Sources of Regional Crime Persistence Argentina 1980-2008

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Abstract

Crime rates vary considerably by region and these differences are found to be persistent over time. The persistence of differences in regional crime rates over time may be explained by two factors. First, differences in the regional institutional and socio-economic conditions that determine crime equilibrium levels are persistent over time. Second, the effects of shocks affecting the crime rate are persistent over time. The aim of this paper is to disentangle these two sources of regional crime persistence in Argentinean regions over 1980-2008 and subperiods for different typologies of crime. Controlling for socio-economic and deterrence effect variables, we specify an econometric model to test the persistence of shocks to crime. Results support high persistence of the effects of shocks to crime.

Resumen

Las tasas de crimen varían considerablemente por región y estas diferencias son persistentes en el tiempo. La persistencia en las diferencias de la tasa de crimen regional puede ser explicada por dos factores. Primero, persistencia de las diferencias en las condiciones socio-económicas e institucionales que determinan las tasas de crimen de equilibrio. Segundo, los shocks que afectan la tasa de crimen. El objetivo de este trabajo es distinguir estas dos fuentes de persistencia temporal en las provincias de Argentina en el período 1980-2008 y en subperíodos para diferentes tipos de crimen. Controlando por las variables socio-económicas y de disuasión, especificamos un modelo econométrico para testear la pesistencia de los shocks sobre el crimen. Los resultados sostienen alta persistencia de los shocks sobre el crimen

Keywords: Crime Persistence, Regional Disparities, Typologies of Crime, Socio-Economic and Deterrence Effect

JEL Classification Codes: K42, K14, C33

I. Introduction

Crime has frequently been identified as one of the most important public problems in Argentina (see, for example, Latinobarometro, 2012). Far from improving, this problem has become even worse over time. According to official statistics, the crime rate in Argentina increased 312.6 % in the period that span from 1980 to 2008 (i.e., it increased at an average annual rate of 5.2%). Moreover, violent crime has increased at a higher rate and raised their participation in total crime.

Although a generalized problem, crime rates vary considerably by region and these differences are found to be persistent over time. For example, in 2000 Capital Federal had the highest crime rates, followed by Neuquén and Mendoza. At the other extreme, Misiones had the lowest crime rate. Eight years later, in 2008, Capital Federal still leaded the ranking of provinces with the highest crime rate, followed again by Neuquén and Mendoza, while Misiones remained at the lower tail of the distribution. Our hypothesis is that these differences in regional crime rates and their persistence over time may be explained by two factors. First, differences in regional crime rates may be persistent due to persistent differences in the regional institutional and socio-economic conditions that determine crime equilibrium levels. Second, crime rate differences across regions may also subsist because of the persistent effects of shocks affecting the crime rate. The aim of this paper is to disentangle these two sources of regional crime persistence in the Argentinean regions over the period 1980-2008. To our knowledge, this topic has not yet been studied in the literature on crime and this is the main contribution of our paper.

From a public policy perspective, studying the sources of crime persistence is a relevant issue. On the one hand, the theoretical literature on crime focuses on two types of variables that determine the financial rewards from crime relative to the financial rewards from legal work: (i) the deterrence related variables, measured by the probability of being arrested and of being condemned, and (ii) the social and macroeconomic environment, which generates an atmosphere more or less prone to crime, measured by variables such as the unemployment rate, income per capita, income growth, income inequality, productive structure, among others. If crime rates are found to mainly respond to these variables, authorities would only be able to reduce crime by acting on these variables.

On the other hand, if shocks have persistent effects on the crime rate, authorities should prevent individuals form entering into criminal activities, since once they are engaged in these activities, it will hard to take them out. This idea of crime persistence is consistent with a dynamic model of criminal activity, where individuals are endowed with legal and criminal human capital and this human capital can be enhanced by participating in the relevant sector and is subject to depreciation (see Mocan et al, 2005). Legal human capital can also be enhanced through investment. According to crime theory, there is a possibility for an individual to participate in the illegal sector during a shock. However, contrary to standard crime theory predictions, this individual may tend to remain in the criminal sector after the shock due to the simultaneous depreciation of her legal human capital and appreciation of her criminal human capital during the time spent in this sector. If this was the case, authorities should promote investment in legal human capital via education either by promoting a sufficiently high rate of return to legal human capital, or by lowering the costs of such investment. Increased legal human capital will prevent individuals form entering to the illegal sector.

We use an annual panel from 1980 to 2008 for 24 Argentinean regions (provinces) to estimate a dynamic model of crime using the Generalized Method of Moments estimator (GMM) proposed

by Arellano and Bover (1995), which allows us to distinguish between the two sources of persistence discussed above. In our analysis, we distinguish among different typologies of crime (total crime, property crime, theft, robbery, crimes against persons and murders).

We find that the parameter of the lagged dependent variable, which measures the degree of persistence of shocks in time, is typically positive and statistically significant. We find a relatively high autocorrelation coefficient in the regional total crime series, even after conditioning on deterrence and socio-economic variables. After a year, between 70% and 80% of a regional shock to crime will still be affecting regional total crime. Two years later, only 40%-50% of the effect of the shock on regional total crime will have disappeared. Crime, at the regional level, presents a very high persistence to idiosyncratic shocks. For all property crimes, robberies and crimes against persons, persistence is similar to total crime. For theft, persistence is much lower and even becomes non-statistically significant when we control for socio-economic variables. This is consistent with our hypothesis that theft involves less illegal human capital than robberies and hence the switch from theft to the legal sector is easier than from robberies.

As expected, we find that the arrest and sentence rates have a negative and statistically significant effect on the crime rate, which points to the relevance of both police and judicial performance in the deterrence of crime. We also find that property crime rates are more sensitive to economic fluctuations than crimes against persons, which is in line with previous findings (see Cook and Sarkin (1985), Arvanites and Delfina (2006)). Finally, we find that regions with higher product shares in construction and government have lower crime. We conjecture that, since these activities are labor intensive, they affect crime rate through unemployment rate, and also through GDP, given that regions with higher product shares in construction and government are those with lower GDP per capita.

The rest of the paper is organized as follows. Section II analyzes the regional structure of crime rate in Argentina and its evolution over time. Section III presents the econometric model to be estimated, which allows us to distinguish between persistence due to socio-economic and deterrence variables and due to the persistence of the shocks. Section IV summarizes the data used for the estimation, while Section V presents the econometric results. Finally, Section VI concludes.

II. Stylized Facts

In this Section, we analyze the regional structure of crime in Argentina to see whether it shows persistence both across provinces and over time.

First, to analyze persistence across provinces, Figure 1 plots Argentinean provinces total crime rankings at two points in time, 2000 and 2008.

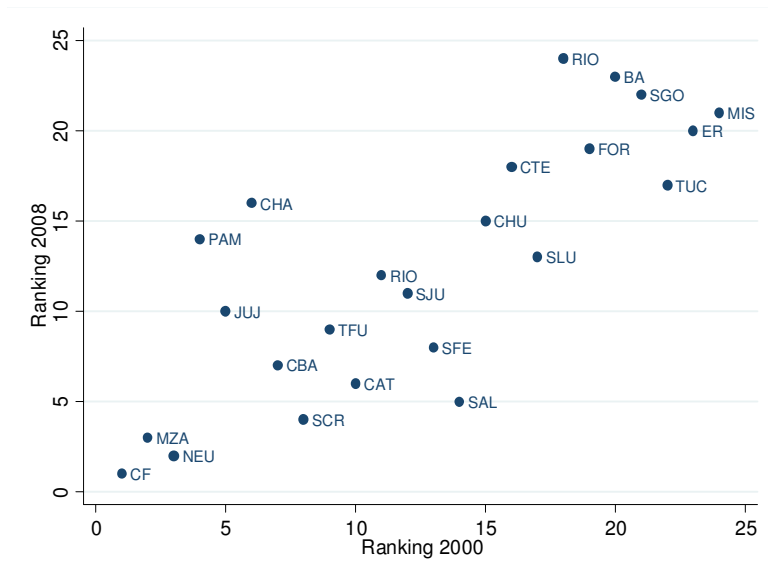**Figure 1.Ranking of total crime in Argentinean provinces. 2000-2008**

Figure 1 shows that the regional structure of crime in Argentina is persistent over time. To test this hypothesis we compute the correlation coefficient between 2000 and 2008 crime rate rankings. The Spearman coefficient is 0.793 and it is statistically significant different from zero at a 1% level, indicating that the regional structure of crime in Argentina has not significantly changed between 2000 and 2008. This result holds when we consider crime rates instead of rankings (correlation coefficient of 0.8435 and statistically significant at a 1% level), different decades (correlation coefficient of 0.693 for 1980-1990 and 0.5409 for 1990-2000, both statistically significant at a 1% level). Only when we consider the longest available period of time (1980-2008), the Spearman coefficient is no longer statistically significant, indicating that persistence, although high, eventually disappears.

Figure 2 shows similar scatter plots for different typologies of crime. As before, we find that the regional structure of different types of crimes remains constant over time. The correlation coefficient between 2000 and 2008 crime rate rankings are positive and statistically significant for all types of crimes (correlation coefficient of 0.8426 for property crime, 0.7496 for robbery, 0.8278 for theft, 0.8130 for other property crimes, 0.8484 for crimes against persons, and 0.6909 for murders).

Figure 2.Ranking of crime in Argentinean provinces by type of crime. 2000-2008
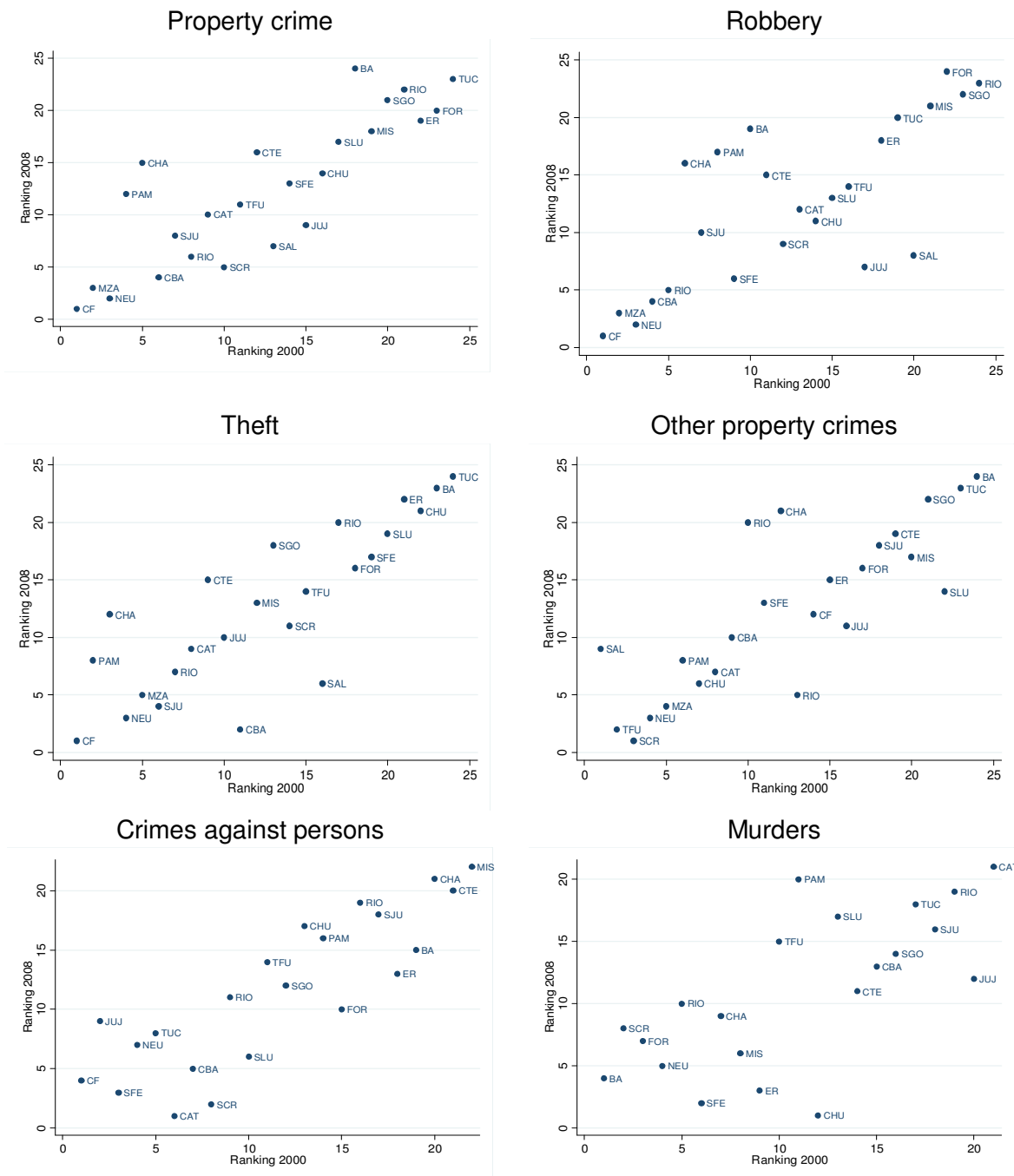
Second, in order to evaluate the dynamics of the changes in the regional crime structure, in Table 1 we compute Spearman correlations for total crime rankings between selected pairs of years. Table A.2 in the Appendix displays correlation coefficients for rankings of different types of crimes for all pairs of years between 2000 and 2008.

Table 1.Spearman correlation coefficients. Total crime rate. Argentina Regions 1980-2008

	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006
1982	0.8209*	1												
1984	0.7417*	0.8243*	1											
1986	0.6922*	0.7983*	0.8452*	1										
1988	0.6235*	0.7739*	0.9322*	0.8487*	1									
1990	0.6930*	0.8443*	0.7991*	0.8365*	0.7435*	1								
1992	0.6539*	0.7817*	0.6922*	0.7400*	0.6104*	0.8765*	1							
1994	0.4887	0.6826*	0.6930*	0.6557*	0.7122*	0.6861*	0.7704*	1						
1996	0.4096	0.6539*	0.6896*	0.6522*	0.7774*	0.6878*	0.6591*	0.9157*	1					
1998	0.5746*	0.7605*	0.8053*	0.6681*	0.8347*	0.7583*	0.6390*	0.8202*	0.9332*	1				
2000	0.3661	0.4939	0.5157*	0.4835	0.6183*	0.5409*	0.493	0.7583*	0.8922*	0.8949*	1			
2002	0.38	0.5157*	0.4478	0.4557	0.5322*	0.5330*	0.4513	0.6209*	0.8035*	0.8902*	0.9070*	1		
2004	0.4183	0.6243*	0.5939*	0.5304*	0.6548*	0.6461*	0.5583*	0.7687*	0.9157*	0.9171*	0.8730*	0.8748*	1	
2006	0.4783	0.6426*	0.6539*	0.5357*	0.6965*	0.5852*	0.513	0.7704*	0.8922*	0.9026*	0.7965*	0.8270*	0.9365*	1
2008	0.3096	0.4948	0.5374*	0.4452	0.6052*	0.44	0.4174	0.7261*	0.8530*	0.7979*	0.7930*	0.7565*	0.8600*	0.9157*

Source: Authors' elaboration.

Table 1 confirms that Argentina presents high persistence in its regional crime structure. There is a clear association between the relative crime situations at the beginning of the 1980s with that at the mid-2000s. Hence, no significant changes have taken place in the regional crime structure of Argentina over time. In addition, the crime ranking changed relatively more in the early 1980s than in the 1990s and 2000s. The Spearman coefficient is 0.62 between 1980 and 1988, while the same statistic is 0.76 for the period 1990–1998 and 0.79 for 2000-2008.

With all this evidence at hand, we can conclude that regional structure of crime rate in Argentina shows very high persistence. This persistence is also observed for different types of crime. Moreover, this structure has changed during this period and persistence was stronger during the 1990s and 2000s, coinciding with a period of structural reforms in the country. Additionally, it is worth noting that crime trended up dramatically during the period studied and the range of variability in the regional crime rates diminished. In the next section we proceed to model the conditional means of the regional crime series.

III. A model of regional crime

Our empirical approach is borrowed from other economic areas, specifically from Unemployment and Income Distribution persistence literature. For example, Galiani et al (2004) analyze the persistence in unemployment in Argentinean regions. They try to identify regional factors that explain regional unemployment differences and whose changes account for the low persistence of the regional unemployment structure. Sosa Escudero et al (2006) investigate the main sources of persistence and variability of incomes using a panel dataset of rural El Salvador. As far as we know, the present paper is the first empirical research that studies the regional persistence of total crime and its typologies.[1]

In order to investigate the persistence of regional crime, we can estimate the following dynamic panel data models:

$$CR_{it}=\alpha_i + \lambda_t + \eta_1 CR_{it-1} + \varepsilon_{it} \qquad\qquad (1)$$

$$CR_{it}=\alpha_i + \lambda_t + \eta_2 CR_{it-1} + \text{ß}X_{it} + \varepsilon_{it} \qquad\qquad (2)$$

Where i states for province and t for year, CR is the log of the number of crimes per 10,000 inhabitants, α_i is a province effect, λ_t is a year fixed effect, X_{it} is a vector of socio-economic and deterrence variables, and ε_{it} is the error term.

As Galiani et al (2004) point out, model (2) overcomes model (1). If X_{it} and CR_{it-1} are strongly exogenous, η_2 identifies the true persistence of the shocks of the crime rate series. If X_{it} are persistent series, the estimate of η_1, picks up the persistence of the X_{it} and confounds it with the persistence of the shocks of the crime rate series. Then, by

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[1]There is abundant literature referring to the persistence of offenders, that try to establish the personal characteristics of criminals, who once onset in criminal activities, persist on them (see Garside (2004), Britta Kygvsaard (2003), Dean, Brame and Piquero (2006)). There is also literature referred to the persistence of crime prone places over time (see Don Weatherburn and Bronwyn Lind (2004)).

estimating model (2) we obtain a better measure of persistence and it is possible to obtain consistent estimates of the persistence of the regional crime rate to pure regional shocks.

Variables X_{it} include variables related to the theoretical model of crime, which focuses on two main issues: (i) the deterrence effect, related to the probability of being arrested and being condemned, and (ii) the social and macroeconomic effects, measured by variables such as income per capita, the productive structure of GDP, income growth, income inequality, unemployment rate, among others.

The expected signs of deterrence variables are negative since they represent a cost to those who commit crimes. Therefore, as the rate of sentence and arrest increase, the crime rate is expected to decrease, *ceteris paribus*. These effects are well documented for the US and Europe (Levitt, 1998; Edmark, 2005; Entorf and Spengler, 2000). For Argentina, Di Tella and Schargrodsky (2004) analyze car thefts before and after a terrorist attack on the main Jewish center in Buenos Aires and find a large deterrent effect of police on crime.

In addition, socio-economic variables have also been proved to affect crime rate. Empirical investigations found that the relationship between crime and economic activity mostly depends on the typology of crime. For example, property crimes are found to be counter-cyclical, while crimes against persons are not as sensitive to economic variations as property crimes.

Unemployment is also central part of criminiometric of Becker-Ehrlich type of models (Entorf and Spengler, 2000). To the extent that unemployment limits the legal income opportunities, it is expected to trigger illegal activities. However, more recent models that proposed slight modifications to the Becker–Ehrlich model produce ambiguous comparative-static results. In fact, some empirical studies on the relationship between crime and unemployment conclude that the effect of unemployment on crime is ambiguous and appears to be very sensitive to the econometric specification. Similarly, the effect of inequality on crime is expected to be negative and there are numerous studies that find a impact of relative income on crime (see Fajnzylber et al., 2002, Brush, 2007; Choe, 2008, Cerro and Meloni, 2001). However, other works fail to find a robust effect of inequality on crime (for instance, Neumayer, 2004).

Finally, the productive structure of the regional GDP can also be related to the crime rate explanation. *A priori*, we do not expect a similar effect of different economic sectors on crime rate. For example, those regions with a higher service sector are those with higher GDP per capita, and so the expected sign is similar to that of the GDP per capita. Similarly, those regions with higher government and construction participation, sectors characterized for being labor intensive, are expected to have lower unemployment rates, and hence a negative relationship with crime rate.

For the estimation of the model, we opt for the GMM estimator proposed by Arellano and Bover (1995). This estimator is designed for dynamic panel data models. The consistency of the GMM estimator depends crucially on the absence of serial correlation in ε_{it}. Then, in all our specifications, we report the significativity of the Arellano-Bond tests for autocorrelation applied to the first difference equation residuals. We expect not to reject the null hypothesis on an autoregressive regression model AR(1) but to reject the null hypothesis of second order autocorrelation that let us to conclude that lagged values of the endogenous variables are valid instruments. Finally, we report the significativity of the standard Sargan test of overidentifying restrictions. Its null hypothesis is that the instruments used by the GMM estimator – *as a group* – are exogenous. These

specification tests will confirm whether the GMM estimator is indeed appropriate in our case.

IV. Data

The dataset used in this paper is a panel of annual, provincial level observations steaming from 1980 to 2008, although time coverage depends on the type of crime. Data were collected from several national sources. Data on crime, arrest and sentences were drawn from the Registro Nacional de Reincidencia Criminal. Crime rates were defined as the number of reported offences per 10,000 inhabitants. Arrest rates were defined as the number of crimes with known subjects related to crimes. Finally, sentence rates were defined as the number of sentences per arrest, with the exception of total and crimes against persons sentence rates that were defined as the number of sentences per crime.

Our empirical specifications include total crime rate, property crime rate, distinguishing between robbery and theft, and crimes against persons, including murders.

Table 2 shows the national total number of crimes as well as the crime, arrest and sentence rates by type of crime in 2008. Property crimes represent nearly 60% of total crimes and it is by far the largest group of crimes. Among property crimes, robbery has the highest participation, with 50% of property crimes, followed by thefts, with almost 40%.[2] The second group in importance for its participation in total crime is crimes against persons, with a share of 20%. Crimes against persons comprise murders, involuntary manslaughter, injuries and traffic fatalities. Even though murders represent less than 1% of the crimes against persons, these crimes are analyzed separately as they are the most sounded ones due to their severity.

Regarding deterrence variables, both the probability of arrest and sentence also varies by type of crime. In particular, the probability of arrest is relatively high in the case of murders, which reflect the fact that for violent crimes the police is more likely to act. Almost 90% of suspected murders are arrested, and 50% of those arrested received a sentence. The probabilities of arrest and sentence are much lower for property crimes. In particular, the probability of arrest is similar for robberies and theft (around 16%). In contrast, given the severity of the offense, the probability of sentence is larger for criminals arrested for robbery (24%) than for criminals arrested for theft.

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[2] Other types of crimes such as extortions, kidnappings, frauds and usurpation account for the remaining 10%.

Table 2.Crime, arrest and sentence rates by type of crime. Argentina 2008

	Reported Crimes	Participation in Total Crime (%)	Crime Rate per 10000 inhabitants	Probability of Arrest (%)	Probability of Sentence(%)
Total Crime	1,310,977	100.00	329.84	-	2.30*
Property	799,137	60.96	201.06	16.96	14.99
Robbery	398,271	30.38	100.20	15.54	24.25
Theft	314,205	23.97	79.05	13.11	6.49
Others	86,661	6.61	21.80	37.51	7.19
Against persons	263,124	20.07	66.20	-	1.74*
Murders	1,986	0.15	0.50	88.67	52.47

Source: Registro Nacional de Reincidencia Criminal
Note: * Sentence rate was defined as the total number of sentences per crime.

Table 3 displays the summary statistics of Argentinean provinces crime rates by type of crime. Crime rates show a great variation across provinces and over time. For instance, the highest crime rate corresponds to the City of Buenos Aires, reaching a rate of 728.3 crimes per 10,000 inhabitants in 2008. The lowest crime rate of around 40 crimes per 10,000 inhabitants was registered in the province of Buenos Aires in 1980. The highest property crime rate also corresponds to the City of Buenos Aires, reaching a rate of 515.8 property crimes per 10,000 inhabitants in 2008. The lowest property crime rate was registered in Formosa in 1994, with 51 property crimes per 10,000 inhabitants.

Table 3. Crime rates summary statistics by type of crime. Argentinean provinces

Crime rates	Period	Observations	Mean	Std.Deviation	Min	Max
Total	1980-2008	694	245.74	131.40	39.63	728.27
Property	1991-2008	408	194.62	98.66	50.78	515.87
Robbery	2000-2008	216	96.96	55.02	24.76	301.60
Theft	2000-2008	216	102.69	49.79	6.01	248.86
Other property crimes	2000-2008	216	33.90	21.25	6.99	135.22
Crimes against persons	2000-2008	198	63.34	22.65	21.82	128.14
Murders	2000-2008	189	0.53	0.26	0.08	1.36

Source: Registro Nacional de Reincidencia Criminal

Finally, regarding socio-economic variables, several sources were used. The Gini coefficient was obtained from Gasparini et al (2000) for 1990-1999 and from the Instituto de Estudios Laborales y Desarrollo Económico (IELDE) from 2000 onwards. No data on the Gini coefficient is available prior to 1990. Information on the GDP per capita and its structure in constant 1993 pesos was obtained from the Office of the Ministry of

Economics, from Mirabella and Nanni (1998), and from estimates based on the income-output matrix for 2000 to 2008. Data on unemployment rates (%) was drawn from the Permanent Household Survey carried out by the Argentine National Institute of Statistics and Census (INDEC).

Table 4 shows the summary statistics for these socio-economic variables. GDP per capita reached a maximum of 31,014 constant 1993 pesos in the City of Buenos Aires in 2008 and a minimum of 2,130 constant 1993 pesos in Santiago del Estero in 1982. Not only the level, but also the GDP structure varies across provinces. For example, manufacturing is relatively important in San Luis, construction in Tierra del Fuego, services in the City of Buenos Aires, government in La Rioja, and mining in Santa Cruz. The relative weight of the different sectors in the product of the provinces has also varied over time, as a result of business cycle, general structural reforms, and specific policies tended to promote one or another sector. Finally, the Gini coefficient and the unemployment rate also vary significantly across provinces and over time. The Gini coefficient ranged from 33 in Santa Cruz in 1990 to 56 in San Luis in 2000. Buenos Aires had an unemployment rate of just 1% in 1980, while unemployment reached more than 27% in San Juan in 2000. These significant differences in the socio-economic variables may be behind the differences in crimes rates across provinces. As explained in the previous section, we will control for differences in these socio-economic variables in our model to take into account this possibility.

Table 4. Summary statistics of socio-economic variables

Variable	Period	Observations	Mean	Std Deviation	Min	Max
GDP per capita	1980-2008	696	6316.28	4439.11	2129.95	31013.88
GDP growth rate	1981-2008	672	1.22	6.75	-22.03	36.33
Manufacturing (%)	1993-2008	384	14.43	8.69	2.85	46.29
Construction (%)	1993-2008	384	6.93	2.45	0.98	13.08
Services (%)	1993-2008	384	42.53	6.58	27.17	62.04
Government (%)	1993-2008	384	7.90	3.05	3.44	17.82
Mining (%)	1993-2008	384	5.43	10.70	0.00	44.40
Others (%)	1993-2008	384	22.78	6.93	9.20	36.55
Gini	1990-2008	433	43.10	3.94	32.91	56.30
Unemployment	1980-2008	628	9.02	4.57	1.00	27.90

V. Econometric results

In this section we present the results of our preferred specifications for the regional models of different types of crimes.

We estimate models (1) and (2) above separately for each type of crime.[3] The parameter of the lagged dependent variable measures the degree of persistence of the shocks in time. As we have previously discussed, model (2) is more appropriate to measure persistency if X_{it} is a matrix of persistent variables.[4]

In all specifications, deterrence variables are assumed to be predetermined.[5] For all cases, we do not reject the null hypothesis of the validity of the overidentification restrictions (Sargan test) nor the lack of autocorrelation in the residuals at the conventional levels of statistical confidence (tests m1 and m2 by Arellano-Bond). Then, these specification tests confirm the appropriateness of GMM system estimators for our models.

GMM estimates are one-step estimates. Although there exist two-step estimators that are asymptotically more efficient, it is well known (see Arellano and Bond, 1991) that two-step estimated standard errors in dynamic models can be seriously biased downward, and for that reason, one-step estimates with robust standard errors are often preferred.

Next we describe the results for each type of crime separately.

Total crime

In Table 5 we present the results for the total crime rate. In column (1), we only include the lagged dependent variable. In column (2) we add deterrence variables. In column (3) we also include the socio-economic variables, except for the product sector composition. In column (4), we replace the socio-economic variables in the previous column by the economic composition variables. Finally, in column (5) we combine the socio-economic and economic structure variables in the two previous columns.

The lagged dependent variable is statistically significant at a 1% level in all specifications. If no other controls are included in the model, we find that a 10% increase in the total crime rate in t-1 increases the crime rate in the next period by 9%. The coefficient of lagged crime slightly decreases when we add the sentence rate (column (2)) and economic structure variables (column (4)) to the model, as expected when persistent variables are included in the model. However, even after conditioning on different sets of explanatory variables we continue to find a relatively high autocorrelation coefficient in the regional total crime series. After a year, between 70% and 80% of a regional shock to crime will still be affecting regional crime. Two years later, only 40%-50% of the effect of the shock on regional crime will have disappeared. Crime, at the regional level, presents a very high persistence to idiosyncratic shocks.

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[3]We tested for unit roots using Levin et al. (2002) test for panel data. The corresponding Levin–Lin modified t-statistic for the test of the null hypothesis of the presence of a unit root suggests that the null should be rejected. It is worth mentioning that the possible low power of the Levin–Lin test for the small sample available should have biased the result toward accepting the null, contrary to our result. Results are similar for different types of crimes (for more details see the Table A.3 in the Appendix).

[4] Results are similar regardless of whether we include regional fixed effects or not. Time fixed effects are highly correlated with socioeconomic variables, which make difficult identifying the effect of these variables on the crime rate. We have then omitted regional and time fixed effects in the models' specifications below.

[5]Predetermined variables are variables that were determined prior to the current period. This implies that the current period error term is uncorrelated with current and lagged values of the predetermined variables but may be correlated with future values. This is a weaker restriction than strict exogeneity, which requires the variables to be uncorrelated with past, present, and future shocks.

Turning to the determinants of crime differences, we find that the sentence rate has a negative and significant effect on the crime rate, which is in accordance with the predictions of Becker's theory (1968) on deterrence.[6] However, its effect is very low: a 10% increase in the sentence rate decreases the crime rate by only 0.9%-1% depending on the model.

On the socioeconomic variables (see column (3)), GDP per capita, intending to capture a cross-section effect, is positively and significantly associated with crime rates, indicating that the higher the regional GDP per capita the higher the crime rate (i.e., a 10% increase in the regional GDP per capita increases the crime rate by 1.8%-2.3%). In contrast, economic growth, which would be capturing a time effect, has a negative effect on the crime rate, indicating that during expansions (recessions) the crime rate decreases (increases).[7] As observed in previous empirical studies (see Fajnzylber et al., 2002), we also find a positive and statistically significant link between inequality, measured by the Gini coefficient, and crime. In particular, a 10% increase in the Gini coefficient increases the crime rate by 2.7%-3-8%. In accordance with crime theory, which suggests that unemployed individuals who have no legal income opportunities are more likely to commit crimes than people who have a job, we find a positive and statistically significant effect of unemployment on total crime.[8] However, due to the high correlation between unemployment rate and other socioeconomic[9] and economic structure variables, which may cause multicollinearity problems, this variable is no longer statistically significant when we include other variables and has been omitted in the full model (column (5)).

Finally, changes in the regional economic structure also affect regional crime. In particular, we find that regions with higher product shares in construction have lower crime. We conjecture that, since this activity is labor intensive, it affects crime rate through the unemployment rate (omitted). We also find that regions with higher product shares in services have higher crime.

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[6] Total sentence rate is defined as the ratio between total sentences and crime, since we do not have total arrests for the whole period.

[7] Results are similar if instead of using regional GDP growth rate, we use a dummy variable that takes value one for recession years and zero otherwise.

[8] To test for hysteresis in the regional unemployment rate, we interacted this variable with a dummy variable that takes value one for recessions and zero otherwise. However, we do not find a significantly different effect of the regional unemployment rate in recessions and expansions.

[9] For example, the correlation between unemployment and Gini coefficient is 0.65 for the period 2000-2008

Table 5 System GMM estimates. Total Crime (log)

Variables	(1)	(2)	(3)	(4)	(5)
Crime Rate$_{t-1}$ (log)	0.893***	0.791***	0.811***	0.716***	0.729***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sentence Rate (log)		-0.098***	-0.094***	-0.088***	-0.089***
		(0.000)	(0.000)	(0.000)	(0.000)
GDP pc (log)			0.229***		0.175**
			(0.000)		(0.029)
Gini coefficient (log)			0.380***		0.270***
			(0.002)		(0.007)
Unemploy. Rate (log)			0.0614***		
			(0.001)		
GDP Growth			-0.003**		-0.0009
			(0.034)		(0.417)
Construction (%)				-0.0258***	-0.0234**
				(0.004)	(0.013)
Services (%)				0.0116***	0.00970**
				(0.004)	(0.012)
Government (%)				-0.0167*	-0.00524
				(0.058)	(0.517)
Mining (%)				0.00731	0.00510
				(0.121)	(0.178)
Others (%)				-0.00477	0.00260
				(0.420)	(0.665)
Constant	0.621***	1.236***	-2.412***	1.565***F 52	-1.226
	(0.000)	(0.000)	(0.000)	(0.000)	(0.219)
Observations	668	667	407	380	367
Number of groups	24	24	24	24	24
Number instruments	400	578	417	387	372
Wald test	3974	2889	2608	4603	2987
Sargan test	500.41***	875.72***	548.83***	504.65***	436.59***
m1	-3.622***	-3.396***	-3.456***	-3.641***	-3.753***
m2	-2.365**	-2.275**	-1.908*	-2.115**	-2.167**

*Note: Robust standard errors are reported in parentheses. *, **, *** means statistically significant at a 10%, 5% and 1% level.*

Property crime: total, robbery and theft

Table 6 presents the results for property crimes, distinguishing by type of crime. The persistence of property crimes varies according to the type of crime. For all property crimes taken as a whole, a 10% increase in the crime rate in t-1 leads to a 7-8% increase in the crime rate in the next period. Persistence is similar for robberies, which comprises

more than 50% of all property crimes. In contrast, for theft persistence is much lower. Moreover, when we control for socioeconomic variables and, particularly, when we control for the regional productive structure, the lagged dependent variable for theft significantly decreases and even becomes non-statistically significant. This indicates that much of the persistence in the theft crime rate is due to the persistence in the regional socioeconomic conditions and economic structure. Theft needs less specialization than robberies and is typically the result of specific economic conditions. Criminals will continue committing theft as long as the economic conditions that originally motivate them to commit these crimes persist. Once these conditions change, they will probably abandon illegal activities.[10] In contrast, criminals involved in robberies will probably continue committing these crimes, even after economic conditions change, as they have already acquired the specific skills this type of crime requires. These findings are in line with the results obtained by Kelaher and Sarafidis (2011) who find that violent crimes show higher persistence than non-violent crimes.

The estimated effects of the arrest and sentence rates are negative and statistically significant for all types of property crimes. These results point to the relevance of both police and judicial performance in the deterrence of crime. By construction of the variables probability of arrest and sentence, we expect that the marginal deterrence effect of the probability of arrest is higher than that of the probability of sentence (see Kelaher and Sarafidis (2011)). Empirical results confirm that the effect of arrests is larger (in absolute value) than the effect of sentences. By type of property crime, the estimated effect of the arrest and sentence rate are larger (in absolute value) for theft than for robbery. This evidence supports the hypothesis that persons committing theft probably do it eventually in a non-professional way and hence are more likely to be deterred by the fear of being caught and condemned.

For all property crimes taken as a whole and robberies, the effect of the GDP per capita is positive and statistically significant. As explained above, this net effect is the result of two countervailing forces at place. On the one hand, a higher GDP per capita means more and more valuable assets and hence higher expected profits for criminals. On the other hand, a higher GDP per capita means lower needs and higher costs for criminals (i.e., the cost of losing what they have if they are arrested). For property crimes taken as a whole and robberies, the effect of GDP per capita that prevails is the first one. The magnitude of GDP net effect is similar than for total crime. Again, as for total crime, economic growth has a negative effect on property crimes and robberies. However, as expected, property crimes are more responsive to the cycle than total crimes.[11]

The unemployment rate is statistically significant only for all property crimes taken as a whole. Again, the non-significance of this variable for robberies may be the result of the high correlation between unemployment rate and other socioeconomic variables (i.e., the Gini coefficient), which intensifies in smaller samples (i.e., from 2000 to 2009), and by causing mulicolinearity problems, prevent us from identifying individual effects.

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[10] We have also tested for asymmetric reaction of crime rate over time, meaning that increases are sharper but decreases are gradual. Mocan and Bali (2005) demonstrate that property crime reacts more (less) strongly to increases (decreases) in the unemployment rate, to decreases (increases) in per capita real GDP and to decreases (increases) in the police force. However we did not find a significant asymmetric reaction.

[11] Results are similar if instead of using regional GDP growth rate, we use a dummy variable that takes value one for recession years and zero otherwise.

In contrast, the Gini coefficient is positive and statistically significant for all types of property crimes. Moreover, the effect of the Gini coefficient on property crimes is larger than on total crimes, indicating that income inequality specially triggers property crimes.

Finally, we find that regions with higher product shares in services and mining have higher property crime rates. Again, as we pointed out before, the non-significance of the economic structure variables for robberies in column (5) may the result of the high correlation between them and the socioeconomic variables, which intensifies in smaller samples, and by causing mulicolinearity problems, preventing us from identifying individual effects.

We suspect multicolinearity is also responsible for the lack of jointly identification in theft's estimations, where none of the socioeconomic or regional productive structure variables are significant (except for the Gini coefficient). Proof of that is the fact that, when included one at a time, socioeconomic variables have the expected sign and are statistically significant. [12]

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[12] Results are available from authors upon request

Table 6 System GMM estimates. Property, robberies and theft crimes (log)

Variables	All					Robberies					Theft				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Crime Rate$_{t-1}$ (log)	0.709***	0.805***	0.771***	0.681***	0.695***	0.706***	0.754***	0.727***	0.574***	0.665***	0.368**	0.443**	0.366*	0.306*	0.281
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.028)	(0.014)	(0.096)	(0.062)	(0.101)
Arrest Rate (log)		-0.235***	-0.175***	-0.188***	-0.174***		-0.199***	-0.121***	-0.205***	-0.153***		-0.539**	-0.525**	-0.601**	-0.612**
		(0.000)	(0.000)	(0.000)	(0.000)		(0.001)	(0.000)	(0.000)	(0.000)		(0.021)	(0.035)	(0.019)	(0.012)
Sentence Rate (log)		-0.115***	-0.106***	-0.113***	-0.111***		-0.120***	-0.078***	-0.091***	-0.084***		-0.192***	-0.150**	-0.159***	-0.162***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.003)	(0.000)	(0.001)	(0.000)		(0.001)	(0.016)	(0.002)	(0.001)
GDP pc (log)			0.216***		0.175***			0.248***		0.245***			-0.207		0.205
			(0.000)		(0.008)			(0.001)		(0.000)			(0.440)		(0.477)
Gini coefficient (log)			0.423**		0.606***			0.442**		0.440***			0.566		0.570*
			(0.027)		(0.003)			(0.032)		(0.004)			(0.216)		(0.096)
Unemploy Rate (log)			0.059***					0.054					0.012		
			(0.003)					(0.131)					(0.897)		
GDP Growth			-0.007***		-0.004**			-0.011***		-0.009***			-0.004		-0.004
			(0.000)		(0.012)			(0.000)		(0.000)			(0.589)		(0.582)
Construction (%)				-0.0303**	-0.0135				-0.037***	-0.011				-0.012	0.003
				(0.011)	(0.161)				(0.000)	(0.327)				(0.520)	(0.897)
Services (%)				0.0134**	0.0105*				0.020*	0.010				-0.006	-0.023
				(0.048)	(0.053)				(0.050)	(0.125)				(0.786)	(0.482)
Government (%)				-0.0107	0.001				-0.032**	-0.002				0.080	0.111
				(0.425)	(0.939)				(0.014)	(0.875)				(0.137)	(0.140)
Mining (%)				0.013*	0.010*				0.015***	0.006				0.026***	0.018
				(0.056)	(0.061)				(0.009)	(0.214)				(0.009)	(0.166)
Others (%)				-0.008	-0.001				-0.001	0.006				0.020	0.025
				(0.389)	(0.877)				(0.874)	(0.360)				(0.258)	(0.119)
Constant	1.530***	1.964***	-1.634*	2.282***	-1.839*	1.328***	1.955***	-2.151**	2.258***	-2.150**	2.852***	4.281***	4.176	4.191***	0.725
	(0.000)	(0.000)	(0.000)	(0.000)	(0.095)	(0.000)	(0.000)	(0.041)	(0.000)	(0.038)	(0.000)	(0.005)	(0.218)	(0.008)	(0.807)
Observations	360	291	269	267	258	192	171	165	171	167	192	164	158	164	160
Number of groups	24	24	24	24	24	24	22	22	22	22	24	22	22	22	22
Number inst	121	226	223	224	222	36	108	112	113	116	36	107	111	112	115
Wald test***	195.1	461.0	1047	1711	2146	69.01	250.9	637.0	539.7	840.2	4.862	179.4	292.6	678.1	761.6
Sargan test	267.66***	320.30***	257.06**	273.43***	225.85	190.86***	192.36***	118.05	172.32***	118.36	115.19***	287.48***	280.94***	278.1***	258.63***
m1	-3.317***	-3.024***	-2.743***	-3.010***	-2.926***	-2.164**	-2.721***	-2.527**	-2.140**	-2.354**	-1.635*	-2.675***	-2.245**	-2.369**	-2.569***
m2	-0.875	-0.632	-1.479	-0.927	-1.289	0.561	0.0891	-0.235	0.194	-0.136	0.501	0.585	-0.0646	0.216	-0.331

*Note: Robust standard errors are reported in parentheses. *, **, *** means statistically significant at a 10%, 5% and 1% level.*

Crimes against persons: total and murders

Table 7 presents the results for all crimes against persons and murders.

The dependent variable lagged once is typically positive and statistically significant for both, crimes against persons and murders, except murders when no additional regressors are included in the model. Moreover, the persistence is much higher for all crimes against persons than for murders. However, the persistence of the crimes against persons decreases from 0.96 (column (1)) to 0.56 (column (5)) as additional controls are included in the model

The sentence rate has a negative and significant effect on both crimes groups. Arrest rate has also a negative and significant effect on murders.

The GDP per capita coefficient is positive for crimes against persons, although not always statistically significant, indicating that the number of crimes against persons increases with income, possibly because these crimes comprise traffic offences, whose participation has increased with the increase in the vehicle fleet, which, in turn, has been higher in regions with higher GDP per capita. In contrast, the GDP per capita coefficient is negative for murders, although not always statistically significant,. GDP growth has a significant effect on crimes against persons, but not on murders. Similarly, neither the unemployment rate nor the Gini coefficients are statistically significant in the explanation of crimes against persons or murders.

Finally, we find that regions with higher product shares in government, which are the regions with lower GDP per capita, have lower rates of crimes against persons. Once we control for GDP per capita, the product share in government is no longer significant. In contrast, the product share in government is statistically significant for murders even after controlling for GDP per capita, probably via employment effect.

Table 7 System GMM Estimates. Crimes against persons and murders (log)

Variables	Crimes against persons					Murders				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CrimeRate$t$-1 (log)	0.955***	0.843***	0.677***	0.618***	0.560***	0.239	0.503***	0.458***	0.436***	0.390***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.109)	(0.000)	(0.000)	(0.000)	(0.000)
Arrest Rate (log)							-0.451***	-0.468***	-0.485***	-0.494***
							(0.000)	(0.000)	(0.000)	(0.000)
Sentence Rate (log)		-0.052**	-0.053**	-0.051**	-0.061**		-0.375***	-0.369***	-0.364***	-0.371***
		(0.019)	(0.014)	(0.031)	(0.021)		(0.000)	(0.000)	(0.000)	(0.000)
GDP pc (log)			0.272**		0.210			-0.194		-0.781**
			(0.050)		(0.236)			(0.385)		(0.043)
Gini coefficient (log)			0.214		0.059			0.096		-0.661
			(0.347)		(0.782)			(0.866)		(0.197)
Unemployment Rate (log)			0.041					0.034		
			(0.447)					(0.722)		
GDP Growth			0.003*		0.005**			0.002		0.004
			(0.094)		(0.039)			(0.715)		(0.567)
Construction (%)				-0.011	-0.027**				-0.014	-0.027
				(0.227)	(0.031)				(0.500)	(0.464)
Services (%)				0.0003	0.011				0.018	0.021
				(0.970)	(0.481)				(0.323)	(0.411)
Government (%)				-0.049**	-0.031				-0.013	-0.094**
				(0.0289)	(0.214)				(0.681)	(0.0486)
Mining (%)				0.004	0.008				0.011	0.016
				(0.588)	(0.238)				(0.412)	(0.378)
Others (%)				-0.010	-0.006				0.016	0.003
				(0.413)	(0.700)				(0.248)	(0.877)
Constant	0.215	0.702**	-1.871	2.253**	-0.135	-0.619***	3.201***	4.432	2.255*	12.32***
	(0.474)	(0.026)	(0.109)	(0.016)	(0.939)	(0.000)	(0.000)	(0.266)	(0.051)	(0.002)
Observations	176	174	168	174	170	168	151	147	151	147
Number groups	22	22	22	22	22	21	20	20	20	20
Number ins	36	80	84	85	88	36	118	122	123	126
Wald test	164.7	211.7	138.5	314.4	149.6	2.570	91.91	124.6	399.1	406.7
Sargan test	39.05	138.70***	126.94***	127.51***	118.60	72.04***	157.90***	153.46***	159:78***	150.25**
m1	-3.387***	-3.498***	-3.153***	-3.531***	-3.102***	-2.909***	-2.178**	-2.147**	-2.270**	-2.363**
m2	0.773	0.750	1.036	0.752	1.441	1.196	1.576	1.542	1.672*	1.676*

*Note: Robust standard errors are reported in parentheses. *, **, *** means statistically significant at a 10%, 5% and 1% level.*

Conclusions

This paper aimed at studying the persistence of Argentinean regional crime rate and its typologies in the period 1980-2008, although time coverage depends on the type of crime. Our goal was to identify the sources of crime persistence: the equilibrium levels of crime and the response to shocks over time.

The descriptive analysis shows that Argentina presents high persistence in its regional crime structure, both for total crime rate and for different types of crime. In all cases, there is a clear association between the relative crime situation at the beginning of the 1980s and that at the mid-2000s. In addition, the provinces crime rankings changed relatively more in the early 1980s than in the 1990s and 2000s.

We then estimated a dynamic panel data model using the GMM estimator proposed by Arellano and Bover (1995), which allows us to distinguish between the two sources of persistence explained above. The model includes a lagged dependent variable and a set of explanatory variables related to the standard theoretical model of crime, which focuses on two main issues: (i) the deterrence effect, related to the probability of being arrested and being condemned, and (ii) the social and macroeconomic effects, measured by variables such as income per capita, GDP productive structure, income growth, income inequality and unemployment rate.

We find that the parameter of the lagged dependent variable, which measures the degree of persistence of the shocks in time, is typically positive and significant. If no other controls are included in the model, we find that a 10% increase in the total crime rate in t-1 increases the crime rate in the next period by 9%. After conditioning on the set of explanatory variables we continue to find a relatively high autocorrelation coefficient in the regional total crime series. After a year, between 70% and 80% of a regional shock to crime will still be affecting regional total crime. Two years later, only 40%- 50% of the effect of the shock on regional total crime will have disappeared. For all property crimes, robberies and crimes against persons, persistence is similar to total crime. For theft, persistence is much lower and even becomes non-statistically significant when we control for socio-economic variables. This indicates that much of the persistence in theft is due to the persistence in the socio-economic variables.

As expected, we find that the arrest and sentence rates have a negative and statistically significant effect on the crime rate, which points to the relevance of both police and judicial performance in the deterrence of crime.

On the economic variables, the effect of GDP per capita on crime is undetermined: it is positive and significant for all crimes, property crimes, robberies, and crimes against persons, and negative for murders. Similarly, economic growth has a negative and significant effect on total crime and all types of property crimes (except for theft for which it is not significant), and a positive and significant effect on crimes against persons.

We find a positive and significant relationship between inequality, measured by the Gini coefficient, and total crime, property crimes, robberies and theft. However, we only find a statistically significant effect of unemployment on total crime and property crimes. We suspect multicolinearity is responsible for the lack of jointly identification of these two variables in theft's estimations. Proof of that is the fact that, when included one at a time, these variables have the expected sign and are statistically significant.

Finally, we find that regions with higher construction and government product shares have lower crime. We conjecture that, since these activities are labor intensive, they affect crime rate through unemployment rate, and also through GDP, given that regions with higher product shares in construction and government are those with lower GDP per capita.

In sum, we found high persistence in regional crime rates over time, for both total crime and different types of crime. This persistence is only partially explained by the persistence of institutional or socio-economic variables. After controlling for institutional and socio-

economic variables, crime at the regional level continues to present a very high persistence to idiosyncratic shocks. These results suggest that policies to deter criminal activities should include preventing individuals from entering into the illegal sector because once they do so; they may have no incentives to abandon it. A possible explanation for this comes from the accumulation of illegal human capital and the depreciation of legal human capital during the time spent in the illegal sector. In this case, prevention would imply encouraging investment in legal human capital via education either by promoting a sufficiently high rate of return to legal human capital, or by lowering the costs of such investment.

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Appendix

Table A.1 Provinces nomenclature

Province	Nomenclature
BUENOS AIRES	BA
CAPITAL FEDERAL	CF
CATAMARCA	CAT
CHACO	CHA
CHUBUT	CHU
CORDOBA	CBA
CORRIENTES	CTE
ENTRE RIOS	ER
FORMOSA	FOR
JUJUY	JUJ
LA PAMPA	PAM
LA RIOJA	RIO
MENDOZA	MZA
MISIONES	MIS
NEUQUEN	NEU
RIO NEGRO	RIO
SALTA	SAL
SAN JUAN	SJU
SAN LUIS	SLU
SANTA CRUZ	SCR
SANTA FE	SFE
SANTIAGO DEL ESTERO	SGO
TIERRA DEL FUEGO	TFU
TUCUMAN	TUC

Table A.2Spearman correlation coefficients by type of crime. Argentina Regions 2000-2008

	2000	2001	2002	2003	2004	2005	2006	2007
Property crimes								
2000	1							
2001	0.9522*	1						
2002	0.9130*	0.9757*	1					
2003	0.9391*	0.9704*	0.9522*	1				
2004	0.8722*	0.8913*	0.8330*	0.9026*	1			
2005	0.8183*	0.8313*	0.7809*	0.8365*	0.9452*	1		
2006	0.8070*	0.8113*	0.7591*	0.8261*	0.9087*	0.9626*	1	
2007	0.8687*	0.8748*	0.8200*	0.8939*	0.8948*	0.8922*	0.9104*	1
2008	0.8470*	0.8217*	0.7548*	0.8417*	0.9035*	0.9026*	0.9035*	0.9391*
Robbery								
2000	1							
2001	0.9800*	1						
2002	0.9704*	0.9922*	1					
2003	0.8974*	0.9313*	0.9383*	1				
2004	0.8278*	0.8591*	0.8574*	0.9243*	1			
2005	0.6930*	0.7183*	0.7157*	0.8035*	0.9061*	1		
2006	0.7009*	0.7217*	0.7252*	0.7957*	0.8991*	0.9904*	1	
2007	0.7122*	0.7217*	0.7287*	0.8035*	0.8922*	0.9809*	0.9835*	1
2008	0.7496*	0.7557*	0.7626*	0.8252*	0.9157*	0.9478*	0.9374*	0.9678*
Theft								
2000	1							
2001	0.9704*	1						
2002	0.9426*	0.9539*	1					
2003	0.9261*	0.9530*	0.9600*	1				
2004	0.8878*	0.9122*	0.8661*	0.9322*	1			
2005	0.8696*	0.8870*	0.8296*	0.8887*	0.9313*	1		
2006	0.8774*	0.8696*	0.8052*	0.8513*	0.9287*	0.9496*	1	
2007	0.9130*	0.9287*	0.9087*	0.8852*	0.8339*	0.8330*	0.8722*	1
2008	0.8278*	0.8009*	0.7435*	0.7826*	0.7887*	0.8652*	0.8896*	0.8313*
Other property crimes								
2000	1							
2001	0.9261*	1						
2002	0.7878*	0.8313*	1					
2003	0.9322*	0.9722*	0.8739*	1				
2004	0.8791*	0.8713*	0.8078*	0.9183*	1			
2005	0.9348*	0.9643*	0.8513*	0.9713*	0.9113*	1		
2006	0.9148*	0.9365*	0.8478*	0.9209*	0.8609*	0.9696*	1	
2007	0.9061*	0.9252*	0.7861*	0.9200*	0.8365*	0.9478*	0.9565*	1
2008	0.8130*	0.8626*	0.6896*	0.8330*	0.7626*	0.8809*	0.8991*	0.9504*

Crimes against persons

	2000	2001	2002	2003	2004	2005	2006	2007	2008
2000	1								
2001	0.9232*	1							
2002	0.9051*	0.9785*	1						
2003	0.8938*	0.9571*	0.9706*	1					
2004	0.9345*	0.9345*	0.9514*	0.9605*	1				
2005	0.9560*	0.9153*	0.9040*	0.8938*	0.9560*	1			
2006	0.9029*	0.8769*	0.8995*	0.8826*	0.9345*	0.9684*	1		
2007	0.9085*	0.8769*	0.8848*	0.8859*	0.9130*	0.9401*	0.9526*	1	
2008	0.8487*	0.8069*	0.8250*	0.8419*	0.8780*	0.8871*	0.9040*	0.9503*	

Murders

	2000	2001	2002	2003	2004	2005	2006	2007	2008
2000	1								
2001	0.7260*	1							
2002	0.7026*	0.7831*	1						
2003	0.7714*	0.6571*	0.8091*	1					
2004	0.7468*	0.7623*	0.7623*	0.6805*	1				
2005	0.5857*	0.7286*	0.8753*	0.7429*	0.8026*	1			
2006	0.5792*	0.7026*	0.7818*	0.6662*	0.7597*	0.9234*	1		
2007	0.6974*	0.6987*	0.8766*	0.7974*	0.8104*	0.9078*	0.8870*	1	
2008	0.6909*	0.7922*	0.8234*	0.8104*	0.7753*	0.8714*	0.8247*	0.8818*	

Table A.3 Levin-Lin-Chu panel data unit test root with 1 lag

	No time trend		Time trend	
	Adjusted t	P-value	Adjusted t	P-value
Total	-2.883	0.002	-2.427	0.008
Property	-5.498	0.000	-2.120	0.017
Robbery	-11.572	0.000	-27.129	0.000
Theft	-8.569	0.000	-26.843	0.000
Other property crimes	-15.316	0.000	-21.875	0.000
Crimes against persons	0.312	0.623	-10.909	0.000
Murders	-6.525	0.000	-13.152	0.000

Note: Ho: Panels contain unit roots. Ha: Panels are stationary.