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Influence of Weapon Types on the Patterns and Outcomes of Violent Encounters

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Influence of Weapon Types on the Patterns and Outcomes of Violent Encounters

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RÉSUMÉ

Contexte et objectifs. En collaboration avec le Service de police de la Ville de Montréal (SPVM), la présente étude vise à bonifier les connaissances quant au caractère structurant de l'arme à feu lors de la réalisation de crimes violents. Plus précisément, cette étude identifie les facteurs associés à l'utilisation d'une arme à feu dans un contexte de crimes violents et estime son effet sur le risque de blessures mortelles et blessures non mortelles.

Méthodologie. Les données utilisées pour l'étude proviennent du Module d'information policière (MIP) pour la période 2011-2012. Les données furent analysées à l'aide de deux stratégies principales. Premièrement, des régressions logistiques ont permis d'identifier les facteurs associés à l'utilisation d'une arme lors de l'occurrence d'un crime violent. Deuxièmement, l'effet moyen de l'arme à feu sur le risque de décès et de blessures non mortelles fut estimé à l'aide d'une méthode nommée le « *propensity score matching* (PSM) ». Il s'agit d'une stratégie statistique qui tente de reproduire les conditions des recherches expérimentales en réponse à l'absence de randomisation dans la plupart des recherches dans le domaine des sciences sociales.

Résultats. Les résultats montrent que les armes à feu sont utilisées principalement lors de la réalisation de crimes liés aux groupes criminels ayant pour cible des victimes plutôt non vulnérables (de jeunes hommes accompagnés d'autres personnes). L'arme à feu leur confère tout de même un avantage en ce sens qu'elle augmente le risque de décès de la victime lors des altercations tout en diminuant le risque de blessures, notamment lors des vols à main armée.

Conclusion. Les résultats indiquent que l'arme à feu confère un avantage significatif, même entre les mains des délinquants les plus puissants. Les résultats suggèrent également que les autres armes ne sont pas des substituts équivalents à l'arme à feu. De même, l'arme à feu constitue une menace suffisante qui ne nécessite pas l'infliction de blessures supplémentaires lors de la réalisation de vols qualifiés.

Mots clés : arme à feu, crime violent, facilitateur, vulnérabilité, décès, blessures, *propensity score matching*

ABSTRACT

Background and objectives. In collaboration with the *Service de police de la Ville de Montréal* (SPVM), this study aims to improve the knowledge about the structuring effect of firearms on criminal violence. This study first identifies factors associated with firearms use in violent crimes and second, estimates the risk of fatal and non-fatal injuries associated with gun use.

Methods. Data used in the present study come from the *Module d'information policière* (MIP), for the period of 2011 to 2012. Data were analyzed using a two-step strategy. First, logistic regressions were conducted to pinpoint factors associated with firearm use in violent crime. Second, estimates of the average treatment effect were computed using the propensity score matching (PSM) technique. PSM is an innovative statistical strategy that attempts to reproduce conditions of controlled experiments when cases were not randomized in the first place.

Results. In general, results show that firearms are more frequently used in gang-related crimes where individuals attack relatively non-vulnerable targets (young males accompanied by other persons). Despite these characteristics, firearm use increases the risk of fatal injuries in violent altercations, but lessens the risk of non-fatal injuries, among other things, in the case of robberies.

Conclusion. Findings establish that firearms facilitate the perpetration of violent crimes, even in the hands of the strongest offenders. Results also suggest that other weapons are poor substitutes for firearms. Although the findings cannot fully corroborate firearms as the great equalizer, these weapons do confer several advantages to their user(s). Firearms also appear to be a sufficient threat in the case of robberies, where additional injuries are not necessary to successfully commit the crime.

Keywords: firearms, criminal violence, facilitator, vulnerability, death, injuries, propensity score matching

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LIST OF ACRONYMS AND ABBREVIATIONS

ATE: Average Treatment Effect

CI: Confidence Interval

CRPQ: Centre de renseignements policiers du Québec

FBI: Federal Bureau of Investigation

MIP: Module d'information policière

OR: Odds Ratio

PSM: Propensity Score Matching

SPVM: Service de police de la Ville de Montréal

SQ: Sûreté du Québec

SB: Standardized Bias

UCR: Uniform Crime Reporting

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INTRODUCTION

In Canada, the rates of firearm-related violent crimes such as homicide, attempted murder and robbery is stable since 2003. In fact, the rate of firearm-related homicides declined during the period of 1976 to 1998 and has remained stable since. Essentially, such decline can be explained by the 86% decrease in homicides committed using rifles and shotguns from 1975 to 2006 (Dauvergne & De Socio, 2008). Yet, the homicide rate involving handguns remains relatively stable. As a result, handguns are the most common type of firearm used to commit homicides. By 2006, the number of victims murdered using a handgun was three times more than those killed by a rifle or a shotgun. Overall, 31.4% of homicides, 36% of attempted murders, 13.9% of robberies, 0.3% of sexual assaults and 1.1% of assaults were committed with a firearm in Canada during the year of 2006 (Dauvergne & De Socio, 2008).

Although handgun homicides account for about two-thirds of all firearm-related homicides, most of the violent crimes in Canada are not committed with a firearm. According to data reported by police to the Uniform Crime Reporting (UCR) Survey in 2006, physical force or threats, without the use of any weapon, accounted for 75% of most violent crimes, while the use of weapons accounted for 18%, with knives (6.2%) and clubs or blunt instruments (3.0%) being the most frequent. Firearms were used in 2.4% of all violent crimes (Dauvergne and De Socio, 2008). Moreover, in 2011, Canadian police forces reported a homicide rate that was 7.4% higher than the previous year. Most of the increase can be attributed to the additional cases involving stabbings, which accounted for 35% of all homicides in 2011. Other methods such as firearms (27%), beatings (22%), and strangulation (7%) are comparatively less common (Perreault, 2012).

In comparison with its American neighbour, Canada's firearm regulation is rather strict and particularly so with respect to handguns. For instance, with the exception of police officers, collectors and members of gun clubs, very few Canadians have a license to carry handguns for self-protection (Davies, 2011).[1] Also, while the number of illicit and licit guns in the United States held by civilians is estimated to be 270 million for a population of 304 million, Canada has a little less than 10 million firearms – including both licit and illicit – for a population of nearly 33 million. Over nine times more populated, the United States has 27 times more handguns than Canada (Small Arms Survey, 2007). As such, in 2009, the American gun homicide rate for a population of 100 000 is 7.5 times the Canadian rate, compared to nearly 3.5 times the Canadian rate for overall homicide rate (UNODC, 2011).[2]

At first glance, one may suggest that the issue of gun violence in Canada does not entreat further exploration into the relationship between firearms and criminal violence. Nevertheless, this matter is highly controversial. In fact, the relationship between firearms and violent crime is a strongly debated topic. Rival theoretical claims have emerged that view guns as a cause of violent crime (Cook, 1981, 1983; Duggan, 2001; MacDonald & Lerer, 1994), an instrument to reduce violent crime (Kates & Mauser, 2007; Kleck, 1997; Lott, 2000; Mauser, 2007), or completely unrelated to violent crime (Moody & Marvell, 2005; Southwick, 1997). Several studies have been conducted over the years suggesting a relationship between violent crime rates and gun availability (Clarke & Mayhew, 1988; Cummings, et al., 1997; Kellermann et al., 1993; McDowall, 1991; Newton & Zimring, 1969; Sloan et al., 1988), but

[1] Since the introduction of Bill C-51 in 1977, owning a firearm for self-protection is illegal, except for existing license holders (grandfather clause).

[2] In 2013, Canada has roughly 825 000 restricted and prohibited firearms registered for a population of 35 million. (RCMP, 2013).

no clear consensus has emerged as to which precedes the other. On one hand, gun control advocates (Cook & Lugwig, 2006; Duggan, 2001; Hoskin, 2001) argue that firearms acquisition increases violent crime rates because the use of guns increases the probability of success in wrongdoer's crime. On the other hand, supporters of the opposing view (Kleck & Gertz, 1995; Kleck & Patterson, 1993) defend that, in fact, firearms are acquired in response to a significantly high level of violent crimes because potential victims feel the need to be armed for self-protection purposes.

Hitherto, very few studies have investigated the actual impact of using firearms, as opposed to the use of comparatively less lethal weapons, on violent crime patterns. Also, the conceptualization of "conventional" control variables such as victims' and/or offenders' age, ethnic group and gender are not tailored to the theoretical implication of these variables to accurately answer the research question. For example, often considered to be a great equalizer, how does the use of a firearm affect criminals' chances of successfully committing their crime? Compared to the use of knives and clubs, does gun use considerably grant relatively weak assailants – women, elders, physically weak or incapacitated individuals – with the power required to attack rather invulnerable – men, young adults, physically strong or fit individuals – targets?

In an attempt to provide enlightening answers to these questions, this study aims to "establish the causal importance of weapon type in influencing the patterns and lethality of personal violence" (Cook, 1991: 1). Actually, Newton and Zimring (1969) have tackled this issue in a report of the National Commission on the Causes and Prevention of Violence. However, motivated by the ongoing debate on the proper gun legislation, the focus of

scientific research has been subjected to several shifts over the years. After the publication of Newton's and Zimring's work (1969), the primary emphasis of weapon research during the 1970s laid on the criminal misuse of guns (Cook 1982; Wright, Rossi & Daly, 1983). Then, the involvement of public health research community raised scholarly awareness to suicide and gun accidents during the 1980s (Mercy & Houk, 1988; National Research Council, 1985). In spite of improved emergency medical response to gunshot cases and adapted design of guns to reduce gun injuries, the mandate to reduce gun violence cannot solely reside in the increased attention brought by the public health framework. A better understanding of the impact of various weapons use on personal violence patterns is fundamental to gun control policies. Hence, the concerns raised by Newton and Zimring (1969) almost four decades ago remain central today.

Accordingly, the main objectives of the current study are to identify factors that predict the likelihood that a gun will be used to commit a crime and, to estimate a victim's risk of fatal and non-fatal injuries in gun-related crimes. Specifically, an overview of various types of violent crime namely homicide, attempted murder, assault and robbery committed in Montreal in 2011 and 2012 will be provided in the first place. Once factors associated with gun use are identified, they are used to compute a propensity score, upon which gun-involving cases are matched to non-gun-involving cases to estimate the effect of firearms on the risk of death and risk of injury.

The present dissertation is divided into four main chapters. In chapter one, a review of the literature details both key concepts and empirical evidence relevant in establishing the relationship between gun availability and criminal violence. Chapter two presents the set of

data that is used, the various variables which are conceptualized according to the theoretical implications of this study, and the analytical strategies that are conducted in order to provide answers to the objectives. Chapter three provides the different crime patterns that are associated with gun use and the relative effect of guns on a victim's risk of fatal and non-fatal injuries. Finally, chapter four interprets the results.

CHAPTER 1:

LITERATURE REVIEW

This chapter is divided into three sections. The first section presents the ongoing debate on the relationship between gun and criminal violence. Two main perspectives are examined: on one side, firearms are viewed as facilitators in the occurrence of a vast array of crimes; on the other side, these weapons are viewed as to be owned for self-protection purposes. Then, a described consideration is given to Cook's (1981) framework which tackles the effect of gun availability on three important dimensions of the violent crime issue.

The second section overviews empirical evidence showing the relationship between gun availability and violent crimes. The first set of studies includes macroscopic research which examine the impact of firearm availability on violent crime rates; the second set of studies includes microscopic research which look at the effect of guns on the risk of homicides and violent deaths; and the last set of studies puts together evidence on the effect of guns on violent crime patterns.

Finally, given the limitations of the existing research that are provided, the third section presents the purposes of the current study, as well as its attempt to make a contribution to the ongoing debate by incorporating an innovative statistical strategy to strengthen the findings.

1.1. Gun and Risks of Criminal Violence: Key Concepts

The relationship between firearm availability and violent crimes is a strongly debated topic. Scholars and different political parties have provided supports and oppositions for gun control policies. Whereas proponents believe that laws intended to control gun availability can prevent a great number of violent crimes (Cook, 1981; Hemenway, 2004), opponents claim

that these preventive measures do not reduce gun-related injuries (Kates & Mauser, 2007; Kleck, 1997).

On one hand, the outcomes of violent offences committed with a firearm are believed to be more serious than those involving other weapons or no weapon at all (Cook & Ludwig, 2006; Duggan, 2001; Hoskin, 2001). Gun availability has a significant influence on violent crime patterns as it can increase the likelihood that any particular dispute will result in an individual being severely injured. Furthermore, all other factors being equal, the use of firearms increases the likelihood of success and gives the perpetrator the power to attack relatively invulnerable victims, whom he would not assault without a gun.

On the other hand, Kleck and Patterson (1993) found evidence supporting the hypothesis that "some violence rates encourage the acquisition of firearms for self-defense, accounting at least partially for bivariate positive associations observed between gun prevalence levels and violence levels" (p.272). According to these authors' findings, certain types of crime, such as homicide, gun assault and rape, provoke so much fear in potential victims that, as a result, people are more likely to acquire firearms for self-protection purposes. For instance, it is believed that criminals who use guns to commit crimes are outnumbered by citizens who use guns to defend themselves. To provide further evidence on urban firearm ownership as a response to homicide, Kleck and Kovandzic (2009) found that a sense of greater collective security provided by larger city police forces discourages gun ownership for it reduces citizens' need to adopt self-protection behaviors. Kleck and Gertz (1995) have estimated that, each year, approximately 2.5 million citizens use guns in self-defence, whereas 1.1 million violent crimes involve the use of a firearm. Hence, it is the high

violent crime rates that induce an increase in gun prevalence. Guns are acquired for self-protection purposes (Cook & Ludwig, 1997), both by criminals and non-criminals, and the former might be deterred from committing crimes when potential victims are as likely to possess a firearm (Wright & Rossi, 1986). Fear toward armed victims seems to discourage criminals to commit crimes, but it does not dampen their gun carrying patterns. The need for self-protection seemed, according to the authors' analysis, influenced to a greater degree by fear of meeting an armed victim than encountering members the police. Here, it is important to note that, an armed victim might not simply stand for average citizens who own guns at home; it can very well also represent other armed delinquents they encounter in their everyday life. Moreover, it seems that being armed reduces both the victims' risk of being injured and the offenders' chances of completing the crime (Kleck & Delone, 1993). For instance, data from the National Crime Victimization Survey (NCVS) from 1979 to 1987 revealed that, in situations where burglars attempt to break into occupied residences in which an individual defended his/her property with a gun, criminals' success rate was only about 14%, compared to an overall success rate of 33% for burglaries. Based on victim surveys in three nations, Kleck (1997) suggests that countries having higher rates of burglaries of occupied residences than the United States also have lower levels of gun ownership.

Along with that idea, Kates and Mauser (2007) suggest that increasing gun availability actually reduces crime. That is, crime rates are inversely related to the gun ownership rate. The idea behind this hypothesis is that the acquisition and ownership of guns by law-abiding citizens act as a deterrent to crime. However, their conclusion has been drawn by solely examining the murder rate and the rate of firearm ownership across several countries; it is rather plausible that other factors which could mediate the relationship between these two

variables are missed out. Yet, their results are similar to those of Lott's. He concludes that the adoption of state laws allowing the general population to freely carry concealed weapons is generally associated with a reduction in violent crimes (Lott, 2000). Highly controversial, his work has been harshly criticized by many other authors and, to date, there are more findings against his conclusion than those supporting it. Nonetheless, other researchers have not found any significant relationship between firearms availability and violent crimes (Moody & Marvell, 2005; Southwick, 1997).

While the debate goes on, the authorities were faced with significant increases in violent crimes in the United States in the mid-1960s. As a result, the government expressed a strong interest in firearm regulation and researchers have then started to investigate the role of firearms in violent crimes. Although firearms are involved in a relatively small proportion of violent crimes, over two-thirds of the most serious offences such as criminal homicides are committed with these weapons. Specifically, the question of great relevance pertained to whether gun availability control strategies can effectively lessen the volume and seriousness of violent crimes.

1.1.1. Philip J. Cook's Framework

Among other scholars, Philip J. Cook provided a framework that tackles the effect of gun availability on three important dimensions that are part of the violent crime problem. The first point examines the distribution of various types of crime across different types of victims. The second element looks at the seriousness of crimes. The last dimension considers the overall incidences of each of these crimes.

Based on the fact that the core of this study lies on Cook's (1981) framework, it is necessary to consider a detailed account of each of the dimensions which are crucial to a better understanding of the relationship between guns and violence.

1.1.1.1. Dimension 1: Distribution – The Vulnerability Pattern

Guns are often viewed as the great equalizer. In fact, its value is particularly important for relatively weak perpetrators. Compared to other commonly used weapons, a gun increases the probability of success while allowing wrongdoers to attack relatively invulnerable – physically strong, armed, young – victims. In their study, Kellermann and Heron (1999) have found that women were shot 8.2 times less often than their male counterparts. For this reason, it is believed that successful programs designed to control gun ownership should result in a change in the distribution of violent crime among different types of victims (Cook, 1981, 1983). To illustrate this point, Cook presented evidence of the vulnerability pattern for criminal homicide and robbery.

Criminal Homicide

When it comes to kill, a firearm can be regarded as a weapon of choice that is easy and safe to use. Not only does it allow the killer to do so in a rather short lapse of time, it also allows the act of killing to be carried out in a less personal manner. The chances that the victim can effectively escape from the attack are also greatly reduced. What's more, firearms are such powerful weapons that even unskilled or otherwise weak assailants can benefit from these favorable factors. Considering these advantages, Cook (1981, 1983) argued that, as a murder weapon, a firearm has greatest value when it is used against invulnerable victims and the probability that a gun is used is significantly influenced by victims' vulnerability.

Additionally, guarded or armed individuals are the least vulnerable (Cook, 1981). In fact, he argues that "all presidential assassinations in U.S. history were committed with a handgun or rifle" (p.66). Presidents might not carry firearms per se, but they are certainly heavily guarded. Furthermore, data from Crime in the United States revealed that almost all law enforcement officer murders were committed with firearms; 91 of 93 murdered officers were shot by guns in 1978 (Cook, 1981).

Given that killings involving firearms are less time consuming, less energy demanding and require less strength and skills compared to killings involving other weapons, victim's physical size, gender and age pattern are also associated with one's perceived vulnerability (Cook, 1983). Along with this idea, it was found that, in 1978, only 51% of female homicide victims were shot, compared to 68.5% of male homicide victims (Statistical Abstract of the United States, 1978). Moreover, Cook theorized that guns enhance the power of attackers by granting them the ability to assault relatively invulnerable targets. In a later study, he finds further support for his theory. Specifically, he observes that guns are more frequently used in homicides in which the offenders is older and seemingly weaker and the victim younger and presumably stronger (Cook, 1982). Referring to findings from the FBI Supplementary Homicide Reports from 1976 to 1977 which have found that guns are used against roughly 70% of victims aged between 20-44 and that this proportion is significantly lower for younger and older victims, Cook (1981) categorizes the former age group (20-44) as rather invulnerable whereas the latter (under 20 and over 44) as more vulnerable.

Cook's (1981) vulnerability hypothesis understands the concept of vulnerability as a relative matter. Using FBI data from 1976 to 1977, he found evidence for the following: (1)

women are more likely to use lethal weapons to kill their partners than men; and, since physical strength is highly correlated with age, (2) the probability that a gun is used increases with the age of the killer, but is negatively correlated with the victim's age. In fact, it is found that, in spousal killings, only 78% of men used firearms or knives to attack their spouses, against 97% of women murderers (Cook, 1981). In short, three mechanisms can summarize Cook's (1981) vulnerability pattern on criminal homicide:

(1) The likelihood that homicidal attacks will fail is greater in cases where individuals go against stronger victims than weaker ones, and this probability of failure is even greater for attacks involving non-firearms weapons than those committed with firearms.

(2) The chances that an individual will act on a homicidal impulse are partly influenced by his/her perception of the probability of success.

(3) When a murder is planned, the potential killer will have the opportunity to equip him-/herself with an instrument deemed adequate for the task.

Robbery

Aside from stealing valuables, a robber's main objective is to prevent victim resistance and escape by means of force or threat of violence. In this perspective, a gun is highly valuable to efficiently gain the victim's compliance, or at least put him/her in a rather powerless state in several manners. First, such lethal weapon allows the wrongdoer to stay at a safe distance from his/her victim while threatening deadly damage. Second, the ability to

control several victims simultaneously is possible if the robber has a firearm (Cook, 1981; Matthews, 2002).

Notwithstanding whether a robbery committed with a firearm brings greater profit to the offender, Cook (1981) argues that having a gun allow a robber to attack less vulnerable targets such as commercial places where there are numerous customers or employees, and perhaps even armed guards. In contrast, an offender who cannot afford such a luxury will have to limit him-/herself to more vulnerable targets such as youngsters, elders, or otherwise physically weak or disabled individuals who are by themselves or who have very little chance to escape. In a previous study, Cook (1980) has found that commercial places were the targets of choice for 55% of gun carrying robbers, compared to 13% of robbers with other weapons. Also, he claimed that street robberies committed with a gun mostly targeted relatively invulnerable victims, while such robberies committed with other weapons were more likely to target females, children or elderly victims.[3]

Cook (1981) proposes two plausible explanations to gun robbery patterns, where the former suggests that the choice of weapon is determined by the task, and the latter implies that the task is influenced by the weapon that is already available. In the first case, robbers equip themselves according to their aspiration in order to increase their chance of success. In the second case, offenders who have access to firearms as well as having the habit of carrying them might be more attracted to lucrative targets than robbers who have other kinds of weapon, if they carry any. Hence, the relationship between the choice of a particular target and

[3] One could argue that guns provide an advantage to the offender, but it is premature to say that guns equalize anything. As it will be later argued, consideration of the concept of vulnerability and the great equalizer needs to take into account the victim(s), the offender(s) and the contextual factors.

the use of a firearm results from the distinction between what Conklin (1972) referred to as "professional" and "opportunistic" robbers. While the former aims for rewarding targets, the latter takes on rather insignificant robberies.

1.1.1.2. Dimension 2: Seriousness – The Objective Dangerousness Pattern

The central idea in the second dimension of Cook's (1981) framework focuses on the odds that a range of outcomes can result from any confrontation, where the consequence of the altercation – ranging from no injury to serious harm or even death – is greatly influenced by the lethality of the assailant's weapon. Although the use of a firearm to perpetrate a violent crime is far less common than the use of knives, bats, or even physical force, such deadly weapon considerably intensifies violence level, thereby increasing the probability of death. Providing evidence for the "objective dangerousness" pattern, Cook (1981) examined two types of crime: serious assault and robbery.

Serious Assault

Some authors argue that the fatality rate of criminal assault is closely linked to the type of weapon used (Kleck & McElrath, 1991; Zimring 1968, 1972), even in cases of family violence (Saltzman et al., 1992). Others who have examined patterns of violent crime observed that serious assaults where a firearm is used were more likely to result in the victim's death than serious assaults carried out using other weapons (Block, 1977; Cook, 1981). Specifically, Block (1977) has found that of all aggravated assaults involving guns, 14% resulted in the victim's death, compared to 4% with those involving knives (Cook, 1981).

When a wrongdoer is determined to kill his/her victim, he/she might want to equip him-/herself to maximize his/her chance of success. In that situation, a gun could be the ideal weapon. Still, it is quite unlikely that all attacks are intended to exterminate. Most often than not, it begins with a dispute between individuals which, after heated exchanges or even the influence of substance use such as alcohol and/or drugs, escalades into a serious, sometimes fatal, confrontation (Felson & Steadman, 1983). In these circumstances, the immediate availability of a firearm plays a critical role because a spontaneous attack with a firearm is much more likely to be fatal compared to a similar situation where a knife is used (Cook, 1981; Zimring, 1972). Hence, among other factors, the probability that a serious assault will result in the victim's death is largely influenced by the offender's intent and the type of weapon that is used. In fact, the odds that a violent crime results in the victim's death are greater when the perpetrator's intent is ambiguous.

Robbery

It is well documented that violence plays an instrumental role in robbery, in the sense that the use of a weapon serves the robber to coerce the victim(s) into compliance; actual violence is not necessary if the threat is sufficiently persuasive. Consequently, the use of force is closely linked to the type of weapon that is used in robbery, where injuries are relatively rare in gun robbery compared to cases of unarmed robbery or armed robbery involving other weapons (Conklin, 1972; Cook, 1976, 1981; Skogan, 1978).

That being said, there are evidence indicating that the instrumental role of violence can only justify a portion of all injuries and deaths that result from robbery (Cook, 1980; Cook &

Nagin, 1979). It seems then important to distinguish robberies belonging to the "instrumental violence" pattern from those associated with the "expressive violence" pattern.

In accordance with the idea that some crimes are premeditated whereas some others are committed when an opportunity presents itself, Felson (1993) distinguishes between dispute-related and predatory offenses, where the former are less likely to be planned than the latter given their spontaneous and context driven nature. For instance, homicide and assault usually stem from heated confrontations where both parties are angry, while crimes such as robbery and sexual assault typically require relatively stable long-term motivations (Felson & Massoglia, 2011). In this sense, robbers and sexual offenders may be more likely to choose their victims and search for low risk opportunities when they plan their crime (Birkbeck & Lafree, 1993).

1.1.1.3. Dimension 3: Incidence – The Substitution Pattern

Evidence in the preceding dimensions puts forward that the distribution and seriousness of violent crime are substantially influenced by the availability of firearms. To further solidify this argument, Cook (1980) claimed that a legal intervention which aims to control gun availability from potential criminals would most probably reduce incidents of violent crime involving firearms. However, as a result, incidents of violent crimes committed using other weapons could increase. Three arguments justify this prediction: (1) non-firearm weapons such as clubs and knives are not as effective as guns to fatally injure a victim, especially against a relatively invulnerable target; (2) Zimring's results (1972) demonstrate that reducing gun use in serious assaults will likely reduce the homicide rate; and (3) results obtained from Cook's study (1979) on murder rates in fifty American cities revealed that the

portion of robberies which involve the death of a victim is closely related to the portion of robberies involving guns.

In reference with the probability that other weapons would be used in substitution of guns to yield deadly attacks, findings provided by several authors (Cook, 1987; Kleck & McElrath, 1991; Zimring, 1968, 1972) have been discussed in previous sections. If this weapon substitution does occur, Cook (1980) predicts that restricting the availability of firearms might well reduce the criminal homicide rate, but might not be as effective to reduce the total number of violent crimes. Also, since the use of weapons other than guns does not offer a success rate as high as that granted by firearms, without the great equalizer, the distribution of violent crime is likely to shift from less to more vulnerable targets. Therefore, Cook (1980) stresses that an effective gun control law must take into consideration the possible outcomes resulting from weapon substitution.

1.2. Effect of Firearms on Criminal Violence: Empirical Evidence

This section will introduce an overview of the macroscopic research findings which looked at the correlation between firearm availability and crime rates. Then, this will be followed by the presentation of more comprehensive microscopic research findings which assessed the risk of death and/or risk of injury that is associated with the presence of a gun and the link between firearms and violent crime patterns.

1.2.1. Effect of Firearms Availability on Crime Rates: Macroscopic Research

Several international studies comparing the prevalence of firearms and the homicide rates of different countries have reached the conclusion that differences in the homicide rates

in two countries is attributable to the differences in firearm availability (Hemenway & Miller, 2000; Hoskin, 2001; Killias, 1993; MacDonald & Lerer, 1994; Sloan et al., 1988). For instance, in a study examining the United States and Britain, Clarke and Mayhew (1988) have found that while non-gun homicide rates in the U.S. was only 3.7 times greater than in Britain, the rate for handgun homicides was 175 times greater.

Other investigators looking at the same relationship between different regions and cities in the United States indicate that cities with low rates of gun-related crimes were the areas with the lowest gun ownership rates (Hepburn, Miller, Azrael & Hemenway, 2004; Kleck & Patterson, 1993; Lester, 1990; McDowall, 1991; Miller, Azrael & Hemenway, 2002a, 2002b; Newton & Zimring, 1969). Similarly, areas with low rates of gun ownership had the lowest rates of gun use in crimes. For example, Duggan (2001) suggests that increases in gun ownership lead to a substantial increase in the overall homicide rate. In fact, he found that a 10% increase in gun prevalence in one year increases a country's or a state's homicide rate the next year by about 2%. Such correlation is however insignificant on all other crime categories. Also, some researchers who conducted case-control studies in the United States find that the risk of death by homicide is two to three times greater when a gun is present in a home (Cummings et al., 1997; Kellermann et al., 1993).

In contrast, other researchers such as Kates and Mauser (2007) suggest that, in Europe, it is fairly uncommon that nations with high gun ownership rates have greater homicide rates than neighboring nations with lower gun ownership rate. For example, although Norway has one of the highest firearm ownership rates among Western Europe nations, it nevertheless has one of the lowest homicide rates. In fact, Norway's homicide rate (0.8 per 100 000) is 33%

lower than Holland (1.2 per 100 000), which has the lowest rate of gun ownership in Europe. Moreover, using both firearm ownership rate and homicide rate in 2001 for the United States, Canada and Mexico, Mauser (2007) argues that findings do not support the hypothesis of more guns, more crimes. For instance, while Mexico has the lowest gun ownership rate among the three North American countries under study, its homicide rate is more than twice that of the United States.

Overall, these findings show that there is relationship between firearm availability and violent crime rates, but its nature is still unclear. Consequently, these studies have been criticized on several grounds (Kleck, 1997; Moody & Marvell, 2005). First, most studies do not investigate the causality direction. One cannot determine whether guns cause violence or violence causes guns. (Kleck & Kovandzic, 2009; Moody & Marvell, 2005; Southwick, 1997). Second, some studies which concluded to a negative relationship between firearm prevalence and violent crime rates did not explore alternative explanations in order to facilitate one's understanding of the lack of correlation. For example, the substitution hypothesis may imply that nations with strict gun control policies might see a large proportion of their violent crimes committed with other types of weapon such as clubs, knives and axes to compensate for the inaccessibility to more lethal weapons like guns. Third, guns are mainly conceptualized as a facilitator to either commit violent crimes or to defend against assailants, but the structuring effect[4] is not investigated at the macroscopic level. In this regard, the type of victims, the

[4] The structuring effect of a firearm can be defined as the advantages conferred by a firearm, which allow its user to attack victim(s) or target(s) in given situations. As it will be developed later, this concept also implies that the firearm has an impact not only on the outcome of a crime, but also on the decision to act on criminal motives, a decision that is likely to be influenced by the victim's characteristics (physical strength, known member of a

relationship between parties and the contexts are not used to create aggregated violent crime rates (Reeves-Latour & Blais, 2014).

1.2.2. Effect of Firearms on the Risk of Homicide and Violent Death: Microscopic Research

Since results from ecological analyses cannot be generalized to the individual level, many scholars have favored case-control studies to investigate individual risk factors relative to a particular variable of interest. Several studies have used such designs in order to examine the relationship between guns kept in households and the risk of homicide and their findings concur that rather than conferring protection, the presence of a firearm in the home increases the risk of homicide and violent death by two to four times (Bailey et al., 1997; Campbell et al., 2003; Cummings et al., 1997; Dahlberg et al., 2004; Grassel et al., 2003; Kellermann et al., 1993; Miller, Azrael & Hemenway, 2002c; Wiebe, 2003a, 2003b; Wintermute et al., 1999), and members of the family are far more likely than intruders themselves to be killed (Kellermann & Reay, 1986; Kellermann et al., 1993). For instance, Kellermann et al. (1993) looked at cases of homicides which occurred in a victim's household in three American counties. Each case under study is paired with a control case according to subjects' gender, ethnic group, age group and neighborhood of residence. Essentially, after controlling for individuals living alone or in a rented residence, residents' illicit drug use, history of arrests or being part of a fight, they find that the presence of a gun in households is strongly associated with a risk of homicide that was 2.7 times greater than for control cases. Similarly, Azrael and

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criminal organization, for example) and other situational factors such as the presence of third parties likely to assist the victim or notify potential guardians.

Hemenway (2000) brought several interesting insights to the debate about gun use in households. They have observed hostile gun displays, a form of gun-related home events which have been rarely reported in the literature, and their findings suggest that such demonstrations against family members may occur more often than gun use in self-defense against intruders. Also, their results suggest that the majority of defensive gun uses takes place outside the home and house crimes are more commonly thwarted using weapons such as baseball bats and knives than firearms.[5]

The use of a firearm to commit robbery is quite a different story. As previously argued in Cook's (1981) framework, a robber's main goal is to prevent the victim(s) from resisting and escaping. The threat of violence is effective to coerce the victims into compliance and the use of a highly lethal weapon like a gun makes the threat even more promising. In this perspective, actual violence is not mandatory to successfully commit a robbery if the threat is persuasive enough. The risk of injury is therefore closely linked to the type of weapon that is used: the use of a less threatening weapon might result in more demonstrations of violent behavior, thus causing more injury to the victim, whereas the use of a deadly weapon can render the victim powerless and as such the risk of injury is largely reduced (Conklin, 1972; Cook, 1979, 1981; Skogan, 1978). For instance, Cook (1987) found that the rates of death for robberies committed with guns is three times the rates of robberies committed with knives, and ten times the rates of robberies carried out with other weapons. Yet, other studies have provided findings indicating that violence might not be purely instrumental to robberies. For example, Cook (1980) provides findings showing that in non-commercial robberies involving

[5] Kleck (1998) has reached similar results.

guns, over two thirds of the injured victims did not offer resistance at all. He also found that in gun robberies committed in Dade County between 1974 and 1976, roughly two thirds of the victims died even though they did not fight back. Moreover, victims are more likely to be injured in a gun robbery involving more than three offenders, which disagrees with the concept that violence only serves an instrumental role, given that victims are less inclined to resist against multiple offenders. Lastly, Cook and Nagin (1979) examined re-arrest statistics in a large group of incarcerated adult robbers in Washington D.C. and they find that those who injure their victims tend to be more prone to violence. Further research is required to understand the different mechanisms behind robberies for which violence only plays an instrumental role and robberies for which patterns of excess violence have been observed.

1.2.3. Guns and Violent Crime Patterns

Although rarely did a study focus on the relationship between guns and violent crime patterns as depicted by Cook's (1981) framework, several studies investigated on firearms, homicides and robberies and provided evidence supporting Cook's (1981) hypotheses. Regarding the vulnerability pattern which claims that the use of a gun allows wrongdoers to attack relatively invulnerable victims whom they otherwise would not consider as a target, some authors have found that compared to females, males are more likely to be killed by firearms (Sampson & Lauritsen, 1994). Data from the FBI also reveal that, assuming that both the murderer and the victim were males, a small portion of killings are committed by youthful (18-39) killers against elderly (60+) victims, while a large fraction of murders involve elderly killers attacking youthful victims (Cook, 1981). Moreover, the National Center for Injury Prevention and Control found that in 1996, nearly 90% of all victims of unintentional

shootings in the United States were males. The proportion of these victims under the age of 20 is about 33% and roughly 60% of them are under the age of 30 (Annest et al., 1996). Cook and Ludwig (2000) have also found that from 1985 to 1993, victims of gun violence were mainly young Hispanic and African American males. As a matter of fact, the homicide victimization rate for black males noticeably increased during this period: threefold for those aged 13-17 and twofold for those aged 18-24.

In cases of robbery, some authors have found that, in commercial robberies where only one employee was present, a gun was used less often than in the cases where two or more employees were present (Skogan, 1978). Furthermore, McDermott (1979) presented evidence to support that robberies involving a firearm granted greater gains, whether in terms of money or value of stolen objects. For instance, by comparing commercial robbery success rates using different types of weapon, he found that success rates drop considerably as the lethality of the weapon decreases (94% for guns; 65% for knives; 48% for other weapons), and a similar pattern is observed in cases of rape. However, findings from Creedon's study (1992) claim the following: "Two points emerge from […]. The first is that there is no direct relation between the size, the calibre lethality of the weapon and the target chosen. Secondly, there is no discernible relation between the weapon selected and the amount stolen" (Matthews, 2002: 73).

Other scholars have provided evidence both supporting and disagreeing with Cook's hypothesis which maintains that a gun allows criminals to attack more valuable targets. Some have found that most offenders commit robberies on impulse and most often than not they had little idea of the type of victim they were likely to confront (Matthews, 2002; Wright &

Decker, 1997). In spite of that, some robbers claim that their choice of targets laid on easily observable cues which indicate whether a particular individual seems to have ready cash and whether he/she gives the impression that he/she will hand over their money without resistance (Wright & Decker, 1997). Other evidence indicates a preference for female victims among some robbers, especially for robbers who work alone, because they are expected to be less likely to disobey (Matthews, 2002; Zimring & Zeuhl, 1986). Yet again, Matthews (2002) has found other accounts stating that, even for robbers who were readily prepared to use violence in the course of the robbery if they deemed necessary, some would go to considerable length to avoid harming undeserving victims such as children, elderly people, and women.

In keeping with the idea that a firearm is mainly used to display promising threat, there are accounts of robbers who carry unloaded or replica guns for fear that they might injure their victim(s), and when they are faced with refusal or non-cooperation, they retreated (Conklin, 1972; Morrison & O'Donnell, 1994; Wright & Decker, 1997). Although the lethal nature of a gun can establish real threat, some robbers opt for other methods to demonstrate their strength and determination. For example, Matthews (2002) found that while some robbers appreciate the fear they impose on their victims by smashing windows with clubs and axes to gain compliance, others preferred knives because they are easily concealed, make little noise and can nonetheless instil considerable fear.

Concisely, most of the available studies suggest that the presence of guns in households increases the risk of homicide and violent death (Bailey et al., 1997; Campbell et al., 2003; Cummings et al., 1997; Dahlberg et al., 2004; Grassel et al., 2003; Kellermann et al., 1993; Miller, Azrael & Hemenway, 2002c; Wiebe, 2003a, 2003b; Wintermute et al., 1999),

which is further enhanced by unsafe firearm storage (Grossman et al., 2005). Gun-related homicides and violent deaths are also much more frequent than episodes of defensive gun use. Although evidence from various studies seem to reveal certain patterns regarding individuals' inclination of gun use, very few studies have investigated the structuring effect of guns on crime as depicted by Cook's (1981) framework. For various reasons, analytical strategies employed by previous studies are not adapted to evaluate Cook's (1981) three-dimension framework.

First, most of the existing studies are descriptive in nature, which precludes researchers to draw any firm conclusions on the relationship between gun use and violent crime patterns (See, for instance, Kellermann & Heron, 1999; Matthews 2002; Statistical Abstract of the United States, 1978). For example, data from the National Center for Injury Prevention and Control have indicated that there are more male victims who are unintentionally shot to death than their female counterparts (Annest et al., 1996). Yet, the implications behind statistics as such are not further investigated. For instance, characteristics pertaining to the different parties involved and the settings in which the incidents took place might be incomplete. Hence, a case in which a child is accidentally shot by his/her sibling who was playing with a gun that has been stored in an unsafe manner would make no statistical difference than that of a hunting accident.

Second, few or no studies have investigated the structuring effect of guns on crime. Despite its importance in Cook's framework, existing studies have not explored victims' and offenders' characteristics when examining assailants' decision to use a gun. There are basic confounding variables such as individuals' gender, ethnic group, age and social economic

status which are systematically controlled in most studies in order to achieve an experimental group and a control group which are as balanced as possible. However, these variables might require deeper conceptualization in relation to the theoretical findings. For instance, it is impossible to know whether guns are used against stronger, thus relatively invulnerable, victims in comparison to violent crimes not involving a firearm. Findings also omit to specify certain aspects such as whether any of the parties are involved in criminal groups or whether wrongdoers who equip themselves with guns are more likely to have to face multiple opponents/targets, which are nevertheless crucial factors to consider. Hence, to explore the benefits that a firearm confers to its user(s), both offenders' and victims' characteristics must be conceptualized accordingly in order to single out the concept of vulnerability.

Consider the study of Kellermann et al. (1993) on the presence of guns in households as a risk factor for homicide. Although the authors have paired their cases on several variables – victims' neighborhood, gender, ethnic group and age range – and later on controlled other variables that also pertain to the victims, information on the offenders was unavailable. Moreover, the inclusion of other variables than those that have been considered in their study – circumstances of the homicides, relationship between the offender(s) and the victim(s), method of homicide, victim's resistance, etc. – could have benefitted the matching by increasing the similarity between paired subjects. Not to discredit the authors' work, the incorporation of variables regarding the assailants and the circumstances under which the event took place can bring a whole new perspective to the study of gun ownership as a risk factor for household homicides. For example, the presence of a gun in the home might only increase the risk of homicide for couples when, compared to the victim, the assailant is younger and less educated.

Lastly, studying the structuring effect of guns on violent crime also raises the issue of group balance. Both experimental and control groups must be balanced with relevance to theoretical and empirical variables. For example, if members of criminal groups are more likely to use guns to commit homicide, one could claim that they are also more inclined to violence and the weapon effect will become debatable. Although multivariate statistical tests control for potential confounders, they do not necessarily verify for group balance. If one important confounder is more likely to be found in the experimental group, it becomes impossible to isolate the effect of gun on violent crime and death (Apel & Sweeten, 2010).

1.3. Problem Statement

As the debate goes on, most research on the topic usually looked at the relationship between gun availability and violent crimes (Clarke & Mayhew, 1988; Cook, 1981, 1982, 1983, 1991; Cook et al., 2009; Cook & Lugwig, 2006; Duggan, 2001; Henemway & Miller, 2000; Hoskin, 2001; Killias, 1993; Kleck & McElrath, 1991; MacDonald & Lerer, 1994; Sloan et al., 1988; Zimring, 1968, 1972) or gun ownership as a risk factor for household homicide (Cummings et al., 1997; Dahlberg et al., 2004; Kellermann et al., 1992, 1993; Miller, Azrael & Hemenway, 2002c; Wiebe, 2003a, 2003b). Very few studies, to date, have focused on advantages conferred by firearms and its structural effect on criminal violence.

As abovementioned, Cook (1981) is one of the few scholars to have formulated a framework which specifically examines possible positive aspects a firearm provides to its user(s) given various circumstances and characteristics of different parties considered. Hence, as a contribution to the ongoing debate as well as to extend Cook's reflection, the objectives and the choice of variables for the current study are founded on Cook's (1981) framework

with a view to improve the understanding regarding the effect of firearms on violent crime patterns. Specifically, this study will attempt to find support for Cook's (1981) framework using a multivariate analysis that isolate the weapon's effect. Considering that, unlike for other violent crimes under study, violence may play an instrumental role in robbery, the use of a gun might not affect the outcome in the same manner. Hence, separate analyses are considered for this type of crime. In other words, robbery is included both in analyses on violent crimes altogether and on its own.

This study also differs from previous studies as it attempts to shed further light on the association between firearm availability and violent crimes because an innovative statistical strategy is incorporated in order to be able to draw robust conclusions. Propensity score matching (PSM) has been traditionally used in natural science research where pure experimental settings are achievable. The adoption of this technique in different social science fields, which usually rely on observational studies, allows researchers to approximate a highly-controlled experimental setting in addition to estimating the effect of a treatment of interest (Rosenbaum & Rubin, 1985). In this study, PSM allows researchers to come close to causal conclusions regarding the relationship between the use of a firearm and the risk of death and injury, while isolating possible confounding effects of a gun.

Thus, the current study has three specific objectives: 1) Identify different factors that predict the use of a gun to commit a violent crime; 2) estimate the effect of firearm use on the probability of fatal injuries; and 3) estimate the effect of firearms use on the risk of non-fatal injuries. The first objective not only gives an overview of various factors associated with firearm use, but also allows the calculation of the propensity score. This score will then serve

in the following steps of the analysis. With balanced groups, the second and third objectives pinpoint the relative effects of firearms on the odds of fatal and non-fatal injuries, respectively. Overall, these objectives determine, on one hand, whether individual and situational characteristics affect gun use in the process leading to crime and, on the other hand, once groups are balanced, whether firearms affect the level of injuries inflicted to a party.

CHAPTER 2:

METHODS

This chapter is divided into three sections. The first section describes the data used in this study. The second section presents the main variable of interest (firearm use), the two outcome variables as well as different covariates that are included in the analyses. Finally, the third section explains the reasons for which propensity score matching (PSM) is selected to estimate the effect of firearms.

2.1 Data Sources

Data used in this study was extracted from the *Module d'information policière* (MIP) which is managed by the *Centre de renseignements policiers du Québec* (CRPQ). Although it is regulated by the *Sûreté du Québec* (SQ), the MIP is available to other police organisations. This system contains a computerized version of all recorded offences committed in the province of Québec which are codified according to the Uniform Crime Reporting (UCR) Survey. Due to the fact that one of the outcome variables, namely the seriousness of the victims' injury, was not previously recorded, only crimes that were committed in Montreal during 2011 and 2012 were analysed.

Data from the MIP is presented in two databases: one contains information about the incidents (nature of the offence, police officers who were in charge, date and actual address where it took place, type of weapon used, etc.) where each entry represents one incident with a corresponding file number, and another which stores information about the people who are involved in those incidents (status, name, gender, ethnic group, age, physical traits, address, etc.) where each entry represents one individual, identified by the same file number.

To facilitate analyses, two databases were first created by merging the two existing databases: one which includes all incidents that took place on the territory of Montreal

between 2011 and 2012, and another one which includes the individuals involved in those incidents. Then, since this study is interested in the influence of firearms on violent crime patterns, both incidents and individuals databases were combined so that each entry of the final database represents one victim, with corresponding information on the incident and the perpetrator(s). In fact, such arrangement corresponds to the method the UCR requests police organizations to record their data: each victim of violent crime is recorded as one case, even if more than one victim was involved in the same event.

In the final database, variables which are not relevant for this study were removed while new ones were created. Crimes that do not involve a person were also removed from the databases. Specifically, to apply Cook's (1981, 1983) hypotheses to this study, only four types of crimes remained: homicide, attempted murder, assault and robbery. Finally, for the benefit of further analyses, the last manipulation consists in removing all entries with missing values on any one of the variables. Thus, the total number of entries dropped from 30,559 to 23,002. Given that the focus of this study lies on the effect of firearms, this final sample includes all cases regardless of the type of weapon used.

2.2. Variables under Study

2.2.1. Dependent Variables

According to Cook (1983), the use of a firearm is so effective in forcing victims into compliance that, the victims are rarely injured. On the other hand, considering the lethality of a gun, using it will more likely result in the victims' death. Hence, to address the objectives of this study, two dependent variables were created: the first measures whether the victim is injured, and the second measures whether the incident resulted in the victim's death.

Non-Fatal Injury

In the database, injuries are codified with a five-point Likert scale (1 = no injury; 2 = minimal; 3 = minor injuries; 4 = severe injuries; and 5 = fatal injuries). When there is no injury reported at the time of the event, victims are considered to be not injured. When the authorities cannot determine the seriousness of victims' injury, for example, when the victim experiences neck pain after a car accident and there is no visible physical injury, the victim's level of injury is said to be "minimal". "Minor injuries" refer to physical injuries such as scratches, bruises and wounds which do not require any medical treatment or which require only first aid care. "Severe injuries" apply to situations in which victims' physical injuries require on-site medical care or transportation to a hospital. For instance, such injuries might include fractures, second-degree burns, mutilations, etc. Since the distribution of this variable was bimodal, it was transformed into a dichotomous variable. Cases involving no injury or no apparent injury (minimal) were codified as 0 (no injury) and all other cases were given the value of 1 (presence of apparent injury). Overall, 51.7% (N = 11,829) of the victims had no apparent injury and 48.3% (N = 11,049) of all victims sustained either visible or fatal injuries.

Fatal Injury

Next, a dichotomous variable was created to indicate the fatality of the incident, where a value of 1 was attributed to cases where the victim had died.[6] In this sample, 0.2% (N = 44) of the victims were fatally injured.

[6] In the cases where the victim did not die at the scene but later due to the injuries, the codification of the severity of his/her injury is modified in consequence by the officer in charge.

2.2.2. Variable of Interest

Use of a Firearm

Given that the main purpose of the current study is to pinpoint the influence of firearms on crime patterns, the variable of interest is the use of a firearm to commit violent crimes against a person. A dichotomous variable was created where a value of 1 was attributed to crimes committed – whether a gunshot has been fired or not – using any type of firearms (automatic firearm, rifle, shotgun, handgun or other firearms) and a value of 0 was assigned to offences carried out with other methods (bladed weapons, poison, fire, drug, explosive material, threats, physical force, etc.). For the purpose of this study, only homicides, attempted murders, assaults and robberies are examined and, combined together, 5.7% (N = 1,320) of the victims were involved in a firearm-related crime.

2.2.3. Covariates

To isolate the relative impact of firearms on crime patterns, several variables were selected in reference to Cook's (1981, 1983) framework. In total, 18 variables were used as controls.

Multiple Offenders/Victims

According to Cook's framework, a firearm can be considered as the great equalizer, which increases the chances that a perpetrator will succeed his/her crime against a rather invulnerable target (Cook, 1981). With a gun, a single offender is more likely to take on multiple victims. Alternatively, in the absence of such a deadly weapon, the offender is likely to need help from other individuals to act against several victims. To account for these

propositions, two variables were created, one for the assailants and one for the victims. In both cases, a value of 1 was assigned to cases in which there were two or more assailants or victims involved in a violent crime, whereas a value of 0 was given to violent crimes involving only one assailant or one victim. In this sample, 20.2% (N = 4,656) of cases involve two or more offenders and 21.7% (N = 4,983) of the crimes were perpetrated against more than one victim.

Age

As previously discussed, Cook (1981) claims that youthful and physically fit individuals are more likely to be killed by a gun than those who are older or less in shape, and elderly individuals are more likely to use a gun to kill than younger people. Using data from FBI's Uniform Crime Reports (1978), Cook (1983) defined youthful and rather invulnerable individuals as being between the ages of 20 to 44. When there were multiple assailants, the average of involved individuals' age was calculated. From 2011 to 2012, 53.1% (N = 12,212) of the assailants were from this age group, while 58.7% (N = 13,500) of the victims were from the same age group.

Gender

In reference to Cook's (1981) vulnerability pattern, one's physical size and strength are two important components in assessing vulnerability. Hence, smaller and weaker individuals are viewed as more vulnerable compared to their bigger and stronger counterparts. In fact, women are generally regarded as being more vulnerable than men. To account for victims' gender, a value of 1 was assigned to cases in which the victim was a male. Provided that each victim could be attacked by a single or multiple offenders, the codification of certain variables would differ depending on the number of assailants involved in a given crime. For instance,

two variables were created for offenders' gender. For the "female" category, a value of 1 was assigned to cases in which the offender was a female, as well as cases in which a victim was attacked by a group of assailants made up predominately of females. The variable "equal gender" was codified 1 when the victim was attacked by a group of offenders consisting of the same number of male and female. In this sample, 39.6% (N = 9,118) of the victims were males, 13.9% (N = 3,189) of the assailants were females, or in predominantly female groups, and 1.7% (N = 382) were in groups composed of the same number of individuals from both genders.

Ethnicity

Although ethnicity is not addressed in Cook's (1981) framework, authors have identified a relationship between ethnicity and one's access to firearms. For instance, Spraggins' study (1999) contrasted the socialization patterns between white men and African American men. In general, it was found that white men were more likely to have learned to use guns form their father, as opposed to African Americans who had been introduced to guns by other men. For both groups, firearms were acquired at an early age and African American boys as young as pre-teens could regularly acquire firearms on the street from peers or older young men. Moreover, a study on black victims subject to violent crimes revealed that in about 77% of homicides against blacks, the victim has been killed by a firearm, compared to 60% of white homicide victims (Harrell, 2007).

Thus, to account for an individual's ethnicity, two variables were created for both assailants and victims: "black" and "others", where the last group consists of South Asians, Orientals, Native/Indigenous people, Latin Americans and other ethnic groups. For this

covariate, "white" is selected as the reference category. A value of 1 is attributed to each ethnic group variables when an individual of that ethnic group has been identified, whether he/she was alone or with others. During the two year period of 2011 and 2012, 26.5% (N = 6,085) of the victims were involved in violent crimes committed by either one black assailant or a group of offenders made up of at least one black individual, while another 22.8% (N = 5,253) of the victims were subjected to violent crimes perpetrated by a single aggressor or a group of multiple assailants where at least one individual was from another ethnic group. On the other hand, 14.3% (N = 3,298) of individuals victimized were black, while 22.4% (N = 5,151) were from other ethnic groups.

Substance and/or Alcohol Use

Cook's (1981) framework did not deal with an individual's level of intoxication, but the relationship between drug use and violence has been well documented in the literature. To describe such correlation, Goldstein (1985) proposed a tripartite conceptual framework. According to the psychopharmacological model, some individuals may become irritable, excitable and even exhibit violent behavior after using substances such as alcohol and drugs. The economic compulsive model provides another explanation, which suggests that some drug users' primary motivation to commit violent crimes is to support their drug use. Finally, the systemic model suggests that violence is an intrinsic aspect of one's involvement in drugs. While there is clear evidence that the strongest relationship between violence and substance use occurs with alcohol, Cohen and Swift (1993) claim that the strongest relationship between violence and drugs seems to stem from their illegal status rather than their

psychopharmacological effect. In spite of this debate, there is clear evidence that substance use and violence are somehow linked together.

A dichotomous variable was created to identify offenders who might have been under the influence of alcohol and/or drugs. A value of 1 was assigned to cases in which assailants were identified to show signs of intoxication at the time the crime was perpetrated and, in cases of multiple assailants, whenever one of the offenders was suspected to be intoxicated at the time of the crime. Unfortunately, the database did not provide information with regard to victims' substance and/or alcohol use at the time of the crime. From 2011 to 2012, 16.5% (N = 3,794) of those responsible for the violent crimes committed in Montreal were believed to be under the influence of alcohol and/or drugs at the time of the crime.

Relationship between Victim(s) and Offender(s)

While the victim-offender relationship is not central to Cook's (1981) framework, this concept has been viewed as an important variable to provide a better understanding of personal violence because it focuses the incident within the context of social structures (Loftin et al., 1987). As a matter of fact, these authors argue that "roles such as husband, wife, friend, lover, and stranger are complex social relationships which may delineate homicides that share a distinctive etiology" (p. 259). In a study where they re-examined Lott and Mustard's (1997) work on the effect of right-to-carry laws on violent crime rates, Olson & Maltz (2001) have found that almost two-thirds of victims of gun homicides knew their killer, about 20% of the offenders were categorized as strangers and the remaining proportion was said to be unknown or unreported.

Hence, to account for the effect of each victim's relationship with his/her assailant(s) on the probability that a gun is used, four dummy variables (k-1) were created: "spouses or intimate partners" (current or previous spouses and intimate partners as well as other intimate relationships); "family members" (parents, children, siblings, step-siblings, grandparents, cousins, uncles, etc.); "acquaintances" (friends, any form of criminal or business relationships, neighbors, acquaintances and authority figures); and "strangers" was attributed to cases where the offender(s) is not known to the victim. In the present study, "undetermined" relationships involving cases where the victim failed to see his/her assailant(s) were selected as the reference category. In the cases where several offenders have attacked a victim, he/she might not know all his/her assailants with the same level of intimacy. To deal with this difficulty, the closest relationship between the victim and one of the offenders was considered. In this sample, 28.2% (N = 6,485) of all victims were attacked by their spouses or intimate partners, 7.3% (N = 1,681) were harmed by their family members, 19.1% (N = 4,396) were abused by their acquaintances and finally, 38% (N = 8,746) were attacked by strangers.

Association with Organized Crime and Street Gang

Forasmuch as the strong association between illicit trafficking of firearms and criminal groups (Cook et al., 2009; Gastrow, 2001; Shaw & Gastrow, 2001; Spapens, 2007), it is assumed that these criminals have an easier access to firearms than individuals from non-criminal groups. "Criminal contacts are pre-eminent in determining the ease with which illegal firearms can be obtained; the better connected someone is, both in terms of numbers and seniority of contacts, the easier it is to get hold of a gun" (Hales et al., 2006: 44), and so for

cheaper prices and even when the overall supply is very low. The same authors also claimed that:

> In the context of a criminal culture in which conflict and firearms are to some extent normalized, conflict can quickly develop into what is effectively a "shoot or be shot" scenario and even very trivial precipitating incidents may result in fatal violence. This scenario is particularly likely if either party to a dispute knows or believes the other to have access to a firearm, the probability of which is increased with gang membership because of the circulation and sharing of firearms within such groups. (Hales et al., 2006: 83)

In 2007, Canadian police forces reported 117 homicides as being gang-related, accounting for roughly 20% of the national homicide rates and 43% of firearm homicides. In fact, a firearm was used in 69% of gang-related homicides, whereas only about 20% of non-gang-related homicides involved the use of a gun (Li, 2008).

In contrast, some argue that gang members do not necessarily have a greater access to firearms, which are controlled by gang leaders to avoid conflicts (Cook et al., 2007):

> In practice access to guns within the gang is regulated, with most transactions in the form of loans or rentals with strings attached. The general rule is that members can only own guns if authorized by gang leaders. […] Sometimes gang leaders actually enlist the police as agents in controlling gun use by notifying the police about unauthorized gun possessions […]. (Cook et al., 2007: 24)

Despite opposing views, it is important to consider such variable in the analyses in order to isolate the impact of firearms on violent crime patterns; in other words, the goal is to determine whether the use of a firearm is accountable for a given crime pattern or it is the fact that an individual is associated with criminal groups that explains the outcome of a crime. To

verify this relationship, one dummy variable was created to identify cases believed or known to be associated with organized crime and/or street gangs. Specifically, the status of being associated with criminal groups is identified for the event itself. For instance, a crime that is committed by a gang member does not necessarily have anything to do with the gang's activity; it might just be an offence committed by that individual outside his/her role as a gang member. Similarly, the victimization of a gang member does not automatically mean that rival gang members are at fault. Alternatively, a crime can be believed to be associated with organized crime and/or street gang without all the individuals involved in said crime to be known or suspected members of criminal groups. In Montreal, street gang and/or organized crime are believed to be responsible for 2% (N = 456) of the violent crimes committed during the 2011-2012 period.

Place of the Crime

Another concept that was not addressed in Cook's (1981) framework but which is deemed to be relevant in the study of criminal violence is the context or places where crimes occur (Birkbeck & Lafree, 1993; Cornish, 1994; Felson & Clarke, 1998). According to Clarke (1997), opportunity plays a crucial role in crime and controlling for these opportunities can, to a certain extent, prevent a crime from occurring. For instance, a crime is unlikely to occur in a setting where favorable conditions are lacking, even for the most motivated criminal. In the criminal opportunity structure, three central components which vary according to specific settings are identified: targets (car, bank, ATM machines, etc.), victims (women alone, drunken individuals, etc.), and crime facilitators (guns, alcohol, drugs, etc.). In complementary to Clarke's classification of opportunity reduction techniques, Wortley (2001) argued that

there are factors he referred to as situational precipitators of crime which may push individuals to commit crimes that they would not have considered in other circumstances. For example, Homel and Clark (1994) have found that factors such as aggressive behavior of security staff, lack of seating and unavailability of food are associated with nightclub violence level.

Consequently, considering that the location where crimes take place can influence the weapon preference or the eventual consequence of criminal acts, a dummy variable was created and given the value of 1 for crimes committed in public places. "Public" places included all commerce (offices, bars, stores, restaurants, etc.), public institutions (hospitals, universities, shopping malls, movie theaters, etc.), financial institutions (banks, ATM machines, etc.), public transportations (buses, metro stations, etc.), and other public places (airports, constructions sites, parks, alleys, tunnels, highways, parking lots, public markets, etc.). "Private" placed included camp, cottage, cabin, hotel, motel, house, apartment, etc. During the 2011-2012 period, 59% (N = 13,564) of the victims of violent crimes committed in Montreal were attacked in public.

2.3. Analytical Strategy

For the purpose of this study, a two-step strategy was used. First, binominal logistic regression analyses were conducted to determine whether the presence of a firearm influences crime patterns. Regression analyses are widely used to estimate the relationship between variables and to predict a specific outcome given a set of independent variables (Tabachnick & Fidell, 2001). However, such observational studies do not allow researchers to infer causal relationships between the variable of interest and the outcome variable. This limitation is frequently encountered by social scientists, whose research is conducted in fields where a

pure, highly controlled experimental setting is quite unlikely due to ethical and practical reasons. Furthermore, non-experimental data that is mostly used in social research bears a selection problem: "a situation in which individuals are free to exercise some degree of discretion or choice with regard to the event(s) that they experience" (Apel & Sweeten, 2010: 543). To mitigate the absence of randomization, researchers attempt to create a situation in which the conditions approximate those of a controlled experiment in a manner that the individuals' chances of receiving the treatment are virtually arbitrary.

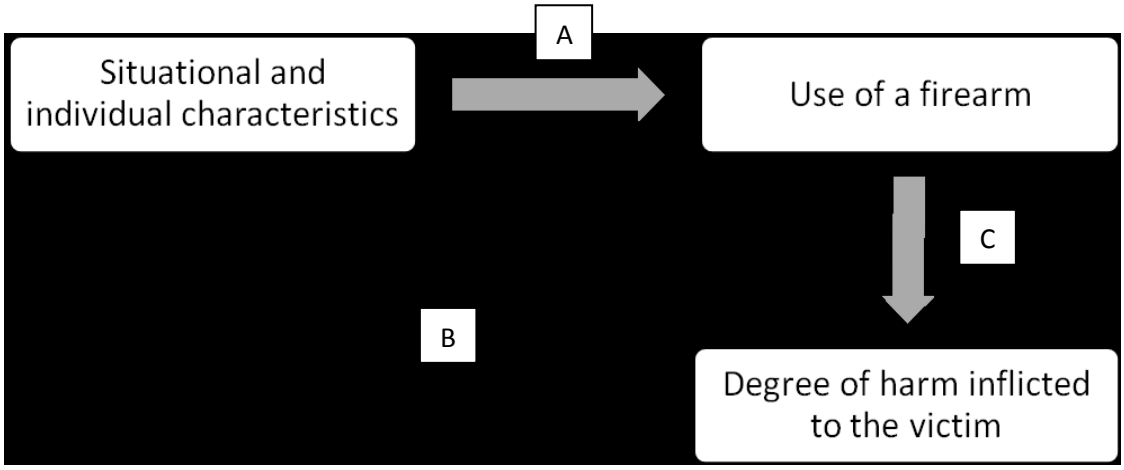
2.3.1. Propensity Score Matching

Several quasi-experimental techniques can be found in the literature, but for this study, we are interested in a particular technique that is known as matching, which is often used in situation where the treatment is not randomly assigned. This procedure consists of finding one or more non-treated unit(s) for every treated unit, based on the similarity of observable characteristics. By matching treated subjects and similar non-treated subjects, researchers are able to estimate the effect of the treatment without the undesirable confounding biases.[7] As shown in Figure 1, matching allows the elimination of the influence of confounding variables, such as assailant's or victim's age, gender and ethnic group, on the variable of interest, which is the likelihood that a gun is used to commit a crime (A), and the outcome variables, namely the victim's death and the victim's injury (B). Consequently, any variation of the outcome variable can be attributed to the effect of the variable of interest (C). In other words, whether

[7] Unfortunately, unknown causes as well as variables which are not included in the model are not controlled for. Hence, although PSM procures several advantages, it is nonetheless a quasi-experimental design (Shadish et al., 2002).

the victim dies is "directly" determined by whether the assailant has used a gun to commit his/her crime.

Figure 1: Expected Relationships between Situational and Individual Characteristics, the Use of a Firearm and the Degree of Harm



Hence, the second stage of the analyses requires some fine-tuning to strengthen the results of this study by removing unwanted effects from other independent variables. The use of a technique called propensity score matching (PSM) (Rosenbaum & Rubin, 1983) is favored for the purpose of this study. Among different existing matching methods, it "has the advantage of allowing researchers to match treated and comparison individuals in a very large number of measured characteristics" (Apel & Sweeten, 2010: 544). Although the traditional regression strategy does control covariates to estimate the effect of the variable of interest, it does so by assuming a linear function to predict treatment effects (Montgomery et al., 2012). On the other hand, PSM controls for the influence of potential confounding covariates by assuring that individuals from the control group share the same characteristics as individuals in the treatment group (Shadish et al., 2002).

Despite the advantages of PSM over regression, it has its own limitations. For instance, its construct validity is questionable when variables are not well measured, especially when variables are scarce, which leads to undermatching (Shadish et al., 2002). As mentioned earlier, all entries with missing values on any one of the variables are removed from matching, which in turn will greatly reduce the number of entries that can potentially be matched. As a consequence, PSM can yield poor results since matching is only possible on a small proportion of individuals. For this study, 18 covariates are included in the PSM model in order to estimate the effect of the use of a firearm on crime patterns. The selection of variables was, for the most part, directed according to Cook's (1981) framework. Other variables related to the use of firearms were also included to complete the model. Of course, there are other variables that could have been included. For instance, Wintemute et al. (2005) have found that the risk of committing violent and firearm-related crimes is higher for handgun buyers with criminal records. Similarly, Lott (2000) has indicated that in 1988, over 89% of adult murderers in the United States had criminal records as adults. However, data as such was not recorded in the MIP and thus was not used in the current study.

2.3.1.1. Estimation of the Propensity Score

In practice, PSM is executed through several steps (Apel & Sweeten, 2010). First, a propensity score is calculated for each individual. By calculating the propensity score, the influence of covariates on the variable of interest is nullified. In this case, the propensity score represents the likelihood that a firearm is used based on characteristics of different covariates that are selected. Individuals are then divided into two groups: the treatment group, in which a firearm has been used, and the control group, in which no firearm has been used. Although the

term “treatment” is traditionally applied to statistical analyses conducted in the medical field, its use has now spread to other fields of social science.

2.3.1.2. Evaluation of Covariate Balance

With the objective of approximating random assignation, the second step is to demonstrate balance on covariates for both groups. Propensity scores and covariates have to be very similar – balanced – between treated and untreated cases if researchers are to make treatment appears random. Different ways are used to assess balance, such as the use of independent samples *t*-tests (Dehejia & Wahba, 2002) and the estimation of the standardized bias (SB) (Rosenbaum & Rubin, 1985), a concept similar to the common measure of effect size, Cohen’s *d* (Cohen, 1988). As a rule of thumb, SB is judged to be large if its absolute value is greater than or equals to 20 (Cohen, 1988; Rosenbaum & Rubin, 1985). To assess balance, SB has to be computed both before and after matching (unadjusted SB and adjusted SB, respectively). If covariate balance is reached, adjusted SB should be greatly attenuated compared to the unadjusted SB. With balanced groups, the effect of firearm use on the risk of death or risk of injury can be isolated.

2.3.1.3. Estimation of the Average Treatment Effect (ATE)

Finally, once cases are matched, the average treatment effect (ATE) is measured to quantify the effect of the variable of interest on the outcome variable. It is important to note that the estimation of the ATE is independent of the nature of the treatment, as long as the treatment is applied to a portion of the sample while the remaining individuals do not receive it. With reference to Rubin’s (2005) potential outcomes framework of causal effects, each subject can be exposed, or not, to a treatment which results in either one of two potential

outcomes: an observable treatment effect or an absence of treatment effect. However, a given subject cannot be exposed to the treatment and the absence of it at the same time (Holland, 1986). Hence, in order to estimate the treatment effect, researchers must take the average outcome of both treatment and control groups, in which subjects are randomly assigned to either group so that both groups have virtually the same characteristics. The difference of these two average outcomes is the ATE. Estimations of ATE are expressed in points, where a positive ATE represents a positive effect.

For the purpose of demonstrating the advantage of using such a method to estimate the ATE of firearms in crime perpetration, standard regressions and different methods of matching were executed in the aim of identifying the most accurate one for each of the analyses: (1) the effect of firearms used to carry out all four types of crime (homicide, attempted murder, assault and robbery) on victims' death (N = 23,002); (2) the effect of firearms used to commit all four types of crime on victims' injury (N = 23,002); and finally, (3) the effect of firearms used in robberies on victims' injury (N = 5,860).

Several matching strategies were used to find the best model and to see whether results are sensitive to these models. If the latter occurs, it means that the distribution of the propensity scores necessitate further investigations to determine the best matching technique. The choice of PSM techniques that are used in this study is inspired by Apel and Sweeten's (2010) work. The first form of matching involved matching *n* untreated units – where a gun was not used – to a particular treated unit with the closest propensity score through single or multiple nearest neighbor(s) matching. To increase accuracy, the notion of "caliper" was introduced to nearest neighbor(s) matching models. The specified caliper determines the

maximum distance or tolerance within which untreated cases are chosen. In this case, several calipers were used (none; 0.01; 0.001; and 0.0001). One important implication of this concept is that if no untreated units are found within the selected caliper, the treated unit is not matched. Similarly, nearest neighbor matching can be performed with or without replacement. Matching with replacement involves having a particular untreated unit available for several treated units. While this strategy can improve matching if the distribution of propensity score differs considerably between the treated and untreated groups, it also reduces the number of untreated units used. On the other hand, matching without replacement involves having an untreated unit removed from the pool once it is matched to a treated unit. In practice, the decision on such trade-off between bias and variance lies in the hands of the researchers (Smith & Todd, 2005). In this study, both strategies are conducted. The other form of matching used in this study involves kernel matching, which weighs untreated units by their distance from treated units. Three models of kernel matching were used in this study: uniform; Gaussian; and Epanechnikov.[8]

[8] For more explanation on the kernels, read Apel & Sweeten (2010).

CHAPTER 3:

RESULTS

In this chapter, different results are shown to clarify the effect of firearm use on violent crime patterns. First, results indicating different patterns associated with the use of firearms[9] are presented for all four types of crime that are considered in this study and then, cases of robbery were isolated to appreciate the same patterns on this specific type of crime. Second, results obtained from standard regressions and analyses where cases are matched using PSM are presented to demonstrate the effect of firearms on victim's risk of death, and risk of injury[10] for the four types of crime altogether and for robberies alone.

3.1. Gun Use and Crime Patterns

3.1.1. Use of Firearms in Violent Crimes

Preliminary analysis on the use of a gun[11] to commit violent crimes against the person (Table 1) revealed that assailants attacking in groups are almost three times more likely (OR = 2.80; $p < 0.01$) to use firearms to commit crimes compared to those committing crimes alone. Criminals belonging to the 20-44 age group were more likely (OR = 1.16; $p < 0.05$) to use firearms. Female offenders, regardless of whether they are offending alone or in groups, are nine times less likely (OR = 0.11; $p < 0.01$) to use guns compared to their male counterparts. The same pattern is observed in groups composed of the same number of individuals from both genders, where wrongdoers are more than six times less inclined (OR = 0.16; $p < 0.01$) to use a gun to commit their crime. Moreover, white offenders are twice more likely than individuals from other ethnic groups (OR = 0.54; $p < 0.01$) to use such a weapon. Assailants

[9] Represented by relationship A in Figure 1.

[10] Represented by relationship C in Figure 1.

[11] The discharge of a firearm is not required. (See methods section)

who are suspected to be under the influence of alcohol or drugs at the time of the crime are nearly three times less likely (OR = 0.35; $p < 0.01$) to use guns.

On the other hand, relatively invulnerable (aged from 20 to 44) victims (OR = 1.23; $p < 0.01$) and those who are in the company of other people at the time of the crime are more likely (OR = 2.37; $p < 0.01$) to be attacked by offenders with a gun. Victims from other ethnic groups are more likely (OR = 1.25; $p < 0.01$) to be assaulted by assailants who had a gun. In general, victims are less likely to be attacked by criminals using a gun who know them, whether they are previous or current spouses or intimate partners, family members or acquaintances. In fact, results show that the closer the relationship between the victim(s) and the assailant(s) is, the less likely a gun is used in the crime (ORs varying from 0.05 to 0.30). Crimes involving the use of a gun are almost twice as likely (OR = 1.85; $p < 0.01$) to be associated with organized crime or street gang. Finally, firearm-related crimes are less likely to take place in public areas (OR = 0.82; $p < 0.05$).

Table 1: Descriptive and Multivariate Statistics on Gun Use: All Types of Crime

Variables	Percentage	Odds Ratio (OR)
Assailants		
2 or more people	21.7	2.80**
Age (20-44)	53.1	1.16*
Gender (reference category = male)		
Female	13.9	0.11**
Equal gender	1.7	0.16**
Ethnic group (reference category = white)		
Black	26.5	0.97
Others	22.8	0.54**
Substance use at the time of the crime	16.5	0.35**
Victims		
2 or more people	20.2	2.37**
Age (20-44)	58.7	1.23**
Gender (male)	39.6	1.04
Ethnic group (reference category = white)		
Black	14.3	1.09
Others	22.4	1.25**
Relationship between assailant(s) and victim(s) (reference category = undetermined)		
Spouses or intimate partners	28.2	0.05**
Family members	7.3	0.09**
Acquaintances	19.1	0.30**
Strangers	38.0	0.90
Events		
Association with organized crime or street gang	2.0	1.85**
Place (public)	59.0	0.82*
Constant		0.08**

Note: N = 23,002. Estimates are unweighted. Means of all variables are presented as percentages. Descriptive statistics are estimated from cases with valid data. Nagelkerke R-square for the logit model is 0.249, with a correct classification of 94.3%.
* = $p < 0.05$; ** = $p < 0.01$

3.1.2. Use of Firearms in Robberies

As shown in Table 2, similar results are observed when the analysis focuses on the use of firearms to commit robberies. Offenders who commit robberies in groups are twice as likely (OR = 1.99; $p < 0.01$) to use a firearm than those who rob alone. Young and relatively invulnerable (aged 20-44) robbers are more likely to use firearms (OR = 1.30; $p < 0.01$). As well, male criminals are over six times more inclined to use firearms than their female counterparts (OR = 0.15; $p < 0.01$), whether they robbed alone or in groups. Compared to groups composed of the same number of male and female members (OR = 0.17; $p < 0.01$), male offenders or wrongdoers in a predominantly male group are almost six times more likely to use a gun to commit robbery. Furthermore, black robbers and those from other ethnic groups are less likely to use firearms to perpetrate a robbery (OR = 0.73; $p < 0.01$ and OR = 0.45; $p < 0.01$, respectively). Intoxicated robbers are half as likely (OR = 0.47; $p < 0.01$) than their sober counterparts to use guns to commit robberies.

Firearms are more than twice as likely (OR = 2.74; $p < 0.01$) to be used in robberies which involve multiple victims than those involving a single target. Moreover, guns are more likely (OR = 1.26; $p < 0.01$) to be used against relatively invulnerable (age 20-44) individuals. As with the previous model, guns are more likely to be used in robberies as the victim-offender relationship weakens (ORs varying from 0.15 to 0.63). Finally, robberies in which a gun has been used are less likely (OR = 0.72; $p < 0.01$) to have taken place in public sites.

Table 2: Descriptive and Multivariate Statistics on Gun Use: Robberies

Variables	Percentage	Odds Ratio (OR)
Assailants		
2 or more people	50.2	1.99**
Age (20-44)	37.3	1.30**
Gender (reference category = male)		
Female	4.8	0.15**
Equal gender	2.3	0.17**
Ethnic group (reference category = white)		
Black	40.7	0.73**
Others	22.9	0.45**
Substance use at the time of the crime	5.9	0.47**
Victims		
2 or more people	26.1	2.74**
Age (20-44)	54.9	1.26**
Gender (male)	25.4	1.17
Ethnic group (reference category = white)		
Black	10.3	1.02
Others	26.1	1.16†
Relationship between assailant(s) and victim(s) (reference category = undetermined)		
Spouses or intimate partners	1.3	0.15**
Family members	0.4	0.00
Acquaintances	8.0	0.63*
Strangers	77.7	0.97
Events		
Association with organized crime or street gang	3.1	1.04
Place (public)	92.3	0.72*
Constant		0.16**

Note: N = 5,860. Estimates are unweighted. Means of all variables are presented as percentages. Descriptive statistics are estimated from cases with valid data. Nagelkerke R-square for the logit model is 0.133, with a correct classification of 83.2%.
† = $p < 0.1$; * = $p < 0.05$; ** = $p < 0.01$

In this section, interesting crime patterns associated with the use of guns have been identified. Not only do they reveal who uses firearms, against whom and in which circumstances they are used, these patterns provide proof that the use of a more complex methodological technique is required to control for their influence on the effect of gun use on a particular victim's risk of death and/or risk of injury. Such findings suggest that crimes committed with a gun do not share the same characteristics than those committed without a firearm. In other words, both groups are unbalanced. In the next section, various strategies of PSM are used to estimate the effect of firearms on violent crime outcomes (based on balanced groups).

3.2. The Effect of Firearms on the Risk of Fatal and Non-Fatal Injuries

As previously argued, the use of PSM to estimate the relative effect of firearms on victim's risk of death or risk of injury is justified by regression analyses' inability to assure that treated units share, as closely as possible, the same characteristics as units from the control group.

Another reason for which several analytical techniques were performed is to ensure results' robustness. In theory, kernel matching should be the best option for this study since the distribution of propensity scores is quite different for the treated and untreated groups for both samples (Apel & Sweeten, 2010). For instance, for the four types of crime, the mean for the treatment group is 0.17 compared to 0.05 for the control group, and the difference is significant ($p < 0.01$). For robberies, although the mean difference between both groups is not as important (0.18 for the treatment group and 0.11 for the control group), it is nonetheless significant ($p < 0.01$). Nevertheless, other techniques of PSM were conducted, first, to verify

whether kernel matching is indeed the ideal for the samples in this study, and second, to identify a better option if kernel matching fails to yield significant results.[12]

To illustrate that, compared to standard regressions, matching does indeed control characteristics of different covariates between treatment and control groups, estimations of SB were computed before and after matching for the samples that are used in the current study (victims of the four types of crime and those of robberies). For illustration purposes, the best matching model for each sample was identified and the results are shown in Tables A-1 & A-2 (Appendix). As previously explained, a balanced model should have estimations of SB equal to or less than 20. In fact, the closer the estimation of SB is to 0, the greater is the balance between treatment and control groups, the better is the matching (Apel & Sweeten, 2010). Moreover, estimations of SB are preferred to other balance assessing methods such as independent samples *t*-tests due to the fact that the latter is fairly sensitive to sample size. The ability to accurately identify balanced matching models is especially important since a strong and statistically significant effect size can prove worthless if it is calculated based upon unbalanced treatment and control groups.

3.2.1. The Effect of Firearms on the Risk of Fatal Injury in Violent Crimes[13]

Table 3 presents various standard regression models as well as regression models based on different propensity score matches: of the 24 estimates of ATE, 14 reach statistical significance. In other words, 14 of these 24 models indicate that a victim's risk of death is

[12] It is recommended to test several matching techniques since theories are not necessarily unerring (Apel & Sweeten, 2010).

[13] Robberies which result in the victim's death are classified as homicides; a separate analysis is thus not required.

greater when a firearm is used. However, statistically significant effects might not be undisputable if covariate balance is not achieved.

With regard to identifying the best matching technique, two series of results are relevant. First, all three kernel matching techniques yielded positive results, suggesting that for violent crimes where a firearm is used, the victim's risk of death is 1.4 to 1.7 points higher than in cases where no firearm is used. However, these models which, theoretically, should be the best options given the propensity scores distribution, did not result in the best-fitted matching models (estimations of standardized bias calculated after matching are too large). Hence, the second series of results reveal that, with the exception of the no-replacement models and those which did not reach statistical significance, several nearest neighbor(s) matching models provided better matching, with estimations of standardized bias significantly reduced. Nonetheless, even though estimations of ATE are slightly lower, results from these nearest neighbor(s) matching techniques support those obtained with the kernel matching strategies. For instance, a victim's risk of death is 0.9 to 1.2 points higher if a firearm is used.

Table 3: Average Treatment Effect of Firearm Use on Victims' Fatal Injury: All Types of Crime

Model	ATE (S.E.)
A. Standard regression adjustment	
No control variables	0.012 (0.001)**
All control variables	0.012 (0.001)**
B. Propensity score model: regression	
No trimming	0.008 (0.005)
With common support	0.009 (0.007)
Trim upper and lower 10%	0.009 (0.006)
C. Propensity score model: matching	
Nearest neighbor matching	
1 nearest neighbor, no caliper	0.009 (0.006)
No replacement	0.011 (0.003)**
1 nearest neighbor, caliper = 0.01	0.009 (0.007)
No replacement	0.011 (0.003)**
1 nearest neighbor, caliper = 0.001	0.008 (0.006)
No replacement	0.011 (0.003)**
1 nearest neighbor, caliper = 0.0001	**0.011 (0.005)***
No replacement	0.009 (0.003)**
3 nearest neighbors, no caliper	0.009 (0.006)
3 nearest neighbors, caliper = 0.01	0.009 (0.005)*
3 nearest neighbors, caliper = 0.001	0.009 (0.005)
3 nearest neighbors, caliper = 0.0001	**0.012 (0.004)****
5 nearest neighbors, no caliper	0.009 (0.005)*
5 nearest neighbors, caliper = 0.01	0.009 (0.005)
5 nearest neighbors, caliper = 0.001	0.009 (0.005)
5 nearest neighbors, caliper = 0.0001	**0.012 (0.005)***
Kernel matching	
Uniform kernel	0.017 (0.006)**
Gaussian kernel	0.014 (0.005)**
Epanechnikov kernel	0.015 (0.006)**

Note: N = 23,002. Estimates are unweighted. For the propensity score regression and matching models, bootstrapped standard errors with 100 replications are provided.
* $p < 0.05$; ** $p < 0.01$ (two-tailed tests).

3.2.2. The Effect of Firearms on the Risk of Non-Fatal Injury in Violent Crimes

Table 4 reveals estimates of ATE of firearm use on the victim's risk of non-fatal injury for all four types of violent crimes. Twenty-four models were conducted and they all reach statistical significance. In other words, during a violent altercation between the assailant(s) and the victim(s), the latter's risk of injury is greatly reduced when a firearm is used.

Although results from these models do not seem to be sensitive to the matching methods used, those for which ideal covariate balances are achieved between untreated and treated groups are identified in bold. As it is the case in the previous table, nearest neighbor(s) matching methods provide better matching given the samples used in this study. Estimates of ATE show that a victim's risk of non-fatal injury is 16.6 to 30.1 points lower for those who were victimized in a crime where a firearm was involved. Furthermore, even though the three models of kernel matching were not as balanced as those of the nearest neighbor(s) matching, their results corroborate those obtained from the better-balanced models (ATE ranging from -0.282 to -0.293).

Table 4: Average Treatment Effect of Firearm Use on Victims' Non-Fatal Injury: All Types of Crime

Model	ATE (S.E.)
A. Standard regression adjustment	
No control variables	-0.289 (0.014)**
All control variables	-0.253 (0.015)**
B. Propensity score model: regression	
No trimming	-0.211 (0.053)**
With common support	-0.232 (0.048)**
Trim upper and lower 10%	-0.236 (0.043)**
C. Propensity score model: matching	
Nearest neighbor matching	
1 nearest neighbor, no caliper	**-0.232 (0.051)****
No replacement	-0.301 (0.016)**
1 nearest neighbor, caliper = 0.01	**-0.232 (0.043)****
No replacement	-0.263 (0.017)**
1 nearest neighbor, caliper = 0.001	**-0.231 (0.047)****
No replacement	-0.262 (0.018)**
1 nearest neighbor, caliper = 0.0001	**-0.238 (0.042)****
No replacement	-0.252 (0.020)**
3 nearest neighbors, no caliper	-0.166 (0.038)**
3 nearest neighbors, caliper = 0.01	-0.166 (0.041)**
3 nearest neighbors, caliper = 0.001	-0.169 (0.045)**
3 nearest neighbors, caliper = 0.0001	**-0.168 (0.031)****
5 nearest neighbors, no caliper	**-0.176 (0.039)****
5 nearest neighbors, caliper = 0.01	**-0.176 (0.036)****
5 nearest neighbors, caliper = 0.001	**-0.180 (0.042)****
5 nearest neighbors, caliper = 0.0001	**-0.176 (0.027)****
Kernel matching	
Uniform kernel	-0.293 (0.018)**
Gaussian kernel	-0.290 (0.015)**
Epanechnikov kernel	-0.282 (0.018)**

Note: N = 23,002. Estimates are unweighted. For the propensity score regression and matching models, bootstrapped standard errors with 100 replications are provided.
* $p < 0.05$; ** $p < 0.01$ (two-tailed tests).

3.2.3. The Effect of Firearms on the Risk of Non-Fatal Injury in Robberies

In Table 5, only robberies are retained. As with the previous table where all four types of crime are examined, results are not sensitive to matching methods. Unlike the other two tables, most nearest neighbor(s) matching models – except a few no-replacement models – as well as the three models of kernel matching reached balance between treatment and control groups, although the former presents slightly better SB estimations after matching. Models of nearest neighbor(s) matching reveal estimates of ATE varying from -0.161 to -0.206, which means that a victim's risk of injury is 16.0 to 20.6 points lower in cases where a robbery is committed using a firearm than for those victimized in robberies where no firearm is involved. Results from the three models of kernel matching corroborate those obtained from nearest neighbor(s) matching models (ATE ranging from -0.202 to -0.203).

Table 5: Average Treatment Effect of Firearm Use on Victims' Non-Fatal Injury: Robberies

Model	ATE (S.E.)
A. Standard regression adjustment	
No control variables	-0.206 (0.017)**
All control variables	-0.197 (0.017)**
B. Propensity score model: regression	
No trimming	-0.199 (0.030)**
With common support	-0.206 (0.026)**
Trim upper and lower 10%	-0.193 (0.031)**
C. Propensity score model: matching	
Nearest neighbor matching	
1 nearest neighbor, no caliper	**-0.206 (0.027)****
No replacement	-0.215 (0.016)**
1 nearest neighbor, caliper = 0.01	**-0.206 (0.028)****
No replacement	-0.200 (0.018)**
1 nearest neighbor, caliper = 0.001	**-0.205 (0.032)****
No replacement	-0.218 (0.020)**
1 nearest neighbor, caliper = 0.0001	**-0.189 (0.035)****
No replacement	**-0.191 (0.022)****
3 nearest neighbors, no caliper	**-0.187 (0.020)****
3 nearest neighbors, caliper = 0.01	**-0.186 (0.022)****
3 nearest neighbors, caliper = 0.001	**-0.184 (0.021)****
3 nearest neighbors, caliper = 0.0001	**-0.161 (0.022)****
5 nearest neighbors, no caliper	**-0.206 (0.018)****
5 nearest neighbors, caliper = 0.01	**-0.206 (0.017)****
5 nearest neighbors, caliper = 0.001	**-0.201 (0.018)****
5 nearest neighbors, caliper = 0.0001	**-0.179 (0.019)****
Kernel matching	
Uniform kernel	**-0.202 (0.016)****
Gaussian kernel	**-0.202 (0.017)****
Epanechnikov kernel	**-0.203 (0.014)****

Note: N = 5,860. Estimates are unweighted. For the propensity score regression and matching models, bootstrapped standard errors with 100 replications are provided.
* $p < 0.05$; ** $p < 0.01$ (two-tailed tests).

CHAPTER 4:

DISCUSSION

The primary objective of this study was to improve the understanding regarding the effect of firearms on violent crime patterns. Most of the existing studies which have investigated the issue are descriptive in nature and they do not provide any firm conclusions to be drawn on the relationship between gun use and violent crime patterns (See section 1.2.3). Furthermore, potential confounders are not based on concepts or factors likely to affect, on one hand, the likelihood that a gun is used and, on the other hand, the outcome of violent encounters. Lastly, most studies focus on the victim(s) and as such, preclude any accurate investigation of the vulnerability concept. The notion of vulnerability must be conceptualized based on the casting (all actors involved in a violent crime) and context (settings in which the crime occurs).[14]

This study differs from its predecessors essentially by its attempt, on one hand, to approximate an experimental-like setting through PSM and, on the other hand, to integrate a conceptual framework in the measurement of confounding factors. With the goal of yielding more robust conclusions regarding the association between the use of a firearm and the risk of death and risk of injury, PSM isolates possible confounding effects of a gun by matching a treatment unit and a control unit that share the same propensity for firearm use to commit a crime (Rosenbaum & Rubin, 1985).

First, the results reveal interesting patterns associated with gun-related violent crimes committed in Montreal in 2011 and 2012. For all violent crimes (Figure 2), a gun is more likely used when the following characteristics related to the offender(s) are present: multiple assailants, invulnerable (20-44), male, white, and not under the influence of alcohol and drug

[14] See Eck (2006) about the importance of theories in quasi-experimental studies.

use. Gun-related crimes are also more likely to target multiple victims, individuals between 20-44 years old, individuals from other ethnic groups and victim(s) not known to the perpetrator(s). Crimes involving firearms are more likely to be associated with organized crime and street gang, as well as to take place in private sites, such as residences. When robberies are considered separately (Figure 3), most of the same patterns remained, except for the association with organized crime and street gang and victims belonging to other ethnic groups.

Second, once these "patterns" are controlled by PSM, the isolated effect of gun use indicates an increased risk of death during a violent altercation, but also a reduced risk of non-fatal injury.

4.1. Violent Crime Patterns

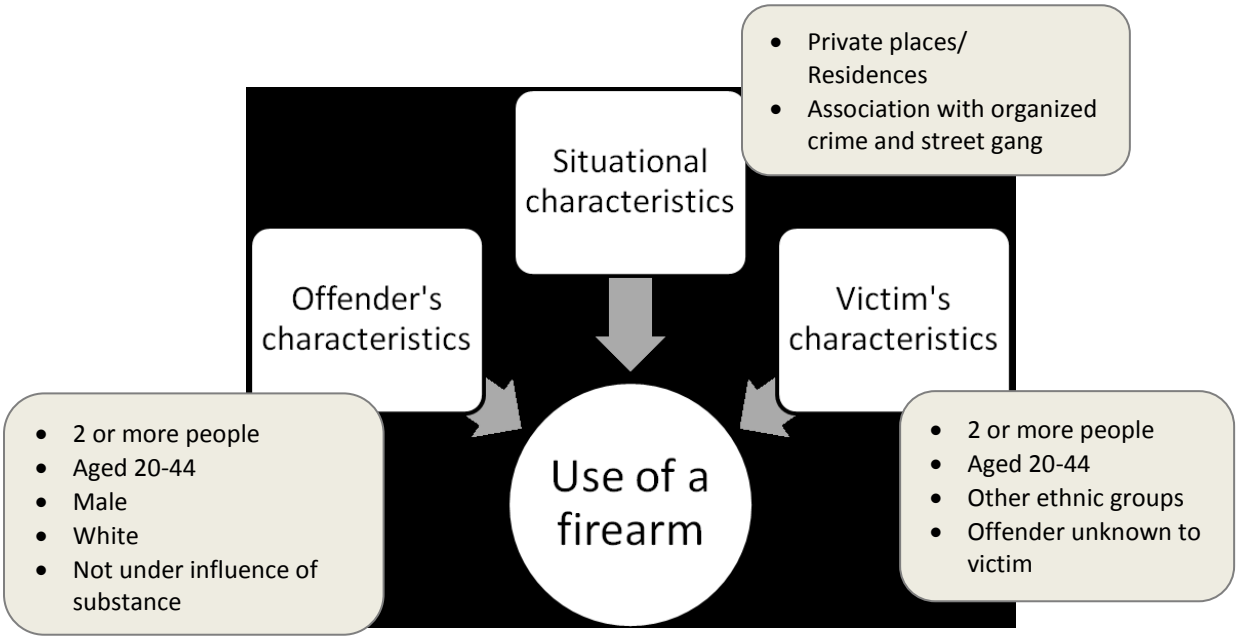
Cook's (1981) vulnerability pattern stipulates that a gun, as the great equalizer, allows wrongdoers to increase their chances to successfully complete their crime. The value of a firearm is greatest when it confers offenders an advantage over relatively invulnerable victims or targets. Depicted in Figures 2 & 3, the findings identified different patterns that are associated with a higher probability of firearm use to commit a crime.

Interpreting these patterns in relation to each other, the results of this study provide partial support for Cook's (1981) vulnerability pattern. In theory, one should expect patterns of weak offenders – females, individuals who are either very young (under 20) or relatively old (over 44) and those who offend alone – using firearms to attack stronger victims – males, a group of individuals rather than lone targets and those in their least vulnerable age range (20-44).

Indeed, for all violent crimes (Figure 2), guns are mostly used against two or more victims. Yet, such weapons are also used by individuals offending in groups. Moreover, unlike other studies which have found that males are more likely to be killed by firearms (Kellermann & Heron, 1999; Sampson & Lauritsen, 1994; Statistical Abstract of the United States, 1978), this study's results are not able to determine which gender a gun was most likely used against. Hence, the examination of the vulnerability pattern as regard to this aspect is not supported. Furthermore, guns are revealed to be mostly used by male criminals, which disagree with the vulnerability pattern. When it is assumed that both the murderer and the victim are males, data from the FBI indicated that a larger proportion of murders are committed by elderly killers against youthful victims (Cook, 1981). This study's findings show that guns are mostly used by youthful offenders against victims of the same age group. Also, studies have found that young Hispanic and African American males are more likely to be victims of gun violence (Cook & Ludwig, 2000). In this study, individuals from ethnic groups other than white and black are more likely to be victims of gun violence.

Based on actual findings, firearms can be conceptualized not just as the great equalizer, but more as the "ultimate enhancing" weapon/facilitator, just like one's asset that provide an overall advantage over other strong "players". The tenuous distinction between the equalizer and the "ultimate enhancer" concepts is likely to vary according to the settings (killing involving gang members or intimate partners) and further investigations are required to deepen the understanding.

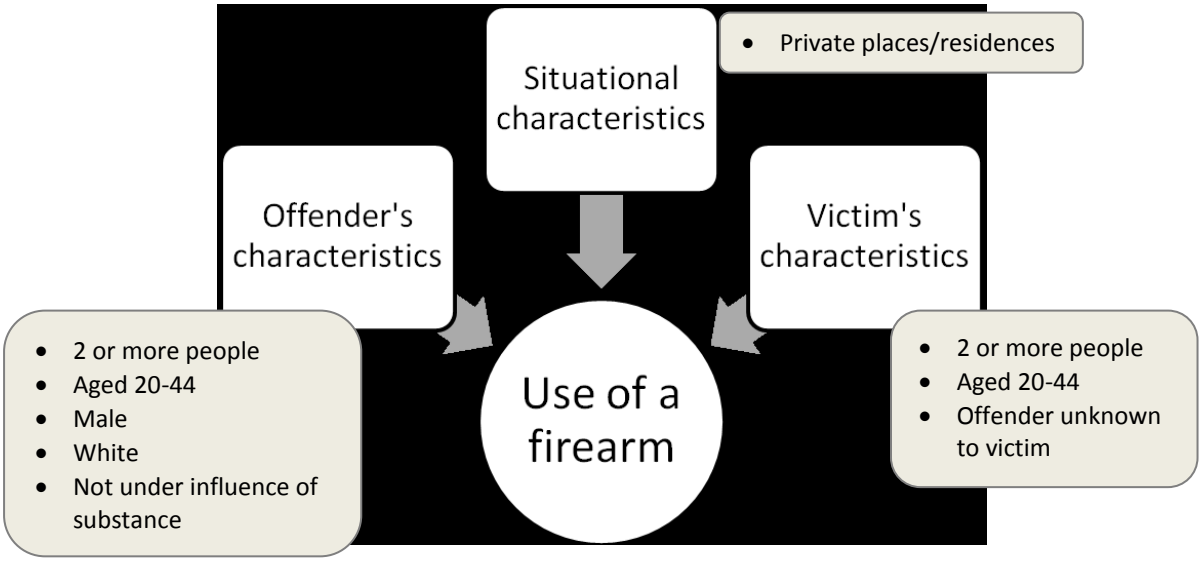
Figure 2: Violent Crime Patterns: All Types of Crime



Likewise, the same conclusion can be drawn on gun use patterns associated with robberies (Figure 3). In robbery, violence is considered to be instrumental, since harming the victims does not guarantee a success. Rather, the threat of violence can frighten the victim into compliance and thus, preventing resistance and escape. From this perspective, a gun can efficiently transmit the robber's intention. Incorporating this to the vulnerability pattern, a firearm gives the offender the opportunity to find less vulnerable targets, such as commercial places where there are possible multiple employees or even armed guards (Cook, 1980, 1981; Skogan, 1978). Although the findings indicate that guns are most likely used against multiple victims, they are also more popular with robbers offending in groups. Here, the notion of vulnerability is rather unclear. Also, despite some authors' studies showing that some robbers have a preference for female victims because they are expected to be less likely to resist

(Matthews, 2002; Zimring & Zeuhl, 1986), this study's findings cannot reveal which gender is more likely to subject to gun robbery. Lastly, robberies where a gun has been used are most likely committed by offenders aged from 20 to 44 against victims of the same age group.

Figure 3: Violent Crime Patterns: Robberies



On the basis of these findings, Cook's (1981) vulnerability pattern is not fully corroborated. Before concluding that firearms cannot be viewed as the great equalizer, the context under which the crimes under study are committed must be considered. Most of the research conducted on gun violence stems from the United States, where the availability and accessibility of guns as well as the rates of violent crime are considerably different from the situation in Canada.

Worldwide, for instance, gun possession in the United States exceeds that of every other country. According to the Small Arms Survey 2007, about 650 million firearms are owned by civilians and some 270 million of these are owned by US citizens alone. In other

words, all countries taken as a whole, there is roughly one firearm per seven people and, without the United States, the number drops to one firearm for every ten people (Karp, 2007). Moreover, in 2010, while 32% of homicides in Canada involved firearms, firearms murders made up 67.5% of all murders in the United States (Uniform Criminal Reports, 2010). Meanwhile, during the same year, 33% of all homicides committed in Montreal were committed with a firearm (Mahony, 2011). Hence, given the dissimilarities between the American context and that of Canada, it is quite possible that a concept like the vulnerability pattern will be played out differently. For example, the fear of running into a potential victim who is armed as a reason to carry gun might certainly seem more reasonable in a context where firearm ownership is relatively higher than it is in Canada, where gun regulations are stricter.

4.1.1. Other Findings

Aside from the main factors which pertain to the vulnerability pattern, analyses in this study also provided interesting elements that are associated with gun use.

4.1.1.1. Private vs. Public Places

At first sight, the results obtained with regard to the place where the crime takes place as well as the relationship between the victim and his/her assailant(s) seem confusing: whether it is for all four types of violent crime that are under study or just robbery by itself, guns are more likely to be used in private sites such as residences, while these lethal weapons are also more often used by people who are less close to the victims. In fact, for three of the four types of crime – homicide, attempted murder and assault – the proportion of crimes committed in public sites is greater than those that took place in private sites. Also, the fraction of crimes

where a firearm has been used is also greater for those that are committed in public sites. Hence, this last observation exclusively concerns robberies.

The results seem to suggest that most robberies committed using a gun are home invasions involving offenders who also robbed the house owner(s). While this might be provided as a partial explanation, the data show that 92.3% (N = 5406) of the victims of robberies committed in Montreal in 2011 and 2012 were victimized in public places; only 7.7% (N = 454) of the victims were robbed in residences, which include camps, cottages, cabins, hotels, motels, houses, apartments, etc. Among victims of residential robberies, 19.4% (N = 88) were threatened by a firearm, compared to 16.7% (N = 905) of victims of non-residential robberies. Therefore, there are not more robberies involving a firearm that are committed in residences compared to firearm-related robberies which took place in public sites, but rather, proportionally, there is a higher probability that a firearm is used against victims of residential robberies than against victims of non-residential robberies.

To account for this finding, several hypotheses can be advanced. First, one may assume that the greater proportion of gun-related violent crimes occurring in private places such as residences is due to the presence of a firearm in the home. As scholars have indicated, the risk of death by homicide is much higher for households where a firearm is present (Cummings et al., 1997; Kellermann et al., 1993). The finding of this study does not support this proposition for cases of family and/or spousal violence since guns are mostly used by individuals unknown to the victims. Second, it might be the fear to run into a resident who owns a gun that causes robbers to equip themselves with weapons of equal lethality. This hypothesis has been supported by the survey conducted by Wright and Rossi (1986). In their

study, robbers have revealed that they are more afraid of meeting an armed resident than running into police officers. Third, there is a possibility that criminals who target residences have a habit of carrying guns. For example, if it is assumes that gun accessibility is easier for gang members and that they do carry them on a regular basis (Cook et al., 2009; Gastrow, 2001; Shaw & Gastrow, 2001; Spapens, 2007), conflicts between members of opposing gangs can be played out by having one gang associate showing up at a rival's house to execute him/her in order to settle a score.

4.1.1.2. Strangers vs. Acquaintances

The victim-offender relationship has been considered as an important variable to improve the understanding of personal violence (Loftin et al., 1987). Most studies claim that gun homicide offenders are most likely to be known to the victim (Fox & Zawitz, 1999). In Olson's and Maltz's (2001) study, it was found that far more victims of gun homicides knew their killer (65.5%), compared to offenders who were categorized as strangers (19.5%), unknown or unreported (15%). Yet, results from this study conclude to the opposite: the closer is the relationship between the victim and his/her assailant(s), the less likely it is that a firearm has been used. Of the 19 homicides involving a firearm, none were committed by current or previous intimate partners, family members, or strangers; 21.1% by acquaintances; and 78.9% by unknown or unreported. This same pattern is also observed for attempted murders, assaults, and robberies committed in Montreal.

To make sense out of the victim-offender relationship, previous research introduced another notion which is closely linked to the relationship between the victim and the offender. Motives are mostly conceptualized as instrumental or expressive, where it is argued that

stranger violence is most often related to an instrumental motive (Block, 1981; Riedel, 1981, 1987; Rojek & Williams, 1993), whereas homicides within closer relationships are expressive in nature (Loftin, 1986; Luckenbill, 1977; Maxfield, 1989; Rojek & Williams, 1993). Hence, a better understanding of the motives behind each murder may bring more insight into the victim-offender relationship, as well as, if any, the choice of weapons.

4.1.1.3. Association with Organized Crime and Street Gang

Criminal groups are generally believed to have an easier access to firearms compared to individuals of non-criminal groups (Cook et al., 2009; Gastrow, 2001; Shaw & Gastrow, 2001; Spapens, 2007). Yet, some argue that this might not be the case, given that leaders tend to control their members' access to such weapons to avoid internal conflicts (Cook et al., 2005). Nonetheless, in 2007, Canadian police forces have reported that gun-related homicides represent 43% of all gun homicides, and that firearms are used much more frequently in gang-related homicides than it is for non-gang-related homicides: 69% and 20%, respectively (Li, 2008).

In this study's sample, 2% (N = 456) of the violent crimes are believed to be gang-related. However, if gang-related gun crimes are considered, the fraction goes up to 7.1% (N = 94). Also, a gun has been used in 20.6% (N = 94) of gang-related crimes and 5.4% (N = 1 226) of crimes not related to gang. A reason for which the variable "association with organized crime or street gang" did not come out to be significant with robberies involving a gun is due to the fact that most cases of gun crimes that are believed to be gang-related are concentrated in the other three types of crime. For instance, of all crimes involving guns, 52.6% (N = 10) of homicides, 34.2% (N = 13) of attempted murders, 13% (N = 35) of assaults, and only 3.6% (N

= 36) of robberies are suspected to be related to organized crime or street gang. From a different angle, 76.9% (N = 10) of homicides, 54.2% (N = 13) of attempted murders, 14.9% (N = 35) of assaults and 19.6% (N = 36) of robberies that are suspected to be associated with gang are committed using a firearm. Here, the findings of this study support the perspective stipulating that the use of guns is strongly association with criminal groups, and especially so for homicide and attempted murder.

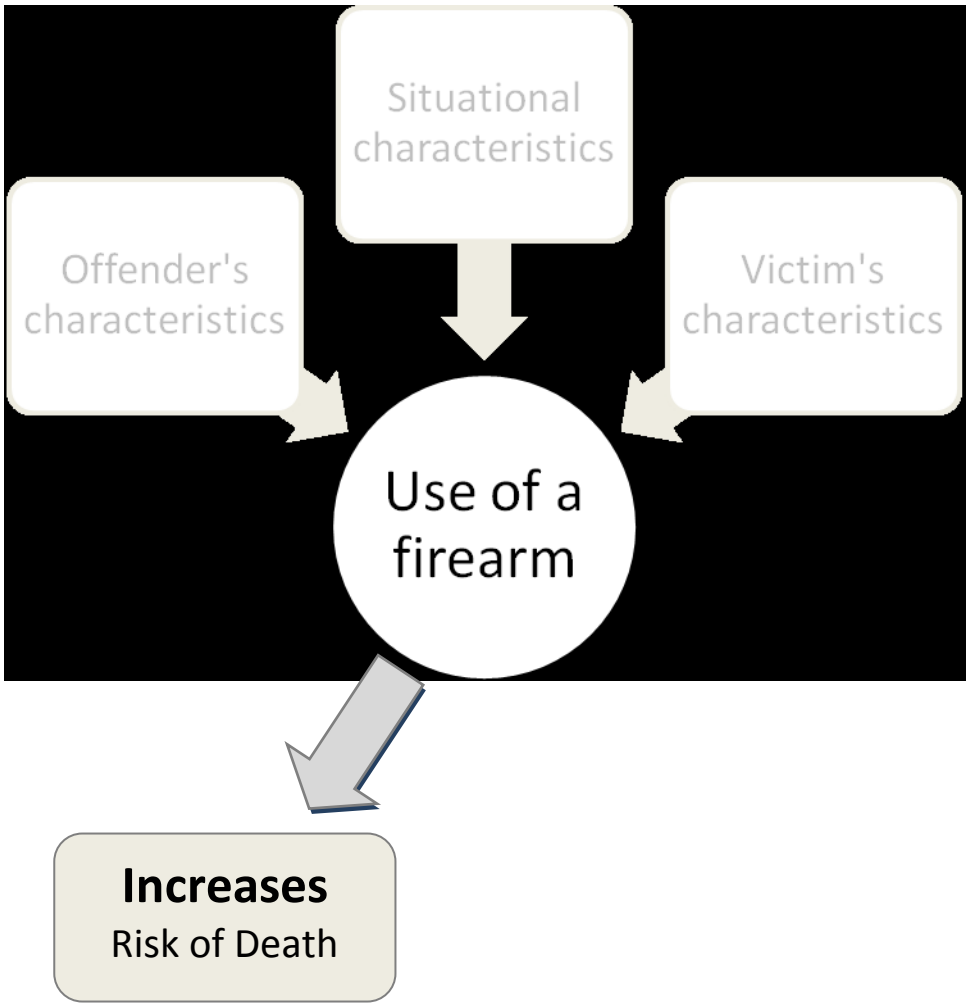
Although the analyses on the effect of guns on violent patterns did not provide full support to the vulnerability pattern, the results revealed other features that are associated with the use of a firearm. Once the probability, or propensity, that an offender will use a gun to commit a crime has been established based on these factors, cases are matched upon their propensity score and then analysed to identify the absolute effect of gun use on the victims' risk of death and risk of injury.

4.2. Risk of Fatal Injury in Violent Crimes

Cook's (1981) second dimension addressed the issue of injury seriousness – the objective dangerousness pattern. The first stipulation is that, in any confrontation, the range of possible outcomes is greatly influenced by the choice of weapon (Kleck & McElrath, 1991; Saltzman et al., 1992; Zimring, 1968, 1972). Given its lethal nature, firearms were found to be more likely to result in the victim's death than other weapons (Block 1977; Cook, 1981). Moreover, a gun's value is at its greatest when the perpetrator's intent is ambiguous because the immediate availability of a firearm is critical in these circumstances (Cook, 1981; Zimring, 1972). Of the 24 models that were conducted to estimate the ATE of firearms on risk of death

in violent crimes, 14 reached statistical significance, indicating that, indeed, a victim's odds to succumb to his/her wounds is greater when the offender has used a gun (Figure 4).

Figure 4: Effect of Firearms on Risk of Fatal Injury



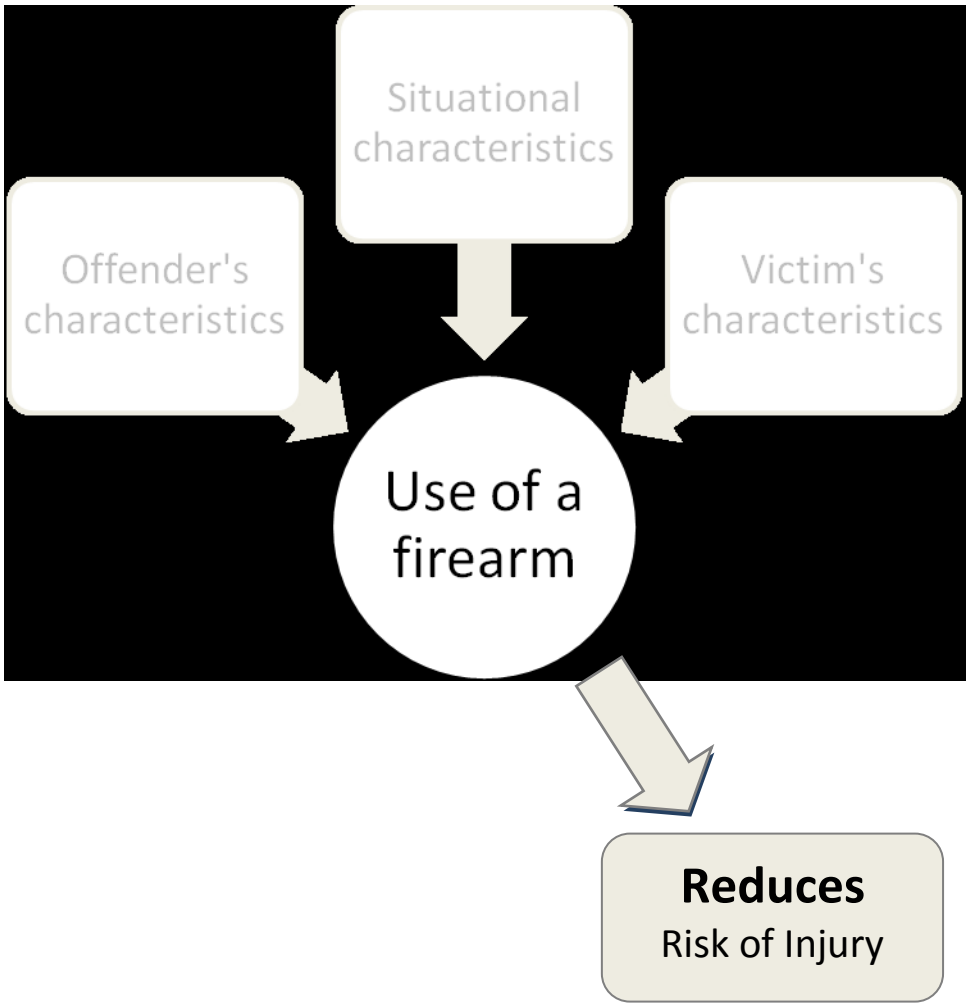
4.3. Risk of Non-Fatal Injury in Violent Crimes and Robberies

The second stipulation of the objective dangerousness pattern claims that in crimes where the primary purpose is not to harm or kill the victim, gun use results in less injury to the victim when compared to the use of other weapons (Cook, 1981). Several authors have found

that injuries are relatively rare in gun robbery cases compared to those involving other weapons or when no weapon is used (Conklin, 1972; Cook, 1981; Skogan, 1978).

Whether it is solely for robbery or all four types of crime considered together, all the models in the analyses show that a victim's risk of getting injured is greatly reduced when a firearm has been used (Figure 5). In fact, the effect of gun use on a victim's risk of non-fatal injury is found to be much stronger than it is on his/her risk of death.

Figure 5: Effect of Firearms on Risk of Non-Fatal Injury



Results suggested here seem contradicting: the use of a fiream both increases the victim's risk of death and reduces a victim's risk of injury. However, it does make sense if the reason for which a gun is used is considered. On one hand, as previously discussed, if the perpetrator's intention is to kill the victim, then a gun seems to be a efficient method to complete the task. On the other hand, if the use of a weapon is merely to induce fear to the victim to reduce his/her likelihood to resist and to escape, then the actual use of the weapon is not necessary. In this perspctive, a gun can certainly suggest promising harm to any victim. Moreover, as many scholars have found, many criminals choose to retreat instead of hurting the victim(s) when they are faced with refusal or non-cooperation (Conklin, 1972; Morrison & O'Donnell, 1994; Wright & Decker, 1997). Of course, there are also other occasions where violence is not instrumental to the perpetration of the crime, but has become excessive for various reasons.

Hence, with the exception of some extreme cases, the use of a firearm can efficiently force the victim(s) into submission and the offender(s) will not have to execute any form of violent behavior to complete his/her crime. Yet, when violence does occur, the impact is much more likely to be fatal if the harm is inflicted with a firearm than it would otherwise be with other weapons.

4.4. Conceptualization

In the present dissertation, Cook's seminal work (1981, 1983, 1991) on guns and violent crime patterns was used to operationalize most of the variables under study. Following his main propositions, the current analyses reveal some novel findings that have several implications for the study of the structuring effect of guns on violent crime patterns. These

implications are closely linked to theoretical perspectives integrating the casting and contextual factors to investigate the crime preparation process and the final outcome (Cornish, 1994; Leclerc, 2014). Contextual as well as individual factors have crucial implications for the understanding of the vulnerability concept and to better appraise the role of guns on violent incident outcomes. The influence of guns on violent crime patterns is expressed in Figure 6. The first series of circles in Figure 6 encompass the casting. The casting refers to all parties that are involved in the crime commission process. In the current study, the casting includes the offender(s), the victim(s), and all other third parties such as co-offenders and witnesses. The results suggest that, indeed, firearms are more likely to be used against invulnerable victims. For instance, most victims attacked with guns were between 20 and 44 years old and were often accompanied by other individuals. In sum, youth victims are likely to be stronger (in comparison with older ones) (Cook, 1981) and the presence of "companions" means that the victim(s) can receive immediate assistance. The latter proposition is compatible with the notion of guardian (Felson, 1986) and companions in crime (Warr, 2002), both able to offer assistance to the victim(s). Cook (1991) also report that guns are more likely to be used against less vulnerable victims.

While victims may appear invulnerable, the vulnerability concept depends also on the offender's characteristics (Cook, 1991). The results show that offenders who are more likely to use guns are already relatively strong. In fact, they were aged between 20 and 44, mainly males, and more likely to offend with partners. Such observation has two implications. First, it further highlights the need for group balance before investigating the effect of weapon on injury. Second, on a conceptual basis, it depicts the gun not just as a great equalizer, but also as the "ultimate enhancer". Even strong offenders appear to have the need to equip themselves

with lethal weapons when they go after their victim(s) (Wright & Rossi, 1986). In this sample, it seems that firearms involve relatively strong parties and that the "weak assailant vs. invulnerable target" pattern is not commonplace, at least on the SPVM territory.

Figure 6 accounts for the fact that interactions between offenders, victims and third parties take place in particular settings (Felson, 1998). Hence, contextual factors refer to settings such as the place where the crime takes place (Cornish, 1994) and the state of the parties (being under the influence of alcohol/drug, emotional state, etc.) in that particular setting (Piquero et al., 2011; Wortley, 2001). Also related to contextual variables, it appears that firearms are more likely to play an instrumental role in the perpetration of crimes. Crimes involving firearms were, among other things, more likely to be associated with criminal organizations (gang, mafia, etc.), whereas crimes committed with other methods were more likely to be associated with substance use as well as with spouses and family members, two characteristics often associated with more expressive and impulsive forms of violence (Felson, 1993; Felson, Ackerman & Yeon, 2003; Felson & Massoglia, 2011).

In sum, the findings suggest that strong and criminally prone individuals such as gang members are more likely to use guns towards their target(s).[15] Since these targets are relatively strong (young and accompanied by other individuals who are likely to offer assistance), firearms can be conceptualized not only as the great equalizer, but also as the "ultimate enhancer". Since guns are mainly used by strong opponents against the less vulnerable targets, it emphasizes the role of guns in criminal activities. These findings question the substitution

[15] In our sample, 76.9% (N = 10) of homicides believed to be associated with criminal groups involved a gun.

hypothesis, since the strongest portions of the delinquent population seem to show a preference for guns to carry out their criminal doings.

This need for guns by stronger assailants is further highlighted by the outcomes observed in the propensity score matching analyses. As argues by Cook (1981), the presence of a gun increases the likelihood of fatal injuries in violent encounters. Considering the portion of gun crimes that are suspected to be associated with criminal groups, one could argue that firearms facilitate the completion of the crime (Cook et al., 2009; Pogrebin, Stretesky, & Unnithan, 2009). It seems reasonable to put forward the hypothesis that killers who engage in planning and seek out "big scores" will take the necessary steps to equip themselves with the appropriate weapon, usually some kind of firearms (Cook, 1991). The fact that less vulnerable offenders are more likely to use guns can be closely linked to the fact that such characteristics (young males hanging out in groups) quite resemble those of members of criminal groups. Vulnerability and inclination to crime are two concepts that need to be further investigated to appreciate their relationship to gun use.

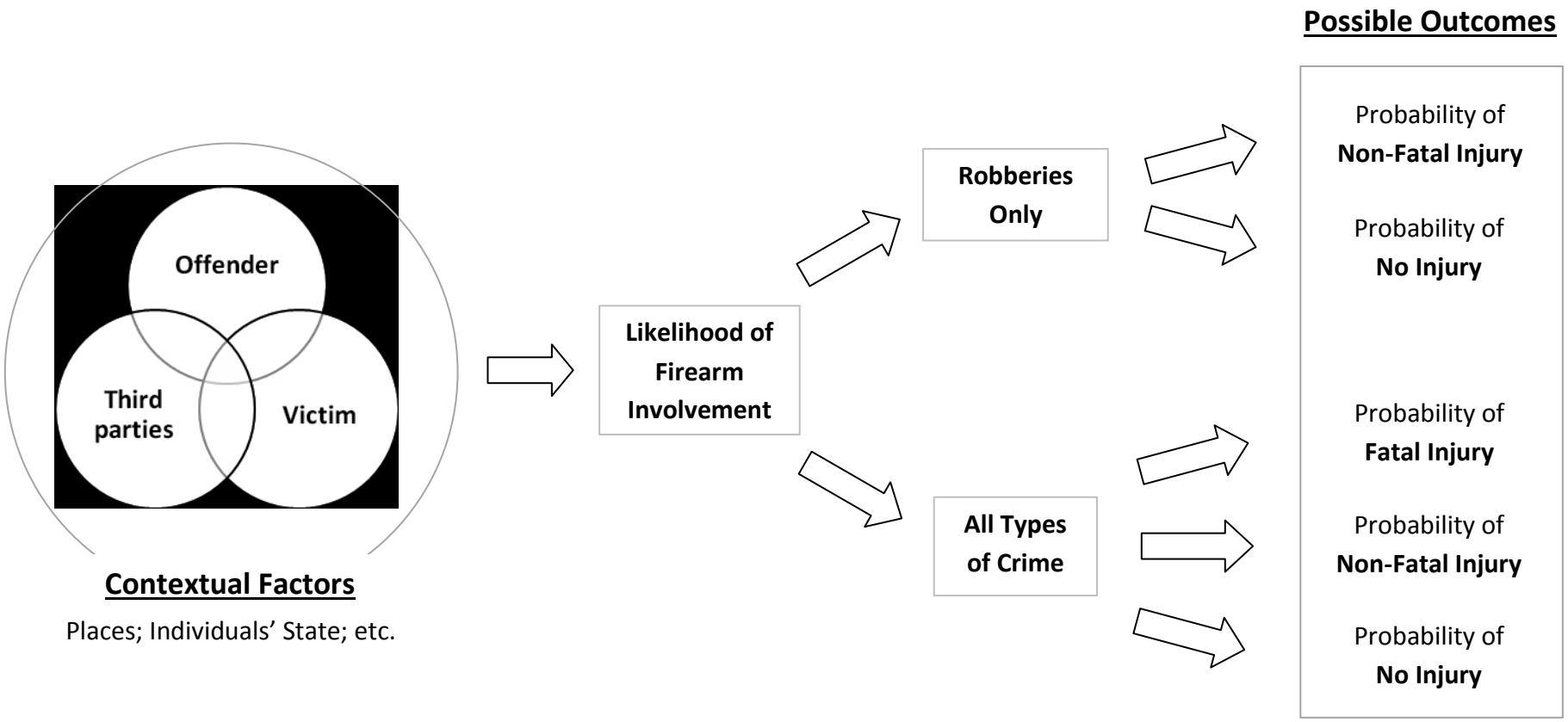
In keeping with the previous propositions, using firearms seems to improve the success rate when it comes to committing robberies. The presence of a gun lessens the risk of injuries, meaning that a firearm is of greater use to threaten the target(s) and to obtain his/her cooperation, without the need for actual harm. A firearm "is the most effective tool for enhancing the robber's power. Unlike other common weapons, a gun give a robber the capacity to threaten deadly harm from a distance, thus allowing him to maintain a buffer zone between himself and the victim and to control several victims simultaneously" (Cook, 1991: 30). This interpretation is in accordance with results found in surveys conducted among

incarcerated offenders. A majority of respondents in Wright and Rossi's (1986) survey indicated that firearms are very or somewhat important to forestall or overcome the victim's resistance, get away unscathed and not having to hurt the victim. This study's findings suggest that robbers might be able to act as expected when they proceed with a gun. In both cases – homicides and robberies – firearms can be conceptualized as crime facilitators.[16]

In conclusion, the findings show the relevance of using the technology of personal violence perspective to understand the role of guns in criminal violence (Cook, 1991). The offender's decision to use a firearm depends not only on the (in)vulnerable character of the victim(s), but also on the offender's status (ex: affiliation to a criminal group) and contextual factors. Even among criminally inclined individuals, guns confer them a significant overall advantage over the target(s) when it comes to either killing or robbing. Fatal outcomes are likely to occur when a firearm is involved and as expected by offenders, injuries are infrequent when robberies are committed with guns.

[16] See Clarke (2009) on crime facilitators.

Figure 6: A Re-Conceptualization of the Relationship between Violent Crime Characteristics, Firearm Use and Possible Outcomes



CONCLUSION

In general, the main results indicate that gun use seems to be influenced by different factors that are associated with characteristics pertaining to the victim(s), the offender(s), and the context in which the crime takes place. These findings provide support for the need to reach group balance prior to any further analysis. This study has also found that the relative effect of firearms increases a victim's risk of death, but reduces the risk of injury. While these results provide greater insight into the association between gun use and criminal violence, it is important to recognize the methodological limitations that were encountered in this study.

First, the main obstacle lays on the accessibility of relevant information in the provided database. To account for Cook's (1981) vulnerability pattern, a specific series of variables concerning both victims' and offenders' characteristics is required. Ideally, a wide range of individual and situational characteristics should be included to the analyses in order to yield stronger results. However, not all variables are consistently recorded and some are simply not available. For example, one demonstration of the vulnerability pattern could be that smaller individuals are more likely to use guns against bigger opponents. Yet, information related to individuals' size is not available in all cases. For instance, after merging crimes that occurred during the two-year period, values for individuals' weight and height are missing, respectively, in 70.4% (N = 368 767) and 66.9% (N = 350 573) of the cases[17]. Although it is understandable that measures as such are difficult to obtain, especially in cases where the suspect is not apprehended, these numbers could nevertheless be useful in these analyses.

Another example concerns information on individuals' criminal history, particularly so if it involved gun use. This data was not presented and given the time allowed, extracting this

[17] These statistics were calculated prior to any modification to the database.

information from a separate database for each individual in the sample did not seem feasible. The last example in relation to the database concerns the main dependent variable, which is the seriousness of injury that was inflicted to the victim. Since this variable was not recorded in databases from previous years, the analyses are limited to a period of two years: 2011 and 2012. If this study had not been subject to this restriction, a longer period of time could be covered, which would considerably expand the sample size and strengthen the validity of the findings. In particular, expending the period of analysis can also increase the number of fatal cases, which can, without any doubt, provide additional credit to any conclusions made in regard to homicides. In brief, all variables that are not available as well as those that are not systematically recorded were not considered in the analyses conducted in this study.

Aside from not being able to use several variables for the reasons that are discussed above, the second obstacle encountered had to do with the use of a statistical method like PSM. It is undeniable that this technique has allowed for the creation of a quasi-experimental setting comparing cases involving a firearm with those involving other weapon, or no weapon at all, to see whether the use of such weapon is directly linked to a victim's death or injury. A downside to this benefit is that a propensity score cannot be calculated for any entry which has a missing value in any of the variables. Therefore, the available number of cases that are used for the current study is further reduced. As an example, 71 homicides were committed in Montreal during the 2011-2012 period, but only 44 were retained in the final sample.

Finally, just as Cook's (1981) vulnerability pattern cannot be entirely confirmed nor refuted due to the dissimilarities between the American and the Canadian context with regard to gun availability and violent crime rates, findings of the current study might not be

generalized to any other cities or nations. Perhaps repeating this study in a city or nation with characteristics such as rates of violent crime, gun availability, and firearm laws comparable to Montreal would yield similar results, but the outcomes might not be as similar if it was conducted in a city where the violent crime rate is high and gun ownership is rather common.

In the light of these limitations, several avenues can be proposed for future research. First, there may be some intrinsic differences in patterns between crimes for which the victim's death is anticipated and those for which the victim's death is accidental and undesired. But since a crime is codified as a homicide when a murder is involved, the initial intention of the perpetrator does not matter at this point. Yet, the pattern can be quite different for the offender who purposefully kills his/her target using a firearm than for the robber who involuntarily killed his/her victim during the course of a gun robbery. Thus, separating crimes on the basis of the second criminal charge that has been made to offenders gives rise to the possibility to investigate the effect of gun use on crime patterns all the while taking into account the initial intention of the crime.

Second, the measurement of success or, in this context, the advantages conferred by guns, can vary from different types of crime. For example, according to the vulnerability pattern, a firearm allows individuals to act against targets that are less vulnerable, more valuable and, in the cases of robbery, more profitable. Hence, measuring the amount that has been stolen or the value of the stolen goods, or even the duration of the crime can reflect the efficiency of using a firearm. In fact, the initial plan is to conduct two sets of analyses where one measures the effect of firearms in relation to the seriousness of the victim's injury in violent crimes, and the other evaluating the same effect on the value of stolen goods (including

money) in robberies. In the end, the second set of analysis was not performed because of the low reported rate for two critical variables: the amount of money stolen and the stolen goods.

Finally, in this study, the independent variable which is the use of a firearm includes the use of any type of firearm that has been reported in the database. Different crime patterns might result based on the type of gun used. For example, handguns might be more prominent in criminal groups than rifles or shotguns, just as certain types of firearm might be responsible for more household homicides as compared with murders occurring in public sites. Hence, studying the issue from different perspectives allows achieving a better understanding of the mechanisms through which firearms provide advantages to their users.

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APPENDIX

A-1: Balance Diagnostics: All Types of Crime

	Balance diagnostics: standardized bias (SB)	
Variables	**Before matching**	**After matching**
Assailants		
2 or more people	80.75	2.2
Age (20-44)	-23.04	-0.9
Gender (reference category = primarily male)		
Primarily female	-40.22	0.6
Equal gender	-3.75	0.9
Ethnic group (reference category = white)		
Black	27.04	1.7
Others	-11.36	-0.3
Substance use at the time of the crime	-33.38	-0.5
Victims		
2 or more people	55.23	-0.3
Age (20-44)	5.72	0.8
Gender (male)	-22.69	-0.7
Ethnic group (reference category = white)		
Black	-1.99	0.7
Others	12.68	-2.1
Relationship between assailant(s) and victim(s) (reference category = Undetermined)		
Spouses or intimate partners	-73.17	1.2
Family members	-21.83	-0.6
Acquaintances	-25.68	1.4
Strangers	76.37	-2.1
Events		
Association with organized crime or street	17.56	4.3
Place (public)	58.84	-0.9

Note: N = 23,002. Estimates are unweighted. Balance diagnostics are estimated from cases with valid data. The post-matching standardized bias is based on 5 nearest neighbours matching caliper = 0.0001.

A-2: Balance Diagnostics: Robberies

	Balance diagnostics: standardized bias (SB)	
Variables	**Before matching**	**After matching**
Assailants		
2 or more people	24.74	1.7
Age (20-44)	9.69	-0.7
Gender (reference category = primarily male)		
Primarily female	-16.61	0.0
Equal gender	-7.22	2.7
Ethnic group (reference category = white)0.7		
Black	-6.00	0.7
Others	-19.21	0.6
Substance use at the time of the crime	-8.59	-2.2
Victims		
2 or more people	47.00	0.3
Age (20-44)	13.95	0.5
Gender (male)	13.63	-1.8
Ethnic group (reference category = white)-0.57		
Black	-0.57	0.0
Others	5.94	0.8
Relationship between assailant(s) and victim(s) (reference category = Undetermined)		
Spouses or intimate partners	-6.54	0.0
Family members	-3.81	---
Acquaintances	-11.11	-1.4
Strangers	9.55	1.2
Events		
Association with organized crime or street	1.97	0.6
Place (public)	-3.62	1.7

Note: N = 5,860. Estimates are unweighted. Balance diagnostics are estimated from cases with valid data. The post-matching standardized bias is based on single-nearest-neighbour matching with a caliber of 0.0001.