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The Role of Public Security Reforms on Violent Crime Dynamics

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In the context of increasing violence, public security reforms are commonly advocated as a solution to the problem despite the lack of empirical evidence. We address this question by evaluating the effect of the *Pacto pela Vida* program, a comprehensive reform on the public security of the state of Pernambuco, Brazil. We document a reduction of 16 homicides per 100,000 inhabitants following the program implementation. We show that a reduction in crimes occurring on the streets and associated with young males and firearm availability are likely to have contributed to the program's effect.

JEL Codes: H76, K42, R58

Keywords: crime, reform, policy evaluation, Brazil

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1 Introduction

Evidence on the causal effect that state reforms might have on crime is scarce. Most of the literature on the subject is descriptive. It usually focuses on changes in political regimes as the source of variation in how public security is structured (Cruz, 2011). In comparison, there is an enormous literature on the effect of changes in specific aspects of the public security policy, such as policing intensity and the police structure (Owens and Ba, 2021). Yet, an evaluation of a comprehensive reform of public security as a whole is still missing. In this paper, we follow Wolff (2017) assessment on the nature of a profound reform on the public security of the Brazilian state of Pernambuco, the *Pacto pela Vida* (PPV) program, to fill this gap.

According to Ratton and Daudelin (2018), the homicide rate per 100,000 inhabitants in Pernambuco was never below 40 between 1996 and 2009, which ranked the state as one of the most violent regions in the country¹. In 2007, the elected governor, Eduardo Campos, chose the fight against crime as one of the state’s priorities. In the first months of his mandate, a workforce composed of governmental and non-governmental authorities launched a state plan for security, the PPV program, which aimed to reduce homicides by 12% per year. Police management changed as the committee divided the state into 26 security areas. By doing so, the government intended to better identify the crime hot spots and allocate resources effectively. In addition, the program changed the level of coordination among public security institutions, which led to an increase in the state’s investigative capacity and public security governance (Wolff, 2017).

da Mota Silveira Neto et al. (2022) document an annual reduction of 10.1 homicides per 100,000 following the PPV implementation. After 2014, however, the homicide rate started to increase again. Authors argue that due to the solid political component of the policy, its persistence depended much on the governor’s figure, who left office in 2014. The valorization of the police force was also a relevant component of the program since its beginning (Wolff, 2017). Ten years after the program’s implementation, however, an explicit performance bonus for police officers who seized firearms was deployed. Barros et al. (2022) suggest that this performance-based incentive had sizeable effects. Using a synthetic-control approach, they show a positive correlation between the bonus incentive and increased firearm seizures. While a decline in overall crime rates is also noted, they argue that this reduction cannot be directly attributed to the program.

We complement da Mota Silveira Neto et al. (2022) and Barros et al. (2022) by

¹According to the FBI’s UCR, Chicago’s homicide rate was about 20 per 100,000 in 2022.

evaluating the effect that the PPV program had on violent crimes through a difference-in-differences and event-study approach. By doing so, we can directly test if the treated and control groups’ crime trajectories were similar before the program’s implementation. Moreover, we evaluate the program’s effect in the first years of implementation, when Pernambuco was the only northeast state experiencing a public security reform. Finally, we also explore several potential mechanisms through which the effect on homicides emerged.

2 Data

We built a panel of Brazilian municipalities from 2004 to 2011². One of our primary data sources is the Brazilian Ministry of Health’s administrative records (DATASUS–SIM), which contains detailed information on deaths by homicides and other causes classified according to the International Statistical Classification of Diseases and Related Health Problems (ICD). From each death record, we also have information on the death’s location, as well as the victims’ demographics. Additionally, we use data from the Brazilian Census Bureau (IBGE) on local GDP, Human Development Index, population estimates, and density. Finally, we make use of data from the *Relação Anual de Informações Sociais* (RAIS), a yearly employer-employee administrative dataset from the Brazilian Ministry of Labor providing information on the universe of formal labor contracts.

3 Empirical Strategy

The PPV program was implemented in all the state’s municipalities in May 2007. Municipalities from the other northeast states did not experience a similar intervention until 2011. We rely on this cross-section variation to build treated and control groups. Then, to assess the impact of Pernambuco’s PPV program, we use a difference-in-differences strategy and estimate the following two-way fixed effects equation:

$$Y_{it} = \beta_0 + \beta_1(T_t \times D_i) + X'_{it}\phi + \theta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is the outcome in municipality i , and year t , D_i is a dummy variable indicating Pernambuco’s municipalities, and T_t represents the treatment period. X_{it} is a vector of covariates interacted with year dummies, whereas θ_i and λ_t indicate municipality and

²After 2011, neighboring states from the northeast region began to implement similar policies. The state of Paraíba was one of them, launching the *Paraíba Unida Pela Paz* program by the end of 2011. The state of Bahia deployed its own PPV in 2012.

year fixed effects, respectively. The municipality’s population in 2000 weighs observations. Standard errors are clustered at the municipality level.

When estimating difference-in-differences models like the one above, unobservable co-founders that also change around the treatment period pose a threat to the identification strategy. In other words, treated and control groups should display similar trajectories were it not for the PPV implementation. We provide evidence on the validity of this parallel trends assumption by using an event-study framework. Formally, we estimate:

$$Y_{it} = \alpha_0 + \alpha_t(D_i \times Year_t) + X'_{it}\phi + \theta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where $Year_t$ is a dummy variable that equals one in year t . All other variables, weights, and clusters are defined as before. The omitted year is 2006, the first pre-PPV year.

4 Estimation results

4.1 Descriptive evidence

Figure 1 illustrates the evolution of the homicide rate in Pernambuco and other states. Despite a similar upward trend, Pernambuco’s homicide rate was at least 2 times higher than the region’s average in 2004 – 2006. After 2007, the state’s homicide rate began to fall, dropping from 51 homicides per 100,000 inhabitants to a rate of 37 in 2011. Despite still being one of the most violent states, Pernambuco displayed a downward trend while the neighboring states continued on the path of increasing violence. This marked difference between the periods before and after 2007 suggests that something happened only in the state of Pernambuco that reverted the region’s violent trend.

4.2 The PPV Effect on crime

Table 1 reports estimates for β_1 from equation (1). Columns (1)-(2) present results for the effect of the PPV program on the homicide rate. The table suggests that the program was responsible for a relative reduction of 16 homicides per 100,000 inhabitants, precisely what we observe in Figure 1. The coefficient is virtually the same after the inclusion of covariates.

Columns (3)-(5) present a robustness exercise to check whether our results depend on the treatment and control groups’ definitions. We increase comparability by limiting the estimation sample to geographically proximate municipalities, using Pernambuco’s border

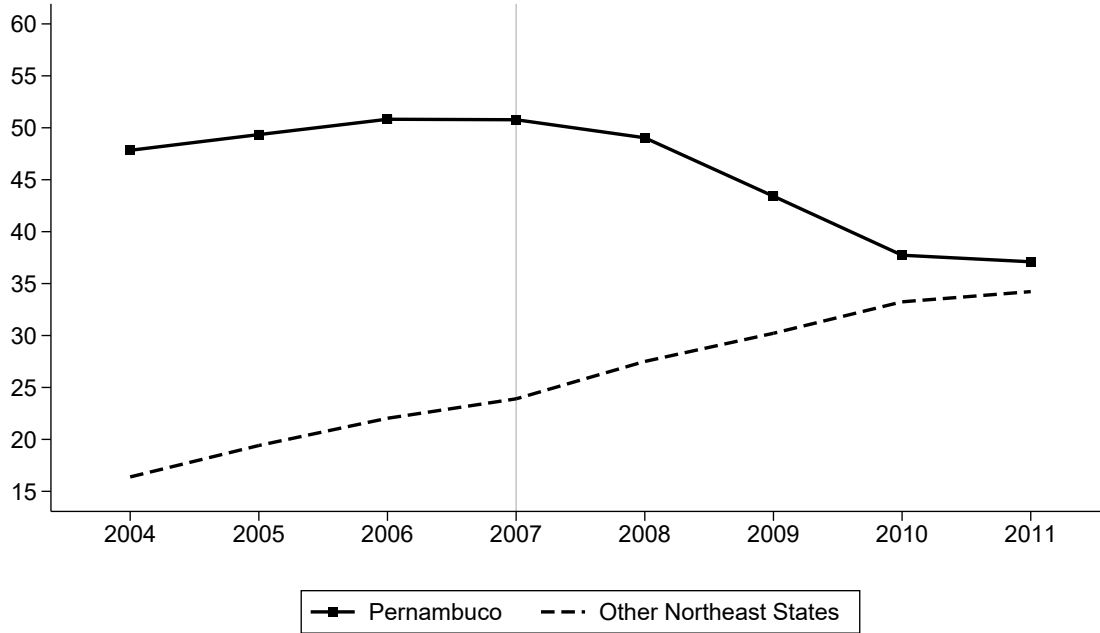


Figure 1: Homicides per 100,000 Inhabitants in the Brazilian Northeast Region

Table 1: Homicides and the *PPV* Program

	Main results		Robustness: distance to PE border		
	(1)	(2)	< 100km (3)	< 75km (4)	< 50km (5)
PPV Program Effect	-16.068*** [2.532]	-16.301*** [2.617]	-9.286*** [2.436]	-8.454*** [2.300]	-7.770*** [2.737]
Covariates	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes
Dep. variable mean	15.88	15.88	20.97	22.02	22.82
Observations	14,288	14,288	3,432	2,744	1,880

Notes: All regressions are weighted by the municipality population in 2000. We include municipality and year-fixed effects in all regressions. The covariates in columns (2)-(5) include the log of the municipality's GDP per capita, the log of formal employment, the Human Development Index, and population density. In brackets, standard errors are clustered at the municipality level. Significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

as the reference point³. There is a reduction in the coefficient's magnitude once we move

³See Appendix Figure A.1 for a graphical visualization.

from the original sample to the restricted sample that includes only municipalities that are, at most, 100 kilometers distant from the Pernambuco’s border. The magnitude reduction, however, is smaller as we move from the sample with the 100-km window to a sample with a 75 or 50-km window. Notice that, in all specifications, the point estimates are statistically significant at the 1% level.

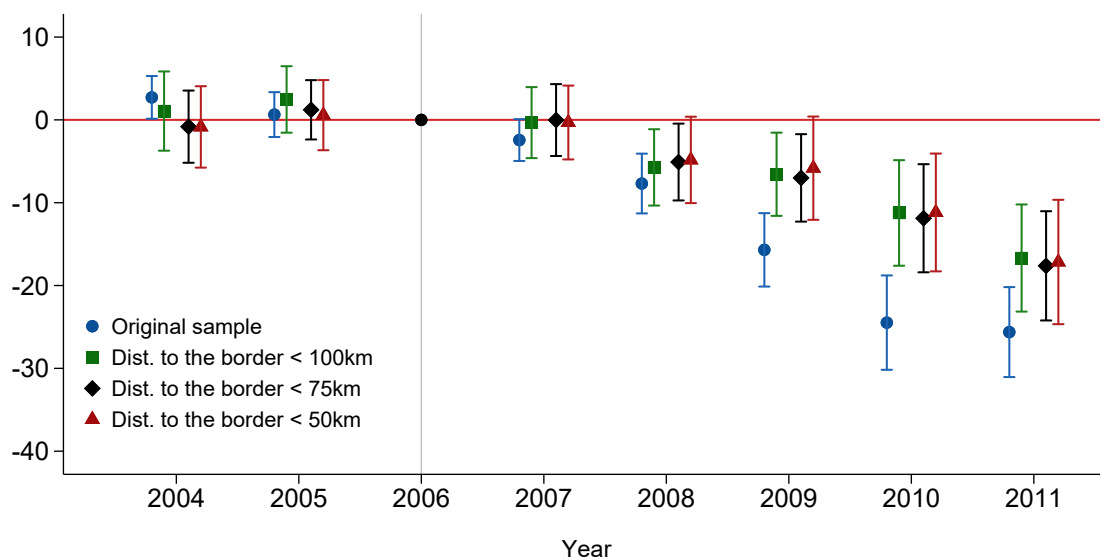


Figure 2: Dynamic Effects on Homicides

We complement this discussion by showing the dynamic effects of the PPV program on homicides. Figure 2 presents the results of estimating equation (2) for all samples. Estimated α_t coefficients are presented graphically, together with the respective 90% cluster-robust confidence intervals. Results suggest that before 2007, the year the PPV program was implemented, the homicide rate displayed a similar trajectory across Pernambuco’s municipalities and the control group, supporting the validity of the parallel trends assumption. Moreover, Figure 2 shows that once the PPV program was implemented, the treated group homicide rate decreased monotonically. In 2010, the program’s accumulated effect was between -10 and -25 homicides per 100,000 inhabitants. This is in line with da Mota Silveira Neto et al. (2022) evidence for the 2007-2011 period and also Figure 1, but now in a setting that accounts for several potential unobservable cofounders.

4.3 Potential Mechanisms

More than an intervention in the police remuneration scheme or in the level of institutional coordination, the PPV program was a public security reform that changed how Pernambuco dealt with violence in many dimensions. Thus, rather than testing a specific channel, in this section, we explore many potential mechanisms that may have contributed to the documented effect on homicide rates.

First, we explore the effect that the PPV had on homicides of young males and on homicides that occurred in public places. Columns (1)-(3) of Table 2 show that the relative decrease in homicides seems to be much concentrated on young males and homicides occurring outside of the victims' homes. Specifically, more than 80% of the estimated effect on homicides comes from males aged 15-39 and from homicides occurring on the streets. These results suggest that the PPV effect is unlikely related to reductions in domestic disputes; reducing conflicts associated with street crime constitutes a more likely mechanism.

Table 2: Potential Mechanisms

	Homicide rate decomposition			Policing intensity, drugs and guns availability			Placebo and spillovers	
	All homicides	Young male homicides	Outside of home homicides	Deaths by police intervention	Fraction of suicides by firearm	Drug overdose deaths	Suicides per 100,000 inhab.	Traffic accident deaths per 100,000 inhab.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PPV Program Effect	-16.301*** [2.617]	-13.355*** [2.274]	-14.171*** [2.526]	-0.042 [0.036]	-0.018** [0.007]	-0.001 [0.037]	-0.209 [0.184]	-0.038 [0.028]
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dep. variable mean	15.88	10.25	5.82	0.05	0.03	0.23	4.30	0.17
Observations	14,288	14,288	14,288	14,288	5,909	14,288	14,288	14,288

Notes: In brackets, standard errors are clustered at the municipality level. Significance at the 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Columns (4)-(6) of Table 2 explore the effect on outcomes associated with policing intensity, illegal market activity, and firearms availability. While no significant effects are observed on deaths by police intervention or drug overdose, we show that the fraction of suicides by firearms, a proxy for local gun availability, experienced a relative decrease of 1.8 pp. While an explicit formal bonus for police officers who seized illegal firearms took place in 2017 (Barros et al., 2022), our results suggest that in the initial years of the PPV program, a reduction in firearm availability was also an important channel through which homicides were reduced (Gius, 2020). Additionally, columns (7)-(8) show that the

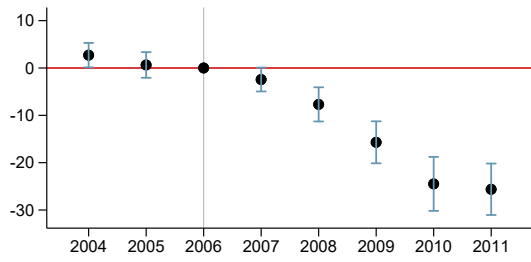
program did not affect the suicide or traffic accident death rates.

For completeness, Figure 3 shows the dynamic effects on outcomes of Table 2. Results corroborate the static estimations and suggest that a lower gun availability and a reduction in disputes that occur on the streets and among young males are indeed the most likely channels behind the PPV program's effect on homicides.

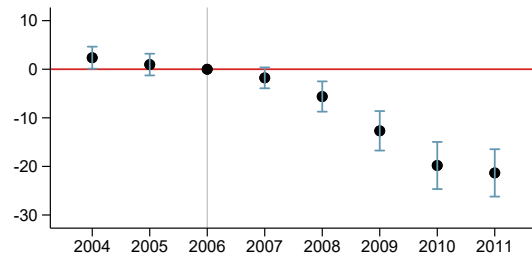
5 Conclusion

Evidence on the causal link between public security reforms and crime is limited. In this paper, we use a deep reform implemented in 2007 in the Brazilian state of Pernambuco to fill this gap. First, we show that Pernambuco experienced a robust relative decrease in the homicide rate following the program implementation. Then, we explore potential mechanisms that might be behind the reduction in homicides. Despite not being able to pin down an exact mechanism, we show that more than 80% of the overall effect came from a relative reduction in homicides of young males that occurred outside the victim's residence. We also present evidence that the program effect might be closely associated with a reduction in firearms availability.

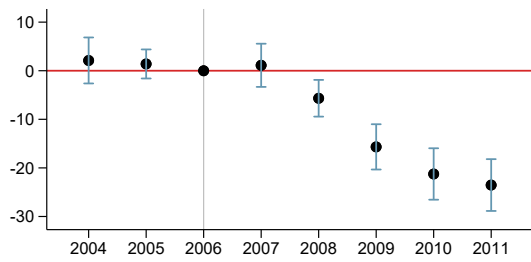
Homicides rate



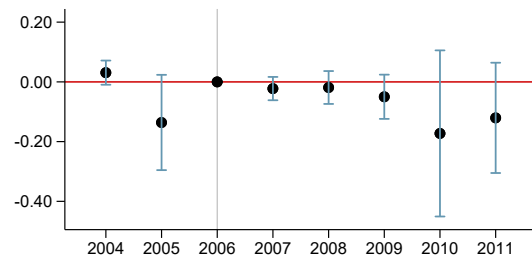
Young male homicides rate



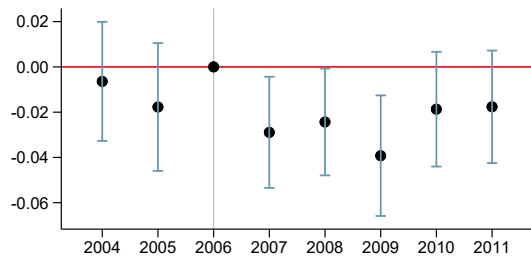
Outside of home homicides rate



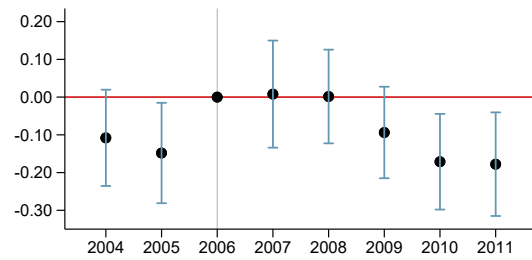
Rate of deaths by police intervention



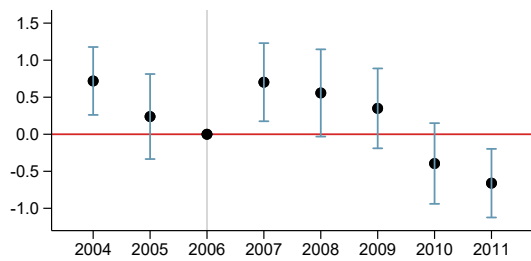
Fraction of suicides by firearm



Rate of drug overdose deaths



Rate of suicides



Rate of traffic accident deaths

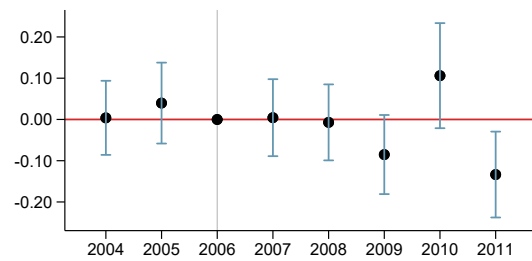


Figure 3: Dynamic Effects on Potential Mechanisms

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Online Appendix (NOT FOR PUBLICATION)

A Additional Tables and Figures

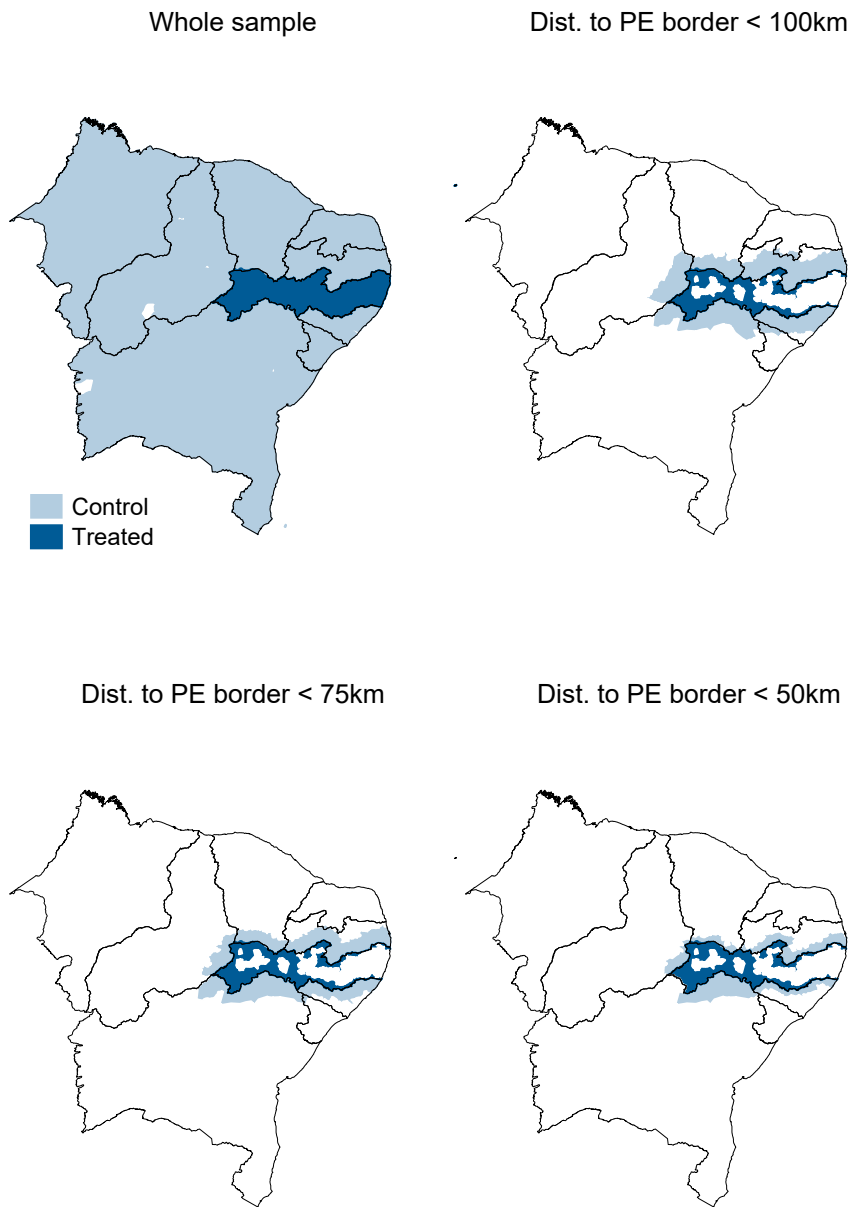


Figure A.1: Robustness: Treated and control groups