Anti-Crime Programs: An Evaluation of the *Comuna Segura* Program*

***Programas antidelincuencia: Evaluando** Comuna Segura*

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Abstract

The aim of this paper is to evaluate the impact that the anti-crime program Comuna Segura: Compromiso 100 *had on the reporting rate of different types of crimes. This program, implemented in Chile starting in 2001, was very highly criticized and, therefore, was eliminated in 2006. This paper provides statistical evidence, using the impact assessment methodology, which shows that the program was successful in increasing the reporting rate in targeted municipalities and also in decreasing levels of crimes associated with other crimes, such as rape. All this underlies the importance of carrying out formal impact assessments in order to determine benefits that are associated with a particular program. However, financial issues are also very important too and it is necessary to take them in account when making a fair statement about the cost-effectiveness of the program. This point is, however, not addressed in this paper but should be kept in mind in order to have a complete picture of the program.*

Key words: *Crime, Program evaluation, Matching.*

Resumen

El objetivo de este trabajo consiste en la evaluación del programa antidelincuencia Comuna Segura *implementado a partir del año 2001, el cual fue muy criticado y, por ende, eliminado en el año 2006. En este artículo se presenta*

* We would like to thank the participants of the Sociedad de Economía de Chile (SECHI) for their helpful comments and suggestions; particularly those of Alexander Galetovic, Osvaldo Larrañaga and Javier Núñez. Benavente acknowledges CONICYT Anillo Grant ACT-87 "Quantitative Methods in Security" for its partial financial support. Also we would like to thank the anonymous referees for their valuable comments. The usual disclaimer applies.
** Business School, Adolfo Ibáñez University.
*** Universidad de Chile. Contreras acknowledges Iniciativa Científica Milenio "Centro de Microdatos" Proyecto P07S-023-F.
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evidencia estadística, utilizando la metodología de evaluación de impacto, que muestra que el programa fue exitoso en aumentar las tasas de denuncia de ciertos tipos de delitos en las Municipalidades beneficiarias, y también en reducir otros delitos como violación. Todo esto recalca la importancia de llevar a cabo evaluaciones de impacto con el objetivo de determinar los beneficios asociados a un programa en particular. No obstante lo anterior, es importante también analizar los aspectos financieros del programa para establecer de una manera más precisa la efectividad del mismo. Este punto no es abordado en este artículo pero debe tenerse presente al analizar integralmente el efecto que tuvo el programa.

Palabras clave: *Crimen, Evaluación de programas.*

JEL Classification: *J18, K14, K42.*

1. Introduction

Various opinion surveys indicate that crime is seen as one of the principal problems facing Chilean society today. A *Fundación Chile XXI* publication states "…alongside poverty and unemployment, public safety has been one of the most worrying problems voiced by respondents across all opinion surveys." Meanwhile, in a recently published report, ADIMARK reports that crime was a key public concern throughout the 1990s, remaining among the top five priorities of public interest. Between 1990 and 1994, it was the number one public concern[1].

Despite the relevance of crime as a major problem for Chilean society, there is very little empirical evidence available. Nevertheless, some studies, using a cross-country database (Loayza *et al.* 2002), found that crime and inequality rates are positively correlated. They specifically show that the causality relationship goes from inequality to crime rates. Similarly, Villavicencio and Molina (2002), using the Becker-Ehrlich model for a regional analysis for Chile, find that socio-economic and demographic variables are determinants of crime rates. These authors also indicate that economic cycles affect the probability of crimes being committed.

Several specific anti-crime proposals have not yet been evaluated. Examples of these are the Penal Reform Process and the *Plan Cuadrante* of the police[2].

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[1] ADIMARK is one of the most important Chilean consulting companies in market research and public opinion.

[2] The Penal Reform Process was a fundamental change of the judicial system which became a system based on a procedure accusatory and oral accounts. On the other hand, the *Plan Cuadrante* is a preventative police surveillance strategy, aimed at progressively satisfying the increasing public demand for security. It is a differentiated, equitable and technical way of allocating human and material resources in the population, through close links and communication with the community. It is currently in operation with 251 *Cuadrantes* or quadrants in all the municipalities of the jurisdictions of the six Santiago Operational Prefectures. This plan works by delimiting an urban zone and giving the responsibility for

The former aims to speed up the legal process and the application of the law in crime cases while the latter aims to reduce crime rates directly.

The program *Comuna Segura: Compromiso 100* was implemented in Chile in 2001. At first it was applied only to twelve municipalities, but over time it expanded[3]. This program, like others of a similar nature, has not been formally evaluated, and its effects have been evaluated from only a judicial perspective. This paper makes a contribution to the evaluation of the program.

Beyer and Vergara (2006) suggest a complete reformulation of the program, since it was not addressing the root of the issue, namely the initiation of teens into crime. Considering the situation in 2006, the authorities of the time chose to close the program. This study, however, provides evidence that the *Comuna Segura* program would have increased the reporting rate of certain types of crimes, particularly those with a gap between the crime rate and the reporting rate also known as "dark figure". It also shows that it would have reduced other types of crimes. These results are stable and robust to different specifications and methodologies.

Vergara (2009) analyzes the impact of the *Comuna Segura* program and the *Plan Cuadrante* using panel data. The results show that only the *Plan Cuadrante* was successful in terms of reducing the crime rate, while the *Comuna Segura* program had no impact based on the original objectives. This paper provides evidence which is complementary to Vergara (2009) in two aspects. First, the techniques and the data set used in this paper have obvious advantages compared to using region panel data set. Second, Vergara uses crime rates which are the final outcome about the public cares about. However, to correctly evaluate *Comuna Segura*, one must look at the reporting rate. The program has the objective of increasing the crime reporting rate. The reduction in crime rate is explained by many factors including increased reporting. Therefore, we use this outcome as the variable most closely related to the main goals of the program.

There are several crime prevention programs in the world, most located in developed countries. For instance, in the United States there is the Portland's Crime Prevention Program, and in the United Kingdom there is the National Community Safety Plan. In short, these programs are designed to get neighbors involved in community policing efforts. These community partnerships are aimed at reducing crime at the neighborhood level. In all of these cases, the communities are at the heart of the plan. However, still there is little evidence of the effects related to such interventions, specifically for developing countries.

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its surveillance to a particular group of police or *Carabineros* which is determined by the specific security needs and characteristics of the sector, so that the same police officers patrol the sector everyday and thus get to know the community, strengthening the bonds of trust and cooperation. Its ultimate objective is to consolidate links with the community and to increase the police presence on the streets. Some of the main objectives of this innovative system are to rationalize and optimize the use of institutional funds, to maximize the coverage provided by preventative vigilance, reduce response times for citizen needs and increase personalized contact with the community and community organizations. In this system, the participation of the local community is fundamental to support the work of the police in their mission of ensuring public security.

[3] More details are available in Dammert and Lunecke (2004).

The evidence suggests that the municipalities enrolled in the program have increased reporting rates of the crimes related to theft. This is consistent with the dark figure being elevated in these crimes, because victims often do not report, probably due to the cumbersome procedures or the value of the item stolen. Unfortunately, the estimates also show that the program had a negative effect on reports of rape. Assuming the dark figures of this type of crime are low, the negative impact of the program may be related to a decrease in this type of the crime, which we assume is due to the dissuasive effect of the program. However, further research is needed for a conclusive result.

Finally, in the program design, *Comuna Segura* seeks to increase social networks. However, we do not have sufficient empirical evidence to support that hypothesis. In particular, we found significant effects only in the short run. This finding may be explained by two potential reasons: the financial component of the program is very important and that the program may not create social capital in the long run.

The paper is structured as follows. After this introduction, section 2 explains the details of the *Comuna Segura* program and provides information concerning its implementation. Section 3 presents the key characteristics of the municipal variables that are considered relevant for this analysis. Section 4 shows the parametric and non-parametric estimates of the program's effects. It also presents some test of the robustness of the results founded. Finally, the main conclusions may be found in section 5.

2. The *Comuna Segura* Program

The *Comuna Segura: Compromiso 100* program is a *Ministerio del Interior* and *Fundación Paz Ciudadana* joint-program[4]. The two main objectives of this program are to: create a crime prevention and control system that promotes citizen participation by means of citizen security councils. These councils allow the security concerns of the residents to be aired and coordinates the various anti-crime initiatives in the municipality. Second, to create a financing system that coordinates the use of existing resources and to deliver new resources to community security projects through open competition for funds. This program had an investment fund, where 70% was used as competitive funds to finance projects submitted by social organizations. The other 30% was invested in projects submitted by municipalities to work specific issues selected as priorities by the Councils. In 2005, of the municipal initiative projects were consolidated, which delineated four strategic issues: domestic violence, neighbor mediation, school coexistence, and children and adolescents at risk.

Through these funds, communities would have had the necessary resources to implement the initiatives they want to combat their crime problems[5]. One

[4] Fundación Paz Ciudadana is a non profit organization that has as a main aim to contribute to the improvement of the public policy in terms of reduction of crime.

[5] The citizen security councils are chaired by the Mayor of the municipality and are made up of the *Carabineros* Police and the Criminal Investigation Department of Chile, counselors and representatives of community organizations as well as representatives of the

of the functions of the citizen security council is to promote, through education and training, participation in the development, execution and evaluation of projects, as well as holding community meetings to keep citizens informed and to get feedback.

Finally, these councils should have an active role in gathering, processing and disseminating relevant information by carrying out a diagnosis of the current local issues related to crime prevention and control. They should also disseminate and promote the financing options available, as well as related projects and developing a communicational strategy to ensure the population is well informed of the security measures being taken.

To sum up, the objective of the program is to generate information (increasing the crime reporting rates) and to negotiate between the community and the respective authorities in order to produce social networks that can help fight crime. Hence, the main contribution of the program is through its effect on crime reporting rates, more than directly on actual crime. This rests on the precept that there are a significant series of both monetary and subjective costs for the victims of crime block the reporting of actual crimes committed[6].

The program started in twelve municipalities nationwide in March 2001: *El Bosque, La Pintana, Lo Espejo, Renca, Santiago, San Bernardo, Copiapó, Coronel, Ovalle, San Pedro, Valdivia* and *Valparaíso*. Table 1 shows the municipalities selected and the total funds allocated. In 2002, and using the same criteria, the program spread to another twelve municipalities: *Cerro Navia, Estación Central, Macul, Pudahuel, San Miguel, San Ramón, Melipilla, Calama, Linares, San Antonio, Talca* and *Talcahuano*. Eventually, the program incorporated 70 municipalities nationwide.

Formally, the relationship between crime reported and the level of crime can be proposed (and given another set of socio-economic variables). This relation allows us to measure the effects of a program like *Comuna Segura* as:

$$D = D(P, C(P) \mid X) \tag{1}$$

where D is the crime reported over a defined period and place, P is a dichotomous variable that represents the program, C is the rate of previously non-observed crimes that can be influenced by the program and X is a vector of various controlled socioeconomic characteristics that could affect the municipal crime reporting rates[7].

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local business, education and health sectors of the area. As the new penal reform process progressed, the respective district attorney would be incorporated into these councils and a technical secretary was added as a consultant.

6 This will naturally depend on the type of crime. Evidence indicates that crimes such as robbery have a relatively low reporting rate. On the other hand, homicide has a nearly 100% reporting rate. This could be proof that people have low return expectations in getting back their goods lost in a robbery relative to the cost of following through with a case. The relation is different when it comes to homicide due to the moral duty to know the truth.

7 Noteworthy among these are inequality, unemployment rate, and average schooling of the population.

TABLE 1
RESOURCES PER MUNICIPALITY

Municipality	Resources assigned (US$)	% of total
Copiapó	199,514	7.8
Ovalle	190,880	7.5
Valparaíso	263,567	10.3
Coronel	212,864	8.3
San Pedro de la Paz	187,390	7.3
Valdivia	200,795	7.9
El Bosque	257,872	10.1
La Pintana	296,712	11.6
San Bernardo	230,571	9.0
Lo Espejo	200,612	7.9
Renca	179,569	7.0
Santiago	132,847	5.2
Total	2,533,191	100.0

Source: Seguridad Ciudadana (Ministerio del Interior).

We shall assume that all the variables described are continuous[8]. Thus, a change in the program variable could produce the following effects on the crime reporting rates:

$$\frac{dD}{dP} = \frac{\partial D}{\partial P} + \frac{\partial D}{\partial C}\frac{\partial C}{\partial P} \tag{2}$$

where dD / dP is the change in the crime reporting rates in the community over a given period when the program variable changes (for example, from a zero value, from not belonging to one, to belonging to one). The first term to the right of equality could be interpreted as the change in the "social environment" directly associated with the program. This effect is assumed to be independent of actual crime rates. In other words, a large part of what the *Comuna Segura* program seeks to achieve as previously stated. The program also has a second indirect effect on crime reporting rates through the actual crime rates that it is summed up in the second term.

In theory, if the program had a significant effect on crime levels, this last term would be negative. The worst case scenario might be the non-existence of such a relationship, that is $\partial C / \partial P = 0$[9]. On the other hand, a positive relation between crime levels and reporting rates would be expected ($\partial D / \partial C > 0$). Thus, the indirect effect of the program on reporting rates compared to crime rates would be expected to have a negative correlation, or at least a value of zero.

[8] This assumption does not affect the conclusion objectives of this exercise in any way.
[9] This effect is what Vergara (2009) looks for.

After linking both effects to the reporting levels associated with the program, it can be shown that the aggregate effect does not have a predictable sign[10]. On one hand, if *dD* / *dP* is greater than zero, the impact through improvement in the "environment" more than compensates the decrease in reporting produced by the crime decrease associated with the program. On the other hand, if *dD* / *dP* is less than zero, the effect of the program would mainly be on actual crime rates and its effect on the "environment" would be comparatively less.

Consequently, as may be expected, the *Comuna Segura* program would have a positive value derived from the equation (2) if the program had a positive effect[11]. The rest of this paper examines the latter hypothesis[12].

Nevertheless, before continuing, it is necessary to state some precautions. In the first place, the public cares about the crime rate, not the crime reporting rate. However, it is, of course, important to have crimes reported in order to solve them. Moreover, since each arrest takes one criminal off the streets, it may deter future crime. On the other hand, it should be noted that the difference between the crime rates and reporting rates, the dark figure, varies based on the type of crime. Thus, while it is likely that the reporting rates of homicide and rape are very high, lesser crimes, such as theft, have a significant dark figure. That is why a positive effect of the program on the reporting rate of thefts can be interpreted as a decrease in this dark figure. In contrast, a negative effect of the program on the reporting rate of rapes could be interpreted as a decrease in the crime rate, for its effect on the dark figure would be null (what was happening was already being reported).

3. Data

There are two sources for the data in this study. First, the crime rate information was provided by the *Ministerio del Interior*, which is measured on the basis of crimes reported per 100,000 inhabitants. This study utilized the information available for the first quarters of 2001 and 2002. Second, in order to control for municipal characteristics information available in the CASEN (*Encuesta de Caracterización Socioeconómica Nacional*) 1998 and 2000 surveys is used[13]. CASEN is a cross-sectional survey with national representation and it is a fundamental tool for social policy in Chile, because it contains valuable information about Chilean households regarding housing, education, health and labor characteristics. Based on this survey, socioeconomic indicators can

[10] Both directly through the environment and indirectly through number of crimes committed.

[11] A *dD* / *dP* value equal to zero may suggest that both effects are perfectly compensated –very improbable– or that the program had no significant effects on crime reporting rates.

[12] As noted before, the program *Comuna Segura: Compromiso 100* was structured through different measures to encourage crime reporting. The aim of this paper is then to evaluate this group of measures, and how they altered (if they did at all) municipal reporting rates.

[13] Additionally, the 1998-2000 characteristic differences are controlled by the fixed effects that exist on a municipal level for the years 2001-2002.

be established on the municipality level, which allows us to complement the reporting rate information.

Table 2 shows descriptive statistics of the variables for the municipalities included in the program (beneficiaries) as well as for those that were not (control)[14]. The table shows that the beneficiary municipalities have comparatively lower levels of inequality, higher school attendance rates, higher unemployment rates, lower per capita income and a higher population density[15].

TABLE 2
SOCIOECONOMIC INDICATORS

	Non beneficiary municipalities	Beneficiary municipalities
Quintil ratio	12.77	12.58
% of non attendance at school (5-18 years old)	7.83	8.14
Unemployment rate	10.22	13.33
Per capita income/median	1.62	1.52
% municipalities with Reforma Procesal Penal	13.41	16.66
Population density (Pop./km^2)	2,907.65	5,113.61
2002-2001 variations on crime reporting rates		
Theft	6.14	27.86
Aggravated theft	–7.33	–3.07
Theft with force	20.27	42.85
Rape	–0.41	–2.07
Homicide	–0.08	–0.16

Source: CASEN survey and Seguridad Ciudadana (Ministerio del Interior).

Panel b of Table 2 shows the 2001-2002 variations on reporting rates (per 100,000 inhabitants) of five types of crime: theft, aggravated theft, theft with force, rape and homicide[16]. Reporting rates of theft and theft with force increased, both in beneficiary and non beneficiary municipalities. The sharp increase in the reporting of theft with force in beneficiary municipalities is particularly remarkable. On the other hand, there was a decrease in reporting of aggravated theft, rape and homicide. However, the variation is practically zero in the case of homicide.

Considering the available information, it can be concluded that the two municipality groups (beneficiary versus non beneficiary) are different, and

[14] The total number of beneficiary municipalities was twelve while there were 82 controls. All had to have over 70,000 inhabitants for inclusion in the program.

[15] Apart from having populations of over 70,000 inhabitants, the selection criteria for inclusion in the *Comuna Segura* program included the poverty index, theft with force and the aggravated theft rates per 100,000 inhabitants of the municipality.

[16] See Appendix for definitions.

therefore, a simple comparison of reporting rates would not identify the causal effect of the program.

4. Program Impact Estimates

This section presents the methodology used in evaluating the effects of the *Comuna Segura* program on municipal crime reporting rates. In order to identify the effects of the program this study has focused on the following crimes: theft, aggravated theft, theft with force, homicide and rape.

As mentioned earlier, to analyze the robustness of the results, two alternative evaluation techniques have been implemented. Firstly, parametric estimates are calculated through a difference-in-difference analysis. Second, non-parametric matching-type estimators are applied as described below[17].

It is possible to consider the decision to participate in the *Comuna Segura* program as a latent variable that is influenced by a vector of characteristics, so one must observe whether the municipality participates or not in the program (C) which is a dummy variable.

More formally, let Y_1 be the reporting rate of a beneficiary municipality of the *Comuna Segura* program, and let Y_0 be that of a non beneficiary municipality. Then we have the following set of equations that describe the behavior of the variable reporting rate:

$$Y_0 = \mu_0 + U_0$$
$$Y_1 = \mu_1 + U_1$$

It is important to note that econometrician could observe the municipality just in one state, as beneficiary or as a non beneficiary. Hence he only observes the following:

$$Y = CY_1 + (1 - C)Y_0$$

Handling the above expression, we come to:

$$Y = Y_0 + (Y_1 - Y_0)C$$

Assuming the case of homogeneous treatment effect $(U_0 = U_1 = U)$ we can arrive to:

$$Y = \mu_0 + (\mu_1 - \mu_0)C + U$$

This least squares approach helps us identify the average treatment effect (*ATE*) assuming that there are no differences in non observables. In fact, in this context all of the treatment parameters are equal: average treatment effect, treatment on the treated, and treatment on the untreated.

[17] See Heckman *et al*. (1998) and Abadie and Imbens (2006) for methodological details and large sample properties of matching estimators.

Given that the selectivity of the *Comuna Segura* program can be controlled, we can get the impact of the program through ordinary least squares (OLS) estimation; however, we are assuming a specific functional form on the outcome equations which enables us to run OLS regressions. So, the logical next step would be to relax this assumption enabling a nonparametric version of this impact. That is exactly what matching does, providing a test for the robustness of the results.

4.1. Parametric Estimates

Considering the above-mentioned the simplest empirical specification for evaluating the effects of the program is as follows:

$$Y_{ij} = \alpha + \beta C_i + u_{ij} \tag{3}$$

where Y_{ij} represents the difference (2001-2002) of the crime reporting frequency of municipality i for the crime j per 100,000 inhabitants and C_i is a dummy variable with a value of 1 when the municipality participates in the *Comuna Segura* program and 0 if it does not. Therefore, the OLS parameter β provides a measure of the program's effect. If this parameter is positive, it would indicate that crime reporting frequency rates of municipality i for the crime j are higher, conditional on its participation in the program. For those crimes whose dark figure is high, that is, whose reporting rate is significantly lower than the real crime rate, this positive value will be the proof that the program is achieving the stated objective of encouraging citizens to report crimes. As was discussed above (see equation 1), if the program does not have a positive effect on the crime rate, then this program's positive impact on the reporting rate represents a decrease in the dark figure. This situation can be seen in crimes such as theft, aggravated theft and theft with force, where the dark figure was significant. Now, in crimes such as homicide and rape, where the dark figure is close to zero, the impact of the program on reporting is not to reduce the dark figure, but to lower the criminality rate. Therefore, in that context, the negative impact of the program on the reporting rate could reflect a decrease in crime.

Table 3 shows the estimates obtained from the model specification in (3). The program positively affects reporting of several types of crime[18]. We can particularly note a positive and significant impact on theft and theft with force. On the other hand, the program negatively affected rape reporting.

Nevertheless, the previous specification does not consider some factors that could affect crime reporting frequency rates beyond the effects of the program. Therefore, the following specification controls for potentially relevant characteristics when evaluating the impact of the program:

$$Y_{ij} = \alpha + \beta C_i + x'_{ij}\gamma + u_{ij} \tag{4}$$

[18] In the case of "theft" participation in the *Comuna Segura* program leads to an almost 400% increase in crime reporting rates per 100,000 inhabitants.

where x'_{ij} represents a vector of socioeconomic characteristics on a municipal level. The CASEN 2000 survey was used to create those controls. According to the literature, the covariates selected are the following: quintile ratios, percentage of non-attendance to educational institutions, unemployment rate, per capita income (standardized by its median), a Penal Reform Process dummy variable, and population density. The quintile ratio variable, an income inequality indicator, shows the possible effects of unequal income distribution on the crimes observed. This rests on the premise that worse income distributions would increase social tensions and thus promote crime. The percentage of non-attendance to educational institutions attempts to capture school drop-out rates caused by the opportunity cost connected to the profitability of illegal activities. The unemployment rate attempts to measure the economic environment and the lack of opportunities in the formal labor markets. Per capita income captures the municipal poverty indices and how these affect the crime rate. The Penal Reform Process dummy variable controls for the possible effects of the penal reform process that had already been implemented in some regions of the country.[19] Finally, the population density variable measures municipal housing and the possible effects of this on the crime indices as population concentrations increase.

TABLE 3
IMPACT EVALUATION, PARAMETRIC (WITHOUT CONTROLS)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Dummy program	21.72**	4.25	22.57*	–1.65**	–0.086
	(10.59)	(5.17)	(12.58)	(0.70)	(0.79)
Constant	6.14*	–7.33***	20.27	–0.41	–0.08
	(3.62)	(2.14)	(7.58)	(0.33)	(0.11)
N	94	94	94	94	94
R^2	0.04	0.005	0.01	0.03	0.0008

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

Table 4 shows the results when estimating equation (4) by traditional parametric methods while controlling for potentially relevant characteristics which might affect crime reporting rates. The results remain stable at least for theft and rape. In other words, there are positive effects (similar to the previous ones) associated with the program that remains after control variables are included.

Given that we have worked with the dependant variable in difference, we believe it is pertinent to evaluate the same specification (4) using the controls in

[19] These regions are *Antofagasta, Atacama, Coquimbo, Del Maule* and *La Araucanía.*

TABLE 4
IMPACT EVALUATION, PARAMETRIC (WITH COVARIATES)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Dummy program	23.58*	2.90	22.11	–2.06**	0.21
	(13.90)	(4.15)	(18.74)	(0.86)	(0.33)
Quintil ratio	0.69	–0.59	–0.02	0.042	–0.06
	(2.14)	(0.79)	(2.23)	(0.11)	(0.04)
% of non attendance at school (5-18 years old)	–1.10	0.17	–4.62**	0.09	0.04
	(1.28)	(0.72)	(2.11)	(0.09)	(0.03)
Unemployment rate	31.77	78.33	134.85	5.20	–3.94
	(103.03)	(61.06)	(172.18)	(9.46)	(3.28)
Per capita income/median	–10.28	13.81	2.06	–0.97	0.99
	(37.45)	(13.69)	(39.03)	(2.04)	(0.81)
Municipality with Reforma Procesal Penal	1.11	8.92**	48.65**	0.60	0.11
	(15.06)	(3.50)	(18.68)	(0.80)	(0.21)
Population density	19.26	–0.001***	–0.0003	0.00002	–0.0000
	(0.0006)	(0.0004)	(0.001)	(0.00005)	(0.00002)
Constant	19.26	–27.89*	30.18	–0.75	–0.89
	(30.02)	(15.79)	(39.08)	(1.95)	(0.78)
N	87	87	87	87	87
R^2	0.06	0.27	0.18	0.07	0.05

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

differences, which allows us to control for fixed effects on a municipal level[20]. We have used the CASEN survey for years 1998 and 2000 for this and obtained the 1998-2000 difference for the control variables: quintile ratios, percentage of non-attendance to educational institutions, unemployment rate, per capita income (standardized by its median), a Penal reform process dummy variable, and population density.

Table 5 shows the results of this specification. The estimated effects are robust to this new model, again for theft and rape. This provides us with clear evidence

[20] Consider the existence of a fixed effect influencing the municipal crime reporting rates in the period t:

$$D_{ijt'} = \alpha + \beta C_{it'} + x'_{ijt}\gamma + \delta h_{ij} + u_{ijt}$$

where D represents the crime reporting rates in the period t and h_{ij} is the fixed effect. The same non-observable fixed factor would be present in the time t':

$$D'_{ijt} = \alpha + \beta C'_{it} + x''_{ijt}\gamma + \delta h_{ij} + u'_{ijt}$$

Thus, taking away both specifications, we remove said fixed effect:

$$\Delta D_{ij} = Y_{ij} = \Delta C_i + \Delta x'_{ij}\gamma + \Delta u_{ij}$$

which is the model that we finally estimate.

TABLE 5
IMPACT EVALUATION, PARAMETRIC (WITH COVARIATES IN DIFFERENCE)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Dummy program	24.38**	5.35	19.09	–1.42*	0.084
	(12.30)	(3.90)	(17.65)	(0.84)	(0.35)
Quintile ratio	–0.62	0.58	–0.78	–0.04	–0.05
	(1.36)	(0.48)	(2.13)	(0.09)	(0.03)
% of non attendance at school (5-18 years old)	–0.24	0.39	–2.57	0.08	–0.007
	(1.44)	(0.54)	(2.14)	(0.08)	(0.02)
Unemployment rate	–46.39	41.15	–25.26	15.18**	2.23
	(110.87)	(50.65)	(221.97)	(6.69)	(3.77)
Per capita income/median	5.22	–10.93	–4.79	1.34	0.68
	(21.17)	(7.69)	(36.08)	(1.69)	(0.44)
Municipality with Reforma Procesal Penal	2.92	9.81***	54.69***	0.61	0.07
	(15.51)	(3.07)	(19.12)	(0.71)	(0.21)
Population density	–0.00005	–0.001***	0.00007	0.00003	–0.00001
	(0.00005)	(0.0004)	(0.0009)	(0.00004)	(0.00002)
N	86	86	86	86	86
R^2	0.06	0.25	0.17	0.13	0.03

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

of the positive and significant effects of the program on the municipal crime reporting rates for theft. On the other hand, the program negatively affected the rape reporting rate, which can be seen as a decrease in the rate of this crime.

As can be seen throughout these three specifications, the variable that identifies those municipalities with the penal reform process has a significant and positive effect on the crime-reporting rate (aggravated theft and theft with force), which is interesting in terms of the signaling role that the reform seems to have played. This could be interpreted as an increase in trust by the community in reporting crimes, since the reform has a facilitating role in judicial processes. In addition, we do not found any effect of unemployment on crime reporting rates[21].

4.2. Non-parametric Estimates

The OLS estimates identify the impact of participating in the *Comuna Segura* program, assuming a homogeneous treatment effect, that selectivity to the program is based on observables (which is, in this case, entirely reasonable),

[21] Additionally, the same estimates were then carried out using the per capita amount of resources assigned to the *Comuna Segura* program as explicative variables considering the positive and significant effect of the program.

and that the outcome equations are well specified. This estimation identifies the average treatment effect, the treatment on the untreated (*TUT*), and the treatment on the treated (*TUT*). All of them are equal. In order to evaluate the robustness of the results, we have implemented the matching estimators, which is a nonparametric way to estimate the effect of the program. Therefore, we do not impose a functional form and select the most comparable municipalities through the propensity score. However, here again, the treatment parameters are all the same[22].

We then implement the cross-section matching estimators that compare the results (differences in crime reporting rates) of the treatment and control groups at some moment after the implementation. Specifically, the following two estimators shall be applied: (1) the cross-section matching estimator of the nearest neighbor, (2) the cross-section matching estimator kernel.

In order to matching works we must establish the following standard assumptions:

$$(Y_0, Y_1) \perp C \big| W$$
$$0 < P(C = 1 \big| W = w) < 1$$

The first condition randomizes *C* with respect to outcomes (unconfoundedness assumption), and second assures comparing comparable municipalities. The common support condition is also necessary.

The first step is to estimate the propensity score or conditional probability of participating in the program[23]. This estimate allows us to reduce the dimensionality of the determinants to carry out the matching; therefore $E(Y \big| P = 0, P(W = w))$ is estimated instead of $E(Y \big| P = 0, W = w)$. To estimate the propensity score, it is necessary to select a set of *W* characteristics as explanatory variables. It is crucial to restrict the selection of *W* to variables not influenced by the program; otherwise the program itself would bias the estimates. This potential problem is eliminated when considering the municipal characteristics of 1998 and 2000.

Table 6 shows the probit model estimated for the probability of being selected for the *Comuna Segura* program. The same controls used in the original model are used as the determinants of the probability of being selected in the program. As may be observed, the only significant variables are the unemployment rate and aggravated theft reporting rates. However, other variables could be not statistically significant because they had a high degree of multicollineality, which would affect the efficiency of the estimation. Moreover, the model presents a good degree of adjustment, since the coefficient of determination (R^2) is 22%, which is positive for the pairing process in the matching implementation. We

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22 The literature has established kernel PMS estimates may produce more efficient estimates than nearest neighbor PSM estimates.

23 Rosenbaum and Rubin (1983).

TABLE 6
PROBABILITY OF PARTICIPATE IN THE PROGRAM
(Propensity score)

	Coefficient
Quintile ratio	0.08 (0.09)
% of non attendance at school (5-18 years old)	0.03 (0.08)
Unemployment rate	14.23*** (5.49)
Per capita income/median	–1.21 (1.62)
Municipality with *Reforma Procesal Penal*	0.75 (0.56)
Population density	–0.00004 (0.00006)
Theft reporting rate in 2001 (per 100,000 inhabitants)	0.003 (0.004)
Aggravated theft reporting rate in 2001 (per 100,000 inhabitants)	0.01* (0.007)
Theft with force reporting rate in 2001 (per 100,000 inhabitants)	–0.003 (0.004)
Constant	–2.60 (1.89)
Pseudo R^2	0.22
N	87

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

would like to have a model with a better degree of adjustment, but given the data only these variables are available and, thus, it is not possible to further increase the coefficient of determination. As mentioned above, two matching estimators will be employed; that of the nearest neighbor, and the Kernel method.

The nearest neighbor is the simplest estimator to implement. It is first necessary to determine how many neighbors shall be utilized. The neighbors are subsequently selected in accordance with their proximity to the treatment group (propensity score) in terms of Euclidian distance. However, one of the problems of this method is that all the clones (control group matches) receive the same weighting. For instance, if there are five neighbors near the experimental individual, then the second and third neighbor receive exactly the same weighting. A kernel regression estimator chooses the weights so that the observations nearest the individual treatment group receive the greatest weighting. The implementation of the kernel function requires the choice of a bandwidth

TABLE 7
IMPACT EVALUATION, NON PARAMETRIC
(Outcome: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
			Nearest neighbor		
Impact	13.63 (14.41)	4.99 (9.03)	38.97 (18.36)	–2.08 (0.91)	0.02 (0.38)
			Kernel		
Impact	16.69 (15.18)	7.29 (7.35)	29.04 (21.65)	–3.00 (1.04)	–0.28 (0.46)

Notes: Standard error in parenthesis. Bandwidth for kernel is 0.06.

(h_n) which is analogous to the choice problem of the number of neighbors in the nearest neighbor estimator[24].

Table 7 shows the effect of the program through the matching estimators. The results are very interesting. First, the program does not appear to have a positive impact on the theft reporting rate. However, now we see a positive and significant impact on reporting theft with force. On the other hand, a decrease in the rape reporting rate is seen again as the result of the implementation of the program, which could be interpreted as a decrease of this type of crime. For the other crimes, the effects are not statistically significant. It is worth mentioning that, although the results for the Kernel estimator give a bandwidth of 0.06, a sensibility analysis was conducted using its different values. The results were robust for the different values of bandwidth used.

An essential aspect when matching estimators are implemented is related to the balancing property of propensity score. That is, the propensity score should construct a control group that exhibits similar characteristics to the group of beneficiary municipalities. This validates the comparison to be done between the two groups, since it ensures that comparable municipalities are being compared and that the clones used are of good quality. Table 8 presents the test of mean differences for beneficiary and non beneficiary municipalities for each of the variables incorporated in the probit model. One can see that for each variable, it is not rejected for the beneficiary and non beneficiary municipalities to have the same average value.

The estimations carried out so far show two things clearly. First that the reporting rate increased in those municipalities that participated in the program, specifically in the theft category. This indicates a positive citizen propensity to report crimes. This is in line with the spirit of the *Comuna Segura* program,

[24] With regard to the bandwidth choice, it is advisable to carry out a sensibility analysis for the different values of h_n.

TABLE 8
BALANCING PROPERTY
(Propensity score)

Variable	Mean		t-test (p-value)
	Treated	Control	
Quintile ratio	12.23	17.59	0.4
% of non attendance at school (5-18 years old)	8.16	7.62	0.54
Unemployment rate	0.13	0.12	0.61
Per capita income/median	1.52	1.89	0.31
Municipality with *Reforma Procesal Penal*	0.18	0.18	1.00
Population density	5,113.6	8,088.3	0.28
Theft reporting rate in 2001 (per 100,000 inhabitants)	90.50	87.00	0.93
Aggravated theft reporting rate in 2001 (per 100,000 inhabitants)	74.54	109.99	0.27
Theft with force reporting rate in 2001 (per 100,000 inhabitants)	151.67	187.73	0.52

which can be summed up as the creation (or utilization) of information networks that promote among an atmosphere that is conducive to crime reporting on a local basis. People feel protected and trust public mechanisms. Secondly, there is a negative effect on rape reporting, which can be interpreted as a decrease in the occurrence of rape given the low dark figure. This impact may be due to the dissuasive effect created by the program. This does not happen with homicides, basically because homicides are probably more driven by other more extreme phenomena not related by interventions that have a community component.

The estimations presented so far may be biased due to the violation of the unconfoundedness assumption (Knutsson and Tilley, 2009). Indeed, the benefits associated with participating in the program could be affecting contiguous municipalities that were not participants. In other words, the effects of the program might have been projected toward other non beneficiary municipalities, which would bias the results presented so far. The effects of spatial displacement are held because, if the transport expenses are not prohibitive (which they were not, at least until 2002), criminals could move from one place to another, biasing the estimate of the program's effects. On the other hand, the benefits associated with the crime control may be dispersed to other municipalities, because contiguous municipalities could be positively affected (Imbens and Wooldridge, 2009). Therefore, in order to analyze the robustness of our results based on those two potential problems, two complementary exercises were carried out. First, the effects of the program were estimated again, without taking into account non beneficiary municipalities that were contiguous to the beneficiaries. In other words, they were not considered in the search for clone municipalities. Second,

a fictitious program was made, which assumed that the contiguous non beneficiaries municipalities were actually the beneficiary ones.

Table 9 presents the parametric estimates using level controls and excluding non beneficiary municipalities that were contiguous. For this group of estimates, the negative and significant impact of the program on rape reporting stands out. It also shows that the program had a positive impact on the reporting of theft with force. However, there are no other significant impacts observed, even the expected effects for crimes such as theft and aggravated thefts. Just as in the previous estimations, we should take into account the efficiency problems related to the small sample, which could affect the statistical significance of the impacts on each type of crime. Table 10 confirms the previous estimation using controls in differences, with the aim of controlling for the existence of fixed effects. As one can see, the program significantly increases the theft reporting rate. It again shows a decrease in rape reporting, which has been very robust throughout all the estimations. Table 11 presents the impact estimates of the program using the matching estimator; theft and rape exhibit the same effects found previously. However, it now shows a positive and significant effect on aggravated theft.

TABLE 9
IMPACT EVALUATION, PARAMETRIC (WITH COVARIATES)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Dummy program	21.73	2.56	14.38	–2.46***	0.24
	(15.65)	(3.84)	(23.27)	(0.87)	(0.32)
Quintil ratio	0.06	–1.19	–0.98	0.08	–0.05
	(2.23)	(0.76)	(2.40)	(0.10)	(0.05)
% of non attendance at	–0.20	0.49	–4.53*	0.04	0.02
school (5-18 years old)	(1.42)	(0.69)	(2.39)	(0.10)	(0.03)
Unemployment rate	26.76	1.54	165.00	12.77	–3.93
	(166.74)	(44.62)	(274.49)	(8.19)	(4.12)
Per capita	2.51	24.34*	19.86	–1.87	0.89
income/median	(39.61)	(13.26)	(41.71)	(1.96)	(0.89)
Municipality with	1.66	8.41**	48.27**	0.46	0.001
Reforma Procesal Penal	(15.23)	(3.71)	(19.12)	(0.80)	(0.22)
Population density	0.0003	–0.0009***	0.001	0.00001	–0.00002
	(0.0008)	(0.0003)	(0.001)	(0.00005)	(0.00003)
Constant	–0.31	–31.12*	10.50	–0.05	–0.45
	(32.24)	(16.63)	(47.86)	(1.68)	(0.96)
N	72	72	72	72	72
R^2	0.06	0.29	0.19	0.10	0.05

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

TABLE 10
IMPACT EVALUATION, PARAMETRIC (WITH COVARIATES IN DIFFERENCE)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated heft	Theft with force	Rape	Homicide
Dummy program	23.63**	2.88	13.49	–1.64*	0.08
	(11.85)	(3.42)	(18.05)	(0.86)	(0.36)
Quintile ratio	–0.18	0.50	–0.06	–0.04	–0.06*
	(1.27)	(0.45)	(2.08)	(0.09)	(0.03)
% of non attendance at school (5-18 years old)	0.52	0.61	–2.33	0.05	–0.008
	(1.59)	(0.42)	(2.36)	(0.08)	(0.031)
Unemployment rate	–49.02	37.30	–20.70	12.75	0.31
	(127.90)	(56.42)	(262.7)	(7.01)	(4.28)
Per capita income/ median	3.70	–7.45	–10.24	1.39	0.78*
	(21.26)	(7.56)	(37.47)	(1.76)	(0.46)
Municipality with *Reforma Procesal Penal*	3.10	8.89***	55.31***	0.58	–0.03
	(15.37)	(2.88)	(19.36)	(0.73)	(0.22)
Population density	0.0002	–0.001	0.001	0.00005	–0.00003
	(0.0007)	(0.0003)	(0.001)	(0.00005)	(0.0000)
N	71	71	71	71	71
R^2	0.06	0.25	0.16	0.12	0.05

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

TABLE 11
IMPACT EVALUATION, NON PARAMETRIC
(Outcome: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated heft	Theft with force	Rape	Homicide
Nearest neighbor					
Impact	2.72	0.56	2.76	–2.65	0.03
	(18.91)	(7.32)	(55.69)	(1.23)	(0.44)
Kernel					
Impact	33.98	16.36	37.49	–1.75	0.21
	(12.19)	(4.99)	(21.69)	(1.29)	(0.19)

Notes: Standard error in parenthesis. Bandwidth for kernel is 0.06.

TABLE 12
IMPACT EVALUATION OF THE "FAKE" PROGRAM, NON PARAMETRIC
(Outcome: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
			Nearest neighbor		
Impact	–3.46 (13.64)	5.18 (13.26)	–9.09 (30.25)	–0.95 (1.24)	–0.26 (0.55)
			Kernel		
Impact	1.40 (20.67)	4.77 (12.92)	8.86 (27.07)	0.95 (1.55)	0.08 (0.51)

Notes: Standard error in parenthesis. Bandwidth for kernel is 0.06.

Since the benefits related to the crime control in some municipalities can positively affect those that are geographically close, but have not been selected for the program as mentioned by Imbens and Wooldridge (2009), it is pertinent to run an estimate using a faked population. Thus we proceeded to reestimate all the impacts, but while considering the beneficiary municipalities to be those that are contiguous to the actual participants. The impact that this false program should have is null and that is precisely what the estimates reveal in Table 12. The evidence indicates that the benefits of the program were not significantly propagated into the neighboring municipalities and, therefore, the estimation strategy used is not biased and allows us to identify the impacts of the program.

There is one more exercise to complete. The program started off in twelve municipalities nationwide in March 2001: *El Bosque, La Pintana, Lo Espejo, Renca, Santiago, San Bernardo, Copiapó, Coronel, Ovalle, San Pedro, Valdivia* and *Valparaíso*. However in 2002, using the same selection criteria, the program was expanded to twelve other municipalities: *Cerro Navia, Estación Central, Macul, Pudahuel, San Miguel, San Ramón, Melipilla, Calama, Linares, San Antonio, Talca* and *Talcahuano.* Therefore, the best municipality control is those that were beneficiaries of the program during the first trimester of 2002 are those that had been enrolled previously. Thus, we reestimate the impact of the program, in a parametric way, using only this reduced group of municipalities. Table 13 presents the results. There is no doubt that we have a serious problem of efficiency, because there are so few observations, however, the associated signs are again the ones expected. Moreover, in the case of rape a negative and significant effect is seen, which is consistent with all the estimations previously carried out. Incorporating covariates the results remain robust, but as there are very little degrees of freedom, it was chosen not to present these estimates.

As mentioned above, the *Comuna Segura* program started in 2001 and ended in 2006.Therefore, there are six years data. In this context, the natural exercise would be to evaluate the effect of the program on a longer term scale – the trajectory of reporting from the year 2003. What has been identified so far are short term

impacts, due to the immediate effect of the program on the municipal reporting rates. However, it should be analyzed if this positive effect persisted over time. Now, when the variation is used on the reporting rate, for example during the period of 2001-2003, the identified beneficial effects disappear (see Table 14). This attests that the program, which had a positive effect in the beginning, was not capable of significantly altering the trajectory of the reporting rates in the long term. There are two potential interpretations to this result: the program does not create the social network needed, or the social network created is very weak and would need additional inputs to continue to work.

TABLE 13
IMPACT EVALUATION USING "NATURAL CONTROLS", PARAMETRIC (WITHOUT CONTROLS)
(Dependant variable: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Dummy program	13.40 (15.70)	13.42 (9.11)	36.75* (20.99)	–2.26** (1.01)	0.005 (0.37)
Constant	12.59 (12.87)	–14.81 (7.85)	2.59 (18.68)	0.63 (0.73)	–0.25 (0.26)
N	24	24	24	24	24
R^2	0.03	0.08	0.12	0.18	0.00

Notes: Standard error in parenthesis. *: significant at 10%, **: significant at 5%, ***: significant at 1%.

TABLE 14
LONG RUN IMPACT EVALUATION, NON PARAMETRIC
(Outcome: difference in crime reporting rates per 100,000 inhabitants, 2002-2001)

	Theft	Aggravated theft	Theft with force	Rape	Homicide
Nearest neighbor					
Impact	10.22 (20.67)	17.36 (15.95)	46.73 (30.01)	0.007 (1.31)	0.16 (0.35)
Kernel					
Impact	5.48 (15.64)	11.95 (12.59)	33.13 (27.84)	–1.66 (1.27)	0.20 (0.37)

Notes: Standard error in parenthesis. Bandwidth for kernel is 0.06.

5. Conclusions

This paper provides evidence on the effects of the *Comuna Segura* program on municipal crime reporting rates. The estimates show clear and significant results for the cases of theft and rape. Indeed, the beneficiary municipalities of the program exhibit an increase in theft reporting rates. This is consistent with the fact that there is a large dark figure, because the victims are less likely to report. On the other hand, the estimates show that the program had a negative effect on rape reporting. As the dark figures of this type of crime are relatively low, the negative impact of the program may be related to a decrease in this type of the crime, which would be due to the dissuasive effect of the program. It is interesting to discuss why this does not happen with homicides, which also has low dark figure. A possible explanation for that is because probably rapes are more affected by interventions that have a community component. On the other hand, homicides are probably more driven by other more extreme phenomena; in fact, Loayza *et al*. (2002) present evidence that homicides seem to be less responsive to economic incentives.

The results allow us to present a more objective picture on the real impact of the *Comuna Segura* program, where positive effects related to the implementation could be seen. This reveals the importance of conducting rigorous procedures to evaluate public policies, even in a context of few resources. However the financial issues are very important too and it is necessary to take them in account in order to make a fair statement about the cost-effectiveness of the program. This point is not tackled in this paper but it must be keeps in mind to have a complete picture of this program.

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APPENDIX

Definition of crimes

***Homicide and Patricide*:** A person, who in full knowledge of the relationship that ties them kills a father, mother or child, be they legitimate or illegitimate, any other ascendant or descendant or their spouse, shall be tried with the crime of patricide. A person, who kills another in any other circumstance, shall be tried for homicide.

***Rape*:** Defined as having sexual contact with a woman in the following circumstances: (i) when force or intimidation is used, (ii) when the woman is deprived of her reason or senses by any cause, (iii) when she is less than twelve years of age, even when none of the above applies.

Theft: Aggravated theft occurs when a person takes another's property with violence or intimidation against people or property without the consent of the owner and with the goal of personal gain; when violence, intimidation and force is absent, it is considered simply theft. Violence or intimidation against people exists when there are damages, threats to handover or provide things, either to block resistance or opposition to the removal of objects, or any other act that may intimidate or force a person to provide or handover an object. It is also considered violence when a person claims to possess orders from an authority, or purports to be a judge or public official.