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Andrea Carolina Aguirre Sanchez

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UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

Groupe d'Analyse et de Théorie Économique Lyon Saint-Étienne, UMR 5824

Université de Lyon École Doctorale de Sciences Économiques et de Gestion 486

**Urban Crime in Ecuador:  
Three essays on the role of economic inequalities, population density and  
emotions**

THÈSE DE DOCTORAT EN SCIENCES ÉCONOMIQUES

Présentée et soutenue publiquement par  
Andrea Carolina AGUIRRE SÁNCHEZ

Devant le jury composé de:

Fabien **CANDAU**, Professeur, Université de Pau et des Pays de l'Adour (Rapporteur).

Nelly **EXBRAYAT**, Maître des Conférences HDR, Université de Saint-Étienne (Directrice de thèse).

Carl **GAIGNÉ**, Directeur des Recherches, INRA de Rennes (Rapporteur).

Camille **HÉMET**, Maître des Conférences, École Normale Supérieure de Paris.

Carolina **CURVALE**, Professeur, Facultad Latinoamericana de Ciencias Sociales - FLACSO.

Fernando **MARTIN**, Professeur, Facultad Latinoamericana de Ciencias Sociales - FLACSO (Directeur de thèse).

Stéphane **RIOU**, Professeur, Université de Saint-Étienne (Directeur de thèse).

Tanguy **VAN YPERSELE**, Professeur, Aix-Marseille Université.

Cotutelle Internationale  
Université Jean Monnet de Saint-Étienne, France  
et  
Facultad Latinoamericana de Ciencias Sociales, Ecuador



To my daughter, the source of my inspiration and my force.  
Thanks for being unconditional,  
for your love and support during the achievement of this dream.

I love you Amelia



---

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---

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## ABSTRACT

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Latin America and the Caribbean (LAC) is one of the most violent regions in the world. Importantly, higher levels of violence prevail in most urbanized LAC cities (UNODC, 2013). Understanding the determinants of urban crime is therefore a major challenge for those countries. The purpose of this dissertation is to explore the role of three crime determinants in Ecuador: economic inequalities, city size, and the emotions caused by soccer events.

Before conducting this empirical analysis, we first review the theoretical and empirical literature on urban crime determinants. An important conclusion is that economic incentives that lead individuals to commit crime are influenced by the location pattern of criminals and victims. Building on these considerations, we perform three empirical analyses at different geographic levels.

First, we explore the effect of income inequality on victimization in Ecuador, using data at the individual level thanks to the Ecuadorian Victimization survey. The main result is that, contrary to the predictions, the Gini coefficient has a negative effect on victimization by robbery. This result could be related to a high residential segregation or a high social control against crime. In addition, we provide evidence for an increasing and concave relationship between the income level of victims and the probability of victimization by vehicle theft, which first increases with a monthly household income up to \$5,100, and then falls.

Second, we test the existence of an urban crime premium (higher crime in urban areas) in Ecuador, at the parish level. Our main result is that population exerts a non-linear influence on the homicide rate. The probability that a homicide happens is higher in larger parishes. However, the homicide rate decreases with population in parishes with positive homicides. By contrast, the results regarding property crimes confirm that the level of population increases the number of pecuniary crimes per inhabitant.

Third, we explore the effect of soccer matches on the number of homicides and property crimes in 16 cantons of Ecuador, at the intra-city level. The aim is to test whether soccer matches alter the temporal and spatial patterns of crime, and the role of emotions (frustration and euphoria) resulting from soccer matches on crime. Results reveal that the number of homicides increases by 0.18% before the match whereas the number of property crimes increases by 12% after the match, near the stadium. Soccer matches also cause spatial spillovers of crime in locations distant from stadiums. On game days, the number of property crimes falls by 0.88% before the match and the number of homicides falls by 0.05% during the match, in these distant locations. After the game, the homicides and property crimes significantly increase in locations distant from stadiums. Finally, the effect of emotions on homicides or property crimes is not significant at the aggregate level but it is significant regarding homicides that occur in the capital of Ecuador, Quito.

**Keywords:** Economics of crime, urban economics, development economics, income inequality, city size, soccer, property crimes, violent crimes.





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## RÉSUMÉ

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L'Amérique Latine et les Caraïbes sont l'une des régions plus violentes du monde. Le niveau de violence est particulièrement élevé dans les plus grandes villes de cette région (UNODC, 2013). La compréhension des déterminants de la criminalité urbaine est donc un défi majeur pour ces pays. Cette thèse vise à pour but d'explorer le rôle de trois déterminants de la criminalité en Équateur: les inégalités économiques, la taille des villes et le rôle des émotions liés aux événements sportifs tels que les matchs de football.

Avant d'entreprendre cette analyse empirique, nous proposons une revue des littératures théorique et empirique sur les déterminants de la criminalité urbaine. Une conclusion importante est que les incitations économiques conduisant à des activités criminelles sont influencées par les schémas de localisation des criminels et des victimes. Partant de ce constat, la thèse propose d'entreprendre trois analyses empiriques à différentes échelles géographiques.

Tout d'abord, nous explorons l'effet des inégalités de revenus sur le risque de victimisation en Équateur, en utilisant des données individuelles issues de l'enquête nationale de victimisation. Le principal résultat est que, contrairement aux prédictions, le coefficient de Gini a un effet négatif sur la probabilité d'être victime de vols. Ce résultat pourrait être lié à une ségrégation résidentielle élevée ou à un contrôle social élevé contre la criminalité. De plus, les estimations révèlent une relation croissante et concave entre le niveau de revenu des victimes et la probabilité de victimisation concernant les vols de véhicule, qui augmente avec un revenu mensuel jusqu'à 5,100 dollars, et puis diminue.

Ensuite, nous testons l'existence d'une prime de criminalité urbaine (criminalité plus élevée dans les zones urbaines) en Équateur, à l'échelle des paroisses. Le principal résultat indique que la taille des villes a une influence non-monotone sur le taux d'homicide. La probabilité de constater un ou plusieurs homicides est plus élevée dans les paroisses les plus peuplées. Toutefois, le taux d'homicide diminue avec le niveau de population dans les paroisses où se produisent des homicides. Concernant les crimes contre la propriété, les résultats confirment l'influence positive de la population sur le nombre de crime par habitant.

Enfin, nous estimons l'impact des matchs de football sur le nombre d'homicides et de crimes contre la propriété dans 16 cantons d'Équateur, à l'échelle intra-urbaine. L'objectif est d'étudier l'influence des matchs de football sur les profils temporels et géographiques des crimes, ainsi que l'impact des émotions (frustration et euphorie) liées aux résultats des matchs sur la criminalité. Les résultats indiquent que le nombre d'homicides augmente 0.18% avant le match, tandis que le nombre de crimes contre la propriété augmente 12% après le match, à proximité du stade. Les matchs de football entraînent également une diffusion spatiale de la criminalité dans des quartiers éloignés des stades. Les jours de matchs, les crimes contre la propriété diminuent 0.88% avant le match et les homicides diminuent 0.05% pendant le match, dans les quartiers éloignés des stades. Après le match, les homicides et les crimes contre la propriété augmentent de manière significative dans les quartiers éloignés des stades. Enfin, l'effet des émotions sur les homicides et les crimes contre la propriété n'est pas significatif au niveau agrégé, alors qu'il est significatif en ce qui concerne les homicides commis dans la capitale de l'Équateur, Quito.

**Mots des clés:** Économie du crime, économie urbaine, économie du développement, inégalités de revenus, taille des villes, football, crimes contre la propriété, crimes violents.



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## ACRONYMS

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<b>ADDHEALTH</b>	National Longitudinal Survey of Adolescent Health in the United States
<b>CBD</b>	Central Business District
<b>COIP</b>	Código Orgánico Integral Penal - Organic Penal Code
<b>CPV</b>	Censo de Población y Vivienda - National Population Census
<b>DPA</b>	Political Administrative Division
<b>ENEMDU</b>	Encuesta de Empleo, Desempleo y Subempleo - National Survey of Employment-Unemployment
<b>ENVIPI</b>	Encuesta de Victimización y Percepción de Inseguridad Ciudadana Victimization and Perception of Insecurity Survey
<b>FARC</b>	Armed Revolutionary Forces of Colombia
<b>FBI</b>	Federal Bureau of Investigation
<b>FCB</b>	Fútbol Club Barcelona
<b>FEF</b>	Federación Ecuatoriana de Fútbol
<b>FGE</b>	Fiscalía General del Estado - Attorney General's Office
<b>FIFA</b>	Fédération Internationale de Football Association
<b>FUA</b>	Functional Urban Area
<b>GDP</b>	Gross Domestic Product
<b>INEC</b>	Instituto Nacional de Estadísticas y Censos - National Institute of Statistics and Census
<b>ITCSJ</b>	Inter-Institutional Technical Commission of Security and Justice of Ecuador
<b>LAC</b>	Latin America and the Caribbean
<b>MDI</b>	Ministerio del Interior - Ministry of Interior
<b>NBA</b>	National Basketball Association
<b>NFL</b>	National Football League
<b>OECD</b>	Economic Co-Operation and Development
<b>OLS</b>	Ordinary Least Squares
<b>SENPLADES</b>	Secretaría Nacional de Planificación y Desarrollo - National Secretary of Planning and Development
<b>SMSA</b>	Standard Statistical Metropolitan Area of the United States
<b>TPM</b>	Two-Part Model
<b>UNHCR</b>	United Nations High Commissioner for Refugees
<b>WLS</b>	Weighted Least Squares



# 1. INTRODUCTION

Criminal activities generate important social and economic costs to the society. The criminology and economic literatures rely on various methodologies to estimate these costs, in majority for developed countries (see [Soares, 2015](#), for a survey). In most recent studies, the estimated societal costs reach 3.2 trillion dollars in the USA ([Anderson, 2012](#)) and 42 million dollars in the UK ([Dubourg \*et al.\*, 2005](#)).<sup>1</sup> These societal costs are even higher in developing countries, especially in Latin America and the Caribbean. This is one of the most violent regions in the world, with a homicide rate equal to 22.3 per 100,000 population<sup>2</sup>, which is six times greater than in Northern America and Western Europe. According to [Soares \(2006\)](#) assessment of the welfare costs due to violent deaths in 73 countries during the 1990s, eight of the nine countries with the highest social value of violence reduction (as a share of GDP) are Latin American and Caribbean (LAC) countries.<sup>3</sup> The analysis conducted by the Inter-American Development Bank confirms this claim. It estimates that crime-related costs in 2014 amounted to 3.55% of GDP in LAC while they were lower than 2.75% of GDP in Germany, Canada, Australia, France, United Kingdom and United States ([Jaitman and Torre, 2017a](#)). Individuals bear up a large part of the costs of crime, but also governments and firms. In 2018, the Colombian and Ecuadorian governments allocate 11.1 and 3.7 billion dollars, respectively to the Departments of Defense, Security and Justice.<sup>4</sup> Private firms are also impacted directly and indirectly. Twenty-three percent of LAC firms declared to have experienced losses by theft and vandalism and forty percent have identified the corruption as a major constraint.<sup>5</sup> In 2010, they spent \$144 billion because of losses and expenditures in security ([World Bank, 2014](#)). In this context, Latin American and Caribbean citizens consider insecurity as their primary concern, even more urgent than poverty ([Dammert and Lagos, 2012](#)). Understanding the determinants of criminal activities is therefore a major challenge for those countries, and is essential to design an effective policy aimed at reducing those costs. The objective of this thesis is to explore some of these determinants in Ecuador by focusing on the urban context.

The high level of urbanization in large cities gives rise to agglomeration economies. People living in large cities enjoy higher nominal wages (urban wage premium) (see [Combes \*et al.\*, 2008](#), among others). Meanwhile, large cities also have higher crime rates (urban crime premium). Empirical evidences confirm the existence of an urban crime premium in developed countries, especially in the United States ([Glaeser and Sacerdote, 1999](#); [O’Flaherty and Sethi, 2015](#)). In developing countries, the urban feature also gives rise to an urban crime premium. For example, the Latin American and Caribbean region hosts only 9% of the world population but is the second region in the world with the highest urbanization rate (81%), just after North America (82%) ([UN-DESA,](#)

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<sup>1</sup> Both studies estimate direct *and* indirect societal costs of crime. However, those numbers are not comparable as the authors rely on different crime statistics and also use different methodologies. For example, [Anderson \(2012\)](#) disregards some violent crimes but estimate the cost of fraud that amounts to more than 1 million dollar. By contrast, [Dubourg \*et al.\* \(2005\)](#) consider violent crimes but disregard other crime categories such as vehicle theft, shop theft, arson, drug offenses, or fraud.

<sup>2</sup> There are marked differences within the region. The highest homicide rates are in El Salvador (108.6), Honduras (63.8), Venezuela (57.1) and Jamaica (43.2); whereas the lowest rates are in Chile (3.6), Argentina (6.5) Ecuador (6.4) and Peru (7.2). Data on the number of victims of intentional homicide per 100,000 population corresponds to 2015 or the latest available at the United Nations website <http://data.un.org>.

<sup>3</sup> Colombia is the first (281%), followed by the Philippines (280%), Venezuela (95%), Chile (86%), El Salvador (73%), Belize (71%), Suriname (67%), Mexico (67%) and Brazil (65%). The 11 following countries with highest social values of violence reduction are all Latin American and Caribbean or Former Communist, whereas countries with the lowest numbers are often Western European countries.

<sup>4</sup> [Colombia’s General Budget, 2018](#); [Ecuador’s General Budget, 2018](#).

<sup>5</sup> World Bank Group. Statistics from the Enterprise Surveys, 2017. Section Obstacles for Firms. Data available at website [www.enterprisesurveys.org/data/exploreeconomies/2017/ecuador#crime](http://www.enterprisesurveys.org/data/exploreeconomies/2017/ecuador#crime).

2018).<sup>6</sup> The largely urbanized cities from Latin America and the Caribbean have higher homicide rates than the national homicide rate (UNODC, 2013). People living in large cities are 20% more likely confronted with violence or assaults than people living in small cities (Gaviria and Pagés, 2002). On average, 60% of robberies in the region are committed with violence (UNDP, 2013).

Latin America and the Caribbean is therefore a particularly interesting region to analyze the determinants of urban crime. The presence of armed groups and drug cartels strengthens the level of urban crime in the region. The Colombian, Peruvian and Bolivian drug cartels produce the largest quantity of cocaine around the world (Bagley, 2013)<sup>7</sup> while the Mexican drug cartels fight for the control of geographic areas and routes that facilitate the transport of drugs to U.S. (Flores and Rodríguez, 2014). Other minor crimes such as verbal abuse in public transportation in El Salvador (Natarajan *et al.*, 2015) or street drug markets in Brazil (Oliveira *et al.*, 2015) also cause disorder and a culture of violence in LAC countries. Detrimental socioeconomic conditions in the region also spurs violence and crime. The level of income inequality in LAC countries is much higher than in OECD countries (Fajnzylber *et al.*, 2002). Meanwhile, the level of schooling is almost one half its level in the United States (Soares and Naritomi, 2010). The economics literature on crime holds that high inequality and low education levels reduce the opportunity cost of crime, thereby rising criminal activities. The LAC region is also characterized by a weak institutional presence in the areas of security and justice. The region has a lower number of prosecutors, judges and correctional staff in adult prisons per 100,000 population than in Canada, United States, the Western and Central Europe (Harrendorf and Smit, 2010).<sup>8</sup> As argued by Couttenier *et al.* (2017), such a weak institutional presence encourages violence as a way to defend private property. According to statistics from the Latinobarometer survey 2016, 73.52% of LAC citizens consider that their country is governed by oligarchic groups that preserve their own interest and 70.24% of citizens say that they have very little or no confidence in their governments. This lack of confidence in institutions could create an environment conducive to crime.

In what follows, Section 1.1 describes the characteristics that make Ecuador an interesting case of study. Section 1.2 presents the aim of the thesis and the research questions. Section 1.3 describes the data and methodology used to answer these research questions. Section 1.4 summarizes the findings of the thesis.

## 1.1. THE CONTEXT OF ECUADOR

Ecuador is a small, democratic and developing country. It is located in South America and shares borders with Colombia in the north, with Peru in the east and the south, and with the Pacific Ocean in the west. The population is 16 million inhabitants ethnically composed by mestizos (71.9%), indigenous (7.03%), afroecuadorians (7.19%), montubios (7.39%), whites (6.1%) and others. The country is organized in 24 provinces, 221 cantons and 1,024 parishes (the lowest geographical and administrative divisions). The country is also decomposed into four natural regions: Coast, Andes, Amazon and Islands. Most of the Ecuadorian population is concentrated in the Coast, located to the West of the Andean range. This region hosts the most populated city Guayaquil, which is also the economic capital of the country thanks to its international seaport. The Andes region covers the Andean cordillera and is crossed by the Pan American highway that runs from the north to the south of the country. The Andes region also hosts the most important political and cultural cities,

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<sup>6</sup> The annual urban population growth is equal to 1.42%, which is higher than that of the European Union (0.60%) and OECD countries (0.95%), but still lower than in Sub-Saharan Africa economies (4.14%). Data corresponds to 2015 and it is available in the World Bank Indicators database at the website <https://data.worldbank.org>.

<sup>7</sup> Latin America is also the third largest market of cocaine consumption in the world (2.4 million users), only after USA (5 million users) and Europe (4.75 million users). See Bagley (2013) for more details about the Andean drug war.

<sup>8</sup> Latin America and the Caribbean has also the highest overcrowding rate (60%) in which more than 40% of inmates are incarcerated without a formal conviction (Jaitman and Torre, 2017c).

the capital Quito and Cuenca, respectively. The Amazon region is located in the oriental part of the country. It is not densely populated because it is covered by exuberant forests with large rivers, but this is also an area with the largest reserves of petroleum in Ecuador. Finally, the Galapagos Islands constitute a touristic archipelago located in the Pacific Ocean.

By some aspects, Ecuador reflects the context of Latin America and the Caribbean, especially of the Andean countries. Ecuador is a low-middle income country with GDP per capita (\$5,969) similar to that of its neighboring countries, Colombia and Peru. The proportion of the Ecuadorian population living in urban areas is 68%, just as in El Salvador, Bolivia and Dominican Republic. The level of income inequalities in Ecuador is similar to that of El Salvador, Peru and Venezuela. The Ecuadorian poverty rate is close to that of Colombia and Bolivia. The number of inhabitants in Ecuador is similar to Guatemala and Chile. However, the most important similarity is that many LAC countries are populated by ethnically diverse people speaking different dialects. This is the case of Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru and Venezuela.<sup>9</sup> (See statistics in [Appendix 1.A](#)).

[Table 1.1](#) presents statistics on crime rates and enforcement in LAC countries. The criminality in Ecuador continues to be an issue for the public policy, which amounted to \$379.6 per capita in 2014 ([Jaitman and Torre, 2017a](#)).<sup>10</sup> While Ecuador enjoys one of the lowest homicides rates (only above Chile) in the region, the robbery rate (570.6 per 100,000 pop) is much higher than the average robbery rate in the region (325 per 100,000 pop). In addition, Ecuador has lower rates of assault, kidnapping and sexual violence, but it is still confronted with human trafficking. In 2012, 255 victims of human trafficking were recovered, of which 47% were captured exclusively for sexual exploitation ([Delitoscopio, 2013](#)). Despite the relatively high level of police officers and correctional staff in prisons, there is a lack of resources devoted of justice authorities (prosecutors and judges) in Ecuador.

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<sup>9</sup> See the information of indigenous and afrodescendants in Latin America and the Caribbean at the ECLAC website <https://www.cepal.org/en/topics/indigenous-peoples-and-afro-descendants/indigenous-peoples-and-afro-descendants-latin-america-and-caribbean-data-bank-piaalc>.

<sup>10</sup> This amount includes the social cost of victimization; the foregone income of imprisoned population; the private expenditure on crime prevention; and the government expenditure on police, justice and the administration of prisons ([Jaitman and Torre, 2017a](#)).

Table 1.1. Statistics on crime and enforcement in LAC countries

Country	Crime-related costs (2014, per capita in \$ U.S.)	Homicide rate (2015, per 100,000 pop)	Robbery rate (2015, per 100,000 pop)	Assault rate (2015, per 100,000 pop)	Kidnapping rate (2015, per 100,000 pop)	Sexual violence rate (2015, per 100,000 pop)	Police Officers (2006, per 100,000 pop)	Prosecutor (2006, per 100,000 pop)	Judges (2006, per 100,000 pop)	Staff in prisons (2006, per 100,000 pop)	Public spending on Prison Admin. (2010-14, share of GDP)
<b>LAC region</b>	<b>486.7</b>	<b>25.2</b>	<b>325.7</b>	<b>184.2</b>	<b>1.1</b>	<b>51.4</b>	<b>320.4</b>	<b>9.8</b>	<b>7.0</b>	<b>48.8</b>	<b>0.2</b>
Argentina	688.6	6.5	1020.4	417.6	.	37.1	.	.	.	.	0.25
Bahamas	1176.7	29.8 <sup>f</sup>	98.5 <sup>f</sup>	841.1 <sup>f</sup>	7.5 <sup>f</sup>	80.3 <sup>f</sup>	.	.	.	.	0.30
Barbados	438.2	10.9	105.6	518.6	4.9	68.3	548 <sup>a</sup>	3.2 <sup>a</sup>	7.2 <sup>a</sup>	18.3 <sup>a</sup>	0.47
Belize	.	34.4 <sup>h</sup>	86.4 <sup>h</sup>	296.3 <sup>h</sup>	1.1 <sup>h</sup>	42.4 <sup>h</sup>	377.2	2.4	.	95.3	.
Bolivia	.	12.4 <sup>f</sup>	140.8 <sup>f</sup>	72.5 <sup>f</sup>	1.0 <sup>f</sup>	47.1 <sup>f</sup>	223.6 <sup>b</sup>	4.2	10.3	13.5	.
Brazil	613.3	26.7	495.7 <sup>g</sup>	323.9 <sup>g</sup>	0.2 <sup>g</sup>	27.5 <sup>g</sup>	.	.	.	.	0.06
Chile	637.1	3.6	593.2	89.0	1.5	65.6	187.6 <sup>c</sup>	15.8 <sup>c</sup>	5.0 <sup>c</sup>	42.6 <sup>c</sup>	0.33
Colombia	420.8	26.5	210.1	180.2	0.4	45.1	229.2 <sup>a</sup>	44.9 <sup>a</sup>	10.0 <sup>a</sup>	160.4 <sup>c</sup>	0.16
Costa Rica	520.9	11.8	1095.6 <sup>h</sup>	174.7 <sup>g</sup>	0.1 <sup>h</sup>	154.7 <sup>g</sup>	275.3	7.7	18.0	69.7	0.27
Dominican Rep.	.	17.4 <sup>h</sup>	144.2 <sup>h</sup>	48.3 <sup>h</sup>	0.2 <sup>h</sup>	2.8 <sup>h</sup>	303.5	2.2	5.9	9.4	.
<b>Ecuador</b>	<b>379.6</b>	<b>6.4<sup>i</sup></b>	<b>570.6<sup>g</sup></b>	<b>46.7<sup>h</sup></b>	0.2 <sup>h</sup>	19.0 <sup>h</sup>	<b>292.6</b>	<b>2.7</b>	<b>1.0<sup>c</sup></b>	<b>87.9<sup>c</sup></b>	<b>0.09</b>
El Salvador	600.7	108.6	84.2	96.1	0.3	72.5	275.2	11.1 <sup>b</sup>	5.4	21.7 <sup>b</sup>	0.20
Guatemala	229.5	31.2 <sup>h</sup>	19.4 <sup>h</sup>	37.3 <sup>h</sup>	0.3 <sup>h</sup>	4.3 <sup>f</sup>	237.2 <sup>a</sup>	19.0 <sup>a</sup>	3.4 <sup>a</sup>	62.1 <sup>a</sup>	0.08
Honduras	302.5	63.8	127.2	16.4	0.5	18.4	.	.	.	.	0.10
Jamaica	354.1	43.2	68.3	178.0 <sup>g</sup>	0.5	79.2	273.9 <sup>a</sup>	.	.	.	0.34
Mexico	345.0	16.4	129.2	35.8	0.9	31.8	485.9 <sup>b</sup>	2.7	0.8 <sup>c</sup>	.	0.12
Nicaragua	.	11.5 <sup>f</sup>	495.5 <sup>d</sup>	319.7 <sup>d</sup>	0.1 <sup>d</sup>	63.2 <sup>d</sup>	166.6	5.2	.	.	.
Panama	.	11.4	207.9	72.4	0.4	80.2	498 <sup>b</sup>	2.4	8.0	23.4	.
Paraguay	284.9	9.3	317.2	10.3	0.0	74.8	331.5	.	.	17.3	0.09
Peru	335.1	7.2	264.4	79.0	0.7	18.2	323.0 <sup>c</sup>	16.3 <sup>c</sup>	.	17.8 <sup>c</sup>	0.09
Uruguay	461.0	8.4	566.0	13.6	0.3	46.1	507.4 <sup>c</sup>	12.7 <sup>a</sup>	13.2 <sup>a</sup>	80.5 <sup>c</sup>	0.25
Venezuela	.	57.1	.	.	.	.	15.6 <sup>b</sup>	4.8	2.6 <sup>a</sup>	11.6 <sup>b</sup>	.

Notes: <sup>a</sup> 2000, <sup>b</sup> 2002, <sup>c</sup> 2004, <sup>d</sup> 2010, <sup>e</sup> 2011, <sup>f</sup> 2012, <sup>g</sup> 2013, <sup>h</sup> 2014, <sup>i</sup> Ministry of Interior. · Not available. Sources: Jaitman and Torre (2017a, 2017c), United Nations database, Harrendorf and Smit (2010).

Among the various types of crime, this thesis focuses on homicides and property crimes that can be considered as the most serious and/or prevalent criminal activities. This choice is in line with most existing empirical studies on crime. For example, the numerous studies on crime in the U.S.A. use Index I crimes that are decomposed in two categories by the U.S. Federal Bureau of Investigation (FBI): violent crimes (murder, forcible rape, robbery and aggravated assault) and property crimes (burglary, larceny, motor vehicle theft and arson). Our choice is also consistent with the Ecuadorian Inter-Institutional Technical Commission of Security and Justice (ITCSJ) that considers homicides and property crimes as the more frequent offenses.<sup>11</sup>

Homicide data comes from the Ministry of Interior (MDI) and National Police databases. According to United Nations, a homicide is an “*unlawful death purposely inflicted on a person by another person*” (UNODC, 2013, page 102). In Ecuador, homicides are considered as murders when the level of violence is so high that the offender is punished with more than 22 years of imprisonment (Penal Code, 1971).<sup>12</sup> In 2011, it was the seventh cause of death, and it is ranked the

<sup>11</sup> ITCSJ defines and homologues statistical information of crime. It is composed by the Ministries of Interior, Justice, and Defense; the Attorney General’s Office (FGE, for acronyms in Spanish); the Justice Institution on Courts (Consejo de la Judicatura); the Secretary on Drugs; the National Agency on Transit; the Institution on Emergency Assistance ECU-911; the National Institute of Statistics and Census (INEC) and the National Secretary of Planning and Development (SENPLADES).

<sup>12</sup> In Ecuador, the Organic Penal Code (COIP), recently published in 2014, is a new Penal Code that includes 77 new types of crime. Regarding Intentional Homicides, COIP punishes intentional deaths and other types of violence that engender death (e.g. sexual violence or robbery that causes the death of the victim). This new classification of homicides does not affect our estimations because we use reported crimes collected before the application of the law.

seventeenth cause of death since 2015. Interestingly, the underreporting issue, often debated regarding crime data reported by the police, should be minor regarding homicides because the police collects information on reports and death certificates. Property crime data is collected from the Attorney General's Office (FGE). The FGE identifies several categories of property crimes depending on the type of victim (individuals, households or institutions) and the motivation of criminals (See definitions in [Appendix 1.B](#)). Offenses against persons consists of robberies, whereas offenses against households consists of burglary, vehicle theft or vehicle accessory theft.<sup>13</sup> The FGE also considers offenses against economics or financial institutions, or thefts that took place on roads. These various types of property crimes share a common feature: criminals always make use of violence or threat of force. Among all of these property crimes, 42% are robberies inflicted against persons<sup>14</sup>, 17% are burglaries, 13% are total thefts of vehicles, 17% are thefts of vehicle accessories, 7% are thefts in economic institutions, the rest accounts for less than 5% of property crimes.

## 1.2. AIM AND RESEARCH QUESTIONS

Understanding the reasons why individuals become criminals is a general concern in various disciplines, such as criminology, psychology, sociology or economics. This thesis tries to evaluate the contribution of the economics literature to the understanding of crime determinants, from the perspective of a developing country such as Ecuador.

In his seminal study "Crime and Punishment: An Economic Approach", [Becker \(1968\)](#) assumes that criminals take rational decisions based on the expected benefits and costs of illegal activities given the probability of arrest and the severity of punishment. This study has inspired a broad theoretical literature on the determinants of crime, especially pecuniary crimes. A large empirical literature has confronted these theoretical predictions with the data, primarily using the reported property or violent crimes from the U.S. Federal Bureau of Investigation.

One prediction from this literature is that the level of income inequality may encourage criminal activities. When the income gap widens in the economy, poor individuals have large incentives to steal rich individuals that are located in their proximity because the gap between the return from illegal activities such as property crimes and the return from legal activities is large ([Chiu and Madden, 1998](#)). However, as a response, rich individuals will try to protect themselves against crime by investing in security devices ([Decreuse et al., 2018](#)), which should dissuade criminal activities. Empirical studies have explored the inequality - crime relationship using aggregate data from police reports. Though, they do not test the non-linear relationship between income and crime, as predicted by the economics literature. This incentive to invest in private protection is all the more important for developing countries where citizens have a limited confidence in their institutions. In Ecuador, 34% of households declared have reinforced housing and vehicle security in order to avoid victimization ([INEC, 2011](#)). In the end, one might ask the two following research questions:

Research question (1): *What is the impact of income inequality on the probability of victimization in Ecuador?*

Research question (2): *Does the income level of individuals increase their probability of victimization?*

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<sup>13</sup> It is noteworthy to mention that while robberies are classified as violent crimes in the U.S.A., they are classified as property crimes (committed with violence) in Ecuador.

<sup>14</sup> United Nations defines the robbery as "the theft of property from a person, overcoming resistance by force or threat of force". The Ecuadorian classification of robbery only considers the thefts inflicted with violence and disregards the larceny (minor thefts without violence).



In another major contribution, Glaeser and Sacerdote (1999) argue that there exists an urban crime premium, that is: “*Crime rates are much higher in big cities than in small cities or rural areas*” (page S225). Three mechanisms contribute to this stylized fact according to the authors: the higher pecuniary returns to crime, the lowest probability of arrest and the over-representation of crime-prone individuals in large cities. Following this seminal article, the analysis of crime has become a central concern in urban economics theory, which allows to analyze the criminal behavior within cities when individuals decide upon both their (legal or illegal) activity *and* their location. Gaigné and Zenou (2015) contributed to the understanding of the urban crime premium by identifying general equilibrium effects through which city size raises more than proportionally the number of criminals. This relationship has been confronted with the data in U.S. metropolitan areas (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015), but there is limited evidence in the case of developing countries. The Latin American and Caribbean region provides an interesting urban feature to the analysis of crime as it is the second region in the world with the highest urbanization rate (81%) (UN-DESA, 2018). Within the region, Ecuador has the highest annual growth of the urban population in 60 years. The third research question aims at testing the existence of an urban crime premium in this country:

Research question (3): *Does city size increase the crime rates in Ecuador?*

The economics of crime literature assumes that criminal activities result from rational choices and pecuniary profits. One can expect these predictions to be more important regarding property crimes. By contrast, violent crimes are not necessarily rational. They often involve emotional reactions caused by frustration, anger and hate. Frustration induces people to react aggressively when faced with unpleasant and unexpected factors, *whatever the economic incentives* (Dollard *et al.*, 1939; Berkowitz, 1989). Interestingly, soccer matches are good examples of events that generate unexpected results, and that might engender aggressive reactions of fans. Recent empirical contributions have explored the effect of unexpected soccer results on crime in developed countries. Beyond this emotional dimensional, other contributions have analyzed the temporal and spatial spillovers of crime related to sports in these developed countries. Given the importance that soccer and violence take in LAC countries, one might expect a strong soccer - crime relationship in these countries. Munyo and Rossi (2013) explore the emotional dimension of soccer on crime in a Latin American city, such as Montevideo (Uruguay). However, they disregard the potential effects that soccer can engender on crime throughout Uruguay, not only in Montevideo. In Ecuador, one might expect significant effects of soccer on crime given the importance of this sport and the strong regional rivalry between fans from different soccer teams.<sup>15</sup> This leads to a last research question:

Research question (4): *How do soccer matches influence the temporal, spatial and emotional dimensions of crime in Ecuador?*

### 1.3. DATA AND METHODOLOGY

In order to answer these research questions, we conducted three empirical analyses. In each one, we use original datasets at different geographic levels and apply various methodologies.

The datasets gather socioeconomic and demographic information in urban areas of Ecuador. The Political Administrative Division (DPA) organizes hierarchically the country in 24 provinces, 221 cantons and 1,024 parishes. The parishes are classified as urban and rural. Urban parishes are the capital of cantons named “cabecera cantonal”. Rural parishes are peripheral parishes that surround

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<sup>15</sup> Soccer has engendered regional rivalries in supporters from the Coast and Andes regions, especially between Barcelona S.C. (the most popular team of Guayaquil) and LDU Quito (the only team that has won international tournaments of Quito).



the capital. Because this classification is based exclusively in the administrative territorial division, the National Institute of Statistics and Census (INEC) has its own classification of parishes based on their level of population. Thence, urban parishes are either the capital or peripheral parishes that host more than 2,000 inhabitants. The parishes hosting less than 2,000 inhabitants are denominated rural. This thesis explores the determinants of crime in urban parishes (capital or peripheral) populated by more than 2,000 inhabitants.

To answer the research questions (1) and (2) about the impact of income inequality on victimization, we use the Victimization and Perception of Insecurity Survey 2011 (ENVIPI-2011). Our unique database identifies the social, economic and demographic characteristics of 117,737 respondents living in 177 cantons.<sup>16</sup> It includes victimization against the households (burglary and/or vehicle theft) and against the individuals (robbery and/or violence). Our database incorporates information about income inequality and other characteristics (e.g. share of young men, proportion of ethnic minorities) at the canton level. To the extent that the characteristics of victims matter for criminals, we collect information about the household income and other personal characteristics of respondents. The ENVIPI-2011 survey allows us to alleviate some limitations of existing studies relying on aggregate data based on police reports, that cannot control for the characteristics of victims and that might suffer from an underreporting issue. Our methodology applies Probit estimates to capture the inequality - victimization relationship taking into account a large set of personal and cantonal variables on different types of victimization.

To answer the research question (3) about the existence of an urban crime premium in Ecuador, we use pooled data on homicide and property crime rates at the urban parish level, over the 2010-2015 period. Because the urban parishes (more than 2,000 inhabitants) are small scale geographic areas, there is a large proportion of urban parishes with zero homicides (64%). Therefore, we estimate the impact of population on homicide rates using a Two-Part model (TPM). This methodology combines a probit model for the probability of observing a positive value of the dependent variable, along with pooled ordinary least squares (OLS) on the sub-sample of positive observations. Contrary to existing studies, we address the issue of zero values and show how this influences the homicide rate - city size relationship. In the case of property crimes, we perform a linear regression model (because only 6% of urban parishes have zero offenses). These estimates also control for the characteristics of the parishes, cantons, and include temporal and spatial fixed effects.

To answer the research question (4) about the effect of soccer matches on the number of crimes, we combine exact information of soccer matches with homicides and property crimes in Ecuador, in the 2010-2015 period. The data of soccer identifies the date, hour, place, seasons, teams, results, and betting odds of 1,600 soccer matches played in 16 cantons that host professional teams. The data on crime identifies the number of homicides and property crimes that occurred at a specific date, hour and place. Our methodology applies Weighted Least Square estimates to identify any effect on crime before, during and after the soccer matches (temporal displacement effect). It also identifies any effect on crime that occurs near or further from the stadium (spatial displacement effect). Finally, we also compare the expected vs. the actual results of soccer matches to estimate the impact of emotions (frustration or euphoria) on crime.

#### 1.4. OUTLINE AND FINDINGS

Before exploring the influence of income inequality, city size, and emotions due to soccer events on criminality in urban areas of Ecuador, Chapter 2 proposes a survey of the modern literature on crime determinants. This review of the literature first presents the personal attributes that encourage individuals to commit crime, regardless of the local environment. Then, it explores how the local,

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<sup>16</sup> INEC collected information in the most populated cantons of each province.

social and economic conditions influence crime, through incentives or other mechanisms. Finally, we analyze how the economic incentives are influenced by the location pattern of criminals and/or victims. This review of the literature allows to better understand the mechanisms behind predictions regarding crime determinants, and also summarizes the results of studies aimed at evaluating the predictive power of these predictions.

Chapter 3 explores the income inequality - victimization relationship and the relevance of the personal characteristics of victims in this relationship at the individual level. Findings show that the income Gini has no significant effect on victimization against the households but a negative effect on victimization against individuals, related to robbery. Regarding the influence of the income level, the probability of victimization by vehicle theft is increasing and concave; it first increases with a monthly household income up to \$5,100, and then falls. This result is in line with theoretical predictions about the non-linear relationship of income inequality and property crime (Chiu and Madden, 1998; Decreuse *et al.*, 2018). This is also consistent with the fact that 34% of Ecuadorian households declared have reinforced housing and vehicle security to avoid victimization (INEC, 2011). The other individual characteristics (such as ethnicity) are also relevant. Indigenous and afroecuadorians are more at risk of violent victimization than mestizos. Conversely, afroecuadorians suffer lower victimization by robbery than mestizos.

Chapter 4 tests the existence of an urban crime premium in Ecuador at the parish level. OLS estimates show that the homicide and property crime rates increase with parish population. The estimation of the two-part model shows that the probability that a homicide occurs is higher in most populated parishes. However, when the estimation restricts the sample to parishes with positive homicides, the parish population now exerts a negative impact on the homicide rate. As population in parishes with positive homicides is seven times higher than the population in parishes with zero homicides, one can conclude that the parish population exerts a non-linear influence on the homicide rate.

Chapter 5 investigates how soccer influences the temporal, spatial and emotional dimensions of homicides and property crimes in 16 cantons of Ecuador, at the intra-city level. Findings regarding spatial or temporal displacement effects differ depending on the type of crime. Regarding temporal displacements, soccer matches increase the number of homicides by 0.18% *before* the match and the number of property crimes by 12% *after* the match, near the stadium. Specifically, soccer matches increase the number of robberies against persons by 4%, burglaries by 2%, vehicle thefts by 1% and vehicle accessory thefts by 5%, near stadiums, in the post-match hours. Regarding spatial displacements, soccer matches decrease the number of property crimes by 0.88% *before* the match and the number of homicides by 0.05% *during* the match, in locations that are distant from the stadium. Regarding emotions, results reveal no significant effects of soccer matches on homicides or property crimes at aggregate level. However, the coefficients of emotions (frustration and euphoria) are significant in very specific cantons. For example, the effect of emotions on homicides follows a U-Shaped distribution in Quito. This suggests that supporters of teams representing Quito commit violent acts when confronted with intense frustration or intense euphoria. Local newspapers confirm this fact in the capital of Ecuador.

Chapter 6 summarizes the principal results of the thesis. We also mention some limitations of our analysis and propose several research perspectives.



## 2. URBAN CRIME DETERMINANTS: A SURVEY ON THEORY AND EMPIRICS

Understanding the reasons why individuals become criminals is a general concern in various disciplines. Criminology analyzes the personal characteristics and the behavior of offenders, as well as the legal conditions that deter crime.<sup>17</sup> Psychological approaches study the role of mental factors in the deviant behavior of criminals. Sociological analyses emphasize on how the social conditions influence the behavior of criminals. Economic approaches focus on the economic conditions that incite individuals to engage in illegal activities. While important contributions have been made in the 18<sup>th</sup> and 19<sup>th</sup> centuries<sup>18</sup>; this chapter surveys the modern literature on the determinants of urban crime, with a special emphasis on the economic incentives formalized by [Becker \(1968\)](#) and [Ehrlich \(1973\)](#).

In his seminal study “Crime and Punishment: An Economic Approach”, [Becker \(1968\)](#) explains that criminals take rational decisions based on the expected benefits and costs of illegal activities given the probability of arrest and the severity of punishment. [Ehrlich \(1973\)](#) enriches this proposition by assuming that legal and illegal activities are not mutually exclusive. Individuals do not have to choose between being criminals and working in the labor market, they only have to set an optimal choice of time allocation between legal and illegal activities that maximizes the expected utility function. Both studies have inspired a broad theoretical literature on the determinants of crime, especially regarding property crimes. A large empirical literature has confronted these theoretical predictions on crime with the data, primarily using the reported property or violent crimes from the U.S. Federal Bureau of Investigation.

This chapter surveys these theoretical and empirical literatures on the determinants of crime. Section 2.1 identifies the personal characteristics of offenders such as the psychological, emotional, individual and familiar factors that will be more or less conducive to a criminal behavior. Criminals are not isolated individuals, they live in social and economic conditions that encourage them to commit acts out of the law. Section 2.2 explains the role of these social interactions and criminal networks. Section 2.3 describes the economic theory of crime, which is the main theoretical background that we rely on in order to analyze crime in Ecuador. Based on the hypotheses formalized by [Becker \(1968\)](#), we review the deterrent factors (e.g. the role of police and prisons) and the economic incentives (e.g. the role of labor market, education, inequality and poverty) of crime. Section 2.4 complements the analysis by explaining how the location of individuals shapes these economic incentives, thereby giving rise to a concentration of criminal activities in some places such as cities. Section 2.5 concludes.

### 2.1. PERSONAL CHARACTERISTICS OF CRIME-PRONE INDIVIDUALS

Pioneering criminological studies have focused on identifying the biological aspects of potential criminals. One of the first relevant contributions is “*L'uomo delinquente*” by Cesare Lombroso, the father of Criminology. According to [Lombroso \(1887\)](#), criminals are born with various physical

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<sup>17</sup> See [Ray \(1959\)](#) for a historical survey in criminology science and [O'Flaherty and Sethi \(2015\)](#) for a recent survey of this literature.

<sup>18</sup> Historical contributions on the *Classical* and *Positivist Schools* refer to the 18<sup>th</sup> and 19<sup>th</sup> centuries, respectively. The Classical School of Criminology, principally developed by Cesare Beccaria (1738-1794), considers that people rationally commit crime and discuss how reforming the legal system to reduce this ‘rational’ criminal behavior. The Positivist School, developed by Cesare Lombroso (1835-1909), rejected the legal statements of the Classical School. According to the latter, criminals are born with congenital defects and must receive an individualized treatment according to the pathology instead of being held in prison.

anomalies that explain their deviant behavior.<sup>19</sup> Posterior studies have discredited Lombroso's hypothesis.<sup>20</sup> Instead, they identify the personal attributes that make some individuals more inclined to adopt a deviant behavior, such as psychological (Section 2.1.1), emotional (Section 2.1.2), gender and age (Section 2.1.3), or family background (Section 2.1.4) factors.

### 2.1.1. PSYCHOLOGICAL FACTORS AND MENTAL ILLNESSES

Psychiatric and Psychological approaches contribute to Criminology by studying the medical reasons that induce individuals to commit violent acts. Brain functioning and structure altered, antisocial personality disorder and mental illnesses can be related to aggressions and violent crime.<sup>21</sup>

In 1887, Lombroso proposed that criminals have different brain functioning and structure compared to non-criminals. A century after, the neuro-criminologist Adrian Raine confirms this statement in his book "*The Anatomy of Violence: The Biological Roots of Crime*". By studying brain imaging scans of criminals vs. non-criminals, Raine (2013) concludes that certain neurological conditions predict violent behavior.<sup>22</sup> For example, murderers have poor functioning of the prefrontal cortex while psychopaths show 18% reduction in the amygdala volume.<sup>23</sup> Besides the biological attributes, certain factors can exacerbate the structural brain deformations such as prenatal exposure to alcohol, cigarettes and drugs (Cassel and Bernstein, 2001; Raine, 2013).<sup>24</sup>

Personality disorders and mental illnesses are also related to crime (Peterson *et al.*, 2014; Prins *et al.*, 2015). Four percent of crimes are related to psychosis while ten percent of crimes are related to bipolar disorder (Peterson *et al.*, 2014). On this field, Prins *et al.* (2015) study the influence of criminogenic factors and psychotic symptoms of 183 individuals with mental illnesses on the incidence of arrest rate.<sup>25</sup> Results reveal that the arrest rate is related with both criminogenic factors and psychotic symptoms in opposite senses. An increased rate of arrests is associated with the antisocial personality, whereas a decreased rate of arrests is related to the psychotic symptoms.<sup>26</sup> Prins *et al.* (2015) explain that psychotic people's instinct leads to self-protection whereas people with antisocial behavior externalize violence against others.

### 2.1.2. EMOTIONAL FACTORS

The role of emotions can also explain the criminal behavior to the extent that, for example, frustration causes violent reactions (Berkowitz, 1989; Dollard *et al.*, 1939; Kregarman and Worchel, 1961; Pastore, 1952). In their original monograph "*Frustration and Aggression*", Dollard *et al.* (1939) explain that frustrated people become aggressive when they find interferences in the achievement of a goal. Berkowitz (1989) also asserts that the unexpectedness of results is an

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<sup>19</sup> Postmortem clinical analyses revealed a predominant asymmetry of the cranium and lower cranial circumference; prognathism, sloping forehead, and asymmetric face in criminals compared to non-criminals (Lombroso, 1887).

<sup>20</sup> Charles Goring, a British criminologist of the Positivist School, found no evidence of a specific type of criminal as did Lombroso (Goring, 1913).

<sup>21</sup> See O'Flaherty and Sethi (2015) for a brief survey of the literature on strong and weak claims of crime.

<sup>22</sup> Despite the contribution of this research, Raine (2013) still leaves open questions that generate controversy among scholars. For example, Van Wieran (2014) raises the two intrinsic following questions: "What percentage of people with abnormal brains do not commit violent crime?" and "What percentage of violent offenders have normal brains?"

<sup>23</sup> The prefrontal cortex controls for impulsive behavior and anger while the amygdala allows differentiating right from wrong and fear of punishment (Raine, 2013).

<sup>24</sup> Raine (2013) holds that avoiding prenatal exposure to psychotropic substances and accessing to better nutrition and cognitive stimulation during childhood may reduce the probability of future criminal offending by 35%.

<sup>25</sup> Prins *et al.* (2015) classify the criminogenic factors in three categories: antisocial behavior or personality; current anger/aggression; and past violence. The psychotic symptoms include hallucinations and delusions such as paranoid, grandiose and persecution.

<sup>26</sup> A possible explanation to the weak association between anger and arrest rate may be related to the effectiveness of the intensive treatment programs that help people to control anger and aggressiveness (Prins *et al.*, 2015).

important cause of violent reactions. In other words, unexpected results trigger greater displeasure and more aggressive inclinations on people than expected results.

The *frustration-aggression hypothesis* has been empirically tested (Kregarman and Worchel, 1961; Pastore, 1952). In a recent strand of the literature, empirical contributions explore how unexpected frustration in sporting events encourages violent behavior of fans (Card and Dahl, 2011; Munyo and Rossi, 2013; Priks, 2010). In the Swedish soccer league, hooligans react more aggressively (throwing bottles in the soccer field) in response to a worse performance of the team they support compared to the previous season (Priks, 2010). In the U.S. National Football League, the domestic violence reports increase as consequence of unexpected losses of the preferred team (Card and Dahl, 2011; Gantz *et al.*, 2006). This effect worsens in playoffs and rivalry games (Card and Dahl, 2011) and continues during the three following days (Gantz *et al.*, 2006). In the Uruguayan soccer league, unexpected results cause emotions of frustration and euphoria in fans (Munyo and Rossi, 2013).

### 2.1.3. GENDER AND AGE

The personal characteristics of individuals, such as the gender and age, exert a strong influence on both the propensity to perform a criminal activity and to be victim of crime.

Men are unambiguously more prone to commit criminal activities. In the world, 95% of intentional homicides are committed by men (UNODC, 2013). In the United States, 74% of the people arrested and 93% of sentenced prisoners (in State and Federal correctional facilities) are men.<sup>27</sup> Raine (2013) explains that men have certain biological conditions that make men more prone to commit criminal activities than women. For example, men have lower resting heart rates, higher testosterone level and lower prefrontal cortex than women. This differential propensity of gender to crime can be measured by estimating the elasticity of crime with respect to the sex ratio (males/females). According to the empirical study of Edlund *et al.* (2013) on Chinese data, the elasticity of crime with respect to the sex ratio in the 16-25 age cohort is equal to 3.4. It means that the male sex ratio can account for 14% of the rise in crime.

Gender is also an important determinant of crime victimization. Regarding homicides, the rate of male homicide is four times higher than that of female homicide: 9.7 versus 2.7 per 100,000 inhabitants, respectively (UNODC, 2013). Indeed, 79% of homicide victims are male, and most of them were killed by organized criminal groups.<sup>28</sup> Men are also more likely confronted with assaults/attacks than women: 34% vs. 12% in UK (Anand and Santos, 2007). Conversely, women are predominantly victims of domestic violence. In 2012, 47% of global female homicides were committed by intimate partners or family members, mostly due to emotional issues (UNODC, 2013). In the United Kingdom, women are more at risk of victimization by sexual assault (15% vs. 5%) and domestic violence (23% vs. 10%) than men (Anand and Santos, 2007).

Young individuals are also more prone to crime. Individuals tend to participate actively in criminal activities at younger ages, especially in the 15-19 age cohort (Levitt and Lochner, 2001; Maguire and Pastore, 2002; University at Albany, 2011).<sup>29</sup> This age of illegal participation and the probability of arrest vary depending on the type of crime. For property crimes, offenders participate actively in crime until they are 16 years old and the likelihood of arresting an adolescent is five

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<sup>27</sup> See data about the “Sex of persons arrested” in 2011 and about the “Characteristics of State prisoners” in 2010 in the Sourcebook of Criminal Justice Statistics, Sections 4 and 6, available at website: <https://www.albany.edu/sourcebook/>.

<sup>28</sup> In the Americas, 96% of homicide victims that were killed by organized criminal groups are men (UNODC, 2013).

<sup>29</sup> The intensity of criminal activity (measured by the arrest rates) decreases from the age of 20 years old, except in the 25-29 age cohort that can also be considered as youth. See Sourcebook of Criminal Justice Statistics, section 4 “Characteristics and Distribution of persons arrested” at the website <https://www.albany.edu/sourcebook/>.



times greater than for adults. For violent crime, offenders are actively involved in crime at 18 years old and their probability of arrest is double that for adults.

Young individuals are also highly victimized. Individuals aged 15-29 are more likely victims of homicide than any other age cohorts (43% of total homicides are young victims, [UNODC, 2013](#)).

#### 2.1.4. FAMILY BACKGROUND

The familiar conditions also matter for the criminal behavior by inciting or reducing the individual's willingness to commit crime. Strong familiar connections reduce youth violence ([Seek Moon et al., 2010](#)) and help in a better identity formation ([Olivetti et al., 2013](#)). In contrast, households with signs of family disruption (e.g. parents divorced or separated, single-headed households, female-headed households) have a strong predisposition to criminal participation. According to [Pratt and Cullen \(2005\)](#) meta-analysis, the family disruption is the 9<sup>th</sup> most important predictor of crime out of 31 factors.

Families related with crime (any member involved in participation of crime or arrested) also facilitate illegal associations for the other family members. In U.S., 49.6% of prisoners reported having other family members who were once incarcerated ([Bureau of Justice Statistics, 2008](#)). [Hederos et al. \(2016\)](#) estimate the importance of familiar factors on criminal convictions and incarceration. Since 34% of prisoners declared having a brother incarcerated ([Bureau of Justice Statistics, 2008](#)), they identify the familiar factors (e.g. having the same biological or adoptive mother) that make siblings more similar in terms of criminal behavior. Results show that siblings of the same-gender (only brothers or only sisters) have a more similar criminal behavior than mixed-gender siblings. Also, having an older sibling currently convicted for a crime has a positive effect on the younger sibling crime participation.

## 2.2. THE ROLE OF SOCIAL CONDITIONS

The social conditions in which individuals grow up and live influence their behavior toward crime ([Merton, 1938](#); *The Chicago School*; [Matsueda and Grigoryeva, 2014](#)). According to [Shaw and McKay \(1942\)](#), delinquency is a response to abnormal social conditions such as discriminatory social structures, detrimental social conditions or weak cohesion in the community.

To the extent that society establishes norms and rules of coexistence, people choose to behave in accordance with those rules or to deviate because of unsatisfactory conditions. The Strain theory by [Merton \(1938\)](#) analyzes the deviant behavior of specific groups of population in response to frustration. Essentially, the theory states that the society sets rules and goals such as the achievement of success and wealth for all population (e.g. *the American dream*). However, predetermined social structures restrict the access and opportunities to certain groups of population (predominantly those with low economic resources and low formal education). Thus, unsuccessful and nonconformist individuals feel frustrated, thereby giving rise to a deviant behavior in response. Deviant behavior is stronger when unsuccessful individuals realize about the relative success of others around them. As result, criminality tend to rise when individuals live in poor social conditions and are confronted with important inequalities.

When the society is no longer able to control for deviant behavior, the social cohesion in the community (e.g. city, neighborhood, residential location) weakens. Communities with high residential mobility or poor supervision of youth's activities by family do not perform adequate social controls against delinquency ([Sutherland, 1947](#)).

Structural disadvantages also trigger disorganization and crime in the community. The *Social Disorganization theory*, developed by the *Chicago School*, explores the mechanisms of social control failure and the detrimental conditions that raise delinquency in disadvantaged communities.

Section 2.2.1 describes the principal statements of this theory. The level of delinquency in the community can also be influenced by the effect of neighbors and peers. If peers support a criminal life, individuals (especially at younger ages) could be involved in criminal activities because of their willingness to imitate the behavior of their peers. Section 2.2.2 describes the mechanisms of the Social Interaction Models that explore the role of social interactions and peer effects. Finally, Section 2.2.3 explores the structural differential conditions of ethnic groups, minorities, and immigrants as a result of social disorganization and cultural social isolation (Sampson and Wilson, 1995).

### 2.2.1. THE SOCIAL DISORGANIZATION THEORY

The Social Disorganization theory explains that disorganized communities, which are no longer able to perform adequate social controls, support a subculture of delinquency and violence, and lead crime to persist (Sutherland, 1947). In such a case, individuals adopt a deviant behavior as a normal response to abnormal community conditions (e.g. high residential mobility, poverty and ethnic heterogeneity) (See Shaw and McKay, 1942, 1969). In other words, the residential location and the social cohesion matter in order to explain the individual willingness to commit crime.<sup>30</sup>

The *Chicago School* has discussed several mechanisms by which the social conditions of neighborhoods give rise to conflicts and high crime rates (Shaw and McKay, 1942, 1969). Here we briefly refer to three of these mechanisms.

*Social networks.* The neighborhoods where residents conform strong social connections provide better social control against crime (Sutherland, 1947). In their British case study, Sampson and Groves (1989) found evidence that strong local friendship networks between neighbors significantly reduced robbery rates in the neighborhood.

*Delinquent information transmission.* Criminals enjoy from an intimate process of communication to teach and learn the techniques to succeed in their criminal activities (Sutherland, 1947). Shaw and McKay (1969) found evidence of an intergenerational transmission of delinquent information where young delinquents learn information and experiences from older delinquents.

*Ethnic groups and immigrants.* In the United States, Shaw and McKay (1942) found that the delinquency is more prevalent in neighborhoods characterized by high proportion of black people and immigrants, large changes in the demographics of population and high poverty rate (Shaw and McKay, 1942). In an updated version of the study using data of crime in Chicago, Shaw and McKay (1969) confirmed that neighborhoods with rapid population changes have the greatest increase of crime over time. However, the most important result is that delinquency rates are endemic in specific neighborhoods regardless of the ethnic/racial group that lived there.

### 2.2.2. SOCIAL INTERACTION MODELS

The individual decision to engage in criminal activities can be motivated by its own intrinsic motivation but also by the social interactions with peers and neighbors (Glaeser *et al.*, 1996). To the extent that social interactions occur within a neighborhood, individuals become accustomed to the illegal activities of their peers (Sutherland, 1947) and imitate them so as not to deviate from the social norms of the group (Liu *et al.*, 2013). Social interactions with delinquent peers facilitate meeting new delinquent members (Patacchini and Zenou, 2008) and sharing information on their criminal techniques (Calvo-Armengol and Zenou, 2004; Shaw and McKay, 1969; Sutherland, 1947). Therefore, social interactions generate a social multiplier effect on crime to the extent that

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<sup>30</sup> In an econometric approach performed with victimization data in France, Hémet (2013) finds that the neighborhood characteristics (e.g. median income, unemployment rate) better explain the risk of victimization than the personal characteristics (e.g. age, gender, nationality). Among them, the unemployment rate is the most significant factor that increases crime.



members who commit illegal activities influence the rest to do so (Liu *et al.*, 2013).<sup>31</sup> Empirical studies corroborate this prediction by revealing that the earlier exposure to neighborhood crime encourages young individuals to be delinquents.<sup>32</sup>

Reciprocally, social interactions can also discourage criminal activities. Denser social interactions with non-criminals lead to perform an informal social control in the community that disapprove illegal performance (Buonanno *et al.*, 2011; Matsueda and Grigoryeva, 2014) and therefore discourage individuals to participate in crime. In addition, this effect could be greater in small communities (e.g. neighborhoods, towns, villages) due to the stronger social networks between relatives and neighbors (Buonanno *et al.*, 2011).

In what follows, we briefly describe the main mechanisms that encourage (e.g. peer effects, strength of social connections, delinquent information transmission) or discourage criminal behavior (e.g. social sanction) through the role of social interactions.

*Peer effect.* Friends, peers and neighbors influence the individual's behavior, especially at younger ages. In the model by Liu *et al.* (2013), the influence of peers operates through social multiplier effects and/or social norms. The social multiplier effect captures the total effort of friends at performing any activity (for example, two opposite activities are education and delinquency). In such a case, the individual benefits from his/her own activity (education or delinquency) and from the aggregate effort of his/her friends. The social norm of the group captures the average effort of friends. In this case, the individual has incentives to perform in a similar way as the group does. In the model, the individual utility increases with the social multiplier effect but decreases with distance from the social norm. For example, good school performance has a positive effect on the individual and their friends, as long as friends also have interest to perform well in school. But, if the social norm of the group supports delinquency, performing well at school creates a distance from the group and incurs in a cost to the individual.

These predictions have been confronted with data of the U.S. National Longitudinal Survey of Adolescent Health (*AddHealth*). *AddHealth* provides information of the social and behavioral characteristics of high-school students and their friends. Liu *et al.* (2013) develop a methodology to create networks between high-school students and their best friends in order to identify the role of social interactions on education and delinquency. Education performance is measured by the grade point average index (GPA) of students in Language, History, Mathematics, etc. Delinquency performance is captured by the illegal behavior of students such as consumption of cigarettes or alcohol; runaway from school. Regarding the education performance, findings reveal that increasing one point the GPA of a four-friend group would increase the individual GPA by 0.06 points (because each individual effort rises the utility for the entire group) and by 0.18 points (because individuals have incentives not to deviate from the good school performance of the group). As result, both the social multiplier effect and the social norm influence the education performance of students. Regarding the delinquency performance, results show that only the social multiplier effects influences crime. It means that students, who have more friends participating in illegal activities, are more likely involved in delinquency.

*Strength of social connections.* Individuals establish social interactions with family, friends and other people not necessarily close-related. Some people may be criminals and others non-criminals.

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<sup>31</sup> According to Glaeser *et al.* (1996), the social multiplier effect implies that the variance of crime rates in the presence of social interactions is a multiple of the variance of crime rates when individuals make independent decisions. In the model by Liu *et al.* (2013), the social multiplier effect is captured by the level of aggregate effort of friends, which increases the individual utility at performing some activity (e.g. delinquency activity).

<sup>32</sup> Case and Katz (1991) reveal that increasing juvenile crime in neighborhood by 10% could raise the individual motivation to be a delinquent by 2.3%. Damm and Dustman (2014) found that a 1% increase in youth crime conviction raises the probability of later conviction by about 7-13% and on the number of convictions by about 10-16%.

However, when an individual decides to participate in crime, it is convenient to interact with as many people as possible in order to hear about criminal opportunities and learn the techniques of crime. The intuition is that the only way to learn about criminal techniques and experiences is through the interaction with other offenders because there is no formal education about crime. [Patacchini and Zenou \(2008\)](#) develop a framework to explain that interactions with acquaintances (e.g. friends of friends) facilitate to enter in criminal activities. They define the interactions with family and friends as *strong ties* and the interactions with acquaintances as *weak ties*. In the model, strong ties are permanent connections formed by two people who may be only criminals, only non-criminals, or one criminal and the other not. The weak ties are transitory connections in which each individual can meet other people. Criminals always take each opportunity to share information on crime to the matched partner, whatever the type of ties. Since every individual who hears about a criminal opportunity always takes it, the number of non-criminal individuals diminishes. At equilibrium, a high number of weak ties (being more in contact with other people than only relatives) increases the level of crime in the economy by the higher opportunity to meet active criminals.

This prediction has been confronted with *AddHealth* data, in which high-school students identify their best friends. [Patacchini and Zenou \(2008\)](#) create friendship networks between students, their best friends (strong ties) and the friends of friends (weak ties). Patacchini and Zenou exploit the effect of friendship relationships (weak ties) on the propensity of students to participate in illegal activities. Results show that connections with friends of friends have a positive effect on criminal behavior, especially for petty crimes (e.g. painting graffiti or acting loud) and less for serious crimes (e.g. use of weapon to steal, sell drugs).<sup>33</sup> [Glaeser et al. \(1996\)](#) confirm those results with data of crimes per capita in U.S. cities. Petty crimes (larceny and auto-theft) are shown to result from a higher degree of social interactions, contrary to murder or rape.

*Sharing information on crime.* An individual who decides to be a criminal benefits from social connections with other criminals by acquiring proper knowledge, techniques and experiences in crime ([Calvo-Armengol and Zenou, 2004](#); [Sutherland, 1947](#)). In the model by [Calvo-Armengol and Zenou \(2004\)](#), social interactions with active offenders ease the learning of the techniques of crime and reduces the probability of arrest. However, an increasing number of active criminals reduces the booty of crime. As a result, social interactions with delinquents generate a multiplier effect on crime by the better opportunity to learn and succeed in criminal activities.

*Social Sanction as a deterrent of crime.* The social sanction can be perceived as a mechanism that reduces crime because interacting with people who disapprove illegal performance leads to an informal social control in the community ([Buonanno et al., 2011](#); [Matsueda and Grigoryeva, 2014](#)). In this case, delinquents will be afraid of being part of denser social connections that stigmatize them as criminals and by the risk of retaliation. For example, delinquents released after a process of incarceration might find it difficult to interact with other people, who may be afraid of victimization.<sup>34</sup>

The model by [Buonanno et al. \(2011\)](#) assumes that victims of crime perfectly know the identity of the offender and have interest to transmit this information to their social contacts. In small communities (e.g. neighborhoods, towns, villages), the information transmission is easily carried out due to the close contact between victims, family, friends and neighbors. Therefore, delinquents avoid to commit crime because they are afraid that their relatives realize about their illegal activities and stigmatize them as criminals. One important prediction from the model is that criminal behavior decreases with social interaction density. The intuition is that in small communities, most

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<sup>33</sup> Increasing by 0.08% the weak ties raises the likelihood to commit a crime by 0.04% for petty crimes and by 0.007% for serious crimes.

<sup>34</sup> See [O'Flaherty and Sethi \(2015\)](#), Section 5.3, for a survey of these post-prison effects.

people belongs to the same neighborhood, so that the risk of recognition, retaliation and apprehension of criminals is large. By contrast, the interaction density is lower in big communities (e.g. cities), where most of the population remains anonymous, so that only the relatives know about the crime and the identity of the offender. Therefore, criminals confront a lower risk of apprehension, which facilitates the performance of crime without being recognized. [Buonanno et al. \(2011\)](#) tested the validity of their theoretical result in the Italian provinces, over 1996-2003. Results show that 1% increase in the strength of social interactions (measured by the proportion of people living in towns with less than 2,000 inhabitants) reduces common theft by 1.57%, aggravated theft by 1.62%, burglary by 1.22%, vehicle theft by 1.53% and robbery by 1.93%.

To summarize, strong social interactions improve the performance of criminal activities to the extent that individuals learn the know-how of criminal techniques and stay in contact with experienced delinquents. However, there are other mechanisms through which social interactions also deter criminal activities as far as people do not want to be associated with crime because of social sanction effects.

### 2.2.3. ETHNIC MINORITIES AND IMMIGRANTS

Structural disadvantages regarding the living conditions of ethnic groups might create frustration, therefore triggering social disorganization and crime ([Blau and Blau, 1982](#); [Sampson and Wilson, 1995](#)). Indeed, ethnic minorities are more exposed to deprived socioeconomic conditions, which reinforces social disorganization and social cultural isolation ([Sampson and Wilson, 1995](#)).

Concerning the case of immigrants, [Shaw and McKay \(1942\)](#) hold that neighborhoods where immigrants settle are characterized by residential instability, social disorganization and violence. In addition, the general perception of native people is that immigrants are associated with crime ([Nunziata, 2015](#)). Albeit and contrary to these kind of perceptions, empirical studies do not find significant associations between immigration and crime ([Bianchi et al., 2012](#); [Stansfield, 2013](#)). In the United States, the rates of incarceration of natives are higher than the rates of incarceration of immigrants ([Butcher and Piehl, 2005](#)). Meanwhile, the groups of *Latinos* (the largest immigrant group in U.S.) are less likely to commit violent acts compared to other ethnic groups ([Rojas-Gaona et al., 2016](#); [Stansfield, 2013](#)).

The economics of crime literature also explains why some minorities are overrepresented in criminal activities. In their model of urban crime, [Verdier and Zenou \(2004\)](#) show that racial inequality between blacks and whites can reinforce the participation of blacks in crime because of self-fulfilling beliefs. They assume that both the distance to jobs and the fact to be involved in some criminal activities will hinder productivity.<sup>35</sup> Moreover, they assume that people believe that blacks are more criminal than whites, even though they are *ex ante* identical. An important consequence is that blacks cannot pay for high rents near the center (where firms are located) because of anticipated lower wages. Thus, they reside in suburban locations and bear the cost of long trips to jobs, making them less productive at work. Therefore, in equilibrium, blacks are more criminals than whites because of limited labor market opportunities (lower wages and greater distance to jobs that reduces their productivity). (See Section 2.4.1 of this chapter for more details of the theoretical background of [Verdier and Zenou, 2004](#)).

Empirical studies have tested the effect of economic and social disparities between blacks and whites. Results show that high racial disparities lead to high levels of violent crime ([Blau and Blau, 1982](#); [Stolzenberg et al., 2006](#); [Ulmer et al., 2012](#)). The intra-racial inequality exacerbates violent

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<sup>35</sup> Distance to jobs affects productivity because long trips to go to work are tiring. Criminality can hurt productivity because criminals: i) tend to be dishonest at work, ii) can be damaged by other criminals or iii) tend to consume drugs and alcohol.

crimes between people belonging to the same ethnic group (Blau and Blau, 1982).<sup>36</sup> For example, black people are more likely victimized by other blacks (Rojas-Gaona *et al.*, 2016; Stolzenberg *et al.*, 2006).

## 2.3. THE ECONOMIC INCENTIVES OF CRIME

In line with Beccaria’s approach, the economics literature considers that criminals are rational individuals who find economic incentives that encourage them to commit illegal activities. This literature was initiated by Becker (1968), who consider that individuals decide whether or not to engage in criminal activities depending on the expected benefits vs. costs of committing crime. Since Becker (1968), researchers have paid great interest to understand the various economic incentives driving criminal activities.<sup>37</sup>

Section 2.3.1 presents the basic theoretical background of the Economics of Crime theory and mentions the main contributions extending this framework. Then, we survey the empirical literature that tests the main implications of Becker’s analysis, regarding the role of deterrent factors (2.3.2), labor market and education (2.3.3), as well as inequality and poverty (2.3.4).

### 2.3.1. THEORETICAL BACKGROUND

In the study “*Crime and Punishment: An Economic Approach*”, Becker (1968) argues that criminals take rational decisions based on the expected benefits and costs of illegal activities, given the probability of arrest and the severity of punishment.

Becker analyzes the supply of crime in a society. In the model, any criminal  $i$  sets his number of offenses  $O_i = O_i(p_i, f_i, h_i)$  depending on the probability of arrest  $p_i$ ; the punishment per offense  $f_i$  if caught; and other factors  $h_i$  (e.g. individual income from legal vs. illegal activities). The expected utility function per offense is given by eq. (2.1):

$$EU_i = p_i U_i(Y_i - f_i) + (1 - p_i) U_i(Y_i) \quad (2.1)$$

The expected utility falls with the probability of arrest and the severity of punishment but increases with the income from any offense ( $Y_i$ ). Therefore, a policy aimed at deterring crime must increase the probability of apprehension ( $p$ ) and be more severe in punishment ( $f$ ) in order to reduce the aggregate supply of crime  $O = O(p, f, h)$ . However, such a policy would also increase the cost of combatting offenses  $C(p, O)$ , which is associated to the detection costs that police incurs when combatting crime and to the punishment costs depending on  $pf$ . As far as increasing the number of offenses causes more damage  $D$  to society, the optimal policy consists in defining values  $p^*$  and  $f^*$  that minimize the social loss in real income from offenses  $L$  given by eq. (2.2):

$$L = D(O) + C(p, O) + bfpO \quad (2.2)$$

where  $D(O)$  is the damage function that crime causes to society;  $C(p, O)$  is the cost of fighting crime;  $bfp$  is the loss per offense punished and  $pO$  is the number of offenses punished.

Importantly, Becker argues that an effective enforcement policy should consider the attitude of criminals toward risk (e.g. murderers are assumed to be more impulsive and, thus, less responsive to punishment than thieves). Criminals who prefer risk would perceive their expected utility to fall with an increase in the probability of apprehension  $p$  rather than with an equal percentage increase in the severity of punishment  $f$ . Therefore, policy-makers can reach the optimal solution ( $p^*, f^*$ )

<sup>36</sup> Blau and Blau (1982) differentiate the effects of the overall income inequality, the racial income inequality and the racial composition in the U.S. Standard Metropolitan Statistical Areas (SMSA).

<sup>37</sup> See Freeman (1999) for a survey of the empirical literature on the economic determinants of crime in the 80’s and 90’s and O’Flaherty and Sethi (2015); Draca and Machin (2015); and Mustard (2010) for more recent surveys on the economics of crime literature.

that minimizes  $L$  through positive and finite values of  $p$  and  $f$ , especially when the elasticity of crime through a change in  $p$  exceeds the elasticity of crime through a change in  $f$ . The opposite happens when criminals avoid risk. In such a case, the expected utility falls with an increase in the severity of punishment more than with an equal percentage increase in the probability of apprehension. Crime is lowered and the punishment costs  $pf$  are hold constant when  $p$  decreases and  $f$  increases. In this case, the policy-makers can set the detection costs arbitrarily close to zero without increasing crime because, at the margin, criminals avoid risk.<sup>38</sup>

This contribution has been enriched by [Ehrlich \(1973\)](#). Assuming that legal and illegal activities are not mutually exclusive, individuals can participate in two market activities: legal ( $l$ ) and illegal ( $i$ ). While the legal activity is safe, the illegal activity is risky because there is a probability  $p_i$  of apprehension and punishment. Therefore each individual has to decide upon the optimal allocation of time between legal activities ( $t_l$ ), illegal activities ( $t_i$ ) and non-market activities such as consumption ( $t_c$ ) that maximizes their expected utility function. Let  $X_s$  refers to the stock of returns from legal and illegal activities, where  $s = \{a, b\}$  denotes two states of the world: apprehension and punishment  $\{a\}$  with probability  $p_i$ , and free to commit crime  $\{b\}$  with probability  $(1 - p_i)$ . The expected utility function is defined in eq. (2.3):

$$EU(X_s, t_c) = (1 - p_i)U(X_b, t_c) + p_iU(X_a, t_c) \quad (2.3)$$

subject to a time constraint:

$$t_i + t_l + t_c = t_0$$

and to wealth constraints:

$$\begin{aligned} X_b &= M' + Y_i(t_i) + Y_l(t_l) \\ X_a &= M' + Y_i(t_i) - F_i(t_i) + Y_l(t_l) \end{aligned}$$

where  $X_b$  is the earning function for individual free to commit crime under uncertainty, whereas  $X_a$  is its earning function when apprehended under certainty;  $M'$  is the net current earnings;  $Y_i$  is the return from illegal activities;  $Y_l$  is the return to labor activities; and  $F_i$  is the punishment if arrested.

Again, the criminals' attitude toward risk matters. Criminals who prefer risk may allocate time to illegal activities despite low expected profits from crime. Conversely, criminals who avoid risk may allocate time to crime only in the presence of high expected illegal profits. Therefore, the crime-reducing policy must contemplate the opportunities that individuals find in both the labor and crime markets. [Ehrlich \(1973\)](#) also holds that the crime-reducing policy that increases the probability of arrest and punishment generates a pure incapacitation effect because criminals in prison are not allowed to commit additional crimes.

In other contributions, dynamic effects and human capital formation are considered. [Flinn \(1986\)](#) formalizes how human capital formation accumulated at work affects future criminal activities. Given that, in the model, legal and illegal activities are substitutes; allocating more time for training in labor activities reduces the time of participation in crime. In the model by [Mocan et al. \(2005\)](#), individuals are endowed with two types of human capital (legal and illegal human capital) which determines the expected earnings in labor market and criminal sectors, respectively. [Sickles and Williams \(2008\)](#) use the human capital and the social capital as factors that influence the participation decision in criminal activities. [Lochner \(2011\)](#) holds that human capital investment (e.g. education) discourages current and future participation in crime.

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<sup>38</sup> Regarding risk-neutral criminals, the expected utility function depends on equal percentage changes in  $p$  and  $f$  ([Becker, 1968](#)). Therefore, the policy-makers may set  $p$  close to zero and  $f$  very high (to compensate the decline in  $p$ ).



In more recent contributions, crime decisions are more tightly related to the supply *and* demand of property crimes. The supply of crime considers all the number of offenses committed by criminals while the demand of crime refers to all the potential victims susceptible of being victimized and investing in private protection. On the supply side, individuals first decide whether to commit crime and, then, which type of criminal to be: burglar or robber (Draca *et al.*, 2018). The latter decision depends on the expected profits of stealing heterogeneous goods (e.g. TVs, DVDs, jewelry, mobile phones, bicycles). On the demand side of the crime market, victims have incentives to reduce their risk of victimization by installing effective protection devices (Decreuse *et al.*, 2018) and/or by reducing the consumption of expensive goods (Mejía and Restrepo, 2016). Criminals search wealthy targets (e.g. rich individuals or high-quality housing) based on pecuniary expectations (Chiu and Madden, 1998; Decreuse *et al.*, 2018). Rich households know that they are the potential victims of property crime, thence they have large incentives to protect themselves against crime. Thus, the crime rates might decrease in rich neighborhoods but increase in poor neighborhoods (Chiu and Madden, 1998; Decreuse *et al.*, 2018). Furthermore, the potential victims of crime can decide whether or not to consume expensive goods, *whatever the wealth of the neighborhood they live* (Mejía and Restrepo, 2016). Wearing conspicuous goods (e.g. jewels, expensive clothing) brings wealth to the person but also attracts the attention of robbers and burglars which increases the probability of victimization.

Since Becker (1968), many empirical contributions have tested the theoretical propositions about the economic incentives of crime. The following sections review the role of police and prisons, and the effects of incapacitation and deterrence on crime (Section 2.3.2). Section 2.3.3 surveys the studies that estimate the labor market influence on criminal activities through unemployment, labor wages and education. Section 2.3.4 reviews the empirical contributions that test the effect of inequality and poverty on different types of crime.

### 2.3.2. ROLE OF POLICE AND PRISONS

Two important mechanisms that deter criminal activity are the probability of apprehension and the severity of punishment (Becker, 1968). Thus, investing more in police resources and establishing strict law enforcements might reduce the level of crime in the society. Here, we refer to the crime-reducing effect of police and prisons.

#### *The role of Police*

Theoretically, a high investment in police resources increases the probability of apprehension and, therefore, reduces criminal activities (Ehrlich, 1973). Technically, the allocation of police resources must be effective in order to reduce crime. As emphasized by Benson (2010), authorities allocate police resources to support the different areas of police operation such as patrol streets, investigate crimes, provide emergency assistance, provide security in courts, assist in investigation of accidents, prepare in civil defense. However, the principal interest is solving violent rather than property crimes. In the case of the United States, the productivity of police (arrests/reported crimes) is higher at solving murder (0.80)<sup>39</sup> or aggravated assault (0.51) than larceny (0.18).

Empirical studies have tested the predictions about the negative relationship between the probability of apprehension (related to police) and the rate of crime (Ehrlich, 1973). Former studies have found positive or insignificant effects in such relationship (Cameron, 1988; Marvell and Moody, 1996; Eck and Maguire, 2000). However, these studies have not considered the potential endogeneity issue due to reverse causality: more police resources reduce crime rates, but at the

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<sup>39</sup> The productivity of police also depends on the level of criminal violence in the country (e.g. homicide rate). The UNODC (2013) report shows that the productivity of police and the homicide rate are negatively related. In low-homicide rate countries, it is easier to catch criminals and the productivity rises to 0.92. In contrast, the productivity of police is lower than 0.52 in high-homicide rate countries.

same time, areas with high crime rates require more police resources. Thus, more recent empirical studies have applied instrumental variables to correct this endogeneity issue.

Levitt (1997) uses the timing of gubernatorial and mayoral elections as an instrument of police because, during the time of elections, politicians seek re-election by investing in a higher level of security. Therefore, the increase in the number of police officers is related to the elections, but not to the level of crime in the city. Using this instrument, Levitt (1997) finds negative elasticities of police officers and crime rates in United States (-0.3 for property and -1.0 for violent crimes). The variation in the number of firefighters is also an instrument for the variation in the number of police officers, if we assume that local investment assigns similar monetary amounts to those services but crime is not affected by the presence of firefighters. Using this instrument, Levitt (2002) estimates elasticities of -0.50 for property and -0.43 for violent crimes. According to Lin (2009), increases in the number of police officers can be made through revenue transfers from state governments to local (city, county) governments. He uses the ‘one-year lagged state sales tax rates’ as instrument for the current local police and presents elasticities of -0.9 for property and -1.1 for violent crimes.

Other studies use information about terrorist attacks to identify the effect of police reinforcements. In Argentina, the police reinforced protection in specific blocks of Buenos Aires after a bomb terrorist attack against the principal Jewish centre in the city.<sup>40</sup> Considering that increases in police are specifically related to this attack, Di Tella and Schargrotsky (2004) estimate the number of vehicle thefts before and after the attack happened. They find an effect of -0.081 vehicle thefts per month in police protected blocks of Buenos Aires while neither effects of spatial displacement nor pre-attack are found. In the United States, the variation in the terror alert system in Washington D.C. (from yellow to orange) leads to police reinforcement through a more number of working hours of police officers. In this case, Klick and Tabarrok (2005) estimate an elasticity between police and property crimes of -0.3.

### *The role of Prisons*

The severity of punishment, if criminals are arrested, discourages the participation in crime (Becker, 1968; Ehrlich, 1973). Thence, sentence enhancements seek to imprison potential offenders who would otherwise continue to commit serious and minor offenses. Levitt (1998a) estimates a reduction of 0.49 - 0.66 in violent crimes and 3.96 - 4.29 in property crimes for each delinquent-year incarcerated. Reciprocally, each prisoner released increases the number of crimes by 15 per year (Levitt, 1996).

The United States are an interesting country to analyze the impact of prisons on criminality as this has the greater incarceration rate compared to other countries (Raphael and Stoll, 2009).<sup>41</sup> In the United States, the prison population rose from 1.8 to 6.9 million inmates during the period 1980-2011.<sup>42</sup> In 2002, 69% of offenders were sentenced to incarceration (in jail or prison) while the rest received a sentence of probation or parole.<sup>43</sup> Raphael and Stoll (2009) identify that prison

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<sup>40</sup> Police reinforced protection in blocks (area of 100 meters of the street between two corners) containing Jewish and Muslims centres. Di Tella and Schargrotsky (2004) use available information of three non-contiguous neighborhoods that contain 876 blocks and represent 3.2% of the surface in Buenos Aires.

<sup>41</sup> In addition, the U.S. provide complete statistics on prison population, courts, sentences, parole, etc.

<sup>42</sup> Sourcebook of Criminal Justice Statistics, Section 6 “Persons under correctional supervision”, Table “Adults on probation, in jail or prison, and on parole” at web site <https://www.albany.edu/sourcebook/>.

<sup>43</sup> “Probation” refers to the penalty imposed to a criminal, as he/she does not go to jail and stays in the community, under the condition of good behavior. “Parole” refers to the anticipated release (before the end of the sentence) of an inmate, subject to good behavior. “Incarceration in Jails” refers to correctional facilities operated by local governments that host inmates serving short-term sentences. “Incarceration in Prisons” refers to correctional facilities operated by state governments and host inmates of serious crimes serving long-term sentences. Regarding sentences to incarceration, they vary depending on the type of crime. For example, 95% of murderers and non-negligent

admissions are mostly given to offenders sentenced of at minimum one year and offenders who returned to custody after violating the parole conditions.<sup>44</sup> Conversely, the prison releases are given by offenders conditionally (e.g. parole) or unconditionally (e.g. expire of sentence) liberated. The large prison population in the United States can be related to the fact that the number of admitted inmates significantly exceeds the number of released inmates ([Raphael and Stoll, 2009](#)).

Theoretically, stricter law enforcements should reduce the expected utility of crime and, therefore, the participation in criminal activities through effects of Incapacitation and/or Deterrence. Incapacitation reduces crime by incarcerating offenders who cannot commit further offenses. Deterrence disincentives potential offenders by threat of punishment. In the United States, the *Proposition 8's enactment* and the *California's Three Strikes law* seek to reduce recidivism by increasing the penalties for repeated offenders and discouraging new offenses.

The Proposition 8's enactment, incorporated to the California Penal Code in 1982, increases the penalty of repeated offenders by punishing prior convictions of serious offenses with a five-year enhancement and prior prison-terms for any offense with a one-year enhancement. After the enactment, eligible crimes (murder, rape, robbery, aggravated assault with firearm, and burglary in residence) immediately fell by 3.9% and then continue falling several years later (by 7.9% in the three years later and by 20% in the seven years later).<sup>45</sup> [Kessler and Levitt \(1999\)](#) suggest that the Proposition 8's reduces crimes through both deterrence due to the immediate reduction, and incapacitation due to the reduction in time and by targeting serious repeated offenders.

The California's Three Strikes law, incorporated in 1994, punishes subsequent serious offenses or offenses with violence named "strikes".<sup>46</sup> One-strike criminals convicted for any subsequent offense receive a double sentence length on that conviction and must serve in prison at least 80% of the sentence length. Two-strike criminals convicted for any subsequent offense receive a sentence of 25 years to life and must serve at least 80% of the 25-year period. [Helland and Tabarrok \(2007\)](#) study the effect of this law on criminal activity of convicted offenders. Findings reveal that two-strike criminals are less likely to be rearrested than one-strike criminals. Indeed, the possibility to be subject of a third-strike reduces arrest rates by 17.2% - 20%.

Another factor that contributes to the reduction of crime is the quality of life in prisons. Delinquents have information about hostile prison conditions where the prison death rate is significantly higher than suicides or executions ([Katz et al., 2003](#); [UNODC, 2013](#)).<sup>47</sup> Around the world, the rate of prison death differs depending on the region. In the Americas, there are 57 prison deaths per 100,000 prisoners, while there are at most three deaths per 100,000 prisoners in Europe, Asia or Oceania ([UNODC, 2013](#)). Scarce prison conditions and, more specifically, the prison deaths have a significant reducing effect on crime rates. In the United States, [Katz et al. \(2003\)](#) estimate that, each additional prison death causes a reduction of 0.1 - 0.8 homicides, 30 - 98 violent crimes and 20 - 150 property crimes.

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manslaughters, 80% of violent offenders and 66% of property crimes offenders received a sentence to incarceration in jails or prisons (University at Albany, Sourcebook of Criminal Justice Statistics, Section 6).

<sup>44</sup> [Raphael and Stoll \(2009\)](#) study the changes in the U.S. prison population over the period 1984-2002.

<sup>45</sup> Non-eligible crimes are aggravated assault without firearm, burglary in non-residence, vehicle-theft and larceny ([Kessler and Levitt, 1999](#)).

<sup>46</sup> Strikes refer to the crimes of murder, attempted murder, rape, arson, kidnapping, robbery, assault (to rape or rob), burglary of residence, any felony which caused bodily harm or deadly weapon, theft with firearm, drug sales to minors ([Helland and Tabarrok, 2007](#)).

<sup>47</sup> Hostile prison conditions refer to violence among inmates, deaths in prison inflicted by other inmates, violence from guards to prisoners, scarce health care, low square space per prisoner, etc. ([Katz et al., 2003](#)).



### 2.3.3. LABOR MARKET INCENTIVES AND EDUCATION

[Ehrlich \(1973\)](#) extends the framework of the expected utility function of individuals by introducing additional states of the world: success and failure in crime, success and failure in labor. The failure in labor refers to the unemployment situation that individuals confront in a given period of their lifetime. Thus, the probability of unemployment reduces the opportunity cost of crime and therefore, encourages the individuals to participate in illegal activities.

Theoretical predictions regarding the unemployment - crime relationship have been confronted to the data without finding a consensus in the effect.<sup>48</sup> According to [Cantor and Land \(1985\)](#), these different results are related to incomplete theories which only analyze the effect of unemployment on criminals but do not consider that victims are also affected by economic downturns. In the model by [Cantor and Land \(1985\)](#), the unemployment rate affects criminals and victims through opportunity and motivational mechanisms. If recent unemployed individuals do not commute to jobs and stay at home protecting their property, criminals have lower opportunities to find suitable victims in the short-run. This is called the *Opportunity mechanism*. If recent unemployed individuals receive unemployment benefits from government or financial aids from family and friends, there is not an instantaneous motivation to commit crime. But, as far as the benefits are reduced, individuals find an economic motivation to participate in criminal activities in the long-run. This is called the *Motivational mechanism*.

[Cantor and Land \(1985\)](#) test those predictions using data on the seven Index I crimes of the FBI, over 1946-1982. The methodology includes contemporaneous and lagged unemployment rates.<sup>49</sup> Findings reveal that the contemporaneous unemployment is negatively associated with homicide, robbery, burglary, larceny and vehicle-theft. Conversely, the lagged unemployment is positively associated with robbery, burglary and larceny. Recent empirical contributions have also tested the validity of Cantor and Land's predictions at different geographic levels in U.S. and Canada. [Phillips and Land \(2012\)](#) identify the effects of unemployment on crime at U.S. county, state and national levels over 1978-2005. The main hypothesis is that analyses at lower geographic levels are more accurate than at a more aggregated level. Their results confirm the negative effect of contemporaneous unemployment and the positive effect of lagged unemployment on rape, larceny and vehicle-theft. As expected, estimates at the county level are more statistically significant than at the state or national levels. [Andresen \(2012\)](#) identifies the opportunity and motivational effects of unemployment in neighborhoods of Vancouver (Canada), for years 1991, 1996 and 2001. In the short-run, results show that only property crimes are negatively associated with unemployment. In the long-run, neighborhoods with high unemployment rates have higher levels of property and violent crimes.

[Janko and Popli \(2015\)](#) introduce an alternative methodology to estimate the effect of unemployment on crime in the short- and long- run. Using data from Canada in the period 1979-2006, their methodology identifies how the variation of contemporaneous ( $\Delta u_t = u_t - u_{t-1}$ ) and lagged ( $\Delta u_{t-1} = u_{t-1} - u_{t-2}$ ) unemployment, the variation of lagged crime ( $\Delta c_{t-1} = c_{t-1} - c_{t-2}$ ) and an error correction term  $Z_{t-1} = c_{t-1} - \gamma u_{t-1}$  affect variations in crime.<sup>50</sup> Results show that the effect of contemporaneous unemployment is positive for robbery and burglary; the lagged unemployment exerts a negative influence on fraud and robbery; the lagged crime has a positive impact on burglary, fraud and vehicle-theft. Although these empirical contributions analyze the

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<sup>48</sup> See [Cantor and Land \(1985\)](#), [Draca and Machin \(2015\)](#) and [Mustard \(2010\)](#) for a survey on the empirical studies with positive, negative or insignificant results of unemployment on crime.

<sup>49</sup> Lagged unemployment is calculated from first and second differences to eliminate secular trends in their levels ([Cantor and Land, 1985](#)).

<sup>50</sup> The error correction term consists in the difference between the lagged crime and the lagged unemployment, where  $Z_{t-1}$  captures the relationship of unemployment  $u$  and crime in the long-run and  $\gamma$  captures the adjustment of crime rates to deviations from long unemployment ([Janko and Popli, 2015](#)).

effect of unemployment at different geographic levels, they do not capture the spatial diffusion of crime.

An important limitation from the above contributions is that the unemployment rate is not the best variable to analyze the effect of labor market on crime. Other measures can better illustrate the labor market-crime relationship, such as the labor wages (Draca and Machin, 2015; Gould *et al.*, 2002; Mustard, 2010). There are several arguments. First, the unemployment rate is cyclical and does not capture the individual shocks that people confront with economic downturns. Second, workers may quit their jobs with the intention to find a better job in the short term. Third, scarce labor market conditions of specific groups of population are permanent and get deteriorated over time. Trends of unemployment rates and labor wages of non-college educated men have different behavior over time.<sup>51</sup> The unemployment rate follows a cyclical pattern, which does not intensively deteriorate in time and, what is more interesting, the rate at the end of the period is similar to that at the beginning (Gould *et al.*, 2002). Conversely, the wage series presents intensive variations over time and deteriorates at the end of the period (20% lower at the end than at the beginning). Fourth, the number of low-wage workers is higher than the number of unemployed people. Thus, one can argue that unskilled men find permanent low wages, scarce labor opportunities and cannot afford for a well-paid job. Those factors can better explain the incentives to participate in crime to the extent that crime responds more to poor long-term market conditions than to short-term economic fluctuations (Gould *et al.*, 2002).

Only few studies exploit the effect of wages on crime. Grogger (1998) calculates an hourly wage measure using the National Longitudinal Survey Youth Cohort for 1980. He finds that 22.8% of young people have been employed in the labor market but also received income from crime. This makes them more sensitive to wage changes and the economic opportunities between legal and illegal activities. Findings also reveal that a 10% increase in wages reduces youth participation in crime by 6% - 9%. Gould *et al.* (2002) compare the effects of unemployment, income and wages<sup>52</sup> on young unskilled men. They find that increasing the wages and the income per capita reduces the crime rates whereas increasing unemployment increases the crime rates. As expected, the effect of wages is greater than the effect of unemployment. A 23% decrease in wages causes a 13% increase in property crime and 25% increase in violent crime. On the other hand, a 3% increase in unemployment causes a 7% increase in property crime and a 4% increase in violent crime.

Another way to test the impact of labor market on criminal activities is through the influence of education. According to Lochner (2011), human capital and training (e.g. formal schooling or informal job-training) raises the opportunity cost of crime. In the model, adolescents allocate time to human capital investment, crime and work. At such stage, the intervention programs that promote learning productivity<sup>53</sup> are so important because they would improve skills at adulthood. Then at adulthood, individuals decide whether to work or commit crime. In equilibrium, increasing the learning productivity both increases the investment of human capital, and reduces the participation in crime of non-working adolescents and adults. Empirical approaches have tested those predictions by exploiting how changes in school leaving age affect crime. In the United States, Lochner and Moretti (2004) found that the arrest rate reduced by 11% with one extra year of education enrollment. In England and Wales, Machin *et al.* (2011) found that conviction rates fell by 4.7% with the increase in the school leaving age reform.

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<sup>51</sup> Gould *et al.* (2002) compare the unemployment rates and labor wages of non-college educated men, in the United States, over the period 1979-1997.

<sup>52</sup> Gould *et al.* (2002) use the log weekly wage residual for non-college educated male, the unemployment rate for non-college educated male and the log income per capita as measures of wage, unemployment and income, respectively. The analysis includes 705 U.S. counties over the period 1979-1997.

<sup>53</sup> The “learning productivity” refers to factors that raise the productivity of human capital through investment in formal education (e.g. subsidies in education) or informal job training (Lochner, 2011).

In a word, most studies show that detrimental economic conditions in the labor market yield to large incentives at performing in crime. In the specific case of unemployed people and people with low wages, the existence of economic recessions leads to consider the crime as a potential alternative to obtain pecuniary resources. Such effect appears to increase immediately the property crimes while the effect appears to be delayed on violent crimes. One can suspect that, in the short run, individuals confronted with economic recessions decide to commit property crimes such as larceny. But, in the long run when the economic situation worsens, criminals may consider to commit more serious crimes such as robbery. In any case, one possible solution to mitigate crime is the education enrollment and the higher opportunities to obtain a well-paid job.

#### 2.3.4. INEQUALITY AND POVERTY

Income inequality and poverty have important economic implications on incentives to commit crime. The inequality of the income distribution raises the gap between the return from illegal activities such as pecuniary crimes and the return from legal activities for low-income people who are placed in proximity with high-income people.

The relationship between inequality and pecuniary crime was formalized by [Chiu and Madden \(1998\)](#). They define social classes depending on the quality of housing and the income level. The first class assumes that high-income individuals are not criminals and live in high-quality housing HQ. The second class refers to middle-income and non-criminal individuals living in low-quality housing LQ. The third class stands on low-income people who are criminals and live in LQ housing. In the model, at the equilibrium, the poorest individuals decide to burglar high-quality housing that belongs to the richest individuals based on high expected proceeds. A rise in income inequality leads to more crime. Indeed, poor people (now with a lower marginal income) have greater incentives to commit crime against high-quality housing which becomes even more attractive to burgle. The relationship between income inequality and crime can be non-linear because rich individuals can protect themselves against burglary by installing an expensive and effective technology against crime. This causes that the level of crime decreases in rich neighborhoods and increases in poor ones.

A large number of empirical contributions have tested the inequality - crime relationship. In a meta-analysis contribution, [Rufrancos \*et al.\* \(2013\)](#) analyze 17 time-series studies with strong evidence that income inequality raises property crimes, but the effect is mixed on violent crimes. [Rufrancos \*et al.\* \(2013\)](#) conclude that the methodology applied and the geographic level matter for the strength of the estimations. Here, we briefly describe several studies using different econometric techniques at different geographic levels.

At the international level, [Fajnzylber \*et al.\* \(2002\)](#) perform a GMM estimation of crime rates to account for criminal inertia. The panel dataset includes 39 countries over 1965-95 for homicides and 37 countries over 1970-94 for robberies. Estimates indicate that increasing income inequality raises homicide and robbery rates, and the effect on robbery is larger than on homicides. Moreover, the lagged<sup>54</sup> homicide and robbery variables have strong positive effects on homicide and robbery, respectively, suggesting the existence of criminal inertia. [Neumayer \(2005\)](#) criticizes the approach by [Fajnzylber \*et al.\* \(2002\)](#) arguing that their results are not consistent because the sample is restricted to a small number of countries and the correlation between inequality and country-specific fixed effects is strong. In turn, Neumayer uses Random Effects and GMM estimations on a sample of 59 countries over 1980-97. He uses a larger sample of countries and control for country-specific fixed effects. His results indicate that the income Gini coefficient is no longer significant regarding robberies and violent thefts. Moving to the U.S. county level, [Kelly \(2000\)](#) estimates a Poisson regression on property and violent crime rates. Results show that income inequality explains the

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<sup>54</sup> The lagged crime refers to the crime rate of the previous five-year average period ([Fajnzylber \*et al.\*, 2002](#)).

rise in violent crimes (assault and robbery) but no effect is found on property crimes. [Brush \(2007\)](#) also refers to the U.S. county level to perform cross-section (Ordinary Least Squares) and time-series estimates (First-difference estimation). With cross-section data, results indicate that increasing income Gini in 0.23 causes a 26% increase in serious crime rates. With time-series data, the variation in income Gini shows negative associations with the variation in serious crime. Brush suspects that an omitted variable can be correlated with changes in inequality and crime. Using data on 2,000 Mexican municipalities, [Enamorado et al. \(2016\)](#) estimate the impact of inequality on crimes related to the Mexican drug war through a 2SLS method. They show that a one point increase in the income Gini raises by 36% the number of drug-related homicides per 100,000 inhabitants. A panel data analysis in seven Colombian cities proposed by [Bourguignon et al. \(2003\)](#) investigates the influence of income inequality on the proportion of people more prone to crime. Results show that the effect of inequality is strongly significant. The largest proportion of criminals are found in the group of people with welfare below 80% of the mean of the entire population. Finally, using data on police precincts in South Africa, [Demombynes and Özler \(2005\)](#) perform a Negative Binomial estimation on property and violent crime rates. Results reveal that inequality is positively related to burglary and vehicle theft in the precinct area. However, the inequality at the criminal catchment area matters more for violent crimes rather than inequality at the precinct area.<sup>55</sup>

In addition to inequalities, poverty can also be associated with crime due to the reduction in the opportunity cost of criminal activities. In the United States, [Ehrlich \(1973\)](#) tests the effect of the percentage of families below one-half of the median income on crime rates. The estimated elasticities on property and violent crimes are positive but larger in the case of property than in violent crimes. In Colombian regions, [Rocha and Martínez \(2003\)](#) find evidence that regions with high levels of poverty have higher crime rates. Findings reveal that high-poverty regions are 10% more likely to increase crime than the national level. Nevertheless, [Mehlum et al. \(2006\)](#) highlight the importance of using instrumental variables to estimate the impact of poverty on crime. They analyze the interrelationship of rye prices, poverty, alcohol consumption and crimes in the 19<sup>th</sup> century in Bavaria-Germany. The intuition is that rainfall determines the prices of rye. In the 19<sup>th</sup> century, rye was the main factor of living standards of the population and therefore can be related to poverty measures. [Mehlum et al. \(2006\)](#) find that high prices of rye increase the property crimes but reduce violent crimes. A possible explanation for the reduction of violent crime is that the costly value of rye increases the prices of beer, thereby reducing alcohol consumption and decreasing violent criminal acts.

## 2.4. THE GEOGRAPHICAL DIMENSION OF CRIME

Social and economic mechanisms that encourage individuals to commit crime are strongly influenced by the location pattern of victims and criminals. As we already discussed (see Section 2.2.2), spatial areas (e.g. communities, neighborhoods, cities) with strong social networks give rise to a social multiplier effect on crime. In addition, criminals prefer to operate in spatial areas that increase the expected proceeds on crime and reduce the risk of apprehension.

In the following Section 2.4.1, we present the location decision models that develop various mechanisms through which crime concentrates in specific areas. According to the first mechanism, criminals that locate in the same area create positive externalities between them that reduce the probability to be caught ([Freeman et al., 1996](#)). More recent theoretical contributions show how racial beliefs ([Verdier and Zenou, 2004](#)) or agglomeration economies ([Gaigné and Zenou, 2015](#))

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<sup>55</sup> [Demombynes and Özler \(2005\)](#) define the “police precinct” as the area where the crime occurred while the “criminal catchment area” contains the own precinct and the bordering precincts where the criminal may reside.

also encourage the spatial concentration of criminal activities. Then, we survey the literature aimed at evaluating the empirical relevance of these theoretical predictions (Section 2.4.2).

#### 2.4.1. THEORETICAL BACKGROUND

If criminals seek to increase the expected proceeds of crime and reduce the risk of apprehension (Becker, 1968), they should rationally analyze where is the best area to operate in.

Following this argument, Freeman *et al.* (1996) explain why crime is concentrated in specific neighborhoods and not distributed throughout the city. In the model, the population lives in a city composed of two *ex-ante* identical neighborhoods  $j = 1, 2$ . Individuals decide to be exclusively workers or criminals. Then, criminals also decide in which neighborhood to operate. For simplicity, the model focuses on criminals who steal, and the returns of workers depend on their wage  $w$ . The expected return of thieves is given by eq. (2.4):

$$v(m_j, i_j) = (1 - p(m_j, i_j)) Y(i_j) \quad (2.4)$$

It depends on the police resources in the neighborhood  $m_j$ , the number of thieves  $i_j$ , the probability of arrest  $p(m_j, i)$  and the return per theft  $Y(i_j)$ .

Increasing the number of thieves in the neighborhood has two opposite effects on their expected returns. On the one hand, the expected returns increase because the probability of arrest falls with more criminals in the neighborhood. On the other hand, the expected returns decrease because of tougher competition for the booty. Freeman *et al.* (1996) show that there exists multiple equilibria depending on the level of wage and the return to theft. At an interior equilibrium, when the returns to work and the expected returns to theft ( $w = v_1 = v_2$ ) are equal, individuals participate in both legal and illegal activities, and thieves are committed in both neighborhoods. At boundary equilibria, some individuals choose not to participate in an activity depending on the wage, the maximum return to theft  $v^*$  and the minimum return to theft  $\bar{v}$ :

1. If ( $w > v^*$ ), all individuals prefer to work (there are two crime-free neighborhoods).
2. If ( $w < \bar{v}$ ), all individuals prefer to steal and choose to settle in equal numbers in both neighborhoods (there are two crime-ridden neighborhoods).
3. If ( $\bar{v} \leq w \leq v^*$ ), three possibilities arise: no thieves settle in each neighborhood; equal number of thieves settle in each neighborhood; or all thieves concentrate in only one neighborhood. This last possibility generates one crime-ridden and one crime-free neighborhoods.

The intuition for the spatial concentration of crime in the latter equilibrium is that criminals create a positive externality between them which, in turn, reduces the probability of arrest. An important consequence is that even if neighborhoods are *ex-ante* identical, the welfare in crime-ridden neighborhoods is affected by crime. People living in crime-ridden neighborhoods have a lower welfare and lower returns to work than people living in crime-free neighborhoods.

Following this seminal contribution, the urban economics literature has developed models of crime participation by introducing commuting costs (Zenou, 2005), the segregation by racial beliefs (Verdier and Zenou, 2004) and the effect of agglomeration economies in a general equilibrium model (Gaigné and Zenou, 2015).

Zenou (2005) develops a model of monocentric city with a labor market, a crime market *and* a housing market. The city is organized as a line and both labor and crime opportunities are by assumption located in the center (named the Central Business District - CBD).<sup>56</sup> Each individual

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<sup>56</sup> A first version of the model and its main results are summarized in Zenou (2003).



simultaneously chooses: i) to locate in the city and ii) to work *or* commit crime. Moreover, individuals bear commuting costs when they move from the residential area at the urban fringe to the CBD. Therefore, utility functions of workers and criminals depend on the return from each activity, the per unit cost of commuting  $t$  at distance  $x$  from the CBD and the land rent  $R(x)$ . Formally, the utility function of workers is given by eq. (2.5):

$$U_l = w - tx - R(x) \quad (2.5)$$

The utility of worker increases with the wage  $w$  but falls with total commuting costs  $tx$  and the land rent. In turn, the expected utility function of criminals is given by eq. (2.6):

$$U_i = (1 - p(m, i))(Y(i) - \alpha tx - R(x)) \quad (2.6)$$

The utility of criminal increases with the return per theft  $Y(i)$  but falls with the probability of arrest  $p(m, i)$ , the number of trips to CBD in order to commit crime ( $\alpha$ ), the total cost of commuting, and the land rent. At the equilibrium, increasing the number of criminals  $i$  in the city generates two opposite externalities on criminals:

1. When  $i$  is low, increasing an additional offender generates a positive externality to crime because the probability of arrest falls.
2. When  $i$  is high, increasing an additional offender generates a negative externality to crime because the booty is reduced to the extent that the competition is strengthened.

The main finding of this model refers to the effect of commuting costs on the number of criminals. Increasing commuting costs negatively affects both utility functions  $U_l$  and  $U_i$  because it raises the cost of land in the city. This negative impact is stronger for workers than for criminals. Considering that workers prefer to reside closer to the CBD, they must bid for land at higher prices. As a result, the utility function of criminals becomes higher than the utility of workers. This fact increases the incentives to commit illegal activities, and therefore, the level of crime in the city.

The model of [Verdier and Zenou \(2004\)](#) incorporates locational segregation and beliefs in an urban crime model to explain why black people are more involved in criminal activities. This model assumes two types of individuals, only different by the color of the skin,  $k = B(\text{black}), W(\text{white})$ . Also, the model assumes that legal and illegal activities are not mutually exclusive. In the morning, non-convicted criminals work in the labor market while, during evenings and weekends, they sell drugs. Importantly, firms do not observe whether individuals are workers or criminals, but anticipate that productivity is negatively affected by distance to jobs and by crime.<sup>57</sup> Thus, firms offer different wages  $w_k = w(x, \theta_k)$  depending on the worker's location ( $x$ ) and on the proportion of criminals of type  $k$  ( $\theta_k$ ) in the city. Once again, individuals find incentives to become criminals when the expected utility from crime is higher than the utility from work.<sup>58</sup> The individual incentives to engage in criminal activity increase with distance to work because being located far away from the CBD reduces the land rent. The racial beliefs matter in the location decision and reinforce segregation. If the entire population believes that the proportion of black criminals is higher than the proportion of white criminals  $\theta_B > \theta_W$ , then the wages offered to whites are higher than the wages of blacks  $w_W > w_B$ . As consequence, blacks segregate themselves and locate further away because they anticipate having a lower ability to bid for land than whites.

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<sup>57</sup> [Verdier and Zenou \(2004\)](#) assume that individuals who perform longer trips to work have more non-work related fatigue and have less flexible working hours. They also assume that criminals are found less productive than workers. Criminals tend to be more dishonest at work, have a higher probability of being damaged by other criminals and also tend to consume drugs and alcohol.

<sup>58</sup> Given the wage differential, the utility function of workers  $U_l^k = w_k - tx - R(x)$  and the expected utility function of criminals  $U_i^k = p(Y - f) + (1 - p)(Y + w_k - tx) - R(x) - \mu$  now depend on the color of skin  $k$ , the commuting costs  $t$  at distance  $x$ , the land rent  $R(x)$  in  $x$ , the probability of arrest  $p$ , the return per theft  $Y$ , the fines if caught  $f$ , and the aversion to crime  $\mu$ .

At the equilibrium, blacks are more criminals than whites due to worse labor market opportunities (lower wages, lower productivity and greater distance to jobs) that are themselves caused by discrimination and self-fulfilling believes.

In a recent contribution, [Gagné and Zenou \(2015\)](#) deepens the analysis of the location of crime in cities by developing a full-fledge general equilibrium model with labor, land, product and crime markets. They first consider one monocentric city populated by  $\lambda$  individuals. Each individual decides to be either a worker or a criminal, and where to live between the CBD and the city fringe. Firms are located in CBD (at  $x = 0$ ), and produce  $n$  differentiated varieties of services under monopolistic competition. Workers that reside at distance  $x > 0$  from the CBD pay a land rent  $R_l(x)$  and bear a per unit commuting cost  $t$ . Their total urban costs are thus given by  $UC_l(x) = R_l(x) + tx$ . Each criminal is assumed to steal a fraction  $\xi$  from these workers, *whatever their income*. Moreover, it is assumed that criminals do not bear commuting costs so that their land rent is constant.<sup>59</sup> Because workers bear commuting costs when they locate far from the CBD, they will bid away criminals. Therefore, workers choose to live between the CBD and city fringe whereas criminals live at the city fringe, where the land rent is normalized to zero.

Given these location choices, equilibrium wages and consumption levels, [Gagné and Zenou \(2015\)](#) obtain the indirect utility function of workers which is given by eq. (2.7):

$$V_l(x) = n + w^* - t\frac{L}{2} - \xi C + \bar{q}_0 \quad (2.7)$$

with  $w^*$  the equilibrium wage paid by service firms,  $t(L/2)$  the equilibrium total urban costs,  $C$  the mass of criminals, and  $\bar{q}_0$  the individual endowment in *numéraire*.<sup>60</sup> In contrast, the indirect utility of criminals is given by eq. (2.8):

$$V_c(x) = n + \xi L - \mu + \bar{q}_0 \quad (2.8)$$

with  $L$  the mass of workers and  $\mu$  the aversion with respect to crime.

The equilibrium share of criminals  $\theta^*$  in city is such that each individual is indifferent between committing a crime or working. [Gagné and Zenou \(2015\)](#) show that:

$$\theta^* = \frac{\lambda t + 2\lambda(\xi - (p^*)^2)}{(\lambda t + 2)} \quad (2.9)$$

with  $p^*$  the equilibrium price of services that positively influence equilibrium wages ( $w^* = \lambda(p^*)^2$ ).

According to eq. (2.9), the equilibrium share of criminals increases with the level of commuting costs and the degree of services differentiation. The influence of city size on the share of criminals is *a priori* ambiguous. On the one hand, there are more incentives to engage in criminal activities when city population rises for two reasons. First, large cities have higher commuting costs that increase the cost of urban life borne by workers and reduce their net wage. Second, the total proceeds from crime are higher. On the other hand, city population raises the equilibrium wage through its positive influence on profits made by firms, which makes it more interesting to enter the labor market. [Gagné and Zenou \(2015\)](#) show that the former effect dominates, so that the share of criminals at the equilibrium increases with city size.

Importantly, this relationship remains valid when the city size is determined endogenously through migration. In an extension of their model, [Gagné and Zenou \(2015\)](#) consider a system of two cities of different sizes. Households choose in which city to reside, without knowing whether they

<sup>59</sup> This assumption is made for simplicity.

<sup>60</sup> On the labor market, firms compete for workers by offering higher wages until profits are equal to zero. Therefore, the equilibrium wage paid by service firms increases with city size and with equilibrium prices of services.

will become worker or criminal. The authors demonstrate that a system of two cities can arise at the equilibrium under two configurations. When commuting costs are very high, the population (including criminals) is equally dispersed across cities in order to reduce urban costs. However for intermediate levels of commuting cost, one city will host a larger share of total population.<sup>61</sup> Indeed, households are attracted by the greater economic opportunities of larger cities, such as higher wages and local varieties. Larger cities also attract more firms because of the higher local demand for services. Regarding criminals, they seek for a larger pool of potential victims in larger cities, too. As a result, provided that the level of commuting cost is low enough for a system of two cities to arise endogenously, it is shown that the share of criminals is higher in the larger city.

Finally, the authors analyze the influence of commuting cost on total criminal activities. In the short-run (exogenous city size), lower commuting costs reduce total criminal activities whatever the city size. In the long-run (endogenous city size), the effect of commuting costs is ambiguous. The reduction of commuting costs causes agglomeration which triggers more criminal activities in the largest city and a lower number of crimes in the smallest city.

#### 2.4.2. EMPIRICAL EVIDENCE ON AGGLOMERATION AND URBAN CRIME

The spatial concentration of crime is documented in a vast empirical literature. We summarize the results of some studies aimed at characterizing the spatial distribution of crime.

To measure the spatial distribution of crime, we are faced with several methodological issues. In their contribution, [Anselin et al. \(2000\)](#) describe these issues and propose methods to alleviate them. The Explanatory Spatial Data Analysis (ESDA) makes possible to identify whether the location of crime is random or follows a specific pattern, for example, by measuring the spatial correlation of neighboring locations. Positive spatial correlations refer to locations with high (low) values which are placed in proximity to neighboring locations with high (low) values. In other words, a high crime rate city is spatially correlated with a neighboring city that also has a high crime rate. By contrast, there are also spatial outliers characterized by locations with high values of crime surrounded by neighboring locations with low values of crime, and vice-versa. ESDA also makes possible to identify the heterogeneity of local areas, for example, by determining whether the crime rates in the central city are different from the crime rates in the suburbs. These methodological issues can bias the results in the classical estimates of crime.

Because of these issues, several empirical studies rely on spatial econometric tools to analyze the determinants of the location of crime in different countries. The results vary depending on the types of crime. In Italy, [Cracolici and Uberti \(2009\)](#) find that murders are strongly concentrated in southern provinces (Puglia, Calabria, Sicilia, Sardegna, Campania) where the presence of organized crime and inter-clan conflicts predominate. Thefts are predominantly concentrated in touristic cities such as Milano, Palermo, Venezia and Roma. In Mexico, [Flores and Rodríguez \(2014\)](#) detect the spatial diffusion of homicides due to law enforcement in regions exposed to joint military operations. Since 2007, the federal government deployed the armed forces to dismantle criminal organizations operating in seven states (Michoacán, Guerrero, Baja California, Nuevo León, Tamaulipas, Chihuahua, Sinaloa and Durango). Their results confirm that there are homicide displacements only in the areas of application of the law, while there is not spatial diffusion of crime throughout the country. In El Salvador, [Carcach \(2015\)](#) analyzes the evolution of homicides through the identification of temporal trends (over 2002-2013) and spatial clusters (in 262 municipalities). Results shows that high homicide clusters remain stable in the western part of the country while there is a new process of formation of high clusters in the eastern part of El Salvador.

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<sup>61</sup> If the commuting cost is low enough, all population is agglomerated in a single city, as in the benchmark case without migration.



The above studies enable to measure and characterize the concentration of crime, and whether or not there are spillover effects associated with crime. Another strand of the literature aims at evaluating the empirical relevance of the main predictions made in the urban economics literature on crime. In what follows and given the focus of the thesis on urban crime, we summarize the contribution of empirical studies aimed at testing the impact of city size on crime rates.

In their seminal study, [Glaeser and Sacerdote \(1999\)](#) define the urban crime premium as the fact that “*Crime rates are much higher in big cities than in small cities or rural areas*” (page S225). In the United States, [Glaeser and Sacerdote \(1999\)](#) estimate that the average elasticity of serious crime with respect to city size is 0.24. Importantly, the effect becomes stronger in the most populated cities. The elasticity of victimization and city size is 0.16 in cities with more than 1’000,000 inhabitants, whereas it is 0.01 in cities with less than 10,000 inhabitants. Assuming that big cities provide higher returns to crime, lower probability of arrest, and attract more crime-prone agents; criminals might prefer to operate in denser areas. [Glaeser and Sacerdote \(1999\)](#) decompose this elasticity to quantify to which extent each one of these mechanisms contribute to the city size - crime connection. The probability of arrest seems to explain approximately 20.8% of the relationship between crime and city size. The return to crime explains 33% of this connection. The individual factors explain 29.2% of the crime - city size connection when controlling for demographics (e.g. percentage of female headed-households). As result, those three parameters explain 83.33% of the relationship between city size and crime.<sup>62</sup>

[O’Flaherty and Sethi \(2015\)](#) have recently replicated the estimates of [Glaeser and Sacerdote \(1999\)](#) using U.S. data at both the inter-metropolitan (State) *and* intra-metropolitan levels. O’Flaherty and Sethi confirm that the elasticities of crime depend on the city size and the type of crime. At inter-metropolitan level, only murder, robbery and vehicle-theft show positive and significant associations with population size. At intra-metropolitan level, all types of crime are positively associated with population size. The greatest effects of crime are found at the intra- rather than the inter-metropolitan levels, which suggests that more aggregate locations cannot capture the specificities of locations at a more local level.

Regarding the Latin American case, [Gaviria and Pagés \(2002\)](#) find that the probability of victimization in large cities (> 1’000,000 inhabitants) is 20% higher than in small cities (< 20,000 inhabitants). They emphasize that the city size effect is stronger in Latin America than in the United States. In Latin America, the likelihood of victimization is 71% higher in cities with more than 1’000,000 inhabitants than in cities between 50,000 and 100,000 inhabitants. In the United States, this likelihood is 28%.

## 2.5. CONCLUSION

This chapter provides a review of the literature on the determinants of crime. We first identify the personal attributes that encourage individuals to commit crime, regardless of the local conditions. Then, we analyze how the social and economic conditions influence crime, through incentives or other mechanisms. Finally, we investigate the influence of the location pattern of criminals and victims on the economic incentives that encourage individuals to commit crime.

Theoretical contributions on the role of social and economic incentives provide many arguments, from both the sociologic and economics literatures, according to which the level of inequality

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<sup>62</sup> Those results are obtained by using the most optimistic elasticity of crime and the probability of arrest given by [Levitt \(1996, 1998b\)](#) which is -0.5. Meanwhile, the most conservative elasticity of crime and the probability of arrest by [Levitt \(1996, 1998b\)](#) is -0.2. Under the assumption of this elasticity, the parameters explain a much lower amount of the relationship between crime and city size. The probability of arrest only explains 8.33% and the return to crime explains 10%. Given that the individual factors still explain 29.2% of the city-size crime connection, those three parameters only explain 50.86% of the overall elasticity of crime and city size ([Glaeser and Sacerdote, 1999](#)).

between individuals could be an important driver of crime (violent or property). We build on these literatures to address two research questions regarding the impact of income inequality on crime in Ecuador. Importantly, existing empirical contributions find positive associations between inequality and property crime while the effect on violent crime is mixed.<sup>63</sup> Nevertheless, these studies are confronted with important issues because they use aggregate data from crime reports. Aggregated data of crime does not enable to control for the personal characteristics of individuals (criminals and victims). This is an important limitation because the personal characteristics can explain why some individuals are more inclined to adopt a deviant behavior and why some individuals are more likely victimized than others, as demonstrated in Section 2.1. In addition, the context of Latin America exhorts to exploit the role of personal attributes on the analysis of crime, because of the large heterogeneity in ethnic groups. Finally, another limitation is the underreporting issue of crime reports because the victims of crime tend not to declare all the offenses to the police authorities. A potential solution to address such limitations is the use of victimization surveys.<sup>64</sup> Our first contribution (Chapter 3) to the empirical literature consists in estimating the impact of income inequality on the probability of victimization in order to control for the characteristics of victims and their place of residence.

Another important conclusion from this survey is that cities are privileged locations to engage in criminal activities. The urban economics literature contributed to the understanding of this fact by identifying general equilibrium effects through which city size could raise the number of criminals more than proportionally (Gaigné and Zenou, 2015). Nevertheless, there are several limits in the existing empirical literature. Existing contributions that provide some empirical evidence for the existence of this urban crime premium mostly consider the case of U.S. metropolitan areas (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015). An exception is the contribution by Gaviria and Pagés (2002) that also provides some evidence for the fact that city size raises the probability of victimization in the case of Latin American cities. However, their study suffers important limitations because they use the Latinobarometer survey. This survey does not ask which types of crime the people confronted, and it collects information in specific cities of Latin America disregarding the importance of medium and small cities in such developing countries. Our second contribution consists in testing the existence of an urban crime premium in Ecuador, by considering all parishes of the country and by distinguishing the effect of city size on the property *versus* homicide rates (Chapter 4).

Finally, this survey shows that emotional reactions of individuals, *besides the economic and sociological environments*, can encourage violent crime. The intuition is that frustration leads to aggressive reactions that can cause violent crimes, *whatever the economic incentives* (Dollard *et al.*, 1939; Berkowitz, 1989). Soccer matches are good examples of events that generate intense emotions on fans, thereby increasing crime (Card and Dahl, 2011; Gantz *et al.*, 2006; Munyo and Rossi, 2013). Given the importance of soccer and violence in Latin America and the Caribbean, one should devote special attention to this region. The study by Munyo and Rossi (2013) is the only one that explores the soccer-crime relationship in a Latin American context. They study how the violation of soccer expectancies generates intense emotions in fans, thereby boosting crime in Montevideo (Uruguay). Though, one limitation is that the analysis concentrates in Montevideo but disregards the effect of emotions throughout Uruguay. In our last empirical contribution, we explore the effect of soccer matches on crime in some cantons of Ecuador by identifying any temporal, spatial or emotional effects on crime (Chapter 5).

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<sup>63</sup> Brush, 2007; Demombynes and Özler, 2005; Enamorado *et al.*, 2016; Fajnzylber *et al.*, 2002; Kelly, 2000; Rufrancos *et al.*, 2013.

<sup>64</sup> There are few existing papers using victimization data but they do not analyze the effect of income inequality on victimization.



### 3. INCOME INEQUALITIES AND VICTIMIZATION: ESSAY AT THE INDIVIDUAL LEVEL

#### 3.1. INTRODUCTION

Latin America and the Caribbean have traditionally been confronted with high inequalities, which have reinforced a subculture of violence. The Economics and Sociology literatures predict that high income inequalities induce more criminal activities. Some empirical evidences confirm this prediction for property crimes, while the effect on violent crimes is often ambiguous. Those studies have applied different econometric techniques at different geographic levels to estimate crime rates in developed and developing countries. Nevertheless, the specificity of their datasets does not allow to identify other important predictors of crime at individual level. This chapter explores the impact of income inequality on victimization in Ecuador and to what extent the personal characteristics and income of victims matter for this relationship.

According to the economics of crime literature, individuals decide to commit criminal acts depending on the difference between expected returns of legal *versus* illegal activities (Becker, 1968; Ehrlich, 1973). This decision is influenced by the probability of apprehension and the severity of punishment (Becker, 1968); or the time allocated to either legal or illegal activities (Ehrlich, 1973). On the basis of this cost-benefit analysis, income inequalities raise the gap between the return from illegal activities such as property crimes and the return from legal activities for low-income individuals that are placed in proximity with high-income individuals. This relationship between the income distribution and property crime was formalized by Chiu and Madden (1998). They define social classes depending on the quality of housing and the income level. In the model, at the equilibrium, the poorest individuals decide to burglar high-quality housing owned by the richest individuals. A rise in income inequalities leads to more crime because high-quality housing becomes even more attractive to burgle. However, the relationship between income inequality and crime in a given neighborhood can be non-linear. Assuming that rich individuals can protect themselves against burglary by installing an expensive and effective technology against crime, the level of crime falls in rich neighborhoods and rises in poor ones.

The sociological literature also provides explanations for both property and violent crimes. According to Merton's (1938) strain theory, the society considers success as a goal for the entire population but the social structures restrict the access and opportunities to certain groups of population (predominantly located at the bottom of those structures). Unsuccessful individuals are frustrated and commit crime in response to discriminatory social structures, *whatever the net return to crime*. Importantly, the frustration for those individuals is exacerbated when they are confronted with the success of others around them (and therefore the level of inequality), which in turn could lead them to commit violent crime. The social disorganization theory also contributes to explain why inequalities can rise crime. According to Shaw and McKay (1942), structural disadvantages in neighborhoods (e.g. poverty, ethnic heterogeneity or residential mobility) weaken community cohesion by limiting informal social networks and the ability of the community to exercise informal social control over the activities that occur within its boundaries. This leads to more crimes by reducing the social cost of crime.

These predictions about the positive influence of inequality on crime have been broadly confronted with the data.<sup>65</sup> At the international level, Fajnzylber *et al.* (2002) perform GMM estimates on

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<sup>65</sup> Section 2.3.4 in Chapter 2 surveys the empirical studies on this topic.

homicide and robbery rates to account for criminal inertia. At the U.S. county level, [Kelly \(2000\)](#) applies Poisson estimates on property and violent crime rates, in a cross-section analysis; while [Brush \(2007\)](#) compares the results of cross-section and time-series analyses on serious crime rates. In Mexican municipalities, [Enamorado et al. \(2016\)](#) estimate the influence of income inequality on drug-related homicide rates through 2SLS. In South African police precincts, [Demombynes and Özler \(2005\)](#) apply Negative Binomial estimates on property and violent crime rates. These studies show a positive effect of inequality on property ([Demombynes and Özler, 2005](#); [Fajnzylber et al., 2002](#); [Rufrancos et al., 2013](#)) and violent crime rates ([Brush, 2007](#); [Enamorado et al., 2016](#); [Fajnzylber et al., 2002](#); [Kelly, 2000](#)). Although they have been improved by considering local determinants of crime, these studies suffer significant limitations due to the use of aggregate data from criminal police reports.

The first limitation is that aggregate data does not enable to control for the personal characteristics of victims. This is an important problem as far as the above theories make different predictions regarding the income status of potential victims. [Chiu and Madden \(1998\)](#) suggest that criminals prefer to target high-income people. Those potential victims have therefore more incentives to install private security devices which protect their properties ([Chiu and Madden, 1998](#); [Decreuse et al., 2018](#); [Shavell, 1991](#)). In consequence, crime decreases in rich neighborhoods and increases in poor neighborhoods ([Chiu and Madden, 1998](#); [Decreuse et al., 2018](#)). In addition, the Ecuadorian context urges to take into account not only the income level of victims but also other personal characteristics such as the gender and the ethnic group. Historically, the women and ethnic minorities have been affected by discrimination and violence. In Ecuador, 37% of people suffer discrimination ([Senplades, 2013a](#)). Women predominantly suffer labor discrimination, gender violence and sexual violence.<sup>66</sup> The groups of indigenous, afroecuadorians and montubios have lower access to education, labor, health and basic services than mestizos and whites ([Senplades, 2013a](#)). Consequently, these people might be more inclined to engage in criminal activities, but also more victimized themselves. In order to control for these personal characteristics of victims, one has to rely on victimization surveys to estimate the risk of crime at the individual or household level. To our knowledge, there are few existing papers using victimization data. [Levitt \(1999\)](#) uses the U.S. National Crime Victimization Survey to determine the potential victims of crime depending on their income status and skin color. [Gaviria and Vélez \(2001\)](#) use the Social Survey of Fedesarrollo to analyze the distribution of crime across victims in Colombia. [Di Tella et al. \(2010\)](#) use a victimization survey collected in Buenos Aires (Argentina) to identify the distribution of crime across income groups. [Hémet \(2013\)](#) uses the French Victimization Survey to recognize the determinants of victimization at the neighborhood level. Nevertheless, none of these studies analyze the effect of income inequality on victimization.

The second limitation is the underreporting issue of police criminal statistics. Since victims do not report all offenses to the police, the reported number of crimes is probably much lower than the actual number of crimes. It is crucial to address this underreporting issue when estimating the influence of inequality on crime because inequality is related with poverty. Indeed, more unequal areas are often associated with a higher poverty rate, and one can expect the rate of reporting crimes to be lower among poor individuals. Consequently, the underreporting bias associated with police data could be more severe in poor and unequal areas. Because the studies above estimate the effect of inequality using crime reports from police, their results might lack of precision.<sup>67</sup>

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<sup>66</sup> Sixty percent of women have been confronted with gender violence while 25 percent have suffered sexual violence in their lifetime ([INEC, 2012](#)).

<sup>67</sup> Two exceptions are [Demombynes and Özler \(2005\)](#) and [Enamorado et al. \(2016\)](#). [Demombynes and Özler \(2005\)](#) use information of the Victimization of Crime Survey of South Africa to obtain adjusted crime statistics. [Enamorado et al. \(2016\)](#) use reports of homicides. Given the severity of such criminal act, the underreporting bias should be limited.

The present chapter aims to alleviate these limitations by using the Ecuadorian Victimization and Perception of Insecurity Survey 2011 (ENVIPI-2011). Specifically, we investigate two main hypotheses regarding the influence of income inequalities on crime. First, higher income inequality raises the probability of victimization in Ecuador, *whatever the type of crime*. Second and regarding property crimes, high-income people are more victimized unless they are so rich that they can protect themselves by investing in private protection devices.

To test these hypotheses, we build a complete database combining information from the victimization survey, household survey and population census in Ecuador. The Victimization Survey provides data on the types of crime as well as the social, economic and demographic characteristics of people living in 177 cantons. For statistical purposes, ENVIPI-2011 collects information on victims living in urban areas of the 177 cantons populated by more than 2,000 inhabitants. Data on the income Gini index at the cantonal level comes from the National Survey of Employment-Unemployment 2011 (ENEMDU-2011). To complete the dataset, the National Population Census (CPV) provides information at the canton level such as the proportion of young men and the proportion of ethnic minorities.

Our contribution is fourfold. This chapter offers the first estimation of the effect of income inequality on the probability of victimization in Ecuador. By relying on a victimization survey, our estimates are less concerned with the underreporting bias because the victims tend to declare more felonies in surveys. We also enrich the existing literature by taking into account the personal characteristics of the victims such as gender, ethnicity, age, schooling and the average income of victims. Finally, our methodological approach also controls for the local characteristics at the canton and within canton levels. This local information contributes to explain the level of criminality according to the social disorganization theory.

The main result regarding the inequality - victimization relationship (first hypothesis) is that the income Gini has no significant effect on victimization against the households but a negative effect on victimization against individuals, related to robbery. One intuition behind this result could be related to the spatial segregation associated with income inequalities. If high inequality triggers residential segregation, the interaction between rich and poor people becomes less frequent. The opportunities to steal rich people become scarce and potential victims are more difficult to reach, thereby reducing crime. Another explanation could be related to the relationship between income inequality and social control. Strong social interactions in small places may also reduce the risk of robbery because of stronger social control (Buonanno *et al.*, 2011). In Ecuador, this is a potential explanation because the cantons with highest inequality are characterized by a low population density and a large proportion of ethnic groups with strong social interactions. Therefore, the higher inequality in these cantons could reduce the probability of victimization by robbery because of stronger social sanctions. Regarding the influence of income on victimization (second hypothesis), findings show an increasing and concave relationship between the household income and victimization against the household (by vehicle theft). This result is consistent with the predictions of the economics of crime literature (Chiu and Madden, 1998; Decreuse *et al.*, 2018). Specifically, the probability of victimization by vehicle theft increases with a monthly household income up to \$5,100, then it falls. Finally, we identify other individual factors that influence the probability of victimization. For example, men are more likely confronted to victimization by vehicle theft, robbery and violence than women. Indigenous and afroecuadorians are more at risk of violent victimization than mestizos, probably related to ethnic discrimination. Conversely, afroecuadorians suffer lower victimization by robbery than mestizos. Criminals might anticipate that afroecuadorians are less wealthy than mestizos, which decreases their expected return of crime.

The remainder of the chapter is organized as follows. Section 3.2 presents some stylized facts of victimization and inequality in Ecuador. Section 3.3 describes the econometric application. Section

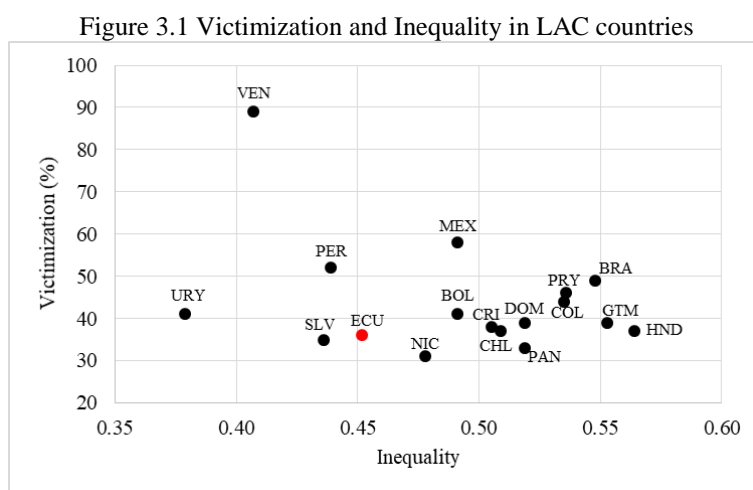


3.4 presents and discusses the results while Section 3.5 includes some robustness checks. Section 3.6 concludes.

## 3.2. INCOME INEQUALITY AND VICTIMIZATION IN ECUADOR

In the 1997-2014 period, the income inequality (measured by the Gini coefficient) in Latin America fell by only four points.<sup>68</sup> Conversely, the victimization rate in LAC countries has widely varied over time.<sup>69</sup> In the 1997-2015 period, the victimization rate of Venezuela and Uruguay have increased by 41 and 16% points, respectively. By contrast, it has decreased in some countries. The largest declines happened in Nicaragua and El Salvador, by 10% points. Ecuador is among these countries that experienced a decline in both economic inequalities (-10.7 points) and the victimization level (-9% points).

Today, Ecuador has one of the lowest victimization rates in the region. In fact, Venezuela is 2.5 times more dangerous than Ecuador. Ecuador also enjoys one of the lowest inequality level among LAC countries (Figure 3.1).



Source: ECLAC. Author's elaboration

In the following, Section 3.2.1 describes the procedure of data collection regarding crime victimization. Section 3.2.2 explains how we collect data on income inequalities in Ecuador.

### 3.2.1. VICTIMIZATION DATA

To analyze the criminal activities in Latin American countries, most studies use data on victimization from the Latinobarometer database.<sup>70</sup> Unfortunately, this database does not collect information by type of crime. Moreover, the number of respondents is limited to 1,200 for each country, and the geographic coverage is limited to the principal cities.<sup>71</sup> These restrictions leads to rely on another information source, namely the Victimization and Perception of Insecurity Survey 2011 (ENVIPI-2011) designed by the Ecuadorian National Institute of Statistics and Census (INEC). ENVIPI-2011 collects information of 117,737 households where only one person (aged

<sup>68</sup> Data available at ECLAC website <http://estadisticas.cepal.org>.

<sup>69</sup> Idem.

<sup>70</sup> Latinobarometer is a public perception survey conducted every two years in 17 countries of Latin America. Regarding crime data, it asks three questions about security perception, two questions about drugs use and one question about victimization. Specifically, the question of victimization is: "Have you or a relative been assaulted, attacked, or the victim of a crime in the last 12 months?"

<sup>71</sup> In Ecuador, respondents come from 67 cantons.

16 years and older) is randomly chosen to answer the questions on victimization and insecurity perception.<sup>72</sup>

The survey is organized in different modules. The household module collects information regarding the characteristics of all residents (gender, age, education, occupation, ethnicity, average monthly income). Then, the informant module asks the randomly chosen respondent whether he/she was victimized during the past year (year 2010) and whether the offenses were perpetrated in his/her canton of residence. According to this survey, 18.85% of the population was victimized in the past year and 83.7% of them declared that those offenses happened in their own canton.

The informant module takes into account various types of crimes (see [Appendix 3.A](#) for the definitions of crimes). The classification of crimes depends on whether the offenses were perpetrated against the household or against the individual. Crimes against households (burglary, vehicle theft and vehicle accessory theft) all consist in property crimes that are related to economic incentives. Alternatively, crimes against individuals consists in robbery against persons, fraud and violence (threat/intimidation, physical violence, kidnapping, others). [Table 3.1](#) provides statistics about the types of victims and crimes. Regarding households, 3.76% of families suffered burglary but the number of occurrences represents more than half of crimes against households. The proportion of households that suffered vehicle accessory thefts is 2.64% (it means that 10.11% of households owning a vehicle experienced accessory thefts). These crimes represent 39% of crime events against households. Looking at crimes against individuals, 10.32% of individuals declared that they have been, at least once, victim of robbery. The proportion of individuals victimized for other types of crime is lower than 3%. Unsurprisingly, the large majority (78%) of crimes toward individuals consisted in robberies, followed by acts of threat/intimidation. In what follows, the crimes against individuals will only account for robbery and violence (threat/intimidation, physical violence, kidnapping and others) in order to compare our results with the existing empirical studies.

Table 3.1 Victimization by type of victims and crimes

Victims	Crimes	Disaggregation	Percentage	N° occurrences	
Against the household	Burglary	Burglary	3.76%	4432	
	Vehicle Theft	Vehicle Theft	0.37%	438	
		Vehicle accessories Theft	2.64%	3109	
Against individuals	Robbery	Robbery	10.32%	12150	
	Violence	Fraud	Fraud	1.88%	2219
		Threat/Intimidation		2.05%	2414
		Physical Violence		0.46%	539
		Kidnapping		0.08%	97
		Others		0.3%	359

Source: INEC, ENVUPI-2011. Total 117,737 observations

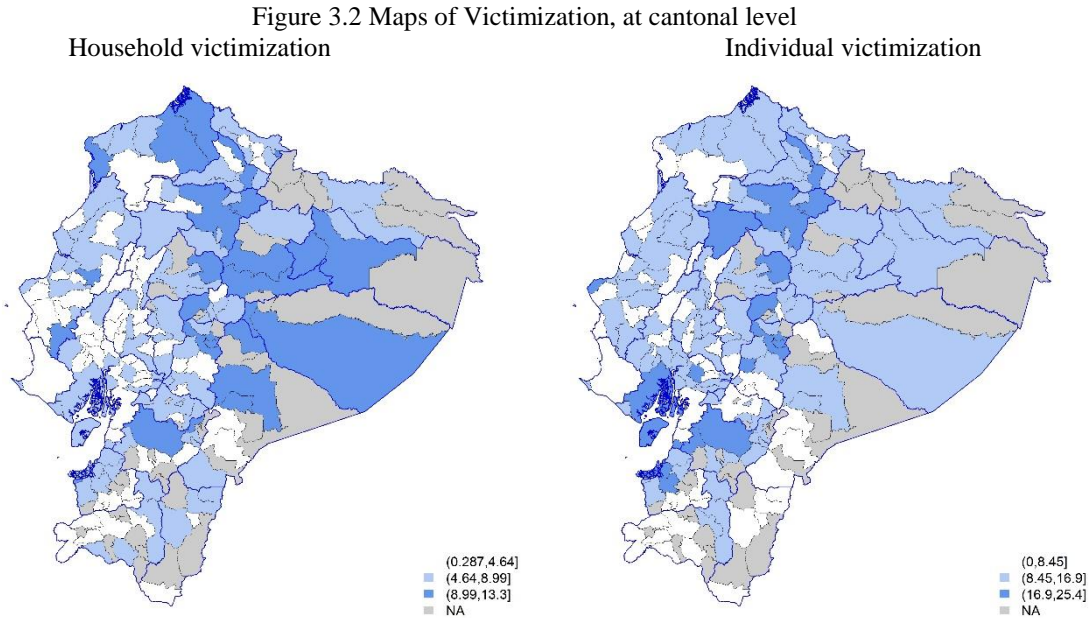
Another important conclusion from [Table 3.1](#) is that a person or household could have been victimized several times in the year. The ENVUPI database reveals that 16,199 individuals and 7,659 households were victimized in the past year. Among them, 1,277 individuals and 292 households were victimized in more than one occasion. For simplicity, in what follows, we will focus on the number of people victimized, at least once, expressed as percentage of the specified population.<sup>73</sup>

<sup>72</sup> The precise methodology is described in “Metodología de la Encuesta de Victimización y Percepción de Inseguridad - 2011” (INEC, 2013), available on the website [www.ecuadorencifras.gob.ec/estadisticas](http://www.ecuadorencifras.gob.ec/estadisticas).

<sup>73</sup> This measure is also called the prevalence rate. An alternative strategy would consist in analyzing the incidence rate, defined as the number of total crimes over the population, per 100,000 inhabitants.



Figure 3.2 plots the victimization rate of households and individuals at the cantonal level. The highest proportion of *households* victimized are located in the North-Andean and the North-Central Amazon regions. In the cantons San Pedro de Huaca, Ambato, Ibarra and Morona, on average, more than 13% of households have been victimized by either burglary or vehicle theft. By contrast, the highest proportion of *individuals* victimized reside in the Central-South Coast and the Andes regions. In the cantons Ambato, Pallatanga, Quito and Ibarra, on average, more than 21% of individuals have been victimized by either robbery or violence.



Source: INEC, ENVIPI-2011. Author's elaboration

### 3.2.2. INEQUALITY AND HOUSEHOLD INCOME

#### *Income Inequality in cantons*

There are several measures to calculate the dispersion of the income distribution such as the Gini index, the Theil index, the Atkinson index, the 90/10 income ratio, etc. The most common is the Gini coefficient. This variable is used in 10 out of 17 time-series studies of the inequality-crime relationship (Rufancos *et al.*, 2013). In order to ensure the comparability of our results with existing studies, we use the Gini coefficient as variable of inequality.

The National Survey of Employment-Unemployment 2011 (ENEMDU-2011) provides data to build the income Gini at cantonal level in Ecuador.<sup>74</sup> ENEMDU-2011 collects data on the revenues (wages, rents, assets, remittances, retirement pensions and state pensions) and the status of individuals on the labor market. This information serves to calculate the average income per person in cantons and, subsequently, the Gini index in canton  $c$  as defined in eq. (3.1):

$$Gini_c = \frac{1}{n} (n + 1 - 2 \frac{\sum_{i=1}^n (n+1-i)y_i}{\sum_{i=1}^n y_i}) \quad (3.1)$$

with the income value  $y_i$  of individuals  $i = 1, \dots, n$  living in canton  $c$ , and ( $y_i \leq y_{i+1}$ ). It measures the deviation (from equality) of the income distribution in a given canton  $c$ .

In Ecuador, the national value of Gini coefficient was 0.47 in 2011. This value varies across provinces and cantons. The provinces of Pichincha (Andes) and Santa Elena (Coast) have the

<sup>74</sup> ENEMDU provides the Gini coefficient at the province level only. We extend their dataset to calculate the Gini coefficient at the canton level. Our methodology is described in Appendix 3.B.

lowest values of inequality (around 0.4). In contrast, Bolivar and Imbabura (Andes) show the highest inequality levels (above 0.53). At cantonal level, panel (a) in [Figure 3.3](#) reveals that coastal cantons have the lowest level on income inequality (0.22) whereas the Andean and Amazon cantons are the most unequal (above 0.67). These disparities may be due to the different economic and social conditions of the regions. Historically, the Coast region has experienced various economic booms (e.g. cacao and banana) that attracted the principal economic and financial firms there. Nowadays, the Coast produces the principal non-petroleum export products (e.g. banana, cacao and shrimp) and benefits from international airports and seaports ([Senplades, 2017](#)). The Coast also enjoys good socioeconomic conditions and high agricultural wages that reduce their level of poverty and, therefore inequality ([Senplades, 2013b, 2014](#)). In contrast, the Andes and Amazon regions predominantly produce agricultural products (e.g. fruits, potatoes, legumes) destined to the internal consumption. Those regions suffer from bad socioeconomic conditions (e.g. chronic child malnutrition, child mortality, illiteracy, poverty) that reinforce their inequality levels ([Senplades, 2013b](#)). The composition of population can also explain these regional disparities. Recall that the Ecuadorian population is mostly composed of mestizos (71.3%) and ethnic minorities (21.61%). Indigenous mainly locate in the Andes and Amazon whereas afroecuadorians and montubios settle in the Coast ([Senplades, 2017](#)). All these minorities have lower access to education and health than mestizos, but the indigenous are those that experience the most severe socioeconomic deprivation e.g. informal labor activities, low wages, child malnutrition and illiteracy ([Senplades, 2014](#)).

#### *Household Income of victims*

If one considers the crime as a market, criminals and victims interact. On the one side, criminals have incentives to commit profitable crimes such as stealing high-valuable goods. [Draca et al. \(2018\)](#) estimate that increasing the relative price of a good by 10% leads to a 3.5% increase in the overall crime. On the other side, victims look to minimize the social and economic damages of crime. For example, the potential victims prefer not wearing jewels ([Di Tella et al., 2010](#); [Mejía and Restrepo, 2016](#)) or avoid walking in dark places ([Di Tella et al., 2010](#); [Gaviria and Vélez, 2001](#)) to reduce victimization. Individuals can also invest in protection devices (ex: locks or alarm for houses, hiring guards) to reduce their risk of victimization and such investments mainly result from high income individuals. Therefore, one can suspect that the income of the victim will influence the probability of victimization.

Our dataset therefore includes the monthly average income of households from ENVIPI. Panel (b) in [Figure 3.3](#) presents the average income (in USD) that the households declared in 2011, at cantonal level. On average, Ecuadorians declare to gain \$485 per month. The cantons with highest income are located throughout the Coast and the Andes regions. Very specific cantons of the Amazon region have high values of monthly income (probably related to petroleum settlements). Samborondón (Guayas) is the richest canton in the country while Palenque (Los Ríos) is the poorest.

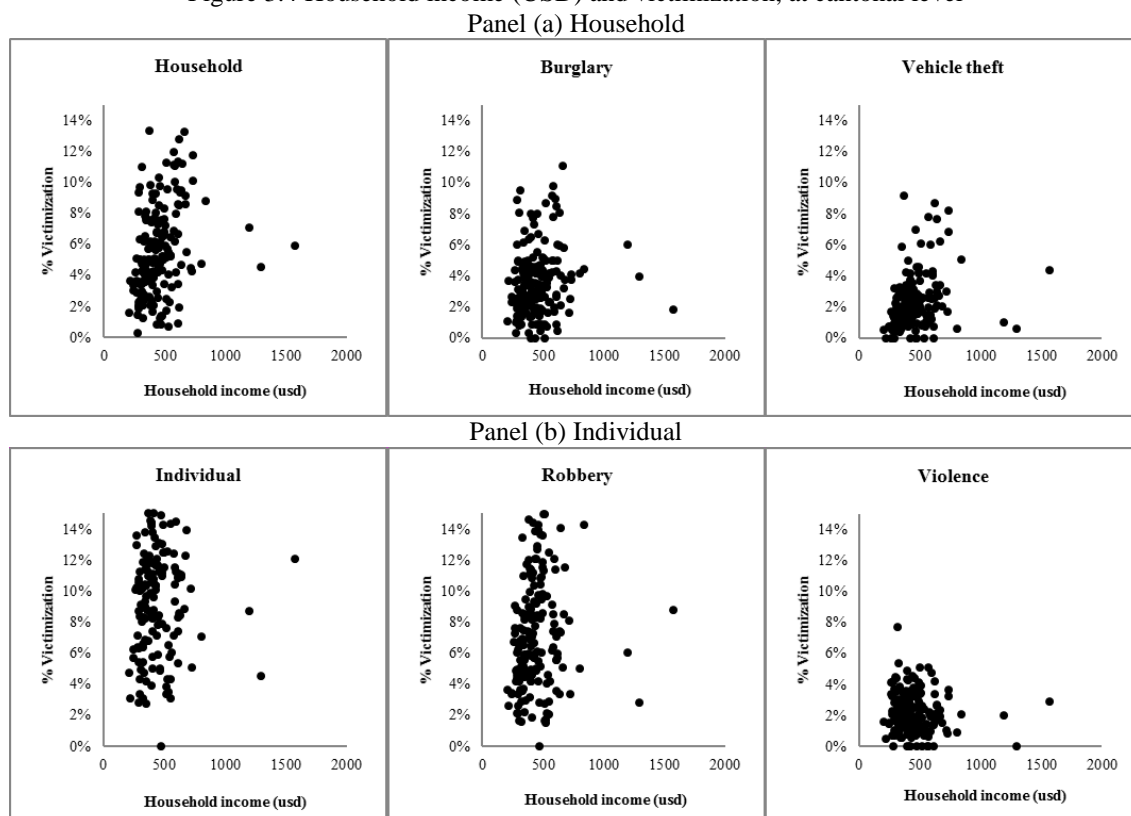
This data is a good proxy of the revenue of victims, although it can be biased downward because people do not declare their real income in surveys ([Di Tella et al., 2010](#), page 181). In general, people declare their real income when paying taxes, but we cannot access to this information. Instead, it is possible to compare the revenue collected by ENEMDU versus ENVIPI. ENEMDU asks all household members aged 5 years and older about their wages, rents, assets, remittances, retirement pensions and state pensions.<sup>75</sup> ENVIPI only asks the household-head about the average monthly household income. In the latter case, it is found that the respondent rounds the amounts of revenue. By comparing the income level from both surveys, we find that the average income is lower in ENVIPI data than according to ENEMDU data ([Appendix 3.C](#)). However and more importantly, the average income from both surveys follow similar patterns across provinces

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<sup>75</sup> ENEMDU surveys the population aged five years old and older to take into account child labor.



Figure 3.4 Household income (USD) and victimization, at cantonal level



One can expect that inequality raises the likelihood of victimization whatever the type of crime ( $\beta_1 > 0$ ), even though the mechanisms differ for property crimes (ex: return to crime) and for violent crimes (ex: frustration or weak social control). Predictions regarding the income level of the victim are captured by the coefficients  $\beta_2$  and  $\beta_3$ . The household income  $Income_h$  can be perceived as a proxy for the return to crime. One expects this variable to increase the likelihood of victimization by pecuniary-motivated crimes (burglary, vehicle theft, robbery). Nevertheless, the returns to crime might fall if rich households invest intensively in protection devices. Criminals can target poor households if rich households protect themselves (Chiu and Madden, 1998; Decreuse *et al.*, 2018) and we can expect  $Income_h^2$  to have a negative effect on victimization. Concerning violent crimes, the level of income might also raise the risk of victimization because of frustration, according to the strain theory of Merton. However, this theory does not provide predictions regarding the shape of the relationship between the income of the victim and its victimization risk, so we can expect  $\beta_3$  to be not significant.

The vector  $\mathbf{X}_k$  refers to social and demographic characteristics (besides the income) of the victim. Our dataset exploits all the personal characteristics collected by ENVIPI-2011 such as the gender, age, years of schooling and occupancy. These variables correspond to the characteristics of the household-head (respectively, characteristics of the respondent) when the victim is a household (respectively, the respondent). For crimes against households, it also includes the number of occupied people in the household. For crimes against individuals, it also comprises the ethnic characteristics (mestizo/white, indigenous, afroecuadorian or montubio) of the respondent.

The vector  $\mathbf{Y}_c$  accounts for the local determinants of crime emphasized by the urban economics literature (Verdier and Zenou, 2004; Gaigné and Zenou, 2015) and the social disorganization theory (Shaw and McKay, 1942). We rely on cantonal data from the National Population Census 2010. As mentioned in Chapter 2, the proportion of young men and the population density can be important factors of crime (Edlund *et al.*, 2013; Gaigné and Zenou, 2015; UNODC, 2013). The



proportion of ethnic minorities are especially relevant to control for ethnic segregation. In the United States, black and white people do not experience similar socioeconomic conditions (Shaw and McKay, 1942; Sampson and Wilson, 1995). Ethnic segregation differentially exposes blacks to detrimental conditions and violence in the community where they live. In the Ecuadorian case, ethnic minorities (indigenous, afroecuadorians and montubios) are still segregated and live in worse conditions than mestizos/whites. Furthermore, we follow the sociological approaches that relate deprived social conditions to criminality (Merton, 1938; Shaw and McKay, 1942) by including the proportion of households with access to basic services. Two last variables account for the geographic characteristics of cantons. We expect that the capitals of provinces have a better access to schools, hospitals, transports, courts, basic services, etc. This accessibility to institutions and public services might reduce criminality. Therefore, we introduce a dummy variable that takes the value 1 if the canton is also the capital of the province, 0 otherwise. The elevation of cantons in meters above sea level accounts for the unique location of Ecuadorian cantons regarding the Natural regions. This information is relevant to capture the influence of physical geography characteristics on the temperament of people and their behavior. The Coastal residents are often more extravert and more open to meet new people than residents of the Andean or Amazon regions. Thence, one can expect that Coastal residents are also more exposed to interpersonal conflicts than the residents in the other regions.

The final dataset comprises 98,649 observations. Appendix 3.D summarizes the description of all these variables, provides descriptive statistics and includes the correlations.

### 3.4. RESULTS

The estimations distinguish the probability of victimization against the households (Section 3.4.1) and the individuals (Section 3.4.2). The results are presented in tables containing three panels of four columns. The first panel corresponds to total victimization, while subsequent panels provide results for each type of crime separately. In each panel, Column (a) presents the effect of Gini coefficient and the average income of the household, without additional controls. Then, Column (b) only controls for personal characteristics and Column (c) only controls for the characteristics of the canton. Finally, Column (d) controls for both the personal and the cantonal characteristics. All estimations include robust standard errors clustered by canton.

#### 3.4.1. PROBIT ESTIMATES FOR VICTIMIZATION AGAINST HOUSEHOLDS

Table 3.2 reports the results of the victimization against households. In the first column, the Gini coefficient has a positive effect on the probability of victimization against the households, predominantly related to burglary. This effect is still positive and significant when controlling for the characteristics of the household-head. However, the effect of income Gini is no longer significant when controlling for the local characteristics of the canton. No significant effect is found in the case of vehicle theft as well. This result confirms the importance of controlling for crime determinants at a low spatial scale in order to evaluate the influence of inequalities on crime.

Regarding the effect of income, the probability of victimization against the households follows a concave distribution. Whatever the type of crime,  $\beta_2$  is positive and significant at 1%, suggesting that the likelihood of victimization increases with income of the households. In addition, the most important result is the concavity of this relationship in the case of vehicle theft ( $\beta_2 > 0$  and  $\beta_3 < 0$ , at the 1% level). This suggests that the probability of victimization by vehicle theft increases with the household income until it reaches \$5,100, and then falls.<sup>76</sup> This result is not surprising as 34% of households declared have reinforced housing and vehicle security using alarms, anti-theft

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<sup>76</sup> See scatterplots by types of crime in Appendix 3.E.

devices, anti-theft insurances, private guards, etc. (INEC, 2011). This result is consistent with theoretical predictions about the falling returns to crime that delinquents find when stealing rich households (Chiu and Madden, 1998; Decreuse *et al.*, 2018).

In Column (b), we introduce additional characteristics of the household-head to identify which characteristics of the victims are more attractive to criminals. Regarding the gender, the sign of the estimated coefficient changes according to the type of crime. Male-headed households are less likely victimized by burglary but more victimized by vehicle theft, compared to female-headed households. A possible explanation for the negative effect of gender on burglary is that criminals might anticipate a high risk of physical confrontation with male household heads. In the case of vehicle theft, the intuition stands on the higher proportion of men owning a car compared to women. In Ecuador, 75% of households are headed by men and 87% of these households own a vehicle.<sup>77</sup> The coefficients associated to the household head's education level and occupancy are significant and positive. The literature suggests that individuals with higher education levels and occupation in the labor market enjoy better opportunities to get well-paid jobs (Machin *et al.*, 2011). Therefore, it can be assumed that highly educated and occupied individuals could afford to improve the quality of their housing and vehicle. If criminals choose their targets based on the quality of housing and vehicles (Chiu and Madden, 1998), the probability of household victimization grows up with the share of highly educated and occupied household-heads.

The coefficient estimates of cantonal variables capture the local determinants of crime. The probability of victimization by burglary increases with the proportion of young men. Young people tend to participate more in criminal activities (Levitt and Lochner, 2001), and have lower skills and experience than adults (Machin *et al.*, 2011). Men also commit more criminal activities than women (UNODC, 2013). Those facts elucidate the higher risk of victimization in cantons with more young men, who predominantly find incentives to participate in burglary. The variables of ethnic minorities suggest that cantons principally populated by indigenous are more at risk of victimization by burglary and vehicle theft than cantons populated by mestizos. This result is in line with the predictions of sociological theories. Ethnic minorities grow up in detrimental conditions that exacerbate social disorganization and crime (Blau and Blau, 1982; Sampson and Wilson, 1995; Shaw and McKay, 1942).

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<sup>77</sup> Statistics from the ENEMDU-2011 survey.

Table 3.2 Estimates of Victimization against the households

	Panel 1: Household				Panel 2: Burglary				Panel 3: Vehicle Theft			
	1a	1b	1c	1d	2 <sup>a</sup>	2b	2c	2d	3 <sup>a</sup>	3b	3c	3d
Gini <sub>c</sub>	0.70*** (0.26)	0.63** (0.26)	0.19 (0.22)	0.16 (0.23)	0.67*** (0.25)	0.64*** (0.25)	0.34 (0.23)	0.33 (0.23)	0.61 (0.43)	0.51 (0.43)	-0.05 (0.28)	-0.10 (0.30)
Income <sub>h</sub>	0.43*** (0.04)	0.29** (0.03)	0.38*** (0.03)	0.26*** (0.03)	0.09*** (0.02)	0.08*** (0.03)	0.08*** (0.02)	0.07*** (0.03)	0.71*** (0.05)	0.44*** (0.05)	0.62*** (0.04)	0.38*** (0.04)
Income <sub>h</sub> <sup>2</sup>	-0.04*** (0.01)	-0.02*** (0.01)	-0.03*** (0.01)	-0.02*** (0.00)	-0.01 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.08*** (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.04*** (0.01)
Gender <sub>h</sub>		0.04* (0.02)		0.05** (0.02)		-0.08*** (0.02)		-0.07*** (0.02)		0.26*** (0.03)		0.27*** (0.03)
Age <sub>h</sub>		-0.00 (0.00)		0.00 (0.00)		0.00 (0.00)		0.00 (0.00)		-0.00 (0.00)		-0.00* (0.00)
Schooling <sub>h</sub>		0.02*** (0.00)		0.02*** (0.00)		0.00** (0.00)		0.00** (0.00)		0.04*** (0.00)		0.04*** (0.00)
Occupancy <sub>h</sub>		0.05* (0.02)		0.06** (0.02)		0.10*** (0.03)		0.10*** (0.03)		-0.04 (0.03)		-0.02 (0.03)
N° occupied <sub>h</sub>		0.01* (0.01)		0.01 (0.01)		-0.02** (0.01)		-0.02** (0.01)		0.07*** (0.01)		0.07*** (0.01)
Young_men <sub>c</sub>			3.28* (1.93)	3.32* (1.97)			4.88*** (1.62)	4.87*** (1.61)			-0.07 (2.78)	-0.15 (2.87)
Density <sub>c</sub>			0.02 (0.02)	0.01 (0.02)			0.00 (0.02)	0.00 (0.02)			0.02 (0.06)	0.01 (0.06)
Indigenous <sub>c</sub>			0.31*** (0.11)	0.29*** (0.11)			0.42*** (0.12)	0.42*** (0.12)			0.13 (0.12)	0.11 (0.13)
Afroecuadorian <sub>c</sub>			0.31 (0.23)	0.31 (0.24)			0.31 (0.23)	0.31 (0.233)			0.16 (0.19)	0.18 (0.21)
Montubio <sub>c</sub>			-0.11 (0.16)	-0.12 (0.16)			-0.26 (0.18)	-0.26 (0.18)			0.10 (0.18)	0.07 (0.18)
Basic_services <sub>c</sub>			0.09 (0.11)	0.07 (0.11)			0.02 (0.12)	0.02 (0.12)			0.15 (0.14)	0.14 (0.14)
Capital <sub>c</sub>			0.06 (0.05)	0.04 (0.05)			0.00 (0.05)	-0.00 (0.05)			0.13** (0.06)	0.11** (0.06)
Elevation <sub>c</sub>			0.37** (0.17)	0.36** (0.17)			-0.44** (0.20)	-0.44** (0.20)			1.24*** (0.26)	1.24*** (0.25)
Constant	-2.03*** (0.12)	-2.26*** (0.13)	-2.55*** (0.39)	-2.79*** (0.40)	-2.11*** (0.11)	-2.14*** (0.12)	-2.90*** (0.35)	-2.95*** (0.36)	-2.53*** (0.19)	-3.06*** (0.21)	-2.50*** (0.53)	-2.99*** (0.55)
Pseudo R <sup>2</sup>	0.0222	0.0276	0.0296	0.0342	0.0026	0.0040	0.0077	0.009	0.0631	0.0865	0.0836	0.1044
Bic	46591.39	46355.79	46330.5	46133.5	31773.61	31753.16	31702.5	31686.6	24793.44	24220.36	24344.4	23838.8
N° Observ.	98771	98649	98771	98649	98771	98649	98771	98649	98771	98649	98771	98649

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Income<sub>h</sub> is expressed in \$1,000. Density<sub>c</sub> is expressed per 1,000 inhab. Elevation<sub>c</sub> is expressed per 10,000 meters above sea level.

### 3.4.2. PROBIT ESTIMATES FOR VICTIMIZATION AGAINST INDIVIDUALS

Table 3.3 presents the results of victimization against individuals. In Columns (a) and (b), the Gini coefficient does not exert any significant effect on victimization against the individuals, related to robbery or violence. However, when controlling for the characteristics of the canton (Columns c and d), the coefficient  $\beta_1$  becomes negative and significant at the 10% level. Estimations by type of crime reveal that this result comes from victimization by robbery ( $\beta_1$  significant at the 5% level).

One intuition behind this result could be related to the spatial segregation associated with income inequalities. If high inequality triggers residential segregation, the interaction between rich and poor people becomes less frequent. Let suppose that criminals are poor individuals who search for pecuniary returns. When segregation is reinforced, the opportunities to steal rich people become scarce because the group of potential victims is more difficult to reach. One can also expect the presence of security forces to be concentrated in rich neighborhoods, which increases the risk of apprehension. Both effects should discourage criminal activities. In other words, higher inequality

in cantons might reduce the probability of victimization by robbery because of residential segregation.

The sociological approach provides another potential explanation for the negative effect of inequality on victimization by robbery through the concept of social sanction. According to [Buonanno et al. \(2011\)](#), delinquents are afraid that relatives learn about their illegal activities and stigmatize them as criminals. In small geographic areas (e.g. towns, communities, neighborhoods), the social interactions between residents are denser. In large geographic areas (e.g. cities), individuals interact with relatives whereas there are few interactions with the other residents of the area. As consequence, criminals may prefer to operate in large areas where the probability of recognition by relatives is weakened. [Buonanno et al. \(2011\)](#) find that a 1% increase in population living in Italian towns (less than 2,000 inhabitants) would reduce robbery by at least 1.93%. In Ecuador as well, the social sanction might influence the relationship between inequality and victimization. The cantons with highest Gini indexes (above 0.60) are Celica, Paltas, Calvas, Zapotillo, Espejo (Andes); Sucua, Tena, Pastaza (Amazon); Montalvo and Buena Fe (Coast). Those cantons are small geographic areas<sup>78</sup> not density populated (10-115 inhabitants/km<sup>2</sup>). In addition, they are largely populated by ethnic groups. One third of the population in these Amazon and Coastal cantons are indigenous and montubios. The large presence of ethnic minorities is especially relevant because those groups tend to establish strong intra-ethnic relationships to preserve their cultural heritage (e.g. language, clothing and traditions). Consequently, one can expect that social interactions and, therefore, the effect of social sanction will be stronger in those cantons, thereby reducing the risk of victimization.

We now turn to the analysis of the effect of the household income on the risk of victimization. Firstly, and as expected, the income of the household exerts a positive impact on the risk of victimization of individuals composing this household. Nevertheless, the effect of  $Income_h$  on the victimization by robbery is only significant at the 10% level. In line with our predictions, we provide some evidence that this relationship is concave ( $\beta_2 > 0$  and  $\beta_3 < 0$ ) when controlling for cantonal characteristics. Given the distribution of income, it suggests that the probability of individual victimization increases with a monthly household income until it reaches \$5,900, then it falls. However,  $\beta_3$  becomes not significant when we additionally control for the remaining characteristics of the victim.<sup>79</sup>

The analysis of personal characteristics of the respondent reveals that men are more likely victimized by robbery and violence than women. This result is consistent with [Anand and Santos \(2007\)](#) and [UNODC \(2013\)](#). In the United Kingdom, [Anand and Santos \(2007\)](#) conclude that men are more likely confronted to attacks/assaults than women (34% vs. 12%). United Nations also reveal statistics according to which 79% of homicide victims are men. Furthermore, the age of individuals exerts a negative influence on all types of victimization, suggesting that older people are less likely victimized than younger ones. This result is consistent with other empirical studies showing that young people are more at risk of victimization. For example, 43% of all homicide victims are young aged 15-29 ([UNODC, 2013](#)). The coefficients associated to the education and occupancy of the respondent are positive for robbery and violence. Indeed, people who commute to work or school are at greater risk of victimization because criminals may consider this pool of victims easier to approach. The information on ethnic minorities enables identifying the vulnerability of those ethnic groups compared to mestizos. With respect to violence, indigenous and afroecuadorians have a higher probability of victimization than mestizos, due to confrontation in interpersonal conflicts. The violence against minorities may arise from the discrimination ethnic

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<sup>78</sup> All those cantons, except Tena and Pastaza, have a surface area lower than 1,200 kilometers.

<sup>79</sup> We performed additional estimates to capture the effect of household income in the cantons characterized by the highest (90 percentile) and lowest (10 percentile) inequality. No significant effects were found on victimization against the households or individuals.



groups suffer. With respect to robbery, afroecuadorians are less likely victimized than mestizos. This can be due to the fact that criminals anticipate that afroecuadorians live in worse socioeconomic conditions and earn a lower income than mestizos, which decreases the expected return to crime.

Finally, the coefficients associated with cantonal variables reveal that a better access to basic services exerts a positive impact on victimization against individuals, related to robbery and violence. Regarding victimization by robbery, this effect may result from the better quality of life that residents enjoy in cantons with more access to electricity, potable water, sewerage and waste collection. Criminals have more opportunities to find wealthy victims in these cantons and obtain higher returns from robberies. The positive coefficient of the capital dummy confirms this fact since local governments usually invest more in the capitals of provinces than in the rest of cantons. Regarding victimization by violence, the positive effect of basic services can be explained by the strain theory of [Merton \(1938\)](#) and the Frustration-Aggression hypothesis of [Dollard \*et al.\* \(1939\)](#). If the access to basic services is conditioned by the neighborhood's wealth, rich neighborhoods will have better access to basic services. In consequence, the less advantaged individuals living in poor neighborhoods find incentives to commit crime in response to discriminatory social structures ([Merton, 1938](#)). These individuals become even more frustrated when they realize about the relative success of others around them. As result, frustration encourages aggressive reactions and violent crime ([Dollard \*et al.\*, 1939](#)).

Table 3.3 Estimates of Victimization against the individuals

	Panel 1: Individual				Panel 2: Robbery				Panel 3: Violence			
	1a	1b	1c	1d	2 <sup>a</sup>	2b	2c	2d	3a	3b	3c	3d
Gini <sub>c</sub>	0.00 (0.29)	-0.07 (0.29)	-0.40* (0.21)	-0.41* (0.22)	-0.07 (0.31)	-0.16 (0.30)	-0.49** (0.21)	-0.51** (0.22)	0.19 (0.22)	0.19 (0.23)	0.17 (0.21)	0.22 (0.21)
Income <sub>h</sub>	0.27*** (0.03)	0.10*** (0.02)	0.20*** (0.03)	0.05*** (0.02)	0.26*** (0.03)	0.08*** (0.02)	0.18*** (0.03)	0.03* (0.02)	0.12*** (0.03)	0.04* (0.03)	0.10*** (0.03)	0.03 (0.03)
Income <sub>h</sub> <sup>2</sup>	-0.03*** (0.01)	-0.01*** (0.00)	-0.02*** (0.00)	-0.00** (0.00)	-0.02*** (0.01)	-0.01** (0.00)	-0.02*** (0.00)	-0.00 (0.00)	-0.01*** (0.00)	-0.00 (0.00)	-0.01*** (0.00)	-0.00 (0.00)
Gender <sub>i</sub>		0.05*** (0.01)		0.05*** (0.01)		0.06*** (0.02)		0.06*** (0.02)		0.03* (0.02)		0.03* (0.02)
Age <sub>i</sub>		-0.01*** (0.00)		-0.01*** (0.00)		-0.01*** (0.00)		-0.01*** (0.00)		-0.01*** (0.00)		-0.01*** (0.00)
Schooling <sub>i</sub>		0.03*** (0.00)		0.03*** (0.00)		0.03*** (0.00)		0.03*** (0.00)		0.01*** (0.00)		0.01*** (0.00)
Occupancy <sub>i</sub>		0.14*** (0.02)		0.15*** (0.01)		0.09*** (0.02)		0.10*** (0.02)		0.16*** (0.02)		0.17*** (0.02)
Indigenous <sub>i</sub>		0.02 (0.07)		-0.01 (0.07)		-0.02 (0.06)		-0.04 (0.06)		0.12** (0.06)		0.13*** (0.05)
Afroecuadorian <sub>i</sub>		-0.04 (0.03)		-0.04 (0.03)		-0.09** (0.04)		-0.07** (0.03)		0.12*** (0.04)		0.07* (0.04)
Montubio <sub>i</sub>		-0.07** (0.03)		0.04* (0.02)		-0.11*** (0.04)		0.01 (0.02)		0.06 (0.04)		0.05 (0.04)
Young_men <sub>c</sub>			0.29 (1.72)	-0.05 (1.80)			-0.10 (1.75)	-0.51 (1.84)			-0.58 (1.93)	-0.77 (1.98)
Density <sub>c</sub>			0.05 (0.04)	0.05 (0.04)			0.07 (0.05)	0.07 (0.04)			0.01 (0.04)	0.00 (0.03)
Indigenous <sub>c</sub>			0.04 (0.12)	0.02 (0.12)			-0.04 (0.12)	-0.03 (0.13)			0.09 (0.14)	0.01 (0.13)
Afroecuadoria <sub>c</sub>			0.10 (0.11)	0.14 (0.11)			-0.09 (0.09)	-0.02 (0.10)			0.37* (0.19)	0.29 (0.20)
Montubio <sub>c</sub>			0.01 (0.15)	-0.01 (0.14)			-0.10 (0.15)	-0.13 (0.14)			0.29** (0.15)	0.28* (0.15)
Basic_services <sub>c</sub>			0.46*** (0.12)	0.45*** (0.11)			0.48*** (0.12)	0.47*** (0.12)			0.40*** (0.13)	0.41*** (0.13)
Capital <sub>c</sub>			0.11** (0.05)	0.08* (0.05)			0.13*** (0.05)	0.11** (0.05)			-0.02 (0.06)	-0.04 (0.06)
Elevation <sub>c</sub>			0.07 (0.19)	0.15 (0.19)			-0.01 (0.21)	0.07 (0.21)			-0.17 (0.23)	-0.12 (0.23)
Constant	-1.20*** (0.13)	-1.17*** (0.13)	-1.32*** (0.36)	-1.21*** (0.37)	-1.34*** (0.14)	-1.28*** (0.14)	-1.36*** (0.37)	-1.22*** (0.38)	-2.06*** (0.10)	-1.96*** (0.10)	-2.14*** (0.38)	-1.99*** (0.39)
Pseudo R <sup>2</sup>	0.0061	0.0337	0.0176	0.0438	0.0060	0.0371	0.0210	0.0499	0.0013	0.0186	0.0049	0.0217
Bic	79731.09	77336.37	78904	76625	66309.28	64116.04	65402	63356	24783.28	24341.35	24786	24355
N° Observ.	98771	98318	98771	98318	98771	98318	98771	98318	98771	98318	98771	98318

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Income<sub>h</sub> is expressed in \$1,000. Density<sub>c</sub> is expressed per 1,000 inhab. Elevation<sub>c</sub> is expressed per 10,000 meters above sea level.

### 3.5. ROBUSTNESS CHECK

This section undertakes additional estimates to test the robustness of the main results presented above. In Section 3.5.1, we estimate the model by controlling for crime determinants at a lower spatial scale within the canton. In Section 3.5.2, we take into account the possible non-linear impact of income inequality on victimization.

#### 3.5.1. THE IMPORTANCE OF ZONE (E.G. WITHIN CANTON) CHARACTERISTICS

The estimates of the household victimization (Table 3.2) lead us to conclude that the Gini coefficient at the canton level loses significance when we control for other characteristics of the

canton. In contrast, the effect of household income on victimization against households or individuals remains significant for most types of crime when we control for individual and cantonal variables. One might object that it is also important to control for characteristics at a lower spatial scale. Despite the significance of cantonal variables, one main concern is whether they capture appropriately the local heterogeneity. In line with ecological theories of crime, the characteristics of the neighborhood matter a lot for the strength of social control, and therefore crime. In this robustness check, we include a set of control variables at the within-canton level to test whether the average income and income inequality variables remain significant once we control for local characteristics.

For statistical purposes, INEC collects census data of households at the *zone* level (geographic areas smaller than parishes). The zones are a proxy of neighborhoods and contain approximately 1,960 households, each one. Our dataset uses information of 1,917 zones in 177 cantons, which correspond to the residence of the ENVIPI's respondent. This robustness estimates replaces the set of cantonal variables  $Y_c$  from equation (3.2) by a set of zone variables  $Y_z$ .<sup>80</sup> The zone variables include the proportion of young men in the zone, the proportion of indigenous, afroecuadorians and montubios in the zones, and the proportion of households with access to basic services in the zone. These variables aim to capture the factors that trigger social disorganization, such as ethnic heterogeneity and disadvantaged living conditions at the local level.

Results are presented in [Table 3.4](#). Panels (1) - (3) present the results of victimization against the households and Panels (4) - (6) refer to victimization against individuals. Columns (a) only control for zone characteristics. Columns (b) control for both the personal and zone characteristics.

We first comment results regarding the influence of income inequalities on crime. Regarding victimization against households, recall that the Gini coefficient exerts a significant and positive effect (predominantly related to burglary) when we do not control for local characteristics (Column a). One would expect the significance of this coefficient to decrease when controlling with the zone variables (Column b). However, this is not the case, the Gini coefficient remains positive and its value is almost the same regarding the victimization by burglary. When it comes to victimization against individuals, the Gini coefficient also remains significant, with a negative sign significant at 10% due to victimization by robbery. As in our baseline regression, no significant effects are found in the case of vehicle theft and violence.

Then, we comment results regarding the influence of the level of income on the probability of victimization. As in the baseline regression, the relationship between victimization and household income is concave in the cases of household victimization, individual victimization and vehicle theft; and linear in the case of burglary. We can therefore conclude that this result is robust.

At the end, we comment results on the control variables at the zone level. Estimates indicate that the zones with a higher proportion of young men have a higher probability of victimization by burglary, as in the baseline regression. The coefficients associated with ethnic minorities reveal that zones principally populated by afroecuadorians are more at risk of victimization by burglary and violence than zones populated by mestizos. This result is in line with the predictions of sociological theories. Ethnic minorities live in deprived socioeconomic conditions that engender social disorganization and reinforce a subculture of delinquency and violence ([Blau and Blau, 1982](#); [Sampson and Wilson, 1995](#); [Shaw and McKay, 1942](#)). In contrast and what is very interesting, the zones with a high proportion of montubios are less at risk of victimization by pecuniary crimes (e.g. burglary, vehicle theft and robbery) than the zones populated by mestizos. One explanation is that pecuniary-motivated delinquents do not find wealthy victims in their own

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<sup>80</sup> Note that we cannot include control variables at both the canton and zone level simultaneously because they are highly correlated.

neighborhoods because the zones populated by montubios have extremely high poverty rates (above 97%). This might incentive pecuniary criminals to operate in other less deprived zones. Finally, the zones with better access to basic services have a higher risk of victimization by property and violent crimes, as in the baseline regression.

Table 3.4 Estimates of Victimization controlling by the zone characteristics

	Victimization against households						Victimization against individuals					
	Panel 1: Household		Panel 2: Burglary		Panel 3: Vehicle		Panel 4: Individual		Panel 5: Robbery		Panel 6: Violence	
	1a	1b	2a	2b	3a	3b	4 <sup>a</sup>	4b	5a	5b	6a	6b
Gini <sub>c</sub>	0.37* (0.22)	0.34 (0.23)	0.46* (0.24)	0.44* (0.24)	0.2 (0.34)	0.15 (0.35)	-0.34 (0.23)	-0.36 (0.24)	-0.44* (0.24)	-0.47* (0.24)	0.07 (0.21)	0.10 (0.22)
Income <sub>h</sub>	0.38*** (0.03)	0.27*** (0.03)	0.09*** (0.02)	0.07*** (0.03)	0.62*** (0.04)	0.38*** (0.04)	0.21*** (0.03)	0.06*** (0.02)	0.19*** (0.03)	0.04* (0.02)	0.10*** (0.03)	0.03 (0.03)
Income <sub>h</sub> <sup>2</sup>	-0.03*** (0.01)	-0.02*** (0.00)	-0.01 (0.00)	-0.00 (0.00)	-0.07*** (0.01)	-0.04*** (0.01)	-0.02*** (0.00)	-0.01** (0.00)	-0.02*** (0.00)	-0.00 (0.00)	-0.01*** (0.00)	-0.00 (0.00)
Young_men <sub>z</sub>	0.56 (0.58)	0.58 (0.59)	1.46*** (0.50)	1.46*** (0.50)	-0.61 (0.87)	-0.65 (0.90)	-0.43 (0.53)	-0.66 (0.54)	-0.61 (0.53)	-0.86 (0.53)	-0.52 (0.63)	-0.73 (0.65)
Indigenous <sub>z</sub>	0.16 (0.18)	0.20 (0.17)	0.24 (0.23)	0.26 (0.23)	-0.02 (0.18)	0.02 (0.19)	0.10 (0.17)	0.22 (0.20)	-0.05 (0.15)	0.09 (0.18)	0.14 (0.23)	0.03 (0.25)
Afroecuadorian <sub>z</sub>	0.11 (0.18)	0.11 (0.18)	0.31** (0.15)	0.31** (0.15)	-0.32 (0.20)	-0.31 (0.21)	0.05 (0.07)	0.05 (0.07)	-0.11 (0.11)	-0.09 (0.11)	0.38*** (0.11)	0.30** (0.13)
Montubio <sub>z</sub>	-0.51*** (0.17)	-0.52*** (0.16)	-0.45*** (0.17)	-0.45*** (0.17)	-0.50* (0.26)	-0.55** (0.26)	-0.28* (0.15)	-0.32** (0.15)	-0.45*** (0.15)	-0.50*** (0.15)	0.24 (0.15)	0.22 (0.16)
Basic_services <sub>z</sub>	0.11 (0.18)	0.11 (0.18)	0.31** (0.15)	0.31** (0.15)	-0.32 (0.20)	-0.31 (0.21)	0.33*** (0.07)	0.31*** (0.07)	0.35*** (0.07)	0.32*** (0.07)	0.20*** (0.06)	0.20*** (0.06)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Personal charac	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pseudo R <sup>2</sup>	0.0264	0.0310	0.0058	0.0071	0.0765	0.0967	0.0120	0.0387	0.0141	0.0437	0.0035	0.0203
Bic	43373.74	46168.09	31724.38	31700.16	24423.49	23928.23	79204.29	76905.2	65693.95	63637.44	65693.95	24364.64
N° Observ.	98701	98580	98701	98580	98701	98580	98701	98248	98701	98248	98701	98248

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Income<sub>h</sub> is expressed in \$1,000.

### 3.5.2. NON-LINEAR IMPACT OF INCOME INEQUALITIES

The economics literature suggests that the relationship between income inequality and crime in a given neighborhood can be non-linear. The intuition is that crime might first rise with income inequalities in a canton, and then might decrease above a given level of inequality in response to the investment in protection devices from richest individuals (Chiu and Madden, 1998; Decreuse et al., 2018). This second robustness test introduces the effect of the quadratic Gini coefficient in equation (3.2) to capture this potential non-linear effect of income inequalities on victimization.

Results are presented in Table 3.5 and control for both the personal and cantonal characteristics. The income Gini completely losses significance when the estimates include its quadratic term. This suggests that the income Gini has only linear effects on victimization in Ecuador. The results on household income remain qualitatively unchanged.

Table 3.5 Estimates of the non-linear effect of income Gini

	Victimization against households			Victimization against individuals		
	Household	Burglary	Vehicle	Individual	Robbery	Violence
Gini <sub>c</sub>	-0.29 (1.38)	-1.18 (1.28)	1.81 (2.05)	0.71 (1.77)	1.52 (2.03)	1.57 (1.42)
Gini <sub>c</sub> <sup>2</sup>	0.49 (1.53)	1.68 (1.43)	-2.12 (2.25)	-1.27 (1.91)	-2.30 (2.14)	-1.52 (1.61)
Income <sub>h</sub>	0.26*** (0.03)	0.07*** (0.03)	0.38*** (0.04)	0.05*** (0.02)	0.03* (0.02)	0.03 (0.03)
Income <sub>h</sub> <sup>2</sup>	-0.02*** (0.00)	-0.00 (0.00)	-0.04*** (0.01)	-0.00** (0.00)	-0.00 (0.00)	-0.00 (0.00)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Personal charac	Yes	Yes	Yes	Yes	Yes	Yes
Canton charact	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R <sup>2</sup>	0.034	0.009	0.105	0.044	0.05	0.022
Bic	46144	31693	23846	76631	63353	24364
N° Observ.	98649	98649	98649	98318	98318	98318

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Income<sub>h</sub> is expressed in \$1,000.

### 3.6. CONCLUSION

This chapter provides new evidence on the analysis of inequality as cause of victimization. The theoretical literature predicts that higher inequality increases the level of crime by affecting the behavior of both the criminals *and* the victims. In the presence of larger inequality, criminals (who are predominantly poor people) have more incentives to obtain higher proceeds of crime from wealthy people (Chiu and Madden, 1998). Conversely, the potential victims (who are predominantly wealthy people) have more incentives to protect themselves against crime (Shavell, 1991; Chiu and Madden, 1998; Helsley and Strange, 2005; Hotte and Van Ypersele, 2008; Decreuse *et al.*, 2018). In such a context, this chapter explores whether the personal characteristics and, more importantly, the level of income of victims are relevant in the analysis of inequality as cause of victimization in Ecuador.

The economics literature holds that higher inequality raises the gap between the expected returns of crime and the legal returns to work for low-income individuals, who are placed in proximity with high-income individuals (Becker, 1968; Chiu and Madden, 1998). According to the sociological literature, inequality engenders crime through its impact on social segregation. The discriminatory social structures restrict the opportunities of success to the population located at the bottom of those structures. Thus, this segregation causes that unfortunate individuals commit crime in response to, *whatever the net return to crime* (Merton, 1938).

These predictions have been widely confronted with the data. Findings reveal that inequality has positive effects on property crimes (Demombynes and Özler, 2005; Fajnzylber *et al.*, 2002; Rufrancos *et al.*, 2013) while the effect on violent crimes is mixed (Rufrancos *et al.*, 2013). Although the exhaustiveness of data collection and methodological applications, this empirical literature suffers two important restrictions. First, these studies use aggregate data at different geographic levels and, therefore, are not able to control for the personal characteristics of victims, such as, their income level. Second, these studies use police crime reports which are concerned by a misreporting issue. A potential alternative is, therefore, using victimization surveys. Only few studies use those surveys to explore the different factors of crime, not necessarily related to the effect of income inequality on the probability of victimization (Levitt, 1999; Gaviria and Vélez, 2001; Di Tella *et al.*, 2010; Hémet, 2013).

Based on the arguments above, this study relies on the Ecuadorian Victimization and Perception of Insecurity Survey 2011 and a vector of explanatory variables at different geographic levels to test two important predictions derived from the economics or sociology literatures on crime.

The first hypothesis holds that income inequality raises the probability of victimization by property and violent crimes in Ecuador. To test this hypothesis, the present study estimates the effect of income Gini on the risk of victimization against the households (caused by burglary or vehicle theft) and the individuals (caused by robbery or violence). Findings from Probit estimates show no significant relationships on victimization against the households when controlling for the complete set of personal and cantonal characteristics. Conversely, the income Gini has a negative effect on the probability of victimization against individuals, related to robbery. This result is robust when controlling for the characteristics at the neighborhood level. There are two potential explanations for this unexpected result. On the one side, under the assumption that high inequality triggers segregation, the interaction between rich and poor people becomes less frequent. So, criminals have lower opportunities to steal rich people and higher risk of arrest (as police forces are expected to be larger in rich locations). In consequence, the risk of robbery may fall with higher inequality. On the other side, the social sanction effect suggests that crime is lower in small places where there are denser social interactions (Buonanno *et al.*, 2011). In Ecuador, this is a potential explanation since the cantons with highest inequality also have a small population density and large ethnic groups with strong social interactions.

The second hypothesis comes from the economics of crime literature (Chiu and Madden, 1998; Decreuse *et al.*, 2018) and applies to pecuniary-motivated crimes. According to this literature, it is more likely that high-income people are more victimized, unless they are so rich that they can protect themselves by investing in private protection devices. To confront this prediction with the data, our estimates include the household income and its quadratic term. In addition, we control for other personal characteristics that may influence the risk of victimization, whatever the type of crime. Findings reveal as expected, there is an increasing and concave relationship between the household income and victimization against the household (by vehicle theft). Specifically, the probability of victimization by vehicle theft increases with a monthly household income up to \$5,100, then it falls. These results confirm the prediction of Chiu and Madden (1998) and Decreuse *et al.* (2018) about the non-linear relationship between income and crime. Regarding victimization by burglary, this relationship is linear. These conclusions are robust to the inclusion of neighborhood characteristics or the non-linear impact of the Gini coefficient.

Finally, it is noteworthy to mention the limits of this study and the calls for future research. A first drawback is the limited temporal dimension because the only victimization survey in Ecuador is ENVIPI-2011. A second drawback refers to the Gini index as unique measure of inequality. The ENEMDU survey only provides the Gini coefficient at the province level. Therefore, to calculate the variables at the cantonal level, it is necessary to comply with some methodological restrictions that guarantee its significance.<sup>81</sup> The Gini index is the unique variable that completely fulfilled these restrictions. Finally, while we would like to test the influence of the income of the victim for crime against individuals, such information is not available in the survey. We could approximate the individual income by the average individual income in its household, but it is inappropriate when the victim is a young person that does not work. We therefore use the average household income in the estimates against the households and against the individuals.

Regarding the influence of personal characteristics (income level and other determinants) on crime, two possible extensions of this study emerge. First, the *combined* effects of income inequality and personal factors could better explain the probability of victimization in cantons. For example, what is the risk of victimization of male household-heads living in inequality conditions compared to

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<sup>81</sup> See [Appendix 3.B](#) for the methodological explanations of cantonal variables.

female household-heads living in inequality conditions? Other personal factors can be the age, schooling, occupancy and ethnicity of victims. Second, the income inequality, personal income and other personal characteristics could also influence the risk of gender violence. In Ecuador, the gender violence is a very important issue due to the increasing trend of female homicides. To analyze the determinants of this specific type of crime, we could apply our methodology by using the Ecuadorian survey on Gender Violence “Encuesta Nacional de Relaciones Familiares y Violencia de Género contra las Mujeres”.





## 4. CITY SIZE AND CRIME RATES: ESSAY AT THE PARISH LEVEL

### 4.1. INTRODUCTION

Looking at the spatial distribution of crime within countries, we often conclude that an important share of criminal activities takes place in cities. The urban feature of crime was first emphasized by criminologists (Flango and Sherbenou., 1976), and later by economists. In their pioneer work, Glaeser and Sacerdote (1999) define the urban crime premium as the fact that “*Crime rates are much higher in big cities than in small cities or rural areas*” (page S225). While this fact has been well documented in the case of developed countries and especially in U.S. cities (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015), the literature has often disregarded the case of developing countries. In countries of Latin America and the Caribbean, UNODC (2013) statistics reveal that capital cities (e.g. Caracas, Panama City, Guatemala City, San Salvador, Tegucigalpa, Quito) have higher homicide rates than the national homicide rate. Gaviria and Pagés (2002) also point out that living in a Latin American city with more than one million inhabitants makes it 20% more likely to be victimized than in cities with less than 20,000 inhabitants. However, whether city size or population density raise the number of crime per inhabitant in developing countries, this is still an open question. The contribution of this chapter therefore consists in testing the existence of an urban crime premium in Ecuador.

In the traditional literature on the economics of crime (Becker, 1968; Ehrlich, 1973), the location of individuals does not influence crime because by assumption, it does not impact neither the expected utility function from illegal activity nor the utility from legal activity. The latter assumption is in contradiction with one of the most important results of the urban economics literature. Population density gives rise to agglomeration economies and an urban wage premium (higher wages in urban areas) (see Combes *et al.*, 2008, among others). Therefore, the analysis of crime has become a central concern in urban economics (O’Flaherty and Sethi, 2015). This literature was first explored through empirical studies, and more recently through theoretical contributions. Below, we survey the main theoretical contributions that predict a multiplier effect of urban population on crime, and therefore, an urban crime premium.<sup>82</sup>

In a first strand of the literature, the proximity between individuals is formalized through social interaction models. The criminal behavior depends on individual incentives and on the behavior of peers. The idea is that some individuals are influenced by the behavior of their peers and tend to imitate them. The social networks created among those individuals reinforce delinquency through several mechanisms.<sup>83</sup> For example, imitating the behavior of peers strengthens the individual’s membership to the group, even if the group supports delinquency (Liu *et al.*, 2013). Establishing relationships with new people foments criminal activities because delinquents and non-delinquents can be in closer contact with each other (Patacchini and Zenou, 2008). The sharing of techniques or crime opportunities between experienced and new delinquents reduces the opportunity cost of crime and the risk of apprehension (Calvo-Armengol and Zenou, 2004). For all these reasons, the social network acts as a social multiplier on aggregate crime. Importantly, one might argue that this multiplier effect is strengthened in larger cities because the population density favors more

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<sup>82</sup> See the Chapter 2 of this dissertation for a detailed presentation of the urban economics literature on crime.

<sup>83</sup> According to Glaeser *et al.* (1996), 70% of the spatial variation of crime can be explained by social interactions.

connection patterns and the people raised in cities tend to present personal characteristics that makes them more prone toward crime.<sup>84</sup>

In another strand of the literature, the criminal behavior is analyzed within cities when individuals decide upon both their (legal or illegal) activity *and* their location. In the model by [Freeman \*et al.\* \(1996\)](#), individuals decide whether to commit crime, and then criminals choose in which neighborhood to operate. In equilibrium, criminals prefer to concentrate in the same neighborhood because the probability of arrest decreases with the number of thieves in the neighborhood. Most recent contributions analyze how interactions between crime, labor and land markets influence the criminal behavior. In [Verdier and Zenou \(2004\)](#), the distance between the residential location and jobs reduces wages and the resulting opportunity cost to commit crimes.<sup>85</sup> [Gagné and Zenou \(2015\)](#) extend the analysis by developing a full-fledged model with interactions between the product, crime, land and labor markets. To our knowledge, this is the only model that analyzes formally the urban crime premium. In the short-run equilibrium, the city size raises more than proportionally the number of criminals in the city.<sup>86</sup> This result is the consequence of two opposite effects. On the one hand, larger cities are associated with higher nominal wages because of monopolistic competition in the goods sector, which raises the opportunity cost of crime. On the other hand, individuals face higher urban costs (commuting costs and urban land rents) and obtain higher proceeds from crime in big cities, which induces more crime. The later effect dominates, so that city size increases the crime rate.<sup>87</sup> According to the above mechanisms, one can expect this relationship to be more important regarding property crimes, and in big cities where agglomeration forces are at work.

Theories on social interactions and crime incentives have been confronted to the data. [Patacchini and Zenou \(2008\)](#) explore the cohesion of social networks, for U.S. adolescents, to measure the propensity of students to participate in illegal activities. Results show that networks with friends of friends instigate to commit illegal behavior, especially for petty crimes. [Glaeser \*et al.\* \(1996\)](#) confirm this result with data of crimes per capita in U.S. cities. Petty crimes (e.g. larceny) are shown to have a higher degree of social interactions compared to serious crimes (e.g. murder). By contrast, the urban crime premium *per se* (e.g. the impact of population density on the crime rates) has been tested in few studies. One of the most cited empirical studies that test the relationship of city size and crime rates is [Glaeser and Sacerdote \(1999\)](#). They combine victimization surveys, youth surveys and crime reports in the Standard Metropolitan Statistical Areas of the United States. They provide evidence for a 0.24 elasticity between serious crime per capita and population, and decompose this relationship into three potential mechanisms that could drive the urban crime premium.<sup>88</sup> [O’Flaherty and Sethi \(2015\)](#) replicate their estimation both at the U.S. inter-metropolitan and intra-metropolitan levels for year 2012.<sup>89</sup> Their elasticities vary across different types of crime. For example, the U.S. inter-metropolitan area population has a positive and significant effect on murder, robbery and vehicle theft whereas rape, burglary and larceny are not

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<sup>84</sup> [Glaeser and Sacerdote \(1999\)](#) define them as crime-prone individuals. Estimates show that crime-prone individual’s characteristics can explain 29.2% of the relationship between city size and crime.

<sup>85</sup> More importantly, they show that locational segregation and racial beliefs result in lower wages for black individuals than for whites. This makes the opportunity cost of crime much lower for black individuals, who will commit more crime because of self-fulfilling beliefs (see Chapter 2, section 2.4.).

<sup>86</sup> [Gagné and Zenou \(2015\)](#) also consider that, in the long run, individuals can move *between* cities so that city size becomes endogenous to the model.

<sup>87</sup> [Gagné and Zenou \(2015\)](#) demonstrate that city size also matters for the ability of police to fight criminal activities. Decreasing commuting costs between the CBD and the city fringe raises the efficiency of police resources by improving the access to jobs.

<sup>88</sup> See Chapter 2 of this dissertation for a summary of the decomposition results.

<sup>89</sup> A major difference in [O’Flaherty and Sethi \(2015\)](#), however, is that they only control for regional dummies whereas [Glaeser and Sacerdote \(1999\)](#) use various city-level controls in order not to overestimate the urban crime premium.

correlated with city size. At the intra-metropolitan level, those elasticities are higher and positive for all types of crimes, which confirm the importance of analyzing crime at the local level.

In developing countries, however, there are few empirical contributions that explore the city size - crime relationship. An exception is the study of [Gaviria and Pagés \(2002\)](#) who analyze the probability of victimization depending on the socioeconomic status of victims and city size, in Latin American cities. They find that rich people, who often live in large cities, are 8% more likely to be a victim of crime than poor people. Moreover, living in a city with more than one million inhabitants makes it 20% more likely to be victimized than living in cities with less than 20,000 inhabitants. Unfortunately, the specificity of their dataset does not allow them to control for other important crime determinants, and they do not test the existence of an urban crime premium. Another important drawback is that they have no information regarding the type of crime.

Our empirical strategy allows to extend the existing literature on the urban crime premium in several ways. First, we test whether city size increases the crime rates in Ecuador. To do so, we use data at a low geographic level (parishes) over the period 2010-2015.<sup>90</sup> Second, we estimate the urban crime premium for homicides *versus* property crimes. Urban crime models that endogenize the location choice of individuals focus on the economic incentives with respect to property crimes ([Verdier and Zenou, 2004](#); [Gaigné and Zenou, 2015](#)). Sociological and psychological approaches could better explain the aggressive nature of violent offenders as a result of discriminatory conditions, *whatever the population density* ([Merton, 1938](#); [Dollard et al., 1939](#)). Thus, we expect the relationship between crime rates and city size to be stronger in the case of property crimes. Third, we take into account the large number of urban parishes with zero homicides (64%) by estimating a Two-Part model (TPM). TPM is appropriate in this case because it accounts for the existence of genuine zeros. In the case of property crimes, we perform a linear regression model because only 6% of urban parishes have zero offenses.

Findings from OLS estimates show that the parish population exerts a positive effect on both the rates of homicides and property crimes. Estimates from the two-part model show that the probability that a homicide occurs is higher in most populated parishes. However, when the estimation is restricted to the sample of parishes with positive homicides, the relationship is reversed. The parish population now exerts a negative impact on the homicide rate and it is significant at the 1% level. As population in parishes with positive homicides is seven times higher than the population in parishes with zero homicides, one can conclude that the parish population has a non-linear influence on the homicide rate. Findings also reveal that the estimated coefficients are stronger and more significant in the case of homicides than for property crimes. In a robustness check, we also find that the probability that a homicide occurs in highly urbanized areas (named FUAs) is higher than in rural parishes. Conversely, the homicide rate decreases more in rural parishes than in FUAs. This result might be related to the stronger social sanction effect in small areas as predicted by [Buonanno et al. \(2011\)](#).

The remainder of this chapter is organized as follows. Section 4.2 provides descriptive statistics on crime rates in Ecuador. Section 4.3 describes the empirical specification. The results are presented in Section 4.4 while Section 4.5 provides several robustness checks. Section 4.6 concludes.

## 4.2. CONTEXT AND STATISTICS OF CRIME IN ECUADOR

This section provides general information about crime data in Ecuador (Section 4.2.1) and descriptive statistics regarding the crime - city size relationship (Section 4.2.2).

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<sup>90</sup> Existing empirical contributions perform cross-section studies at the inter- or intra- U.S. metropolitan levels ([Glaeser and Sacerdote, 1999](#); [O’Flaherty and Sethi, 2015](#)).

#### 4.2.1. CRIME DATA

To analyze the local determinants of crime in this country, we collect data on homicides and property crimes in Ecuador from two sources.

Homicide data comes from the Ministry of Interior and covers the period 2010-2014. This database provides information regarding the motivation of homicides classified in five categories: delinquency, interpersonal, domestic, sexual, and undetermined.<sup>91</sup> The *delinquency* category refers to robberies that engendered deaths, confrontation with security organisms, organized and common delinquency, or rebellions. The *interpersonal* category includes deaths caused by emotional fights, hate acts, debts, revenge or retaliation between two or more people. It also encompasses contract-killings considered as a growing factor of homicides in Ecuador (Ministry of Interior, 2011). The *domestic* category refers to deaths caused by intra-familiar controversy, which are often due to sentimental issues, property litigation, and abuse. Homicides can also result from *sexual violence* that ended in death. Finally, the *undetermined* category involves the cases where it has not been possible to identify the motivation of the homicide. In 2014, the main cause of homicides was interpersonal violence (65%), followed by delinquency (21%) and domestic violence (12%). Importantly, the underreporting issue regarding homicides should be less important than for less serious crimes such as robbery, theft, etc. (Bourguignon, 2009). So, one expects the estimates on homicides not to be biased.

Property crime data comes from the Attorney General's Office (FGE) and covers the period 2012-2015. This database includes all offenses concerning a pecuniary motivation such as robbery against people, burglary, vehicle theft, vehicle accessory theft, theft against financial and commercial institutions, etc. (see definitions in Appendix 1.B).<sup>92</sup> Given the pecuniary motivation of these property crimes, one can presume those offenses to be more closely related with the economic incentives described by Becker (1968), Ehrlich (1973) or Gagné and Zenou (2015).

#### 4.2.2. DESCRIPTIVE STATISTICS

This section gathers statistics on the evolution of crime over time and space. First, we describe the evolution of criminal activities between 2010 and 2015. Second, we analyze the spatial distribution of crime at the parish level. Third, we comment the correlations between city size and crime rates.

##### *Trends at the national level*

In Ecuador, the evolution of homicide and property crime rates, at the national level, presents opposite trends (Figure 4.1). The homicide rate decreased by 11 points over the period 2010-2015. Conversely, the property crime rate remained stable between 2012 and 2014 and then increased during year 2015. Both tendencies are not directly related to the evolution of urbanization rates (proportion of people living in urban areas). Since 1950, Ecuador has an annual urbanization growth of 3.8% (the fastest in Latin America). However, the share of urban population increased only slightly over the period for which we observe crime data.

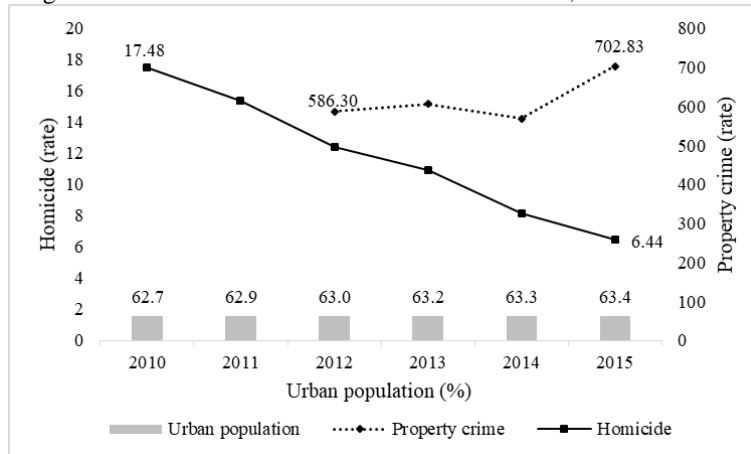
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<sup>91</sup> Other types of homicides account for less than 1% (accidental deaths, victims of projectiles without origin).

<sup>92</sup> Part of criminal activities in Ecuador is due to trafficking of drugs and arms, as well as (either direct or indirect) consequences of the Colombian conflict in areas close to the border. We disregard these types of criminal activities, and we refer the reader to the official report of Criminal Statistics in Ecuador for more evidence on all types of crime. The monthly report is available at <http://www.ecuadorencifras.gob.ec/justicia-y-crimen/> (in Spanish only).



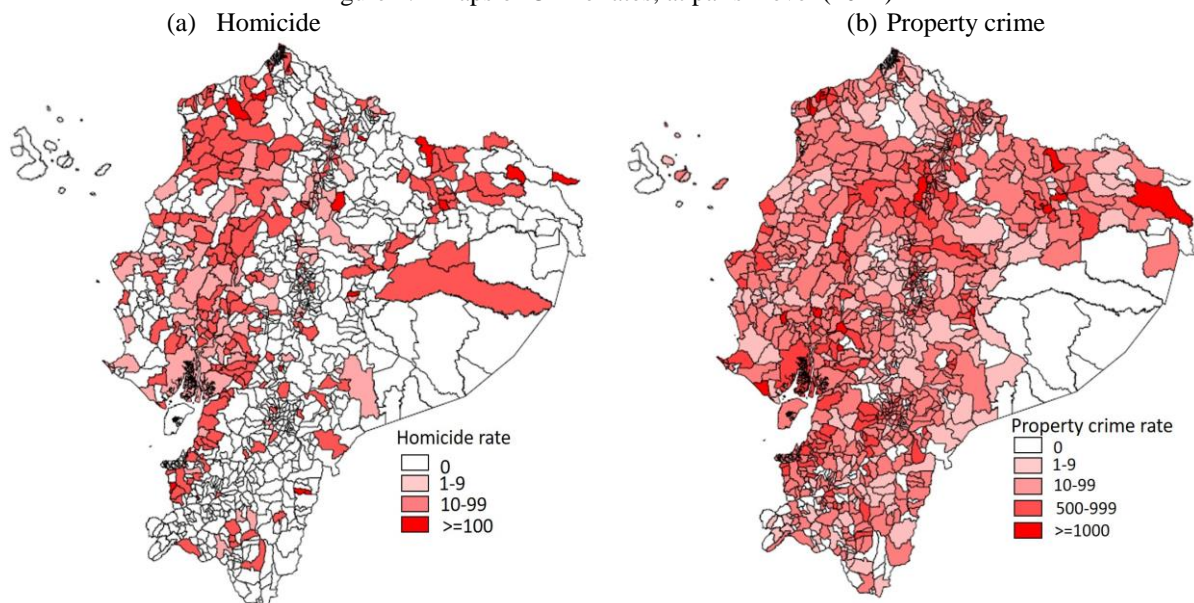
Figure 4.1 Crime and urbanization rates in Ecuador, at national level



### Spatial Distribution of crime rates

The spatial distribution of homicide and property crime rates reveals interesting facts. Figure 4.2 depicts the crime rates at the parish level, for year 2014. Regarding homicides (panel a), two facts appear. First, there is a strong concentration of crime in the Coast region where are located big cities such as Guayaquil, Machala, Manta and Santo Domingo. Second, there is a high proportion (72%) of parishes in which there are no homicides. This is due to the severity of those crimes and the low geographical scale used in this analysis. Regarding property crimes (panel b), the crime rates are higher and more dispersed across parishes than homicides. However, similarly as for homicide rates, the highest property crime rates are observed in parishes of the Coast region. Finally, only 14% of parishes report zero property crime rates, most of them being located in the center of the Amazon region.<sup>93</sup> Note that the homicide and property crime rates at the parish level are weakly correlated (correlation coefficient equal to 0.046). This suggest that each type of crime follows a specific pattern and should by analyzed separately.

Figure 4.2 Maps of Crime rates, at parish level (2014)



Source: Data from Ministry of Interior for homicides and the Attorney General's Office for property crime. Author's elaboration.

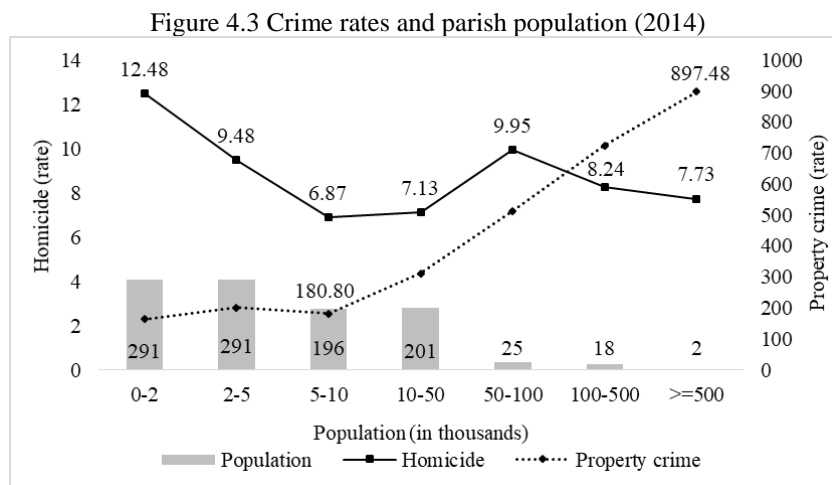
<sup>93</sup> Note that this percentage is probably biased upward as the underreporting issue is often pronounced regarding property crimes.

*Correlation between crime rates and population size at the parish level*

Figure 4.3 provides some descriptive statistics about the distribution of parishes depending on their population size. There are 28% of parishes with less than 2,000 inhabitants. The remaining parishes can be decomposed into four groups. There are 39% of parishes with between 2,000 and 5,000 inhabitants. 54% of parishes can be considered as the medium-sized parishes with a population between 5,000 and 50,000 inhabitants. Nearly 6% of parishes can be considered as big parishes with more than 50,000 inhabitants. Finally, the two parishes with more than 500,000 inhabitants are Quito and Guayaquil Metropolitan Districts.

The distribution of crime rates varies depending on the parish population. Regarding homicides, no specific pattern emerges. The highest average homicide rates (more than 9.5 homicides per 100,000 inhabitants) are observed in either the less populated parishes or in big parishes with between 50,000 and 100,000 inhabitants.<sup>94</sup> In contrast, homicide rates reach their lowest level (around 7 homicides per 100,000 inhabitants) in medium-sized parishes.<sup>95</sup> Surprisingly, Quito and Guayaquil districts report a slightly lower homicide rate than big parishes.

By contrast, the distribution of property crime rates presents a clear pattern. In parishes with less than 10,000 inhabitants, there are on average 180 property crimes (per 100,000 inhabitants), and this rate does not change drastically with the level of population. However, in parishes with more than 10,000 inhabitants, the property crime rate increases continuously with the level of population. Thus, property crime rates are four times higher in Quito and Guayaquil Districts than in medium-sized parishes.



We now turn to the analysis of the correlation between population and crime at the parish level, focusing only on parishes with more than 2,000 inhabitants and a positive number of crimes (Figure 4.4). The correlations between the population and the total number of homicides and property crime are unambiguously positive (Upper panels). However, looking at the correlation between population and crime rates (Lower panels), it appears that the type of crime matters a lot. The level of population appears to be negatively correlated with homicide rates (Bottom-left panel) but

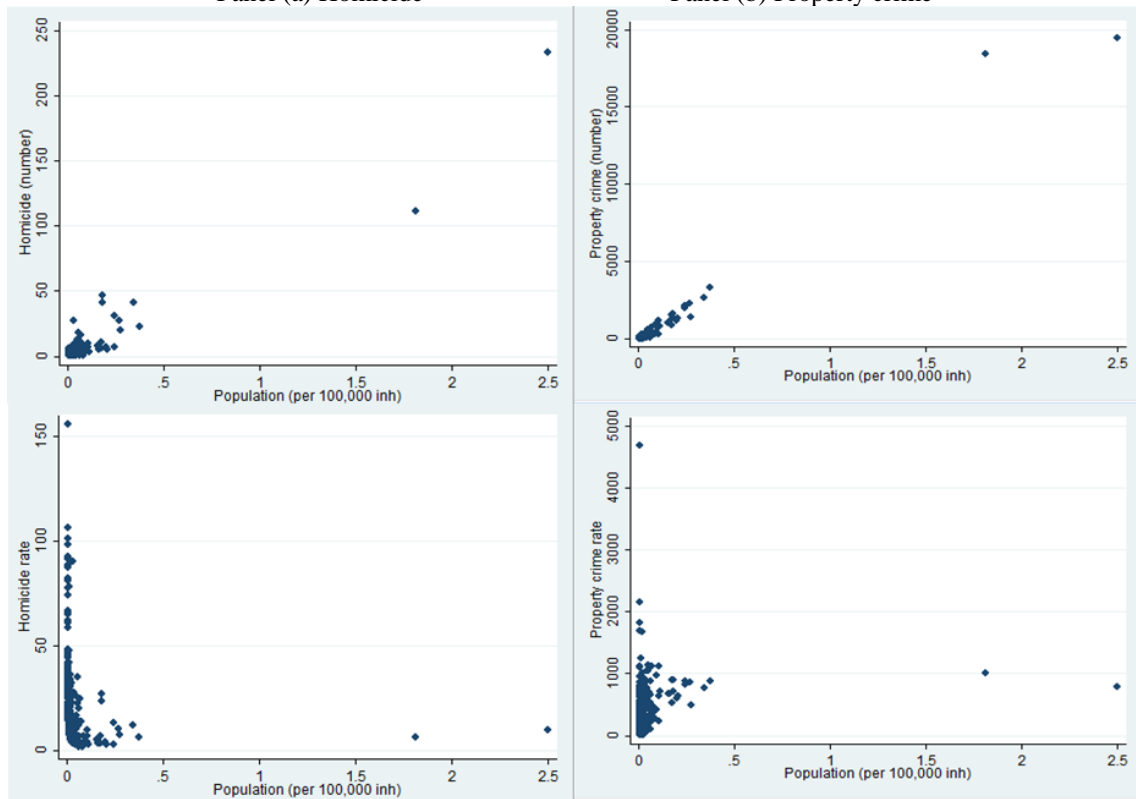
<sup>94</sup> Most of least populated parishes with a high crime rate are located at the border with Colombia. Criminality in those parishes is partially explained by the Revolutionary Armed Forces of Colombia (FARC) giving rise to the presence of refugees. According to UNHCR, 84,000 refugees live in Ecuador, mostly in Esmeraldas and Sucumbios (Senplades, 2013a).

<sup>95</sup> Gaviria and Pagés (2002) observe the same pattern in Colombia. The peak of homicide rates is seen in the lowest cities (less than 20,000 inhabitants) and the big cities (500,000 inhabitants), but it decreases in Bogota and medium-sized cities.



positively correlated with property crime rates (Bottom-right panel). A similar result holds with respect to the correlation between crime and population density (see [Appendix 4.A](#)).<sup>96</sup>

Figure 4.4 Correlation of crime rates and population, at parish level (2014)  
 Panel (a) Homicide Panel (b) Property crime



### 4.3. EMPIRICAL SPECIFICATION

This section first describes the econometric issues related with the data and the empirical strategy that tackle these issues (Section 4.3.1). Then, Section 4.3.2 details the explanatory and control variables used in the econometric application.

#### 4.3.1. ECONOMETRIC ISSUES

Several issues have to be addressed in order to specify the empirical model.

The first issue is the choice of the relevant spatial unit. In our baseline estimation, we restrict the sample to parishes populated by more than 2,000 inhabitants. Indeed, the population density is so low in parishes with less than 2,000 inhabitants that one might argue that the literature on urban economics to which we refer is not the most appropriate.<sup>97</sup> This choice reduces the sample to 733 spatial units.

Another issue is the high proportion of parishes in which there are no homicides. Focusing on areas with more than 2,000 inhabitants, there are still 64% of parishes without homicides. The homicide rate variable can therefore be considered as a limited dependent variable. Moreover, we can argue that the zero values are genuine zeros given the seriousness of such a crime. Following [Jones \(2000\)](#) taxonomy for dealing with these kind of limited dependent variables, we rely on the Two-Part

<sup>96</sup> See [Appendix 4.A](#) for the correlation between crime and population in logarithms.

<sup>97</sup> We also consider the parishes with the lowest population density in a robustness check.

model to estimate the homicide rates.<sup>98</sup> This methodology combines a probit model to estimate the probability of observing a positive value of the dependent variable, along with pooled ordinary least squares (OLS) on the sub-sample of positive observations. It is recommended under two hypotheses. First, it is appropriate when zeros are not due to non-observable data. Second, a TPM is relevant when the participation decision (taking part in a criminal activity) and the consumption decision (the number of offenses committed) are independent. Having in mind that the large majority of homicides are unrelated with delinquency, one can reasonably consider that this is the case in this dataset. In the case of property crime rates, there are only 6% of parishes, larger than 2,000 inhabitants, without property crimes. Therefore, the methodology relies on a linear regression model to estimate the effect of city size on property crime rates.

The baseline regression is defined in eq. (4.1):

$$Crime_{pt} = \alpha + \beta Pop_{pt} + \delta^r X_{rt} + \delta^p Y_p + \eta_c + \eta_{prov} + \gamma_t + \varepsilon_{pt} \quad (4.1)$$

where  $Crime_{pt}$  is the probability that at least one homicide occurs in parish  $p$  during year  $t$ , the homicide rate in parishes with at least one homicide, or the property crime rate.  $Pop_{pt}$  is the number of inhabitants in the parish  $p$ ,  $X_{rt}$  is a vector of time-varying characteristics at parish ( $r = p$ ) or canton ( $r = c$ ) level,  $Y_p$  is a vector of parish characteristics at the beginning of the period ( $t=2010$ ), and  $\varepsilon_{pt}$  is the error term. All continuous variables are expressed in logarithm form. Data definitions, summary statistics and correlations are detailed in [Appendix 4.B](#).

Because the probability of observing spatial autocorrelation is greater at lower geographic levels, the baseline regression includes a large vector of explanatory variables and fixed effects at the upper geographical level.<sup>99</sup>  $\eta_c$  stands for a canton fixed effect while  $\eta_{prov}$  captures the province fixed effect. Both geographic fixed effects capture the unobserved heterogeneity across cantons or provinces, respectively.  $\gamma_t$  is a year effect which accounts for secular trends.

As expected, the size of parishes and their cantons are positively correlated. To isolate the influence of parish population on crime, we estimate an extended regression where the parish population is expressed as the product of cantonal population and the ratio of parish over cantonal population. In logarithm form, the extended regression is defined by eq. (4.2):

$$Crime_{pt} = \alpha + \beta^p RelPop_{pt} + \beta^c Pop_{ct} + \delta^r X_{rt} + \delta^p Y_p + \eta_{prov} + \gamma_t + \varepsilon_{pt} \quad (4.2)$$

where  $RelPop_{pt}$  is the ratio of parish over cantonal population and  $Pop_{ct}$  is population of the canton.  $\beta^p$  captures the effect of the relative population size of parish  $p$  with respect to the canton  $c$  it belongs to while  $\beta^c$  captures the effect of the size of this canton  $c$ . In eq. (4.2), the spatial fixed effects are at work at the province rather than the cantonal level to avoid a bias due to the strong multicollinearity between population and fixed effects at the cantonal level.

#### 4.3.2. EXPLANATORY VARIABLES

The main explanatory variables are the population at the parish and cantonal levels, obtained from projections of intercensal growth.<sup>100</sup> According to the literature, one can expect a positive effect of population on crime rates, especially on crimes resulting from a rational behavior and inducing pecuniary benefits. Intuitively, one can argue that the mechanisms described by [Glaeser and](#)

<sup>98</sup> The existence of genuine zeros makes the Heckman model not appropriate to our data. Indeed, the zeros in the Heckman selection model denote censored values of the positive outcome, while zeros in the two-part model are true zeros. See [Humphreys \(2013\)](#) for a recent survey of the literature regarding zeros in economic data and [Belotti et al. \(2015\)](#) for the Stata routine of Two-Part model.

<sup>99</sup> We cannot introduce fixed effects at the parish level because this would strongly reduce the degree of freedom.

<sup>100</sup> The population projections extrapolate the intercensal population growth between 2010 and 2020 at different geographic levels. See data at the website <http://www.ecuadorencifras.gob.ec/proyecciones-poblacionales/>.

Sacerdote (1999) or Gaigné and Zenou (2015) could be more relevant for property crimes and homicides engendered by delinquency, whereas this is less obvious when it comes to homicides caused by domestic violence for which sociological and emotional factors may be predominant. One might argue that population is endogenous because of crime-related migration flows. We have considered to test the endogeneity bias by using a long-lagged population variable as instrument. Nonetheless, the historic data on population is only available for 1990 or 2001, which makes it a weak instrumental variable. In any case, data on internal migration flows suggests that the endogeneity bias should be limited.<sup>101</sup>

The large set of control variables aims at capturing the crime incentives at the parish level. While these variables are available only from the National Population Census 2010, they show enough dispersion over space to capture interesting effects. Moreover, the fact that parish variables are lagged compared to crime rates observations (except for homicide data in 2010) should limit a potential endogeneity bias.

We first control for the influence of labor market opportunities on crime through the proportion of occupied people among people aged 15 years or older (*Occupancy<sub>p,2010</sub>*). One can expect this variable to exert a negative influence on crime because the opportunity cost of crime is higher for occupied people.

Second, it is also important to control for the influence of education on crime. According to Lochner and Moretti (2004), this effect can be opposite depending on the type of crime. On the one hand, higher education should ease the access to well-paid jobs and reduce crime by increasing its opportunity cost. On the other hand, white collar crimes can require a certain level of education, and educated people have a lower probability of being caught. The present study controls for these potential effects through the number of years of schooling for the population aged 24 and above (*Schooling<sub>p,2010</sub>*).

Third, most pecuniary crimes (e.g. robbery, burglary, vehicle theft, delinquency homicide) are predicted to happen in the business centers where the expected return to crime is higher (Gaigné and Zenou, 2015; Verdier and Zenou, 2004). We introduce the share of people occupied in the commercial sector (*Business<sub>p,2010</sub>*), which we expect to exert a positive influence on crime, especially for property crimes and homicides engendered by delinquency.

Fourth, the migration flows might well be another crime determinant, especially in Ecuador that has received an increasing number of immigrants from Colombia, Peru and Cuba over the last years.<sup>102</sup> To control for this potential effect, the proportion of foreigners who were living abroad five years before the census in 2010 is used (*Foreigners<sub>p,2010</sub>*). In addition, we control for the effect of internal migration flows on crime through the internal migratory balance at the parish level using data from 2010 census (*Migratory\_balance<sub>p,2010</sub>*). In line with the inter-city labor and criminal mobility analysis by Gaigné and Zenou (2015), the internal migration flows can exert two opposite effects on crime incentives. On the one hand, more agglomeration in a city due to migration flows raises urban costs as compared to the city losing inhabitants. This effect incites more people to become criminal by deteriorating job accessibility. On the other hand, to the extent that migration inflows raise the overall income in some parishes, it could strengthen agglomeration

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<sup>101</sup> The inter-parish migratory balance (difference between the number of people having entered in the parish and the number of people having left the parish in the past five years, over the share of parish population) has a median around -0.003 and varies between [-0.14; 0.13]. Those values are so low that if there was any influence of crime on migration behavior, its final impact on our explanatory stock variable (the level of population) should be limited.

<sup>102</sup> INEC, statistics on International arrivals and departures. Data on the number of foreigners by country corresponds to 2015. See data at the website <http://www.ecuadorencifras.gob.ec/migracion/>.

economies, thereby raising real wages and reducing the number of criminals. Therefore, the expected effect of internal migration flows on crime rates is ambiguous.

Finally, we include a vector of social and demographic determinants of crime that varies over time and space. In line with the literature (Edlund *et al.*, 2013; Pratt and Cullen, 2005), the share of young people ( $Young_{pt}$ ) exerts a positive influence on crime.<sup>103</sup> Considering family structure as a determinant of crime (Hederos *et al.*, 2016; Pratt and Cullen, 2005), this model controls for the proportion of household-heads cohabiting as a couple, whether they are married or not ( $Couple_{ct}$ ). This information is available only at the cantonal level. The intuition suggests that this variable negatively influences criminality because couples have higher opportunity costs of crime when they are arrested than single people. Given that the detrimental socioeconomic conditions of people encourage crime, we also control for the share of people with monthly income below the poverty line ( $Poverty_{ct}$ ). This variable varies over time and is available at the cantonal level.

#### 4.4. RESULTS

The first estimations distinguish the influence of urban population on homicide from its impact on property crime through linear regression models (Section 4.5.1). Then, the estimates deal with the zero issue of homicides using a Two-Part model (Section 4.5.2). Finally, the effect of population is decomposed in density and surface effects to differentiate which factor is stronger at explaining the influence of population on crime.

##### 4.4.1. OLS ESTIMATES

Table 4.1 presents the results of the linear estimations. For each type of crime, Column (1) refers to the results of the baseline regression (see eq. 4.1) without control variables. Column (2) reports results of the extended regression (see eq. 4.2) without control variables, while Column (3) provides results of the extended regression with all control variables. Results in Columns (1) and (2) include time and geographic fixed effects, and somehow replicate estimations conducted by O’Flaherty and Sethi (2015).<sup>104</sup>

As expected, the parish population exerts a positive influence on both homicide and property crime rates, when controlling for the full set of year, province, and canton effects (Column 1). By decomposing the influence of parish population (Column 2), it appears that both the relative parish population and the cantonal population significantly raise crime rates. Moreover, the coefficient associated with cantonal population is higher than the coefficient associated with parish over cantonal population. Since all variables are expressed in logarithm terms, the net influence of cantonal population on crime rates is positive (with an elasticity equal to 0.02 for homicide and 0.17 for property crime), but much lower than the influence of the parish population (elasticity equal to 0.48 for homicide and 0.51 for property crime).

Column (3) enriches the analysis of Glaeser and Sacerdote (1999) and O’Flaherty and Sethi (2015) by including year dummies and a full set of control variables aimed at capturing crime determinants at the parish and cantonal levels. Population variables remain significant, except the influence of the relative size of the parish on the property crime rate. Coefficients are also lower, as expected. Regarding the homicide rate, the proportion of foreigners has a positive effect whereas the internal migratory balance is negative. Both variables are significant only at the 10% level. Regarding the

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<sup>103</sup> While we wanted to control for the influence of the share of male people on crime rates, this was unfortunately unfeasible. The descriptive statistics show a far too low variance both between parishes and over time to capture any reliable effects.

<sup>104</sup> The authors use cross section data and estimate the elasticity of crime rates with respect to city size by controlling for regional fixed effects exclusively.

property crime rate, two determinants strongly influence those pecuniary crimes. As expected, the share of activities in the business sector, within the parish in 2010, exerts a strong and positive influence on property crime rates. The level of education at the parish level in 2010 also influences positively the property crime rates. It may capture the fact that it requires skills to perform crimes such as burglary, theft against financial and commercial institutions.<sup>105</sup>

Table 4.1 OLS estimates

	Homicide			Property crime		
	(1)	(2)	(3)	(1)	(2)	(3)
Parish Population	0.459** (0.07)			0.453*** (0.02)		
Parish over Canton Population		0.480** (0.07)	0.348** (0.05)		0.512*** (0.02)	0.088 (0.04)
Canton population		0.503** (0.07)	0.342** (0.06)		0.679*** (0.03)	0.218* (0.07)
Poverty			-0.102 (0.05)			-0.079 (0.10)
Young			0.534 (0.43)			-0.519 (0.31)
Couple			0.305 (0.13)			0.062 (0.45)
Occupancy			0.084 (0.12)			-0.420 (0.65)
Schooling			-0.276 (0.11)			0.930** (0.16)
Business			0.190 (0.08)			0.605*** (0.07)
Foreigners			0.095* (0.02)			0.102 (0.06)
Migratory balance			-2.657* (0.81)			3.667 (1.74)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	Yes	No	No	Yes	No	No
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R <sup>2</sup>	0.304	0.258	0.285	0.387	0.199	0.339
N° Observ.	3613	3613	2819	2919	2919	2209

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms. Sample of parishes with more than 2,000 inhabitants.

#### 4.4.2. TWO-PART MODEL ESTIMATES

Since there is a high proportion of zero homicides in parishes, this section estimates a two-part model to identify the effect of parish population on homicides at both the extensive and intensive margins.<sup>106</sup> Results are reported in Table 4.2. The left hand side of the table provides results of the Probit estimation on the full sample of parishes (extensive margin), while the right hand side describes results of the pooled OLS estimation on the subsample of parishes in which homicide rates are strictly positive (intensive margin). For each part of the estimation, Column (1) refers to the results of the baseline regression without control variables, Column (2) reports the results of the extended regression without control variables, and Column (3) provides results of the extended regression with all control variables.

*At the extensive margin*, results show that parish and cantonal populations significantly increase the probability that a homicide occurs, even controlling for time, cantonal and province fixed effects. This result is consistent with the main findings of the literature on urban crime. Larger

<sup>105</sup> We checked that the positive impact of education on the property crime rate remains significant even controlling for the income level of households at the cantonal level instead of the poverty rate. So, this effect does not seem to act through the demand side of the crime market.

<sup>106</sup> Even though only 6% of urban parishes have zero property crimes, an additional robustness test estimates the effect of population on property crime rates using TPM. The results are qualitatively similar to those of the OLS estimation on the whole sample.



cities have more crime prone individuals, the return to crime and crime opportunities are higher and the probability to be caught is lower (Glaeser and Sacerdote, 1999; Gaigné and Zenou, 2015). As result, the probability of any homicide occurring is higher in most populated parishes, and parishes belonging to the most populated cantons.

In order to test the urban crime premium hypothesis, one has to go further and analyze results *at the intensive margin*. The estimation focuses on the parishes where at least one homicide occurs and tests the influence of population on the intensity of criminal activities, measured by the number of homicides per 100,000 inhabitants. The right hand side of Table 4.2 (see Column 1) suggests that the parish population now exerts a negative and very significant effect on the homicide rate. By decomposing this effect (Columns 2 and 3), it appears that both the relative parish population and the cantonal population exert a negative and significant impact on the homicide rate. Therefore, consistently with the descriptive statistics in Section 4.2.2, the homicide rate decreases with the number of inhabitants in parishes with a positive number of homicides.

To reconcile the above results on the population size - homicide rate relationship, it is important to notice that the population in parishes with positive homicides is seven times higher than the population in parishes with zero homicides.<sup>107</sup> Therefore, one can conclude from the estimation of the two-part model that the influence of parish population on the homicides is non-linear. Thus, the population has a positive impact in the whole sample, but a negative impact in the parishes with at least one homicide. Taking into account zero values is therefore crucial when analyzing the relationship between population of a parish and its homicide rate. To the best of our knowledge, this issue is ignored in the literature. Comparing the results of TPM (Table 4.2) with naïve OLS estimates (Table 4.1), our results suggest that this misspecification may lead to ignore the non-monotonicity of the homicide rate - city size relationship.

To understand why population can reduce the homicide rate, one has to recognize the fact that killing someone in purpose is a very specific criminal activity. Firstly, victims are often not randomly chosen. Victims and criminals often know each other (directly or indirectly) before the crime happens.<sup>108</sup> In the specific case of murders perpetrated by contract - killers, the victim is very well identified. Secondly, homicides generally occur in private spaces (Klick and Tabarrok, 2010), contrary to property crimes that happen in public areas. Both characteristics imply that the standard mechanisms identified by the urban crime literature might be less relevant regarding those homicides unrelated with pecuniary motivation. Probably, the most important deterrent factor of homicide could be the likelihood of recognition (and subsequent reporting to the police) by people surrounding the homicide area. In such a case, the probability of arrest might well be increasing with population size, contrary to what is expected for property crimes where the risk to be caught depends more importantly on the presence of the police forces. In addition, it can be argued that large parishes benefit from a greater number of police officers per inhabitant because the quality of institutions involved in crime deterrence (courts, police departments, violence prevention) is higher in large cantons where the economic activity is mostly concentrated. It is also possible that there are increasing returns to scale and that policemen are more productive in big cities. Despite the importance of this deterrent factor of crime, we unfortunately cannot analyze its influence on the city size - crime relationship for reasons of data availability.

The coefficient estimates of control variables also provide significant effects on crime. From Column (3), the share of foreigners exerts a positive and very significant impact on homicides in both the Probit and OLS regressions. One possible explanation is that people, who come from

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<sup>107</sup> In average, there are 31,961 habitants in parishes with positive homicide rates, and 4,520 in the remaining parishes.

<sup>108</sup> In Ecuador, 48.4% of victims who suffered intimidation have already met the offender (ENVIPI-2011). Moreover, 60% of women are victims of violence and 90% of them are victimized by their intimate partner (Data calculated from the Survey of Violence against Women, 2011). An exception is the case of robberies which ended in death.

countries with armed conflicts and who often live in deprived socioeconomic conditions, have lower opportunity costs of crime in Ecuador. Conversely, the migratory balance across parishes reduces the homicides in both regressions as well. This result is in line with the intuition of [Gaigné and Zenou \(2015\)](#), in which migration inflows might raise the overall income, thereby increasing real wages and reducing the number of delinquents.

It is essential to notice that some control variables can have an opposite impact on property crimes *versus* homicides. For example, the level of education and the share of people occupied in the commercial sector both raise the property crime rate ([Table 4.1](#)) whereas they reduce the homicide rate ([Table 4.2](#)). Those results confirm that crime incentives are often specific to the type of criminal activity. An intuition for this result could be that the share of commercial activities has a positive impact on the demand side of the “market for property crimes”, whereas it reduces the supply side of the “market of violent crimes” because wages (and the opportunity cost of crime) are higher in that sector. The deterrent effect of education on the homicide rate probably goes through a supply effect, more educated people being less subject to adopt a violent behavior.

Table 4.2 Estimates of Two-Part model on homicides

	Probit			OLS		
	(1)	(2)	(3)	(1)	(2)	(3)
Parish Population	0.926*** (0.09)			-0.244*** (0.06)		
Parish over Canton Population		0.870*** (0.08)	0.791*** (0.06)		-0.276*** (0.05)	-0.255*** (0.04)
Canton population		0.923*** (0.09)	0.825*** (0.07)		-0.267*** (0.05)	-0.282*** (0.05)
Poverty			-0.135* (0.06)			-0.207** (0.06)
Young			0.232 (0.61)			-0.298* (0.13)
Couple			0.347* (0.15)			-0.017 (0.14)
Occupancy			-0.453 (0.30)			-0.188 (0.26)
Schooling			-0.297 (0.16)			-0.279* (0.13)
Business			0.155 (0.10)			-0.091* (0.04)
Foreigners			0.094** (0.03)			0.175*** (0.02)
Migratory balance			-1.344* (0.67)			-3.341*** (0.91)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	Yes	No	No	Yes	No	No
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R <sup>2</sup>	0.323	0.307	0.321			
Adjusted R <sup>2</sup>				0.494	0.392	0.408
N° Observ.	3275	3693	2814	1267	1267	1015

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms. Sample of parishes with more than 2,000 inhabitants.

To complete the above results, [Table 4.3](#) presents the estimates regarding the motivation of homicides. Our comments will focus on the OLS regression (right panel) with the homicide rate as dependent variable. Clearly, the above conclusions regarding the relationship between population and homicides are not specific to a particular motive of homicide. However, this relationship is stronger in the case of homicides engendered by domestic violence. The predictive power of the empirical model reaches its highest level with an Adjusted R<sup>2</sup> of 0.82 (against 0.72 for homicides caused by delinquency and 0.54 for those engendered by interpersonal conflicts outside the family). An intuition could be that denunciation to the police by the family or acquaintances of the victims is more frequent when they live in more populated areas, and/or the probability of arrest in case of homicide is higher because policemen are more skilled.



Table 4.3 Estimates of Two-Part model by homicide motives

	Probit			OLS		
	Delinquency violence	Domestic violence	Interpersonal violence	Delinquency violence	Domestic violence	Interpersonal violence
Parish over Canton Population	0.751*** (0.08)	0.681*** (0.06)	0.783*** (0.06)	-0.362** (0.04)	-0.525*** (0.03)	-0.353*** (0.04)
Canton population	0.839*** (0.07)	0.598*** (0.07)	0.821*** (0.11)	-0.311*** (0.02)	-0.440*** (0.02)	-0.394*** (0.04)
Poverty	-0.066 (0.12)	-0.200 (0.12)	0.002 (0.13)	-0.217** (0.07)	-0.063 (0.06)	-0.194*** (0.06)
Young	-0.502 (0.69)	-1.241* (0.58)	0.516 (0.88)	-0.208 (0.50)	-1.785*** (0.31)	0.023 (0.29)
Couple	-0.116 (0.33)	-0.138 (0.24)	0.190 (0.16)	0.171 (0.21)	0.129 (0.19)	-0.121 (0.15)
Occupancy	-1.146 (0.64)	-0.770 (0.89)	-0.256 (0.51)	-0.954 (0.71)	-0.390 (0.23)	-0.031 (0.16)
Schooling	-0.621* (0.27)	-0.412* (0.20)	-0.101 (0.27)	-0.548* (0.25)	0.369 (0.27)	-0.414 (0.19)
Business	0.157 (0.09)	0.242* (0.10)	0.004 (0.10)	-0.273 (0.11)	-0.240** (0.08)	-0.102 (0.06)
Foreigners	0.144* (0.06)	0.094 (0.08)	0.109*** (0.03)	0.155*** (0.04)	0.093* (0.04)	0.129* (0.05)
Migratory balance	0.803 (1.45)	-2.342*** (0.61)	-1.632 (1.51)	-0.389 (1.45)	-1.490* (0.67)	-3.540*** (1.13)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	Yes	No	No	Yes	No	No
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R <sup>2</sup>	0.370	0.317	0.342			
Adjusted R <sup>2</sup>				0.720	0.819	0.546
N° Observ.	2814	2789	2814	357	319	662

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms. Sample of parishes with more than 2 000 inhabitants.

#### 4.4.3. DENSITY VS SURFACE EFFECTS

Given the high correlation between the population and the surface area of parishes, one might object that the influence of population on crime rates is only driven by a scale effect. To go further in the analysis, the variable population is decomposed as the sum of the surface area (in km<sup>2</sup>) and the population density (population/km<sup>2</sup>) of a given parish. The variables being expressed in logarithm form, the baseline regression eq. (4.1) becomes eq. (4.3):

$$Crime_{pt} = \alpha + \beta Density_{pt} + \rho Surface_p + \delta^r X_{rt} + \delta^p Y_p + \eta_c + \eta_{prov} + \gamma_t + \varepsilon_{pt} \quad (4.3)$$

The extended regression eq. (4.2) reads eq. (4.4):

$$Crime_{pt} = \alpha + \beta^p RelDensity_{pt} + \rho^p RelSurface_p + \beta^c Density_{ct} + \rho^p Surface_c + \delta^r X_{rt} + \delta^p Y_p + \eta_{prov} + \gamma_t + \varepsilon_{pt} \quad (4.4)$$

where  $RelDensity_{pt}$  is the ratio of parish over canton population densities and  $RelSurface_p$  is the ratio of parish over cantonal surface areas.

Results are summarized in Table 4.4. Probit estimates of homicides are in the top panel while OLS estimates regarding homicide and property crime rates are in the bottom panels. In each panel, Column (1) refers to the baseline regression without control variables, whereas Columns (2) and (3) correspond to the extended regression without and with control variables, respectively. Both the population density and the surface area exert a positive and significant effect on the probability of homicide, with slightly higher -in absolute terms- coefficients for the surface area in the preferred specification (Column 3). This result is not surprising as far as the dependent variable is defined as the probability that at least one homicide occurs in a given area. In parishes with positive homicides, the coefficients associated with population and surface area are negative (around -0.25) and significant at 1% level. Regarding the property crime rate, the coefficient of the parish relative

surface area is positive and significant at 10%.<sup>109</sup> This might capture the negative effect of job market accessibility (or the positive effect of commuting costs) on -pecuniary- crime rates formalized by [Gaigné and Zenou \(2015\)](#). The relative surface area of a given parish raises urban costs within the canton, which might lead some individuals to prefer criminal activities to legal activities. The population density also exerts a positive influence on the property crime rate but exclusively at the cantonal level. This suggests that pecuniary-motivated criminals move across parishes so that their catchment area is defined at the canton (rather than the parish) level.

Table 4.4 Estimates of density and surface area, at parish level

	Homicide rate: TPM			Property crime rate: OLS		
	(1)	(2)	(3)	(1)	(2)	(3)
	<i>PROBIT</i>					
Parish density	0.934*** (0.09)					
Parish surface	0.907*** (0.08)					
Parish over canton density		0.876*** (0.08)	0.737*** (0.05)			
Parish over canton surface		0.868*** (0.08)	0.809*** (0.06)			
Canton density		0.908*** (0.08)	0.738*** (0.05)			
Canton surface		0.938*** (0.10)	0.878*** (0.08)			
	<i>OLS</i>			<i>OLS</i>		
Parish density	-0.253*** (0.05)			0.545*** (0.02)		
Parish surface	-0.216** (0.07)			0.210*** (0.03)		
Parish over canton density		-0.292*** (0.05)	-0.293*** (0.04)		0.589*** (0.02)	0.058 (0.05)
Parish over canton surface		-0.244*** (0.06)	-0.233*** (0.04)		0.307*** (0.03)	0.105* (0.04)
Canton density		-0.257*** (0.06)	-0.256*** (0.06)		0.743*** (0.04)	0.249** (0.05)
Canton surface		-0.247*** (0.05)	-0.294*** (0.05)		0.415*** (0.03)	0.202 (0.09)
Control Variables	No	No	Yes	No	No	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	Yes	No	No	Yes	No	No
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
	<i>PROBIT</i>					
Pseudo R <sup>2</sup>	0.323	0.308	0.324			
N° observ.	3275	3593	2814			
	<i>OLS</i>			<i>OLS</i>		
Adjusted R <sup>2</sup>	0.495	0.393	0.411	0.407	0.224	0.339
N° observ.	1267	1267	1015	2919	2919	2209

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms. Sample of parishes with more than 2,000 inhabitants.

#### 4.5. ROBUSTNESS CHECK

Additional estimates in this section aim to verify the consistency of the main results presented above.

##### *Estimates on rural parishes, capital parishes and Functional Urban Areas*

The first robustness test aims at evaluating the empirical relevance of [Glaeser and Sacerdote \(1999\)](#) assertion according to which “*crime rates are much higher in big cities than in small cities or rural*

<sup>109</sup> Note, however, that the influence of the surface is not significant anymore when estimating the model on the subsample of parishes with strictly positive values of property crime rates (92.3% of total observations).

areas” (page S225). Therefore, we estimate the population - crime rates relationship in areas characterized by different levels of urbanization.

First, we rely on the INEC’s classification according to which urban parishes host more than 2,000 inhabitants and can be either the capital of canton or peripheral parishes; whereas the rural parishes host less than 2,000 inhabitants.

Second, we consolidate crime and population variables at the level of the Functional Urban Area (FUA) in order to alleviate the statistics issues associated with the administrative territorial division. According to OECD (2012) definition, a FUA is composed of densely inhabited urban cores and hinterlands connected to the urban core by having a certain share of their employed residents working in the urban core. The OECD methodology relies on commuting data to define the ‘hinterland’. This definition is more consistent with the mechanisms described by Verdier and Zenou (2004) or Gaigné and Zenou (2015). In other words, the delimitation of FUAs provides a more convincing approximation of the criminal catchment area than parish or canton delimitations that are purely administrative. Obaco *et al.* (2017) extend the OECD methodology to developing countries -such as Ecuador- for which commuting data is not available. They substitute such socioeconomic flows by available information on road structure to measure accessibility between the urban core and its hinterland. Thanks to this methodology, they obtain 29 FUAs.

Table 4.5 presents statistics on population density in each area. The average population density in the most urbanized areas -FUA- is 655 inhabitants per square kilometer (km<sup>2</sup>), 277 inhabitants/km<sup>2</sup> in capital parishes, 172 inhabitants/km<sup>2</sup> in peripheral urban parishes (populated with more than 2,000 inhabitants), and 25 inhabitants/km<sup>2</sup> in rural parishes.

Table 4.5 Population density statistics by areas

Population density	Mean	Min	Max	Median	Std. Dev.
Rural parishes <= 2000 inhab.	25	0.034	461	12.7	44
Peripheral urban parishes > 2000 inhab.	172	0.337	5400	52.7	433
Capital parishes	277	0.546	5400	80	677
FUAs	655	2.86	5400	401.6	881

Results of estimations for each area are reported in Table 4.6. The first column presents results of estimates in the subsample of rural parishes<sup>110</sup>, the second column reports the results for the subsample of capital parishes and the last column provides the results regarding the 29 Functional Urban Areas defined by Obaco *et al.* (2017). There are 291 rural parishes, 221 capital parishes, and 122 parishes belonging to an FUA.<sup>111</sup> In the estimation of FUAs, the main explanatory variable is FUA population, decomposed as the sum of the FUA population and the relative population of the parish in its FUA.

Regarding homicides, Probit estimates show that the parish population (in relative terms) exerts a higher effect in the subsample of parishes belonging to FUAs. Meanwhile, the OLS estimation shows that the negative impact of the relative parish population is significant only in rural areas and in FUAs, and this effect is much stronger in rural areas.<sup>112</sup> This result confirms the prediction of Buonanno *et al.* (2011) related to the effect of social control as a deterrent of crime in small places. Indeed, social control might be a more effective crime deterrent in small and rural areas, where the population density is small, and therefore, the density of personal acquaintanceship is likely to be higher. Another explanation for this result could be that police resources are disproportionately concentrated in capitals, so that people in rural areas could be tempted to take

<sup>110</sup> Note that there are only 79 observations in the OLS part of the TPM. This is due to the fact that the proportion of zero homicides is higher in rural parishes (92%) than in urban parishes (65%) or FUAs (43%).

<sup>111</sup> Only 2% of parishes in this subsample are identified as the capital of a canton or belong to a functional urban area, so that this subsample can be considered as independent of the two other subsamples.

<sup>112</sup> The influence of population through both density and surface is also checked. Results are available upon request.

their own - violent - measures to obtain justice. Finally, goodness-of-fit measures for the sub-sample of FUAs or capital parishes are twice higher than the level for the sub-sample of rural areas. In conclusion and as we expected, the model has a much better predictive power when it comes to understanding crime determinants in urbanized areas.

Results on property crime rates are less clear-cut. On the one hand, the model has a much better predictive power when it comes to understand crime determinants in urbanized areas. The adjusted R<sup>2</sup> reached 0.56 in parishes belonging to an FUA, against 0.21 in rural parishes. On the other hand, the coefficients of population are no longer significant when the model is estimated in parishes belonging to FUAs. This result is consistent with the conclusion of O’Flaherty and Sethi (2015) who mention that “*crime is only weakly associated with larger metropolitan areas*” (page 89). In their estimates, the elasticity of crime rates with respect to population in the United States is lower and less significant at the inter-metropolitan level than at the intra-metropolitan level.<sup>113</sup> Regarding Ecuador, one possible reason comes from the strong restriction of the sample as only 12% of parishes belong to an FUA. In addition, one might suspect that the non-significant impact of population on crime rates in parishes belonging to FUAs is due to a stronger underreporting bias in the property crime rate, which we expect to be increasing with the level of urbanization (Glaeser and Sacerdote, 1999).

Table 4.6 Estimates at different levels of urbanization

	Homicide rate: TPM			Property crime rate: OLS		
	Rural parishes (<= 2 000 inhabitants)	Capital parishes	Functional Urban Areas	Rural parishes (<= 2 000 inhabitants)	Capital parishes	Functional Urban Areas
	<i>PROBIT</i>					
Parish over Canton Population	0.366 (0.19)	0.820*** (0.08)				
Canton population	0.388*** (0.13)	1.277*** (0.16)				
Parish over FUA population			0.865*** (0.05)			
FUA population			0.614*** (0.16)			
	<i>OLS</i>			<i>OLS</i>		
Parish over Canton Population	-0.627*** (0.08)	-0.243 (0.14)		0.562* (0.23)	0.635* (0.26)	
Canton population	-0.952*** (0.10)	-0.088 (0.06)		0.913** (0.20)	0.428** (0.09)	
Parish over FUA population			-0.176*** (0.03)			0.043 (0.04)
FUA population			-0.170* (0.08)			0.065 (0.08)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	No	No	No	No	No	No
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
	<i>PROBIT</i>					
Pseudo R <sup>2</sup>	0.162	0.456	0.406			
N° observ.	879	708	509			
	<i>OLS</i>			<i>OLS</i>		
Adjusted R <sup>2</sup>	0.214	0.434	0.491	0.208	0.409	0.560
N° observ.	79	448	300	678	549	421

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms.

<sup>113</sup> In their estimates at the inter-metropolitan (state level), the coefficient of population is significantly positive, but they only control for region fixed effects. Without control variables, the coefficient of population is also positive and significant in FUAs of Ecuador. Obviously, accounting for year effects and the standard crime determinants is therefore crucial to estimate the influence of population on crime rates.

*Non-linear impact of population on the property crime rate*

We have demonstrated, through the two-part model estimates, that parish population can exert a non-linear influence on homicides (see Section 4.4.2). In the positive sense, the parish population increases the probability of at least one homicide occurs in the parish. In the negative sense, the parish population exerts a negative influence on the homicide rate in the subsample of parishes where there are some homicides and the population is, on average, higher.

One can expect such a non-linear relationship for property crimes, too. As demonstrated by [Shavell \(1991\)](#), [Helsley and Strange \(2005\)](#), [Hotte and Van Ypersele \(2008\)](#), [Decreuse et al. \(2018\)](#), the investment of individuals in protection devices (ex: locks or alarm for houses, hiring guards) can reduce property crime. Such investments mainly result from high income individuals. In Ecuador, 34% of households declared to have reinforced housing and vehicle security through alarms, anti-theft devices, anti-theft insurances, private guards, etc. ([INEC, 2011](#)). As far as wages are higher in large urban areas (see [Duranton, 2016](#) for evidence in Colombia), one can expect the relationship between city size and property crime rate to be concave. This robustness check therefore explores whether population size also exerts a non-linear impact on the property crime rate.

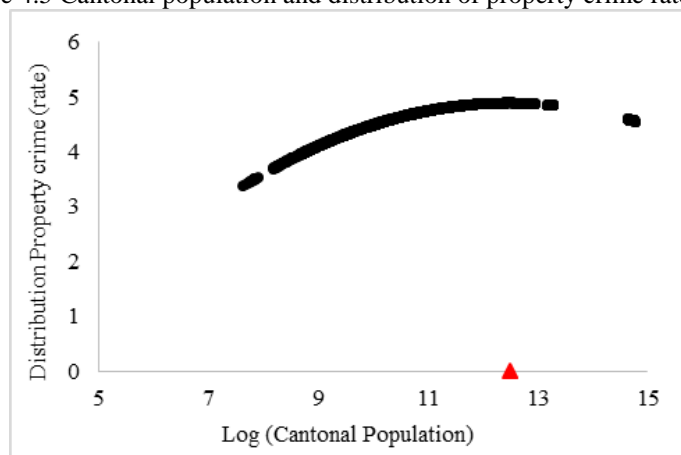
To test the above prediction, the baseline and extended regressions add the square of population variables. Results are detailed in [Table 4.7](#) for parishes with more than 2,000 inhabitants. In the first column, the baseline regression estimates the *absolute* parish population on the property crime rate, in order to ease the interpretation of results. Column (2) replicates this estimation by using the canton rather than the parish population.

In Column (1), only the coefficient associated with parish population is positive and significant at 10% level. Moreover, the most important result is the concavity of the relationship between the cantonal population and property crime rates (Column 2). The property crime rates increase in parishes belonging to cantons populated with up to 266,494 inhabitants (log 12.49), and then decrease ([Figure 4.5](#)).

Table 4.7 Estimates of the non-linear effect of population on property crime rate

	Property crime rate: OLS	
	(1)	(2)
Parish Population	0.289*	
	(2.57)	
Square of parish population	-0.009	
	(-1.39)	
Canton population		1.604**
		(4.04)
Square of canton population		-0.064**
		(-3.87)
Control Variables	Yes	Yes
Year Effect	Yes	Yes
Canton Effect	No	No
Province Effect	Yes	Yes
Adjusted R <sup>2</sup>	0.335	0.343
N° observ.	2209	2209

Figure 4.5 Cantonal population and distribution of property crime rates (log)



#### *Additional robustness checks*

One might argue that, due to the mobility of workers and/or criminals, more control variables should be defined at the canton rather than the parish level. We estimate the extended regression (see eq. 4.2) by expressing variables of vector  $Y$  and the share of young people at the canton level (Columns 3 in Table 4.8). Results show that replacing the control variables at cantonal level does not affect our main conclusions regarding the existence of an urban crime premium in Ecuador. That is, parish population still exerts a positive impact on the probability of homicide and a negative influence on the homicide rate in the subsample of parishes for which we observe a positive number of homicide. By contrast, the parish population (in absolute or relative terms) exerts a significant and positive impact on property crime when all control variables are expressed at the canton level. However, the goodness of fit is lower (with R-squared equal to 0.24) than when we control for crime determinants at the parish level (R-squared of 0.34). These results confirm the importance of controlling for crime determinants at a low geographical scale when trying to estimate the urban crime premium hypothesis.

Table 4.8 Estimates of crime rates with controls at cantonal level

	Homicide rate: Two part model			Property crime rate: OLS		
	(1)	(2)	(3)	(1)	(2)	(3)
	<i>PROBIT</i>					
Parish Population	0.926*** (0.09)					
Parish over Canton Population		0.870*** (0.08)	0.866*** (0.08)			
Canton Population		0.923*** (0.09)	0.862*** (0.11)			
Poverty			-0.192** (0.08)			
Young			0.583 (1.21)			
Couple			0.286* (0.16)			
Occupancy			-0.708* (0.39)			
Schooling			0.291* (0.16)			
Business			0.009 (0.02)			
Foreigners			-0.011 (0.05)			
Migratory balance			-14.418** (7.24)			
	<i>OLS</i>			<i>OLS</i>		
Parish Population	-0.244*** (0.06)			0.453*** (0.02)		
Parish over Canton Population		-0.276*** (0.05)	-0.256*** (0.05)	0.512*** (0.02)	0.454*** (0.03)	
Canton Population		-0.267*** (0.05)	-0.328*** (0.05)	0.679*** (0.03)	0.460*** (0.05)	
Poverty			-0.183*** (0.05)		-0.267** (0.11)	
Young			0.431 (0.49)		2.727*** (1.06)	
Couple			0.012 (0.21)		-0.252 (0.32)	
Occupancy			-0.332 (0.25)		-3.178*** (0.53)	
Schooling			0.234*** (0.06)		0.645** (0.29)	
Business			-0.095 (0.08)		-0.099 (0.10)	
Foreigners			0.058 (0.09)		0.048 (0.07)	
Migratory balance			-8.913* (5.21)		15.522* (9.40)	
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Canton Effect	Yes	No	No	Yes	No	No
Province Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
	<i>PROBIT</i>					
Pseudo R <sup>2</sup>	0.323	0.3076	0.317			
N° Observ.	3275	3593	2814			
	<i>OLS</i>			<i>OLS</i>		
Adjusted R <sup>2</sup>	0.494	0.3921	0.3814	0.387	0.199	0.243
N° Observ.	1267	1267	1015	2919	2919	2209

Note: \* p<0.01, \*\* p<0.05, \*\*\* p<0.01. Robust standard errors in parentheses. Continuous variables in logarithms. Sample of parishes with more than 2,000 inhabitants



## 4.6. CONCLUSION

This study provides new evidence regarding the impact of city size on crime rates. The literature on urban crime defines the urban crime premium as the fact that “*Crime rates are much higher in big cities than in small cities or rural areas*” (Glaeser and Sacerdote, 1999, page S225). This hypothesis has been confronted with the data in cities of the United States (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015) but has been often disregarded in the case of developing countries. Our aim is to test the existence of an urban crime premium in Ecuador.

To this concern, we first test whether city size increases the crime rates in Ecuador, using data on crime at the urban parish (parishes with more than 2,000 inhabitants) level. We provide estimates of the urban crime premium by distinguishing property crimes and homicides. The location choice of individuals provides the economic incentives to perform property crimes by taking advantage of the population density (Verdier and Zenou, 2004; Gaigné and Zenou, 2015). Meanwhile, the discriminatory social conditions cause frustration and, therefore, trigger violent reactions, *whatever the population density* (Merton, 1938; Dollard *et al.*, 1939). Thus, our intuition is that the urban crime premium primarily encourages individuals to commit property crimes rather than homicides.

Our empirical strategy extends the existing literature on the urban crime premium by estimating crime rates at a low geographic level over the period 2010–2015, in contrast to existing cross-section studies at the inter- or intra-metropolitan levels (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015). Given that a large proportion of urban parishes has zero homicides (64%), we use a Two-Part model to estimate the effect of city size on homicide rates. The TPM is appropriate in this case because it accounts for the existence of genuine zeros and for independent participation and consumption decisions. We perform a linear regression model to estimate the effect of city size on property crime rates because only 6% of urban parishes have zero property crimes.

Linear estimates show that the parish population exerts a positive effect on both the homicide and property crime rates. By decomposing the influence of parish population into the relative parish population (parish over cantonal population) and the cantonal population, results show that both variables significantly raise crime rates. However, the net influence of cantonal population is much lower than the influence of the parish population.

Further estimates on homicide rates, using the two-part model, show that the probability that a homicide occurs is higher in most populated parishes and parishes belonging to most populated cantons, as predicted by the urban economics literature (Gaigné and Zenou, 2015). However, when the estimation restricts the sample to parishes with positive homicides, the results are reversed. The parish population (in absolute and relative terms) now exerts a negative impact on the homicide rate and it is significant at the 1% level. Therefore, one conclusion is that the parish population has a non-linear influence on the homicide rate. These results remain valid under alternative estimates that: i) decompose the effect of population between density *versus* surface area effects, and ii) test the urban crime premium in areas characterized by different levels of urbanization (rural parishes, capital parishes and FUAs). Our potential explanations for the negative impact of population on the homicide rate are based on the fact that killing someone on purpose is a very specific criminal activity that involve emotional factors rather than economic incentives.<sup>114</sup> Criminals and victims of homicides often know each other before the crime happens. The homicides are also more likely to occur in private rather than in public areas.

Our methodology also tests the Glaeser and Sacerdote (1999)’s assertion in areas with different levels of urbanization. Findings show that the probability that a homicide occurs in FUAs is higher

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<sup>114</sup> Except in the case of contract-killings, in which the offender receives an economic return from killing a very well identified victim.

than in rural parishes. Conversely, the homicide rate decreases more in rural parishes than in FUAs. This result might be related to the stronger social sanction effect in small areas as predicted [Buonanno \*et al.\* \(2011\)](#).

Finally, it is noteworthy to mention the limits of this study and the avenues for future research. The first drawback is the limited temporal analysis. Because the Security Institutions search to increase the quality of data, the methods of data collection are continuously updated and do not provide long time series of crime rates. A second limitation is due to the way we deal with zero data on homicides. There are alternative ways of dealing with this issue, such as the negative binomial model, which we will implement as a robustness check. A third way to improve this work will consist in disaggregating property crime data in sub-categories such as thefts of vehicle or vehicle accessories, burglaries, and robberies against people and thefts against institutions.

This chapter estimates the city size - crime relationship in a developing country. One might regret that we do not explore some of the mechanisms behind this relationship. According to [Gaigné and Zenou \(2015\)](#), larger cities would be characterized by higher crime rates because they enjoy higher nominal wages, cost of commuting and land rents. These features are considered as fundamental aspects of urban development. However recent studies also denote that in developing countries, some characteristics are opposed to the urban economics predictions. For example, [Duranton \(2016\)](#) points out that in Colombia, the (external) market access exerts a negative impact on wages, and that agglomeration economies are stronger in the informal sector where workers are younger and less educated. Therefore, a future research could be to analyze how agglomeration economies can shape the city size - crime connection in the case of developing countries. To explore such mechanisms in Ecuador, one can obtain relevant information about wages and the cost of living in Ecuador from the Consumer's Price Index, the Living Conditions survey and the Socioeconomic Stratification survey.<sup>115</sup>

Lastly, there might be a crime-resource curse (paradox of countries with large concentration of natural resources that have poor economic growth, poor institutional presence and high level of crime) in some parishes characterized by a high concentration of natural resources. According to [Couttenier \*et al.\*, \(2017\)](#), early mineral discoveries in the USA are associated with higher levels of interpersonal violence in the past and today. This might result from the fact that the rents associated with those resources provide both the incentives and the means to corrupt political institutions. This can be also the case in Ecuador where there is a large concentration of natural resources (e.g. wood, gold, silver) and a poor local institutional presence ([Harrendorf and Smit, 2010](#)). Therefore, another call for research could be the analysis of the role of local institutions on crime in parishes where there are deposits of natural resources.

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<sup>115</sup> The Consumer's Price Index measures the variation of the average cost of goods and services consumed by households, expressed in relation to a base period. The Living Conditions survey collects information about the different living conditions of the Ecuadorian households. The Socioeconomic Stratification survey provides an adequate segmentation of the consumer market based on the characteristics of households (e.g. education, dwelling, access to information technologies, etc.).



# 5. SOCCER, EMOTIONS AND CRIME: ESSAY AT THE INTRA-CITY LEVEL

## 5.1. INTRODUCTION

Soccer is the most popular and passionate sport in Latin America and the Caribbean. It generates millionaire investments in professional teams and players, marketing, media, etc. Based only on the market price of its players, the value of the French team winner of the FIFA 2018 world cup is around \$1,4 billion closely followed by Brazil, Spain and England. Regarding Latin American soccer teams which participated to the World cup, Argentina ranked 7<sup>th</sup> (\$785 million), Uruguay ranked 10<sup>th</sup> (\$457 million), Colombia ranked 13<sup>th</sup> (\$326 million), Mexico ranked 19<sup>th</sup> (\$190 million) and Peru ranked 29<sup>th</sup> (\$49 million).<sup>116</sup> The value of the national team of Ecuador is around \$35 million.

This sport is also a social phenomenon that gives rise to the construction of social and cultural identities, especially in Latin America countries (Pérez, 2006). Fans recognize themselves as part of a soccer culture, in which they support and defend the performance of teams and players against rival fans. In Ecuador, soccer has engendered historical rivalries between supporters from the most important cities. In Guayaquil (Coast), Barcelona S.C. and Emelec play the most important derby, named “Clásico del Astillero”. In Quito (Andes), LDU Quito and El Nacional play the derby “Clásico Capitalino”. Interestingly, the rivalry between Barcelona S.C. and LDU Quito have marked regional differences in supporters from both teams (Magazine *et al.*, 2010).

In parallel to social and economic phenomena, soccer like other sports engenders a social cost. The white collar criminality is frequent and the recent FIFA corruption scandal is only the most visible among many others in national leagues.<sup>117</sup> These scandals are the most mediatized but represent a marginal part of the social cost of soccer compared to street criminality or violence in family context that soccer events directly or indirectly generate. This chapter evaluates the impact of soccer events of the Ecuadorian Soccer National League on the incidence of this kind of crimes within capital cities of 16 cantons. Given the importance of soccer and criminal activities in the Ecuadorian society, one may expect a strong relationship. Our contribution explores this relationship by disentangling its temporal, spatial and emotional dimensions.

Empirical evidences confirming that crime increases in the presence of sporting events are now numerous and soccer is not the only sport to be concerned. In the United States, the National Football League (NFL) is associated with increases of larceny and vehicle thefts (Kalist and Lee, 2014) and gender violence (Card and Dahl, 2011; Gantz *et al.*, 2006). The National Basketball Association (NBA) games also induce some peaks of crime. In Memphis (Tennessee), the number of individual robberies increases by 19% during NBA home games (Yu *et al.*, 2015). The college basketball competitions are also associated with a 31% increase of individual robberies during home games (Yu *et al.*, 2015). Meanwhile, college football home games increase the number of offenses related to assaults by 9%, vandalism by 18%, disorderly conduct by 41%, liquor law

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<sup>116</sup> See updated statistics online at the Transfermarkt website: <https://www.transfermarkt.es/>. The World Cup also generated large investments in marketing (\$2.4 billion), which represents a 10% increase in global marketing destined to 3.5 billion spectators worldwide ([www.eleconomista.es](http://www.eleconomista.es)). The LAC media firms are expected to increase in marketing investment by 4% (<https://es.statista.com/>).

<sup>117</sup> In 2006, five Italian soccer teams were accused of conspiring to assign favorable referees in featured matches. In 2011, 41 South Korean soccer players were punished for receiving bribes to lose matches. In 2015, several FIFA officials and associates were accused of corruption, money laundering, wire fraud and racketeering. In 2015, the Ecuadorian referee Byron Moreno was accused of conspiring to let win South Korea in the 2002 FIFA World Cup versus Spain.

violations by 76% and driving under the influence of alcohol or drugs by 13% (Rees and Schnepel, 2009).

This over-representation of crime during sport events may be explained by various arguments and mechanisms.

Marie (2016) suggests three channels. First, cities hosting major sporting events (e.g. professional soccer or basketball leagues) receive large crowds of rival fans. This *fan concentration* leads to an increased risk of potential confrontations that worsens with derbies, play-offs and alcohol consumption. Second, cities that host matches see large numbers of police officers deployed inside and near the sports facilities. This *police concentration* makes other areas attractive targets for delinquents. Third, fans (criminals and non-criminals) attending sports substitute other activities for those events. This creates a *self-incapacitation* effect as criminals are kept away from illegal activities during the match. Using data of home and away matches of nine London soccer teams, Marie (2016) finds that violent crime is significantly associated with derbies. This suggests that fan concentration with strong rivalry increases the number of violent confrontations. Vehicle theft and shop theft are also associated with home and away soccer matches. Those crimes happen far from stadiums suggesting that both police concentration and self-incapacitation are at work during soccer matches.

Other empirical studies more accurately explore the temporal, spatial and emotional dimensions of crime during sporting events. Most of them analyze these three dimensions separately.

Empirical evidence regarding the temporal pattern of crime suggests that a larger number of offenses occurs at night, on weekends, on holidays and in summer (Doleac and Sanders, 2015; Montolio and Planells-Struse, 2016). During the day, the peak of offenses at different hours depends on the type of crime. For example, robbery and theft first rise in the morning, fall at noon and then rise again in the afternoon. Violent crime and gender violence increase during the day but peak in the evening whereas crime against police and driving crime increase from 00:00 until 03:00.<sup>118</sup> Interestingly, the existence of sporting events alters this temporal profile of crime. Montolio and Planells-Struse (2016) analyze this effect with data of F.C. Barcelona (FCB) soccer matches in Barcelona (Spain). Findings reveal different effects of home and away matches in the pre-match and post-match hours depending on the type of crime. When FCB plays at home, thefts increase two hours before the match, reach the peak one hour after the match and continue throughout the night. The crimes against police fall before the match but increase two - three hours after the home match. When FCB plays away, the crimes against police, violent crimes and driving crimes also increase in the city of Barcelona.

Sporting events also alter the spatial dimension of crime in two ways. On the one side, a concentration effect attracts delinquents to sport facilities because of the large number of suitable victims there (Eck *et al.*, 2007). On the other side, a spillover effect encourages delinquents to operate in areas far from stadiums because of the high concentration of police in sport facilities (Marie, 2016). Empirical studies use geospatial data on crime to identify the location of offenses and the association to sporting events. On match days, crime increases near sports facilities (within 0.5 miles) and decreases further away (up to 2 miles) compared to non-match days (Billings and Depken, 2011). In London, the number of violent crimes is four times higher near the Wembley stadium on match days compared to non-match days (Kurland *et al.*, 2013).

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<sup>118</sup> Montolio and Planells-Struse (2016) define the robbery and theft as misappropriation of others belongings with violence in the former and without violence in the latter; the violent crimes are physical injuries from one to another person; gender violence refers to the physical and psychological violence at home; the crimes against police include resistance and aggressions against police officers; the driving crimes refer to driving under the influence of drugs or alcohol.

Crime peaks may also be associated with emotional factors directly generated from results of sporting events. The well-known “frustration - aggression hypothesis” claims that people become aggressive when they find interferences in the achievement of a goal (Dollard *et al.*, 1939). Berkowitz (1989) reformulates this hypothesis and proposes that unexpected interferences lead to greater displeasure and more aggressive reactions than expected interferences. Empirical studies have confronted this hypothesis with data of sporting events and crime. In Sweden, the hooligan violence appears in response to a worse performance of the soccer team that fans support compared to the previous season (Priks, 2010). In the United States, the number of assaults, vandalism and unlawful behavior of fans increases due to upset results (defeated ranked teams by unranked teams) of college football games (Rees and Schnepel, 2009). The incidence of domestic violence is also related to upset losses of football matches in the NFL league. The rate of domestic violence increases by 10% due to upset losses, by 13% in playoffs, by 20% in rivalry games (Card and Dahl, 2011) and the effect continues during the three following days (Gantz *et al.*, 2006).

The literature cited above is mainly dedicated to developed countries. The conclusion that sport meetings may generate peaks of violence provides some rigorous elements for policy makers to reduce violence, and therefore, the social cost of such events. There is no reason to expect that such relationship vanishes in the context of developing countries and especially in Latin America and the Caribbean. On the contrary, given the importance of soccer and violence in LAC countries, one may consider that a greater attention should be devoted to soccer-related violence and crime in these countries. In particular, given the emotional dimension of soccer in Latin American and Caribbean societies, they offer a well-adapted context to estimate the effects of frustration and euphoria on crime. To the best of our knowledge, the study by Munyo and Rossi (2013) is the only one that explores the effect of soccer on crime in a Latin American context. Precisely, they quantify frustration and euphoria effects after unexpected vs. expected results of Peñarol and Nacional soccer teams on crime in Montevideo (Uruguay).<sup>119</sup> Findings reveal that frustrating losses increase the number of robbery whereas euphoric wins reduce it. Both effects are significant only in the first post-match hour. However, there are two important limitations in this study. First, Munyo and Rossi (2013) do not capture spatial spillovers of crime in Montevideo. If sporting events alter the spatial profile of crime during matches, criminals may prefer to operate either near stadiums (due to the high concentration of fans) or further away (due to the high concentration of police in stadiums). Second, they do not capture the effects of frustration and euphoria in the rest of the country. Since 81% of Uruguayans are fans either of Peñarol or Nacional<sup>120</sup>, one can expect the emotions to engender crime throughout Uruguay, not only in Montevideo.

We alleviate these limits in this chapter by estimating the effect of the Serie A soccer matches on the number of homicides and property crimes within capital cities of 16 cantons over the 2010-2015 period. Specifically, we investigate whether the presence of home soccer matches increases the number of homicides and property crimes in Ecuador. More importantly, we identify whether soccer alters the temporal, spatial or emotional dimensions of crime in order to recognize any effects of self-incapacitation, fan concentration or police concentration. To do so, we collect information on the date, hour and place of 1,600 Serie A soccer matches played in 16 cantons and combine with exact information on the date, hour and place where offenses happened. This information enables to identify the number of crimes that occurs before, during or after soccer matches (temporal dimension); near or further away from stadiums (spatial dimension). The information of odds in the betting market enables to identify any emotions of frustration or euphoria associated with the results of soccer matches in Ecuador (emotional dimension).

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<sup>119</sup> Munyo and Rossi (2013) indicate that frustration occurs when the unexpected loss is higher than the expected loss, while euphoria occurs when the unexpected win is higher than the expected win.

<sup>120</sup> In 2013, 46% of Uruguayans declared to be fans of Peñarol and 35% declared to be fans of Nacional, <https://www.referi.uy/encuesta-46-son-hinchas-penarol-y-35-nacional-n261045>.



As it is often the case in the economics of crime literature, our main findings depend on the type of crime. At the aggregate level, the temporal analysis reveals that soccer matches at home increase the number of homicides by 0.18% before the match and the number of property crimes by 12% after the match, near the stadium. Specifically, soccer matches increase the number of robberies against persons by 4%, burglaries by 2%, vehicle thefts by 1% and vehicle accessory thefts by 5%, near stadiums, in the post-match hours. The spatial analysis confirms spatial spillovers of crime in locations that are distant from the stadium. Soccer matches at home decrease the number of property crimes by 0.88% before the match and the number of homicides by 0.05% during the match, in locations far from the stadium. Conversely, homicides and property crimes significantly increase after the match, in these distant locations. These effects can be associated to interpersonal confrontations in the case of homicides and to pecuniary opportunities in the case of property crimes. The emotional analysis reveals no significant effects of soccer matches on homicides or property crimes at aggregate level. However, the coefficients of emotions (frustration and euphoria) are significant on homicides that occur in Quito. The U-Shaped distribution suggests that supporters of teams representing Quito commit violent acts when confronted with intense frustration or intense euphoria. Local newspapers confirm this fact in Quito. Finally, the existence of derbies significantly increases the number of property crimes by 15% (no significant effects on homicides).

The remainder of the chapter is organized as follows. Section 5.2 presents the data on soccer and crime. Section 5.3 describes the temporal, spatial and emotional dimensions of crime in Ecuador. Section 5.4 presents the econometric model while Section 5.5 presents and comments the results. Section 5.6 concludes.

## 5.2. DATA

### 5.2.1. SOCCER DATA

The dataset gathers information on the National Championship of Soccer named the First Division “Serie A” in Ecuador, in the 2010-2015 period. The Serie A is a 12-team tournament played in two stages of six months. The champions of both stages compete in the playoffs to win the National Cup.<sup>121</sup> In the period of analysis, 1,600 soccer matches were played by 19 teams in 16 cantons of Ecuador. These 16 cantons are capital cities of provinces<sup>122</sup> and represent 54% of the Ecuadorian population.

Figure 5.1 presents the geographical distribution of teams and stadiums in the cantonal map of Ecuador. To facilitate the reading, Table 5.1 describes the distribution of teams and stadiums by canton. Five teams play at home in Coastal cantons while 14 teams play at home in Andean cantons. The existence of derbies is usual in Guayaquil, Ambato and Quito because several teams play there. In the 2010-2015 period, there were 176 derbies in these cantons. The three teams of Guayaquil play in different stadiums while the three teams of Ambato play at home in the Bellavista stadium. The case of Quito exposes the most difficult distribution because the stadiums are located throughout the canton. LDU Quito and Aucas have their home stadiums in the northern and southern part of the canton, respectively. Meanwhile, Nacional, Dep. Quito and U. Católica play at home in the Atahualpa stadium, located in the center of Quito. As expected, the existence of derbies

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<sup>121</sup> At the end of each stage, the two lowest-ranked teams will play, the next period, in the Second Division “Serie B” of soccer. In the contrary, the two best-ranked teams of the Second Division will play, the next period, in the First Division.

<sup>122</sup> The cantons Milagro, Quevedo, Manta and Rumiñahui are not capitals of provinces but constitute important economic centres near the capitals.



poses a potential risk of violent confrontations between fans. The most dangerous scenarios stand in Quito and Guayaquil since half of matches are played there.

This dataset also considers six replacement stadiums even if there are no professional teams playing there regularly. When violent confrontations take place during any match, the Federación Ecuatoriana de Fútbol (FEF) authorities impose a punishment on the team by prohibiting the use of the stadium.<sup>123</sup> In consequence, the punished team must play the next match in another stadium. Although cantons with replacement stadiums can be quite peaceful, the number of crimes may exceptionally increase with the presence of a soccer match. Additional descriptive statistics regarding the distribution of matches by team and stadium are provided in [Appendix 5.A](#).

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<sup>123</sup> The FEF punished the teams 58 times in the period 2010-2015.

Figure 5.1 Map of distribution of teams and stadiums, at cantonal level

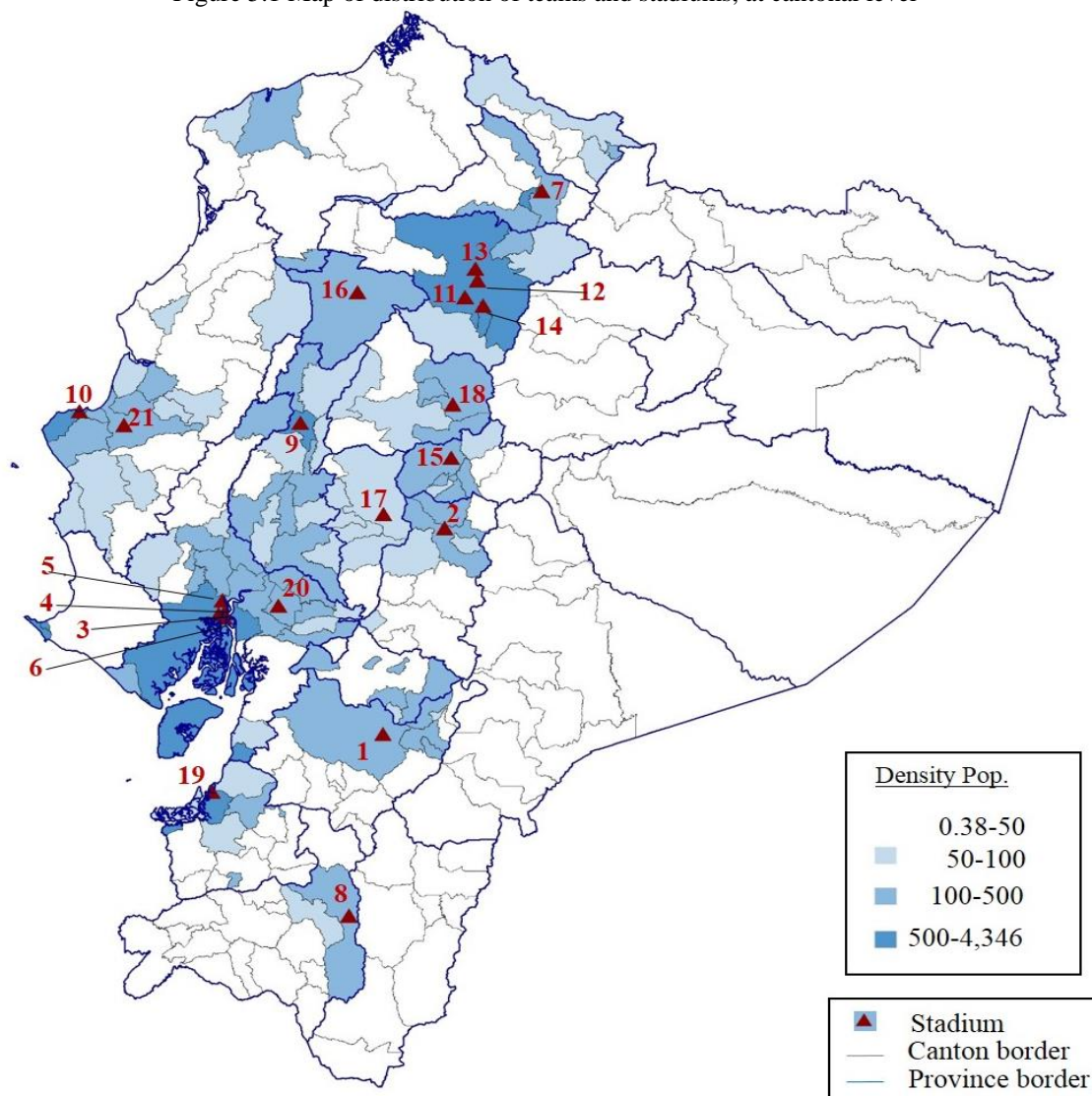


Table 5.1 Distribution of teams and stadiums by canton

Nº	Canton	Stadium	Teams
1	Cuenca (Andes)	Alejandro Serrano Aguilar	Deportivo Cuenca
2	Riobamba (Andes)	Olímpico de Riobamba	Olmedo
3	Guayaquil (Coast)	Monumental Banco Pichincha	Barcelona Sporting Club
4	Guayaquil (Coast)	George Capwell	Emelec
5	Guayaquil (Coast)	Christian Benítez Betancourt	River Plate Ecuador
6	Guayaquil (Coast)	Modelo Alberto Spencer	<i>No team</i>
7	Ibarra (Andes)	Olímpico de Ibarra	Imbabura Sporting Club
8	Loja (Andes)	Federativo Reina del Cisne	Liga Deportiva Universitaria Loja
9	Quevedo (Coast)	7 de Octubre	Deportivo Quevedo
10	Manta (Coast)	Jocay	Manta
11	Quito (Andes)	Gonzalo Pozo Ripalda	Aucas
12	Quito (Andes)	Atahualpa	El Nacional, Deportivo Quito, Universidad Católica
13	Quito (Andes)	Casa Blanca	Liga Deportiva Universitaria Quito
14	Rumiñahui (Andes)	Rumiñahui	Independiente del Valle
15	Ambato (Andes)	Bellavista	Macara, Técnico Universitario, Mushuc Runa
16	Sto. Domingo (Andes)	Etho Vega	Espoli
17	Guaranda (Andes)	Centenario de Guaranda	<i>No team</i>
18	Latacunga (Andes)	La Cocha	<i>No team</i>
19	Machala (Coast)	9 de Mayo	<i>No team</i>
20	Milagro (Coast)	Los Chirijos	<i>No team</i>
21	Portoviejo (Coast)	Reales Tamarindos	<i>No team</i>

Eighty percent of soccer matches were played during weekends between 09:00 and 20:59 (Table 5.2).<sup>124</sup> The FEF organizes the dates of the tournament, but the local teams can suggest the time of the match they prefer to play, according to agreements with the FEF committee and based on broadcasting rights on national television.<sup>125</sup> The temperature of the home canton can be another factor on the time decision because the performance of teams and match attendance might vary depending on temperature and rain. In general, the teams from the Andes prefer to play in the morning and noon when the temperature is high in Andean cantons. The teams from the Coast prefer to play in the afternoon and evenings when the temperature and the level of humidity fall in the Coastal cantons.<sup>126</sup>

Table 5.2 Distribution of soccer matches by day and hour window

	09:00 - 11:59	12:00 - 14:59	15:00 - 17:59	18:00 - 20:59	21:00 - 23:59	Total
<b>Monday</b>	0	0	1	14	0	15
<b>Tuesday</b>	1	1	2	8	0	12
<b>Wednesday</b>	4	24	43	193	1	65
<b>Thursday</b>	2	4	4	10	0	20
<b>Friday</b>	2	12	14	155	0	183
<b>Saturday</b>	16	98	212	93	0	419
<b>Sunday</b>	176	322	174	14	0	686
<b>Total</b>	201	461	450	487	1	1,600

### 5.2.2. CRIME DATA

Recall that Ecuador is organized in 24 provinces, 221 cantons and 1,024 parishes. Urban parishes host more than 2,000 inhabitants and can be either the capital of canton or peripheral parishes whereas rural parishes host less than 2,000 inhabitants.

The data on homicides comes from the Ministry of Interior (MDI), which collects the information at the *police precinct* level. The police precinct is an administrative organization of the National Police that not necessarily fits the Political Administrative Division. There are 1,134 police precincts throughout the country. Each police precinct corresponds to an area with, on average, 11,000 inhabitants.<sup>127</sup>

The data on property crimes comes from the Attorney General’s Office (FGE), which collects the information at the parish level. There are two important precisions about this data. First, FGE identifies the location of offenses *within* the capital parish of each canton.<sup>128</sup> This geographic area can be considered as a good proxy of neighborhoods that compose capital parishes. We exploit the benefits of this detailed information at a very local geographic level by quantifying the number of property crimes that occurred there. To ease the reading, we will refer to the ‘within capital parish level’ simply as the ‘neighborhood level’. Second, the FGE classifies the property crimes as robbery against persons (39%), burglary (16%), vehicle theft (12%), vehicle accessories theft (12.8%) and others.<sup>129</sup>

As MDI and FGE report the data on crime at different geographic levels, we build two databases. The first database combines the information of soccer with homicides at the police precinct level.

<sup>124</sup> Note also that the number of matches is much lower in January, June and December (see Appendix 5.A).

<sup>125</sup> See websites at <http://www.ecuafutbol.org>, <http://www.futbolecuador.com>, <https://www.eluniverso.com>.

<sup>126</sup> The temperature in the Andes varies between 9°-20° in the day while the temperature in the Coast varies between 20°-30° in the day.

<sup>127</sup> Descriptions are found on institutional websites online at <http://www.planificacion.gob.ec/3-niveles-administrativos-de-planificacion/> and <http://www.planificacion.gob.ec/folleto-popular-que-son-las-zonas-districtos-y-circuitos/>.

<sup>128</sup> The complete distribution of the number of crimes, regarding the jurisdiction where the crime occurred, is presented in Appendix 5.B.

<sup>129</sup> Definitions are presented in Appendix 1.B.

Regarding capital parishes of the 16 cantons to which the “Serie A” teams belong to, we are left with 5,051 homicides (51% of total homicides) over the period 2010-2014. The second database combines information of soccer with property crimes at the neighborhood level. We are left with 258,420 property crimes (66% of total property crimes) that occurred within 151 capital parishes, over the period 2012-2015.

### 5.3. THE DIMENSIONS OF CRIME

This section first presents some stylized facts of the temporal (Section 5.3.1) and spatial (Section 5.3.2) dimensions of crime. Then, we define the identification strategy to capture the influence of emotions such as frustration and euphoria caused by soccer results (Section 5.3.3).

#### 5.3.1. TEMPORAL DIMENSION

Time influences the behavior of victims and criminals. Most people go outside home in summer, on weekends, and also commute daily to work or to study. Therefore, delinquents find higher expected returns to crime from suitable victims at specific times (Doleac and Sanders, 2015; Montolio and Planells-Struse, 2016). These temporal patterns depend on the type of crimes (property or violent) and can show displacements attributable to major events (e.g. concerts, sports). This section explores the daily and hourly patterns of crime in Ecuador conditional on the existence of soccer matches.

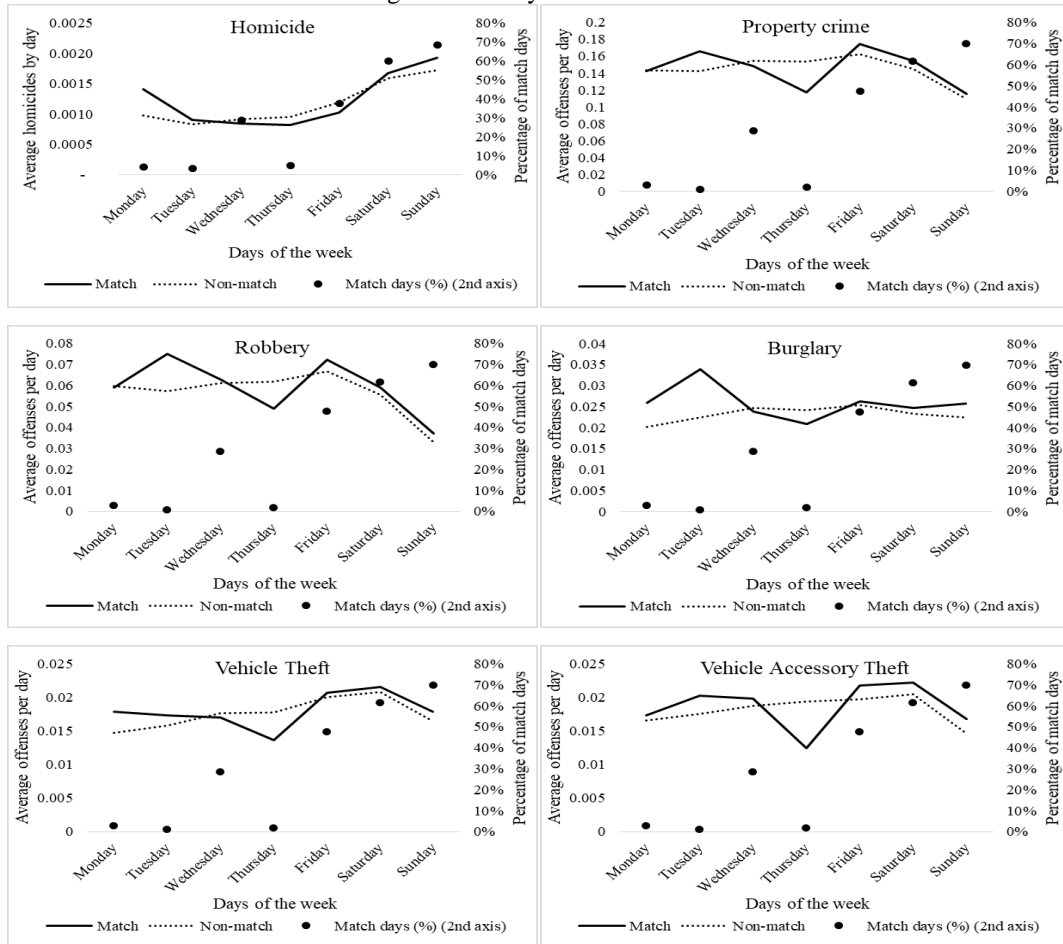
We first describe the daily pattern of crime on match *versus* non-match days to identify any possible temporal displacement effect (Montolio and Planells-Struse, 2016). Figure 5.2 depicts the daily average number of crimes conditional on match days and non-match days. The solid lines represent the average number of crimes in the presence of soccer matches whereas the dotted lines represent the average number of crimes when no soccer matches were played during the day. The bulleted points indicate the percentage of days during which there was a soccer match. In Ecuador, most matches are played on Wednesdays, Fridays, Saturdays and Sundays.<sup>130</sup>

The trend of the average number of homicides reflects a weekend effect: their number increases from Thursday to Sunday, especially during no working days. However, no marked differences arise in the presence of match and non-match days. The average number of property crimes reflects a slightly increasing trend on weekdays in the absence of soccer matches. By contrast in the presence of matches, the number of property crimes vary depending on the day and the type of offense. In general, robbery against persons and burglary first rise on Tuesday, fall until Thursday, rise again on Friday, and finally fall on weekends. Regarding vehicle theft and vehicle accessory theft, we observe an under-representation of offenses during match days that take place on Thursdays.

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<sup>130</sup> In the period of analysis, there were soccer matches in 60% of Saturdays and 70% of Sundays.

Figure 5.2 Daily crime evolution



To go more into detail, we now explore the time pattern by analyzing the hourly distribution of crime. Figure 5.3 depicts the hourly patterns of crime, expressed as the average number of offenses by date and hour window. We disaggregate the timing into 3-hour periods starting at midnight. The 3-h window is appropriate to capture any soccer-related effects because the matches roughly last two hours and most of them start on the dot hours (63.4% of soccer matches). These hour breakdown also isolates the case of duple-games (two consecutive soccer matches played the same date in the same stadium).<sup>131</sup> All panels differentiate the hourly patterns of crime conditional on match and non-match days/hours. The solid lines represent the average crimes in the presence of soccer matches and start at 09:00 a.m. (this is the earliest time that soccer teams play). The dotted lines represent the average number of crimes when no soccer matches were played during the day/hour window. The red vertical lines represent the most common hours at which soccer matches take place.<sup>132</sup>

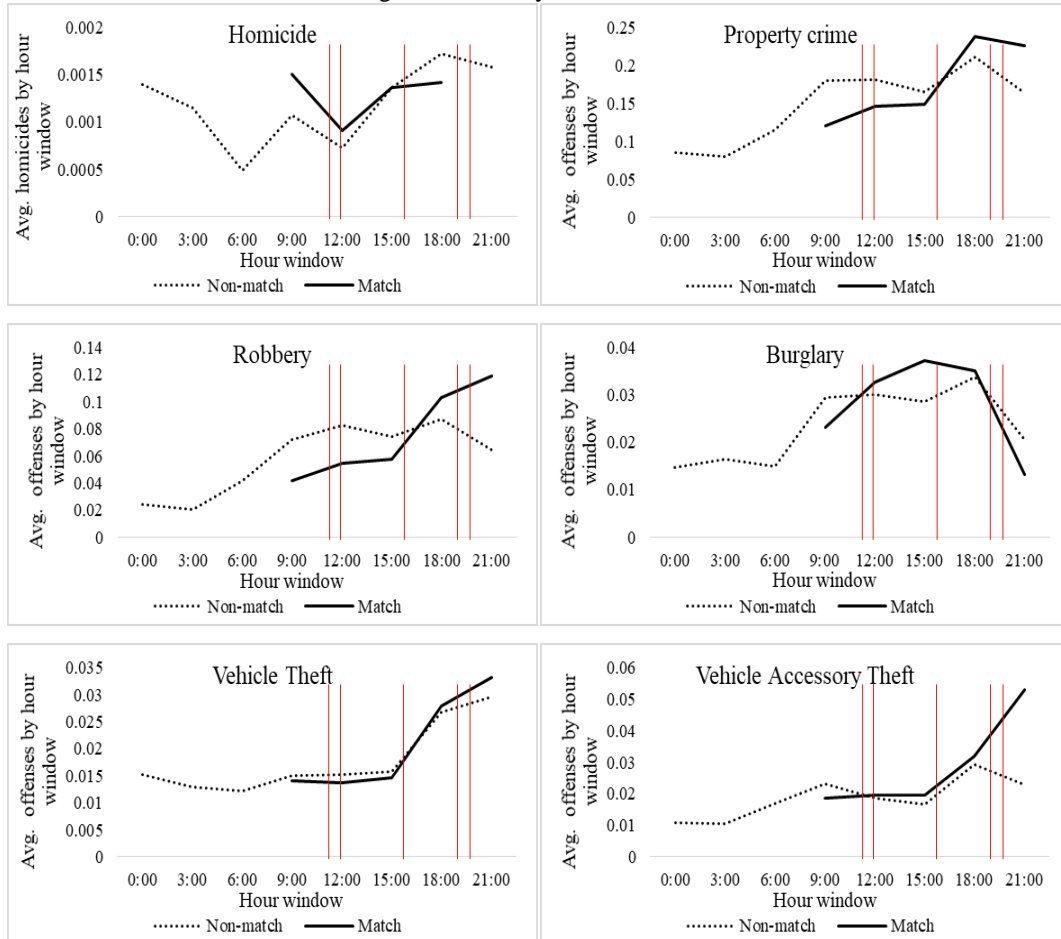
Regarding no-match trends, homicides fluctuate throughout the day but rise from the beginning of afternoon until midnight and then fall until sunrise. The average number of property crimes raises from 06:00 a.m., reaches a peak at 18:00, and then it falls. This hourly pattern is in accordance with the hours of entry and exit from work and school.

<sup>131</sup> In the period 2010-2015, there were 26 duple-games in the Atahualpa stadium. The objective of duple-games is to attract a large number of supporters to the stadium who pay one ticket to watch two consecutive soccer matches. Duple-games are more frequent in non-salient soccer matches.

<sup>132</sup> In the period 2010-2015, 9% of matches started at 11:30, 19% started at 12:00, 9% started at 16:00, 7% started at 19:00 and 7% started at 19:30.

Regarding match trends, the patterns are similar as in the case of no-match days/hours, but property crimes (except burglary) become heightened with soccer matches during the evening. Indeed, the average number of robbery against persons, vehicle theft and vehicle accessory theft surprisingly increase after soccer matches starting at 16:00. This increasing trend continues when soccer matches play at 19:00.

Figure 5.3 Hourly crime evolution



### 5.3.2. SPATIAL DIMENSION

The spatial dimension of crime has attracted great attention because of the observed higher crime rates in densely populated areas. Indeed, agglomeration provides high expected illegal returns, low probability of arrest, a large number of crime-prone individuals and a large number of social interactions, which encourage criminal activities (Freeman *et al.*, 1996; Gaigné and Zenou, 2015; Glaeser and Sacerdote, 1999; Liu *et al.*, 2013; Patacchini and Zenou, 2008; Zenou, 2003; Zenou, 2005). These factors can be strengthened in the presence of major events, as criminals can actively operate to take advantage of crowds (Billings and Depken, 2011). Soccer matches are a good example because thousands of people go to stadiums, bars and restaurants to watch games. These facilities constitute potential targets for pecuniary crimes and interpersonal confrontations. Soccer matches might encourage delinquents to commit crimes near stadiums. It is also possible that they prefer to operate further away, which gives rise to potential spatial spillover effects. To describe the spatial dimension of soccer and crime, we identify whether the offenses occurred in the



jurisdiction  $j$  (e.g. police precinct or neighborhood) the stadium belongs to or in the other jurisdictions  $(1 - j)$  of canton  $c$ .<sup>133</sup>

### 5.3.3. FRUSTRATION AND EUPHORIA

Sports cause intense emotions in supporters, inducing them to react aggressively when expectations on results are thwarted (Dollard *et al.*, 1939; Berkowitz, 1989; Card and Dahl, 2011; Gantz *et al.*, 2006; Priks, 2010; Rees and Schnepel, 2009). Munyo and Rossi (2013) identify how the violation of expectancies of soccer matches causes frustration or euphoria in supporters, thereby influencing their criminal behavior in Montevideo (Uruguay). This section explains our identification strategy to quantify the emotions of frustration or euphoria caused by the Ecuadorian Serie A soccer results, in the 2010-2015 period.

The methodology by Munyo and Rossi (2013) separates the effects of frustration and euphoria by comparing unexpected vs. expected results of Peñarol and Nacional soccer matches. They define  $W$  as the actual win result,  $L$  as the actual loss result and  $E(.)$  as the pre-game expectation. The impact of frustration is analyzed by comparing the number of crimes after unexpected soccer losses  $E(W)/L$  vs. expected soccer losses  $E(L)/L$ . The impact of euphoria is captured by comparing the number of crimes after unexpected soccer wins  $E(L)/W$  vs. expected soccer wins  $E(W)/W$ .

Our identification strategy follows the methodology by Munyo and Rossi (2013). However, we introduce some modifications to quantify the intensity of frustration and euphoria resulting from home soccer matches. Our identification strategy comprises four steps.

First, we identify the *actual* results of soccer matches. The dataset reports 759 soccer matches in which the home team won, 413 soccer matches in which the away team won and 428 matches that ended in a draw. Winner teams get a value of ( $W = 1$ ), loser teams get a value of ( $L = 0$ ) and both teams get a value of ( $D = 0.5$ ) when they drew.

Second, we collect information of the *expected* results of soccer matches using odds in the betting market. The dataset reports that home teams were expected to win in 1,237 soccer matches, away teams were expected to win in 362 matches and one match was expected to draw.

Table 5.3 presents a comparison of these actual results vs. expected results for the 1,600 soccer matches in Ecuador. Comparing the actual results and the expected results, we are left with 657 expected wins (home team expected to win and that won), 102 unexpected wins (home team expected to lose but that won), 261 unexpected losses (home team expected to win but that lost) and 152 expected losses (home team expected to lose and that lost). Draw results are also interesting. Home teams were expected to win in 319 soccer matches but the match ended in a draw. Reciprocally, away teams were expected to win in 108 soccer matches but the match ended in a draw.

Table 5.3 Comparison of Actual vs. Expected Results

		Actual Result			Total
		Home (Local team)	Draw	Away (Visitor team)	
Expected Result	Home	E(W)/W=657	319	E(W)/L=261	1,237
	Draw	0	1	0	1
	Away	E(L)/W=102	108	E(L)/L=152	362
Total		759	428	413	1,600

<sup>133</sup> It is noteworthy to mention that we regret that we do not capture spatial spillovers at the inter-canton level. As far as supporters can easily move between cantons, the existence of a soccer match might attract supporters from neighboring cantons to watch the match in the stadium. Thus, the canton hosting the match can be confronted with more interpersonal confrontations or delinquency related to soccer.

Third, we calculate the implied probabilities of soccer results using the inverse of betting odds for “Home”, “Draw” and “Away”.<sup>134</sup> The information of betting odds, presented in decimal values, indicates how much the betting house will pay when betting on a team. They also indicate which result is the most expected to occur (home team wins, away team wins or both teams draw). Table 5.4 illustrates this strategy using three real examples of soccer matches. Regarding the match Espoli vs. Manta, the betting house will pay \$2.29, for each dollar invested, when betting on Espoli and \$2.75 when betting on Manta. These odds indicate that Espoli is the team that is most expected to win. The inverse of odds (e.g.  $1/2.29 = 0.44$ ) serves to calculate the implied probabilities of results. Since the inverse odds for home, draw and away do not exactly sum 1; we divide each inverse odds by their sum ( $0.44/1.11 = 0.39$  for the first example) to get the corrected implied probabilities. Thus,  $P(H)$  is the (corrected) implied probability that the home team wins the match,  $P(A)$  is the (corrected) implied probability that the away team wins the match and  $P(D)$  is the probability that both teams draw. In the example, the probability that Espoli wins is  $P(H) = 0.39$ , the probability that Manta wins is  $P(A) = 0.33$  and the probability that both teams draw is  $P(D) = 0.28$ .

Table 5.4 Actual results and betting odds. Three real examples

Team		Raw Result	Winner	Bet 365-Decimal			Implied Probab.			Corr. Implied Probab.			Emotions	
Home	Away			Home	Draw	Away	Home	Draw	Away	Home P(H)	Draw P(D)	Away P(A)	Home	Away
Espoli	Manta	2:0	Home	2.29	3.21	2.75	0.44	0.31	0.36	0.39	0.28	0.33	0.61	-0.33
Dep. Quito	LDU Quito	0:1	Away	2.95	3.22	2.14	0.34	0.31	0.47	0.30	0.28	0.42	-0.3	0.58
Ind. Valle	U. Católica	1:1	Draw	2.1	3.25	3.18	0.49	0.31	0.31	0.44	0.28	0.28	0.06	0.22

Note: The three matches were played on March, 6<sup>th</sup> 2010.

Fourth, we quantify the emotions of frustration and euphoria caused by unexpected vs. expected soccer results by an index that lies in the interval  $[-1,1]$ . A negative value captures the frustration when the actual result is worse than the expected result. A positive value captures the euphoria when the actual result is better than the expected result. The emotions of supporters of the home team are measured by the eq. (5.1):

$$Home\_react = (W, L, D) - P(H) \quad (5.1)$$

where  $(W, L, D)$  is one of the three possible options of actual results that the home team can get: win  $W$ , lose  $L$  or draw  $D$ . Reciprocally, the reactions of supporters of the away team are measured by the eq. (5.2):

$$Away\_react = (W, L, D)' - P(A) \quad (5.2)$$

where  $(W, L, D)'$  is the corresponding result regarding the away team. In the first example (Table 5.4), Espoli won the match 2:0 to Manta. Thus, we quantify the emotions of supporters of Espoli in  $W - P(H) = 1 - 0.39 = 0.61$  and the emotions of the supporters of Manta in  $L - P(A) = 0 - 0.33$ . In the second example, Dep. Quito lost at home vs. LDU Quito. The emotions of supporters of Dep. Quito are quantified in  $L - P(H) = 0 - 0.30$  while the emotions of supporters of LDU Quito are  $W - P(A) = 1 - 0.42 = 0.58$ . In the last example, Ind. Valle and U. Católica drew 1:1. The emotions of supporters of Ind. Valle are quantified in  $D - P(H) = 0.5 - 0.44 = 0.06$  and those for the supporters of U. Católica are  $D - P(A) = 0.5 - 0.28 = 0.21$ . To summarize the results, soccer matches engendered frustration to supporters of Manta and Dep. Quito and euphoria to supporters of Espoli, LDU Quito and U. Católica.

<sup>134</sup> The information on betting odds is available at the website online <https://www.bet365.es/>

Our methodology provides an index that measures the intensity of frustration and euphoria for supporters. Regarding the case of Espoli and LDU Quito, both teams were expected to win and won their matches (the former playing at home and the latter playing away). However, the level of euphoria of supporters of Espoli is larger because the expectations were lower as LDU Quito was expected to win. Regarding the case of Ind. Valle, the team was widely expected to win but drew. Our index reports a value close to zero in which we can interpret that supporters might be qualified as “calm” in average even if some of them may be frustrated by the result.

#### 5.4. ECONOMETRIC MODEL

Firstly, our econometric model tests whether the existence of home soccer matches increases the number of homicides and property crimes in Ecuador. Our intuition is that the existence of simultaneous or consecutive soccer matches in different cantons can induce some peaks of crime in various parts of the country. During soccer matches, thousands of supporters go to stadiums, bars and restaurants to watch the match. This engenders a potential risk of delinquency and interpersonal confrontations not only in the vicinity of stadium but also in locations further away.

The dependent variable  $Crime_{j,t,h}^i$  stands for the number of offenses of type  $i$  (homicide or property crimes) reported in jurisdiction  $j$  (police precinct for homicides or neighborhood for property crimes) belonging to a canton, and that happened on date  $t$  at hour window  $h$ . The baseline regression is defined in eq. (5.3):

$$Crime_{j,t,h}^i = \beta Home_{j,t,h} + \gamma Derby_{c,t,h} + \varphi \mathbf{X}_{time} + \vartheta_j + \boldsymbol{\tau} + \varepsilon_{j,t,h} \quad (5.3)$$

where  $Home_{j,t,h}$  is a binary variable that takes the value 1 if a team representing the canton  $c$  plays in the home stadium, located in jurisdiction  $j$ , on date  $t$  at hour window  $h$ , 0 otherwise.  $Derby_{c,t,h}$  is a binary variable that takes the value 1 when both teams playing the match originally belong to the same canton, 0 otherwise.  $\mathbf{X}_{time}$  is a vector of time control variables such as hour window, day of the week, hour window by weekday, week of the year, month, year and holidays.<sup>135</sup>  $\vartheta_j$  controls for time-invariant jurisdiction fixed effects. Finally,  $\boldsymbol{\tau}$  controls for the characteristics of the match such as the stage (First season, Second season or Play-offs).

Secondly, our econometric model introduces the temporal, spatial and emotional dimensions of crime. We identify the number of homicides and property crimes occurring before, during or after home soccer matches; near stadiums or further away; and conditional on the role of frustration and euphoria. To identify the temporal displacement effect, let  $h = -1$  stands for the pre-match period (3-h window before the game starts),  $h = 0$  stands for the during-match period (3-h window during which the soccer match takes place) and  $h = 1$  stands for the post-match period (3-h window after the end of the match). To identify the spatial displacement effect, we introduce the binary variable  $(1 - Home_{j,t,h})$  that takes the value 1 in the remaining jurisdictions (of the canton) that does *not* host the stadium of the team playing at home, 0 otherwise.  $Home\_react_{j,t,h}$  quantifies the emotions of supporters of the home soccer teams. Then, the extended regression is specified in eq. (5.4):

$$Crime_{j,t,h}^i = \sum_{h=-1}^1 \beta_h Home_{j,t,h} + \sum_{h=-1}^1 \delta_h (1 - Home_{j,t,h}) + \psi_1 Home\_react_{j,t,h} + \psi_2 Home\_react_{j,t,h}^2 + \gamma Derby_{c,t,h} + \varphi \mathbf{X}_{time} + \vartheta_j + \boldsymbol{\tau} + \varepsilon_{j,t,h} \quad (5.4)$$

$\beta_h$  captures the temporal displacement effect of home soccer matches in the jurisdiction  $j$  where the home stadium is located during the period  $h$ .  $\delta_h$  captures the temporal and spatial spillovers of

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<sup>135</sup> Holidays include the National holidays (New Year’s Eve, Carnival, Easter, Christmas; Worker’s day, Death’s day; the National Independence; the Independences of Pichincha, Guayaquil, and Cuenca) and Local holidays (Local Independences and cantonal festivities).

crime related with home soccer matches during the period  $h$ . Specifically, it identifies whether or not a soccer match that takes place in a jurisdiction encourages crime in the remaining jurisdictions of the canton. This effect might occur before, during and after home matches. Finally,  $\psi_1$  captures the effect of emotions that supporters of the home team feel. We introduce its quadratic term to identify any possible non-linear effect of frustration and euphoria on crime.

We estimate the baseline and extended regressions using the Weighted Least Squares (WLS) method. This method is appropriate when the variance of residuals is not homogenous as indicates the Breusch-Pagan test for heteroscedasticity.<sup>136</sup> We also apply WLS considering the fact that more than one offense can occur in the same period of time and place. Therefore, we weigh up the observations using the number of offenses per date, hour and jurisdiction.

## 5.5. RESULTS

This section first discusses the results of our baseline regression to keep comparability with the existing studies that exploit the effect of sports on crime. Our principal contribution consists in analyzing the soccer-crime relationship at the aggregate level (in 16 cantons) and in each canton, in contrast to existing studies that analyze the case of one city. Section 5.5.1 presents the results of the effect of soccer matches played at home on the number of homicides and property crimes, in Ecuador. Then, we complement our study through the analysis of the temporal, spatial and emotional dimensions of soccer on homicides (Section 5.5.2) and on property crimes (Section 5.5.3). These estimates are performed at the aggregate level and in 16 cantons.

### 5.5.1. BASELINE ESTIMATES

Tables 5.5 and 5.6 present the results of home soccer matches on homicides and property crimes, respectively. First columns display the results at the aggregate level and subsequent columns present the results in each canton. All estimations control for derbies, time, jurisdiction and stage of the match fixed effects.

Let us first analyze the effect of soccer events on crimes at the aggregate level. Results show no significant effects of home soccer matches on homicides or property crimes, at the aggregate level. However, the existence of derby matches causes that the number of property crimes increases by 16%. This result is in line with the intuition that spatial concentration of rival fans creates a particular context of violence.

Results at the canton level present significant effects in specific cantons. Our unique context of cantons with replacement stadiums provides evidence that soccer matches influence the number of crimes in cantons that rarely host a match.<sup>137</sup> Significant coefficients of home soccer matches indicate that the number of property crimes increase in Machala but decrease in Milagro.<sup>138</sup> Observe that Barcelona S.C. and Emelec usually play in Milagro when punished by the FEF. As both teams attract thousands of supporters in Ecuador<sup>139</sup>, one can expect that a large number of police officers is deployed in Milagro. In consequence, the number of property crimes might fall

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<sup>136</sup> The Breusch-Pagan test indicates values of  $\chi^2=3.85e+06$  and  $p=0.0000$  for the estimation of homicides and  $\chi^2=4.63e+06$  and  $p=0.0000$  for the estimation of property crimes. In both estimations, we reject the null hypothesis of homogeneity of residuals.

<sup>137</sup> The cantons with replacement stadiums only host Serie A soccer matches when the FEF punishes a professional team due to violence in the stadium. Thence, the punished team must play the next match in another stadium. See the location of replacement stadiums in Section 5.2.1.

<sup>138</sup> In the 2010-2015 period, the cantons Machala and Milagro have hosted six and eight soccer matches (after a punishment), respectively. Other cantons with replacement stadiums are Guaranda, Latacunga and Portoviejo.

<sup>139</sup> On Facebook, there are more than 3 million followers of Barcelona S.C. and more than 300 thousand followers of Emelec.

due to the concentration of police in the canton. Unfortunately, we cannot control for the number of police officers in stadiums due to the lack of data availability. Finally, the existence of derbies increases the number of property crimes by 24% in Guayaquil and by 10% in Quito.<sup>140</sup>

In order to better recognize the mechanisms that alter crime during sporting events, it is essential to identify the exact time and place in which crimes often occur. This information enables us to capture any temporal and spatial displacements on crime associated to soccer. In addition, soccer matches can provoke emotional reactions on fans that could lead to criminal activities. The methodology, proposed in Section 5.3.3, provides an index that measures the intensity of frustration and euphoria associated to soccer results. Sections 5.5.2 and 5.5.3 present the estimates that capture the temporal, spatial and emotional effects of soccer on homicides and property crimes, respectively.

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<sup>140</sup> The effect in Guayaquil might be related to the most important derby in the country, named “Clásico del Astillero” (Barcelona vs. Emelec), which attracts, on average, 23,000 supporters to the stadium. In Quito, the derby named “Clásico Capitalino” (LDU Quito vs. El Nacional) attracts, on average, 8,000 supporters to the stadium.

Table 5.5 Estimates of baseline regression on homicides

	Aggregate	Cuenca	Riobamba	Guayaquil	Ibarra	Loja	Quevedo	Manta	Quito	Rumiñahui	Ambato	Sto. Dgo.	Guaranda	Latacunga	Machala	Milagro	Portoviejo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Home	0.0016 (0.00)	-0.0000 (0.00)	0.0002 (0.00)	-0.0006 (0.01)	-0.0001 (0.01)	0.0001 (0.00)	-0.0010 (0.02)	0.0002 (0.01)	0.0030 (0.00)	0.0088*** (0.00)	0.0002 (0.00)	0.0003 (0.01)	.	-0.0013 (0.02)	-0.0008 (0.02)	-0.0000 (0.03)	-0.0004 (0.04)
Derby	-0.0010 (0.00)	.	.	-0.0002 (0.01)	.	.	.	.	-0.0016 (0.00)	.	-0.0002 (0.01)	.	.	.	.	.	.
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Precinct f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Match stage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.0018	0.0008	0.0008	0.0019	0.0009	0.0006	0.00032	0.0019	0.0021	0.0021	0.0012	0.0013	0.0016	0.0012	0.0010	0.0009	0.00018
N° Observ.	4251050	335984	204512	788832	189904	233728	116864	189904	686680	87648	219138	292160	102256	160688	306768	189904	146080

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01, . omitted because of multicollinearity. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2010-2014 period.

Table 5.6 Estimates of the baseline regression on property crimes

	Aggregate	Cuenca	Riobamba	Guayaquil	Ibarra	Loja	Quevedo	Manta	Quito	Rumiñahui	Ambato	Sto. Dgo.	Guaranda	Latacunga	Machala	Milagro	Portoviejo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Home	-0.011 (0.02)	0.0197 (0.05)	0.0273 (0.07)	0.0303 (0.07)	-0.1697 (0.26)	-0.0303 (0.05)	-0.0661 (0.07)	0.069 (0.06)	-0.0311 (0.05)	-0.0989** (0.04)	-0.0124 (0.03)	.	-0.014 (0.12)	-0.0577 (0.23)	0.979*** (0.18)	-0.401** (0.20)	-0.0021 (0.21)
Derby	0.16*** (0.03)	.	.	0.2455** (0.11)	.	.	.	.	0.1041* (0.06)	.	-0.0851 (0.12)	.	.	.	.	.	.
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neighborhood f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Match stage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.2751	0.0450	0.0683	0.3704	0.0487	0.0250	0.0527	0.0881	0.2580	0.0821	0.0316	0.0272	0.0073	0.0227	0.0987	0.1467	0.0883
N° Observ.	1765006	187008	70128	198696	70128	58440	116880	70128	385804	46752	116898	93504	46752	70128	93504	23376	116880

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01, . omitted because of multicollinearity. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2012-2015 period.

### 5.5.2. EXTENDED ESTIMATES FOR HOMICIDES

Table 5.7 presents the impact of soccer matches on homicides, with an emphasis on the temporal, spatial and emotional factors. Column (1) presents the results at the aggregate level while the subsequent columns present the results in 16 cantons.<sup>141</sup> All estimations control for derbies, time, precinct and stage of the match fixed effects.

At the aggregate level, the extended estimate shows that soccer matches cause temporal and spatial spillovers regarding homicides. The temporal analysis reveals that soccer matches at home increase the number of homicides by 0.18%, near the stadiums, during the 3-hours prior the match. This effect can be related to a fan concentration effect because crowds of supporters go to stadiums several hours before the game. The spatial analysis identifies whether a soccer match in a canton causes spillover effects by raising crime in precincts of this canton that are distant from the stadium. Results show that the number of homicides in these distant precincts decreases by 0.05% during the home match but rises by 0.06% in the post-match hours. During the home match, the homicides might decrease by an effect of self-incapacitation, since most supporters would prefer to attend the match until the final whistle. After the match, the homicides might increase probably related to interpersonal confrontations derived from social interactions between fans or soccer results. Notwithstanding, estimates reveal non-significant effects of emotions on homicides at the aggregate level.

We now analyze results at the canton level by first focusing on spatial and temporal displacement effects. In Guayaquil, the number of homicides decreases before and during home matches but rises in the post-match hours, in distant precincts of the canton (non-significant effects near the stadiums). In Quito, the number of homicides increases significantly before the match in the vicinity of stadiums. A potential explanation is that, even if authorities prevent rival confrontations by separating the entry of rival supporters to the stadiums, they cannot provide large control outside (in public transport or streets) due to the large crowds mobilizing to the stadium. In fact, Quito records several homicides caused by rival supporters before entering the Atahualpa and Casa Blanca stadiums, in the 2010-2014 period.<sup>142</sup> The number of homicides also increases during soccer matches in Rumiñahui and after the games in Machala. These positive effects on homicides occur near and far away from stadiums.

Finally, the coefficients of emotions (frustration and euphoria) resulting from soccer matches are significant in Quito. Figure 5.4 plots the relationship between homicides and emotions in these cantons. In Quito, the effect of emotions on homicides follows a U-Shaped distribution (blue diamonds). This suggests that supporters of teams representing Quito commit violent acts when confronted with intense frustration or intense euphoria.<sup>143</sup>

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<sup>141</sup> Appendix 5.C presents the estimates of soccer on homicides at the aggregate level by introducing, step by step, the temporal, spatial and emotional dimensions specified in the extended regression (eq. 5.4).

<sup>142</sup> See the official reports of the Ministry of Interior at website [www.ministeriodelinterior.gob.ec](http://www.ministeriodelinterior.gob.ec) and local news at websites [www.elcomercio.com](http://www.elcomercio.com) and [www.metroecuador.com.ec](http://www.metroecuador.com.ec).

<sup>143</sup> Actually, various people were hurt and killed near the Casa Blanca and Atahualpa stadiums, during soccer matches of LDU Quito, U. Católica and Dep. Quito. To mention the most remarkable cases: one supporter of LDU Quito died near the Casa Blanca stadium in 2012; one police officer was hurt in the Atahualpa stadium during the derby LDU Quito vs. Dep. Quito in 2013; one minor supporter of LDU Quito died in 2014. In 2015, one supporter of LDU Quito died and other was hurt in the vicinities of Casa Blanca and Atahualpa stadiums, respectively ([www.elcomercio.com](http://www.elcomercio.com), [www.metroecuador.com.ec](http://www.metroecuador.com.ec)).

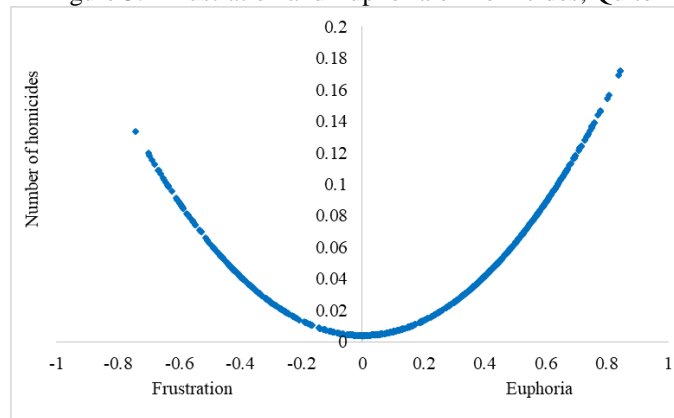


Table 5.7 Estimates of extended regression on homicides

	Aggregate	Cuenca	Riobamba	Guayaquil	Ibarra	Loja	Quevedo	Manta	Quito	Rumiñahui	Ambato	Sto. Dgo.	Guaranda	Latacunga	Machala	Milagro	Portoviejo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
<i>Near stadium</i>																	
Home pre-match	0.0018* (0.00)	-0.0008 (0.00)	-0.0004 (0.00)	-0.0026 (0.00)	-0.0007 (0.00)	-0.0004 (0.00)	-0.0068 (0.01)	0.0072* (0.00)	0.0069*** (0.00)	-0.0003 (0.00)	-0.0001 (0.00)	-0.0013 (0.01)	.	-0.0004 (0.01)	-0.0015 (0.02)	-0.0000 (0.03)	-0.0006 (0.02)
Home	0.0015 (0.00)	-0.0000 (0.00)	0.0002 (0.00)	-0.0014 (0.01)	-0.0002 (0.01)	0.0001 (0.00)	-0.0009 (0.02)	0.0002 (0.01)	0.0032 (0.00)	0.0081*** (0.00)	0.0001 (0.00)	0.0002 (0.01)	.	-0.0002 (0.02)	-0.0005 (0.03)	-0.0000 (0.03)	-0.0003 (0.07)
Home post-match	0.0006 (0.00)	-0.0009 (0.00)	-0.0005 (0.00)	-0.0004 (0.00)	-0.0007 (0.00)	-0.0001 (0.00)	-0.0095 (0.01)	-0.0034 (0.00)	0.0009 (0.00)	-0.0009 (0.00)	-0.0006 (0.00)	-0.0016 (0.01)	.	-0.0006 (0.01)	0.2492*** (0.02)	-0.0003 (0.03)	-0.0016 (0.02)
<i>In other precincts</i>																	
Home pre-match	-0.0002 (0.00)	-0.0002 (0.00)	-0.0003 (0.00)	-0.0009* (0.00)	-0.0005 (0.00)	-0.0004 (0.00)	-0.0023 (0.01)	0.0005 (0.00)	0.0003 (0.00)	-0.0001 (0.00)	-0.0004 (0.00)	0.0005 (0.00)	.	-0.0003 (0.00)	-0.0010 (0.00)	0.0004 (0.01)	-0.0011 (0.01)
Home	-0.0005** (0.00)	-0.0001 (0.00)	-0.0000 (0.00)	-0.002*** (0.00)	-0.0005 (0.00)	-0.0001 (0.00)	0.0051 (0.01)	0.0004 (0.00)	-0.0004 (0.00)	0.0041*** (0.00)	-0.0004 (0.00)	-0.0019 (0.00)	.	-0.0004 (0.00)	-0.0006 (0.00)	0.0004 (0.01)	-0.0017 (0.01)
Home post-match	0.0006*** (0.00)	0.0005 (0.00)	-0.0004 (0.00)	0.0016*** (0.00)	-0.0004 (0.00)	-0.0001 (0.00)	0.0034 (0.01)	-0.0013 (0.00)	-0.001*** (0.00)	-0.0007 (0.00)	-0.001 (0.00)	0.0015 (0.00)	.	-0.0004 (0.00)	0.0129*** (0.00)	0.0001 (0.01)	-0.0021 (0.01)
<i>Intense Reactions</i>																	
Home_react	-0.0023 (0.00)	0.0001 (0.00)	-0.0001 (0.00)	0.0001 (0.01)	-0.0001 (0.01)	0.0000 (0.00)	-0.0002 (0.02)	0.0001 (0.01)	-0.0002** (0.00)	0.0078** (0.00)	-0.0000 (0.00)	-0.0002 (0.01)	.	0.0027 (0.06)	0.0018 (0.13)	.	0.0035 (0.09)
Home_react <sup>2</sup>	0.0063 (0.01)	-0.0001 (0.01)	0.0001 (0.01)	0.0006 (0.02)	0.0009 (0.02)	-0.0001 (0.01)	-0.0002 (0.06)	-0.0008 (0.02)	0.2350** (0.01)	-0.0064 (0.01)	0.0005 (0.01)	0.0015 (0.03)	.	-0.0050 (0.16)	-0.0022 (0.51)	.	0.0177 (0.64)
Derby	-0.001 (0.00)	.	.	0.0003 (0.01)	.	.	.	.	-0.0015 (0.00)	.	0.0005 (0.01)	.	.	.	.	.	.
Constant, Time, Precinct and Match controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.0018	0.0008	0.0008	0.0019	0.0009	0.0006	0.0032	0.0019	0.0022	0.0024	0.0012	0.0013	0.0016	0.0012	0.0018	0.0009	0.0018
N° Observ.	4251050	335984	204512	788832	189904	233728	116864	189904	686680	87648	219138	292160	102256	160688	306768	189904	146080

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01, . omitted because of multicollinearity. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2010-2014 period.

Figure 5.4 Frustration and Euphoria on homicides, Quito



### 5.5.3. EXTENDED ESTIMATES FOR PROPERTY CRIMES

Table 5.8 presents the results of home soccer matches taking into account the temporal, spatial and emotional factors on property crimes. Column (1) presents the results at the aggregate level while the subsequent columns present the results in each canton.<sup>144</sup> All estimations control for derbies, time, neighborhood and stage of the match fixed effects.

At the aggregate level, the existence of home soccer matches increases the number of property crimes by 12% near the stadiums after the match. This result is in line with findings of Montolio and Planells-Struse (2016) in Barcelona (Spain). They find that property crimes (theft and robbery) peak in the hour after the home match and the effect continues for several hours after.<sup>145</sup> In Ecuador, the number of property crimes decreases by 0.85% before the match but increases by 0.88% after the final whistle, in distant neighborhoods from the stadium. The temporal pattern can be explained by the expected returns from crime related to soccer. Before the match, supporters are not still congregated in bars and restaurants to watch the match, which reduces the opportunity of delinquents to obtain a profitable booty. Conversely, supporters can stay in bars and restaurants for several hours after the soccer match, which increases the expected profits from crime. The presence of a derby increases the number of property crimes by 15%. In conclusion, it seems that soccer matches offer the opportunity for pecuniary delinquents to obtain additional expected returns from crime.

Let now describe results of estimates at the canton level. For simplicity, we discuss the most significant results in the cantons that regularly host a match.<sup>146</sup> In Ibarra and Rumiñahui, the effect of soccer on property crimes varies depending on the timing of the game, near stadiums. There are positive effects before the match, negative effects during the match and positive effects again after the match. One explanation is that, on match days, pecuniary delinquents could decide to commit crimes before and after the game by taking advantage of large crowds near the stadium. However, if delinquents are supporters of the team that plays the match, they could also decide to attend the game (*self-incapacitation*). Thus, delinquents reduce their participation in criminal activities at least during the soccer match. In Riobamba and Guayaquil, the number of property crimes significantly increases near the stadiums after the game. It can be argued that delinquents take advantage of pecuniary crimes when people move from the stadium, which reduces the risk of arrest.

Finally, the coefficients associated with emotional reactions only show positive and linear effects in Riobamba and Quevedo. One can interpret that supporters are directly impacted by emotions resulting from home soccer matches that encourage them to commit property crimes.

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<sup>144</sup> Appendix 5.C presents the estimates of soccer on property crimes at the aggregate level by introducing, step by step, the temporal, spatial and emotional dimensions specified in the extended regression (eq. 5.4).

<sup>145</sup> Recall that our estimates consider the timing of 3-hour windows in which the regular time of a soccer match is included (two hours with the extra time). Montolio and Planells-Struse (2016) find that the number of thefts increases by 39.9% in the hour after the match when F.C.B. plays at home in the city of Barcelona. Unfortunately, it is not possible to identify whether the effect occurred near the 'Camp Nou' stadium or in distant locations because they estimate the effects for the entire city of Barcelona.

<sup>146</sup> Estimates also show significant effects of soccer matches in cantons with replacement stadiums (e.g. Latacunga and Portoviejo). An interesting case of analysis is Latacunga. Given the short distance between Quito and Latacunga, the soccer teams of Quito usually play in Latacunga when punished by the FEF. Thus, the existence of sporadic soccer matches increases the number of property crimes in Latacunga. This effect can be related to delinquents that take advantage of the large number of fans who rarely congregate there.

Table 5.8 Estimates of extended regression on property crimes

	Aggregate	Cuenca	Riobamba	Guayaquil	Ibarra	Loja	Quevedo	Manta	Quito	Rumiñahui	Ambato	Sto. Dgo.	Guaranda	Latacunga	Machala	Milagro	Portoviejo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
<i>Near stadium</i>																	
Home pre-match	-0.0037 (0.01)	0.0729** (0.03)	-0.0567 (0.05)	-0.0287 (0.05)	0.8251*** (0.26)	-0.0087 (0.03)	-0.15*** (0.05)	0.0232 (0.04)	-0.0039 (0.03)	0.0679** (0.03)	-0.0052 (0.02)	.	-0.0187 (0.07)	-0.0578 (0.23)	0.133 (0.16)	0.3356* (0.18)	0.1776 (0.13)
Home	-0.0043 (0.02)	0.0226 (0.05)	0.0782 (0.07)	0.0301 (0.07)	-0.1685 (0.26)	-0.0387 (0.05)	-0.0683 (0.07)	0.071 (0.06)	-0.0315 (0.05)	-0.1165** (0.05)	-0.0144 (0.03)	.	0.575 (6.52)	-0.0546 (0.23)	-0.8385 (0.63)	-0.4032 (0.37)	-0.0179 (0.30)
Home post-match	0.126*** (0.01)	0.023 (0.03)	0.1143** (0.05)	0.4076*** (0.05)	0.8299*** (0.26)	0.0213 (0.03)	0.0153 (0.05)	0.0255 (0.04)	0.0618* (0.03)	0.118*** (0.03)	0.0011 (0.02)	.	-0.0123 (0.07)	-0.0634 (0.23)	-0.0674 (0.16)	0.1546 (0.18)	-0.0154 (0.13)
<i>In other neighborhoods</i>																	
Home pre-match	-0.0085** (0.00)	0.0056 (0.01)	-0.0005 (0.02)	0.0183 (0.02)	-0.0742 (0.13)	-0.0199 (0.02)	0.0166 (0.02)	0.0536** (0.02)	0.0019 (0.01)	-0.0205 (0.02)	-0.0093 (0.01)	.	-0.0100 (0.05)	-0.0160 (0.11)	-0.0382 (0.07)	.	-0.0186 (0.05)
Home	0.0057 (0.00)	-0.0103 (0.01)	0.017 (0.02)	0.0164 (0.02)	-0.0678 (0.13)	-0.0069 (0.02)	0.05*** (0.02)	-0.0029 (0.02)	-0.0115* (0.01)	0.0133 (0.02)	0.002 (0.01)	.	-0.0136 (0.05)	0.2372** (0.11)	0.0089 (0.07)	.	-0.0935** (0.05)
Home post-match	0.0088** (0.00)	-0.015* (0.01)	0.0341 (0.02)	0.0184 (0.02)	-0.0694 (0.13)	0.0376* (0.02)	0.0057 (0.02)	-0.0172 (0.02)	-0.0116* (0.01)	0.024 (0.02)	0.0062 (0.01)	.	-0.0035 (0.05)	-0.0216 (0.11)	-0.0303 (0.07)	.	0.1134** (0.05)
<i>Intense Reactions</i>																	
Home_react	-0.0001 (0.03)	0.0074 (0.06)	0.3131*** (0.10)	0.1248 (0.10)	.	-0.042 (0.07)	0.1902* (0.10)	-0.01138 (0.08)	-0.0832 (0.06)	0.0441 (0.06)	-0.01 (0.05)	.	-2.5912 (27.74)	.	2.0069 (1.59)	0.1844 (1.40)	-0.041 (0.68)
Home_react <sup>2</sup>	-0.0263 (0.07)	-0.1864 (0.16)	-0.2261 (0.26)	-0.2308 (0.27)	.	0.2392 (0.19)	0.0024 (0.27)	0.116 (0.21)	0.1358 (0.17)	-0.4155** (0.17)	0.0678 (0.12)	.	2.6876 (28.21)	.	54.45*** (16.86)	-0.4494 (6.48)	0.4121 (4.90)
Derby	0.1502*** (0.03)	.	.	0.2620** (0.11)	.	.	.	.	0.1080* (0.06)	.	-0.0858 (0.12)	.	.	.	.	.	.
Constant, Time, Neighborhood and Match controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.2751	0.0451	0.0685	0.3706	0.049	0.0251	0.0528	0.0882	0.2581	0.0826	0.0316	0.0272	0.0073	0.0227	0.0992	0.1469	0.0884
N° Observ.	1765006	187008	70128	198696	70128	58440	116880	70128	385804	46752	116898	93504	46752	70128	93504	23376	116880

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01, . omitted because of multicollinearity. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2012-2015 period.

Considering that there are different types of delinquents who search for different types of victims, we analyze whether the existence of soccer matches engenders different types of property crimes. Table 5.9 presents the results of the extended estimation on robbery against the persons, burglary, vehicle theft and vehicle accessory theft, at aggregate level.<sup>147</sup>

Findings indicate that soccer matches played at home increases the number of robberies against persons near stadiums by 4% in the post-match hours. Robbers actively operate near stadiums because the agglomeration of people in these facilities provide high expected economic proceeds and low probabilities of arrest. The number of burglaries is found to increase before and after soccer matches near stadiums. One potential explanation stands in the long period of time during which houses are unattended because supporters, who go to the stadium, leave their homes alone. Thus, burglars can operate during this period of time that homes are unattended in order to reduce the risk of arrest. Home soccer matches also cause a positive effect on burglary occurring in distant neighborhoods during the timing of the match. This can also be explained by an effect of police concentration (Marie, 2016). Since the large number of police officers congregate around stadiums, they may leave other neighborhoods unattended, thereby, giving rise to burglaries. The number of vehicle thefts increases after the soccer match throughout the cantons (in neighborhoods near and far from stadiums). One possible reason is that supporters can leave their vehicles in private parking lots during the match, which makes it difficult to steal these vehicles. However, when supporters drive their vehicles after the match ends, delinquents can steal these vehicles on the streets. Finally, the effect of soccer matches on vehicle accessory theft is positive after soccer matches near stadiums. Assuming that thieves of vehicle accessories are dedicated to steal and resale auto parts (e.g. mirrors, wiper washers, wheel hubcaps), the existence of soccer matches at home provides large opportunities to find suitable victims who use their vehicles to move to and from the stadiums.

Table 5.9 Estimates of extended regression by type of property crimes at aggregate level

	Robbery against persons (1)	Burglary (2)	Vehicle Theft (3)	Vehicle accessory theft (4)
<i>Near stadium</i>				
Home pre-match	-0.0070 (0.01)	0.0133*** (0.01)	-0.0032 (0.00)	0.0017 (0.00)
Home	0.0061 (0.01)	0.0072 (0.01)	-0.0069 (0.01)	0.005 (0.01)
Home post-match	0.0422*** (0.01)	0.0212*** (0.01)	0.0136*** (0.00)	0.0542*** (0.00)
<i>In other neighborhoods</i>				
Home pre-match	-0.0049** (0.00)	-0.0019 (0.00)	-0.0006 (0.00)	-0.0016 (0.00)
Home	0.0027 (0.00)	0.0042*** (0.00)	-0.001 (0.00)	0.0009 (0.00)
Home post-match	0.0032 (0.00)	0.0021 (0.00)	0.0045*** (0.00)	0.0017 (0.00)
<i>Intense Reactions</i>				
Home_react	0.0356** (0.02)	-0.0102 (0.01)	-0.0125 (0.01)	-0.0022 (0.01)
Home_react <sup>2</sup>	-0.1558*** (0.04)	0.0776*** (0.03)	-0.0163 (0.02)	0.0496** (0.02)
Derby	0.0386* (0.02)	0.0629*** (0.01)	0.0187* (0.01)	0.0084 (0.01)
Constant	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
Neighborhood f.e.	Yes	Yes	Yes	Yes
Match stage	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.1761	0.0611	0.0555	0.0662
N	1765006	1765006	1765006	1765006

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2012-2015 period.

<sup>147</sup> Results of the effect of soccer matches on the types of property crimes in 16 cantons are available under request.

## 5.6. CONCLUSION

This study provides new evidences regarding the impact of soccer matches on the number of crimes. Recent empirical contributions have explored this relationship in developed countries and clearly establish that sport meetings may generate some peaks of violence (Billings and Depken, 2011; Card and Dahl, 2011; Gantz *et al.*, 2006; Kalist and Lee, 2014; Kurland *et al.*, 2013; Marie, 2016; Montolio and Planells-Struse, 2016; Priks, 2010; Rees and Schnepel, 2009; Yu *et al.*, 2015). There is no reason to expect that such relationship vanishes in the context of developing countries, especially in Latin America and the Caribbean. This chapter explores the impact of soccer matches on crime in Ecuador, and disentangles the temporal, spatial and emotional dimensions of crime.

In Montevideo (Uruguay), Munyo and Rossi (2013) explore the effect of emotions (frustration and euphoria) on property crime. Their methodology compares the number of crimes, conditional on frustrating losses and euphoric wins, caused by soccer matches of Peñarol and Nacional teams. Findings show that the number of robbery increases, in the first hour post-match, after frustrating losses. The contrary happens in the case of euphoric wins. Despite the relevance of this study in the Latin American context, there are still important limitations. Munyo and Rossi do not capture spatial spillovers of crime in Montevideo. This is relevant if one considers that some criminals may prefer to operate either near stadiums (due to the high concentration of fans) or in areas further away (due to the high concentration of police in stadiums). Munyo and Rossi also disregard the effects of frustration and euphoria on crime throughout Uruguay. Given that most Uruguayans are fans of Peñarol or Nacional, the emotions resulting from soccer can engender crime in the whole country, not only in Montevideo.

To alleviate both limitations, we estimate the effect of soccer matches on the number of various types of crimes in 16 cantons of Ecuador over the period 2010-2015. Our empirical strategy extends the existing literature on sports and crime by estimating the effect of soccer matches within numerous cities of the country, in contrast to existing studies at the one-city level. Our methodology also captures the number of crimes occurring before, during or after soccer matches (temporal dimension); near or further away from stadiums (spatial dimension); and conditional on frustration and euphoria (emotional dimension).

Our baseline estimates show that soccer matches played at home do not have significant effects on homicides or property crimes, at the aggregate level. However, the existence of derbies significantly increases the number of property crimes by 16%. More importantly, our extended estimates confirm the existence of temporal and spatial spillovers of crime at the aggregate level. In average, soccer matches at home increase the number of homicides by 0.18% *before* the match and the number of property crimes by 12% *after* the match, near the stadium. Specifically, soccer matches increase the number of robberies against persons by 4%, burglaries by 2%, vehicle thefts by 1% and vehicle accessory thefts by 5%, near stadiums, in the post-match hours. In addition, the spatial analysis confirms that spatial spillovers influence crime in other jurisdictions that are distant from the stadium. Soccer matches at home decrease the number of property crimes by 0.88% *before* the match and the number of homicides by 0.05% *during* the match, in these distant jurisdictions. The former effect can be related to the low expected returns from crime since supporters are not still congregated in bars and restaurants to watch the match. The latter effect is probably derived from the self-incapacitation of criminals if they prefer to attend the match instead of committing crime. Conversely, homicides and property crimes significantly increase after the match, in these distant jurisdictions of the local canton. These effects can be associated to interpersonal confrontations in the case of homicides and to pecuniary opportunities in the case of property crimes. The emotional analysis reveals no significant effects of soccer matches on homicides or property crimes at aggregate level. However, the coefficients of emotions (frustration and euphoria) are significant on homicides in Quito. The U-Shaped distribution suggests that supporters of teams

representing Quito commit violent acts when confronted with intense frustration or intense euphoria.

Finally, it is noteworthy to mention the limits of this study and propose different ways in which it could be enriched. The first limitation is the lack of geocoded data of crime. Crime reports of security institutions identify the canton and parish where offenses occurred but do not provide more precise local information. This restriction limits the possibility of spatial exploratory analyses as it is hard to identify the exact place of crimes occurrence. The second limitation is the lack of information about the location of risky facilities (e.g. bars, restaurants). The exact location of bars and restaurants allows identifying the places of risk where supporters prefer to congregate. If one could identify the exact location of offenses and the location of risky facilities (e.g. bars, restaurants) besides the stadiums, then it would be easier to recognize any soccer-related effect on crimes. In addition, this analysis can be enriched by including the effect of home and away soccer matches. The *home effect* refers to the impact that sports can have in the city that host a game. On game days, the number of crimes may increase in the local city due to the large concentration of fans or the economic incentives of delinquents. The *away effect* refers to the impact that sports can have in the city that the soccer team originally represents, when this team plays as visitor in another city. On game days, the number of crimes may also increase in the city the visitor team represents because some fans can follow the match on TV in bars or restaurants. Thus, we can complement the results of this chapter by estimating the effect of home and away soccer matches on crime using geocoded data of crime and risky facilities. It would also be interesting to include the soccer results of the Second Division “Serie B” to analyze the effect of changing positions in the tournament.





## 6. CONCLUSION

Latin America and the Caribbean is one of the regions in the world with the highest level of violence, which costs billion dollars to its countries (Jaitman and Torre, 2017a, 2017b; Soares, 2006; UNODC, 2013; World Bank, 2014). Importantly, higher levels of violence prevail in most urbanized LAC cities. Capital cities have higher homicide rates than the national homicide rates (UNODC, 2013). The risk of victimization is also higher in large LAC cities than in small LAC cities (Gaviria and Pagés, 2002). Understanding the determinants of urban crime is therefore a major challenge for those countries, and is essential to design an effective policy aimed at reducing the crime-related costs. The objective of this thesis is to explore the role of three crime determinants that are of particular relevance for cities of a country such as Ecuador: economic inequality, city size, and soccer events.

Before exploring each on these potential crime determinants, Chapter 2 provides a thorough review of the literature on the determinants of urban crime. While various disciplines (psychology, sociology, criminology) contribute to understand the emergence of criminal activities, our survey puts a special emphasis on the economic incentives formalized by Becker (1968) and Ehrlich (1973). An important conclusion is that these economic incentives are influenced by the location pattern of criminals and/or victims (Freeman *et al.*, 1996; Glaeser and Sacerdote, 1999; Gaigné and Zenou 2015). This central conclusion motivates our empirical strategy, all along the thesis, to explore the impact of crime determinants on the spatial distribution of crime using data at either the city level, the intra-city level, or the individual level.

The cost-benefit analysis is at the center of the economics of crime literature (Becker, 1968; Ehrlich, 1973). According to this reasoning, income inequality should raise the gap between the return from illegal (e.g. property crimes) and legal (e.g. labor income) activities for low-income individuals that are placed in proximity with high-income individuals. Thence, a rise in the income inequality could increase the level of crime in the economy because low-income individuals face higher incentives to participate in pecuniary crime (Chiu and Madden, 1998). Sociological foundations also assert that inequality instigates the less-advantaged individuals to commit crime in response to deprived social structures, *whatever the net return to crime* (Merton, 1938; Shaw and McKay; 1942). Chapter 3 investigates the role of income inequality on crime in Ecuador using individual data, in contrast with existing studies that rely on aggregated crime rates. Therefore the contribution to the literature is twofold. First, we estimate the impact of income inequality on the probability of victimization by different types of crimes. Second, we provide empirical evidence about the effect of the income level and the personal characteristics of individuals on their probability of victimization. Our main result is that, contrary to the predictions, the Gini coefficient has a negative effect on victimization by robbery. One intuition is that inequality triggers residential segregation, which reduces robberies because of the difficulty to steal rich victims. Another potential explanation is that inequality is associated with social control. In Ecuador, cantons with highest inequality are characterized by a low population density and a large proportion of ethnic groups that establish strong social interactions, and therefore, social control against crime. Regarding the impact of the income at the individual level, the principal finding is that there is an increasing and concave relationship between the income level of victims and the probability of victimization by vehicle theft. It first increases with a monthly household income up to \$5,100, and then falls. This result is in line with theoretical predictions about the non-linear relationship of income inequality and property crime (Chiu and Madden, 1998; Decreuse *et al.*, 2018). This is also consistent with the fact that 34% of Ecuadorian households declared have reinforced housing and vehicle security using alarms, anti-theft devices, anti-theft insurances, private guards, etc. (INEC, 2011).

The traditional economics of crime literature has been considerably enriched by the urban economics literature, by showing that the location of individuals influences crime incentives. This gives rise to a central prediction according to which population density leads to agglomeration economies that result in higher crime in urban areas (Gaigné and Zenou, 2015). The existence of such an urban crime premium has been tested in the case of developed countries, especially in the United States (Glaeser and Sacerdote, 1999; O’Flaherty and Sethi, 2015). Chapter 4 contributes to this literature by testing the presence of an urban crime premium in Ecuador, using data on homicide and property crime at the parish level. OLS estimates show that the parish population exerts a positive effect on both the homicide and property crime rates. However, OLS estimates do not allow to deal with the high number of parishes with zero homicides. Thence, we estimate a Two-Part Model. The results reveal that parish population has a non-linear influence on the homicide rate. The probability that one or more homicides happen is higher in larger parishes. However, the homicide *rate* decreases with population in parishes with positive homicides. Therefore, the existence of an urban crime premium in Ecuador is relevant for property crimes, rather than violent crimes. In a robustness check, we also find that the probability that a homicide occurs in highly urbanized areas (named FUAs) is higher than in rural parishes. Conversely, the homicide rate decreases more in rural parishes than in FUAs. This result might be related to the stronger social sanction effect in small areas as predicted by Buonanno *et al.* (2011).

While the economics of crime literature is particularly relevant to investigate the determinants of pecuniary crimes, the predictions on violent crimes are less clear, probably because these offenses are often also associated with emotional issues. The emotional dimension seems therefore crucial to better understand the violent behavior of individuals. Some individuals commit violent acts when they are faced with negative emotions such as frustration (Dollard *et al.*, 1939). Empirical studies have confronted this hypothesis using data on sporting events (Card and Dahl, 2011; Gantz *et al.*, 2006; Priks, 2010; Rees and Schnepel, 2009). Findings reveal positive associations between unexpected results of sporting events and criminal activities. These studies have been conducted in developed countries. The importance of soccer and violence in LAC countries makes it even more interesting to explore the influence of soccer-related emotions on crimes in these countries. That is why Chapter 5 investigates the impact of soccer matches on crime in Ecuador, using data at the intra-city level. Our contribution is threefold. First, we identify and test the effects of frustration and euphoria resulting from unexpected vs. expected results of soccer matches on homicides and property crimes. Second, we identify whether soccer matches alter the temporal and spatial patterns of crime. Third, we perform the estimations in 16 cantons of Ecuador, contrary to existing studies that consider a single city. At the aggregate level, the effect of emotions (frustration and euphoria) is not significant on homicides or property crimes. However, the relationship of emotions and homicides follows a U-Shaped distribution in the capital of Ecuador, Quito. This result suggests that supporters of teams representing Quito commit homicides when confronted with intense frustration or intense euphoria. Estimates confirm that soccer matches engender temporal spillovers effects. On match days, the number of homicides increases by 0.18% *before* the match whereas the number of property crimes increases by 12% *after* the match, near the stadium. Lastly, soccer matches also cause spatial spillovers by influencing crime in neighborhoods distant from stadiums. On match days, the number of property crimes falls by 0.88% *before* the match and the number of homicides falls by 0.05% *during* the match, in these distant neighborhoods. Conversely, *after* the soccer match, the number of homicides and property crimes significantly increases in locations distant from stadiums.

## 6.1. LIMITATIONS AND AVENUES FOR FUTURE RESEARCH

The present dissertation provides empirical evidence on the inequality - crime connection, the city size - crime connection, or the soccer - crime connection, by exploring each of these relationships

with three original datasets regarding cities of Ecuador. Despite our efforts to collect the most appropriate data, we can mention three limits that result from problems of data availability. First, the most reliable source of information in Ecuador is the National Population Census. This census collects social and demographic data at a local geographic level, but it is conducted only every ten years, which limits the temporal variability of important explanatory variables. While there exists alternative information sources (e.g. surveys or institutional reports) that are collected periodically, they do not provide exhaustive information at local levels. Second, the lack of police and justice information also limits the empirical analysis in Ecuador. This information is especially relevant since theoretical predictions show the importance of deterrent factors of crime. Unfortunately, the number of police officers, firearm provisions, investment in police offices; the number of judges by canton, pending court cases, among others, is restricted to the use of security institutions and is collected at the national level. Third, the lack of geocoded crime data limits the possibility of spatial exploratory analyses. Crime reports of security institutions identify the canton and parish where offenses occurred but do not provide more precise local information. This makes it hard to identify the exact place of crimes occurrence.

Despite these limitations, we can extend our empirical work in several ways. First, we might explore other types of offenses such as domestic or sexual violence. The societies of Latin America and the Caribbean are patriarchal societies with high levels of domestic and sexual violence against women.<sup>148</sup> A potential source of information in Ecuador is the Gender Violence survey “Encuesta Nacional de Relaciones Familiares y Violencia de Género contra las Mujeres”. This survey collects information on the physical, psychological and sexual violence that women have suffered during their lifetime. Thence, a call for future research could be to identify the individual characteristics of the victims of domestic and sexual violence in Ecuador in order to help the design and the efficiency of the prevention policy.

Second, we estimate the city size - crime relationship in a developing country; however, one might regret that we do not explore more in detail one or some mechanisms underlying this relationship that are described in the theoretical literature. The return to crime, the probability of arrest and the proportion of crime-prone individuals are the three main mechanisms that explain the urban crime premium (Glaeser and Sacerdote, 1999). The nominal wages, the cost of commuting and land rents also contribute to explain this relationship (Gaigné and Zenou, 2015). One might wonder to which extend these mechanisms are relevant in developing countries. Recent studies point out that certain characteristics of developing economies are opposed to the urban economics predictions. For example, the market access is negatively related to wages, or there are higher returns in the informal sector (Duranton, 2016). Thence, it would be interesting to test whether the mechanisms that explain the city size - crime connection are also relevant in the case of developing countries, especially in Latin America and the Caribbean. Regarding the Ecuadorian case, one can obtain relevant information about wages and the cost of living in Ecuador from the Consumer’s Price Index, the Living Conditions survey and the Socioeconomic Stratification survey.

Third, we could also study the resource curse (paradox of countries with large concentration of natural resources that have poor economic growth and poor institutional presence) in Ecuador. According to Couttenier *et al.*, (2017), early mineral discoveries in the USA are associated with high levels of interpersonal violence in the past and today. This might result from the fact that the rents associated with those resources provide the incentives and the means to corrupt political institutions. Ecuador constitutes a good environment to analyze the crime - resource curse due to the poor institutional presence (Harrendorf and Smit, 2010), the high level of corruption<sup>149</sup> and the

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<sup>148</sup> In Ecuador, 60% of women have confronted gender violence while 25% have suffered sexual violence in their lifetime (INEC, 2012).

<sup>149</sup> Transparency International creates the Corruption Perception Index to measure the perceived levels of corruption in the public sector of 180 countries. This index assigns a value of 0 to highly corrupt countries and 100 to transparent

diversity of mineral resources (e.g. gold, silver, copper). This analysis is especially relevant in Ecuador as the country has recently granted mining concessions to few companies to exploit minerals for 25 years, without asking the local communities. In response, families dedicated to the exploitation of minerals have reacted violently against mining companies.<sup>150</sup> In such a context, a future research could be to analyze the role of local institutions and mining concessions on the illegal exploitation of minerals in order to better design policies for the granting of mineral resources, and therefore reduce crime.

Fourth, the lack of geocoded crime data limits our capacity to better identify spatial displacement effects related to soccer matches. If one could identify the exact location of offenses and the location of risky facilities (e.g. bars, restaurants) besides the stadiums, then it would be easier to recognize any soccer-related effect on crimes. Moreover, our analysis can be enriched by including the effect of home and away soccer matches. The *home effect* refers to the impact that sports can have in the city that host a game. On game days, the number of crimes may increase in the local city due to the large concentration of fans or the economic incentives of delinquents. The *away effect* refers to the impact that sports can have in the city that the soccer team originally represents, when this team plays as visitor in another city. On game days, the number of crimes may also increase in the city the visitor team represents because some fans can follow the match on TV in bars or restaurants. Thus, we can complement the results of chapter 5 by estimating the effect of home and away soccer matches on crime using geocoded data of crime and risky facilities. The results of such an analysis could be helpful to better distribute the police forces around stadiums and entertainment facilities.

Finally, the recent attacks of an irregular armed group in the border of Ecuador and Colombia provides another potential call for future research. Since January 2018, the irregular group “Grupo Armado Oliver Sinisterra” in charge of Walter Arízala Vernaza alias “Guacho”, have caused nine attacks at the Ecuador-Colombia frontier.<sup>151</sup> Alias Guacho is also responsible for the kidnapping and assassination of several Ecuadorians including military officers, journalists and civilians. After the first bomb attack in San Lorenzo (Esmeraldas), authorities have increased the presence of security forces in this canton. This context provides a natural experiment to identify the effect of police reinforcements in Ecuador. Given that increases of security forces in Esmeraldas are related to the attacks but not to the level of crime in the province, it constitutes a potential alternative to treat the endogeneity issue of police and crime. Thence, a future research could estimate the number of property and violent crimes before and after the attacks in Esmeraldas, at the cantonal level.

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countries. Ecuador ranks 117 and obtains an index of 32. Information available at website online <https://www.transparency.org>

<sup>150</sup> See more information at <http://www.planv.com.ec/investigacion/investigacion/la-bomba-tiempo-minera>.

<sup>151</sup> Alias Guacho was a member of the Armed Revolutionary Forces of Colombia (FARC) who did not agree the peace process. Currently, Guacho manages the transport of drugs in Tumaco-Nariño (Colombia). He transports the drug using the river “Mataje” in the border between Ecuador and Colombia. See information at local newspapers online <https://www.eltelegrafo.com.ec/noticias/judicial/12/guacho-ecuador-colombia-atentados-frontera>; <https://www.elcomercio.com/actualidad/ecuatoriano-disidente-farc-sospechoso-atentado.html>.



# APPENDICES

## A. APPENDIX TO CHAPTER 1

### Appendix 1.A

Table 1.A.1 Statistics of Latin American and Caribbean countries

Cod	Country	GDP per capita (2016, PPP \$)	Income Gini (2014)	Poverty rate (2014, %)	Population (2015, number of inhabitants in million)	Density (2015, pop/km <sup>2</sup> )	Population growth (2015, annual %)	Urban population (2012, %)	Urban population growth (2010-2015, annual rate)
ARG	Argentina	12,479	.	.	43.3	15.6	1.0	93	1.2
BHS	Bahamas	28,676	.	.	0.4	27.9	1.3	84	1.5
BRB	Barbados	15,891	.	.	0.3	661.0	0.3	45	0.1
BLZ	Belize	4,960	.	.	0.4	15.6	2.1	45	1.9
BOL	Bolivia	3,100	0.49 <sup>d</sup>	32.7 <sup>d</sup>	10.7	9.8	1.5	67	2.3
BRA	Brazil	8,561	0.55	16.5	207.7	24.4	0.9	85	1.3
CHL	Chile	13,675	0.51 <sup>d</sup>	7.8 <sup>d</sup>	17.9	23.7	1.0	89	1.1
COL	Colombia	5,806	0.54	28.6	48.2	42.2	0.9	76	1.4
CRI	Costa Rica	.	0.505	18.6	4.8	94.3	1.1	65	2.4
DOM	Dominican Rep.	6,720	0.519	37.2	10.5	216.4	1.2	70	2.6
ECU	<b>Ecuador</b>	<b>5,969</b>	<b>0.45</b>	<b>29.8</b>	<b>16.1</b>	<b>63.0</b>	<b>1.5</b>	<b>68</b>	<b>2.1</b>
SLV	El Salvador	4,237	0.436	41.6	6.3	299.4	0.3	65	1.5
GTM	Guatemala	4,116	0.553	67.7	15.9	146.2	2.0	50	3.6
HND	Honduras	2,554	0.564 <sup>d</sup>	74.3 <sup>d</sup>	8.8	78.4	1.4	53	2.8
JAM	Jamaica	5,003	.	.	2.9	261.3	0.2	52	0.9
MEX	Mexico	8,530	0.491	41.2	124.6	63.4	1.3	78	1.6
NIC	Nicaragua	2,150	0.478 <sup>a</sup>	58.3 <sup>a</sup>	6.1	46.7	1.1	58	1.5
PAN	Panama	14,486	0.519	21.4	3.9	52.1	1.6	76	2.1
PRY	Paraguay	4,079	0.52	42.3	6.6	16.3	1.3	62	2.3
PER	Peru	6,031	0.44	22.7	31.4	24.4	1.3	78	1.8
URY	Uruguay	15,226	0.38	4.4	3.4	19.5	0.4	93	0.5
VEN	Venezuela	12,473 <sup>d</sup>	0.41 <sup>d</sup>	32.1 <sup>d</sup>	30.6	33.5	1.3	94	1.6

Sources: ECLAC and United Nations databases. <sup>a</sup> 2009, <sup>b</sup> 2010, <sup>c</sup> 2012, <sup>d</sup> 2013, <sup>e</sup> 2014, . Not available

## Appendix 1.B

Table 1.B.1 Definitions of crimes

Type of crime	Definition	Source	Proportion of crimes by sub-category
Homicide	Unlawful death deliberately inflicted on a person by another person, proceeding with malice. It includes murders when placing the victim in a situation of impotence or inferiority; flooding, poisoning or using fire; deliberately and inhumanly increasing the victim's pain; ensuring the impunity of another offense; carrying out the death at night, in isolated areas or during popular commotion. It excludes attempted homicides and suicides.	Ministry of Interior. National Police Database	
Robbery against persons	Theft of personal property, by a person or group of people, overcoming the threat of force or use of violence against the victim, in public or private places.		41.7%
Burglary	Unlawful breaking and entering in a house or apartment to steal goods that are inside, by a person or group of people, overcoming the threat of force or use of violence.		17.2%
Vehicle theft	Theft of total vehicle, by a person or group of people, overcoming the threat of force or use of violence on vehicles (trucks, cars, trailers, buses, motorcycles), in public or private places.		12.8%
Vehicle accessory theft	Theft of vehicle accessories or goods inside the vehicle, by a person or group of people, overcoming the threat of force or use of violence on vehicles (cars, motorcycles), in public or private places.	Attorney General's Office	16.5%
Theft in economic institutions	Theft of assets, money or goods, by a person or group of people, overcoming the threat of force or use of violence on economic institutions (private or public institutions, commercial businesses, enterprises that produce goods or services).		7.2%
Theft in financial institutions	Theft of assets or money, by a person or group of people, overcoming the threat of force or use of violence on financial institutions (banks, financial cooperatives).		0.2%
Theft in roads	Theft of money or goods, by a person or group of people, overcoming the threat of force or use of violence on roads.		1.1%
Others	Thefts not properly classified		3.3%

Note: Definitions homologated by the Ecuadorian Inter-Institutional Technical Commission of Security and Justice

## B. APPENDIX TO CHAPTER 3

### Appendix 3.A

Table 3.A.1 Definitions of types of victimization

Type of crime	Description
<b>Against households</b>	
Household Victimization	Household victimized by burglary or vehicle theft
Burglary	Unlawful breaking and entering in a house or apartment to steal goods that are inside, by a person or group of people, overcoming the threat of force or use of violence.
Vehicle Theft	Theft of total vehicle, by a person or group of people, overcoming the threat of force or use of violence on vehicles (trucks, cars, trailers, buses, motorcycles), in public or private places.
Vehicle Accessory Theft	Theft of vehicle accessories or goods inside the vehicle, by a person or group of people, overcoming the threat of force or use of violence on vehicles (cars, motorcycles), in public or private places.
<b>Against individuals</b>	
Individual Victimization	Individual victimized by robbery, threat, physical violence, kidnapping or other.
Robbery against persons	Theft of personal property, by a person or group of people, overcoming the threat of force or use of violence against the victim, in public or private places.
Fraud	Trick to get cash in exchange of prizes. It includes credit card cloning.
Threat/ Intimidation	Intimidation of hurting the individual or the family, for a particular reason, without asking for money or any exchange.
Physical Violence	Hurt by gunshot, cut, hit or push by a person on purpose to cause damage.
Kidnapping	Unlawful hold against the will, to ask for money, in exchange of freedom.
Other	Any other crime as Attempted murder, sexual crimes, betrayal of trust, etc.

Source: ENVIPI, INEC. Methodology of Victimization Survey.



### Appendix 3.B

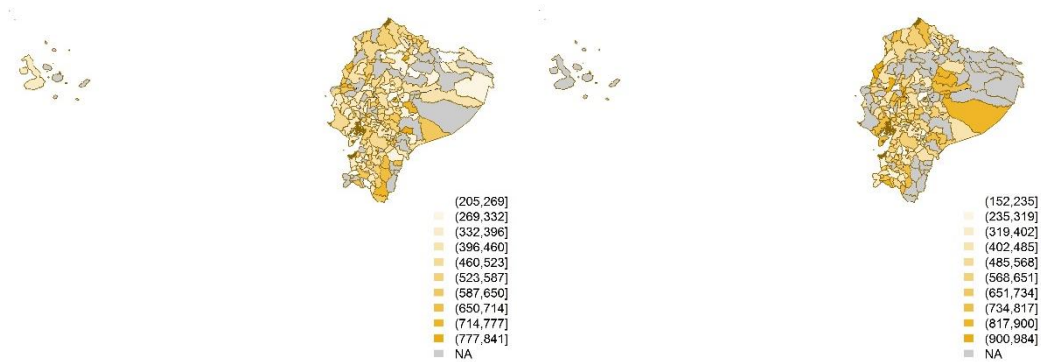
The National Survey of Employment and Unemployment (ENEMDU) is a household survey specialized in labor market and revenue information. The periodicity ensures a quarterly collection with differentiated coverage. The months of March and September stand on 6,876 households; while the rounds of June and December cover 21,768 households. This survey is representative at national and provincial levels.

To improve the efficiency and precision of estimators, the survey respects a sample design based on primary units, stratification and weighting factor. First, the primary sampling units -*psu* are geographical limits with 12 housing inside. The ENEMDU has 32,129 *psu* in total. Second, the stratification is the process of clustering primary sampling units by similar socioeconomic characteristics. Then, the stratified units stay on 11 domain categories. The domains are Quito, Guayaquil, Cuenca, Machala, Ambato, other urban Highlands, other urban Coast, urban Amazon, rural Highlands, rural Coast and rural Amazon. Third, the weighting factor is the instrument used to expand the sample data to the whole population. Basically, a weighting factor of a household is the inverse of the selection probability.

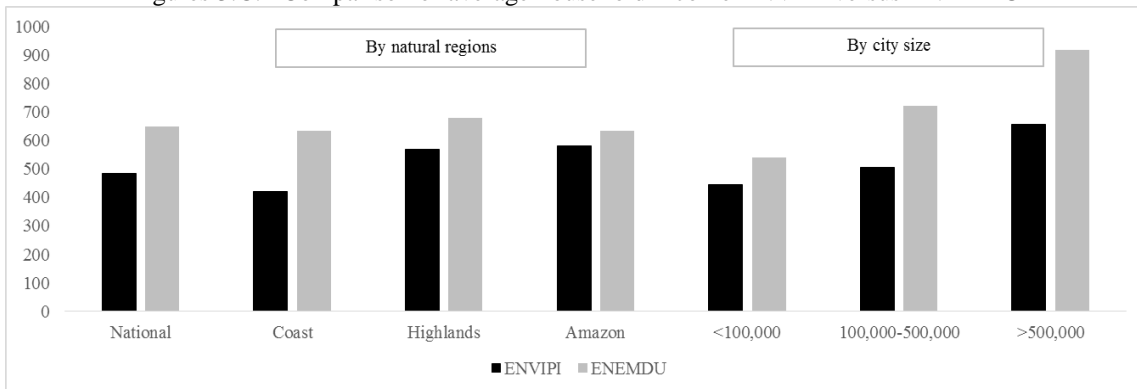
Given those parameters, ENEMDU only provides information at provincial level. For the purpose of our study, we create a new domain category with 47 domains using the round of December. It combines data of 23 provinces with urban/rural area. The last domain takes information of Non-defined cities. To ensure the representativeness of socioeconomic characteristics in cities, we only validate variables where the confidence level (error/coefficient) is lower than 0.25 in, at least, 70% of cities.

### Appendix 3.C

Figures 3.C.1 Maps of average household income by cantons  
Panel (a) ENVIPI Panel (b) ENEMDU



Figures 3.C.2 Comparison of average household income ENVIPI versus ENEMDU



## Appendix 3.D

Table 3.D.1 Variables: description and statistics

Variable	Description	Source	Mean	St. Dev	Min - Max	Observ
<i>Inequality and Income variables</i>						
Gini	Income inequality in canton	ENEMDU	0.44	0.09	[0.21, 0.67]	165
I <sub>h</sub>	Household Income (\$1000)	ENVIPI	0.49	0.59	[0.01, 20]	101536
<i>Household Head Characteristics</i>						
Gender	Gender of household head. Man=1, woman=0	ENVIPI	0.75	0.43	[0, 1]	117737
Age	Age of household head in years	ENVIPI	47.76	15.75	[15, 97]	117737
Schooling	Years of schooling approved by household head	ENVIPI	9.84	4.99	[0, 23]	117513
Occupancy	Whether household head occupied in any economic activity. Occupied=1, Not occupied=0	ENVIPI	0.84	0.36	[0, 1]	117737
N° occupied in hh	Number of household residents occupied in any economic activity	ENVIPI	1.67	1.01	[0, 11]	117737
<i>Individual Characteristics</i>						
Gender	Gender of respondent. Man=1, woman=0	ENVIPI	0.43	0.50	[0, 1]	117737
Age	Age of respondent in years	ENVIPI	40.42	17.09	[16, 97]	117737
Schooling	Years of schooling approved by respondent	ENVIPI	10.49	4.79	[0, 23]	117639
Occupancy	Whether respondent occupied in any economic activity. Occupied=1, Not occupied=0	ENVIPI	0.64	0.48	[0, 1]	117737
Ethnicity	Ethnicity of the respondent. Mestizo is the baseline	ENVIPI				
	-Mestizo	ENVIPI	0.83			97657
	-Indigenous	ENVIPI	0.03			3646
	-Afroecuadorian	ENVIPI	0.07			7999
	-Montubio	ENVIPI	0.07			7829
<i>Canton Characteristics</i>						
Young men	Proportion of men aged 15-24 years old over total men	CPV 2010	0.19	0.01	[0.16, 0.25]	177
Density	Number of residents per square kilometer (1000 population)	CPV 2010	0.14	0.34	[0.0024, 4.04]	177
Indigenous	Proportion of indigenous living in the canton	CPV 2010	0.09	0.17	[0, 0.94]	177
Afroecuadorian	Proportion of afroecuadorians living in the canton	CPV 2010	0.06	0.10	[0, 0.72]	177
Montubio	Proportion of montubios living in the canton	CPV 2010	0.11	0.17	[0, 0.80]	177
Basic Services	Proportion of households with access to electricity, potable water, sewerage and waste collection.	CPV 2010	0.30	0.21	[0, 0.89]	177
Capital	Whether the canton is also the capital of the province	DPA 2010	0.14	0.34	[0, 1]	177
Elevation	Elevation in meters above sea level (10,000 m.a.s.l)		1.06	1.13	[0.003, 3.2]	177
<i>Zone Characteristics</i>						
Young men	Proportion of men aged 15-24 years old over total men	CPV 2010	0.19	0.02	[0.07, 0.54]	1917
Indigenous	Proportion of indigenous living in the zone	CPV 2010	0.27	0.07	[0, 0.97]	1917
Black	Proportion of black people living in the zone	CPV 2010	0.08	0.10	[0, 0.98]	1917
Montubio	Proportion of montubio living in the zone	CPV 2010	0.06	0.09	[0, 0.77]	1917
Basic Services	Proportion of households with access to electricity, potable water, sewage and sanitary garbage collection and disposal.	CPV 2010	0.48	0.32	[0, 0.94]	1917

Table 3.D.2 Correlations

		Household variables									
		1	2	3	4	5	6	7	8	9	10
1	Gini <sub>c</sub>	1									
2	Income <sub>h</sub>	0.07	1								
3	Victimiz <sub>h</sub>	0.03	0.10	1							
4	Burglary <sub>h</sub>	0.02	0.02	0.75	1						
5	Vehicle <sub>h</sub>	0.03	0.14	0.66	0.04	1					
6	Gender <sub>h</sub>	-0.02	0.11	0.02	-0.01	0.05	1				
7	Age <sub>h</sub>	0.01	0.02	-0.02	-0.01	-0.02	-0.10	1			
8	Schooling <sub>h</sub>	0.09	0.40	0.09	0.02	0.12	0.06	-0.31	1		
9	Occupancy <sub>h</sub>	0.00	0.08	0.03	0.01	0.03	0.29	-0.41	0.18	1	
10	N <sup>o</sup> occupied <sub>h</sub>	0.01	0.21	0.03	0.00	0.05	0.13	0.06	0.01	0.29	1

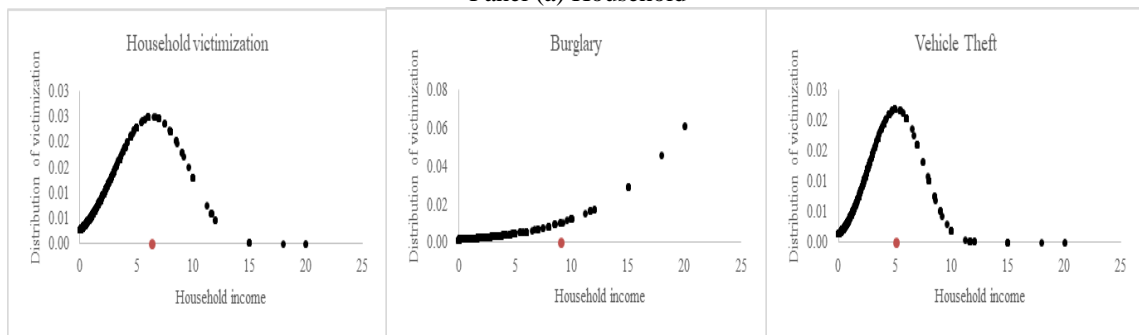
		Individual variables									
		1	2	3	4	5	6	7	8	9	10
1	Gini <sub>c</sub>	1									
2	Income <sub>h</sub>	0.0656	1								
3	Victimiz <sub>i</sub>	0.0055	0.0607	1							
4	Robbery <sub>i</sub>	0.0016	0.0559	0.8505	1						
5	Violence <sub>i</sub>	0.0073	0.0145	0.4144	0.0923	1					
6	Gender <sub>i</sub>	-0.017	0.0319	0.0259	0.0222	0.0138	1				
7	Age <sub>i</sub>	0.0143	-0.016	-0.113	-0.11	-0.051	0.028	1			
8	Schooling <sub>i</sub>	0.0926	0.3704	0.1295	0.1251	0.0374	-0.006	-0.328	1		
9	Occupancy <sub>i</sub>	0.0081	0.0832	0.0499	0.0329	0.0276	0.339	0.026	0.1134	1	
10	Etnicity	-0.052	-0.101	-0.025	-0.031	0.0079	0.0321	0.0106	-0.137	0.0055	1

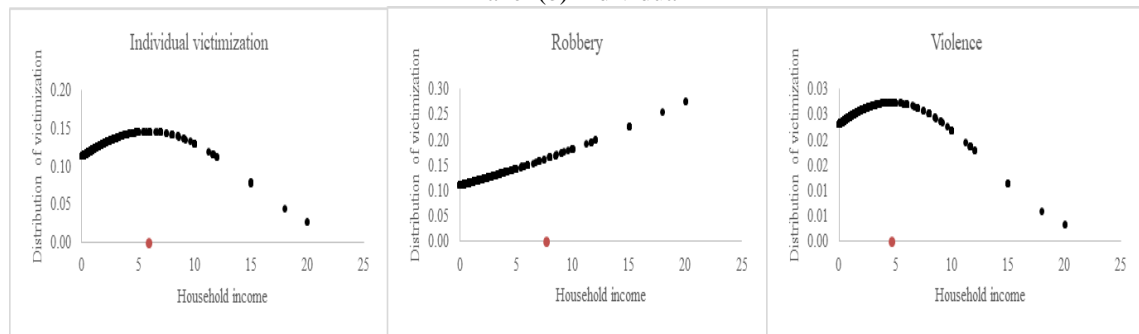
		Cantonal variables									
		1	2	3	4	5	6	7	8	9	10
1	Gini <sub>c</sub>	1									
2	Young_men <sub>c</sub>	0.08	1								
3	Density <sub>c</sub>	-0.03	0.01	1							
4	Indigenous <sub>c</sub>	0.13	0.22	-0.11	1						
5	Afroecuadorian <sub>c</sub>	-0.02	-0.15	0.02	-0.18	1					
6	Montubio <sub>c</sub>	-0.20	-0.48	-0.04	-0.30	-0.06	1				
7	Migration_rate <sub>c</sub>	-0.25	0.27	0.14	-0.08	-0.05	-0.08	1			
8	Basic_services <sub>c</sub>	0.13	0.36	0.16	0.01	-0.14	-0.51	0.16	1		
9	Capital <sub>c</sub>	0.23	0.23	0.04	0.09	0.01	-0.17	0.03	0.38	1	
10	Elevation <sub>c</sub>	0.03	0.25	-0.02	0.16	-0.08	-0.08	-0.01	0.00	-0.05	1

Appendix 3.E

Figure 3.E.1 Household income (in 1,000 usd) and the distribution of victimization  
Panel (a) Household



Panel (b) Individual



C. APPENDIX TO CHAPTER 4

Appendix 4.A

Figure 4.A.1 Crime and population at the parish level, in logarithms  
Homicide  
Property crime

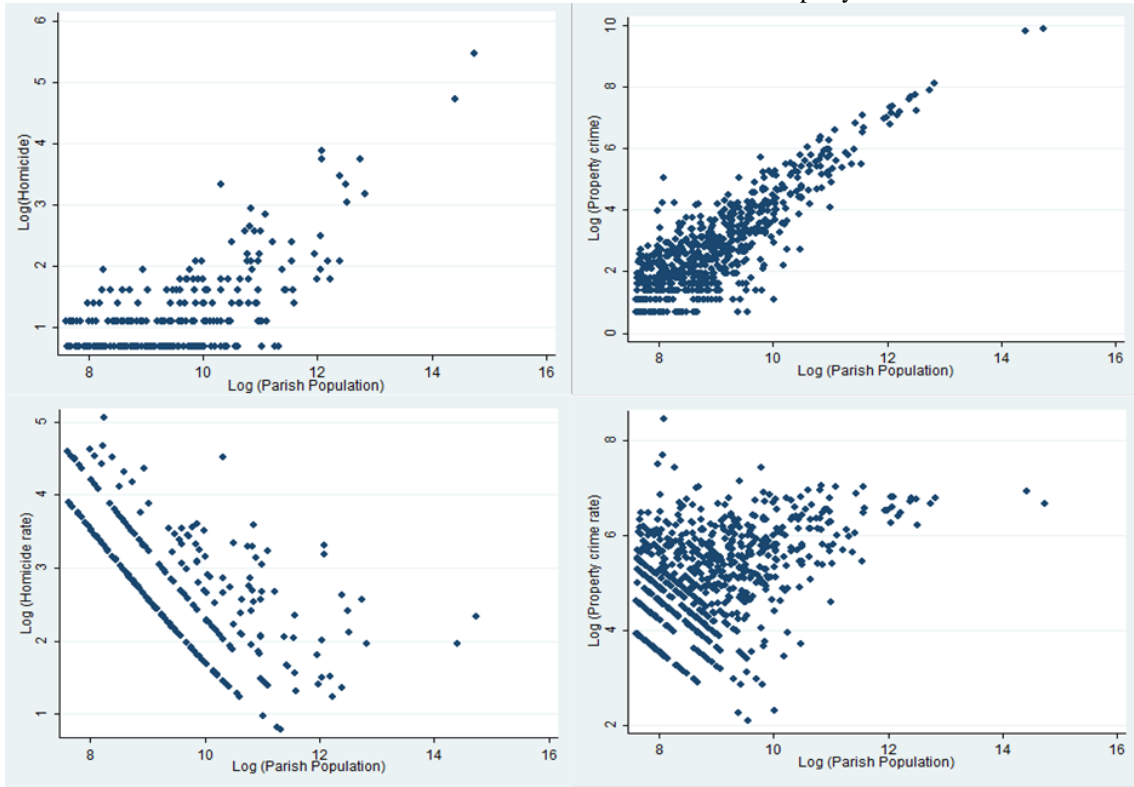


Figure 4.A.2 Crime and population density at the parish level  
Homicide  
Property crime

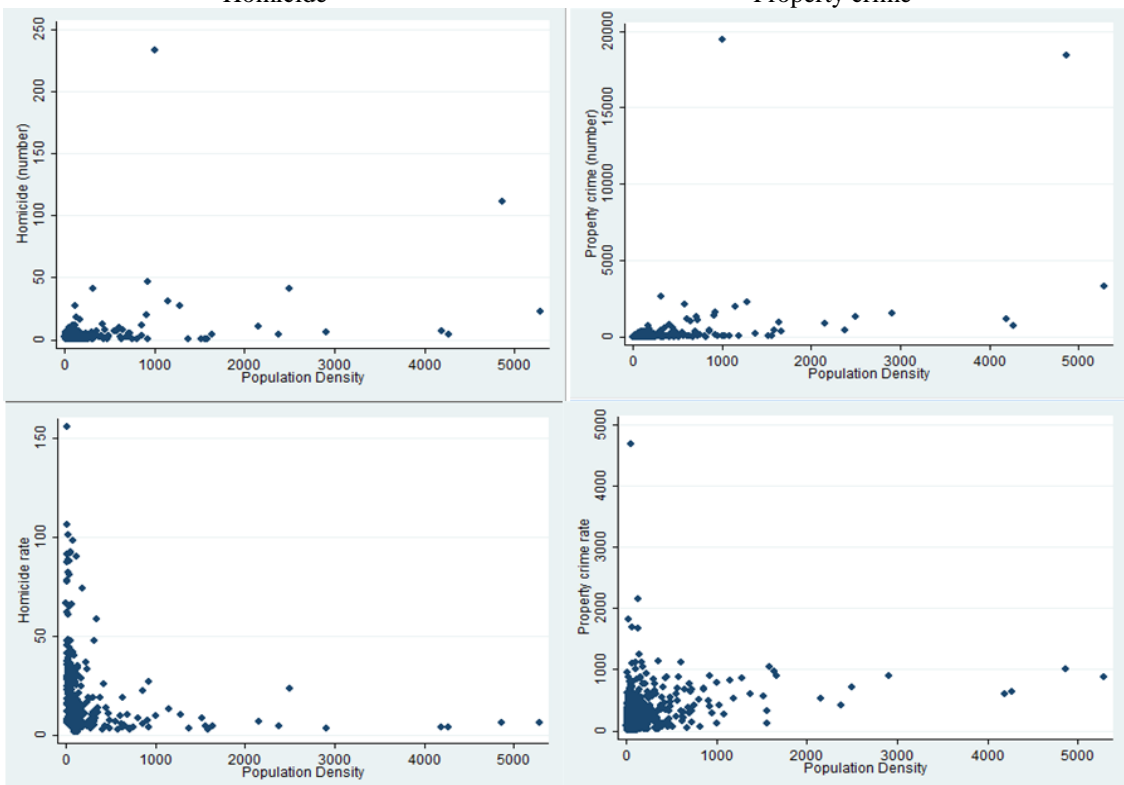
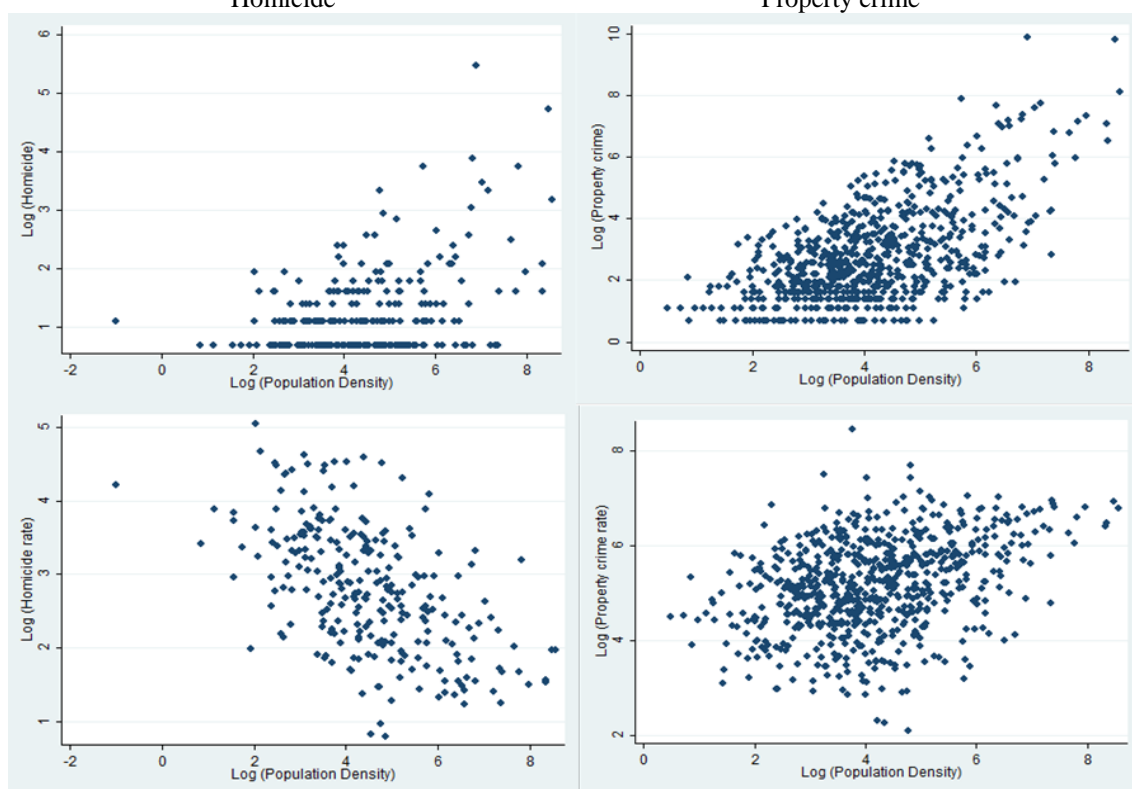


Figure 4.A.3 Crime and population density at the parish level, in logarithms  
Homicide Property crime



## Appendix 4.B

Table 4.B.1 Definitions and Sources

Variable	Definition	Source	Data
Homicide	Unlawful death deliberately inflicted on a person by another person, proceeding with malice.		
Classification by motivation of homicides	Homicides by Delinquency. Death originated by robberies, confrontation with security officers, organized and common delinquency, or rebellions.	Ministry of Interior. National Police of Ecuador database.	Parish level, 2010 - 2014
	Homicides by Interpersonal violence. Death caused by emotional fights, hate acts, debts, revenge or retaliation between two or more people.		
	Homicides by Domestic violence. Death caused by intrafamiliar controversy like sentimental issues, property litigation, and abuse.		
Property crime	Theft of property from a person, overcoming resistance by force or threat of force. It includes robbery against persons, burglary, vehicle theft, vehicle accessory theft, theft in economic institutions, theft in financial institutions, theft in roads, other thefts.	Attorney General's Office database.	Parish level, 2012 - 2015
Population	Number of inhabitants in geographical units per year.	National Institute of Statistics and Census. Estimation of population projections using inter-censal data 2001 - 2010	Parish level, 2010 - 2015
Young	Proportion of people aged 15-29 years old over total population.		
Poverty	Proportion of people with monthly income per capita below the poverty line	National Survey of Employment and Unemployment	Canton level, 2010 - 2015
Couple	Proportion of households with household-heads living as a couple, over the total households.		
Occupancy	Proportion of occupied population over the economically active population (15 years or older).	National Census of Population and Dwelling, 2010	Parish level, 2010
Schooling	Average years of schooling approved by the population aged 24 years and older.		
Business	Proportion of population occupied in the commercial sector, over the total occupied population (15 years or older).		
Foreigners	Foreign people living habitually in the country but that were living abroad five years ago.		
	Proportion of foreigners over the total population.		
Migratory Balance	Internal Migratory Balance. Difference between the number of people having entered in the parish and the number of people having left the parish in the past five years, over the share of parish population.		

Table 4.B.2 Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Homicide (rate)	5120	0.83	1.47	0	8.26
Property crime (rate)	4096	4.34	2.13	0	8.64
Parish Population	6144	8.34	1.33	3.69	14.74
Parish over cantonal population	6144	-2.36	1.44	-7.95	0
Cantonal Population	6144	10.7	1.4	7.53	14.77
Young (rate)	6144	3.23	0.12	2.75	3.71
Poverty (rate)	4657	3.58	0.57	1.66	4.58
Couple (rate)	5588	4.22	0.12	3.22	4.59
Occupancy (rate)	6144	4.03	0.15	3.02	4.55
Schooling (years)	6144	1.93	0.24	0.94	2.66
Business (rate)	6144	1.58	0.99	-2.3	3.47
Foreigners (rate)	6144	-0.9	1.48	-4.61	2.52
Migratory Balance (rate)	6144	0	0.05	-0.43	0.16

Note : All variables in logarithms

Table 4.B.3 Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Homicide (rate)	1												
2 Property crime (rate)	0.178	1											
3 Parish Pop.	0.345	0.405	1										
4 Parish/cantonal pop.	0.183	0.055	0.493	1									
5 Cantonal Pop.	0.124	0.314	0.399	-0.6	1								
6 Young (rate)	-0.05	-0.25	-0.2	0.43	-0.64	1							
7 Poverty (rate)	0.165	0.257	0.363	0.121	0.206	-0.29	1						
8 Couple (rate)	-0.02	-0.04	-0.01	0.057	-0.07	0.062	0.05	1					
9 Occupancy (rate)	-0.06	0.003	-0.06	-0.17	0.123	-0.23	0.264	-0.02	1				
10 Schooling (years)	0.172	0.352	0.404	0.207	0.152	-0.31	0.429	0.021	0.07	1			
11 Business (rate)	0.241	0.48	0.627	0.188	0.378	-0.33	0.379	-0.1	-0.03	0.497	1		
12 Foreigners (rate)	0.079	0.243	0.142	0.08	0.046	-0.2	0.332	0.007	0.157	0.361	0.347	1	
13 Migratory Balance (rate)	0.06	0.255	0.093	-0.09	0.179	-0.26	0.45	0.025	0.17	0.331	0.196	0.239	1

## D. APPENDIX TO CHAPTER 5

### Appendix 5.A

Table 5.A.1 Descriptive Statistics of soccer matches

Month	N°	Month	N°	Month	N°	Month	N°
Jan	30	Apr	164	Jul	169	Oct	148
Feb	142	May	138	Aug	174	Nov	182
Mar	156	Jun	99	Sep	120	Dec	78

Cantons	N°	Teams	N°
Cuenca	132	Deportivo Cuenca	132
Riobamba	87	Olmedo	88
Guayaquil	281	Barcelona Sporting Club	134
		Emelec	137
		River Plate Ecuador	22
Ibarra	24	Imbabura Sporting Club	22
Loja	107	Liga Deportiva Universitaria - Loja	111
Quevedo	20	Deportivo Quevedo	22
Manta	108	Manta	110
Quito	508	Sociedad Deportiva Aucas	22
		Deportivo Quito	134
		El Nacional	133
		Liga Deportiva Universitaria - Quito	136
		Universidad Católica	88
Rumiñahui	132	Independiente del Valle	133
Ambato	132	Macará	66
		Mushuc Runa	44
		Técnico Universitario	22
Sto. Domingo	42	Espoli	44
Guaranda	3	No team / Replacement Stadium	
Latacunga	4		
Machala	6		
Milagro	8		
Portoviejo	6		

Statistics for 1,600 matches played by 19 teams in 16 cantons. N<sup>a</sup> number of matches

Appendix 5.B

Table 5.B.1 Distribution of crimes by area of occurrence

Canton	Stadium	Teams	Homicide <sup>³</sup>				Total Property crime <sup>³</sup>			
			Homicide <sup>³</sup>	Stadium <sup>ˆ</sup>	Within capital <sup>ˆ</sup>	Peripheral <sup>ˆ</sup>	Stadium <sup>ˆ</sup>	Within capital <sup>ˆ</sup>	Peripheral <sup>ˆ</sup>	
Cuenca	Alejandro Serrano Aguilar	Dep. Cuenca	<b>135</b>	9%	70%	21%	<b>3477</b>	9%	77%	14%
Riobamba	Olimpico de Riobamba	Olmedo	<b>50</b>	8%	70%	22%	<b>1305</b>	49%	47%	4%
Guayaquil	Monumental Banco Pichincha	Barcelona S.C.	<b>1994</b>	1%	94%	2%	<b>38574</b>	29%	54%	1%
	George Capwell	Emelec		2%				2%		
	Christian Benítez Betancourt	River Plate Ecu		0%				14%		
	Modelo Alberto Spencer	<i>No team</i>		1%				0%		
Ibarra	Olimpico de Ibarra	Imbabura S.C.	<b>74</b>	12%	72%	16%	<b>986</b>	40%	53%	6%
Loja	Federativo Reina del Cisne	L.D.U Loja	<b>33</b>	6%	79%	15%	<b>1389</b>	26%	69%	5%
Quevedo	7 de Octubre	Dep. Quevedo	<b>303</b>	32%	62%	6%	<b>2359</b>	43%	54%	3%
Manta	Jocay	Manta	<b>278</b>	14%	85%	1%	<b>2285</b>	12%	87%	0%
Quito	Gonzalo Pozo Ripalda	Aucas	<b>1050</b>	2%	78%	16%	<b>33731</b>	2%	72%	15%
	Atahualpa	El Nacional, Dep. Quito, U. Católica		2%				10%		
	Casa Blanca	L.D.U Quito		1%				1%		
Rumiñahui	Rumiñahui	Ind. Valle	<b>26</b>	27%	65%	8%	<b>804</b>	64%	35%	2%
Ambato	Bellavista	Macara, Tec. Universitario, Mushuc Runa	<b>99</b>	2%	73%	25%	<b>1504</b>	13%	71%	16%
Sto Domingo	Etho Vega	Espoli	<b>397</b>	2%	87%	11%	<b>3744</b>	19%	76%	6%
Guaranda	Centenario de Guaranda	<i>No team</i>	<b>24</b>	8%	50%	42%	<b>128</b>	41%	48%	11%
Latacunga	La Cocha	<i>No team</i>	<b>44</b>	11%	45%	43%	<b>767</b>	38%	51%	11%
Machala	9 de Mayo	<i>No team</i>	<b>273</b>	8%	92%	0%	<b>4332</b>	44%	55%	1%
Milagro	Los Chirijos	<i>No team</i>	<b>99</b>	13%	79%	8%	<b>2379</b>	95%	0%	5%
Portoviejo	Reales Tamarindos	<i>No team</i>	<b>172</b>	6%	85%	9%	<b>3970</b>	2%	93%	5%

<sup>³</sup> Sum of offenses (Homicide and Property crime) occurred in cantons. <sup>ˆ</sup> Percentage of the number of offenses occurred near stadiums, in within capital parishes and in peripheral parishes.



## Appendix 5.C

Table 5.C.1 Estimates of each dimension of soccer on crime, at aggregate level

	Homicide					Property crime			
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
<i>Near stadium</i>					<i>Near stadium</i>				
Home pre-match		0.0018*	0.0018*	0.0018*	Home pre-match		-0.0032	-0.0037	-0.0037
		(0.00)	(0.00)	(0.00)			(0.01)	(0.01)	(0.01)
Home	0.0016	0.0016	0.0015	0.0015	Home	-0.011	-0.0051	-0.0043	-0.0043
	(0.00)	(0.00)	(0.00)	(0.00)		(0.02)	(0.02)	(0.02)	(0.02)
Home post-match		0.0005	0.0006	0.0006	Home post-match		0.1256***	0.126***	0.126***
		(0.00)	(0.00)	(0.00)			(0.01)	(0.01)	(0.01)
<i>In other precincts</i>					<i>In other neighborhoods</i>				
Home pre-match			-0.0002	-0.0002	Home pre-match			-0.0085**	-0.0085**
			(0.00)	(0.00)				(0.00)	(0.00)
Home			-0.0005**	-0.0005**	Home			0.0057	0.0057
			(0.00)	(0.00)				(0.00)	(0.00)
Home post-match			0.0006***	0.0006***	Home post-match			0.0088**	0.0088**
			(0.00)	(0.00)				(0.00)	(0.00)
<i>Intense Reactions</i>					<i>Intense Reactions</i>				
Home_react				-0.0023	Home_react				-0.0001
				(0.00)					(0.03)
Home_react <sup>2</sup>				0.0063	Home_react <sup>2</sup>				-0.0263
				(0.01)					(0.07)
Derby	-0.0010	-0.0012	-0.001	-0.001	Derby	0.1600***	0.1525***	0.1498***	0.1502***
	(0.00)	(0.00)	(0.00)	(0.00)		(0.03)	(0.03)	(0.03)	(0.03)
Constant	Yes	Yes	Yes	Yes	Constant	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes	Time f.e.	Yes	Yes	Yes	Yes
Precinct f.e.	Yes	Yes	Yes	Yes	Neighborhood f.e.	Yes	Yes	Yes	Yes
Match stage	Yes	Yes	Yes	Yes	Match stage	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.0018	0.0018	0.0018	0.0018	R <sup>2</sup>	0.2751	0.2751	0.2751	0.2751
N° Observ.	4251050	4251050	4251050	4251050	N° Observ.	1765006	1765006	1765006	1765006

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01. Standard errors in parentheses. An observation is a 3-h period starting from midnight over the 2010-2014 period. Estimates on homicides consider 291 precincts of 16 cantons. Estimates on property crimes consider 151 parishes of 16 cantons.



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