

# The Effect of the Argentine Gun Buy-Back Program on Crime and Violence

David Lenis

*Universidad Torcuato Di Tella*

Lucas Ronconi

*CIPPEC*

Ernesto Schargrodsky\*

*Universidad Torcuato Di Tella*

September 27, 2010

## Abstract

The effect of policies and regulations affecting the availability of guns in the population is an unsettled and controversial issue. In this paper, we contribute to this debate by analyzing the effect of PEVAF, a large national gun buy-back program implemented in Argentina, on crime and violence. The empirical evidence suggests that the program has been successful in reducing the number of deaths from firearm accidents, but has not achieved a reduction in suicides, homicides and car theft.

---

\* David Lenis, UTDT, Saenz Valiente 1010, Buenos Aires, Argentina, [dlenis@utdt.edu](mailto:dlenis@utdt.edu). Lucas Ronconi, CIPPEC, Av. Callao 25, Buenos Aires, Argentina, [ronconilucas@gmail.com](mailto:ronconilucas@gmail.com). Ernesto Schargrodsky, UTDT, Saenz Valiente 1010, Buenos Aires, Argentina, [eschargr@utdt.edu](mailto:eschargr@utdt.edu). We thank Fabián Pons from CESVI, Marisa Peyton, Adrián Santoro, and Elida Marconi from Ministerio de Salud, José Oubel from Superintendencia de Seguros de la Nación, Hernán Olaeta from Ministerio de Justicia, and Red Argentina para el Desarme (RAD) and Fernando Rodriguez for valuable help.

## 1. Introduction

Hundreds of thousand of people in the world are killed every year by firearms, even after excluding war casualties from the count (World Health Organization, 2005). However, firearm policy is a highly contentious subject mainly because firearms are also used as a defensive weapon and they deter an unknown number of crimes (Wellford, Pepper and Petrie, 2004).

This paper estimates the effect of a gun buy-back program on crime and violence, a policy for which little rigorous evidence is available. We analyze the *Programa Nacional de Entrega Voluntaria de Armas de Fuego* (PEVAF) which collected 104,782 firearms between July 2007 and December 2008 in Argentina. PEVAF provides a neat natural experiment to identify the effects of gun buyback programs.

First, the program was not introduced simultaneously with other gun control interventions as the buyback programs in Australia, Brazil and UK. Therefore, it is simpler to disentangle the effect of the program from other interventions. Second, provinces entered into PEVAF at different dates and this variation occurred because, when the program was launched, the federal agency in charge of collecting firearms did not have a local office in every province. Hence, we can control for the potential endogeneity of the program to crime and violence trends. Third, the relatively large scale of PEVAF and the prevalence of firearm related morbidity in Argentina makes feasible that its effects would be detected. Estimates suggest there were approximately 1.5 million firearms in Argentina

before PEVAF (DerGhougassian et al., 2007). If a different firearm were used in each homicide, suicide or accidental death, then, the probability that a particular firearm would be used to kill an individual in a particular year is 1.5 in 1,000. Because the program collected about 100,000 firearms, a random sample would imply 150 fewer deaths per year. That is, the effects are detectable.

Theoretically, the impact of a buyback program on crime and violence is ambiguous. On the one hand, if criminals are less likely to commit a crime when they suspect that the potential victim carries a firearm (Lott, 2000) and if those who hand over their firearms to the program used the guns for protection, then PEVAF would produce an increase in crime. On the other hand, if access to firearms facilitates crime or increases the probability that a dispute ends up with the death of an individual, then a reduction in the stock of guns can produce a reduction on crime and homicides (Duggan, 2001; O'Flaherty and Sethi, 2010). Furthermore, if the program leads to a reduction in the number of guns on the street because there are fewer firearms available for theft or trade, then violence could decline. The reduction in the availability of guns at homes could also reduce firearm accidents and suicides.

The manner in which the buyback program was implemented in Argentina produces some additional opposing hypothesis regarding its effects on crime and violence. On the one hand, PEVAF participants received a monetary compensation regardless of the condition of the firearm. This could actually produce an increase in the stock of usable firearms if people who handed over a useless gun bought a working gun with the money

received. Moreover, PEVAF introduces amnesty, meaning that every person that hands over a firearm cannot be penalized for possessing an illegal gun as established in the Argentine Penal Code, and the returned weapons were not used as proofs to pursue individuals. The amnesty clause might have implied a reduction in the number of incapacitated criminals (if some of them would have been incarcerated in absence of the program), thus potentially leading to higher crime levels. On the other hand, people who handed over a firearm enjoyed anonymity. This could have allowed an individual who committed a crime in the past, and wants to leave illegal activities, could participate in the program since he does not run any risk of being incarcerated for previous crimes.

There is little empirical evidence on the effect of gun buy-back programs. Marinho de Souza et al. (2007) suggest that the buyback program implemented in Brazil in 2004 has contributed to the observed reduction in firearm related mortality. Most of the other evaluations analyze buybacks in developed countries and conclude that the interventions are usually ineffective because a large share of the collected firearms do not function and because most people who participate in the program rarely uses the firearm. See for example Plotkin (1996) and Sherman (2001) for the programs in Baltimore, Saint Louis, Seattle and Washington D.C. in the United States; and Reuter and Mouzos (2003) and Baker and McPhedran (2006) for Australia.

It is unclear, however, whether these previous evaluations actually capture the causal effect of the program. First, some of these evaluations lack statistical power. Most buyback programs evaluated in the United States are small. They usually collected about

1,000 firearms; a tiny amount given that the probability that a particular gun is used to kill a person is less than 1 in 10,000 (Wellford, Pepper and Petrie, 2004). Second, larger buyback programs were usually implemented together with other interventions making it difficult to disentangle the effect of the program. In Australia, the gun buy-back program collected 650,000 firearms (20% of the estimated stock) between 1996 and 1997. But it was just one component of a broader plan of gun control. The buyback was implemented simultaneously with other policies, such as a ban on certain types of firearms, more control, and new registration, licensing, training and safe storage requirements (Baker and McPhedran, 2006). Similarly, the buyback program in Brazil was part of a set of new gun regulations, such as making illegal to carry guns outside of the possessor's home and owning guns that are not registered, raising the minimum age for firearm purchase to 25, and imposing new penalties to those who violate these laws (Marinho de Souza et al., 2007). Third, evaluations usually do not deal with the potential endogeneity of the program to crime and violence trends. Buyback programs are not exogenous events, but the result of a number of societal factors that are unobservable to the econometrician and that could influence future levels of crime and violence. For example, the Port Arthur massacre that occurred in Australia in 1996 could have produced changes in attitudes towards firearms among the population, and those changes could have affected both the political support for a gun buyback program and the likelihood of firearm related deaths. Furthermore, the number of firearms collected could also be endogenous to crime. If people are more likely to hand over their guns when crime is lower, then, estimates of the effect of the program on crime would be biased upwards.

In summary, the effect of policies and regulations affecting the availability of guns in the population is an unsettled controversial issue. In this paper, we contribute to this debate by analyzing the effect of the large Argentine gun buy-back program on crime and violence.

Our results suggest that the program has been successful in reducing the number of deaths from firearm accidents, but has not been successful in reducing suicides, homicides or car theft. Thus, the program does not seem to have convinced criminals and potential suicides, to hand in their weapons, but it seems to have had an effect on the amount of weapons in the hands of the general population, leading to a significant reduction in the number of non-intentional firearm deaths.

After this introduction, section 2 describes the PEVAF program. Section 3 presents our data. The econometric identification is discussed in Section 4. The results are reported in Section 5, while section 6 concludes.

## **2. The PEVAF Program**

PEVAF was created by Law No. 26,216 and implemented by the *Registro Nacional de Armas* (RENAR). Participation in PEVAF was voluntary. Individuals who handed over a firearm received a compensation ranging between 100 and 450 pesos (i.e., between 30 and 145 US\$) depending on the type of firearm. All types of firearms were accepted, as well as both registered and unregistered firearms, and the collected firearms were

destroyed. PEFAV also collected ammunition and the compensation ranged between 0.05 and 0.10 pesos per unit. The government ensured that the person who handed over the firearm and/or ammunition remained anonymous.

The program started in July 2007 in those provinces where RENAR had a local office, and finished in December 2008. It collected a total of 104,782 firearms, representing about 10 percent of the stock of registered firearms and 7 percent of the estimated total stock of firearms (DerGhougassian et al., 2007). The amount of ammunition collected is 747,000 units. According to official figures, the program increased the amount of surrendered weapons from an average of 17 per day for 1993-2004, to 248 per day during the program period.

Figure 1 shows the evolution of the stock of firearms collected by the program over time. In June 2007, the number of firearms collected was zero because PEVAF began in July 2007. By October 2007, about half of the total accumulated number of firearms, were already collected.

**Figure 1 – Number of Firearms collected by PEVAF**

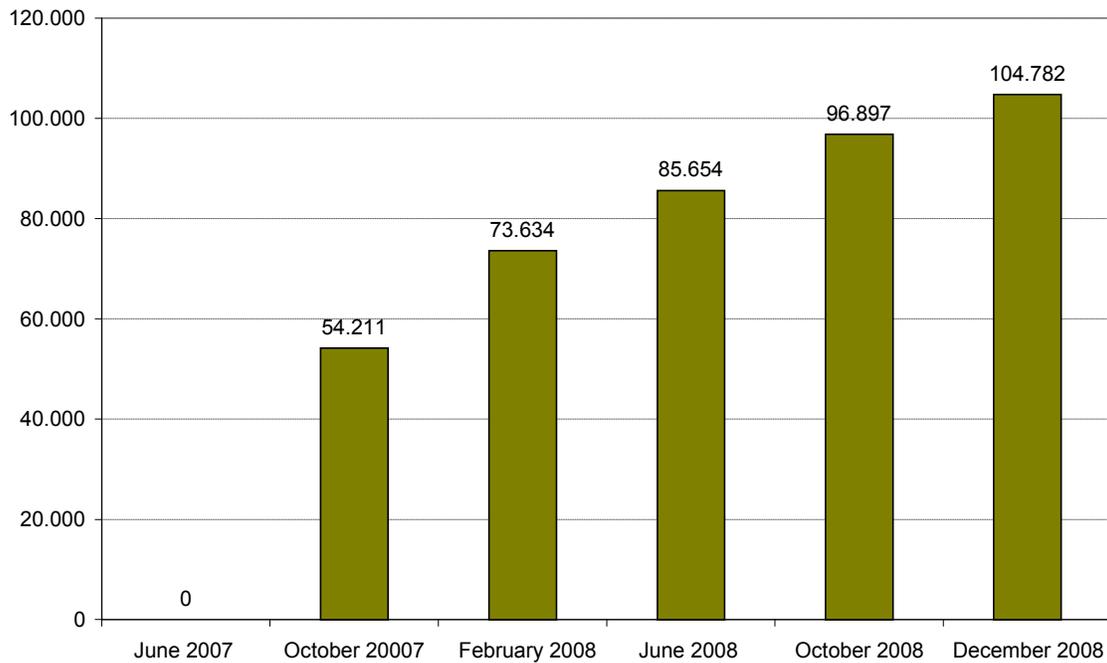
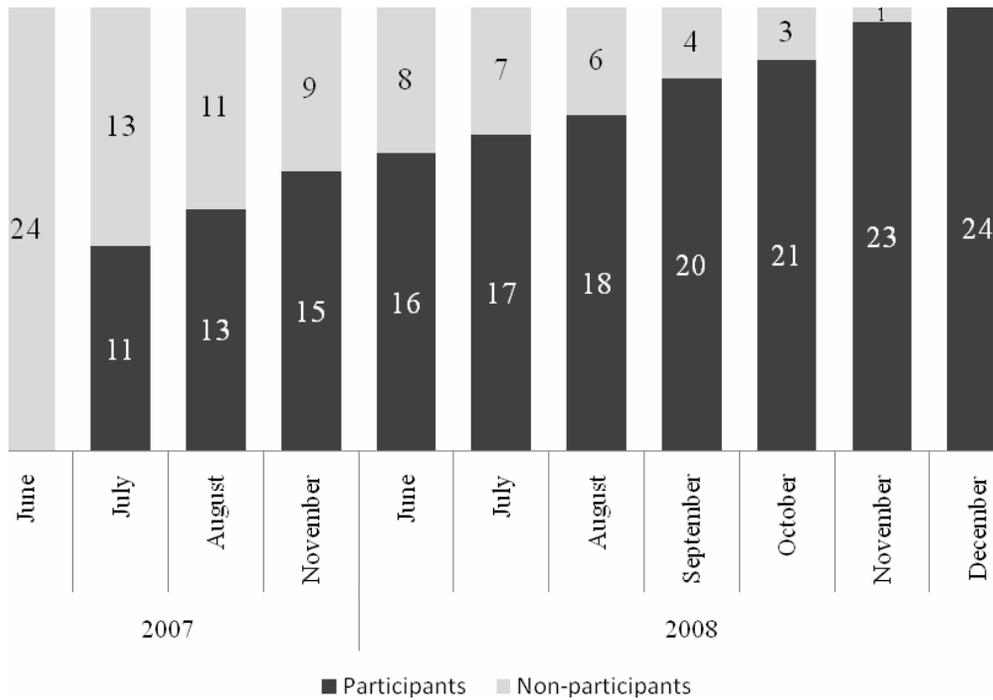


Figure 2 illustrates the staggered nature of the program across provinces. Thirteen out of the 24 Argentine provinces began collecting firearms since July 2007. These were the provinces which already had a local office of RENAR, the federal agency in charge of collecting the firearms. The other 11 provinces started collecting firearms later on as municipal offices and other facilities began to be utilized as weapon collection centers.

**Figure 2. Participating vs, Non-Participating Provinces**



Before estimating the effect of the program using hard measures of crime and violence in the next sections, we analyze two surveys and some administrative data provided by RENAR that helps illustrating the PEVAF program and the characteristics of participants and firearms collected. Although these surveys are unlikely to provide measures for a representative sample of the population, they provide useful information to understand the potential mechanisms that could be driving the impacts of the program on crime and violence.

**2.1. Survey among firearm possessors**

Between May and September 2009 (that is, few months after the program ended), we conducted a telephone interview among 211 households who had reported in LICIP’s

surveys of 2006 and 2007 (before the launching of PEVAF) that either they have or had a firearm. The sample is restricted to households living in the six largest Argentine cities where almost 80 percent of the firearms were collected.<sup>1</sup> The response rate was 60 percent.

We found that 87.1 percent of the sample knew about the program, that is, PEVAF was well advertised. We also found that nine percent of the sample handed over a firearm, which appears relatively high considering that the number of firearms collected at the national level represents about five percent of the estimated stock of firearms. About one fifth of firearm possessors report that they decided not to participate because they feel more secure having a firearm (Table 1).

**Table 1 – Participation in PEVAF, and reasons for not participating, among a sample of households who reported that either they have or had a firearm**

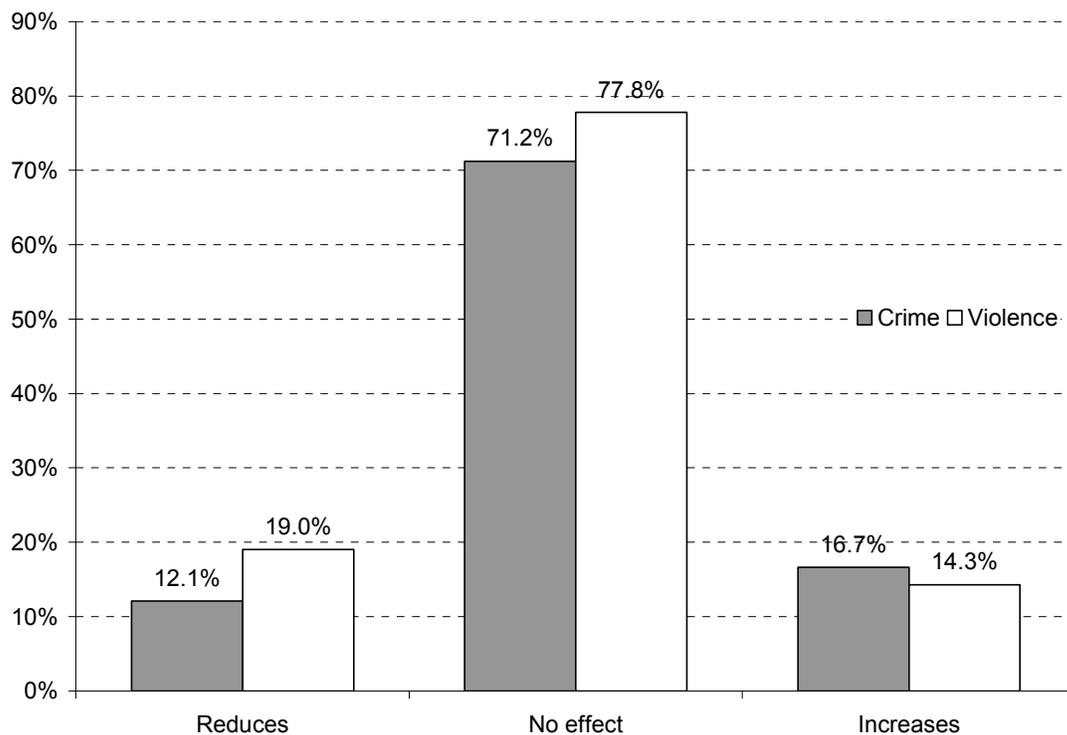
Did you hand over a firearm to PEVAF?	Number	Percentage
Yes	19	9.0 %
No, because firearms provide security	43	20.4 %
No, because the monetary compensation was too low	12	5.7 %
No, because I did not have a firearm at that time	16	7.6 %
No, other reasons	107	50.7 %
Don't know / No answer (N.A.)	14	6.6 %
<b>Total</b>	<b>211</b>	<b>100 %</b>

<sup>1</sup> LICIP (Laboratorio de Investigaciones sobre Crimen, Instituciones y Políticas) runs regular surveys on crime victimization and citizen security on a random sample of households in the City of Buenos Aires, Córdoba, Great Buenos Aires, Mendoza, Rosario and Tucumán. For more information about LICIP surveys see [www.utdt.edu/licip](http://www.utdt.edu/licip).

We asked about the potential impact of the gun buy-back program on crime and violence.

Most interviewees are quite skeptical about the effectiveness of the program (Figure 3).

**Figure 3 – Do you think PEVAF affects crime and violence?**



Finally, we asked a few more questions to the small sample of 19 individuals who reported having participated in the program: how many firearms they handed over, whether the weapons worked, whether they bought a new gun with the money received, and whether they handed over all the firearms they had. We find that the average participant handed over 1.2 firearms, about two thirds of participants declared they handed over all the guns they had, only 1 individual declared he bought a new firearm

with the money received, and one fourth of participants handed over firearms that did not function.

**Table 2 – Participation characteristics (in percentages)**

	Yes	No	N.A.	Total
Did you hand over all the firearms you had?	63	32	5	100
Did you buy a new firearm with the money received?	5	90	5	100
Did the firearms you handed over functioned?	69	26	5	100
Would you participate again?	75	25	-	100

## 2.2. Survey among program participants

The *Red Argentina para el Desarme* (Argentine Network for Disarmament) collected information from individuals who handed over a firearm at the reception stations sited in the cities of Morón, Bahía Blanca and Necochea.<sup>2</sup> Participation in the survey was voluntary and the questionnaire anonymous. A total of 530 people filled out the questionnaire in Morón, and the estimated response rate equaled 73 percent.<sup>3</sup> In Necochea 63 people filled the questionnaire and in Bahia Blanca 35. No information is available to estimate the response rate in these two cities. Table 3 presents some basic figures for each of the three samples. For a detailed analysis of the Morón sample see DerGhougassian et al. (2007).

<sup>2</sup> Morón is a municipality located in the Buenos Aires Metropolitan area, and the two other cities are located in the south of the province of Buenos Aires.

<sup>3</sup> There is no information about the number of people who handed over a firearm. However, a total of 1,070 firearms were collected in Moron during the analyzed period, and the average number of weapons handed over by those who completed the questionnaire was 1.47.

**Table 3 – Socioeconomic characteristics of participants and their opinions (%)**

	Morón	Necochea	Bahía Blanca
Panel A: Sex and age			
Women	33.4	46.0	31.4
30 years old or younger	8.5	15.9	11.4
Panel B: Main reason for handing over a firearm			
It is risky to have a firearm	34.2	34.9	-
Children could have an accident	18.6	34.9	-
Monetary compensation	13.1	7.9	-
Because I don't use the firearm	33.0	17.5	-
Other	1.1	-	-
Don't know / No answer	-	4.8	-
Panel C: Type of firearms			
Revolver	60.0	39.2	37.9
Shotgun	29.2	20.3	22.4
Rifle	5.2	29.7	20.7
FAL machine gun	0.2	8.1	10.3
Other	5.4	2.7	5.1
Don't know / No answer	-	-	3.4

About a third of participants are women, and very few are 30 years old or younger.

Although there is little information on the characteristics of firearms possessors, anecdotal evidence suggests that the share of men and youth possessing firearms is much higher than the above figures. That is, a selected group of possessors participated in the program (and in the survey). This is consistent with buyback programs implemented in other countries where most people who participated rarely used the firearm. There is also selection in the characteristics of the firearms collected. A large share is rifles and fusils

(which are infrequently used in crimes) and about one fourth of the firearms handed over do not function. Furthermore, RENAR conducted a background check and found that only 0.1 percent of the firearms collected were reported as stolen to the police, which is a very small figure given that eight percent of the estimated stock of firearms has been reported as stolen (DerGhougassian, 2007). Although not all stolen guns are reported to the police, this figure suggests that most of the collected firearms have never been used to commit a crime.

The strong selection into the program suggests that the buyback program had no or little effect on crime and violence. First, the idea that by ensuring anonymity the program could reduce the number of guns in the hands of criminals is unlikely to occur because many of the firearms surrendered are useless to commit a crime. Second, the argument that the program would disarm potential victims and hence increase crime is also unlikely because those who feel that firearms provide protection did not hand over their guns. Interestingly, this is also consistent with the opinions of interviewees. Selection, however, suggests that the program could be effective to reduce firearm accidents. About two thirds of program participants report that they handed over the firearm to reduce the risk of suffering an injury (we return to this issue below). These arguments, of course, are highly speculative and will be subject to a more rigorous program evaluation.

### **3. Data Description**

Information regarding deaths from homicides, suicides and accidents, occurred with or without firearms, was obtained from the Dirección de Estadísticas of the Ministerio de

Salud de la Nación. Deaths classification is done following the International Classification of Diseases (10th revision) of the World Health Organization. Data is available for each province and Buenos Aires City, with monthly frequency from January 2003 to December 2008.

Data concerning auto-theft was provided by the Superintendencia de Seguros de la Nación (SSN). The information is available for each province and the city of Buenos Aires, with monthly frequency from January 2004 to June 2009. The SSN counts with the information from all insurance companies of Argentina.

Proportion of auto-theft in the street and carjacking at gunpoint was facilitated by CESVI (Centro de Experimentación y Seguridad Vial). The data is available with monthly frequency for each province and the city of Buenos Aires from January 2005 to December 2009. Combining this data with the information provided by the SSN we can estimate the number of cars stolen in the street and the number of carjacking at gunpoint. CESVI counts with information from approximately 70 percent of all insurance companies.

The stock of firearms collected by the PEVAF is available in the program web site.<sup>4</sup> Information prior to October 16th of 2007 was provided by RAD (Red Argentina para el Desarme). Information was posted with (approximately) weekly frequency.

---

<sup>4</sup> <http://www.desarmevoluntario.gov.ar/>

We also compute socioeconomic characteristics for each province (average education of the population, average household income per capita, the unemployment rate, and the proportion of the population between 16 a 30 years old that is out of school and not working) using the official household survey (EPH) which is published quarterly by the INDEC (Instituto Nacional de Estadísticas y Censos). Information is available from first quarter of 2004 to fourth quarter 2009. Statistics regarding unemployment are available from the first quarter 2003. Quarterly data is converted into monthly assuming a constant variation rate between quarters.

Population data per each province and Buenos Aires City was obtained from the annual estimates of the INDEC. To obtain monthly estimations of the population, a constant growth rate is assumed. The following table resumes the main descriptive statistics:

**Table 4 - Descriptive Statistics**

Variable	Mean	Standard Deviation	Observations	Period Available
Homicides with firearms <sup>†</sup>	3.7	9.3	1728	Jan 03 - Dec 08
Non-intentional deaths with firearms <sup>†</sup>	0.5	1.6	1728	Jan 03 - Dec 08
Suicides with firearms <sup>†</sup>	2.9	6.2	1728	Jan 03 - Dec 08
Homicides without firearms <sup>†</sup>	3.6	6.6	1728	Jan 03 - Dec 08
Non-intentional deaths without firearms <sup>†</sup>	36.6	56.4	1728	Jan 03 - Dec 08
Suicides without firearms <sup>†</sup>	7.9	13.0	1728	Jan 03 - Dec 08
Stock of firearms	3123.3	6900.1	432	Jul 07 - Dec 08
Stolen cars	161.1	514.2	1584	Jan 04 - Jun 09
Proportion of stolen cars in the street	0.7	0.4	1440	Jan 05 - Dec 09
Proportion carjacked at fire point	0.3	0.3	1440	Jan 05 - Dec 09
Income per capita <sup>‡</sup>	596.0	418.9	1728	Jan 04 - Dec 09
Proportion of Primary Education	0.3	0.1	1728	Jan 04 - Dec 09
Proportion of Secondary Education	0.4	0.1	1728	Jan 04 - Dec 09
Proportion of Tertiary Education	0.3	0.1	1728	Jan 04 - Dec 09
Proportion of young unemployed and out of school	0.1	0.0	1728	Jan 04 - Dec 09
Unemployment	8.9	4.5	2016	Jan 03 - Dec 09

**Notes:** <sup>†</sup> Rates per 100,000 inhabitants, <sup>‡</sup> in Argentinean pesos.

#### 4. Econometric Methods

Our objective is to identify the effect of the PEVAF gun buy-back program on firearm crime (homicides and car theft), suicides, and accidents. Specifically, we are interested in comparing the number of firearm crimes, suicides, and accidents in each province when firearms are collected by the buy-back program relative to the values in the same provinces and periods of time without the program. Since the counterfactual is never observed, we must estimate it. Ideally, we would like to have a randomization assigning the program across provinces and compare the average outcomes of the two groups. In the absence of a randomized experiment, we are forced to turn to non-experimental methods that mimic it under reasonable conditions.

As discussed in Section 2, the gun buy-back program was implemented at each province between July 2007 and December 2008. The program first started operations in the 11 provinces where RENAR, the federal agency in charge of collecting the weapons, had a local office. The other districts started collecting the weapons later using municipal and other facilities as collection centers. A major concern is that the provinces where the program first started could be different from the areas that started later, and that these differences may be correlated with the outcomes under study. For example, high crime areas could be more likely to have a RENAR office. In this case, the correlation between the program implementation and the outcomes under study would be confounded with the crime differences.

It is certainly possible that the distribution of RENAR office across the country is not random, but dependent on provincial characteristics. The presence of RENAR offices, however, was pre-determined before the beginning of the process. If their geographic distribution was based on heterogeneous provincial characteristics, it was potentially correlated with the baseline values of those characteristics, and not with the time-varying levels. Therefore, these potential sources of heterogeneity are fixed over time in our experiment. In order to control for time-invariant heterogeneity we use panel data and estimate a difference-in-differences model introducing fixed effects. By conditioning on fixed effects, the difference-in-differences estimator identifies the parameter of interest without ruling out selection of program timing based on time-invariant unobservables.

In addition to the potential correlation between the outcomes of interest and time-invariant province characteristics, which is addressed by the inclusion of fixed effects, another potential identification concern is the existence of trends in the outcomes under study. As the program is a before-after variable, a secular crime reduction trend, for example, could be confounded with the effects of the program. We include a linear time trend for each province to address this issue.

Thus, without the benefit of a randomized experiment, we turn to a difference in differences approach, which compares the change in outcomes in the early-treated group relative to the change in outcomes in the late-treated group. By comparing changes, we control for observed and unobserved time-invariant characteristics that might be correlated with the program timing as well as with the outcomes under study. The difference-in-differences model can be specified as a two-way fixed effect linear regression model:

$$y_{it} = \alpha b_{it} + \beta x_{it} + \sum_i \delta_i m_t + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

where  $y_{it}$  are different crime, suicide, and accident outcomes in province  $i$  and period  $t$ ,  $b_{it}$  indicates whether the program is operational in province  $i$  and period  $t$  (we use both a continuous and a dummy variable),  $x_{it}$  is a vector of control variables that vary across province and time,  $\delta_i$  is the province –specific coefficient associated to the time trend  $m_t$ ,  $\lambda_t$  is a time (monthly or quarterly) fixed effect,  $\mu_i$  is a province fixed effect, and  $\varepsilon_{it}$  is the

error term. In this model,  $\alpha$  estimates the effect of the gun buy-back program on the different outcomes.

We exploit this difference in differences strategy for firearm crimes, suicides, and accidental deaths. In spite of the inclusion of a set of control variables, it is still possible that at the time of the implementation of the program there may have been other unobserved changes correlated with our outcome variables. For example, there may have been enhancements in the health care system correlated by chance with the development of the program reducing mortality from wounds in general. In order to explore the potential presence of spurious correlation, as a falsification exercise we also examine the impact of the program on crimes, suicides, and accidental deaths not caused by firearms. If the program is spuriously capturing the effect of unobservable shocks, we should also see effects on non-firearm events. Instead, the effect of the gun buy-back program should only affect firearm crimes, suicides, and accidents.

Three different model specifications are considered in our study. The first model specification includes fixed effects for each province (and Buenos Aires City), fixed effects for every month, and a linear time trend for each province (and Buenos Aires City). The second specification incorporates control variables. The controls included are: unemployment, maximum level of educational attainment, percentage of the population between 16 and 30 years old that is unemployed and out of school, and per capita income. The last specification differs from the second one in the fact that considers Buenos Aires City and Buenos Aires Province as one jurisdiction. Since the participants of the program

remained anonymous and since many people who live in Province of Buenos Aires, work in Buenos Aires City (and vice versa) it seems likely that people could have handed their guns in a jurisdiction different that the one they live.

## **5. Results**

We study the effects of PEVAF on crime, suicides and accidents. We are interested of course on events with the use of firearms, but we also analyze non-firearm events as falsification tests. To quantify the effects of the program on crime we use the number of firearm homicides, non-firearm homicides, auto theft in the streets and carjacking at gunpoint as dependent variables. To measure the effects of the program on violence we use the number of firearms suicides and non-firearm suicides. Finally to quantify potential effects of the program on accidents, we considered as dependent variables the number of non-intentional deaths (committed with or without firearms).

Table 5 summarizes our findings of the effect of the program on crime. Columns 1 to 3 present the coefficients on the variable of interest, the stock of firearms collected by the program, for our three model specifications.

**Table 5 - Effects on Crime**

DEPENDENT VARIABLES	REGRESORS		
	LN [Stock of Collected Guns/Population]		
	(1)	(2)	(3)
Ln [Firearm Homicide / Population]	0.02 (0.06)	0.02 (0.06)	0.02 (0.06)
Ln [Non-firearm Homicide / Population]	0.03 (0.05)	0.02 (0.05)	0.02 (0.05)
Ln [Carjacking at gunpoint / Population]	-0.03 (0.04)	-0.03 (0.03)	-0.02 (0.04)
Ln [Auto Theft in the street / Population]	-0.04 (0.05)	-0.04 (0.05)	-0.04 (0.05)
<i>Controls</i>	<i>no</i>	<i>yes</i>	<i>yes</i>
<i>City and Province of Buenos Aires as one jurisdiction</i>	<i>no</i>	<i>no</i>	<i>yes</i>

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the ln(Stock of Collected Guns/Population). Monthly data. All the regressions include month fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models.

Even though, our results suggest a positive relation between the stock of firearms collected by the program and homicides (committed with or without firearm) throughout different model specifications, the relationship is never statistically significant. We also find under different specifications a negative relation between auto theft in the street, carjacking at gunpoint, and the stock of firearms collected, although again these results are not statistically significant. In conclusion, we cannot say the program has been effective in reducing crime.

Table 6 summarizes our results on the effects of the program on suicides; with columns 1 to 3 presenting our findings from the three model specification. We do not find a

significant relationship between the variables. The results stand throughout model specification.

**Table 6 - Effects on Suicides**

DEPENDENT VARIABLES	REGRESSORS		
	LN [Stock of Collected Guns/Population]		
	(1)	(2)	(3)
Ln [Firearm Suicide / Population]	0.01 (0.09)	0.01 (0.09)	0.01 (0.09)
Ln [Non-firearm Suicide / Population]	0.02 (0.03)	0.02 (0.03)	0.02 (0.03)
<i>Controls</i>	<i>no</i>	<i>yes</i>	<i>yes</i>
<i>City and Province of Buenos Aires as one jurisdiction</i>	<i>no</i>	<i>no</i>	<i>yes</i>

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the ln(Stock of Collected Guns/Population). Monthly data. All the regressions include month fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models.

Finally we considered the effects of the program on deaths from accidents. To quantify the effects of the program we considered as dependent variable the number of non-intentional deaths (occurred with or without firearms). Table 7 summarizes the effects of the stock of firearms collected by the program on accidents.

**Table 7 – Effects on Accidental Deaths**

DEPENDENT VARIABLES	REGRESSORS		
	LN [Stock of Collected Guns/Population]		
	(1)	(2)	(3)
Ln [Firearm Accidental Deaths / Population]	-0.07* (0.04)	-0.08* (0.04)	-0.08* (0.04)
Ln [Non-Firearm Accidental Deaths / Population]	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
<i>Controls</i>	<i>no</i>	<i>yes</i>	<i>yes</i>
<i>City and Province of Buenos Aires as one jurisdiction</i>	<i>no</i>	<i>no</i>	<i>yes</i>

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the ln(Stock of Collected Guns/Population). Monthly data. All the regressions include month fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models. \* Significant at 0.1 level.

We find statistically significant evidence (at the 10% level) that the program has successfully reduced the number of firearm accidental deaths. According to our estimates, doubling the stock of collected firearms would reduce per capita firearm accidental deaths by eight percent.<sup>5</sup>

These results stand throughout the different model specifications. It is reassuring that using the same methodology we do not find a significant effect of the program on non-firearm accidents. Thus, the reduction in the number of firearm accidents survives this falsification test as it does not seem to be driven by a reduction in the overall number of accidents, but reflecting a specific phenomenon on firearm accidental deaths. This empirical evidence suggests that the program has partially fulfilled its goal.

<sup>5</sup> Argentina suffered a total of 115 firearm accidental deaths the year before the launching of the program.

We explore the robustness of our results in several dimensions. First, we substitute the continuous independent variable  $\ln(\text{Stock of Collected Guns/Population})$  for a dummy variable that identifies the provinces participating in the program at each given period. Table 8 summarizes our findings of the effects of the program when the independent variable is the participation dummy. Columns 1 to 3 collect the results from the three model specifications. Rows 1 to 4 gather the results for the impact on crime, 5 to 6 the results of the impact on suicides and rows 7 to 8 the results of the impact on accidents.

**Table 8 – Program Participation Dummy**

DEPENDENT VARIABLES		REGRESSOR			
		PEVAF PARTICIPATION DUMMY			
		(1)	(2)	(3)	
Crime	1	Ln [Firearm Homicide / Population]	0.73 (3.41)	0.83 (3.39)	0.73 (3.49)
	2	Ln [Non-firearm Homicide / Population]	1.43 (2.90)	1.32 (2.87)	1.03 (2.89)
	3	Ln [Carjacking at gunpoint / Population]	-1.71 (2.06)	-1.47 (2.00)	-1.40 (2.07)
	4	Ln [Auto Theft in the street / Population]	-2.48 (3.01)	-2.28 (3.02)	-2.33 (3.07)
Suicides	5	Ln [Firearm Suicide / Population]	0.49 (5.16)	0.74 (5.02)	0.79 (5.16)
	6	Ln [Non-firearm Suicide / Population]	0.99 (1.83)	1.15 (1.80)	1.22 (1.82)
Accidents	7	Ln [Firearm Accidental Deaths / Population]	-4.19* (2.19)	-4.58** (2.12)	-4.35* (2.10)
	8	Ln [Non-Firearm Accidental Deaths / Population]	0.11 (0.38)	0.09 (0.38)	0.11 (0.41)
<i>Controls</i>		<i>no</i>	<i>yes</i>	<i>yes</i>	
<i>City and Province of Buenos Aires as one jurisdiction</i>		<i>no</i>	<i>no</i>	<i>yes</i>	

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the Program Participation dummy. Monthly data. All the regressions include month fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models. \*\* Significant at 0.05, \* Significant at 0.1 level.

When the independent variable considered is the program participation dummy, the results obtained are similar than those calculated when the stock of firearms collected by the program was used as the regressor. We still find no significant effects of the program on crime and suicides. The impact of the program on firearm accidental deaths is statistically significant and negative, with no effect on non-firearm accidents. The conclusions that we arrive when the independent variable was the stock of firearms collected, stand when we use as explanatory variable the participation dummy; the program has successfully reduced the firearm accidents.

Given the potential noisiness in the monthly data (in particular, because of potential delays in the firearm collection reporting), we also explore the robustness of our results to using as a regressor the stock of firearms collected by the program with quarterly data. Table 9 presents the results from the three model specification with quarterly frequency data. Rows 1 to 4 gather the results for the impact on crime, 5 to 6 the results of the impact on suicides, and rows 7 to 8 the results of the impact on accidents. All the results previously found are robust to the change in data frequency. The program only shows an effect on the reduction in the number of firearm accidents with no effect, as expected, on non-firearm accidents.

**Table 9 – Quarterly Data**

DEPENDENT VARIABLES		REGRESSOR			
		LN [Stock of Collected Guns/Population]			
		(1)	(2)	(3)	
Crime	1	Ln [Firearm Homicide / Population]	0.02 (0.06)	0.02 (0.06)	0.01 (0.06)
	2	Ln [Non-firearm Homicide / Population]	0.03 (0.05)	0.03 (0.05)	0.02 (0.05)
	3	Ln [Carjacking at gunpoint / Population]	-0.02 (0.04)	-0.02 (0.04)	-0.02 (0.04)
	4	Ln [Auto Theft in the street / Population]	-0.04 (0.05)	-0.03 (0.05)	-0.03 (0.05)
Suicides	5	Ln [Firearm Suicide / Population]	-0.02 (0.09)	-0.01 (0.09)	-0.01 (0.09)
	6	Ln [Non-firearm Suicide / Population]	0.00 (0.03)	0.01 (0.02)	0.01 (0.03)
Accidents	7	Ln [Firearm Accidental Deaths / Population]	-0.07 (0.04)	-0.08** (0.04)	-0.08* (0.04)
	8	Ln [Non-Firearm Accidental Deaths / Population]	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
<i>Controls</i>		<i>no</i>	<i>yes</i>	<i>yes</i>	
<i>City and Province of Buenos Aires as one jurisdiction</i>		<i>no</i>	<i>no</i>	<i>yes</i>	

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the ln(Stock of Collected Guns/Population). Quarterly data. All the regressions include quarter fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models. \*\* Significant at 0.05, \* Significant at 0.1 level.

Finally, we conclude our robustness analysis in Table 10 verifying if our results remain valid to changes in both the dependent variable and the data frequency. The non-significant results obtained for crime and suicides remain unaffected. The significant results previously obtained for firearm accidents are also robust to these alternative specifications.

**Table 10 – Program Participation Dummy and Quarterly Data**

DEPENDENT VARIABLES		REGRESSOR			
		PEVAF PARTICIPATION DUMMY			
		(2)	(4)	(6)	
Crime	1	Ln [Firearm Homicide / Population]	-0.33 (3.10)	-0.76 (3.11)	-0.86 (3.18)
	2	Ln [Non-firearm Homicide / Population]	1.72 (2.95)	1.68 (2.78)	1.50 (2.80)
	3	Ln [Carjacking at gunpoint / Population]	-0.96 (1.73)	-0.96 (1.66)	-0.84 (1.73)
	4	Ln [Auto Theft in the street / Population]	-0.53 (2.18)	-0.41 (2.17)	-0.41 (2.21)
Suicides	5	Ln [Firearm Suicide / Population]	0.27 (5.10)	0.53 (5.09)	0.60 (5.29)
	6	Ln [Non-firearm Suicide / Population]	-0.94 (1.29)	-0.67 (1.31)	-0.66 (1.36)
Accidents	7	Ln [Firearm Accidental Deaths / Population]	-3.72* (2.04)	-4.38** (1.87)	-4.09** (1.82)
	8	Ln [Non-Firearm Accidental Deaths / Population]	0.30 (0.49)	0.31 (0.49)	0.35 (0.53)
<i>Controls</i>		<i>no</i>	<i>yes</i>	<i>yes</i>	
<i>City and Province of Buenos Aires as one jurisdiction</i>		<i>no</i>	<i>no</i>	<i>yes</i>	

Notes: Each cell presents the coefficient from different regressions of the dependent variables on the ln(Stock of Collected Guns/Population). Quarterly data. All the regressions include quarter fixed effects, province fixed effects, and province time trend. Robust standard errors are in parentheses and are clustered by province in all models. \*\* Significant at 0.05, \* Significant at 0.1 level.

The empirical evidence suggests that the program has reduced the number of deaths from firearm accidents, but has not been successful in reducing suicides, homicides or car theft. Our results are robust to model specification, choice of independent variable, and data frequency.

## **6. Conclusions**

The effect of policies and regulations affecting the availability of guns in the population is an unsettled and controversial issue. In this paper, we contribute to this debate by analyzing the effect of PEVAF, a large Argentine gun buy-back program, on crime and violence.

Our results suggest that the program has been successful in reducing the number of deaths from firearm accidents, but has not been successful in reducing suicides, homicides or car theft. This is consistent with strong selection of the program participants. As complementary survey evidence suggests, most people who participated rarely used the firearm and most of the collected firearms were never used to commit a crime. Thus, the program does not seem to have convinced criminals and potential suicides, to hand in their weapons, but it might have had an effect on the general population leading to a reduction in the number of domestic guns and, thus, firearm accidental deaths.

## References

- Banco Mundial (2006). "Crime, Violence and Economic Development in Brazil: Elements for Effective Public Policy", Report No. 36525.
- Baker, Jeanine, and Samara McPhedran (2006). "[Gun Laws and Sudden Death: Did the Australian Firearms Legislation of 1996 Make a Difference?](#)" *British Journal of Criminology*: 455.
- Duggan, Mark (2001). "More Guns, More Crime", *Journal of Political Economy*, Vol. 109 (5): 1086-1114.
- DerGhougassian, Katchik, Diego Fleitas, Pablo Dreyfus, Antonio Rangel Bandeira y Alejandra Otamendi (2007). "Las Armas y las Víctimas: Violencia, Proliferación y Uso de Armas de Fuego en la Provincia de Buenos Aires y en la Argentina." *APP-Universidad de San Andrés*.
- LICIP (2009), "Informe de Victimización Abril 2009", Universidad Torcuato Di Tella.
- Lott, John (2000). *More Guns, Less Crime: Understanding Crime and Gun Control Laws*. University of Chicago Press, Chicago: IL.
- O'Flaherty, Brendan and Rajiv Sethi (2010). "Peaceable Kingdoms and War Zones: Preemption, Ballistics, and Murder in Newark" in R. Di Tella, S. Edwards and E. Schargrodsky (eds.), *The Economics of Crime: Lessons for and from Latin America*, Chicago and London: NBER-University of Chicago Press, pp. 305-357.
- Marinho de Souza, Maria de Fátima; James Macinko, Airlane Pereira Alencar, Deborah Carvalho Malta and Otaliba Libânio de Moraes Neto (2007). "Reductions In Firearm-Related Mortality And Hospitalizations In Brazil After Gun Control", *Health Affairs*, 26, no. 2.
- Plotkin, Martha, ed. (1996). *Under Fire: Gun Buybacks, Exchanges and Amnesty Programs*. Police Executive Research Forum.
- RENAR (2009), <http://www.desarmevoluntario.gov.ar/acerca.html>, retrieved May 18, 2009.
- Reuter and Mouzos (2003) *Australia: A Massive Buy back of Low-Risk Guns*.
- Sherman, Lawrence (2001). "Reducing Gun Violence: What Works, What Doesn't, What's Promising?" *Criminal Justice*, Vol. 1: 11-25.
- Wellford, Charles, John Pepper and Carol Petrie, eds. 2004. *Firearms and Violence: A Critical Review*. Committee on Law and Justice, National Research Council, National Academies Press.