example, even after multiplying the total licenses coefficient estimate by 1000 (slightly less than a one-eighth increase relative to the mean) the total number of firearms violations would increase by 0.128 per hundred thousand. This is practically small, considering the average number of total firearms violations is 9.4 per hundred thousand, such a small response in our dependent variable relative to a large hypothetical increase in our independent variable. There appears to be no relationship between the annual percentage change in total licenses and all columns of our top panel. The bottom panel shows the total registered and restricted firearms as the main independent variable. In this case, all columns show a positive relationship between the total level of registered and restricted firearms and crime outcomes, excepting the null relationship in the firearms documentations column. Again, there appears to be no relationship between annual percentage changes in registered and restricted handguns. Finally, the practical significance of these coefficient estimates are small for analogous reasoning to the top panel: the level effect necessary to generate a large dependent variable response is unrealistically large.

Table 5 shows the coefficient estimate when modelling provincial level deaths associated with suicides, homicides, accidents, and all other deaths, with total licenses (top panel) and total registered and restricted firearms (bottom panel) as in Equation 2 and akin to the previous table. Columns one through four restrict our dependent variables to the sample of both sexes, while columns five through eight, and nine through twelve, are restricted to only males and only females samples, respectively. Across both panels, and excepting the residual "other" deaths category which is negative and statistically significant for both sexes and only males, annual percentage changes are not associated with deaths across any of the samples. The level of licenses coefficient estimates are positive and statistically significant for: suicides across all samples; accidental deaths across males only and females only; and all other deaths across both sexes and males only. The total number of registered and restricted firearms coefficient estimates of the levels are associated with positive and significant effects for homicides across all samples, accidents for both sexes and only males samples, and accidents for the only males samples. Similar to the previous table, even large changes in the levels of restricted guns or

or total restricted and registered firearms) (per $100,000$) at the provincial level as:

$$y_{pt} = \beta_0 + \beta_1 \text{ Guns Variables}_{pt} + \beta_2 \%\Delta\text{Guns Variables}_{pt} + \varepsilon_{pt}. \quad (2)$$

licenses (*i.e.* multiplying our coefficient estimate by 1000) would be associated with very small changes in deaths.

We draw three conclusions suggested from the previous figures and tables. First, there is relative stability between 2013 and 2019 national levels of homicides, suicides, total licenses and total registered and restricted firearms. When looking at 2019 only, the ranking of provinces for homicides, suicides, total licenses and registered and restricted firearms is not invariant: the choropleth map colours change with each of the different measures. Second, when modelling the relationship between crimes (or deaths) and our guns variables, levels are more likely to matter than annual percentage changes. Third, any of the effects which we might be picking up and which may appear to align with the intuition that guns are associated with more crimes and more deaths, are economically insignificant due to the size of the coefficient estimates. This last point should be understood relative to the model, estimation and data, all of which are simple and exploratory and mask substantial heterogeneity. To better understand potential relationships, our next section explores models aimed at similar relationships at finer geographic levels.

5.2 Deaths Due to Firearms

Firearms-related deaths are a small fraction of total deaths in Canada, even conditional on age and sex, suggesting our previous measure is unlikely to be able to detect a signal from the noise. We overcome this data limitation by accessing administrative deaths data, using Statistics Canada's *Research Data Center*. There, we perform analysis on the Canadian Vital Statistics Death Database (CVSD) (synonymously called the Vital Statistics Death Database, VSDD).

Table 6 uses the deaths where a firearm was the leading cause (*per* $100,000$ individuals) as a dependent variable and follows Equation 1. Estimates use ordinary least squares, weighting all observations with their annual population and clustering standard errors at the provincial level. Columns change the variables included as covariates, where the panels change the guns variables of interest.

Panel 1 shows the coefficient estimates across different specifications only including restricted firearms as the guns variable. Panel 2 only has licenses as our guns variable. Panel 3 uses both guns and licenses. Panel 4 breaks our licenses into PALs and RPALs while including total restricted guns. Panel 5 breaks out our guns variable into three categories: handguns, rifles, and a residual category of firearms (called other guns), whilst including PALs and RPALs. The other guns category includes the other firearms from earlier: restricted commercial versions, shotguns, machine guns and submachine guns.

Panels 1, 3, and 4 of Table 6 show no statistically significant effects of total restricted firearms on the total number of firearms deaths across every model. Panels 2, 3, and 4, show positive and statistically significant coefficient estimates of granted licenses on total firearms

deaths in columns 1 through 4. Coefficient magnitudes are approximately 0.0003 for all licenses, suggesting about 3,330 fewer license holders (per 100,000) would reduce one firearms death (per 100,000). Similar effect sizes can be seen in Panel 5 for our two license types in columns 1 through 4 when also controlling for handguns, rifles, and other guns. Rifles and the neither rifles nor handguns category are not significantly different from zero in any of columns 1 through 4. Our handguns coefficient in column 4 of panel 5 is 0.00012 and significant at the 5% level.

Column 5 of Table 6 introduces CMA and CA fixed effects. Coefficient estimates of licenses are no longer statistically significant in column 5 of any of our panels and also decrease by an order of magnitude. The neither handguns nor rifles category is the only statistically significant variable in column 5, equalling 0.00197.

We choose to follow the specification in column 5 of Table 6 in our successive models for two reasons. First, the lack of parameter stability between columns 4 and 5 suggest there is considerable unobserved heterogeneity across CMAs and CAs. Column 5 takes this into account in the estimation where as column 4 omits these fixed effects. This also represents a key advantage of panel data: to control for unobserved heterogeneity, which often includes places' time-invariant characteristics, like desire for firearms ownership and total deaths from firearms. Second, Cook and Ludwig (2006), Leigh and Neill (2010), and Khalil (2017), include their finest geographic fixed effect in *all* of their models. In Duggan (2001), all models are over differences in dependent and independent variables, making fixed effects inestimable. This helps us remain consistent with a literature that believes in controlling place-specific fixed effects.

One question is whether the intent surrounding someone's death matters for our legal licenses and firearms variables. This is especially important if assaults or suicides are more likely to be correlated with legal firearms. Table 7 shows the prevalence of firearms deaths by intent. There are three columns representing the three different types of deaths by intent: assaults, self-harm (interpreted as suicides) and unknown. We present two panels which represent three different models for our guns variables: panel 1 models total licenses and total restricted firearms jointly; panel 2 includes total restricted guns, PALs, and RPALs, while panel 3 has handguns, rifles, other guns, PALs and RPALs. All columns control for year, province, CMA/CA fixed effects as well as time-varying covariates.

Firearms deaths whose intent are considered to be assaults, self-harm, or unknown, are statistically insignificant across all three models at all traditional levels with respect to our licenses variables. This suggests that being able to legally acquire a firearm may not affect deaths. Panel 1 suggests total restricted firearms do not affect the assaults, suicides or deaths whose intent is unknown.[30] Total restricted firearms in a CMA/CA do not appear to affect deaths by assaults or whose intent is unknown (panel 2). Total restricted firearms has a coefficient equalling -0.000023 and statistically significant at the 5% level with respect to self-harm (panel 2, column 2). However, we fail to reject an F-test for joint significance for all of

[30]When modelling either total licenses or restricted firearms in models where they are the only key variable of interest, all results are also statistically significant at all traditional levels.

firearms variables in panel 2, suggesting they add little explanatory power. We decompose the total restricted guns in panel 3 into handguns, rifles and other guns. Handguns are statistically insignificant, while the rifles and other guns coefficients are statistically significant and equal -0.000022 and 0.00127, respectively. The rifles coefficient magnitude is similar to the total restricted guns effect in the previous panel. However, the other guns coefficient is two orders of magnitude larger, suggesting a reduction of these firearms by 787 (per $100,000$) may decrease one death (per $100,000$). Our takeaway from these results, in conjunction with table 6 is that all firearms deaths is most affected by our other guns category, which appears be coming from suicides, once taking into account our unobserved heterogeneity at the CMA/CA level.

An additional question is how well our legal firearms variables, and especially the *type* of legal firearms, correspond to the type of firearm suspected to be the cause of death. If one supposes that all deaths by handguns are attributable to *legal* handguns, then we should suspect positive and statistically significant coefficient estimates on our handguns variables.

Table 8 shows the different types of firearms involved in the firearms deaths. Handgun deaths, rifle deaths, unspecified firearms deaths and uncategorized firearms deaths, are shown in columns 1, 2, 3, and 4, respectively. Panels 1, 2 and 3 are the same models as Table 7. Again when modelling total restricted firearms and total licenses, we fail to detect effects at all traditional levels. We see that restricted firearms effects on handgun deaths are positive and statistically significant in panels 2 and 3, with a coefficient estimates of 0.000006 (*i.e.* 166667 required for one additional death) and 0.000018 (*i.e.* 55556 required for one additional death), respectively. In column 1 of panel 3, we also see that rifles are positive and statistically significant with respect to handgun deaths. While an order of magnitude less than handgun effects, it is somewhat surprising to be statistically significant. In any case, the amount of firearms necessary to change the amount of firearms-related deaths are well beyond what most CMAs or CAs have as their stock. Licenses variables and the neither rifles nor handguns category are not significant in column 1.

Column 2 of panel 2 shows restricted firearms effects on rifle deaths are negative and statistically significant, suggesting rifle deaths decrease with additional restricted firearms. This effect is shown to be coming from rifles and neither rifles nor handguns in panel 3, both of which are negative and statistically different from zero.

Column 3 of Table 8 shows the prevalence of firearms deaths where the firearm type is unspecified. Panel 2 and 3 show possession and acquisition licenses (PALs) coefficient estimates are 0.00019 for either model, and statistically significant at the 10% level. Total restricted firearms is statistically indistinguishable from zero (panel 2) but when broken down into its components, the other guns coefficient equals 0.00247 and statistically significant at the 1% level. Uncategorised firearms deaths appear unaffected by our firearms variables in either model.

Between Tables 6, 7 and 8, a clearer relationship between our legal firearms variables and firearms deaths are emerging. First, being able to acquire firearms (*i.e.* our licenses variables) are almost always unrelated to our firearms deaths variables once taking into account CMA/CA

unobserved heterogeneity. Moreover, total firearms deaths, firearms deaths whose intent was assaults and self-harm, as well as deaths with unspecified firearms appear to be positively related to our residual firearms category (including restricted shotguns, submachine guns, commercial versions and machine guns).

Less clear are the effects of specific legal guns on firearms deaths specific to a type of firearms, like a handgun or rifle. While handgun deaths are positively related to handguns, rifle deaths seem to be negatively correlated with legal rifle ownership. The effects on rifles runs counter to our the intuition for legal firearms to be a driver of firearms deaths. One possible explanation is that the majority of rifles are unrestricted and hence, do not enter our counts of *restricted* firearms. There may exist a negative correlation between restricted rifles and unrestricted rifles, especially if they are substitutes in use. This would also justify the statistically significant and negative coefficient on the neither rifles nor handguns category, since they are composed of weapons most likely to be long-guns (types of shotguns, commercial versions, submachine guns and machine guns).

What is clear is that reducing the total number firearms, or limiting the ability to acquire firearms through fewer granted licenses, does not appear to universally reduce the total number of deaths involving firearms.

5.3 CMA-level Crimes

Our deaths data, in either datasets, do not have what type of crime the deaths were classified as. They also only pick up fatality costs of firearms harms while missing outcomes on society not involving death. Data pertaining to firearms-related crime, homicides, murders and manslaughter are readily available at the CMA level outside a *Research Data Center*. While this restricts our total number of observations, it allows us to investigate outcomes which are publicly available.[31]

Table 9 shows the coefficient estimate when modelling CMA level crimes associated with firearms violations according to Equation 1 and our preferred specification estimated using ordinary least squares. Noting our previous small coefficient estimates, we standardize our guns variables for easier interpretation. Panels one through five vary the main independent variables involved in the model. Columns one through nine vary the dependent variable and denote total firearms violations, discharging a firearm with intent, using firearms in commission of an offence, firearms documentation and administration issues, unsafe firearms storage, homicides, first-degree murder, second-degree murder, and manslaughter. Panel one uses the prevalence of all restricted guns. Panel two uses the prevalence of all licenses. Panel three is a model with both total firearms and total licenses.

We focus our attention on panel three since coefficient estimates in panel three resemble the results from panels one and two: coefficient estimates have the same sign and approximately

[31] We are currently working to incorporate more granular data using the *Uniform Crime Reporting Survey* in the RDC.

the same values when modelling guns and licenses separately (due to the correlation between licenses and guns). Additionally, panel three helps contextualize the results in panels four and five which successively disaggregate licenses (panel four) then firearms (panel five) by their respective types. Panels four and five refine and focus coefficient estimates from panel three, as well as better showing which variables are affecting the different crimes. Panel three suggests no effects of restricted firearms on any of our crimes outcomes. Total licenses has no effects on total firearms crimes or crimes related to firearms discharges, using firearms, improper storage, or manslaughter. A one standard deviation increase in the number of licenses in a CMA would decrease the prevalence of documentation issues by about 1.56 per annum. We see that the prevalence of homicides is decreasing by approximately 0.332 for a one standard deviation increase in the number of licenses. This appears to be a result of two opposing effects: increasing 1st degree murders (coefficient estimate being 0.529, significant at the 10% level) and decreasing 2nd degree murders (coefficient estimate being -0.883 and significant at the 5% level).

Panel four models our key explanatory variables as total restricted guns and breaks out licenses into PALs and RPALs. In this way, we are seeing if it is the *type* of license owner which may be causing some of our changes in crimes. Columns one through six, all non-homicides as well as all homicides, show no effects for guns or either types of licenses. Coefficient estimates on total restricted firearms show null effects for first degree murders, negative effects on second degree murders (coefficient equals -2.176, significant at 5% level), and positive effects on manslaughter (coefficient equals 0.964, significant at 10% level). Our coefficient estimates on PALs suggest a one standard deviation increase would translate to 0.647 (significant at 10% level) more first degree murders, -1.066 (significant at 1% level) second degree murders, and no effects on manslaughter. RPALs have null effects on first and second degree murders and negative effects on manslaughters (coefficient equals -0.660, significant at 5% level).

Panel five includes PALs, RPALs, handguns, restricted rifles, and restricted other guns. Panel 5 is similar to the effects in panel 4 in many ways with respect to licenses variables which display both parameter stability (magnitude and sign). Allowing for heterogeneity in our firearms refines the estimates on licenses enough to show RPALs to be increasing using firearms (coefficient estimate equalling 1.917 and significant at 10% level) and PALs to be decreasing documentation issues (coefficient estimates equalling -1.526 significant at the 10% level). With respect to manslaughter, our coefficient estimates on RPALs is statistically significant and positively related to manslaughter.

While panel four shows no effects across non-homicide crimes, panel five finds effects when breaking firearms out by their types. A one standard deviation increase in rifles correspond to an increase in 22.352 firearms violations (approximately four times the dependent variable mean). Columns 2 through 5 show that the increasing firearms violations due to rifles comes from discharges (coefficient estimate equalling 10.859), using firearms (coefficient estimates 6.663) and improper storage (coefficient estimates equalling 2.643). Handguns seemingly offset

using firearms and improper storage, with coefficient estimates being -6.673 and -1.607 in their respective models. Handguns do correspond to greater documentation issues however, with statistically significant and positive coefficient estimates equal to 4.563.

Homicides generally are unaffected by any of our licenses or guns variables, with all coefficient estimates being statistically insignificant. First degree murders are positively related to handguns (coefficient equalling 1.658) and PALs (coefficient equalling 0.601), both of which are statistically significant at the 10% level. Second degree murders are decreasing in rifles (coefficient equalling -2.257, significant at the 5% level) and PALs (coefficient equalling -1.137, significant at the 1% level). Manslaughters are increasing in rifles (coefficient equalling 1.636, significant at the 1% level), other guns (coefficient equalling 0.325, significant at the 1% level) and PALs (coefficient equalling 0.328, significant at the 1% level), but decreasing in RPALs (coefficient equalling -0.662, significant at the 5% level).

6 Conclusions

This paper aims to document for the first time the landscape of firearms licenses and registered and restricted firearms across Canada. In so doing, we make an empirical contribution to the debate on gun regulation in Canada. This is particularly relevant given the recently proposed freeze on handguns. This importantly offers a discussion on the role of regulating firearms in Canada, itself a highly dynamic and contentious subject, based on available data. More broadly, we contribute to a literature often hampered by a deficiency of accurate data or direct measures.

Making use of a unique dataset on Canadians' restricted and registered firearms and those with valid licenses, we investigate the relationship between these firearms variables and deaths, crime and homicides. Importantly for us, this dataset contains all people who can acquire a firearm through the legal market and the total counts of handguns. We provide descriptive evidence of firearms prevalence at the national level as well as in simple provincial regressions. Using a fixed effects model to control for heterogeneity across space in Canada, we estimate the impacts of licenses and restricted guns on firearms deaths, crimes and homicides at the CMA/CA level and the CMA level. In general, licenses appear to be unrelated to firearms related deaths. Other guns (commercial versions, some shotguns, air guns, submachine guns, machine guns, and some combination guns) appear to be increasing all firearms deaths as well as the subsets of firearms related deaths whose intent are thought to be assaults and self harm. Legal handguns are unrelated with total firearms deaths, deaths by assaults and self-harm. Legal handguns are, however, positively related with total handgun deaths.

With respect to firearms related crimes, we find actual counts of rifles to be increasing total firearms violations with licenses playing a much lesser role. While total homicides appear to be unrelated to different types of firearms and different types of licenses, the different types of murder - first degree, second degree and manslaughter - have substantial heterogeneity.

The location of guns and their owners are unlikely to be randomly assigned across Canada.

Future research should aim to incorporate both economic models and plausibly exogenous variation in the assignment of guns and licenses – be they tightening or loosening of restrictions – to yield credible estimates on the impacts of guns on outcomes like crime and suicides. Being able to better match the guns and licenses data with quality data on causes of deaths – currently unavailable to us researchers – represent tangible improvements to this paper.

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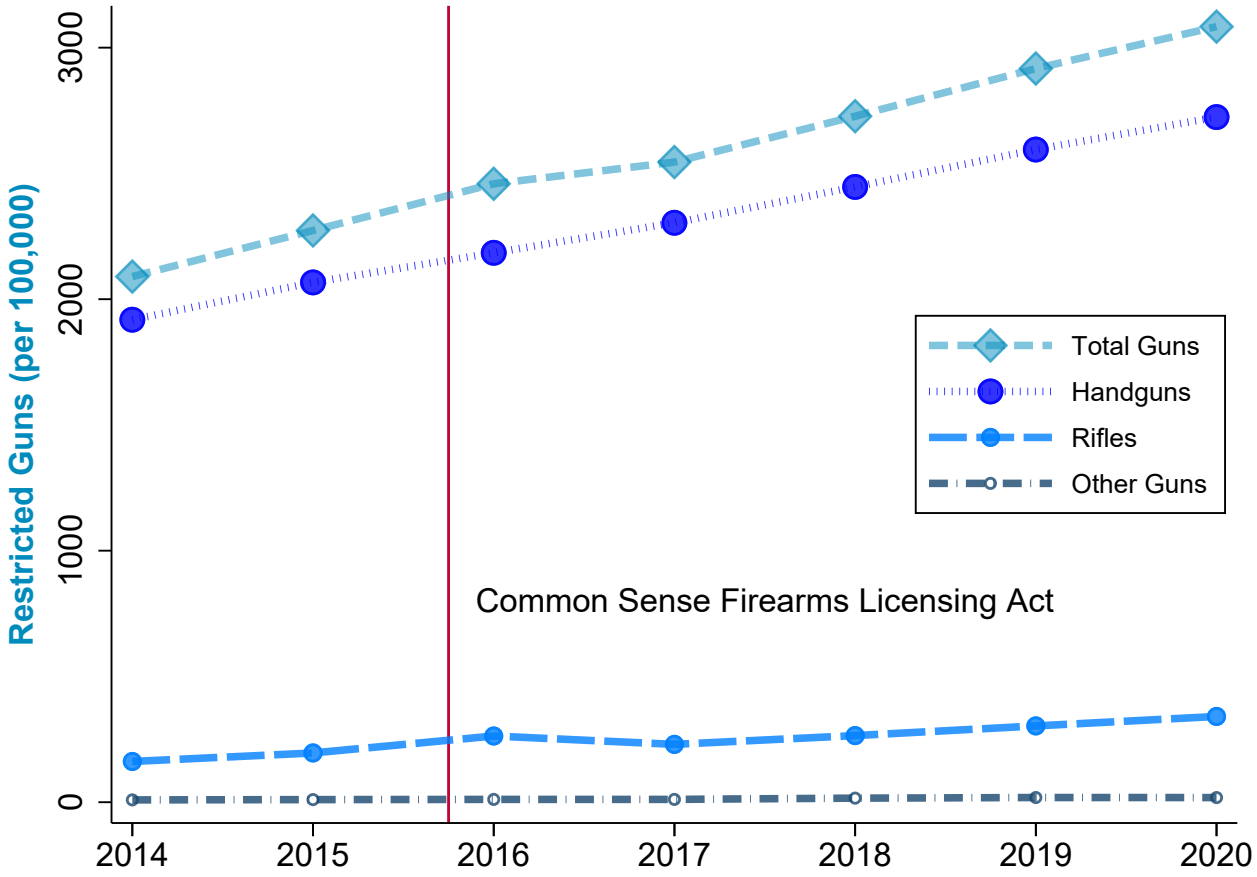
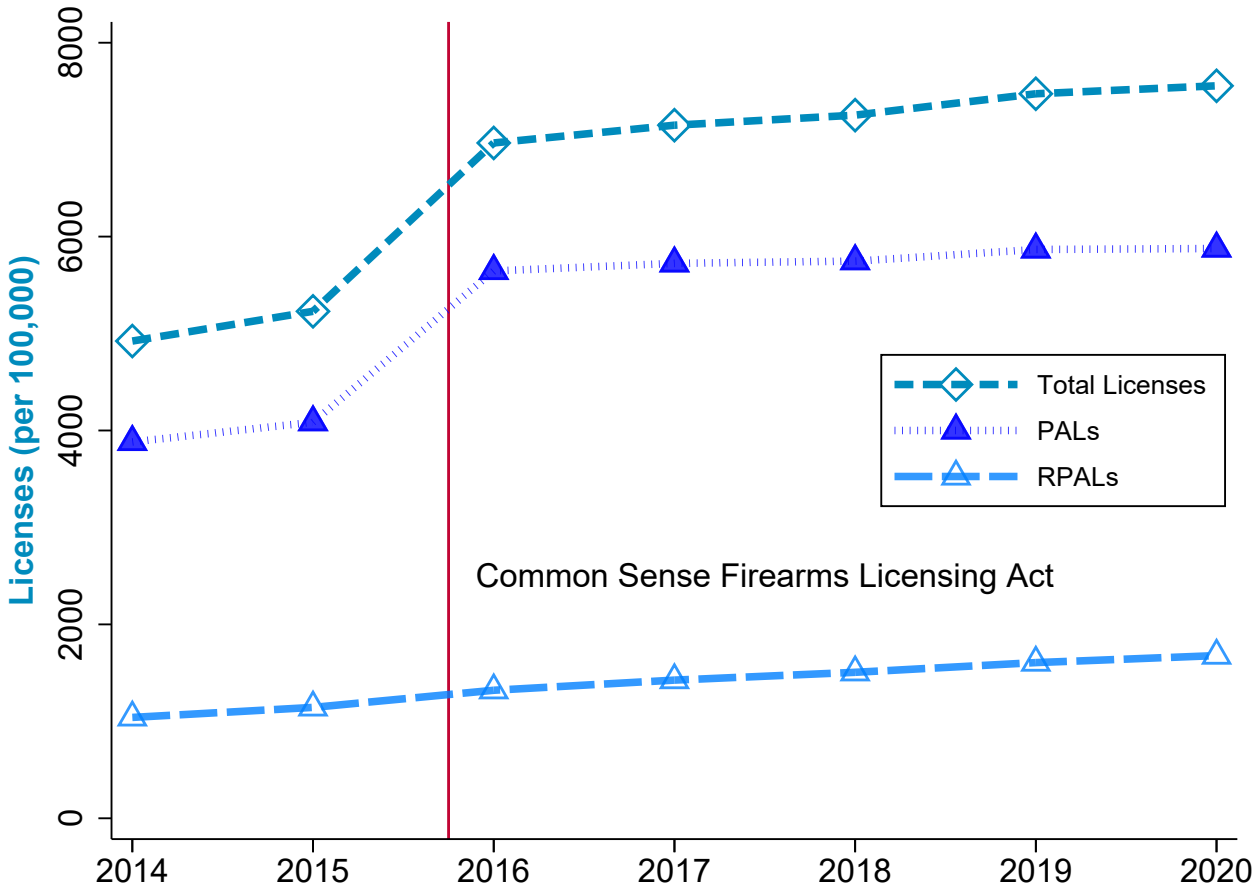
8 Figures

Figure 1: Canadian Restricted Firearms



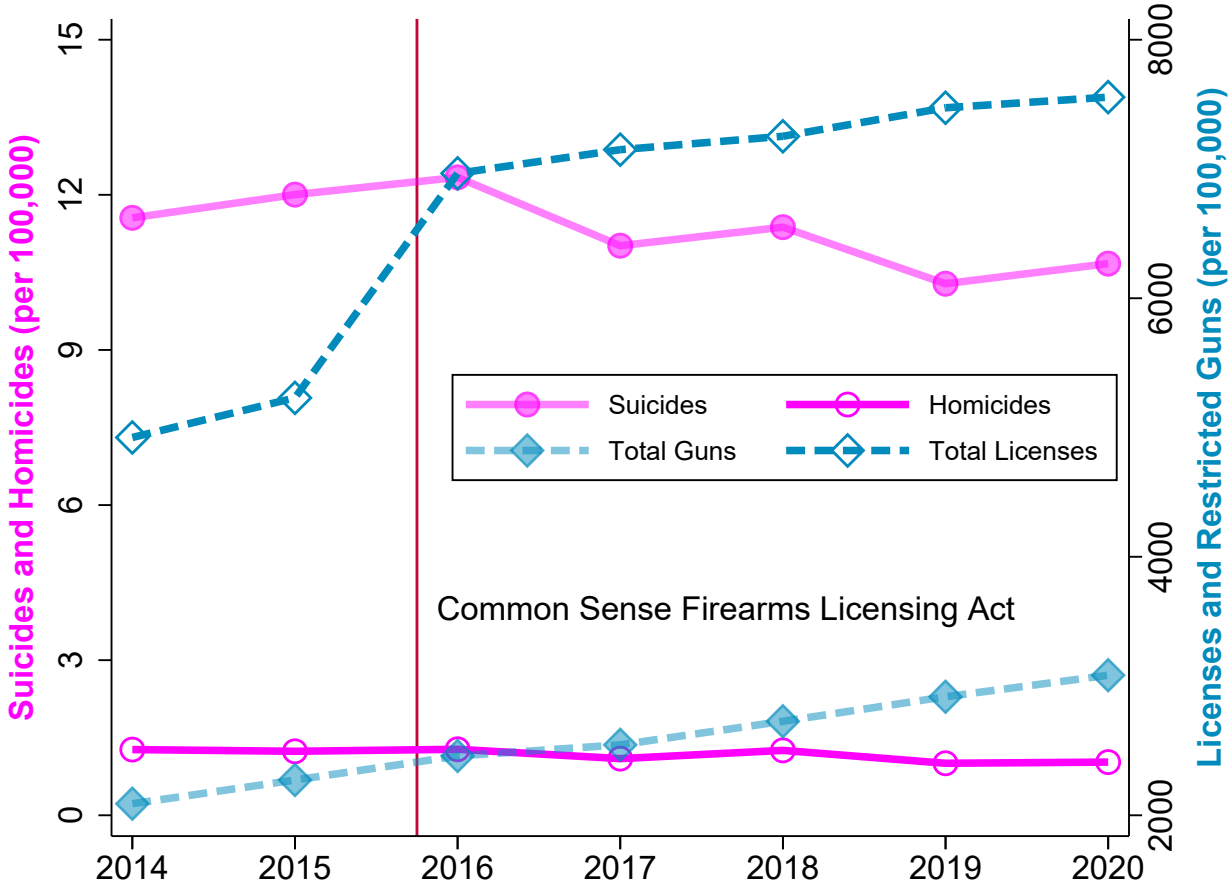
Notes: Authors' calculations. Guns data from *Access to Information Request* from the Royal Canadian Mounted Police (RCMP). Scaled by population data from Statistics Canada (2021b).

Figure 2: Canadian Licenses



Notes: Authors' calculations. Guns data from *Access to Information Request* from the Royal Canadian Mounted Police (RCMP). Scaled by population data from Statistics Canada (2021b).

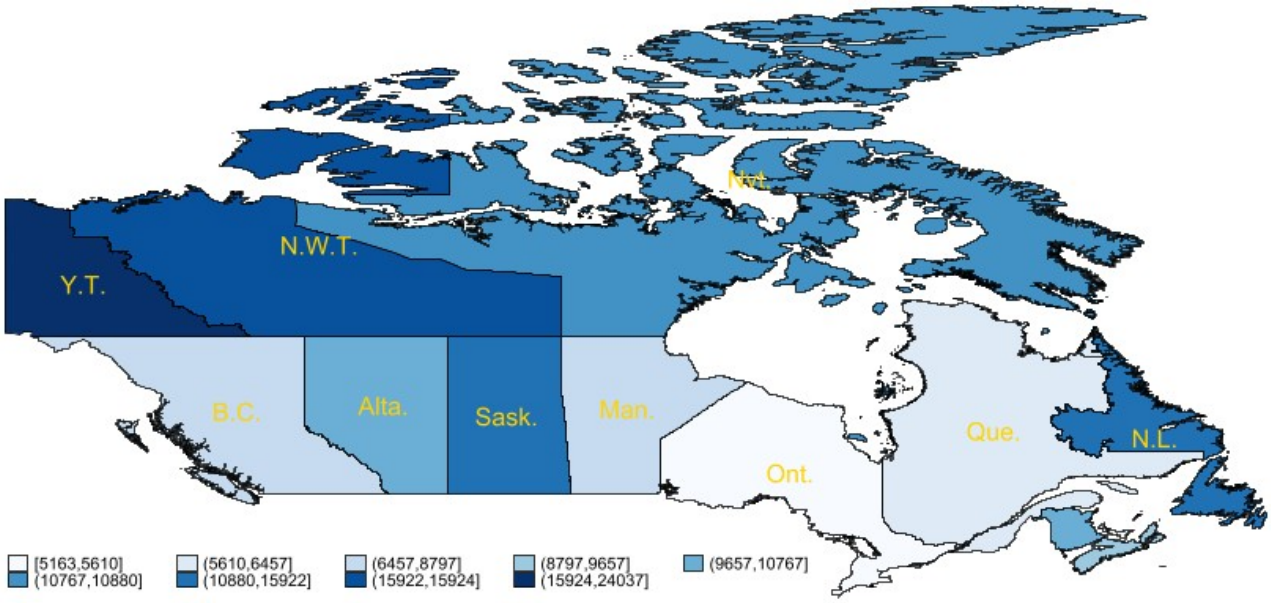
Figure 3: Canadian Restricted Firearms, Licenses, Homicides and Suicides



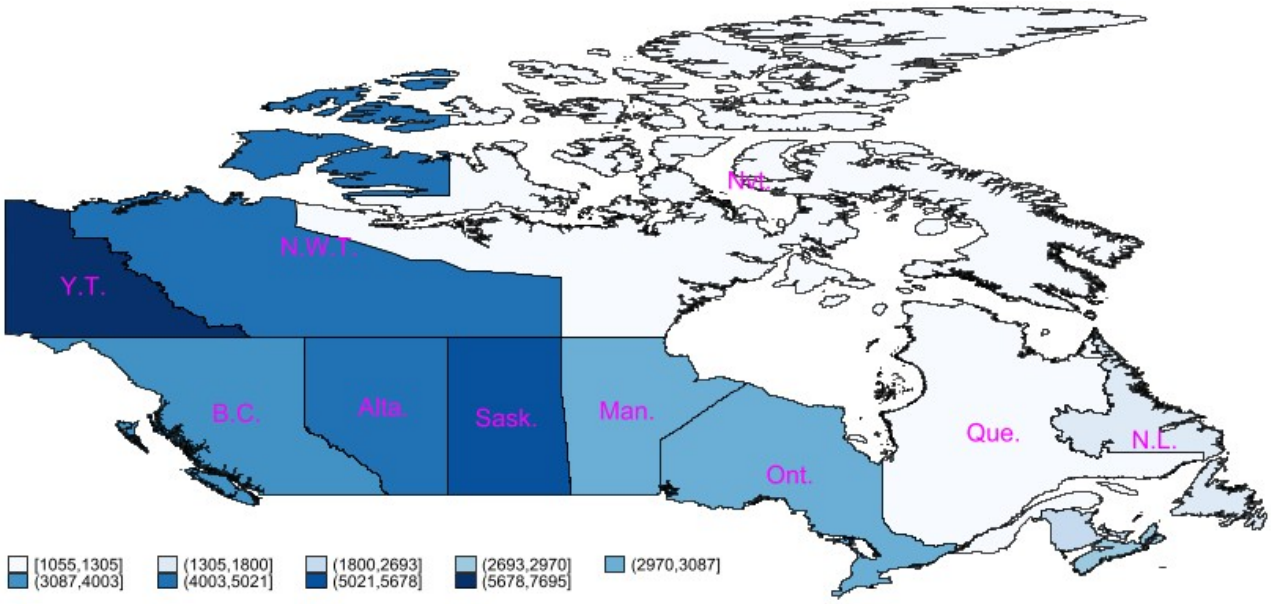
Notes: Authors' calculations. Guns data from *Access to Information Request* from the Royal Canadian Mounted Police (RCMP). Deaths data from Statistics Canada (2022). Scaled by population data from Statistics Canada (2021b).

Figure 4: Distribution of Licenses and Restricted Firearms by Canadian Province during 2019

(a) All Licenses (per 100,000)



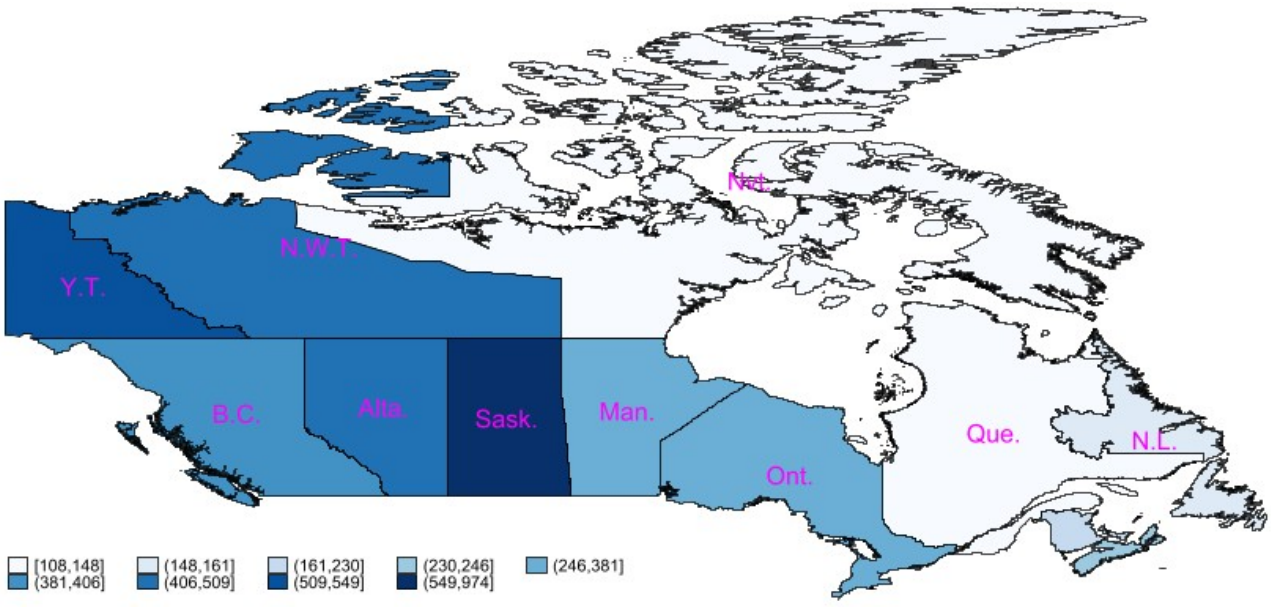
(b) Total Restricted Firearms (per 100,000)



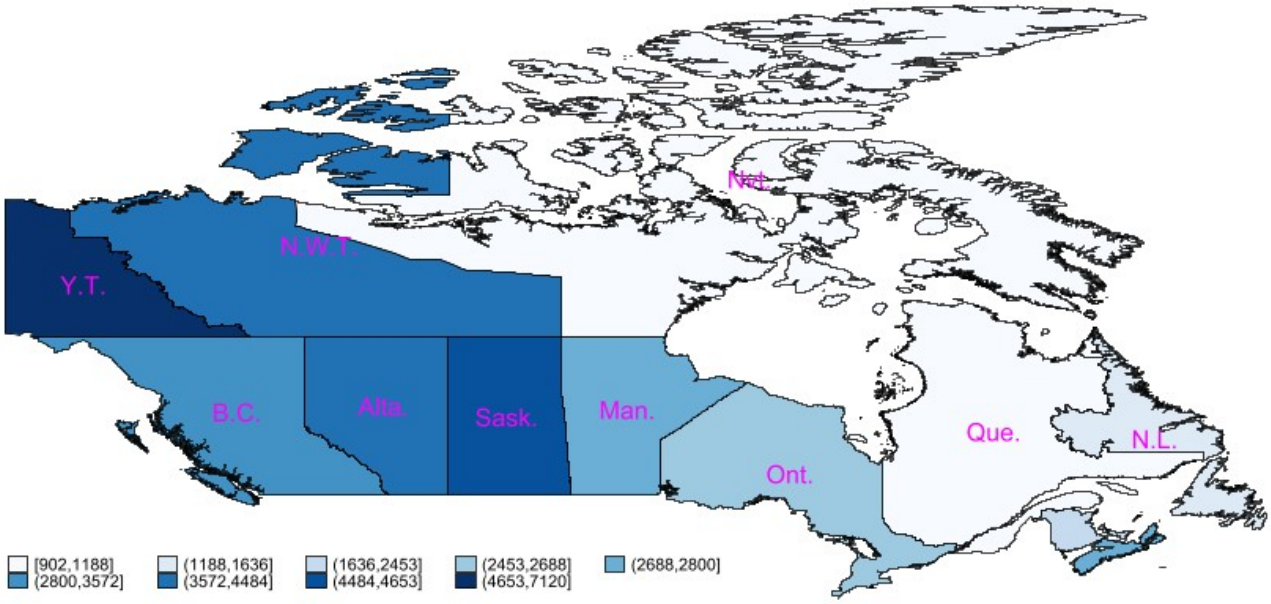
Notes: Authors' calculations. Guns data from *Access to Information Request* from the Royal Canadian Mounted Police (RCMP). Population data is from Statistics Canada (2021b). The map is constructed on the subset of data for 2019. New Brunswick, Nova Scotia, and PEI are not labelled (bottom-right corner). Panel A shows all licenses (PAL + RPAL) per 100,000. Panel B shows all restricted firearms per 100,000.

Figure 5: Distribution of Restricted Rifles and Restricted Handguns by Canadian Province during 2019

(a) Total Restricted Rifles (per 100,000)



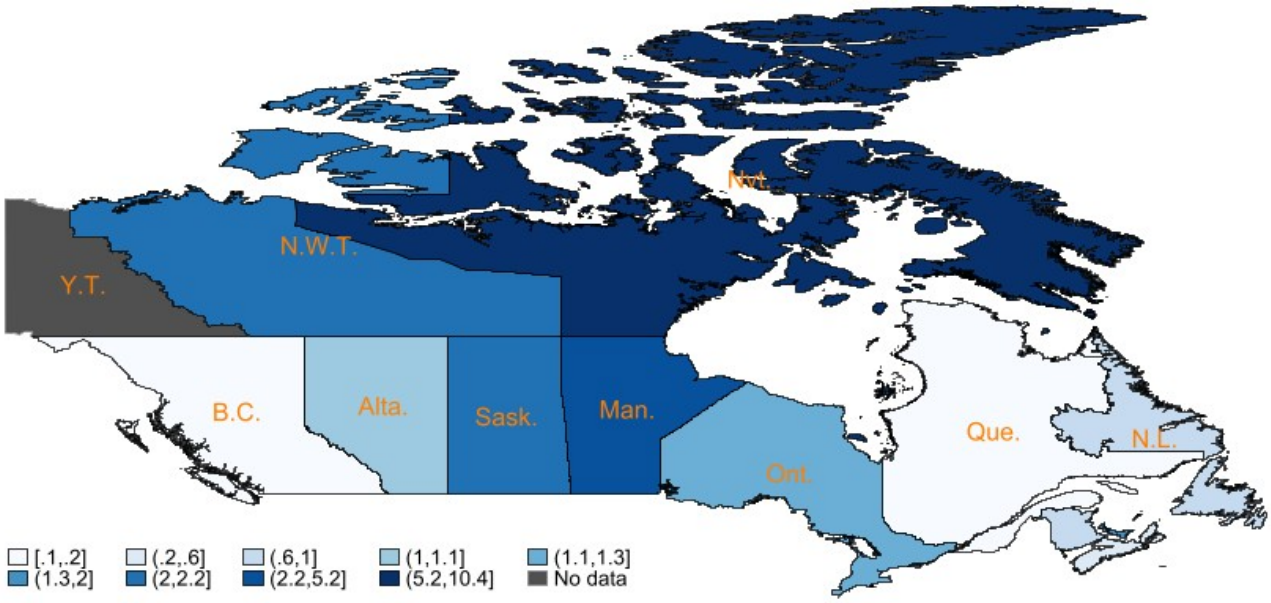
(b) Total Restricted Handguns (per 100,000)



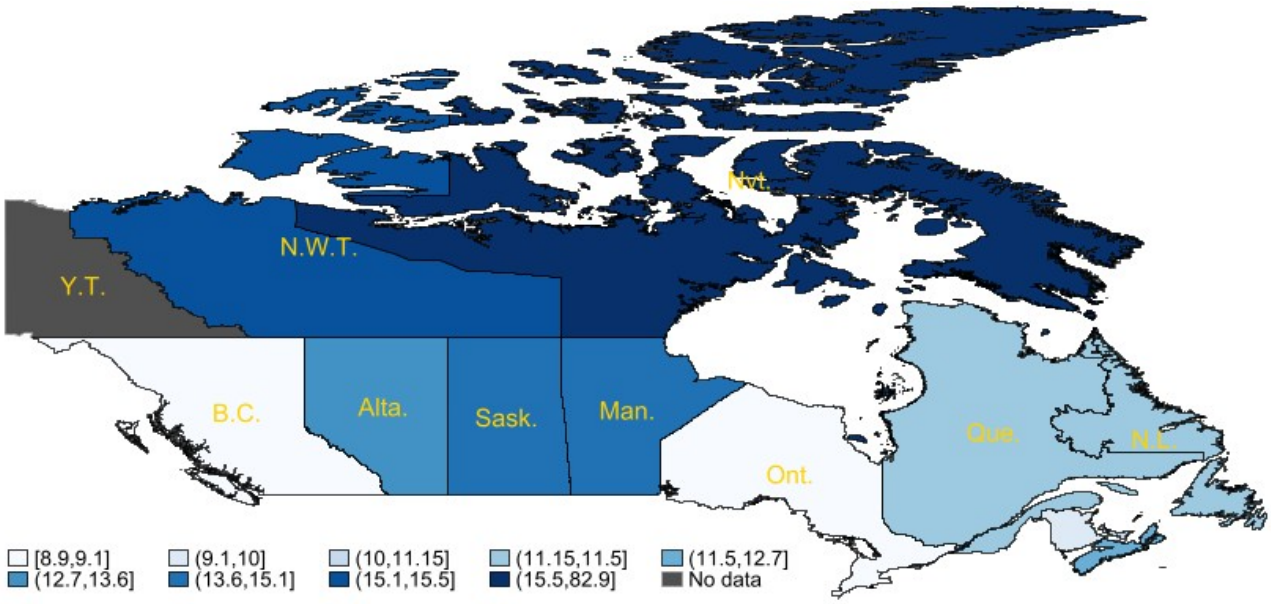
Notes: Authors' calculations. Guns data from *Access to Information Request* from the Royal Canadian Mounted Police (RCMP). All data is scaled by population data from Statistics Canada (2021b). The map is constructed on the subset of data for 2019. Panel A shows total restricted rifles per 100,000. Panel B shows total restricted handguns per 100,000. New Brunswick, Nova Scotia, and PEI are not labelled (bottom-right corner).

Figure 6: Distribution of Homicides and Suicides by Canadian Province during 2019

(a) Total Homicides (per 100,000)



(b) Total Suicides (per 100,000)



Notes: Authors' calculations. Deaths data from Statistics Canada (2022). All data is scaled by population data from Statistics Canada (2021b). The map is constructed on the subset of data for 2019. Panel A shows total homicides per 100,000. Panel B shows total suicides per 100,000. New Brunswick, Nova Scotia, and PEI are not labelled (bottom-right corner).

10 Tables

Table 1: Broad Differences between Canada and US Gun Regulation

Policy Characteristics	Canada	USA
More Restrictive Access		
Must be over 18 to *own* firearms	✔	✔
Required Background Checks	✔	✔
Mandatory Training and Licensing	✔	✔
Safe Storage Laws	✔	✔
Firearms Registration	✔	✘
Restricted Ownership of Handguns	✔	✘
Prohibited Ownership of *Most* Magazine-fed Semi-Automatic Rifles	✔	✘
Prohibition of Short-barrelled Handguns	✔	✘
Less Restrictive Access		
Open- or Concealed-Carry of Handguns	✘	✔
Second Amendment	✘	✔

Green check marks (✔) mean "yes", yellow check marks mean "sometimes" (✔) and red check marks (✔) mean "no."

Table 2: Summary Statistics for Census Metropolitan Areas and Census Agglomerations

Summary Statistics for CMA and CA	Mean	Std. Dev.	Min	Median	Max	Observations
Main Independent Variables						
PAL per 100,000	8241.64	4138.53	790.4	7307.7	24627.9	1089
RPAL per 100,000	1968.38	1356.50	0.0	1545.5	7711.2	1089
Total Restricted Guns per 100,000	3658.36	3563.61	228.5	2929.2	77084.5	1089
Different Gun Types						
Handguns per 100,000	3241.02	2283.69	215.6	2673.0	26001.9	1089
Rifles per 100,000	403.51	2442.70	10.2	210.6	73939.8	1089
Restricted Commercial Versions per 100,000	9.30	10.89	0.0	6.0	77.9	1089
Shotguns per 100,000	3.62	12.10	0.0	0.0	137.1	1089
Machine Guns per 100,000	0.72	7.87	0.0	0.0	112.5	1089
Submachine Guns per 100,000	0.16	0.78	0.0	0.0	8.7	1089
Control Variables						
% of Females	51.30	1.07	47.0	51.0	54.0	1089
Avg. Age of Persons	41.01	3.88	31.0	41.0	55.0	1089
% of Married Persons	37.74	6.52	18.0	39.0	60.0	1089
# of Persons Reporting EI	124997.44	367064.71	860.0	23000.0	3658630.0	1089
# of Persons Reporting Federal Child Benefits	24540.06	73437.26	190.0	4360	801050.0	1089

Notes: Authors' calculations. Years range from 2013 - 2019. Guns data from *Access to Information and Privacy* Request from the RCMP; Crime and taxfiler information data from Statistics Canada (2021b) and Statistics Canada (2021a), respectively. Each observation is year by Census Metropolitan Area or Census Agglomeration. EI stands for employment insurance. PAL is an acronym for Possession and Acquisition License. RPAL is an acronym for *Restricted* PAL. All tables constructed using Jann (2005, 2007).

Table 3: Summary Statistics for Census Metropolitan Areas

Summary Statistics for CMA	Mean	Std. Dev.	Min	Median	Max	Observations
Outcome Variables						
Total Firearms Violations (Use, discharge, pointing) per 100,000	5.65	4.77	0.0	4.27	27.9	225
Discharge Firearm with Intent per 100,000	1.80	2.40	0.0	0.9	13.4	225
Using Firearm in Commission of Offence per 100,000	1.55	1.61	0.0	1.0	9.1	225
Firearms Documentation Issues per 100,000	1.37	2.98	0.0	0.2	19.5	225
Unsafe Firearms Storage per 100,000	1.70	1.60	0.0	1.3	9.2	225
Homicides per 100,000	1.62	1.29	0.0	1.4	9.0	225
1st Degree Murder per 100,000	0.68	0.62	0.0	0.6	4.1	225
2nd Degree Murder per 100,000	0.75	1.01	0.0	0.5	9.0	225
Manslaughter per 100,000	0.19	0.30	0.0	0.0	1.6	225
Main Independent Variables						
PAL per 100,000	4639.85	2252.93	790.4	4168.5	12640.1	225
RPAL per 100,000	1338.99	662.31	115.2	1217.2	3383.3	225
Total Restricted Guns per 100,000	2526.20	1059.47	228.5	2449.2	7110.8	225
Different Gun Types						
Handguns per 100,000	2229.75	821.15	215.6	2186.4	4216.1	225
Rifles per 100,000	279.83	338.26	12.1	219.7	2849.2	225
Shotguns per 100,000	4.45	9.29	0.0	1.3	71.0	225
Restricted Commercial Versions per 100,000	8.68	6.56	0.0	6.6	34.7	225
Machine Guns per 100,000	3.24	17.06	0.0	0.0	112.5	225
Submachine Guns per 100,000	0.22	0.68	0.0	0.0	8.7	225
Control Variables						
% of Females	51.57	0.55	50.0	52.0	53.0	225
Avg. Age of Persons	40.25	1.99	36.0	40.0	44.0	225
% of Married Persons	38.55	4.88	24.0	40	44.0	225
# of Persons Reporting EI	424345.20	699475.67	55060.0	140770	3658630.0	225
# of Persons Reporting Federal Child Benefits	83071.29	140891.64	10760.0	30540.0	801050.0	225

Notes: Authors' calculations. Years range from 2013 - 2019. Guns data from *Access to Information and Privacy* Request from the RCMP; Crime and taxfiler information data from Statistics Canada (2021c) and Statistics Canada (2021a), respectively. Each observation is year by Census Metropolitan Area. EI stands for employment insurance. PAL is an acronym for Possession and Acquisition License. RPAL is an acronym for *Restricted* PAL.

Table 4: Provincial Firearms Crimes, Homicides, Firearms Licenses and Registered Restricted Firearms

	Dependent Variable: Total Crimes (per 100,000)							
Model/Independent Variables	Total Firearms Violations	Firearms Discharge	Using Firearms	Documentation Issue	Improper Storage	1st Degree Murder	2nd Degree Murder	Manslaughter
Total Licenses (per 100,000)								
$\hat{\beta}_1 \times 1000$	0.128***	0.040***	0.024***	-2.601***	0.064***	0.003	0.012***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\hat{\beta}_2$ (annual %Δ)	-0.031	-0.017	-0.006	-0.116	0.004	-0.002	-0.001	0.001
	(0.028)	(0.018)	(0.005)	(1.030)	(0.016)	(0.002)	(0.004)	(0.001)
Independent Variable Mean	8620.9	8620.9	8620.9	8620.9	8620.9	8620.9	8620.9	8620.9
Total Registered Restricted Firearms (per 100,000)								
$\hat{\beta}_1 \times 1000$	0.003***	0.001***	0.000***	-0.005	0.001***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.010)	(0.000)	(0.000)	(0.000)	(0.000)
$\hat{\beta}_2$ (annual %Δ)	-0.139	-0.015	-0.016	8.068	-0.129	0.003	-0.001	0.002
	(0.116)	(0.048)	(0.028)	(8.548)	(0.147)	(0.013)	(0.017)	(0.008)
Independent Variable Mean	2775.8	2775.8	2775.8	2775.8	2775.8	2775.8	2775.8	2775.8
Dependent Variable Mean	9.4	3.5	1.7	30.5	3.8	.7	.9	.3
Observations	60	60	60	60	60	60	60	60

Notes: Authors' calculations. Guns data from *Access to Information and Privacy* Request from the RCMP; Deaths data from Statistics Canada (2022). Observations are Province-by-year between 2014 and 2019. There are ten provinces and six years. Models are: $y_{p,y} = \beta_0 + \beta_1 x_{p,y} + \beta_2(\Delta_{\%} x_{p,y}) + \varepsilon_{p,y}$. All models are estimated use ordinary least squares and standard errors clustered at the provincial level. Provincial population are used as weights. Columns vary by the dependent variable used in the model. Columns 1 is Criminal Code violation 150 (per 100,000) - total firearms violations, use of, discharge, pointing. Column 2 is Criminal Code violation 1450 (per 100,000) - discharge firearms with intent. Column 3 is Criminal Code violation 1455 (per 100,000) - using firearms in commission of offence. Column 4 is Criminal Code violation 3390 (per 100,000) - firearms documentation or administrations. Column 5 is Criminal Code violation 3395 (per 100,000) - unsafe storage of firearms. Columns 6 is Criminal Code violation 1110 (per 100,000) - Murder, first degree. Columns 7 is Criminal Code violation 1120 (per 100,000) - Murder, second degree. Columns 8 is Criminal Code violation 1130 (per 100,000) - Manslaughter. Each panel represents a different model, each with two estimated coefficients. Panel 1 regresses outcome variables on Total Licenses; Panel 2 regresses outcome variables on Total Restricted Guns. $\hat{\beta}_1$ is multiplied by 1000 for interpretation. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 5: Provincial Homicides, Suicides, Firearms Licenses and Registered Restricted Firearms

	Dependent Variable: Total Deaths (per 100,000) by Sample and Type											
	Both Sexes				Males				Females			
Model/Independent Variables	Suicides	Homicides	Accidents	Other	Suicides	Homicides	Accidents	Other	Suicides	Homicides	Accidents	Other
Total Licenses (per 100,000)												
$\hat{\beta}_1 \times 1000$	0.057***	0.003	0.025	0.342**	0.047***	0.002	0.051**	0.217***	0.010***	0.001	-0.026*	0.129
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\hat{\beta}_2$ (annual %Δ)	0.039	0.005	-0.041	-0.388**	0.057	0.004	-0.047	-0.428**	0.023*	0.006	-0.034	-0.349
	(0.024)	(0.006)	(0.062)	(0.193)	(0.037)	(0.009)	(0.079)	(0.170)	(0.013)	(0.004)	(0.064)	(0.222)
Independent Variable Mean	8620.9	8620.9	8620.9	8620.9	17354.4	17354.4	17354.4	17354.4	17134.2	17134.2	17134.2	17134.2
Total Registered Restricted Firearms (per 100,000)												
$\hat{\beta}_1 \times 1000$	0.000	0.000**	0.002**	0.002	0.000	0.000**	0.002***	0.003*	0.000	0.000**	-0.001	-0.001
	(0.000)	(0.000)	(0.001)	(0.003)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.002)
$\hat{\beta}_2$ (annual %Δ)	-0.104	0.029	0.017	-0.340	-0.154	0.035	-0.035	-0.577	-0.041	0.021	0.083	-0.106
	(0.121)	(0.032)	(0.210)	(1.117)	(0.201)	(0.050)	(0.214)	(1.142)	(0.051)	(0.015)	(0.235)	(1.140)
Independent Variable Mean	2775.8	2775.8	2775.8	2775.8	5580.6	5580.6	5580.6	5580.6	5524.4	5524.4	5524.4	5524.4
Dependent Variable Mean	12.4	1.4	37	165.8	18.9	2	43.1	147.9	5.9	.7	31	183.5
Observations	60	60	60	60	60	60	60	60	60	60	60	60

Notes: Authors' calculations. Guns data from *Access to Information and Privacy* Request from the RCMP; Deaths data from Statistics Canada (2022). Observations are Province-by-year between 2014 and 2019. There are ten provinces and six years. Models are: $y_{p,y} = \beta_0 + \beta_1 x_{p,y} + \beta_2(\Delta_{\%} x_{p,y}) + \varepsilon_{p,y}$. All models are estimated use ordinary least squares and standard errors clustered at the provincial level. Provincial population (by sample) are used as weights. Each panel represents a different model, each with two estimated coefficients. Panel 1 regresses outcome variables on Total Licenses; Panel 2 regresses outcome variables on Total Restricted Guns. Columns 1 to 4, 5 to 8, 9 to 12, are over the samples of both sexes, only males, and only females, respectively. $\hat{\beta}_1$ is multiplied by 1000 for interpretation. Columns vary the sample and the deaths by category. Columns 1, 5, and 9 are the total suicides per 100,000. Columns 2, 6, and 10 are the total homicides per 100,000. Columns 3, 7, and 11 are the total accidental deaths per 100,000. Columns 4, 8, and 12 are the total other deaths per 100,000. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 6: Firearms Deaths

Independent Variables (per 100,000)	*Dependent Variable*: Total Firearms Deaths (per 100,000)				
Panel 1					
Total Restricted Guns	0.00041	0.00026	0.00023	0.00020	-0.00001
	(0.00023)	(0.00014)	(0.00016)	(0.00015)	(0.00003)
Panel 2					
All Licenses	0.00029***	0.00026***	0.00029***	0.00030***	0.00006
	(0.00004)	(0.00004)	(0.00004)	(0.00005)	(0.00006)
Panel 3					
Total Restricted Guns	0.000000	-0.000000	0.00004	0.00004	-0.00002
	(0.00004)	(0.00003)	(0.00004)	(0.00004)	(0.00002)
All Licenses	0.00029***	0.00027***	0.00028***	0.00029***	0.00006
	(0.00003)	(0.00004)	(0.00003)	(0.00004)	(0.00006)
Panel 4					
Total Restricted Guns	-0.00001	0.00001	0.00003	0.00002	-0.00002
	(0.00001)	(0.00002)	(0.00002)	(0.00001)	(0.00002)
PAL	0.00027***	0.00028***	0.00027***	0.00025***	0.00008
	(0.00003)	(0.00005)	(0.00004)	(0.00004)	(0.00011)
RPAL	0.00046*	0.00018	0.00036*	0.00053**	-0.00002
	(0.00021)	(0.00011)	(0.00016)	(0.00019)	(0.00049)
Panel 5					
Handguns	0.00009	0.00011	0.00017	0.00012**	-0.00002
	(0.00008)	(0.00010)	(0.00010)	(0.00004)	(0.00006)
Rifles	-0.00006	-0.00004	-0.00003	-0.00003	-0.00002
	(0.00004)	(0.00004)	(0.00003)	(0.00002)	(0.00002)
Other guns	0.00071	0.00114	0.00122	0.00092	0.00197***
	(0.00200)	(0.00168)	(0.00172)	(0.00184)	(0.00048)
PAL	0.00026***	0.00027***	0.00026***	0.00025***	0.00008
	(0.00002)	(0.00004)	(0.00004)	(0.00004)	(0.00012)
RPAL	0.00034	0.00007	0.00020	0.00040*	-0.00001
	(0.00021)	(0.00014)	(0.00019)	(0.00019)	(0.00053)
P-value (All Guns Sum to 0)	.718	.487	.454	.596	.002
Province Fixed Effects (FE)	Yes	No	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes
CMA and CA FE	No	No	No	No	Yes
Observations	1015	1015	1015	1015	1015

Notes: Authors' calculations. Deaths data from the Vital Statistics Death Database (VSDD) accessed in Statistics Canada's *Research Data Center*. Years range from 2013 - 2019. Each observation is year by Census Metropolitan Area (CMA) *or* Census Agglomeration (CA). All equations are estimated using ordinary least squares with weights applied. Panels vary the different firearms variables used in each model. Columns vary by their inclusion of various control variables and fixed effects (FE). Columns (2) to (5) control for demographic characteristics at CMA or CA level. These variables include: the average age of a person, the percentage of people that are female, the percentage of people that are married, the number of people receiving (un)Employment Insurance (EI) Benefits, and the number of people receiving federal child benefits. PAL is an acronym for Possession and Acquisition License; RPAL is a Restricted PAL. Standard errors are constructed using a CRVE and clustered at the province-level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 7: Firearms Deaths by Intent of Death

Independent Variables	*Dependent Variables*: Deaths by Intent *(per 100,000)*		
(per 100,000)	Assaults	Self-Harm	Unknown
Panel 1			
Total Restricted Guns per 100,000	-0.00000059	-0.00001908	0.00000074
	(0.00000936)	(0.00001104)	(0.00000116)
All Licenses per 100,000	0.00000710	0.00005605	-0.00000354
	(0.00001940)	(0.00006453)	(0.00000647)
P-value (Licenses + Guns = 0)	.803	.603	.638
Panel 2			
Total Restricted Guns	0.00000384	-0.00002286**	0.00000145
	(0.00001027)	(0.00000980)	(0.00000158)
PAL	0.00003205	0.00003470	0.00000047
	(0.00002472)	(0.00010691)	(0.00000872)
RPAL	-0.00014418	0.00018546	-0.00002780
	(0.00021519)	(0.00032843)	(0.00003673)
P-value (RPAL + PAL + Guns = 0)	.596	.453	.436
Panel 3			
Handguns	0.00002588	-0.00004642	0.00000498
	(0.00002833)	(0.00003977)	(0.00000378)
Rifles	0.00000107	-0.00002168*	0.00000117
	(0.00000601)	(0.00001075)	(0.00000114)
Other guns	0.00072414**	0.00127345***	0.00000427
	(0.00024766)	(0.00028761)	(0.00002517)
PAL	0.00003248	0.00003229	0.00000064
	(0.00002604)	(0.00010765)	(0.00000874)
RPAL	-0.00015595	0.00021223	-0.00003048
	(0.00022681)	(0.00036163)	(0.00003703)
P-value (All Guns Sum to 0)	.013	.001	.724
Province, Year and CMA FE	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes
Observations	1015	1015	1015

Notes: Authors' calculations. Deaths data from the Vital Statistics Death Database (VSDD) accessed in Statistics Canada's *Research Data Center*. Years range from 2013 - 2019. Each observation is year by Census Metropolitan Area (CMA) *or* Census Agglomeration (CA). All equations are estimated using ordinary least squares with weights applied. Panels vary the different firearms variables used in each model. Columns vary the different dependent variables. All columns control for demographic characteristics at the census metropolitan area (CMA) or census agglomeration (CA) level. These variables include: the average age of a person, the percentage of people that are female, the percentage of people that are married, the number of people receiving (un)Employment Insurance (EI) Benefits, and the number of people receiving federal child benefits. All columns also include province, year and CMA/CA fixed effects. PAL is an acronym for Possession and Acquisition License; RPAL is a Restricted PAL. Standard errors are constructed using a CRVE and clustered at the province-level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 8: Firearms Deaths by Different Types of Firearms

Independent Variables	*Dependent Variables*: Types of Firearms Deaths *(per 100,000)*			
(per 100,000)	Handguns	Rifles	Unspecified	Uncategorised
Panel 1				
Total Restricted Guns per 100,000	0.00000527	-0.00000756	-0.00001833	-0.00000170
	(0.00000417)	(0.00003381)	(0.00002326)	(0.00000193)
All Licenses per 100,000	0.00001055	-0.00002157	0.00007569	0.00000506
	(0.00002099)	(0.00003820)	(0.00004228)	(0.00000646)
P-value (Licenses + Guns = 0)	.542	.514	.202	.64
Panel 2				
Total Restricted Guns	0.00000558**	-0.00002589***	0.00000234	-0.00000039
	(0.00000231)	(0.00000725)	(0.00001262)	(0.00000137)
PAL	0.00001231	-0.00012495	0.00019230*	0.00001245
	(0.00001485)	(0.00013402)	(0.00009165)	(0.00000962)
RPAL	-0.00000016	0.00060528	-0.00063143	-0.00003980
	(0.00011182)	(0.00069915)	(0.00042327)	(0.00003464)
P-value (RPAL + PAL + Guns = 0)	.881	.455	.269	.355
Panel 3				
Handguns	0.00001797*	-0.00005761	0.00002175	-0.00000232
	(0.00000801)	(0.00004238)	(0.00003836)	(0.00000778)
Rifles	0.00000450**	-0.00002288***	-0.00000128	-0.00000022
	(0.00000155)	(0.00000681)	(0.00000983)	(0.00000101)
Other guns	0.00004131	-0.00053796***	0.00246760***	-0.00003091
	(0.00008800)	(0.00011374)	(0.00039103)	(0.00004028)
PAL	0.00001290	-0.00012602	0.00019092*	0.00001239
	(0.00001451)	(0.00013324)	(0.00008887)	(0.00000986)
RPAL	-0.00000934	0.00062569	-0.00062908	-0.00003853
	(0.00010825)	(0.00068460)	(0.00038878)	(0.00003686)
P-value (All Guns Sum to 0)	.511	.001	.000	.411
Province, Year and CMA FE	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
Observations	1015	1015	1015	1015

Notes: Authors' calculations. Deaths data from the Vital Statistics Death Database (VSDD) accessed in Statistics Canada's *Research Data Center*. Years range from 2013 - 2019. Each observation is year by Census Metropolitan Area (CMA) *or* Census Agglomeration (CA). All equations are estimated using ordinary least squares with weights applied. Panels vary the different firearms variables used in each model. Columns vary the different dependent variables. All columns control for demographic characteristics at the census metropolitan area (CMA) or census agglomeration (CA) level. These variables include: the average age of a person, the percentage of people that are female, the percentage of people that are married, the number of people receiving (un)Employment Insurance (EI) Benefits, and the number of people receiving federal child benefits. All columns also include province, year and CMA/CA fixed effects. PAL is an acronym for Possession and Acquisition License; RPAL is a Restricted PAL. Standard errors are constructed using a CRVE and clustered at the province-level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 9: Crimes, Licenses, Restricted Registered Guns in CMAs

	Dependent Variables: Total Offences (per 100,000) by Type								
Model/Independent Variables	Total Firearms Violations	Firearms Discharge	Using Firearms	Documentation Issue	Improper Storage	Homicides	1st degree Murder	2nd degree Murder	Manslaughter
Model 1									
Total Restricted Guns per 100,000 (Standardized)	15.785	7.595	2.304	3.341	1.924*	0.326	1.480	-1.632**	0.483
	(12.153)	(5.868)	(4.320)	(2.101)	(1.008)	(1.389)	(0.865)	(0.679)	(0.456)
Model 2									
All Licenses per 100,000 (Standardized)	-0.300	-0.344	0.376	-0.993	0.450	-0.265	0.699***	-1.051***	0.091
	(2.213)	(1.261)	(0.647)	(0.639)	(0.406)	(0.235)	(0.189)	(0.220)	(0.140)
Model 3									
Total Restricted Guns per 100,000 (Standardized)	17.066	8.315	2.276	4.090	1.830	0.485	1.226	-1.208	0.470
	(12.329)	(6.058)	(4.487)	(2.270)	(1.124)	(1.401)	(0.797)	(0.881)	(0.437)
All Licenses per 100,000 (Standardized)	-2.673	-1.500	0.059	-1.561**	0.196	-0.332***	0.529*	-0.883**	0.026
	(1.790)	(1.214)	(0.651)	(0.633)	(0.349)	(0.081)	(0.237)	(0.299)	(0.144)
Model 4									
Total Restricted Guns per 100,000 (Standardized)	16.981	9.112	1.079	3.636	1.183	0.615	1.831	-2.176**	0.964*
	(13.143)	(5.243)	(4.735)	(2.678)	(0.897)	(1.704)	(1.124)	(0.831)	(0.515)
PAL per 100,000 (Standardized)	-2.246	-0.969	-0.363	-1.451	-0.061	-0.231	0.647*	-1.066***	0.191
	(1.569)	(1.178)	(0.634)	(0.800)	(0.426)	(0.209)	(0.281)	(0.292)	(0.132)
RPAL per 100,000 (Standardized)	-0.605	-1.481	1.632	0.193	0.926	-0.266	-0.675	1.070	-0.660**
	(4.711)	(2.150)	(1.574)	(1.275)	(0.625)	(0.686)	(0.569)	(0.615)	(0.276)
Model 5									
Handguns per 100,000 (Standardized)	-4.486	-1.064	-6.673**	4.563**	-1.607*	1.117	1.658*	-0.157	-0.376
	(5.028)	(3.658)	(2.868)	(1.880)	(0.775)	(1.438)	(0.794)	(0.687)	(0.496)
Rifles per 100,000 (Standardized)	22.352***	10.859***	6.663*	1.321	2.643***	0.247	0.863	-2.257**	1.636***
	(6.212)	(1.657)	(3.098)	(0.760)	(0.576)	(0.986)	(0.975)	(0.885)	(0.069)
Other guns per 100,000 (Standardized)	1.568	0.559	1.321	0.128	0.375	0.199	-0.073	-0.055	0.325***
	(1.763)	(0.402)	(1.044)	(0.216)	(0.211)	(0.334)	(0.224)	(0.342)	(0.071)
PAL per 100,000 (Standardized)	-1.100	-0.498	0.355	-1.526*	0.155	-0.210	0.601*	-1.137***	0.328***
	(1.916)	(1.297)	(0.777)	(0.802)	(0.404)	(0.209)	(0.322)	(0.252)	(0.095)
RPAL per 100,000 (Standardized)	0.360	-1.002	1.917*	-0.037	1.033	-0.386	-0.694	0.970	-0.662**
	(4.045)	(2.109)	(0.946)	(1.285)	(0.666)	(0.708)	(0.562)	(0.786)	(0.234)
Province, CMA and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	225	225	225	225	225	225	225	225	225
Dependant Variable Mean	5.653	1.798	1.548	1.373	1.702	1.62	.679	.749	.193

Notes: Authors' calculations. Years range from 2013 - 2019. Each observation is year by CMA. All equations are estimated using ordinary least squares. Columns vary by their different types of crimes or violations. Columns 1 is Criminal Code violation 150 (per 100,000) - total firearms violations, use of, discharge, pointing. Column 2 is Criminal Code violation 1450 (per 100,000) - discharge firearms with intent. Column 3 is Criminal Code violation 1455 (per 100,000) - using firearms in commission of offence. Column 4 is Criminal Code violation 3390 (per 100,000) - firearms documentation or administrations. Column 5 is Criminal Code violation 3395 (per 100,000) - unsafe storage of firearms. Column 6 is Criminal Code violation 110 (per 100,000) - homicide. Columns 7 is Criminal Code violation 1110 (per 100,000) - murder, first degree. Columns 8 is Criminal Code violation 1120 (per 100,000) - murder, second degree. Columns 9 is Criminal Code violation 1130 (per 100,000) - manslaughter. These variables include: the average age of a person, the percentage of people that are female, the percentage of people that are married, the number of people receiving EI or Benefits, and the number of people receiving child benefits. Standard errors are constructed using a CRVE and clustered at the province-level. * significant at 10%, ** significant at 5%, *** significant at 1%.

A2 Data Appendix

Cleaning

Cleaning the Guns Data

Most cleaning associated with the guns data amounted to making the unit of observation suitable to be merged with the CSD to CMA/CA crosswalk dataset. We imputed zeros for those CSDs which had missing observations for a given year. For PALS and RPALS, three observations were dropped in total: two because they were redundant and one because it was empty. For the types of guns data, the process was similar: clean it to make the unit of observation more suitable for the merge with the crosswalk while imputing zeros for omitted values.

Cleaning the CANSIM Data: Deaths, Taxfilers and Crimes

Most cleaning done to these datasets were associated with tidying up the observations in order to better match it to the crosswalk. Most of this amounted to string manipulation. In some specific instances, like the CMA of "Greater Sudbury / Grand Sudbury" we had to rename some observations. Another example is the residual group for provinces' "non-CMA and/or non-CA" which was named inconsistently across the datasets. A final example is the changing of a double dash to a single dash, or trimming the spaces between dashes.

Merging and Cleaning

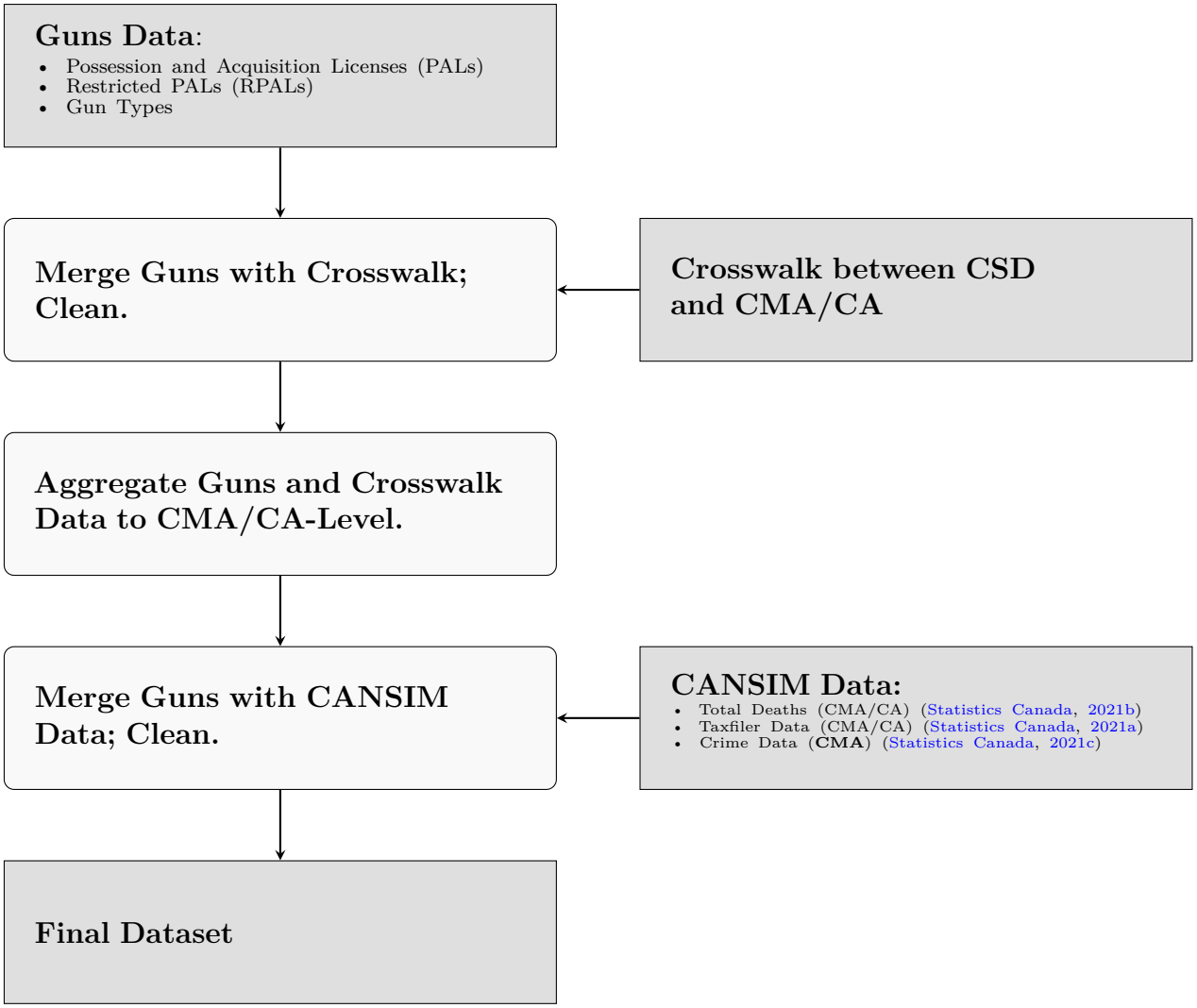
Merging the Guns data with One another - PALS, RPALS, and Gun Types.

The PAL and RPAL datasets merged with perfectly with one another for all 3753 rows. However, merging the RPAL + PAL dataset with the types of guns dataset, our merge was successful for only 3320 rows, with 252 from the master dataset and 175 from the "using" dataset (the one being merged into the master dataset) being unmatched. 128 rows were found to be merged unsuccessfully yet having discernibly the same identifying variables and were corrected. Some observations were found to be redundant and therefore dropped. The final dataset resulted in 3581 matched rows, with 125/252 from the master dataset and 135/175 of the using datasets being matched correctly. 70 rows were dropped since as they were redundant.

This code concluded with reshaping the dataset from wide – columns were year-by-statistic. The final number of observations was 25,067.

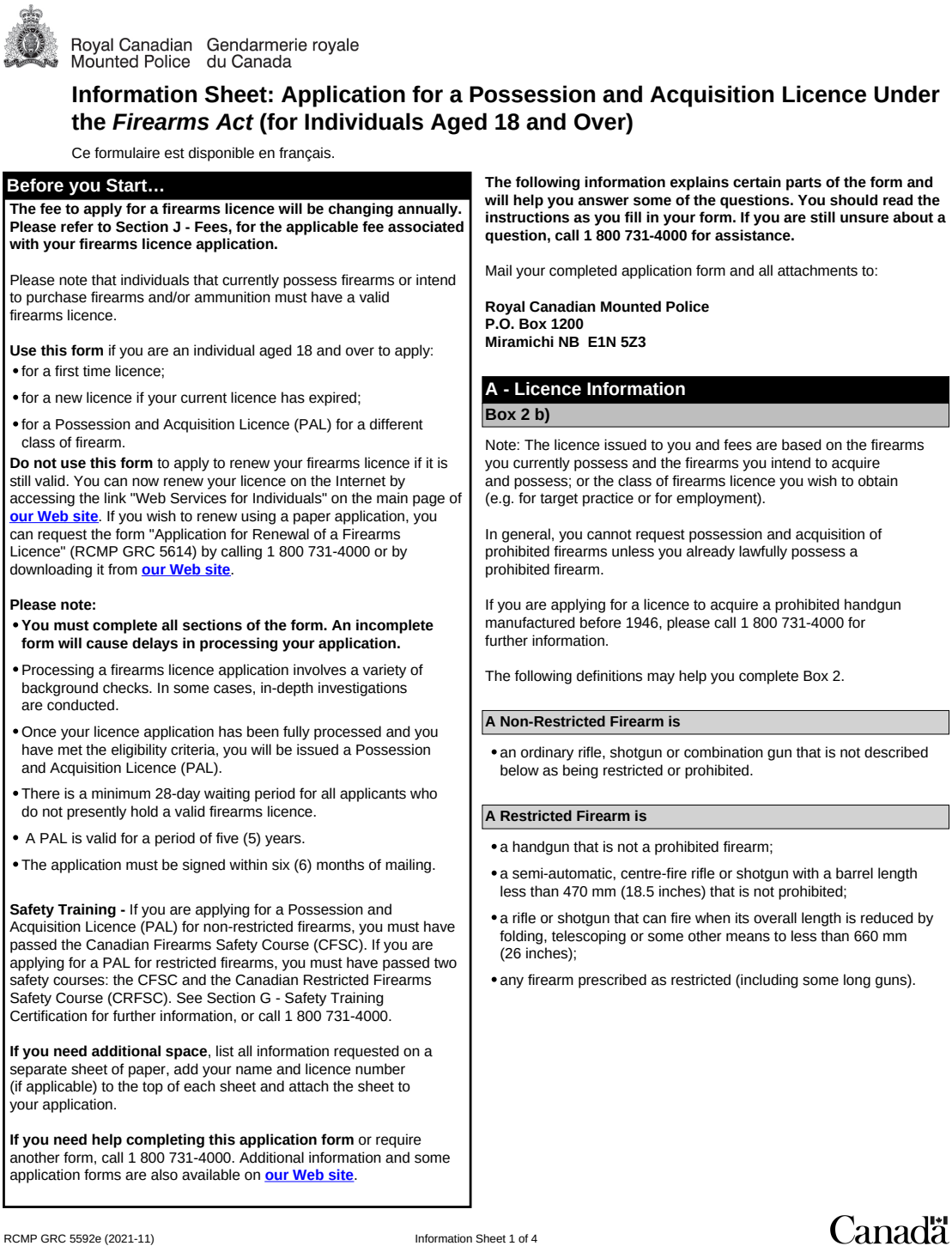
Merging Gun Types and Licenses Dataset with CSD to CMA/CA Crosswalk

The gun types and licenses dataset (all three merged, with their specific variables concatenated as columns) merged with the CSD to CMA/CA cross walk forming 23,499 / 25,067 successful matches. It should be noted that this is an many-to-one merge since each geographic region corresponds to 7 rows (the number of years) of the gun types and licenses dataset. There 79 CSDs which did not match in the crosswalk.


Guns Data:
Possession and Acquisition Licenses (PALs)
Restricted PALs (RPALs)
Gun Types
Merge Guns with Crosswalk; Clean.
Crosswalk between CSD and CMA/CA
Aggregate Guns and Crosswalk Data to CMA/CA-Level.
Merge Guns with CANSIM Data; Clean.
CANSIM Data:
Total Deaths (CMA/CA) (Statistics Canada, 2021b)
Taxfiler Data (CMA/CA) (Statistics Canada, 2021a)
Crime Data (CMA) (Statistics Canada, 2021c)
Final Dataset

A4 RCMP Application for Firearms

Figure A1: RCMP Application for Gun Licenses - Information Sheet



Royal Canadian Mounted Police / Gendarmerie royale du Canada

Information Sheet: Application for a Possession and Acquisition Licence Under the *Firearms Act* (for Individuals Aged 18 and Over)

Ce formulaire est disponible en français.

Before you Start…

The fee to apply for a firearms licence will be changing annually. Please refer to Section J - Fees, for the applicable fee associated with your firearms licence application.

Please note that individuals that currently possess firearms or intend to purchase firearms and/or ammunition must have a valid firearms licence.

Use this form if you are an individual aged 18 and over to apply:

- for a first time licence;
- for a new licence if your current licence has expired;
- for a Possession and Acquisition Licence (PAL) for a different class of firearm.

Do not use this form to apply to renew your firearms licence if it is still valid. You can now renew your licence on the Internet by accessing the link "Web Services for Individuals" on the main page of **our Web site**. If you wish to renew using a paper application, you can request the form "Application for Renewal of a Firearms Licence" (RCMP GRC 5614) by calling 1 800 731-4000 or by downloading it from **our Web site**.

Please note:

- **You must complete all sections of the form. An incomplete form will cause delays in processing your application.**
- Processing a firearms licence application involves a variety of background checks. In some cases, in-depth investigations are conducted.
- Once your licence application has been fully processed and you have met the eligibility criteria, you will be issued a Possession and Acquisition Licence (PAL).
- There is a minimum 28-day waiting period for all applicants who do not presently hold a valid firearms licence.
- A PAL is valid for a period of five (5) years.
- The application must be signed within six (6) months of mailing.

Safety Training - If you are applying for a Possession and Acquisition Licence (PAL) for non-restricted firearms, you must have passed the Canadian Firearms Safety Course (CFSC). If you are applying for a PAL for restricted firearms, you must have passed two safety courses: the CFSC and the Canadian Restricted Firearms Safety Course (CRFSC). See Section G - Safety Training Certification for further information, or call 1 800 731-4000.

If you need additional space, list all information requested on a separate sheet of paper, add your name and licence number (if applicable) to the top of each sheet and attach the sheet to your application.

If you need help completing this application form or require another form, call 1 800 731-4000. Additional information and some application forms are also available on **our Web site**.

The following information explains certain parts of the form and will help you answer some of the questions. You should read the instructions as you fill in your form. If you are still unsure about a question, call 1 800 731-4000 for assistance.

Mail your completed application form and all attachments to:

Royal Canadian Mounted Police
P.O. Box 1200
Miramichi NB E1N 5Z3

A - Licence Information

Box 2 b)

Note: The licence issued to you and fees are based on the firearms you currently possess and the firearms you intend to acquire and possess; or the class of firearms licence you wish to obtain (e.g. for target practice or for employment).

In general, you cannot request possession and acquisition of prohibited firearms unless you already lawfully possess a prohibited firearm.

If you are applying for a licence to acquire a prohibited handgun manufactured before 1946, please call 1 800 731-4000 for further information.

The following definitions may help you complete Box 2.

A Non-Restricted Firearm is

- an ordinary rifle, shotgun or combination gun that is not described below as being restricted or prohibited.

A Restricted Firearm is

- a handgun that is not a prohibited firearm;
- a semi-automatic, centre-fire rifle or shotgun with a barrel length less than 470 mm (18.5 inches) that is not prohibited;
- a rifle or shotgun that can fire when its overall length is reduced by folding, telescoping or some other means to less than 660 mm (26 inches);
- any firearm prescribed as restricted (including some long guns).

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Application for a Possession and Acquisition Licence Under the *Firearms Act* (for Individuals Aged 18 and Over). Retrieved January 2022 from https://www.rcmp-grc.gc.ca/en/firearms/firearms-forms.

Figure A2: RCMP Application for Gun Licenses - Personal History

Application for a Possession and Acquisition Licence Under the *Firearms Act* (for Individuals Aged 18 and Over)

Protected B once completed

For Administrative Use

Mailing Address

Your mailing address is the address where you receive your mail.		☐ Mailing address is the same as home address	
15. a) Street / Rural Route / PO Box Number			15. b) Apt./Unit
15. c) City	15. d) Province/Territory	15. e) Country	15. f) Postal Code

C - Personal History

New Canadian Residents and Non-residents, refer to Information Sheet.

If you answer **yes** to any of the questions in this section, you must provide details on a separate page. Add your name at the top of each page you attach. If details are not provided, your application cannot be processed. A **yes** answer **does not mean** your application will be refused but it may lead to further examination. If you have been granted **a record suspension or a pardon** for any offence listed in box 16 a), you are **not** required to disclose the offence.

16. a) Have you ever been charged, convicted or granted a discharge for an offence: (i) under the *Criminal Code* or the *Youth Criminal Justice Act* where violence was used, threatened or attempted; (ii) involving the misuse, possession or storage of a firearm; or (iii) involving trafficking or importing drugs or controlled substances?	◯ Yes ◯ No
16. b) Have you ever been subject to a peace bond, protection order or an order under section 810 of the *Criminal Code*?	◯ Yes ◯ No
16. c) Have you or any member of your household ever been prohibited from possessing any firearm?	◯ Yes ◯ No
16. d) Have you ever threatened or attempted suicide, or have you ever suffered from or been diagnosed or treated by a medical practitioner for: depression; alcohol, drug or substance abuse; behavioural problems; or emotional problems?	◯ Yes ◯ No
16. e) Do you know if you have ever been reported to the police or social services for violence, threatened or attempted violence, or other conflict in your home or elsewhere?	◯ Yes ◯ No
16. f) During the past two (2) years, have you experienced a divorce, a separation, a breakdown of a significant relationship, job loss or bankruptcy?	◯ Yes ◯ No

D - Conjugal Status

You must answer both questions 17. a) and b) or your licence application will be delayed.

17. a) Do you currently have a spouse, common-law or other conjugal partner?	◯ No ◯ Yes. If yes, you **must** complete Section E.
17. b) Within the last two (2) years have you lived in a conjugal relationship other than with the person you may have referred to in question 17. a)?	◯ No ◯ Yes. If yes, you **must** complete Section F.

E - Information About Current Conjugal Partner

18. a) Last Name of **Current** Spouse, Common-Law or other Conjugal Partner	18. b) First Name	18. c) Middle Name	18. d) Date of Birth (yyyy-mm-dd)

If the signature of your current spouse, common-law or other conjugal partner is not provided, the Chief Firearms Officer has a duty to notify them of your application.

If you have any safety concerns about this application, please call 1 800 731-4000.

18. e) Signature of Current Spouse, Common-Law or other Conjugal Partner	18. f) Date (yyyy-mm-dd)	18. g) Telephone Number	Extension	When can he/she be reached at this number? ☐ Day ☐ Evening

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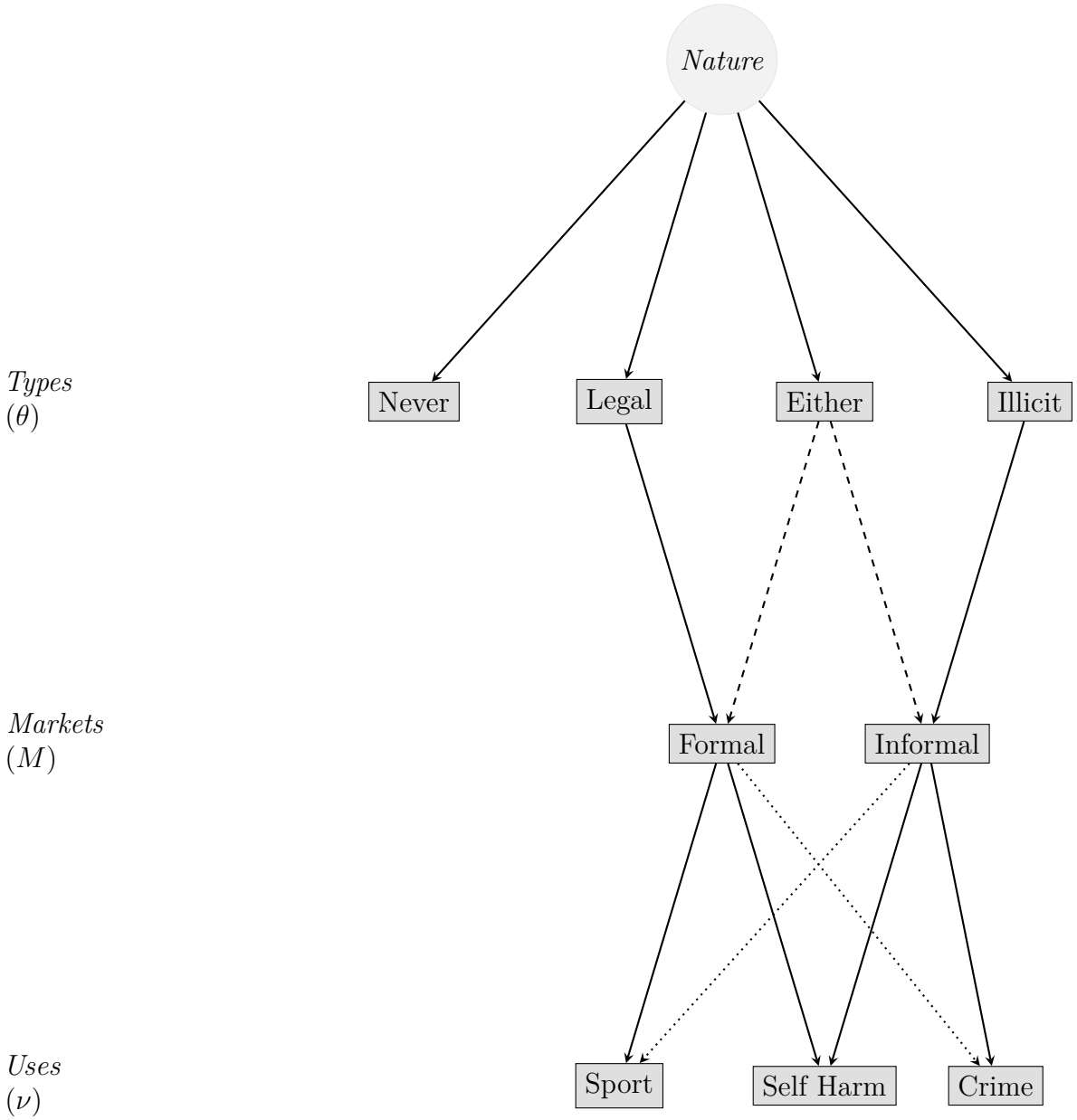
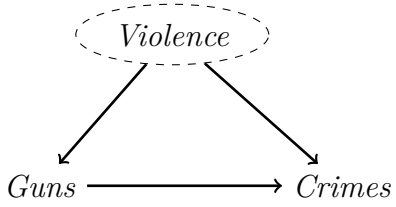
Application for a Possession and Acquisition Licence Under the *Firearms Act* (for Individuals Aged 18 and Over). Retrieved January 2022 from https://www.rcmp-grc.gc.ca/en/firearms/firearms-forms.

Figure A3: Schematic Diagram for Firearms Markets and Uses

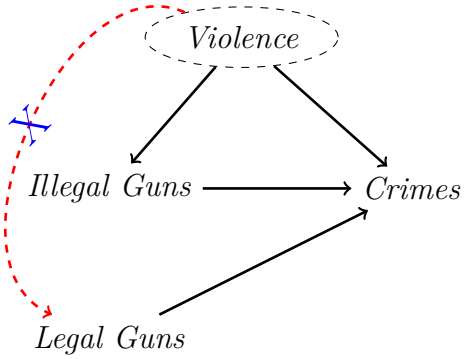


DESCRIPTION: *Nature* assigns individual i type θ, who chooses to access firearms in market M which then allows use ν.

Figure A4: Directed Acyclic Graphs (DAGs) of Guns and Crime



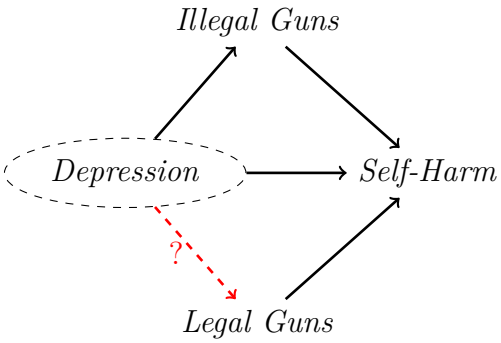
(a) Usual Concern with Guns and Crimes



(b) Legal versus Illegal Guns and Crimes

Notes: Proclivity for violence (*Violence)* affects guns and crime but is hard to measure (as outlined by the dashed ellipse). This is depicted in subfigure A4a and represents the usual concern with this estimation strategy. We disaggregate guns into those owned legally compared to those owned illegally in subfigure A4b. Proclivity for violence (*Violence*) affects *illegal* guns and crime but is less likely to affect *legal* gun use (as suggested by the red and dashed edge with a blue 'X' in the edge's center). This is particularly true in the Canadian context which has strong guns regulations relative to other contexts. Previous literature suggests a null relationship from legal firearms to crimes (Khalil (2017) in the US) as well as a null relationship between (modest) volunteer firearms buybacks and crimes (Ferrazares et al. (2022) in the US).

Figure A5: Legal versus Illegal Guns and Self-Harm DAG)



Notes: Depression is likely to affect both *illegal* gun users and *legal* gun users, though the concern should be dampened by firearms regulation (as suggested by the red and dashed edge with a question mark over the edge's center). Previous literature suggests a positive relationship between the dashed, red line from depression to legal firearms (Perlis et al., 2022). Previous literature suggests either a positive relationship between black arrow running from legal firearms to self-harm (as in Leigh and Neill (2010) in Australia) or a null relationship between (modest) volunteer firearms buybacks and self harm (as in Ferrazares et al. (2022) in the US).