Essays on Microeconomic Analysis of Choice, Trust, and Organised Crime with an Emphasis in Mexico

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Abstract

This thesis consists of three independent chapters that aim to contribute applying theoretical and empirical microeconomic tools to the understanding of acute social problems present in every society, and that are of particular relevance to contemporary Mexico. Each respective chapter investigates issues related to aspirations and identity adoption; trust and its relationship with social gap and crime; and the competitive interaction between a kleptocratic government and criminal organisations.

The first essay presents an axiomatic model of type formation and how features of social environment can determine suboptimal type adoption. In the model a type search process is defined for agents with incomplete information on their true type. The model incorporates a type search process that finishes with an adopted type. Results are linked with the literature on extended choice models with frames, offering a rational on frame formation processes for individuals with limited information on opportunity sets.

A second piece of work empirically investigates possible correlates of trust in Mexico. This work focuses on the association of trust with crime and social gap. Trust is considered an asset that contributes to favour transactions and bonding within societies, thus it is important to understand what affects it, while crime and inequality constitute two of the most severe problems historically faced by Mexican society.

The third chapter looks at competitive interaction between a kleptocratic government and organised crime when they compete in crime markets. In this work the State and the criminal organisation are modelled as two-level organisations that aim at capturing as much rents from society as they can competing in criminal markets. Comparative statics analysis is presented to study this interaction and public policy implications under some scenarios.

Final commentaries are included to summarise results and highlight important points from findings on the three essays.

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Declaration of authorship

I declare that this thesis work, presented for examination for the Doctor of Philosophy degree at the University of York, constitutes my own sole work and effort. This thesis has never been submitted for any other degree at any other university or educational institution. This thesis contains original research except for external sources which have been acknowledged and cited.

The material presented in Chapter 3 of this thesis is a continuation of my own previous study on social capital and trust presented as thesis for a Maestria (Master of Arts) in Economics and Public Policy at the Instituto Tecnológico y de Estudios Superiores de Monterrey, and as thesis of Licenciatura (Bachelors degree) at the Universidad Autónoma de Nuevo León. Part of this earlier work has been published as:

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Aguayo Téllez, Ernesto, Ayala Gaytán, Edgardo A., and Martínez Cárdenas, Rubén (2014). A quantitative analysis of social capital in Mexico. Well-Being and Social Policy, 9(1):5–19.

However, all material in Chapter 3 has been produced anew, including all work on data from both survey waves, the literature review, all estimations included in the models, and all the analysis and results presented.

Chapter 1

Introduction

This thesis is formed by three independent chapters that aim to contribute to the understanding of three central topics in modern societies, and in particular in Mexico. These topics are inequality of opportunities, its effect on aspirations, and the effects that this has on individual choice processes; trust and its relation with crime and social deprivation; and organised crime and its competition in the extraction of rents with the state. The first constitutes a historical source of struggle for Mexican society, namely poverty and inequality, in particular the aspects related to the lack of opportunities, the negative effect that it has on aspirations, and the disadvantages that the most deprived sectors of the society experience. The second topic relates to a factor that has been related, theoretically and empirically, to the development of societies and their appropriate functioning. Finally, the third concerns to a constant problematic that has recently escalated to exceeding levels with the upsurge of violence and the sophistication of criminal organisations.

Chapter 2 presents an axiomatic model of type formation, and studies how aspirations can determine suboptimal type adoption. In the setting of model a type search process is defined for agents with incomplete information on their true type. The individuals use information from their environment to determine where to search for a type, and which type they should aspire to adopt using a heuristic based on the concept of satisficing. The model incorporates the type search process with an extended choice model with frames, and it is shown under which circumstances an adopted type can function as a frame and bias choice, offering a rational on frame formation processes for individuals with limited information on opportunity sets.

The model contributes to the theoretical explanations of poverty traps, the scarcely explored economics of aspirations and their effects, and to the study of frames and consideration sets in choice. The chapter closes with applications of the model to

inequality of opportunities, and to subsidies directed to poverty alleviation. Some implications for public policy arise from this latter analysis, in particular, the results contribute showing the possibility for subsidies aiming at improving attainment in type adoption outcomes to backfire with opposite effects to the ones desired.

The work presented in Chapter 3 seeks to investigate the relationship between trust and two strong influencers of the development of societies, social deprivation and violent crime. Using two waves of survey data collected in Mexico on social capital, the chapter analyses the relationship between trust, as measured in the Word Values Survey, and violent crime and social deprivation. These two issues are of importance due to the high impact they have on well-being, and their relevance is particularly prominent for Mexican society, which has struggled with persistent poverty and inequality, despite the continuous application of economic reform and programmes in line with international recommendations, and that has experienced an alarming rise in crime and violence since 2006, the year the first wave of data was collected, and that reached it's highest point near 2011, the year the second survey took place.

The analysis focuses on disentangling associations between trust and two explanatory variables in particular: violent crime approximated by homicides, and social deprivation as measured by the construct social gap. Alternative measures of trust are considered, the first measure is the standard question about trust used in the *World Values Survey*; the second measure is an index of trust in public institutions. Asymmetries between trust and distrust are explored constructing measures of both concepts departing from the original responses on trust reported by surveyed subjects. Additionally, robustness checks are implemented using different specification models, including instrumental variables, and the parallel lines assumption is also tested. The analysis includes other variables of interest regarding individual characteristics and experiences, as well as regional, social and institutional indicators as controls.

Chapter 4 looks at competitive interaction between a kleptocratic government and organised crime when they compete in a crime market. Crime is an activity that has been and is part of every society, and has many implications in the way they function. This phenomenon has caught economists attention over the years, with the seminal work of Becker (1968), the study of crime from economist's perspective has produced theoretical and empirical economic work that has permeated the literature on crime and has influenced policy, not only based on individual behaviour, but also focusing on organised crime. However, the study of criminal organisations is rather scarce, let alone theoretical models in which the state profits from the existence of crime.

In this work, the state and the criminal organisation are modelled as entities structured in two levels that aim at capturing as much rents from society as they can by competing

in a criminal market. In the model, both players have limited resources to compete, hold lexicographic preferences over markets, and decisions and actions take place in two steps, each of which is conducted by one of the two organisational levels. The introduction of multi-level organisations allows to consider discrepancies in policy design and implementation. Also, the magnitude of the rents that can be extracted are endogenised in the model. A comparative statics analysis is presented to study public policy implications of a number of scenarios.

Chapter 2

Type Search and Choice: True and Adopted Type Mismatch and the Generation of Frames

In this chapter a model of type search and adoption is presented. Individual's type is assumed to be determined by Nature and ignored by individuals. Self-Type ignorance starts a process in which individuals search for a type to adopt. In this search process, individuals take into account the information in their current state, together with a net valuation function and a threshold, to determine when the search process must stop. The type-search process produces an adopted type that may or may not coincide with the true type of the individual. If the adopted type is different to the true type, this adopted type is shown to function as a frame in an extended choice problem. In this framework, adopted types that constitute frames can lead to sub-optimal choices with individual well-being implications. Possible applications of the model are suggested.

2.1 Introduction

Decision processes can be overwhelming and costly in terms of the time invested and information search and acquisition. Given that there is usually a level of information absence involved in decision making, even consciously selected choices in a bounded setting may or may not (in the end) be the optimal for each individual. This is particularly true if knowledge about self-characteristics, areas of strength or capabilities are not well defined or are non-existent.

The presence of suboptimal choice among individuals is usually linked to either poor judgement, or to a negative bias in opportunities. For example, when individuals choose which level of education to attain, what health behaviours to follow, how much should be saved, or which goods to acquire, it is often observed that their decisions deviate from their optimal as dictated by rational agent models. These "anomalies" raise questions about the nature of these discrepancies, and why they emerge, in particular among the poor or socially disadvantaged.

As stated by Duflo (2006), a branch of literature has researched the permanence of poverty led by the "poor but efficient hypothesis", based on the work of Schultz et al. (1964), which succinctly states that the poor behave as rationally as their environment allows them to. Nevertheless, further developments in the literature opened a new research avenue where the effort focused on market failures and how they hinder the result of individual's rational behaviour (Duflo, 2006, p. 367). On these grounds, it seems reasonable to conjecture individual characteristics and environmental influences affect agents' behaviour. In this regard, Ray (2006) argues there is more to the behaviour of an individual than its own self, and that "individual desires and standards of behaviour are often defined by experience and observation; they do not exist in social isolation" (Ray, 2006, p. 409). The author refers to the influence that an individual's environment has on her behaviour as *aspirations*, and defines an *aspirations window* as the set of reachable individuals someone can aspire to be.

This chapter presents a model that can accommodate these and other behavioural patterns that are commonly observed, and depart from the fully rational individual setting. The approach focuses on phenomena related to education and career choice, with the main motivating example being related to educational choices. However, the generality of the model allows the setting to be extended to other realms such as consumer behaviour, gender bias, crime, and other similar topics. This work builds on existing tools in the literature to present a model that provides insights that can help support policies addressing the negative effects of inequality of opportunities, poverty traps, aspirations, and escalation costs in social mobility, and that can be translated into identity adoption and the literature related to it. Additionally, the introduction of status quo provide means to analyse how the distribution of types can produce traps that affect efficiency.

More precisely, the chapter presents a model of type determination for boundedly rational agents. An individual's type in this context is parallel to the concept of identity explored by Akerlof and Kranton (2000). In the model's setting, individuals are unaware of their type, and posses limited information on which type is appropriate for them. This limitation leads them to embark on a type search process guided by a heuristic

rule defined by a satisficing criterion based on Simon (1955). The satisficing strategy is particularly determined by payoff thresholds that are influenced by the composition of types in social environments, and that inform the agent when to stop searching and adopt a type . These thresholds can be interpreted as the aspirations individuals posses, where aspirations are understood as in Appadurai (2004) and Ray (2006). The type search and adoption process can lead individuals to choose types that do not correspond to their true types. It is shown in the model how an individual's adopted type can constitute a frame that interferes with choice processes in extended choice problems, providing a link between the model and the literature on choice with frames (Bernheim and Rangel, 2007; Salant and Rubinstein, 2008), choice with search (Dalton and Ghosal, 2012; Horan, 2010; Masatlioglu and Ok, 2005), and other related work. Finally, the results in the model are used to explore the effects that inequality of opportunities and subsidy based policies can have on type adoption.

One can find in the literature a number of other approaches that also investigate non-optimal behaviour. Bounded rationality, for example, is one of the earliest attempts to do so, aiming to model choice behaviour considering boundaries to the unlimited capabilities of the rational man on information processing. A common reference for the origin of this line of research is Simon (1955), where the author exposes the problems and weaknesses of theories based on the rational individual, and defines an agent with less demanding assumptions. Lipman (1995), Selten (1999), and Rubinstein (1998) present a variety of models relying on the concept of bounded rationality.

On the other hand, theoretical research on type unawareness is rather scarce. Murayama (2010), for example, develops a two sided search model where agents are not aware of their type, and discover it by process of rejection and acceptance with implications for welfare in equilibrium. Concerning work related to individual behaviour and choice, Young (2008) builds a model introducing self-image in individual's utility function, in the model's setting individuals do not have a clear idea of what their identity is. He finds that, under certain assumptions, agents may find impossible to define an identity for themselves. Also, Gul and Pesendorfer (2007) develop a model where agent's preferences depend on other individuals' characteristics and personalities; and Calvó-Armengol and Jackson (2009) study the influence that social environments have on both parents and children. This interaction results in overlapping environments determining behaviour correlation among the two agents. Regarding the industrial organisation literature, Boone and Shapiro (2006) build a model where the type of consumer changes over time as a function of previous consumption of goods, giving power to the producer on rent extraction. Learning theory approaches situations similar to those of type ignorance or adjustment usually by departing from models that assume rational equilibrium or that are built in a game theoretical setting (Slembeck, 1998). In learning theory

models, individuals adjust their behaviour incorporating information captured by social interaction in a way such that they optimize on payoffs via imitation of better strategies, or at least strategies that seem to be the best.

The model of type search and adoption presented here is closely related to a relatively new line of research that has been coined as identity economics. This topic has been recently developed by Akerlof and Kranton (2000), Bénabou and Tirole (2011), and Fryer and Jackson (2008), among others; and can be traced back to Sen (1985), Folbre (1994), and Kevane (1994). The core idea in this literature is that by developing an identity, an individual's sense of self, agents can see their choices limited, in turn affecting outcomes in their environment, which can work in detriment of their well-being. Individuals subject to identity standards aiming at perceiving a positive payoff, which derives from fitting in a social environment and within particular groups. Within this literature, work is scarce on the formalisation of identity formation, this is an avenue where the present work seeks to contribute. Regarding the applied literature, research has focused on identity (type) awareness instead of unawareness. In these studies, identity influences judgements individuals make about themselves and others, and affects choices that have short and long term impacts on individual and collective life. The relation between identity and these outcomes can be found in the works of Humlum et al. (2012) who use factor analysis methodology to extract how identity influences educational or career choices; Benjamin et al. (2010) who implement experiments to capture the effects of race identity on patience in decision making; Shayo (2009) and Klor and Shayo (2010) develop a model of identity and then test it using experiments to determine the effect of identity on redistribution preferences, the former focusing on payoff maximization behaviour, and the later with class and national identities as focal points; Hoff and Pandey (2006) use two experiments in rural India to consider if social identity of individuals can explain cognitive performance and responses to economic incentives. Although this work focuses on identity and not on types, the latter can be related to the former if type adopted is instead defined as identity (For other approaches see Blume and Durlauf (2001), Ozgur and Bisin (2011): social interactions; Bénabou and Tirole (2011): identity driven by moral behaviour; Jamison and Wegener (2010): multiple selves).

Recently, an interest in the study of aspirations as an influential element in individual behaviour has emerged in economics. In an influential work, Appadurai (2004) argues that aspirations are a result of both individual and social factors, as stated in his own words "Aspirations are never simply individual (as the language of wants and choices inclines us to think). They are always formed in interaction and in the thick of social life" (Appadurai, 2004, p. 67). The concept of aspirations has been used to develop theoretical models that aim at explaining the determinants of poverty from

an individual perspective. For example, among those leading this efforts one can find the work of Ray (2006), and Genicot and Ray (2014). The former presents strong arguments in favour of the inclusion of aspirations in the standard economic framework, while the latter presents a model in which aspirations are determined by the distribution of income in individual's environment, affecting their investment decisions, which consequently affect society's wealth. They use their model to explain how economic outcomes are so persistent. More recently, Dalton et al. (2016) have contributed with a model where poverty deters aspirations and generates poverty traps, in their model all agents, independent of their status, posses the same features, but the lack of resources generates inconsistencies in the way aspirations are formed and considered by individuals. The influence that inequality plays on aspirations (modelled as reference points), subsequently affects investment behaviour on individuals. In their model, too high aspirations truncates investment, while moderately high aspirations spur it.

With respect to research that seeks to extend the classical models choice literature, recent work on choice has focused on the introduction of frames, search processes, and consideration sets in the traditional framework. This new literature has emerged with interesting results that illuminate on possible reasons and processes behind sub-optimal choice among individuals. For example, in the literature on frames and choice, Salant and Rubinstein (2008) model choice with frames, where the pair composed by a frame and the set of alternatives defines an extended choice problem, and axiomatically determine and study the implications for choice behaviour. Bernheim and Rangel (2007) suggest a framework with ancillary conditions that affect choices, focusing on welfare implications. Applying the concept of frames to the economics of imperfect competition, Eliaz and Spiegler (2011) develop a model of consumer choice with consideration sets where entities with market power can affect choice via frames.

With respect to choice involving search processes, Masatlioglu and Nakajima (2013) present a model of iterative search and decision making with reference points leading the search process. Horan (2010) offers a model of choice form lists in which a search process takes place. Dalton and Ghosal (2012) build a model where choices are driven by frames that are endogenously determined with a feedback process involved, they describe choice procedures in their framework and explore the effects on welfare under a number of assumptions that restrict the information on the part of the decision maker. Other related literature includes Masatlioglu and Ok (2005) who expand the classical choice theory to include the influence of status quo in choice behaviour departing from the revealed preference theory. Concerning choice models that make use of the satisficing criterion, Papi (2012) presents an axiomatic model of bounded rationality, making use of the satisficing concept within the revealed preference framework. Additionally, Caplin

and Dean (2011) build a model of choice with search in which search is costly, and where one of the search criteria explored involve decision makers having a reservation utility that indicates when to stop searching. In their model the reservation utility is actually a satisficing criteria.

By offering a framework that helps understand why individuals may end up taking actions that seem to be suboptimal from the point of view of a purely rational agent, this chapter contributes adding to the existent literature on bounded rationality. The model offers a rational on how types are formed in social environments, this contribution helps filling some gaps in the identity economics literature leadered by Akerlof and Kranton (2000), where efforts have focused on the consequences of identities on outcomes, and little has been done in terms of formalising how identities are formed. When formalising the search process that leads individuals to adopt a type, the concept of satisficing as a stop/choice criteria is borrowed form Simon (1955, 1997). This strategy has been used mainly in the context of the firm, and have not been fully exploited in individual choice settings (Some exemptions are Papi (2012) and Caplin and Dean (2011)).

In the type adoption process presented, thresholds constitute a fundamental part of type adoption, determining the extent of sub-optimality of adopted types. In the model, thresholds can be linked to aspirations by adapting the definition of the latter from the studies of Appadurai (2004) and Ray (2006). Thus the chapter also contributes to research in economics on the relationship between aspirations and identity, offering a framework that can be used to analyse identity adoption among individuals in society. Also, while Dalton et al. (2016) model aspirations as individual processes, and in Genicot and Ray (2014) aspirations emerge from individual's social environment, the approach followed here allows for individual and environmental factors to influence individuals' aspirations and outcomes, an addition to the contributions mentioned above.

Additionally, by linking the model's search and adoption type process to the work on frames in extended choice problems developed by Bernheim and Rangel (2007) and Salant and Rubinstein (2008), among others, the chapter contributes with the inclusion of self-type unawareness as an explanation of how frames are formed. Furthermore, in the model type unawareness and type adoption emerge as a leading cause of rationally bounded behaviour. Concerning policy implications, two applications of the model offer interesting results. In one the effects of inequality of opportunities on type selection are analysed, formally showing how inequality produces low aspirations, and how them lead to sub-optimal type selection. Another application shows how certain policies that reduce the costs of type search, oriented at improving type selection can backfire leading individuals to opposite behaviour to the one intended.

In the following sections the main elements of the model of type search are presented, followed by the result of such search process. Then, the extended choice model is developed with adopted types as frames. Finally, some possible applications of the model are offered. A section with final comments including future extensions closes the chapter.

2.2 Two motivating examples

Before the model is presented it is convenient to offer some motivating examples of how aspirations and the social environment of an individual can influence choice behaviour. The examples are purely anecdotal, nevertheless they offer insight into the core idea of the model.

2.2.1 Aspirational changes

This first case exemplifies how aspirations can be influenced by environments. The case presented involves an orphanages, run by catholic nuns, where the following events where observed. The orphanage was exclusively for girls, and offered primary and secondary education to the girls in the orphanage in a school located in the same premises that the orphanage occupied, schooling was also open to external children. The institution took care of the girls until they finished secondary school, then they had to decide how to continue their lives, some of them choosing a career path to follow. It was noticed that most of the girls that opted for a career path where choosing either to become school teachers, clerical staff, or nuns, precisely the type of activities they observed in their social environment composed predominantly by nuns, external teachers, and administrative staff.

The director of the orphanage decided to start a programme in which families would "godparent" one or more girls from the orphanage, inviting the girls to live with them for short periods of time, usually a couple of weekends per month, or for the whole summer vacation. Not all the girls entered into the programme, and the ones that entered where selected in a rather random fashion. After a period of time, it was observed that the girls who where in the programme started to choose paths different from the historical trend observed among other girls from the same institution. These paths included studying dentistry, law, business administration, among others. Although both groups continued to choose the common paths, one could easily observe the programme was changing the aspirations of the girls that participated in it, which was precisely one of the goals of the programme.

2.2.2 Environmental change

A second example illustrates how changes in environment could lead to behavioural changes. Countries usually differ in their laws, and also on how strictly those laws are enforced. When differences are marked between two countries sharing a border, it is often observed that individuals change behaviour when moving from one country to another. Take for example border sharing countries in Europe and America. In some countries the highway codes differ, and also the degree to which the codes are followed by drivers tend to be dissimilar. It is common to hear comments on how residents of one country drive carelessly, and engage in littering behaviour, and do not respect speed limits for example. But as soon as they cross the border to another country where residents show the opposite behaviour, those same individuals that usually misconduct change their behaviour once they move from one environment to the other. In this case, it is the environment that changes, and possibly the expected costs of engaging in inappropriate behaviour.

The elements mentioned in the previous examples: aspirations, social environment, and predominant behaviour, together with the benefits and costs experienced by individuals will be part of the key elements introduced in the model. The examples presented here do not exactly match the theoretical model, nor are they intended to claim that they are determined by the factors mentioned here, surely there is a complex line of causation in those behaviours including a variety of factors, still they illustrate the main features of the model, as well as the issues to be address in the model presented in what follows.

2.3 Model

The model develops as follows, agents are born in random environments without an identity, but in possession of an initial signal that constitutes incomplete information on their true type. They use this information to start a type search process that will end with the adoption of a type. In order to adopt a type, agents need to acquire characteristics, which are defined for each type and can be obtained by agents at a cost. To complement the initial signal, agents take into account information about the status quo of types in their environment, together with a sense of distance between types that allows them to distinguish how far types are from each other.

The rationale behind the inclusion of diverse environments is to take into account the fact that individuals are born under dissimilar circumstances, which provide them with social and institutional support that may vary in quantity and quality among different existent environments. By introducing the possibility of having various status

quos across environments, the model takes into account that agents can have different reference types at which they can aim, mimicking the influence that certain types have on agent's aspiration formation, given the environment where they are immersed.

To adopt a type agents take into account the payoff they will perceive from adopting a given type, the cost of adopting such a type, and a *satisficing* criterion that consists in at least perceiving certain level of net payoff, this latter defined as the difference between the payoff and the cost of adopting a type. The assumption of agents following this criterion is in the spirit of the concept of *satisficing* introduced by Simon (1955).[1]

Concerning the payoff perceived from adopted types, assume that agents preferences over types are representable by a function $\pi : \Theta \to \mathbb{R}_+$ of class C^2, for which $\pi_\theta > 0$, $\pi_{\theta^2} \leq 0$, and such that $\pi_i = \pi(\theta_i^{'}) = \pi(\rho(\lambda_i^{'}))$. That is, $\pi(\cdot)$ has a positive and increasing at a decreasing rate valuation for types, and the values attained by the function for every type are specified for each characteristic that produces such types.

Type adoption is not a costless action. There are costs produced by the adoption of a type that are generated by the resources exerted to reach the possibility of adopting the type. On the one hand, acquiring characteristics is costly, e.g. obtaining a formal education diploma requires at least time and effort. On the other, not all environments possess the same provisions to help individuals in the enterprise of pursuing a type to adopt, just as not all towns in a country have a university campus at a walking distance. Also, even people in the same environment experience the world in different ways, they have different perceptions over what is achievable, and what is not, and how much effort is needed to reach a given goal. To introduce these features in the model, it is assumed that agents' costs depend on the characteristics, the status quo of their environment, and the distance defined over types. Let the costs of adopting type θ_k be represented by $\mathcal{C}_i = \mathcal{C}(\rho(\lambda_i^{'}), \theta_{\aleph_i}, \mathcal{M}_i)$, where $\rho(\lambda_i^{'}) = \Theta_i^{'}$. Assume C is a linear function of $\theta_\aleph$, and convex with respect to both θ and $\mathcal{M}$. Furthermore, assume $\mathcal{C}$ has an additive functional form composed by a linear function $C_{\aleph_i} = C_\aleph(\theta_{\aleph_i})$, for which $\dfrac{\partial C_\aleph}{\partial \theta_\aleph} < 0$, $\dfrac{\partial^2 C_\aleph}{\partial \theta_\aleph^2} = 0$, and a class C^2 function $C_i = C(\rho(\lambda_i^{'}), \mathcal{M}_i)$, with $\dfrac{\partial C}{\partial \theta} \geq 0$, $\dfrac{\partial^2 C}{\partial \theta^2} > 0$, $\dfrac{\partial C}{\partial \mathcal{M}} \geq 0$, $\dfrac{\partial^2 C}{\partial \mathcal{M}^2} > 0$. Thus, the general cost function $\mathcal{C}(\rho(\lambda_i^{'}), \theta_{\aleph_i}, \mathcal{M}_i)$ is convex and the signs of the partial derivatives are preserved.[2]

The net valuation agent i has on adopting a type $\theta^{'} \in \rho(\lambda^{'})$ is $\mathcal{V}(\theta^{'})$ and is equal to the difference between her valuation and her cost of adopting that particular type, that

[1] The concept of *satisficing* appears first in (Simon, 1997, p. 118-120). The world is a combination of the words "satisfy" and "suffice", and is meant to represent a heuristic choice procedure that does not necessarily involves an optimising criteria.

[2] That is $\mathcal{C} : \Lambda \times \Theta \times \mathcal{M} \to \mathbb{R}$. As the sum of convex functions produces a convex function we have $\mathcal{C}_\theta \geq 0, \mathcal{C}_{\theta^2} > 0$, $\mathcal{C}_{\theta_\aleph} > 0$, $\mathcal{C}_{\theta_\aleph^2} > 0$, $\mathcal{C}_\mathcal{M} > 0$, $\mathcal{C}_{\mathcal{M}^2} > 0$.

is $\mathcal{V}(\theta', \lambda', \theta_{\aleph}, \mathcal{M}) = \pi(\theta') - \mathcal{C}(\rho(\lambda'), \theta_{\aleph}, \mathcal{M})$. Whenever $\mathcal{V} < 0$ the cost of adopting type θ' surpasses the payoff of adopting that type, and thus type θ' is not chosen. Furthermore, as criterion of type choice, we don't only require $\mathcal{V}$ to be positive, but also that it reaches at least a minimum threshold value to capture the idea of agents evaluating the worthiness of adopting a given type not only on the basis of private costs and payoff, but also on the valuation that a type has in each of the environments. Notice that imposing these threshold conditions the way individuals guide their type choice behaviour by taking into account their valuation and how their social environments bias the selection of each type, and that, by doing so, the demands on individuals being fully rational optimisers are relaxed. Define this threshold as $\Gamma_i = \Gamma(\lambda_i^t, \theta_{\aleph_i}, \mathcal{M}_i)$ where Γ is increasing in λ, that is, the higher the characteristics in the $\succsim_\Lambda$-ranking the higher the threshold, and also increasing in $\theta_{\aleph_i}$ as an indicator of what is acceptable in each environment, and what the agent should aim to according to what society dictates is the norm (the status quo). Feasibility of types is captured by $\mathcal{M}_i$, the distance from one type to another influences the threshold by informing on how hard it is, from the point of view of the individual, to reach any type from a given point in the types space.

Notice that the threshold just described can be interpreted as the aspirations of the individuals, summarising information on what is available, what is reachable, and what individuals should aim at according to the characteristics they posses, what can be expected from a member of the social environment the individual belongs to, and the beliefs the individual has on how difficult it is for them to reach a given type to adopt.

2.3.1 Types and characteristics

Let i indicate an individual in a shared environment $\aleph_i$. Let the set $\Theta \ni \theta,\ \theta \in [\underline{\theta}, \overline{\theta}]$ be a compact metric space with typical element θ, henceforth called a *type*, and $\underline{\theta}$ and $\overline{\theta}$ as the respective lower and upper bounds with finitely many types between them. Assume there is a complete partial order $\succsim_\Theta$ on Θ, that represents preferences over the elements of Θ. Define $\Omega := 2^\Theta \setminus \emptyset$ as the set of all non-empty subsets of the set of types Θ, and let $\Theta_h \in \Omega$ be one of those subsets, as Θ is finite Θ_h so is as well. Each Θ_h, as subsets of Θ, are bounded, additionally if the subsets are also closed then they are compact metric spaces as well. Observe that any preference $\succsim_{\Theta_h}$ respects $\succsim_\Theta$.

Let $\mathcal{L}$ be the total number of existent characteristics, and $\Lambda \subseteq \mathbb{R}_+^{\mathcal{L}}$ be the space to which the vectors of characteristics $\lambda \in \Lambda$ belong, and whose elements $\{\lambda_1, \lambda_2, \ldots, \lambda_{\mathcal{L}}\}$ indicate the magnitude of each characteristic. Let $\succsim_\Lambda$ be a complete partial order for all elements in Λ. Define the pairs $(\Theta, \succsim_\Theta)$ and $(\Lambda, \succsim_\Lambda)$ as the corresponding complete partially ordered sets. Given that Θ is compact, $(\Theta, \succsim_\Theta)$ forms a complete lattice (Steen

(1995, p. 67)), and thus its infimum and supremum exist. Additionally, each type $\theta^{'}$ has a vector of characteristics $\lambda^{'}$ that corresponds to it and accompanies that particular type, indicating the characteristics that each type possesses and in which magnitude, with a type $\theta^{'}$ being better allotted in terms of $\succsim_{\Lambda}$-ranked characteristics in comparison to any other type $\theta^{''}$ if and only if $\theta^{'} \succsim_{\Theta} \theta^{''}$. As higher types are preferred to lower types as ranked by $\succsim_{\Theta}$, $\underline{\theta}$ contains the lowest $\succsim_{\Lambda}$-ranked characteristics and $\overline{\theta}$ the highest $\succsim_{\Lambda}$-ranked characteristics. To formalise these observations the relationship between characteristics and types is specified as a correspondence in the following definition

Definition 1. [Characteristics to types correspondence] Let $\rho : \Lambda \rightrightarrows 2^{\Theta} \setminus \emptyset$ be an order-preserving mapping from the set of characteristics to the set of types, that is, ρ defines which vector $\lambda^{'} = \{\lambda_1^{'}, \lambda_2^{'}, \ldots, \lambda_{\mathcal{L}}^{'}\}$ of characteristics corresponds to the subset of types $\Theta^{'} \subseteq \Theta$.

The assumption of ρ being order-preserving is imposed to assure that if $\rho(\lambda^{'}) \ni \theta^{'}$ and $\rho(\lambda^{''}) \ni \theta^{''}$, then $\theta^{'} \succsim_{\Theta} \theta^{''}$ if and only if $\lambda^{'} \succsim_{\Lambda} \lambda^{''}$; that is ρ will assign a higher $\succsim_{\lambda}$-ranked vector of characteristics to higher $\succsim_{\Theta}$-ranked types. The intuition behind this is simple: for higher types, more characteristics and/or characteristics of higher magnitude are needed, as higher types are preferred to lower types, vectors of characteristics that lead to higher types must be preferred to those that lead to lower types. Definition 1 specifies the *bridge* between characteristics and types aiming to represent a mental process on the part of the agents, but such processes correspond to observations that could potentially be confirmed by data sets.

Types in Θ are distributed across agents according to a density function $g(\theta)$ with c.d.f $G(\theta)$, each type with the corresponding vector of characteristics according to $\rho(\lambda_i) \ni \theta_i$. It is assumed that own types are unknown to the agents, however, they possess information about the distribution of types. In the model, own types will be referred to as the *true types*. Although the true type is unknown to each agent i, the agent receives a signal λ_i^o of her endowed characteristics, still, this signal is not complete and is not taken as the final set of characteristics that i possesses.

Assume $\Theta_i \in \Omega$ is the set of all types i could adopt given her characteristics. In order to complete the signal λ_i^o, each i searches for information on the types, and thus the characteristics, of other agents in the agent's current environment $\aleph_i$. Notice that, as types are different among themselves, individuals should be able to capture these differences in a way that is consistent to the ranking of types. Also information coming from each environment may be of different relevance to each agent depending on their own environment and on how close environments are to each other. A definition of agent's perceived distance between types is specified as follows

Definition 2. [Type-to-type distance] Let $\mathcal{M} : \Theta \times \Theta \to \mathbb{R}_+$ be a metric on Θ that completes the metric space $(\Theta, \mathcal{M})$. Define the type-to-type distance as the distance between two given types $\theta^{'}$ and $\theta^{''}$ and denote this by $\mathcal{M}(\theta', \theta'')$.

The value of $\mathcal{M}(\cdot)$ gives a measure of the proximity, or the lack of, between types. A value of $\mathcal{M}(\theta^{'}, \theta^{''})$ close to $\mathcal{M}(\underline{\theta}, \overline{\theta})$ indicates that the difference between the types $\theta^{'}$ and $\theta^{''}$ is as big as possible, indicating that one of the two is either close to the top or the bottom, and the other near to the opposite end. Similarly, if the difference is close to zero, then we can infer that the two environments are close to each other according to this criterion. Thus, $\mathcal{M}$ gives a non-negative measure of how apart types are from each other, including representative types of each environment (status quo), these measures will be particularized to each agent i to focus on the perspectives of the agents. Notice as well that these measures are one-to-one comparisons and do not aggregate information, however aggregation can easily be done by summation over the status quo of all environments or particular types.

As will be seen later, it is argued that the distances between types influence the determination of agents' adopted types, together with i's initial signal λ_i^o. As both elements carry relevant information both should bear some weight in agent's type determinacy explanation.

2.3.2 Search environments

Assume now that the agent is randomly allocated to an environment placed in a continuum of environments $\aleph = [\underline{\aleph}, \overline{\aleph}] \ni \aleph_j$, with environments indexed by $j \in \mathcal{J}$. Each agent is assigned, at a starting period, to a particular environment $\aleph_j$ according to a continuous differentiable cumulative distribution function $F : \aleph \to [0, 1]$ with density f.

Define $\eta_{i,j}$ as the fraction of types θ_i located in group $\aleph_j$. Each environment could have one or various types with higher frequency than the rest of the types present in such environment, for simplicity assume there is only one such type. Such over represented type constitutes the status quo in that given environment, this is specified in the following definition

Definition 3. [Predominant type (Status quo)] A predominant type $\theta_{\aleph_j}$ in an environment $\aleph_j$ is a type defined as

$$\theta_{\aleph_j} = \{\theta_i \in \Theta \mid \eta_i(\aleph_j) > \eta_{i' \neq i}(\aleph_j) \; \forall \; \eta_{i' \neq i}(\aleph_j) \in \aleph_j\} \tag{2.1}$$

The type $\theta_{\aleph_j}$ represents the status quo of types in environment $\aleph_j$; where the status quo is the type of reference of those belonging to environment $\aleph_j$. For simplicity, and without loss of generality, $\eta_i(\aleph_j) = \eta_{i'' \neq i}(\aleph_j)$ for some $\eta_{i'' \neq i}(\aleph_j) \in \aleph_j$, that is more than one status quo existing in a given environment, is a possibility discarded in the definition.

Predominant types work as *aggregators* of information regarding the composition of environments, indicating not only which type is the most representative in terms of number, but also a way to rank types in terms of representativity within and across environments. Using Definition 2, we can also define the status quo distance between the status quos in environment $\aleph_i$ and environment $\aleph_j$ as $\mathcal{M}(\theta_{\aleph_i}, \theta_{\aleph_j})$. Similarly, if $\aleph_i < \aleph_j$ then $\mathcal{M}(\overline{\theta}_{\aleph_i}, \underline{\theta}_{\aleph_j})$ gives an indication of the differences across environments i and j if $\overline{\theta}_{\aleph_j}, \underline{\theta}_{\aleph_i}$ are respectively the highest type in environment i and the lowest type in environment j respectively.

Now a description of how agents order the information about the types available in environments is introduced. It is assumed here that agents have full awareness of the type's space, and that they can form a complete ordering of such types and are able to form a type set list, that is an ordered list L of the elements of the types' set, with the order of the elements corresponding to the order relation $\succsim_\Theta$, the following definition specifies ordered lists in the context of this work

Definition 4. [Type set list] Recall $\Theta_K \subseteq \Omega := 2^\Theta \setminus \emptyset$. A list $L_K = L\big(\Theta_K, \succsim_\Theta\big) = \{\theta_k, \theta_{k+1}, \ldots, \theta_K\}$ on the set of types Θ^K is a sequential order of every $\theta \in \Theta_K$, using $\succsim_\Theta$ as criterion of order, and meeting the condition that whenever θ' is placed after θ'' in $L_K(\cdot)$, $\mathcal{M}(\underline{\theta}_K, \theta') > \mathcal{M}(\underline{\theta}_K, \theta'')$. Let L_K^t be a list under consideration at stage t.

To make exposition clearer, the superscript t in lists, which indicates the stage at which the list is being considered, will be omitted unless it is necessary to specify it.

From Definition 4 we can derive a property of list and the sub-lists that can be formed from its elements. This property concerns the transferability of order and rank from sets of types to corresponding lists of types

Lemma 1. ***[List and sub-list elements order]*** *Fix L as the list of all elements in the set Θ ordered in accordance to $\succsim$. For any $\Theta_H, \Theta_K \subseteq \Omega$ and $L_H, L_K \in L$; if $\Theta_H \subset \Theta_K$ then $L_H \subset L_K$. If $\theta', \theta'' \in L_K, \theta' \succsim \theta''$, it is the case that $\theta' \succsim \theta''$ whenever $\theta', \theta'' \in L_H$. Call such a list $L_H \subseteq L_K$ a sub-list of L_K.*

Proof of Lemma 1. Let $\Theta_H \subset \Theta_K$, then there exists a subset $\{\theta\}' \subset \Theta_K$, with at least one type, such that $\{\theta\}' \not\subset \Theta_H$, $\{\theta\}' \cup \Theta_H \subseteq \Theta_K$. From Definition 4 a list L_D

contains only the elements of set Θ_D in ascending order of preference. Since for the set of types Θ_K, corresponding to the list L_K, and the set of types Θ_H, corresponding to the list L_H, we have that for all $\theta^{'} \in \Theta_H$ it must be the case that $\theta^{'} \in \Theta_K$, but not the converse, then there is a $\{\theta_i\}^{'} \subset L_K, \{\theta_i\}^{'} \not\subset L_H$, with $\{\theta\}^{'} \cup L_H \subseteq L_K$, and then $L_H \subset L_K$ □

These results define how lists can be divided in sub-lists that contain only a fraction of the elements contained in the *universal* list. Notice that $\Theta_H \subset \Theta_K$ implies $card\{\Theta_H\} < card\{\Theta_K\}$, and as $L_H \subset L_K$, it is also the case that $\#L_H < \#L_K$. Also, as lists contain all sub-lists that are exclusively formed by elements in the list, sub-lists inherit the ordering properties of lists that contain them, thus results found for one list, over elements contained in both lists, also hold for the other list. For ease of exposition, sub-lists will be referred to only when the context requires this, but references will be on lists for most of the definitions and results.

2.3.3 States and beliefs

In the previous sections the main informational elements about individuals and social environments with respect to types and characteristics have been introduced. Also, it has been established that, within the context of the model, this information is partially available to each agent. In this section the degree of information availability is defined for each individual in the form of perceptions hold by them, and are specified in informational states that summarise how individuals find themselves in terms of the information over types that they hold.

The information that each agent i takes into account at each stage t is defined by the *state* $\langle \lambda_i^t, \theta_{\aleph_i}, \mathcal{M}_i \rangle = \sigma_i^t \in \Sigma$, where Σ is the set of all possible states, λ_i^t is the vector of characteristics possesed by i at stage t, $\theta_{\aleph_j}$ is the status quo in i's environment, and $\mathcal{M}_i$ is a metric defined over Θ according to i's perceptions. Notice that the metric is defined for each i and thus we are assuming it can vary across agents, and also that the set of status quos and the metric remain constant with changes in t. Let the initial state σ_i^o be characterised by the triplet $\langle \lambda_i^o, \theta_{\aleph_i}, \mathcal{M}_i \rangle$.

σ_i^t specifies the information held by agent i at t. Thus, at each stage t the agent updates her informational state given the current status, incorporating updated information provided by the triplet that defines σ_i^t, that is, information updating is deterministic and depends on the vector of characteristics, the status quo, and the metric on type distance at each stage. Notice that, for an agent i, $\rho(\lambda_i^t)$ reports a subset of types Θ_i^t, thus it is implicitly assumed that the probability from the point of view of the agent of

having a true type $\Theta_k \subseteq \Theta$ given state σ_i^t is not zero even if Θ_k is a singleton.[3] This is not considered a strong assumption, as if a vector of characteristics produces only one possible type, then it should be clear for the individual that the type produced is a possibility.

2.3.4 Type search process

Agent's type search starts at each stage t with the information available to the agent at that stage. As already specified, this information defines a current *state* that is described by the characteristics at t, the status quo in the agent's environment, and the type-to-type distances. Agents use the information available at $t = 0$ to determine a *point of departure* from which they start their type-search process, and use updated informational structures to define a *search-departure type* at each stage t. The type search process finishes with a final product $\tilde{\theta}_i$ that is the *adopted-type* that i takes as a *satisfactory measure* of her type.

A search type process should also specify the direction of search that individuals take within the type's space that is being searched, in this case a list of types. Search processes can be assumed to proceed in different formats. For example, agents can search randomly through opportunity sets, testing types with no discernible order, or search unidirectionally, with the search process being determined by a departure point and a direction of search according to an established order. For the present setting it is assumed that agents search sequentially, either progressively or regressively, within a list of types as the one described in Definition 4. This assumption implicitly requires individuals having perfect recall, that is, agents know exactly where in the list they are positioned, where they have been, and retain all information derived from their past search in the list. This is clarified further below starting with the following assumption on sequential searching

Assumption 1. [Sequential type search process] Agent i's type search process on a list $L\big(\Theta, \succsim_\Theta\big)$ is sequential departing from a given type θ_i^t, continuing progressively, $\delta \nearrow \overline{\theta}$, by testing types of higher order $\theta_i^{t+1} > \theta_i^t$, or regressively, $\delta \searrow \underline{\theta}$, by testing types of lower order $\theta_i^{t-1} < \theta_i^t$. This search process starting from an initial type search $\theta_i^o \in L^o$, where L^o is an initial list.

[3] Thus if the subset of types θ_k includes types $\{\underline{\theta}_k, \ldots, \overline{\theta}_k\}$, then the probability from the point of view of agent i of being of type θ_k is given by $Pr(\theta_i = \theta_k \mid \sigma_i) = \int_{\underline{\theta}_k}^{\overline{\theta}_k} \theta f(\theta) d\theta$. This observation is not necessarily redundant as it permits to discard agents not considering the possibility of adopting a type because of the lack of probability of that type being one they can adopt, or even their true type.

Departing from Assumption 1, i's *search-departure type* at any stage t, given state σ_i^t, can be defined as follows

Definition 5. [Search-departure type] Let agent i's search departure type at stage t be the type from which agent i initiates her type search process, at that stage, given beliefs σ_i^t, and define it as

$$\begin{aligned} \theta_i^t &= inf\{\rho(\lambda_i^t \mid \sigma_i^t)\} \text{ if } \delta \nearrow \overline{\theta} \\ \theta_i^t &= sup\{\rho(\lambda_i^t \mid \sigma_i^t)\} \text{ if } \delta \searrow \underline{\theta} \end{aligned} \tag{2.2}$$

Let θ_i^o be the *initial search-departure type* for $t = 0$ and $\rho(\lambda_i^o \mid \sigma_i^o)$ in the specification above.

From Definition 5, all the information i possesses at t is contained in σ_i^t, this information gives i a (biased) perspective on the distribution of types across environments and is used to determine her search-departure type θ_i^t.

The valuation over types, the cost of adopting a type, and the threshold, described above are assumed to guide a type search process for the individuals. Each i searches the type's space for a type to adopt taking into account the information available to her at each state. Define now a search and stopping rule indicating when the agent is to continue searching for a type or stop and adopt the type reached at that stage of the type-search process. Clearly this stopping rule should require, to be convenient to the agent, the net valuation to be positive, this is imposed also as a requirement for the type adopted by any i. This is a form of bounded rationality, and is less restrictive than full rational behaviour, allowing for near optimising choice, without demanding from the individuals a choosing rule based on a strict optimisation process (Simon, 1955).

The search rule is specified as a heuristic criteria $\Phi\big(L\big(\Theta, \succsim_\Theta\big), \mathcal{V}, \Gamma\big)$, that takes into account the types available to the individual, in the form of a list L, whose elements $\theta \in \Theta$ are ordered according to the preference ordering $\succsim_\Theta$, the net valuation over types $\mathcal{V}$, and the threshold Γ. $\Phi(\cdot)$ is a heuristic rule that indicates if search is to be stopped or continued, and is based on the idea of *satisficing* criteria as described by Simon (1955), specifying the type that should be adopted under the considered parameters. Notice that at each stage for which no type has been adopted, the payoff perceived by the agent is zero, and the cost incurred in acquiring new characteristics, different from the once the agent already possesses, starts form zero as well, as characteristics already obtained in previous stages do not need to be acquired again.

Taking into account the elements described so far, an intuitive rule for type selection requires the net payoff to be positive when valued at the potential type to be adopted, and it should also be at least equal to the threshold value, this observation is formalised in the following assumption

Assumption 2. [Type search rule] A type-search rule $\Phi\big(L\big(\Theta, \succsim_{\Theta}\big), \mathcal{V}, \Gamma\big)$ indicates to the agent, in a given state $\sigma_i^t = \langle \lambda_i^t, \theta_{\aleph_i}, \mathcal{M}_i \rangle$, whether to continue or to stop searching for a type to adopt based on the type alternatives at stake and the preferences over them and the availability criteria represented by the list $L\big(\Theta, \succsim_{\Theta}\big)$, the net payoff $\mathcal{V}(\sigma_i^t)$, and the threshold $\Gamma(\sigma_i^t)$, determining search behaviour as follows

$$\Phi\big(L\big(\Theta, \succsim_{\Theta}\big), \mathcal{V}, \Gamma\big) = \begin{cases} \text{i) Continue type search at stage } t \text{ if, for } \lambda^t \in \sigma_i^t,\ \theta^t = \rho(\lambda^t) \text{ is such that } \Gamma(\sigma_i^t) > \mathcal{V}(\sigma_i^t) \\ \\ \text{ii) Stop type search if : } \begin{cases} iia)\ \theta^t \text{ is such that } \mathcal{V}(\sigma_i^t) \geq \Gamma_i(\sigma_i^t); \text{adopt } \tilde{\theta}_i = \theta^t \in L^t\big(\Theta, \succsim_{\Theta}\big) \\ iib)\ \Gamma > \mathcal{V}\ \forall\ \theta \in \Theta; \text{adopt } \tilde{\theta}_i = \theta^* \in L^t\big(\Theta, \succsim_{\Theta}\big), \theta^* \in \operatorname{argmax} \mathcal{V} \end{cases} \end{cases} \tag{2.3}$$

Rule 2.3 in Assumption 2 describes individual's search behaviour. It indicates to stop searching for a type if either the threshold has been satisfied by the net valuation, or if it is never satisfied for any existing type. In the former case, the type to adopt, according to the search rule, is the first one for which the threshold is satisfied, for the latter the type to adopt is the one that renders the highest net valuation possible. In this case the intuition is evident, if an individual has a threshold large enough, she will search for a type to adopt through all those types up to the one that maximises $\mathcal{V}$, that is $\theta^* \in argmax\ \mathcal{V}$, and possibly one more to allow the agent to realise that θ^* is the type that optimises $\mathcal{V}$ as she searches though types on a list. This does not implies i is finding θ^* via mathematical optimisation (full rationality), but by trial and error, covering enough types until she discovers the one that maximises $\mathcal{V}$.

The description on how search processes take place, in terms of direction, as stated previously in Assumption 1 does not provide information on how the search process will actually take place. In particular, it is relevant to determine the direction of search to characterise type search and adoption behaviour of individuals. It has been already defined where the type search process starts, under which rules it operates, and over which space it takes place. The following result shows in which cases the agent will search progressively or regressively given the behavioural rules already specified

Proposition 2. ***[Search direction]*** *Given a state σ_i^t, if $\Gamma^t > \mathcal{V}^t$, the type-search direction $\delta(\sigma_i^t)$ is from above and towards $\underline{\theta}$ ($\searrow \underline{\theta}$) if condition $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} < 0$ holds for*

$\rho(\lambda_i^t) = \theta^t$, *with* $\theta^t > \theta^{t+1}$. *Conversely type-search direction is from below and towards* $\overline{\theta}$ ($\nearrow \overline{\theta}$) *if condition* $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} > 0$ *is met, with* $\theta^t < \theta^{t+1}$.

Proof of Proposition 2. First notice that, according to Assumption 2, for any state σ_i^t, $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta}$ and θ, if $\Gamma \leq \mathcal{V}$ then the search process stops as the agent has either exactly reached or surpassed the threshold value, thus to have a search direction condition $\Gamma > \mathcal{V}$ is needed. This shows why the first part of Proposition 2 is needed. Now notice that, at θ^* condition $\dfrac{\partial \mathcal{V}(\theta^*)}{\partial \theta} = 0$ holds, with $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} > 0$ holding before it, and $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} < 0$ happening after that point, for both $\delta \nearrow \overline{\theta}$ and $\delta \searrow \underline{\theta}$.

When $\Gamma > \mathcal{V}$, the agent has not reached a *satisfactory* type and the agent's search process continues pursuing either higher types, $\theta^t < \theta^{t+1}$, or lower types, $\theta^t > \theta^{t+1}$, these two cases are covered in what follows in the proof.

Case 1. Assume first that $\theta^t < \theta^{t+1}$, then two outcomes are possible, either the net valuation increases or it decreases when testing a type at $t+1$, that is either $\mathcal{V}(\theta^t) > \mathcal{V}(\theta^{t+1}) > 0$ or $0 < \mathcal{V}(\theta^t) < \mathcal{V}(\theta^{t+1})$ is observed by the agent.

Case 1a. Assume the individual observes $\mathcal{V}(\theta^t) > \mathcal{V}(\theta^{t+1}) > 0$, that is $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} < 0$, then the gap between π and $\mathcal{C}$ is closing from t to $t+1$, and thus i is searching in a neighbourhood of types located after θ^*. Notice that the difference between π and $\mathcal{C}$ is positive. By assumption $slope(\pi)$ is strictly decreasing and $slope(\mathcal{C})$ is strictly increasing in θ, then the gap that produces $\mathcal{V}$ will continue to close as θ increases, thus increases in θ work in detriment of $\mathcal{V}$. This trend will lead the agent to switch the direction of search either immediately or after some iterations in the same direction, with switching direction implying that search direction is $\searrow \underline{\theta}$.

Case 1b. If instead $0 < \mathcal{V}(\theta^t) < \mathcal{V}(\theta^{t+1})$ is observed by the individual, or equivalently $\dfrac{\partial \mathcal{V}(\theta^t)}{\partial \theta} > 0$, then the agent is searching in a neighbourhood of types located before θ^*. Searching for higher types provides i with enough incentives to keep searching as increases in θ produce increases in $\mathcal{V}$. These changes inform the agent the gap between π and $\mathcal{C}$ is becoming wider. Notice that, if the gap is increasing then the individual has not reached θ^* and then this trend will be sustained, but just up to θ^* as by assumption $slope(\pi)$ is strictly decreasing and $slope(\mathcal{C})$ is strictly increasing in θ. This provides incentives to the agent to keep searching in the direction to which θ increases. Thus, the direction of search in this case will be $\nearrow \overline{\theta}$.

The proof for the case in which $\theta^t > \theta^{t+1}$ is symmetric to Case 1, and is provided for completeness.

Case 2. Assume that $\theta^t > \theta^{t+1}$, two outcomes are possible at $t+1$, case 2a: $\mathcal{V}(\theta^t) > \mathcal{V}(\theta^{t+1}) > 0$, or case 2b: $0 < \mathcal{V}(\theta^t) < \mathcal{V}(\theta^{t+1})$.

Case 2a. Assume $\mathcal{V}(\theta^t) > \mathcal{V}(\theta^{t+1}) > 0$, then the gap between π and $\mathcal{C}$ is closing from t to $t+1$. By assumption $slope(\pi)$ is strictly decreasing and $slope(\mathcal{C})$ is strictly increasing in θ, and thus $\mathcal{V}$ will continue to close as θ decreases. This trend will lead the agent to switch the direction of search after some iterations (or none) in the same direction, towards searching for higher types, that is $\nearrow \overline{\theta}$.

Case 2b. Assume $0 < \mathcal{V}(\theta^t) < \mathcal{V}(\theta^{t+1})$, then the agent has incentives to keep searching in the same direction, that is in the direction in which θ decreases, as these changes produce increases in $\mathcal{V}$. Again, this trend will be sustained up to θ^*, as $slope(\pi)$ is strictly decreasing and $slope(\mathcal{C})$ is strictly increasing in θ by assumption. This trend generates incentives for the agent to keep searching in the direction to which θ decreases. Thus, the direction of search in this case will be $\searrow \underline{\theta}$.

□

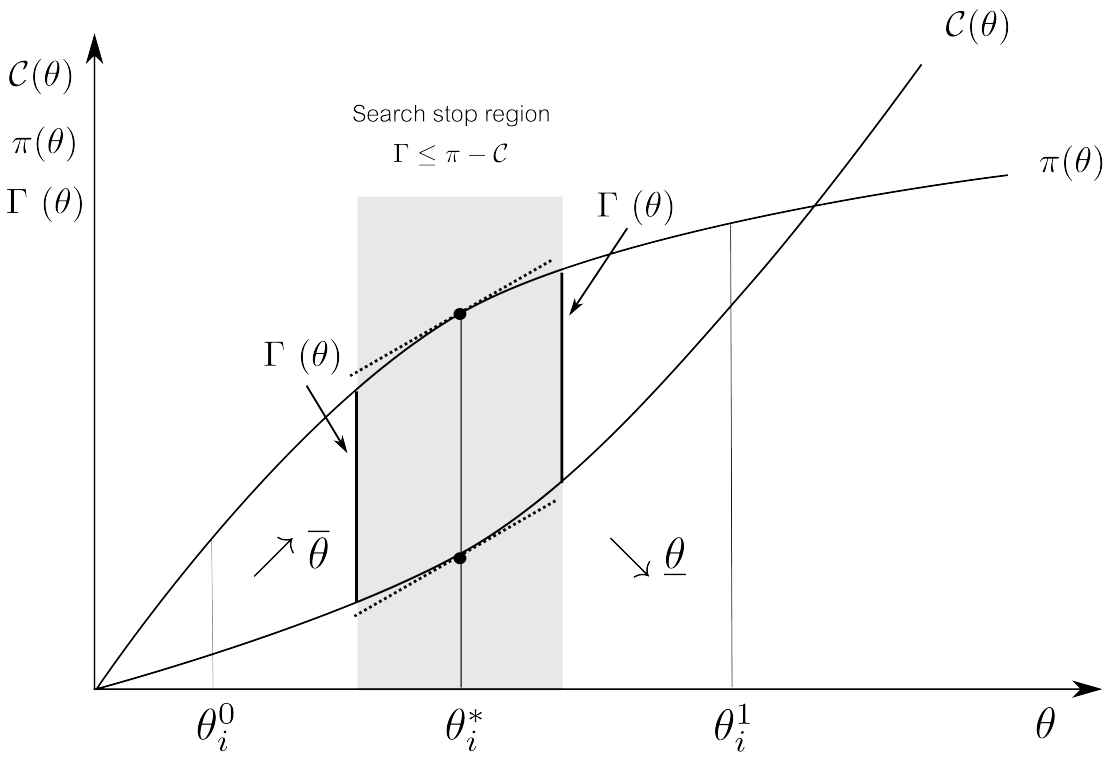
Proposition 2 implies individuals will define their direction of choice based on how convenient, in terms of perceived net payoffs, it is to search in one direction compared to the opposite one. The result also states the direction will be preserved all along the search process, adding consistency to the search process by preventing individuals from searching types they have already discarded as not appropriate for type adoption.

Figure 1 presents in a graphical manner the search process as previously described with all its components, it also shows the results obtained in Proposition 2. In the figure, we can appreciate how the convex cost function $\mathcal{C}(\cdot)$ and the concave payoff function $\pi(\cdot)$ form a locus within which a positive net payoff, $\mathcal{V}$, is perceived by agent i. The shadowed square shows the area in which condition $\Gamma \leq \pi - \mathcal{C}$ holds, that is the area in which searching stops. The optimal type to adopt is θ_i^*, for this type the net payoff is as big as possible. If the agent search departure type is θ_i^0, the agent will search for a type to adopt in direction $\nearrow \overline{\theta}$, while if θ_i^1 is the search departure type the agent will search in direction $\searrow \underline{\theta}$. The idea behind this behaviour is that for those two search departure types, the corresponding directions of search are the ones that produce new types to test for adoption with increasing net payoffs, this is just what Proposition 2 shows.

2.3.5 Search neighbourhood extension

A situation that can arise during the type-search process is that, for the conditions stated in Assumption 2, the agent may not reach a type to adopt in the list L^t in which

FIGURE 1: Type search process



the search process is contained at a particular stage t. That is, condition $\Gamma(\lambda^{'}, \theta_{\aleph}, \mathcal{M}) \geq \mathcal{V}(\theta^{'}, \theta_{\aleph}, \mathcal{M})$ for all $\theta^{'} \in L^t \subset L$ may hold for the whole list or search neighbourhood where the search process is taking place at a given stage t. In such a case, i will need to continue the search process in another neighbourhood of types. Here we define a search neighbourhood and a search continuation neighbourhood that describe what happens when these case arises. Also, a result is presented showing the conditions that need to hold for i to continue the search process in a new neighbourhood.

Definition 6. [Search neighbourhood] A *search neighbourhood* for i at stage t is formed by the subset of types Θ_i^t, whose elements correspond to the types reachable by the characteristics possessed by i at that stage. That is, $\Theta_i^t = \{\underline{\theta}_{\Theta_i^t}, \overline{\theta}_{\Theta_i^t}\} = \{\theta \in \Theta : \theta = \rho(\lambda_i^t), \lambda_i^t \in \Lambda\}$. The corresponding type list being $L^t\big(\Theta_i^t, \succsim_\Theta\big)$.

According to Definition 6, the initial search neighbourhood is given by $\Theta_i^o = \{\theta \in \Theta : \theta = \rho(\lambda_i^o)\}$. Indeed this is the subset of types that correspond to the initial characteristics as perceived by the signal λ_i^o. An initial search neighbourhood produces the subset of types $\Theta_i^o \subseteq \Theta$ that corresponds to the signal λ_i^o. Then, given a search direction as specified in Proposition 2, the agent searches $L^o\big(\Theta_i^o, \succsim_\Theta\big)$ until she finds $\theta^{'} \in \Theta_i^o$ such that $\mathcal{V}(\theta^{'}) \geq \mathit{\Gamma}(\theta^{'})$ as the search rule indicates in Assumption 2. If such a type is found, then i adopts $\tilde{\theta} = \theta^{'}$. Otherwise she continues searching in the next search neighbourhood, which is defined as follows

Definition 7. [Continuation search neighbourhood] Define a *continuation search neighbourhood* for i at stage $t+1$ as $\Theta_i^{t+1} = \{\theta \in \Theta : \theta = \rho(\lambda_i^{t+1})\}$; $\Theta_i^{t+1} \subseteq \Theta \setminus \bigcup_{k \leq t} \Theta_i^k$. With $\lambda_i^{t+1} = \lambda_i^t + \Delta\lambda_i^t$, and $\Delta\lambda_i^t$ equal to the change in λ_i^t.

Definition 7 says that if at any stage t an agent searches within the neighbourhood without reaching a type to adopt conforming to the search rule previously described, then i will search in a new neighbourhood that is a continuation of the types already tested. The initial departure type given beliefs σ_i^o is $\theta_i^o \in \rho(\lambda_i^o \mid \sigma_i^o)$, with $\sigma_i^o = \langle \lambda_i^o, \theta_{\aleph_i}, \mathcal{M}_i \rangle$. A key determinant of this initial stage is the characteristics signal the agent receives, λ_i^o, which partially defines the search departure type θ_i^o, and which is the only variable that can be modified by i in the following stages if the proper incentives exist.[4] Such a change in λ occurring at a stage t is denoted by $\Delta\lambda_i^t$, and the new vector of characteristics is $\lambda_i^{t+1} = \lambda_i^t + \Delta\lambda_i^t$.

These definitions do not state if it is rational for i to acquire the characteristics needed to proceed to the next type search neighbourhood. The following result clarifies on this

Lemma 3. ***[Characteristics acquisition incentives]*** *If a type-search process is in place at t, and no type has been adopted after testing all types in $L^t(\cdot)$. Then, the individual will continue the search process in a new neighbourhood of types if the following conditions hold*

$$For\ \delta(\sigma_i^t) = \nearrow \overline{\theta}: \quad \frac{\partial \pi(\rho(\lambda))}{\partial \lambda} \geq \frac{\partial C(\lambda, \cdot)}{\partial \lambda} \tag{2.4}$$

$$For\ \delta(\sigma_i^t) = \searrow \overline{\theta}: \quad abs\left(\frac{\partial \pi(\rho(\lambda))}{\partial \lambda}\right) \leq abs\left(\frac{\partial C(\lambda, \cdot)}{\partial \lambda}\right) \tag{2.5}$$

Proof of Lemma 3. Notice that the conditions stated in Equation 2.4 and Equation 2.5 just require the individual to have proper incentives to acquire the characteristics needed to proceed to search in a new neighbourhood of types. If the individual is searching towards higher types, $\delta(\sigma_i^t) = \nearrow \overline{\theta}$, then the increase in payoffs needs to be higher than the increase in cost of acquiring those characteristics. Similarly, if the agent is searching towards lower types, then the condition states that the decrease in payoffs should be smaller than the decrease in costs of acquiring the characteristic needed to have access to those lower types.

To show that these are the cases actually observed in the search process, recall form Proposition 2 that at θ^* condition $\frac{\partial \mathcal{V}(\theta^*)}{\partial \theta} = 0$ holds. Before point θ^*, from the left and

[4] That is the payoff of increasing λ should be at least equal to the costs.

right, we observe that $\mathcal{V}$ is increasing in θ, which means either that π is increasing at a higher rate than C, or that C is decreasing at a higher rate than π. Given convexity and concavity assumptions on C and π we know that to the left of θ^* the payoffs are increasing in θ at a higher rate than the costs, this is the condition stated in Equation 2.4. Similarly, for the same reasons, to the right of θ^* the costs decrease at a higher rate than that of the payoffs, this is what Equation 2.5 expresses.

□

What Lemma 3 states is that a necessary condition for $\Delta\lambda_i^t$ to take place is either to observe that when the search direction is towards higher types, the increase in payoffs of acquiring the characteristics needed to have access to the next set of types should be higher that the increase in costs of acquiring them. The opposite happens if the search direction if towards lower types, in this case the absolute value of the change in cost of acquiring the characteristics should be larger than the absolute change in payoffs that they generate. Observe that, according to the Lemma, these conditions hold when the individual is still searching for a type, otherwise there is no incentive to obtain more characteristics.

2.3.6 Type adoption

The result of the search process is an adopted type, in this section this outcome is described in a pair of results. These results specify the situations under which there is a match between the adopted type and the true type, and those under which a mismatch emerges. The process depends on the characteristics possessed by the individual (including the initial signal), the set of status quos, and the metric over types. Notice there is an implicit evolution of the agent's characteristics that emerges through stages. All these information is summarised in a history of states $\sigma_i = \{\sigma_i^o, \sigma_i^1, \dots, \}$ that constitute the perceptions that drive agent i's type choice. Now results for the existence of an adopted type are provided.

Proposition 4. ***[Existence of adopted type]*** *Assume $\rho(\lambda^o) \neq \theta^*$. For all i, at some stage t, given a state σ_i^t, and direction $\delta(\sigma_i^o)$, under a search rule as stated in Assumption 2, there exists a $\tilde{\theta}_i \in \Theta_i^t$ such that $\tilde{\theta}_i$ is i's adopted type. Furthermore, if $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$, then there is some $\theta_{\Gamma \geq \mathcal{V}}$ that will be reached at some stage t and will be adopted, with such type being $\theta_{\Gamma \geq \mathcal{V}} = \tilde{\theta}_i = \theta^* \in \operatorname{argmax} \mathcal{V}$.*

Proof of Proposition 4. Notice that conditions $\Gamma \leq \mathcal{V}$ for some $\theta \in \Theta$ or $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$ must be reached in the closure of Θ. Also, observe that from the concavity of π and the convexity of $\mathcal{C}$, $\exists\ \theta^*$ for which $\dfrac{\partial \pi(\theta^*)}{\partial \theta} = \dfrac{\partial \mathcal{C}(\theta^*)}{\partial \theta}$, $\theta^* \in \operatorname{argmax} \mathcal{V}$.

The proof consists on showing that either there exists $\theta \in \Theta$ such that $\tilde{\theta} = \theta \in \Theta \setminus \theta^*,\ \theta^* \in \operatorname{argmax} \mathcal{V}$, for $\Gamma \leq \mathcal{V}$ or that $\tilde{\theta} = \theta^*$ if $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$. In the former case, for both $\delta = \nearrow \overline{\theta},\ \delta = \searrow \underline{\theta}\ , \exists\ \Theta^t \subseteq \Theta$ for some t such that $\Gamma \leq \mathcal{V}$. The proof is made here for $\delta = \nearrow \overline{\theta}$, a parallel proof can be made for $\delta = \searrow \underline{\theta}$ by following a similar argument.

Notice that, if $\inf\{\rho(\lambda_i^o)\} = \theta_i^*$ then $\Gamma(\theta^*) = \theta^*$, and the type search process finishes with $\tilde{\theta}_i = \theta_i^*$. This case is excluded from the proposition. Thus a type search process starts with either $\theta_i^o < \theta_i^*$ or $\theta_i^o > \theta_i^*$. Then either $\Gamma \leq \mathcal{V}$ for some $\theta \in \Theta$ should be reached within the interval $(\theta_i^o, \theta_i^*]$ if $\theta_i^o \in [\underline{\theta}, \theta_i^*]$, or the interval $[\theta_i^*, \theta_i^o)$ if $\theta_i^o \in [\theta_i^*, \overline{\theta}]$. Otherwise condition $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$ holds. For each case the search rule specified in Assumption 2 indicates which search behaviour i will adopt. Let $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$ be Case 1, and $\Gamma \leq \mathcal{V}$ for some $\theta \in \Theta$ be Case 2.

Case 1: Assume $\Gamma > \mathcal{V}\ \forall\ \theta \in \Theta$ holds. Then the maximum for $\mathcal{V}$ that i can reach is precisely $\mathcal{V}(\theta^*)$. In this case, for any $\theta' \in \Theta \setminus \theta^*$ is to the right or to the left of θ^*, the type search procedure will produce a net payoff $\mathcal{V}(\theta) < \mathcal{V}(\theta^*)$, this from the conditions of convexity and concavity of the cost and payoff function. Thus for any of $\delta = \nearrow \overline{\theta}$ or $\delta = \searrow \overline{\theta}$ the type adopted will be $\tilde{\theta} = \theta_{\Gamma > \mathcal{V}} = \theta^*$. In this case, i exhausts the set of all types in the range of types between θ_i^o and θ_i^* searching for a type to adopt, with the search ending with the adoption of θ_i^* according to Assumption 2.

Case 2: Assume $\Gamma(\theta_i', \cdot) \leq \mathcal{V}(\theta_i', \cdot)$ for some $\theta_i' \in \Theta$. Either Case 2a: $\theta_i^o \in [\underline{\theta}, \theta_i^*]$ holds, or Case 2b: $\theta_i^o \in [\theta_i^*, \overline{\theta}]$ does.

Case 2a. Assume $\theta_i^o \in [\underline{\theta}, \theta_i^*]$. Then, i will search for a type according to Assumption 2, until finding $\tilde{\theta}_i \in \rho(\lambda_i^t)$ for λ_i^t at some t, including $t = 0$. If $\tilde{\theta}_i \in \rho(\lambda_i^o) = \Theta_i^o$, then i searches within $L(\Theta_i^o, \succsim_\Theta)$ with direction $\delta_i = \nearrow \overline{\theta}$ until condition $\Gamma \leq \mathcal{V}$ holds and the search process finishes with $\tilde{\theta}_i \in \Theta_i^o \subseteq (\theta_i^o, \theta_i^*]$. If $\Gamma(\theta_i', \cdot) > \mathcal{V}(\theta_i', \cdot)$ for all $\theta \in \Theta_i^o$, then $\tilde{\theta}_i \notin \Theta_i^o$ and $\Theta_i^o \subsetneq (\theta_i^o, \theta_i^*]$. Under this case i continues the search process at subsequent stages h, with $\tilde{\theta}_i \notin \bigcup_{h<t} \Theta^h$. For conditions stated in Lemma 3, i acquires characteristics λ_i^h at each stage h, continuing her type search in new neighbourhoods $\Theta_i^t \subseteq \Theta \setminus \bigcup_{h<t} \Theta^h$ as specified in Definition 7, until condition $\Gamma(\theta_i'', \cdot) \leq \mathcal{V}(\theta_i'', \cdot)$ holds for some $\theta_i'' \in \Theta_i^t \subseteq (\overline{\theta}_{\Theta_i^{t-1}}, \theta_i^*]$, $\overline{\theta}_{\Theta_i^{t-1}}$ the supremum of Θ_i^{t-1}, and $\tilde{\theta}_i = \theta_i''$. Condition $\theta_i'' \not\succ \theta_i^*$ holds, for if this were the case i would realise there is a θ^* and would adopt it, but this is Case 1, with $\mathcal{V}(\theta_i'') < \mathcal{V}(\theta_i^*)$ from the convexity and concavity of the cost and payoff functions.

Case 2b. This part is the symmetric version of Case 2a. Assume $\theta_i^o \in [\theta_i^*, \theta_i^o)$. Then, i will search for a type according to Assumption 2, until finding $\tilde{\theta}_i \in \rho(\lambda_i^t)$ for λ_i^t at some t, including $t = 0$. If $\tilde{\theta}_i \in \rho(\lambda_i^o) = \Theta_i^o$, then i searches within $L(\Theta_i^o, \succsim_\Theta)$ with direction $\delta_i = \searrow \underline{\theta}$ until condition $\Gamma \leq \mathcal{V}$ holds and the search process finishes with

$\tilde{\theta}_i \in \Theta_i^o \subseteq [\theta_i^*, \theta_i^o)$. If $\Gamma(\theta_i^{'}, \cdot) > \mathcal{V}(\theta_i^{'}, \cdot)$ for all $\theta \in \Theta_i^o$, then $\tilde{\theta}_i \notin \Theta_i^o$ and $\Theta_i^o \subsetneq (\theta_i^o, \theta_i^*]$. Under this case i continues the search process at subsequent stages h, with $\tilde{\theta}_i \notin \bigcup_{h<t} \Theta^h$. For conditions stated in Lemma 3, i acquires characteristics λ_i^t at each stage t, continuing her type search in new neighbourhoods $\Theta_i^t \subseteq \Theta \setminus \bigcup_{h<t} \Theta^h$ as specified in Definition 7, until condition $\Gamma(\theta_i^{''}, \cdot) \leq \mathcal{V}(\theta_i^{''}, \cdot)$ holds for some $\theta_i^{''} \in \Theta_i^t \subseteq [\theta_i^*, \underline{\theta}_{\Theta_i^{t-1}})$, $\underline{\theta}_{\Theta_i^{t-1}}$ the infimum of Θ_i^{t-1}, and $\tilde{\theta}_i = \theta_i^{''}$. Condition $\theta_i^{''} \not< \theta_i^*$ holds, as if this were the case $\mathcal{V}(\theta_i^{''}) < \mathcal{V}(\theta_i^*)$ from the convexity and concavity of the cost and payoff functions, i will adopt θ_i^* which is Case 1, a possibility already discarded.

□

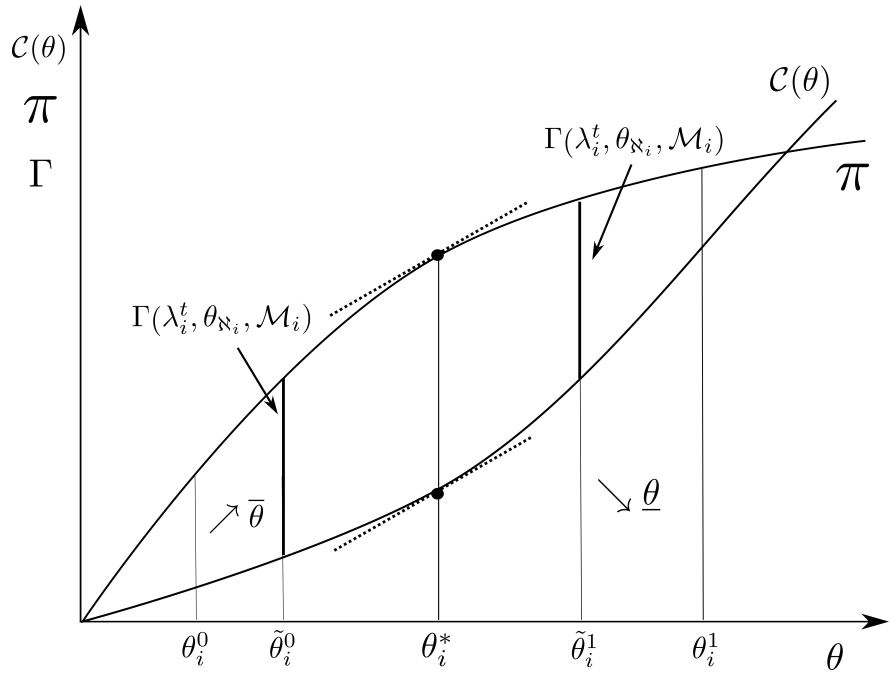
Corollary. ***[Adopted type mismatch]*** *Any adopted type will be a mismatch, $\tilde{\theta}_i \neq \theta_i^*$, unless $\Gamma(\lambda_i^*, \theta_{\aleph_i}, \mathcal{M}_i) = \mathcal{V}(\theta^*)$, for $\theta_i^* = \rho(\lambda_i^*)$; or $\Gamma(\lambda_i^t, \theta_{\aleph_i}, \mathcal{M}_i) > \mathcal{V}(\theta, \cdot)\ \forall\ t,\ \theta \in \Theta$.*

Proof of Corollary of Proposition 4. These results arise directly form Proposition 4 and Assumption 2. If λ_i^* is such that $\rho(\lambda_i^*)$ produces the true type θ_i^* when condition $\Gamma(\lambda_i^*, \theta_{\aleph_i}, \mathcal{M}_i) = \mathcal{V}(\theta^*)$ is met, then it is clear the adopted type will be her true type indeed. The second part of the claim states the individual will adopt her true type if it exhausts all types up to the optimal type (and possibly one more) searching in one direction according to Assumption 2. As the searching process does not produces a type to adopt then the agent will observe the best option is her true type and will indeed select it as her adopted type. This is Case 1 of Proposition 4.

□

Proposition 4 shows a type will always be adopted under the the stated conditions, and its Corollary specify the conditions that lead to a match between the adopted type and the true type. It was shown that, given a history of states σ_i and a search direction $\delta(\sigma_i^o)$, an agent will adopt a type $\tilde{\theta}_i \in \Theta_i^t$ at some stage t, with the following possible outcomes for a given true type θ^*: either $\tilde{\theta}_i = \theta^*$ or $\tilde{\theta}_i \neq \theta^*$. In the former case no implications arise as i adopts a type that matches her true type and thus the full rationality results apply. On the contrary, the latter case presents a situation in which the type adopted by i differs from i's true type, in this case additional considerations need to be taken in choice analysis as each i in this situation would chose as if her choices did not agree with fully rational behaviour. Indeed, the choice of type corresponds to a boundedly rational behaviour, in which rationality is limited by the search rule that guides i's choice of type. This search rule has as distinctive element a threshold, which resembles the idea of aspirations.

FIGURE 2: Type search with adopted type mismatch



These results are illustrated in Figure 2. In the figure it can be seen that for an initial search type θ_i^0 the direction of search is towards higher types, and with a threshold equal to $\Gamma(\theta)$, the adopted type ends up being $\tilde{\theta}_i^0$, which falls short of the optimal type θ_i^*. Similarly, if the initial search type is θ_i^1 the direction of search is towards lower types, and for a threshold $\Gamma(\theta)$, the adopted type is $\tilde{\theta}_i^1$, which is higher than the optimal type θ_i^*. Both cases present mismatches of adopted type with the true type. Observe that, unless $\Gamma(\cdot) > \mathcal{V}(\cdot)\ \forall\ \theta \in \Theta$ or $\Gamma(\lambda_i^*) = \mathcal{V}(\theta_i^*)$ for $\rho(\lambda_i^*) = \theta_i^* \in \operatorname{argmax} \mathcal{V}(\cdot)$ a mismatch will emerge.

2.3.7 Choice with types as frames

So far the focus has been placed on type search and type adoption processes. The results obtained indicate that a mismatch between the agent's adopted type and her true type can emerge when the threshold (aspirations) of the individual bound their type selection behaviour. In this section the focus turns to subsequent choices when type adoption acts as a pre-choice process.

Assume the agent goes trough two phases: e_1 and e_2. In e_1 the individual selects a type $\tilde{\theta}_i$, and in e_2 she faces a choice problem guided by the type output in e_1. e_1 can be a process in which i selects the degree of information she will gather before making a choice in e_2, for example the agent can select a level of formal education to obtain before entering the job market, may search for information regarding a good

she wants to acquire, or she may consult a number of specialists before selecting which medical procedure is the one that she will have. In terms of the previous analysis the educational level, the amount of information, or the number of specialists she consults are the adopted type, while the types of jobs selected in the job market, the goods to be chosen, or the selected medical treatment are the choices to be made in e_2.

To proceed with this analysis an extended choice problem is defined. An extended choice problem is formed by an opportunity set, and a set of frames that can alter the choice process without necessarily having any rational fundamental. Both the opportunity set and the set of frames conform the choice problem faced by the individual. This framework has been developed in both Bernheim and Rangel (2007) and Salant and Rubinstein (2008), and is used here to show how such frames can arise in the type adoption model presented.

Following Rubinstein (2012), let X be the finite set of all available alternatives, $\mathcal{X} := 2^X \setminus \{\emptyset\}$, a class in X containing all non-empty subsets of X; and $\mathcal{A} \subseteq \mathcal{X}$ a *consideration set*, that is, a set that contains only the options to be considered by the individual. An *extended choice set* $\{X, f\}$ includes a choice set X and a frame $f \in F$, with the set of all frames denoted by F. An extended choice set, "expands" the standard choice set with the inclusion of an additional criteria of relevance to the agent, when selecting an option from a variety of alternatives. It is thus a useful tool for the analysis of decision making when the individual restricts choice to a consideration set. The extended choice set requires a choice function that contemplates this "extension". An extended choice correspondence $c(\{X, f\})$ selects a unique option $\{x\} \subseteq \mathcal{X}$ from the choice problem $\{X, f\}$, notice that the choice $\{x\}$ can be a singleton or a subset of X. Define a consideration set as follows

Definition 8. [Consideration set] A *consideration set* $\mathcal{A} := \{X, f\} \subset \mathcal{X}$ is a set that contains only the choices from X that will be considered by the individual when facing choice problem $\{X, f\}$ given a frame $f \in F$.

At this point, it is worth clarifying what is considered a frame in this context. Here, as in Salant and Rubinstein (2008), a frame is not additional information that can be of relevance for a rational decision to take place. In the type search framework presented, i's true type can (should) be of relevance when choosing from the set of viable alternatives, as the true type can reveal rational behaviour on the individual, and thus, i's true type is not considered as a frame. A different situation emerges if, an adopted type distinct from the true type is used to define the set of choices to be considered. In this case i's adopted type can lead her to select choices she would not have considered from the set X, had she adopted her true type.

Thus, when frames are absent, under full information, the choice problem is determined by the set of alternatives that are precisely available to i and that are reachable to her. When this is not the case, frames constitute distractors that can lead choice behaviour in a bounded manner. This is introduced here as an assumption explicitly requiring each possible consideration set to be attached to a particular type

Definition 9. [Consideration set by type] Given a type $\theta^{'} \in \Theta$, there exists a unique set $\mathcal{A}_{\theta'} \in \mathcal{X}$ to be referred to as $\theta^{'}$ *consideration set*, this set contains only the alternatives that those i's of type $\theta^{'}$ will take into account, given that they are of type $\theta^{'}$. For a true type θ_i^*, $\mathcal{A}_{\theta^*}$ denotes i's consideration set when $\tilde{\theta}_i = \theta_i^*$.

According to Definition 9, a consideration set corresponds to every i's true and adopted types. The following results shows when an adopted type can be considered a frame, and if it is the case that such type-frames lead to suboptimal choices under all possible scenarios

Proposition 5. ***[Adopted type as frame]*** *An adopted type $\tilde{\theta}_i$ can be considered a frame f, if and only if it is not equal to i's true type, $\tilde{\theta}_i \neq \theta_i^*$, and $x \in \text{argmax} \succsim_i \notin \mathcal{A}_{\theta_i^*} \cap \mathcal{A}_{\tilde{\theta}_i}$.*

Proof of Proposition 5. Assume $\tilde{\theta}_i \neq \theta_i^*$, then by Definition 9 $\mathcal{A}_{\tilde{\theta}_i} \neq \mathcal{A}_{\theta_i}$. For the two distinct sets, two possibilities arise, either $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*} = \emptyset$ or $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*} \neq \emptyset$. If $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*} = \emptyset$ then $\forall\ x^{'} \in \text{argmax} \succsim_i (\mathcal{A}_{\tilde{\theta}_i})$, $x^{'} \notin \text{argmax} \succsim_i (\mathcal{A}_{\theta_i^*})$, thus it is not possible for i to choose $x^* \in argmax \succsim^i (\mathcal{A}_{\theta_i^*})$ having adopted a type different from her true type.

If $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*} \neq \emptyset$, then for $x^{'} \in \text{argmax}(\mathcal{A}_{\tilde{\theta}_i})$ either $x^{'} \in \left(\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*}\right)$ or $x^{'} \notin \left(\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*}\right)$. If $x^{'} \in \left(\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*}\right)$, $x^{''} \in \text{argmax} \succsim_i (\mathcal{A}_{\theta_i^*})$ if $x^{''} \in \left(\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*}\right)$ then it must be the case that $x^{'} = x^{''}$, that is $\tilde{\theta}_i$ is not a frame. If on the contrary $x^{''} \notin \left(\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_{\theta_i^*}\right)$ then i chooses $x^{'} \notin \text{argmax} \succsim_i (\mathcal{A}_{\theta_i^*})$ when adopting a type $\tilde{\theta}_i \neq \theta_i^*$. But then i is not maximising $\succsim_i$ while being able to do so, thus it must be the case that $x^{'} = x^{''}$.

□

Proposition 5 shows that although adopted type and true type mismatch is a necessary condition for inefficient choices to arise, it is not a sufficient condition on it's own. In our framework, even if the adopted type does not coincide with the true type, it loses its biasing power if the optimal choice under the absence of frame is still reachable. This latter case emerges when both sets $\mathcal{A}_{\tilde{\theta}_i}$ and $\mathcal{A}_{\theta_i^*}$ have a non-empty intersection, and optimal choices on both lead to the same element. A direct implication for individual well-being from Proposition 5 is presented next

Proposition 6. ***[Weak preference for true-type consideration sets]*** *Define a type extended choice set as* $\{X, \theta\}$*. If* $\tilde{\theta}_i \in F$*, then* $\tilde{\theta}_i \neq \theta_i^*$ *with* $\{X, \tilde{\theta}\}$ *as consideration set. If* $\{X, \theta\} = \{X\}$ *then* $\tilde{\theta}_i = \theta_i^*$*,* $\tilde{\theta}_i \notin F$*. Given an adopted type* $\tilde{\theta}_i \in F$*,* $\{X\} \succsim_i \{X, \tilde{\theta}\}$*, or equivalently* $\mathcal{A}_{\theta_i^*} \succsim_i \mathcal{A}_{\tilde{\theta}_i}$*.*

Proof of Proposition 6. First notice that if $\mathcal{A}_{\tilde{\theta}_i} = \mathcal{A}_{\theta_i^*}$ then i must be indifferent between the two sets, as they contain exactly the same elements and $x \in argmax\ \mathcal{X} \in A_i^*$. This case is equivalent to the absence of frame. Now for the cases where $\mathcal{A}_{\tilde{\theta}_i} \neq \mathcal{A}_i^*$, assume $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_i^* \neq \emptyset$. Then i will be indifferent between any of the two sets if $x^{'} \in \mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_i^*$ and $x^{'} \in$ argmax$(\mathcal{A}_i^*)$, as then we also have $x^{'} \in$ argmax $(\mathcal{A}_{\tilde{\theta}_i})$, with $x^{'} = x^*$. If on the contrary, $\mathcal{A}_{\tilde{\theta}_i} \cap \mathcal{A}_i^* \neq \emptyset$ holds, with $x^{'} \in$ argmax$(\mathcal{A}_{\tilde{\theta}_i})$ and $x^{'} \notin$ argmax$(\mathcal{A}_{\theta_i^*})$, then from Definition 9 we have $\mathcal{A}_{\theta_i^*} \succ_i \mathcal{A}_{\tilde{\theta}_i}$. Putting these two outcomes together leads to conclude that $\mathcal{A}_{\theta_i^*} \succsim_i \mathcal{A}_{\tilde{\theta}_i}$. Thus, either $A_{\tilde{\theta}_i} \sim A_{\theta_i^*}$ or $A_{\tilde{\theta}_i} \succ A_{\theta^*}$, and then $\mathcal{A}_{\theta_i^*} \succsim_i \mathcal{A}_{\tilde{\theta}_i}$.

□

The result from Proposition 6 reveals that agents have a weak preference for true-type's consideration sets over those consideration sets that do not correspond to the true-type. The interpretation lies in the fact that when only relevant options are available, there is no possibility for options outside the corresponding true-type consideration set to be considered and chosen. Thus an optimal element should be selected. In opposition, when relevant elements are absent, the case where adopted types are effectively frames, non-optimal options are chosen affecting individual well-being.

The results presented in Proposition 5 and Proposition 6 show how the model of type adoption can be related to choice with frames, and in which cases an adopted type can be considered to work as a frame in an extended choice problem. For a frame to be effective, or for it to actually be a proper frame, it needs to discard from the consideration set those options deem optimal with respect to the preferences of the individuals. This results are interesting as they suggest a step towards a framework to study how frames are formed, and how individual's attention emerges, topics that are becoming more relevant in the literature and practice (Caplin, 2016).

2.4 Applications

This section presents two applications of the model. The first one analyses the effect that inequality of opportunities has on type adoption, and the other studies how anti

poverty policies, exclusively directed to reduce the cost of acquiring a type, can backfire when not accompanied by changes in individual's aspirations.

2.4.1 Inequality of opportunities and adopted type bias

This section studies the bias effect that higher inequality of opportunities has on the type search process. To do so, the distance between types as perceived by a given agent, the metric $\mathcal{M}_i$, is deemed as an approximation of the inequality of opportunities as perceived by individual i. To do so the analysis proceeds by comparing two states each with different distances between types, that is each with different inequality of opportunities.

The convexity of the cost function $\mathcal{C}(\theta_i^{'}(\lambda_i^{'}), \theta_{\aleph_i}, \mathcal{M}_i)$ with respect to θ and the concavity of the payoff function produce an area for which positive net payoffs can be obtained if the corresponding types are adopted, call this area the type-locus. Formally, [5] the type-locus can be expressed as $\int_{\underline{\theta}}^{\overline{\theta}^{'}} \pi(\theta) - \mathcal{C}(\theta, \mathcal{M})\, d\theta$, where $\overline{\theta}^{'}$ is the highest value of θ for which the type-locus is positive. Notice that the threshold $\Gamma(\lambda_i^t, \theta_{\aleph_i}, \mathcal{M}_i)$ also depends on $\mathcal{M}$.

Assume that all remains the same but for the distance between types, and to simplify the analysis lets compare only two distinct cases defined by the two metrics $\mathcal{M}_i^0$ and $\mathcal{M}_i^1$. Then an increase in $\mathcal{M}$ will have the effects described in what follows: fix the environment $\aleph$ and the state σ^t, increases in the distance between types, increases in the metric $\mathcal{M}$, shrinks the type-locus and displaces the threshold restricted area in the type-locus towards the origin.

For a given environment $\aleph_j$, assume that $\mathcal{M}_i^0 < \mathcal{M}_i^1$, then $\mathcal{C}(\theta, \mathcal{M}^o) < \mathcal{C}(\theta, \mathcal{M}^1)$ as the bigger the perceived distance between types is, the bigger the costs of being able to select a higher type to adopt. Given that the payoffs do not depend on $\mathcal{M}$, the type-locus decreases[6]

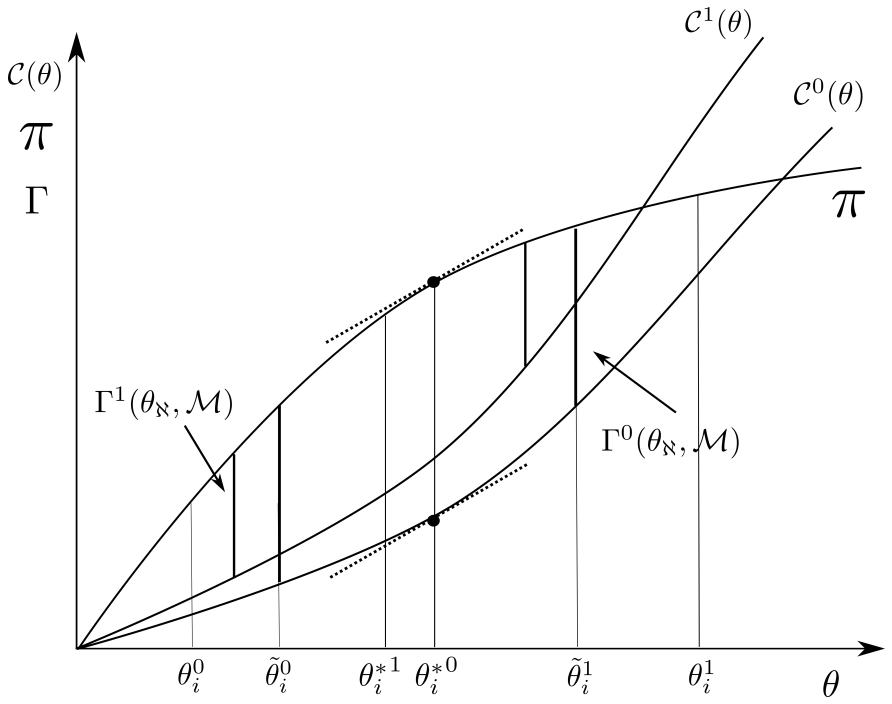
$$\int_{\underline{\theta}}^{\overline{\theta}^{'}} \pi(\theta) - \mathcal{C}(\theta, \mathcal{M}^o)\, d\theta > \int_{\underline{\theta}}^{\overline{\theta}^{''}} \pi(\theta) - \mathcal{C}(\theta, \mathcal{M}^1)\, d\theta$$

On the other hand, $\Gamma(\theta_{\aleph}, \mathcal{M})$ decreases when $\mathcal{M}$ increases, the intuition behind this effect is that the threshold of the agent will decrease as higher types are less feasible as

[5] A little abuse of notation is used here avoiding the use of all super-indexes and sub-indexes when no confusion can be created.

[6] Even if π depends on $\mathcal{M}$, if $\frac{\partial \pi}{\partial \mathcal{M}} < \frac{\partial C}{\partial \mathcal{M}}$ the analysis would be the same.

FIGURE 3: Comparison of type-search process with different type distance



candidates for type adoption. Figure 3 shows the effects of an increase of $\mathcal{M}$ in both the type-locus and the set of types that lie in the area constrained by the left and right thresholds. The costs increase from $C(\theta)^0$ to $C(\theta)^1$, while the threshold changes from $\Gamma(0)^o$ to $\Gamma(1)^1$. For the case depicted in the figure, the threshold decreases enough to fit inside the new type-locus. If this were not the case, then $\Gamma(\cdot) > \mathcal{V}(\cdot)\ \forall\ \theta \in \Theta$. Assumption 2 indicates that in this case i will adopt her true type θ^*. However, for the case illustrated in Figure 3 the threshold decreases enough to fit inside the type-locus, driving all those individuals whose types lie to the left of $\Gamma(\theta)^1$ to adopt lower types than those whose threshold is $\Gamma(\theta)^0$.

Notice that those that start their search to the right of θ_i^*, when facing $\mathcal{M}_i^1$, adopt types that are closer to their true type, as the increase in costs and the decrease in threshold guides them to satisfy the type search criteria described in Assumption 2 closer to the origin, and to the left of those that face $\mathcal{M}_i^0$ instead. The opposite happens for those whose type search starts to the left of their true type. When facing type distance $\mathcal{M}_i^1$, these individuals see their search criteria satisfied closer to the origin, and further from their true type in comparison with those that face type distance $\mathcal{M}_i^0$. Thus, the effect of higher perceived distance between types, has distinctive effects depending on the relative place where they start their type search process. Notice that this works in detriment of those who start searching to the left of their true type, potentially those in more of a disadvantage, and in favour of those that start searching to the right of their true type, presumably those more advantaged amongst those with higher $\mathcal{M}$.

2.4.2 Cost improving subsidies

Many anti poverty policies pursue reducing the cost of reaching outcomes via subsidies. For example, a policy may aim at decreasing the costs of accessing secondary education with the objective of having more citizens graduating with such an educational level. The motivation behind these interventions resides on the idea that by reducing the costs of reaching individuals will, *de facto*, reach the outcome.

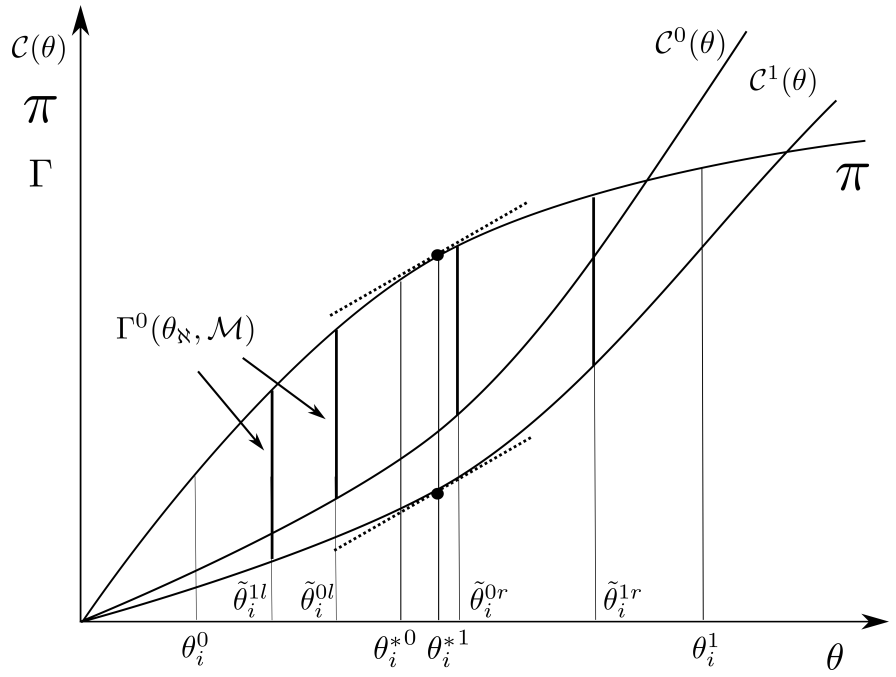
In the model this policy can be represented as an exogenous reduction in the costs of search, one that does not involve any changes in the arguments of the function, and that does not affect neither the payoff or the threshold. *Ceteris paribus*, a decrease in the cost increases the area of the locus formed between the payoff and the cost functions. At the new cost, with the threshold remaining at the same level, the satisficing criteria is met at a lower type (higher type) for those whose type search departure is located to the left (right) of θ_i^*, thus inducing individuals to adopt lower types (higher types) than those that would emerge at the original cost. Figure 3 presents this case with $C(\theta)^0$ being the initial cost, and $C(\theta)^1$ the cost after a cost-improving subsidy is introduced. If θ_i^0 is the search departure type, by Proposition 2 the individual will search types in an upward direction, searching for upper types. Given that the threshold has not been affected, it remains at $\Gamma(\theta)^0$, and since the locus $\int_{\underline{\theta}}^{\overline{\theta}'} \pi(\theta) - \mathcal{C}(\theta, \mathcal{M})\ d\theta$ has increased, the aspiration level (the threshold) is reached at a lower type. The individual adopts type $\tilde{\theta}_i^{1l}$, a type that is lower than that that would be adopted at the original cost $\mathcal{C}^0(\theta)$, that is $\tilde{\theta}_i^{0l}$. For those whose type search starts to the right of θ_i^* the effect is symmetric. They end up adopting type $\tilde{\theta}_i^{1r}$ at the new cost instead of adopting $\tilde{\theta}_i^{0r}$, which leads them to adopt a type that is further from their true type. The next result formalises this observation.

Proposition 7. ***[Cost-improvement policy backfire]*** *Assume the benefits perceived by acquiring any type, and the threshold remain the same. A cost-improving policy that decreases the cost of acquiring any type, induces individuals to adopt a type further from the optimal type in comparison with the initial state.*

Proof of Proposition 7. Let a initial state with payoff function $\pi(\theta)$, costs $C(\theta)^0$, and threshold $\Gamma(\theta)$, produce an adopted type $\tilde{\theta}_i^0$. *Ceteris paribus*, assume a decrease in the cost of acquiring all types with a new cost function $C(\theta)^1$. Such a change will increase the area of the locus $\int_{\underline{\theta}}^{\overline{\theta}'} \pi(\theta) - \mathcal{C}(\theta, \mathcal{M})\ d\theta$. Let θ_i^0 be the search departure type, then from Proposition 2 the individual will search types in an upward direction if this type is located to the left of the optimal type, and in downward direction if the

initial type is located to the right of the optimal type, with the individual searching for upper types in the former case, and for lower types in the latter. At the new cost, with $\Gamma(\cdot)$ and $\Pi(\cdot)$ remaining at the same level, the satisficing criteria is met at a lower type $\tilde{\theta}_i^1 < \tilde{\theta}_i^0$, for those whose type search departure is to the left of their true type, and at higher types for those starting to the right of it, $\tilde{\theta}_i^1 > \tilde{\theta}_i^0$. Thus inducing individuals to adopt lower or higher types in comparison with those that would emerge at the original cost levels. □

FIGURE 4: Cost improvement via subsidies



The intuition behind this result is the following. If the benefit of acquiring any type remains the same, and the aspirations of the individual (as measured by the threshold) do not change, a policy directed at decreasing the costs of accessing education aiming at more individuals attaining secondary education (type θ_i^0 in Figure 3) via generalised subsidies will reduce the cost of attaining all levels of education (all types). This policy will widen the net valuation not only for that type (secondary education) but for all types, this allows for the threshold to be reached closer to the lowest type, or closer to the origin in Figure 3. This result emerges as individuals can now reach their aspirations adopting lower types such as primary education (type θ_i^1 in Figure 3), as they can reach their aspirations at that lower type, which leads them to do so.

2.5 Final comments

In this chapter a model of type unawareness and type search and adoption was presented. The chapter adds to existing research offering a theoretical model that helps understand why and how suboptimal behaviour emerges among individuals, and the role that their social environment plays in shaping their type (identity), via aspirations dictating what is attainable for a given benefit and cost structure. The model also illustrates how rationally bounded behaviour arises from framework effects emerging from adopted and true type mismatches . The chapter also presents policy implications, with results that show how inequality of opportunities hinders suboptimal choices, and how policies that subsidise costs can backfire if they are not accompanied by complementary policies aiming at improving their satisficing criteria, or aspirations.

In this setting, individuals start a type search process with the purpose of finding a type to adopt, and the search process ends when a satisficing criterion is met guided by a search stopping rule. The rule is characterised by three elements: the payoffs proceeding from adopting a given type, the type search and adoption cost, and a satisficing threshold. It was shown under which circumstances this process can lead to suboptimal type choices, resulting in adopted types not corresponding to individual's true types. The results show that agents can adopt a type that matches or mismatches their true type. In the former case, no problem arises, the type they adopt is the one that corresponds to the individual. In the latter case suboptimal type selection emerges. For individuals starting their type search process at low types, relative to their true type, the adopted type falls short of their true type, thus selection is sub-optimal in the sense that they do not realise their full capacity. For those starting their type search process at a level above their true type, type adoption happens at types higher that the true type that corresponds to them, sub-optimality in these cases arises from under-performance at higher types than that that their capacity indicates.

Additionally, the model of type search and adoption was linked to a two phase choice process. In a first phase type selection happens, then in a second phase the agent faces a choice problem in which the adopted type is used as guide in choice. It was shown under which circumstances type mismatch produces frames in extended choice problems. Also, results show why an adopted type working as a frame can limit choice alternatives, forming consideration sets from which choice is made, and that may not contain preference maximising choices that would be available in the absence of frames, affecting individual's well-being.

Two applications of the model show how inequality of opportunities can make the output of the type adoption process more salient, and how policies aiming at improving type

adoption can backfire. When comparing results for individuals with higher perceived distance between types, what is interpreted as a measure of inequality, those in more disadvantage choose types that are lower than those that are in a more privileged position,thus worsening their mismatch. On the other hand, those individuals at the top of opportunities, although they keep choosing higher types with respect to their true type, end up adopting types that are closer to their true type. Thus, inequality of opportunities affects those at the bottom of the disadvantaged worsening their situation, but leads those at the top of the disadvantaged to adopt types closer to their true type in comparison with those at the top of the privileged.

In the second application, the effects of cost improving subsidies are analysed. The results show these type of policies can generate opposite effects to those that are been sought. If subsidies that decrease the cost of type search and adoption are applied in a generalised fashion, and not directed to the costs of adopting certain types, then individuals end up adopting types that are even further from their true types. This result emerges when thresholds and payoffs are not affected by the policy. If thresholds are interpreted as aspirations, under this cost improving policy, an increase in aspirations can help reach the objectives of the policy. This result highlights the importance of aspirations shaping the effectiveness of these kind of initiatives.

The model presented in this chapter could be improved in a number of ways. For instance, the static nature of the model does not allow to study intertemporal effects that may emerge from individuals adjusting their types through time. Also, adding feedback effects from individuals to environments could make the model more realistic in certain ways, however, the complications added could make the model less tractable. The link between type search and adoption and choice in extended choice problems merits further investigation. For once, it could be interesting to build a model in which frames are formed on their own in the type search and adoption framework presented, *mutatis mutandis*, and then analyse its effects for choice in extended choice problems. Finally, a more abstract setting could allow for applications of the model to artificial intelligence and robotics, or to virtual environments.

Chapter 3

Social Gap and Crime as Influencers of Generalised Trust and Trust in Public Institutions in Mexico

This chapter studies the relationship between trust, both generalised and in public institutions, and social gap and crime in Mexico. The relevance of this work resides on the fact that poverty and inequality, indicators of which the social gap index is constructed, and crime are two main influencers of well-being, and are of particular importance for Mexico as the country has historically struggled with these issues. To the author's knowledge there is no previous research on the relationship between crime and trust in Mexico, and no other research exists on the relation between trust and social gap in the literature. Findings indicate crime holds a negative relationship with generalised trust and trust in public institutions, however, the effect survives on ly for generalised trust when implementing instrumental variables. The results for social gap are the most interesting. When social gap is measured at three distinct levels, on average, those at intermediate levels of social gap are the ones that report lower levels of trust, while those under more deprived conditions report to be more trusting. When measures of trust and distrust are used instead, asymmetries between the two measures emerge. The results hold in general for social gap, but this is not the case for crime as estimates show that it holds a negative relation with trust, but not statistical relation with distrust emerges. This indicates that important asymmetries exist between trust and distrust.

3.1 Introduction

Trust is one of the most important intangible assets that any individual and society can possess. It is trust that allows us to share experiences and goods, to trade and have access to credit, and to let what we most value into the care of others. The existence, or non-existence, of this intangible asset is at the core of all human activities. As Kenneth Arrow affirms in a widely cited quote "Virtually every commercial transaction has within itself an element of trust, certainly any transaction conducted over a period of time" (Arrow, 1972, p. 357).

In the last 20 years economists have become increasingly interested in trust and, more broadly, social capital, the latter a broad concept that some authors consider embraces trust. Early examples of this interest can be found in Berg et al. (1995), Knack and Keefer (1997), La Porta et al. (1997), Glaeser et al. (1999), Dasgupta (2000), and Alesina and La Ferrara (2002) among others. This departure from market-price based analysis aims to complement the fundamental basis of economic theory, by including other mechanisms that play an important role in the functioning of our activities in society.

In particular, economic transactions possess a strong cohesion component, which is created from the conjunction of trust, norms, values, membership, and networks among others. A common factor among all these concepts used to be the lack of tangibility, and difficulty in measurement. Until recently it was rare to have access to data that could appropriately value these type of variables, but with the advent of information on social networks, and the appearance of surveys that aim to capture, both directly or indirectly, the value of abstract concepts such as trust, work on the empirical analysis of these variables has become possible.

To illustrate the importance of trust, consider the sharing economy. Without mutual trust among participants it would be difficult for markets in such a sector to exist. In CouchSurffing, a hospitality exchange website, users agree to host strangers at their places without any charge; similarly Airbnb allows owners to offer the same service, but charging a fee for it. These services are supported by reputation systems that signal the level of trustworthiness held on providers; but in addition a trust component, independent of the signal, must be present when the decision of participating or not in the exchange is made.

Similarly, in more traditional markets, if potential consumers do not trust the provider of a good or service, they will be reluctant to get involved in any exchange with him or her; if this persists the provider will cease to be active, and if the problem generalises to other producers the market will dissipate. The mutual share of trust between the

trustee and the trustor generates benefits that are fundamental for the appropriate work and development of our societies.

As trust is at the core of all human activities, its study should arguably be at the centre of the research agenda among social scientists. Although an important number of empirical investigations on trust are now available in the literature (as discussed in the next section), there are aspects of trust that have not yet been explored and further understanding of this concept is essential before its integration into economic models is reached. The present work seeks to investigate the determinants of trust using two waves of survey data collected in Mexico. The analysis focuses on the associations between trust and two explanatory variables in particular: crime/violence, and social deprivation.

Alternative measures of trust will be considered, the first measure is the standard question about trust used in the *World Values Survey*; the second measure is an index of trust in public institutions. Both measures are self reported data obtained from the Urban Social Capital survey (SEDESOL 2006) and the National Social Capital Survey (UNDP-Mexico, 2011). Among the determinants considered in this work, there is a focus on multi-dimensional social deprivation, and experienced violence or crime. To the author's knowledge, no previous work has studied the relationship between these two factors and trust for Mexico, and a limited number of empirical studies exist on the relationship between trust and crime for other countries. Regarding trust in public institutions, few studies can be found in the literature, most of them are for the United States, and no research was found applied to Mexico (these research work is covered later in Section 3.2).

Studying the relationship between trust, crime and social deprivation is of importance due to the high impact that these have on social well-being. The relevance is particularly prominent for Mexican society, that has struggled with persistent poverty and inequality, despite the continuous application of economic reform and programmes in line with international recommendations. Mexican society has experienced an alarming rise in crime and violence since 2006, the year the first wave of data was collected, and reached it's highest point near 2011, the year the second survey took place.

This chapter contributes to the literature investigating associations that generalised trust, and trust in public institutions can hold with social gap and crime. The chapter also adds to previous research on trust in Mexico by Martínez Cárdenas et al. (2014) and Aguayo Tellez et al. (2014) with a more in depth analysis. Different from these two works, this chapter introduces the analysis of the effect of social gap and crime on trust, to the author knowledge no previous investigation has studied the relationship that crime and social gap hold with generalised trust for the case of Mexico, and studies are

scarce for other regions. Additionally, the analysis implements instrumental variables strategies to detect spurious associations, two strategies are followed to disentangle true associations, namely two-stage predictor substitution and two-stage residual inclusion. Additionally, this research tests assumptions of the ordered choice model implemented, and implements alternative estimation methods for the models of trust. Finally, the chapter introduces a second wave of the survey to the analysis, allowing to study trust in Mexico at periods of time where violence in the country experienced a marked variation.

3.2 Trust

The study of trust has attracted scholars from varied disciplines, and has been done from a number of approaches. Thus, one can expect a multiplicity of definitions to emerge for this concept. Francis Fukuyama, for example, defines trust as "the expectation that arises within a community of regular, honest, and cooperative behaviour, based on commonly shared norms, on the part of other members of that community" (Fukuyama, 1996, p. 26); Partha Dasgupta is inclined to define trust in terms of asymmetries in information, the behavioural advantages that such asymmetries can generate, and the use that agents make of such advantages (Dasgupta, 2000, p. 3). Sabatini (2009) considers that trust can be differentiated into four types that he coins as: "social trust", "knowledge-based trust", "trust towards institutions", and "trust in public services". Carolyn McLeod, in her entry on the Stanford Encyclopaedia of Philosophy, mentions four elements present in trust: 1) a requisite for self vulnerability; 2) having others in good regard; 3) having a positive attitude with respect to other's capacities; and 4) the existence of acting motives on the other part (McLeod, 2015). Fukuyama (1996), Coleman (1994), and Hardin (2000) offer extensive treatments on definitions and importance of trust; and Watson (2005), focuses on the definitions that are given to trust in psychology, management, organisational behaviour, public relations, and marketing.

In the literature, two broad types of trust are commonly defined; generalised trust, and institutional trust. The former refers to interpersonal trust generated or existent within exchanges that emerge in social interactions. The later is related to trust that individuals express in formal institutions either public (like the government or the police), private (such as financial institutions or firms), or other types of institutions (like the Catholic Church).

Trust may be viewed as an asset, and as an asset it has an economic value; even if it is intangible in its own nature, its economic value can be derived from the benefits it can generate in any given circumstance. In this regard, (Dasgupta, 2000, p. 50) states

that "trust is not dissimilar to commodities such as knowledge or information". The fact that we do not specify the value of trust in our formal transaction records does not mean that the presence (or the lack of it) is not implicitly imputed in market prices. But a problem remains in any case: that of computing the value, or the price, of trust; a problem that not only pertains to this asset, but to others that share the intangible characteristics of trust and knowledge and information.

Nevertheless, an equally problematic issue emerges when a value or a measure, is to be assigned to trust. The most frequently used approach is based on self reported trust information collected by way of surveys. This measure is not free of criticism, besides the well known problems associated with survey data (circumstance dependence, question design, scale) there is one issue that is more prominent in the case of trust: what is it that is being reported? Among the possible options that can be named two appear more frequently in the literature: *trustworthiness*, and *trusting*. In this regard, Glaeser et al. (2000) use experimental techniques to disentangle these concepts. They find that the standard survey questions on trust, such as the one present in the World Values Survey, measures trustworthiness rather than trust. Similarly, Naef and Schupp (2009) design a series of experiments to test different specifications for measures of trust. They fragment the WVS question differentiating from trust in familiar people and strangers, the authors find that their measure of trust in strangers is highly correlated with trust shown in laboratory experiments on investment games, that capture trust in strangers, both measures showing a strong correlation. These studies point out care should be taken when using proxies of trust.

Although empirical studies on trust are still scarce, there is evidence that indicates the relationship that this asset has with a number of factors. Trust has been negatively associated with social inequality (Fischer and Torgler, 2013), is positively related with cooperation, and negatively related to places where hierarchical religions dominate La Porta et al. (1997). It is higher in wealthy neighbourhoods (Leigh, 2006), increases with wealth (Steijn and Lancee, 2011), is directly related to commercial transactions, international trade, and spurs private provision of public goods (Pargal et al., 2002).

The relationship existent between development, growth and trust is closely related to the absence of strong institutions, in that trust works as a relatively cheaper substitution mechanism. In this regard, Knowles (2006) presents arguments to establish similarities between social capital, including trust, and informal institutions as defined by North (1990). Also, Ahlerup et al. (2009) present results that support the positive role that institutions and trust play on growth. The authors find that both trust and institutions have a positive effect on growth, but the effect of trust tends to vanish the stronger the institutional setting, their results being robust to different specifications tested. Guiso

et al. (2004), find that the use of formal financial instruments is higher where higher levels of trust prevail, and that this relationship is more prominent as legal enforcement is more deficient. Knack and Keefer (1997), Zak and Knack (2001), and Helliwell and Huang (2011) also find empirical evidence of a positive relationship between trust and growth, or trust and well-being.

Regarding inequality, Bjørnskov (2007), Knack and Keefer (1997), Zak and Knack (2001), Knack and Zak (2003) find evidence of a negative effect of inequality on trust. The particular importance of this variable resides in the fact that interventions to modify inequality are already in place, it is part of the agenda of authorities and the public to implement these policies, and thus constitutes an already existing channel to affect trust.

There is also considerable empirical evidence on trust based on experimental methods. Berg et al. (1995) test trust and reciprocity behaviour in an investment game (a trust game). They find behaviour they attribute to trust that cannot be explained by self-interest or expected reciprocity. This work has been replicated a number of times, with a variety of populations, and with varied treatments (for a good account on this see Johnson and Mislin (2011)). Ashraf et al. (2006) run experiments in which subjects, from three different countries, participate in both dictator and investment games, they find that trust behaviour is mainly driven by expected trustworthiness, while trustworthiness is mostly explained by unconditional kindness. Glaeser et al. (2000) use experimental and survey methods finding that trust, as measured by surveys, seems to be an indicator of trustworthiness more than trustiness. This work highlights the important question of what self-reported trust really measures. However, these results are contradicted by findings in Fehr et al. (2002), which combine survey data with experimental results on trust games. The authors find that survey questions that aim to capture trust in strangers and trusting[1] are correlated with trusting behaviour among senders in trust experiments, and this relationship does not hold for subjects being worth of trusting. Aiming at solving these disparate results, Sapienza et al. (2013) segment the effects into belief and preference components. They find that a belief-based component is associated with the measure of generalised trust commonly used (the World Values Survey question), and past behaviour regarding trust is more related to the preference component.

For the case of Mexico, although there are a number of works that research social capital, the studies that investigate trust are limited. Among the investigations available, Rodriguez-Oreggia (2012) analyses the use of networks in job searching, considering the

[1]One of these items corresponds to the WVS question, the other one asks about involvement in actions that require trusting strangers. Nevertheless, trust in strangers seems to result from expectations over second movers actions according to their results.

access to such networks as social capital, and finds that there exists a wage-premium for those that do not make use of social networks to find a job. A similar analysis is conducted by Sandoval and Lima (2014) who find that poorer individuals tend to rely more on social networks to find jobs. Hernández Angeles et al. (2014) measure social capital in three ways: as help or support received, as participation in civic activities, and as number of voluntary memberships, and estimate associations with access to healthcare, and find that at least one type of social capital can be positively related to healthcare access. Concerning crime and social capital in Mexico, López Rodríguez et al. (2014) use the number of people, who are non-family members, that individuals meet on a monthly basis as proxy of social capital. Their estimates indicate that perception of violence has a negative effect on social capital. Vargas Chanes and Merino Sanz (2014) use structural equation models to test the relationship between public investment and social capital (social cohesion), finding a positive association between the asset and improvement of public spaces.

Considering trust analysis conducted for Mexico, the author is aware of only three studies: Campos Vázquez and Cuilty (2014), Martínez Cárdenas et al. (2014), and Aguayo Tellez et al. (2014). In their work, Campos Vázquez and Cuilty (2014) find that investing in public spaces has a positive effect on a social capital index which includes a measure of trust in neighbours, although they find social capital vanishes quickly over time and with conflict. Martínez Cárdenas et al. (2014) define a statistical profile for those with lower values of trust, they find that being of indigenous extraction, lower educated, female, and from the southern part of the country describes the average individual with lower levels of trust. Aguayo Tellez et al. (2014) estimate correlations between social capital as measured by the number of memberships to organisations, and two measures of trust; in general they find that the results from Martínez Cárdenas et al. (2014) extend to social capital as measured by voluntary memberships.

Guiso et al. (2004) study the effects of bilateral trust on economic exchanges (trade and investment). As part of the investigation they asked in a survey "Suppose that a random person you do not know personally receives by mistake a sum of 1000 euros that belong to you. He or she is aware that the money belongs to you and knows your name and address. He or she can keep the money without incurring in any punishment. According to you what is the probability (a number between zero and 100) that he or she returns the money?" The answer to this question turned out to be correlated with their measure of trust towards individuals of different nationalities. The authors interpret this result as an indicator that "the reported level of trust reflects the subjective probability that a random person is trustworthy" (Guiso et al., 2004, p. 5).

The work of Alesina and La Ferrara (2002) looks at the determinants of trust using as a proxy of it the World Values Survey question *"Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?"*. They use data from the United States collected in the General Social Survey and find strong results that link trust to negative financial and labour outcomes, traumatic experiences, discriminated groups such as females and black people, lower levels of income and education, and the racial composition and income inequality present in the community the individuals belong to.

There are other important relationships between trust and factors related with human well-being in the literature. Among these findings it can be mentioned that trust is related to the improvement in institutional performance, self-reported health, access to health services, is negatively related to the probabilities of mental illness, and is also positively associated with better public services provision, performance and productivity, cooperation, participation in civil organizations, collective action and household income (Hendryx et al. (2002); d'Hombres et al., 2010; McCulloch (2001); Putnam et al. 1994; Brown et al. (2015); Acedo and Gomila (2013); Zak and Knack (2001); Attanasio et al. (2009); and Narayan and Pritchett (1999)).

With respect to work on trust in public institutions such as the government and police, Stevenson and Wolfers (2011) analyse trust in government and its association with unemployment rates. The authors find that decreasing trends in trust in government are associated with high unemployment rates in cross-country comparisons, and at a national level for the USA (but not at state-level). Guiso et al. (2003) study confidence in the government and the police, their findings indicate a positive relationship between social class and trust in police and the government, but a negative relation between these measures of trust and income. Keele (2007), using data for the United States, constructs a measure of trust in government from 9 different surveys. His findings indicate that trust in government holds a direct relation with an indicator of consumer confidence, congressional approval for the administration, and generalised trust. Crime shows a negative coefficient, but it lacks of statistical significance.

To close this section the concepts of trust and trust in public institutions, to be used, are described in a more succinct way. Trust is defined as a measure of the belief that a positive outcome would emerge when being involved in an exchange with other members of society or with a public institution.[2] Such a belief is interpreted here as a form of

[2] Regarding trust in public institutions, it is important to notice that here public institutions include only those organisations or subjects that participate in the provision of public goods and services. Those involved in the procurement of justice and security, those in charge of public policy and the government in general.

asset[3] that contributes to the realisation of exchanges among individuals, ameliorating the cost implicit in the realisation of the exchange, and increasing the value of the exchange, heightening the satisfaction provided by the exchange in itself.

Hence, an individual will consider engaging in an exchange if she thinks it is worth doing so, where the worthiness of an exchange is determined by what can be expected as outcome from it, contingent on the level of trust involved. The expectations on the outcome of the exchange can then be expressed as subjective probabilities over the level of trustworthiness on the subject or institution with which the exchange will take place. Thus, the individual will be willing to get involved in a higher number of exchanges with other agents of society (individuals or institutions) when her subjective probability on the level of trustworthiness of an average agent is higher.

3.3 Model variables

This section discusses the dependent and independent variables to be included in the estimations below. The focus of study of this work are *generalised trust* and *trust in public institutions*, given their importance as indicators of trust individuals show towards agents they interact with on a daily basis. Factors that affect trust are related experiences that have an impact on individuals' well-being such as poverty and inequality, the level of safety, differential treatment, institutional and social support. Poverty and inequality are related to social deprivation, the perceived level of safety is clearly related to the incidence of crime and violence in a society, differential treatment emerges with discrimination in all its facets, and institutional and social support is related to the elements that facilitate the participation of individuals in exchanges.

The dependent variables in this work are measures of *generalised trust* and *trust in public institutions*. After describing these two measures of trust, specifications of the variables that will be fitted in the model as covariates are presented. Two variables are of particular interest for this work: a measure of the degree of social deprivation experienced by individuals, and a measure of violence or crime that predominates in the environment in which individuals reside. Historical struggles Mexico has experienced with poverty and inequality, and the recent increase in violence and crime, make the analysis of the relation between trust and these two variables more pertinent. This section ends by elaborating on the inclusion of other variables as controls in the estimation. A measure of social capital, and indicators of discrimination are covered first, followed by additional socio-demographic characteristics, and regional indicators.

[3]The Oxford Dictionary defines an asset as "a useful or valuable thing or person" Asset (2015). This is how asset is understood here.

Generalised trust and trust in public institutions

The analysis conducted is based on the concept of trust defined for two types of social agents: individuals in general, and public institutions.[4] As discussed above, it is important to emphasise this analysis focuses on these two measures of trust given the fact that the high levels of crime and violence, and social deprivation in Mexico influence the level of trust of individuals on other members of society and public institutions (Fukuyama, 1996). Thus, it becomes salient to observe trust individuals report not only in other members of society in general, but also in those institutions that are in charge of providing an appropriate environment for society to develop.

Generalised trust, corresponds to the level of trust individuals hold over other members of society in general. A common proxy measure of generalised trust used in the literature is based on responses to the question from World Values Survey (WVS), and is employed under the assumption that individuals' response to this question corresponds to their trust over members of society in general, without making a difference between close friends, family, acquaintances or strangers.

This measurement is not free of criticism and can be subject to different interpretations (Glaeser et al. (2000) and Fehr et al. (2002)). Knack and Keefer (1997) question whether individuals report trust towards close members of society, i.e. family and friends, or towards members of society in general. This illustrates the different interpretations respondents can give to the question when answering the survey; however, the measure of trust employed in the present investigation and the reported level of trust in family and trust in friends show small correlation values (Spearman correlation values were 0.0739 between generalised trust and trust in family, and 0.2655 for trust in friends), which suggests the level of trust reported to the WVS question reasonably represents trust towards members of society in general, and can be used as such in this analysis.

Trust in public institutions is approximated by the level of trust individuals hold over institutions that provide public services that are considered fundamental for society's appropriate performance and development. Such institutions are the ones in charge of procuring security, law enforcement, and policy making (i.e. police, judicial system, political parties, and the government as a whole). This measure is constructed from respondents' report of trust towards institutions in a scale of 1 to 10. Trust held by citizens towards these institutions is of interest in any society, but even more for a society

[4]These two measures of trust are approximated by responses of surveyed individuals to two types of questions, the first one is the World Values Survey question *"Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?"*, the second is a 0 to 10 scale question that asks *From 0 to 10, where 0 means zero trust and 10 is full trust, how much do you trust in X?* where X stands for social agents, the ones we are concerned here are police, government, political parties, judges.

going through a violence outburst (see Ríos (2013), and Guerrero-Gutiérrez (2011)), and where institutions are rather weak (see the introductory chapter of Acemoglu and Robinson (2012) for an account of how weak institutions in Mexico operate).

Social deprivation

Social deprivation refers to an individual's lack of required means to maintain a life status according to the standards of the society in which the individual develops. This understanding of social deprivation, that implicitly embraces multidimensionality in its components, is based on Townsend (1979).[5] Social deprivation is a situation in which individuals lack access to options available to others as a norm; delineating differences, stratifying, and polarising members of the society. It can be suggested that trust is affected by the increase on polarisation between social groups when inequality becomes salient. A number of studies support this hypothesis, some of them have found that inequality holds a negative relationship with trust, while others focus on social class. For example, Wang and Gordon (2011) find a strong negative relationship between income inequality and generalised trust, Bjørnskov (2007) using the Gini index as a proxy for social polarisation, finds a negative association with generalised trust in cross-country comparisons. Using WVS data for the United States, Knack and Keefer (1997) find a positive relationship between absence of social polarisation (Gini Index) and trust; similarly Zak and Knack (2001) confirm the predictions of their model, finding that measures of inequality and diversity are associated with lower levels of trust. Additionally, using data from the General Social Survey for the USA, Alesina and La Ferrara (2002) find that inequality has a negative effect on trust, with results corroborated when implementing a robustness check.

The relation between social class and trust has been studied by Guiso et al. (2003) and Guiso et al. (2007), who find a positive relation between trust and social class and income, these results are obtained using data from the World Values Survey and the German Socio Economic Panel respectively. Bjørnskov (2008) studies trust using data from the World Values Survey and other similar surveys (Danish Social Capital Proyect, Afrobarometro, Latinobarometro), the author tests the relationship between trust and indicators of "fractionalisation", which include income inequality, and political and ethnic heterogeneity. He finds that only income inequality and political heterogeneity

[5]Townsend states that "Individuals, families and groups in the population can be said to be in poverty when they lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or are at least widely encouraged or approved, in the societies to which they belong"(Townsend, 1979, p. 31).

have a significant negative effect. These effects remain significant only in societies that are rich, democratic, and with significant left or right wing political presence.[6]

A way in which trust is affected by social deprivation is via polarisation of society, as polarised environments strengthen the perception of differences between individuals from different social groups, resulting in an increase in uncertainty in interactions, affecting trust across groups. This can be understood from the perspective of Class Conflict Theory, which states that class differences produce conflict between groups (see Parsons (1949) for an account of class conflict from the point of view of the early economic literature). For example, in a model about social class conflict and ethnic conflict developed by Robinson (2003), one of the results shows that social class conflict increases with inequality. Also, a similar argument to the one presented here is offered by Zak and Knack (2001), in their model trust is negatively related to a measure of differentiation between participants in an investment transaction, with differences driving distrust among them, increasing verification costs and deteriorating investment.

Another line of reasoning implies that individuals that experience higher levels of social exclusion (represented as being part of the working class, having immigrant status, being poor, among others) also confront low levels of trust and other forms of social capital. Individuals experiencing high levels of social deprivation also face social exclusion in multiple forms such as discrimination, segregation, isolation; these problems lead to more onerous exchanges, at least in terms of psychological costs. In turn, this would be detrimental for the level of trust held by individuals as exclusion leads to higher exchange costs (see Coffé and Geys (2006), Saltkjel and Malmberg-Heimonen (2014), Li et al. (2003), Daly and Silver (2008) for example).[7]

The arguments aforementioned, and the evidence discussed, imply that trust has a negative and significant relation with inequality, social class, and social deprivation. However, this relation may not be maintained equally for individuals involved in more homogeneous interactions, and individuals that do so with more heterogeneous groups. Individuals experiencing different degrees of social deprivation should report lower levels of trust if their interactions are primarily held with members of other classes, and the opposite would happen if exchanges were held only with members of the same group.

On the other hand, trust in public institutions may be affected by the degree of social deprivation via an abandonment effect. If individuals that belong to the group with

[6] In Bjørnskov (2008), when splitting the sample, the effect remains significant only for societies identified as big, rich, democratic countries that have a "left-wing median political ideology." While the significant negative association between trust and political heterogeneity is consistent only for rich, "politically competitive" countries with a "right-wing median ideology".

[7] Regarding other proxies of social capital not related to trust, Coffé and Geys (2006) find that more than inequality, it is heterogeneity in ethnicity that drives lower levels of social capital, measured as number of associations in the locality, vote turnover, and rate of crime.

higher levels of social deprivation experience higher costs of exchange, individuals may impute this disadvantage to public institutions, affecting the level of trust in the institutions. Stevenson and Wolfers (2011) find trust in government is negatively associated with high unemployment rates, which can be perceived as a component of social inequality. Also, in their study of trust on government and police, Guiso et al. (2003) find that trust held over these two agents is higher among individuals from less deprived social classes, although a negative relation is associated with income.

In summary, an important effect is expected between social deprivation and the level of trust towards both individuals in general and public institutions. Nevertheless, distinct directions for the effects can be expected depending on which effect dominates. If interactions are held mainly among members of the same group, a positive effect on trust should emerge, while a negative effect should be expected if individuals interact with members of other groups. The results of the estimation can contribute to clarify this matter.

Violence and Crime

Violence and crime deteriorate social relationships and destroy social and institutional arrangements. When insecurity increases, the uncertainty generated in the environment fosters lower levels of trust. Fukuyama (1996) links the increasing level of distrust in the United States to increases in crime and observes this is accompanied by the presence of more stringent law, which together "produce greater suspiciousness on the part of those who would normally be trusting and trustworthy themselves"(Fukuyama, 1996, p. 310).

With respect to trust towards public institutions, higher indices of criminality affect the perception of the public regarding the efficiency of the institutions in procuring security. Individuals may perceive public institutions do not care for the well-being of citizens, a situation that may lead to an decrease in the level of trust amongst the public. Therefore, perception of public institutions being inefficient affects the level of trust held on those institutions.

Experimental evidence, particularly in places that have experienced violence caused by war and political instability, confirms a negative association between trust and violence. For example, Cassar et al. (2013) implement a series of experiments in a former war zone, their findings indicate that higher exposure to war violence negatively affects trust and deters market participation. Simultaneously, it increases the tendency to seek support from relatives instead of institutions in order to resolve conflicting situations. In an experimental study held in Nairobi, where violence exploded during the 2007-08

Kenyan crisis, Becchetti et al. (2013) find that subjects who had experienced episodes of violence reciprocate less in investment games after participation in common-pool resource games. Evidence from these experiments also suggest that subjects show a decrease in trustworthiness when they are not sufficiently represented in the ethnicity composition of their groups, and when there is low cooperation; however, when not facing both circumstances (i.e. representativeness and low cooperation) the effect is absent. The authors discard endogeneity problems via joint effects, the implementation of an interim common-pool resource game, and robustness tests.

The literature that explores relationships between trust and crime finds consistent negative relations between these two variables. Nevertheless, evidence of causality is rather mixed and difficult to establish. Using data for Holland, Akçomak and ter Weel (2012) test for statistical relations between crime and different measures of social capital, one of which is trust. Some of their findings indicate an inverse association between a latent measure of trust (comprised by generalised trust, blood donations, voluntary giving (charity), voting turnout) and generalised trust with crime. The authors claim to identify causality using different instruments for social capital,[8] with social capital causing a negative effect in their crime index, they also find causality to hold in some instances from trust towards crime, but this effect depends on the inclusion of other variables in the model, and is inconsistent when partitioning the sample by population size.

Evidence of causality from social capital to homicide rates has also been found by Rosenfeld et al. (2001). The authors use General Social Survey data for the USA to estimate structural equation models to test for associations between homicide rates and an index of social capital that includes trust as a component.[9] Their results lead them to reject the hypothesis of a two way association between their measure of social capital and homicide rates, with evidence suggesting the direction of causality running from social capital towards homicide rates. Cuesta and Alda (2012) use information on trust from the second most violent city in Colombia, Cali; their findings indicate that their victimization indicator variable[10] and a trust index (comprising reported trust, and beliefs about people taking or not advantage of others, and being willing to help others or not) hold a negative relation. However, when testing for relationships among

[8]The authors instrument for social capital using municipality level data from 1859 on population heterogeneity (% of foreigners, percentage of protestants, number of schools

[9]They create a latent variable with measures of generalised trust (generalised trust, and people's fairness and helpfulness), electoral participation and membership to organisations (Elks).

[10]The authors define their victimization index as a dichotomous variable "taking the value of 1 if the individual or someone in his or her household has been subject to any of the following offences in the last year: larceny, threats, beatings, beatings by police, injuries, sexual abuse, property damage, kidnapping, murder and domestic violence."

individual types of crime, trust does not show statistical significance of association with homicide, kidnapping, or sexual offences.

Using WVS data for 36 countries, Lederman et al. (2002) find results that point to a negative effect of trust on homicide rates. Causality is determined using geographic location, degree of development, and also numbers of telephones and radios per capita as instrumental variables, their findings indicate causality running from trust towards homicide rates. Additionally, when testing for associations between rates of change in homicide rates and the rates of change in an index of trust[11], Galea et al. (2002) find evidence that crime and trust are negatively associated for data from the General Social Survey for the United States. The authors use Markov transition matrices to disentangle causality without success, which leads them to hypothesise a bi-directional relationship.

It has been argued that crime and trust have a negative relationship, and this is supported by results in the literature. As noted by Putnam (2001, p. 138) "have-nots are less trusting than haves,... people who have been victims of a crime.. [tend to trust less] than those who haven't." Literature suggests trust and homicide rates, and other measures of crime and violence, have a negative relationship. Some of the studies cited indicate that causality runs from trust (or social capital) towards crime. Nevertheless, most of the authors acknowledge that a bi-directional association exists, and that this relation can be grounded both theoretically and empirically. Therefore, an important relationship is expected to emerge from the statistical evidence and estimations.

Social capital

Social capital is of relevance in the creation of trust facilitating interaction among individuals. Interactions create experiences, which can be positive, negative, or neutral, as Beem (2000, p. 162) asserts when mentioning that trust is built with "face-to-face interactions". Putnam et al. (1994, p. 168-169) offer an illustrative example by citing an informant expressing that "social networks allow trust to become transitive and spread". Dekker and Uslaner (2003, p. 3) offer a definition of social capital based on two of its properties: *bonding* and *bridging*. The authors specify that "social capital is all about the value of social networks, bonding similar people and bridging between diverse people, with norms of reciprocity." Following this approach, defining social capital in terms of social networks, the number of interactions that happen within the network (frequency of use), and the benefit provided by them, will affect the level of

[11] A measure that takes into account the % of individuals positively answering to the WVS trust question, and also positive answers to questions regarding people mostly acting fairly and acting helpfully

trust shared among its members. This means incentives to participate in the network must be related to the utility that individuals can derive from such participation.

Nevertheless, the direction of the relationship can be expected to go in a negative or a positive direction. If participating in interactions results in a loss of utility, then individuals will tend not to interact in the network; if, on the contrary, participation results are beneficial to the individual, then she or he will be willing to participate in it. Newton (2001) mentions two main theories within a "compatible model of trust",[12] both supporting the bi-directional possibility. The first one based on the social psychology literature which, in a simplistic version, states that one becomes of a trusting type or of a distrusting type early in life. Even though choice of type is bounded by personality, experiences influence the type one ends up being; however, the author suggests that ones type seems to be rather constant. The second theory relates to what the author calls the "macro approach to social capital." In this version, social relations and voluntary associations, together with appropriate institutional support, spur all types of trust, with a reciprocal effect from trust to institutions and "norms of civil society". Again, it is the experience created by social capital that relates it to trust held by individuals.

As noted by Putnam (2001), one can expect the relationship to run in both directions; with social capital affecting trust and trust influencing social capital. The value of a social network should differ according to the degree of trust shared within it, networks with higher levels of trust provide incentives for more participation, producing higher levels of social capital, which consequently affects trust.

The premise supported here holds that social capital, as approximated by number of voluntary memberships, increases individual cohesion and bonding, which in turn spurs trust. For example, Glanville (2015) finds, from survey data for the United States, that membership in voluntary organisations is positively associated with trust. Although the effect is relatively small, the results indicate this effect is conducted via ethnic diversity in networks, with this relationship maintained for different ethnicities. Using data from the World Values Survey focusing on Switzerland, Freitag (2003) studies the relationship between trust and a series of covariates, placing emphasis on the effects of memberships to diverse associations and trust. From all associations considered (including political, economic, cultural, community, and those of private interest) the author finds evidence of correlation only for cultural associations in a restricted model; however, the significance vanishes when estimating an extended model. Similarly, Li et al. (2005) estimate a logit model for trust and social capital approximated by neighbourhood attachment, social networks, and civic participation; being this last

[12]Compatibility among social trust, general social trust, and political trust. The author also covers two more models, an incompatible and a conditional model with possible different implications.

proxy of social capital the closest specification to the one used in the present study. The authors find a positive relationship between civic participation and trust only for the individuals with top quartile values of civic participation, but the effect turns not significant when including a lagged value of trust.[13]

Another related result is obtained by Knack and Keefer (1997) in their cross-country analysis discussed before, in which the authors find no relationships between trust and memberships to voluntary associations. Further evidence of a weak relationship between trust and social capital has been obtained using data from the British Household Panel Survey. Analysing data on generalised trust from 6 waves between 1991 to 2008, Sturgis et al. (2012) estimate pooled cross-sectional, fixed effects, and random effects models. The authors find a positive statistically significant relation between memberships and generalised trust for the first two estimated models, but the effect vanishes when implementing random effects. Testing model appropriateness, using the Hausman test, leads them to favour the estimation results offered by the random effects model.

The hypothesis for the relation between trust and social capital is weakly supported by evidence in the literature, still it is regarded as worth pursuing. An argument to support the relevance of its study pertains to the premise that trust tends to be higher when social capital is high as well. A higher level of social capital provides individuals with richer participation networks, which facilitates finding someone to interact with. This is the hypothesis to be tested later in this analysis. Notice that, if social capital is high among agents, and if there is strong presence of reciprocity, then trust will be higher, and a positive link between trust and social capital should be expected.

Discrimination

Trust can be influenced by individual's characteristics that place them in disadvantaged positions. Such disadvantages can emerge from elitism, institutional design, cultural traits, among others. For example, ethnic minorities and females are two groups historically discriminated against in most cultures, and particularly in Mexico (see below for references). If trust is affected by cultural traits of beliefs about who should be involved in such interactions, the cost of participating in them will be higher for those not identified as "appropriate participants". For instance, a person from a given ethnic origin that is frequently discriminated against will have a higher number of negative experiences when interacting with others, specially with those not sharing the same ethnicity. If a female individual interacting in a male dominated sector, for example

[13] Coefficients turn significant for social networks and neighbourhood attachment for most quartiles in all three models tested, restricted and not.

the construction industry in India (Kakad, 2002), or academia in the UK (Knights and Richards, 2003); differential treatment can emerge leading to lower levels of trust.

Gender violence and discrimination represent a significant problem in Mexico. Recent survey results indicate that the percentage of women that have experienced violence from their partner reaches 44.9%; with 11.7% reporting having experienced sexual violence, 25.8% physical violence, and 89.2% emotional violence from their partner. From this sample, 31.8% report experiencing violent events in their community, from which 38.3% report having been victims of sexual violence, and 86.5% report incidents of intimidation in their communities (INEGI, 2013). Navarro et al. (2014) offer an account of women's state of disadvantage and violence in Mexico, and Reguera Torres et al. (2013) focus on gender violence in the Northeastern region of the country. Given the historical disadvantage and abuse that women have experienced in the country, it could be expected that this group would show lower levels of trust compared with men. In this regard, Alesina and La Ferrara (2002) find a negative relation between female gender and trust. Similarly, in their analysis of survey data for the United States, Glaeser et al. (2000) find males report higher trust.

There is evidence that indicates that groups that experience discrimination tend to show lower levels of trust. This negative relationship is found by Alesina and La Ferrara (2002) among groups that are known to experience high levels of discrimination, and argue that Demaris and Yang (1994) find similar results. Helliwell (1996) also finds a negative relationship when testing differences in effects between stressing ethnic origin when reporting nationality and not doing so in Canada. On the other hand, Fershtman and Gneezy (2001) find discriminating behaviour in trust games experiments ran with Israeli university students with this effect holding only for male subjects.

Indigenous groups are amongst the most discriminated against in Mexico. The direction of the effect can be either positive or negative depending on the group of reference when reporting their level of trust. If trust reported is towards individuals they identify as belonging to their own group, a positive level of trust would be expected; conversely, the effect will be negative if they report trust towards individuals belonging to other ethnic groups. Additionally, trust attitudes rooted in their culture or believes may be distinct for indigenous populations. Hence, a separate indicator variable for this group is included in the analysis.

Other variables of interest

Additionally, regional indicators are included in the estimation to account for cultural diversity and differences in living conditions across the country, as well as other regional

specific traits. Mexico can be divided into three different regions: North, South, and Centre. These regions are characterised for their marked differences in terms of geography, ethnic composition, and degree of development. For example, natural resources are more prevalent in the south than in the centre, and even more relative to the north of the country; the vast majority of the indigenous population is located in the south and centre of the country; and poverty concentrations are less marked in the north. These differences may spur divergent attitudes towards trust. As an example of emerging regional differences for trust, Helliwell (1996) finds this type of divergence when contrasting data for the USA and Canada. The author speculates this effect has something to do with the type of population that migrated to areas that nowadays present higher levels of trust. It is expected that ethnic composition and cultural differences will account for similar effects to the ones reported in the cited work.

A number of socio demographic variables, together with indicators of social protection, are also introduced as controls. The socio demographic variables used are age and education, including non-linear effects, and the presence of social benefits, such as subsidies and health coverage, are included as measures of social protection. Two variables are included as indicators of social protection: access to health coverage, and access to state subsidies. The hypothesis is that the higher the level of social protection, the higher the level of trust reported. As suggested by Bjørnskov (2007), generating interventions aiming to spur trust (or any other form of social capital) can be cumbersome. Nevertheless, there are policies that are particularly clear in their objectives, one of which is redistribution policy. If income redistribution or widening opportunities (approximated by social protection in the form of health assistance and subsidies) can contribute to increase trust, the estimates for this variable can help shed some light in this regard.

Other factors that have been considered in the literature to hold associations with trust are age and education. With respect to the variable age, different relationships can emerge. On the one hand, it could be that as age progresses, individuals accumulate more life experiences, which make them more prone to have been exposed to negative situations that decrease their trust, but learning and maturity play their part and make the level of trust converge to certain value. Thus, a U-shaped relationship between trust and age could emerge, or a negative but decreasing effect could be expected. Delhey and Newton (2003) and Alesina and La Ferrara (2002) find that generalised trust increases with age, but increments happen at a decreasing rate. On the contrary, Berggren and Jordahl (2006) find in their study that age and trust do not follow this pattern but an inverse relation. Sturgis and Smith (2010) find a positive association between age and generalised trust and a measure of trust in neighbours, although only the latter is

statistically significant; Robinson and Jackson (2001) find a direct decreasing association between age and trust, and that trust is smaller for younger generations relative to those born before 1940's. With respect to social capital measured as memberships, Putnam (2001, p. 249) finds an n-shaped relationship between social capital and age-cohorts for the USA, and argues that there is a declining trend on trust across generations for the case of the USA; this n-shaped relationship is confirmed by Glaeser et al. (2002) for the same proxy of social capital (memberships) with respect to age. Thus, based on this evidence, a positive decreasing relationship between trust and age can be expected to emerge. As suggested elsewhere, this association may be related to the cycle of life, where consequences of trusting are higher in the middle ages, and less so at the early and last stages of life.

Formal education, in general, gives access to more and better opportunities. Individuals that have acquired more formal education can be expected to accumulate more economic resources, and have access to networks of "higher value." They also possess more social skills, and earn about contributive responsible participation in society, which leads to higher levels of social capital (Heyneman, 1998). This may provide both more resources to deal with negative experiences emerging from trusting behaviour, and access to a richer set of options regarding social interaction. Uslaner (2002, p. 90) suggests that people with higher social status, which includes people with higher education, have more resources to assimilate negative shocks derived from trusting behaviour, and thus are more willing to trust. Alesina and La Ferrara (2002), and Glaeser et al. (2002) find a positive effect of education, with no evidence of decreasing effects, both using data for the USA contained in the General Social Survey. Using data from the World Values Survey, Knack and Zak (2003) find a positive relation between trust and schooling in their cross-country analysis. This evidence points at a positive association, though at a decreasing rate, between trust and education. Higher levels of education can provide more resources to deal with negative experiences that can emerge from trusting behaviour, and also grant access to social networks in which interaction occurs, in some way, more secure in terms of the lower likelihood of negative experiences emerging from participation in them.

Finally, it is possible for social and cultural changes to have an influence on the level of trust held by individuals. This may be related to changes in attitude driven by media, policy, or events that change the perception of individuals. An indicator variable is included to take into account temporal differences between each survey wave or changes in trust over time. Table 1 shows that all reported types of trust but trust in the church (the WVS measure and with respect to particular social agents and institutions) increased from the 2006 to the 2011 wave, thus a positive sign is expected.

Table 1: Mean values for measures of trust per year

	2006	2011	Total		2006	2011	Total
Trust	0.4711	0.7439	0.6232				
Business owners	4.704	5.374	5.099	Close friends*	7.102	7.272	7.205
Government	5.036	5.315	5.192	Work fellows	7.246	7.588	7.441
Judicial system	4.840	5.425	5.169	Family	8.756	9.171	8.987
Police	4.434	5.564	5.062	Neighbours	6.219	7.150	6.737
Political Parties	3.844	4.636	4.289	Friends	6.374	7.348	6.920
Church	8.025	7.735	7.863	Teachers	7.246	7.588	7.441

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011). Trust has values of 0, 1, and 2; all other trust measures range from 0 to 10. *Close friends is used as a translation for the concept *compadres*, used to refer to ones child's godfather.

3.4 Data

The analysis uses data collected in two surveys for Mexico in the years 2006 and 2011. The first information corresponds to the Urban Social Capital Survey (ENCASU), these data was collected by the Secretariat of Social Development in Mexico (Secretaria de Desarrollo Social or SEDESOL in Spanish) in 2006; while the second source corresponds to the continuation of the same project, developed by the United Nations Development Programme office in Mexico. This second survey took place in the year 2011, and is referred to as the National Social Capital Survey (ENCAS). The data consists of repeated cross-sections as the two waves do not survey the same individuals, although the set of municipalities covered in both waves are roughly the same. Data used as indicators of social deprivation are produced by the National Council for the Evaluation of Social Development Policy (CONEVAL, for its Spanish acronym), and information about crime rates is taken from the National Office of Health Information, and the National System of Public Security. Details about sources are presented below in this section together with some descriptive statistics.

For the first wave, ENCASU 2006, data for 44 municipalities is available, with a total of 2167 urban households completely surveyed, 700 for each of the regions represented in the survey: north, south, and centre. The second wave, ENCAS 2011, extended the coverage to rural areas, a total of 90 municipalities and 5391 households were surveyed, with 1200 located in rural areas, 4191 in urban locations, and 1800 surveys taking place in the northern, southern, and central regions of Mexico. The sampling processes for

the two surveys is a stratified, multistage, cluster-sampling design. Both surveys are representative at a national level and for three regions: north, south, and centre; and both contain the same questions relevant to the analysis presented here, in particular, the questions related to the variables of trust are exactly the same on both surveys and are compatible with the questions on trust included in the World Values Survey, which allows the comparison of results with most of the studies found in the literature. In the analysis carried out later only urban observations are used for consistency and comparability.

The measure of generalised trust used corresponds to the question introduced in the World Values Survey, that is, *"Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?"*, which allows for three different responses: *Most people can be trusted*, *There is a little bit of everything*, and *You can never be too careful when dealing with others*. To construct the variable *Trust*, the responses were codified with values of 2, 1, and 0 for each of the respective answers, thus higher values of the variable indicate that surveyed individuals report that people in general can be trusted rather than not. As can be seen in Table 2 the average value for *Trust* is 0.623, with a standard deviation of 0.818, which indicates a concentration of responses towards zero; in fact, approximately 60% of the individuals surveyed report a level of trust of zero, 19% a level of one, and the remaining 22% report a value of 2.

Table 2: Trust statistics

	Frequency	Percent	Cumulative	Overall statistics
0	2,900	59.39	59.39	
1	923	18.9	78.29	Mean = 0.606
2	1,060	21.71	100	Obs. = 4,883

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

To measure the level of trust in public institutions, five indexes were constructed using information on the levels of trust reported for a group of institutions, or representatives of such institutions, that are providers of public services, and who are in charge of activities that affect the security, law, public policy, and the administration of the public goods. The institutions included are government, police, judicial system (those who represent it, i.e. judges), and political parties. For each institution the level of trust reported in the survey is used, and a global trust index including all four institutions is also calculated. To construct the global index, a weighted average of the levels of trust reported for each institution was computed. The weights were estimated using

principal component analysis; taking the first component of the output as weights.[14] This approach has been used in the literature to reduce dimensionality and to construct latent variables (see for example Morcillo and de Juan Díaz (2016), Alesina and Giuliano (2010), Cortés Aguilar et al. (2011), and Ram (1982)).

The responses for the variables that report individual's trust on public institutions range from zero to ten in the data base. To facilitate the interpretation of the results the measures of trust in public institutions were collapsed to three values using the cumulative square root of the frequency method introduced by Dalenius and Hodges (1957) as cited by Singh and Mangat (2013). For the index of trust in public institutions, the cutting points were 3.5 and 6.5. Thus the variable takes the value 0 if the index has a value in the range [0, 3.5], a value 1 if in the range [3.5, 6.5], and a value of 2 if the index is between the segment [6.5, 10]. The mean for this variable is 1.014301 and the standard deviation is 0.7799859; with roughly 30% of the values at 0, 40% at 1, and the remaining 30% at a value of 2.[15] Measures of trust for government, police, political parties, and judicial system were computed in a similar manner, as can be observed in Table 3 the mean and standard deviation values are pretty similar for all measures.

Table 3: Statistics for trust in public institutions

Trust in:	Judicial	Political parties	Police	Government	Public Institutions
Mean	1.167	1.110	1.113	1.140	1.014
Standard deviation	0.807	0.847	0.810	0.813	0.779
Observations	4889	4889	4889	4889	4615

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

In addition to the indicators of trust, data regarding socio-demographics, geography, access to social support, socio-environmental experiences, and social capital contained in the ENCASU and ENCAS surveys are used as part of the set of covariates. The socio-demographic variables included are age, formal education, and gender of the surveyed subjects (see Table 4). The sample data is balanced in terms of gender with females constituting 58% of the observations. All interviewed individuals are over 18 with the youngest subject being of this age and the oldest being 97 years old, the average age is 41 years with 16.34 of standard deviation, and with a positively skewed distribution of values. The variable years of formal education was constructed taking

[14] Principal component analysis is a statistical technique that permits the extraction of information on the existent covariance among a set of variables. The principal components are produced by computing the eigenvectors and eigenvalues of the covariance matrix, and produce linear transformations in the direction of principal variance, with the first principal component having the highest variance among all the components. The approach of Alesina and Giuliano (2010) is followed here when choosing the weighted index instead of the linear sum, using the strong correlation (0.999) between the two indexes as guidance.

[15] See in Section 3.11.1 of the Appendix for a note on this methodology.

into account the number of years that correspond to the last stage of education reported and adding the reported number of years of completed education for that last level. The minimum number of years of formal education imputed is 0 and the maximum 24. The average number of years of formal education is 9.5 with a standard deviation value of 5.04, with a bell-shaped distribution of values.

The regional variables used refer to the region of residence: south, centre or north of the country, and to the size of the municipality of residence. Around 31 % of the observations reside in the north region, 35 % in the south, and 25 in the central region of the country. Regarding the size of the municipalities, roughly 33 % of the observations have their residence in municipalities with less than 100,000 inhabitants, and 67% live in municipalities of less than 500,000 inhabitants.

To approximate the effect that social support, or the lack of it, has on the level of trust, responses on access to subsidies are included in the analysis. From all subjects 14.81% report perceiving support in the form of subsidies. The most reported subsidy is Oportunidades (a conditioned cash subsidy) with 10% of the sample having access to it, other subsidies are less represented, with Procampo (a subsidy to agricultural producers) received by 1% of the sample, and 2.4% reporting having access to other types of subsidies. Additionally, information about the right to access health services, publicly or privately provided, are also used as measures of social protection. A total of 32.6% of the sample reports not having access to any type of health service protection. Public health services are included for obvious reasons as measure of social protection, but private health merits some explanation. Private health services are provided by employers as part of the contract benefits, or are self financed by individuals in the form of private health insurance. Although it is possible for individuals not to perceive self financed private health insurance as social support, this information is interpreted as an indicator of not experiencing the lack of protection. In this regard it is assumed that experiencing or not lacking social protection have equivalent effects on trust.

The variables used to represent experiences of discrimination are constructed from questions that reveal information about ethic origin and violation of rights. Speaking an indigenous language is used as an indicator of ethnic origin. Subjects that are speakers of an indigenous language constitute around 9% of the sample. Surveyed individuals were also asked about their experiences with discrimination. In particular subjects were asked if they have perceived their rights to have been limited or have not been respected because of their physical appearance, gender, religion, sexual preferences, skin colour, ethnic origin, age, income, region of origin, or other reasons. For this indicator 46.64% of the surveyed individuals report having experienced some type of

Table 4: Dependant and explanatory variables statistics

Variable	mean	min	max	sd
Trust (= 0, 1, 2)	0.623	0	2	0.818
Trust in public institutions (= 0, 1, 2)	1.014	0	2	0.780
Social gap	.259	0	2	.588
Homicides per 100,000 habitants	8.601	0	59.374	10.324
Age	41.189	18	97	16.347
Formal education in years	9.448	0	24	5.040
Gender (female)	0.575	0	1	0.494
Has experienced discrimination	0.466	0	1	0.499
Has no social security (1 if so)	0.326	0	1	0.469
Resident of the northern region	0.308	0	1	0.462
Resident of the southern region	0.346	0	1	0.476
Indigenous condition (speaker)	0.088	0	1	0.283
Social capital (# of memberships)	0.207	0	4	0.445

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

discriminatory experience, a positive answer is assigned the value of one in the variable *Discrimination*.

As a measure of social capital, the number of voluntary memberships to organisations is used. In the survey individuals were asked about the number of voluntary organisations in which they participate. These organisations were classified as religious organisations, trade unions, parents associations, neighbours associations, elderly groups, self-support associations, sports or recreational groups, and other organisations. The variable was constructed adding the number of memberships for each observation. As can be seen in Table 4 , the values for the number of memberships ranges from a minimum of zero to a maximum four. The distribution of values indicates that 80.83% of the subjects report having no memberships at all, 17.78% report one, 1.29% two, and 0.06% and 0.04% report having 3 and 4 memberships respectively. Other alternatives to measure social capital in the data set include the number of social meetings, or the number of people that subjects meet with on a monthly basis, these two proxies where discarded in favour of voluntary memberships as they present a high number of missing values.

To approximate the level of social deprivation experienced by individuals, data on a social gap index estimated by the National Council for the Evaluation of Social Development Policy (CONEVAL) is used. CONEVAL is an autonomous organisation coordinated by the Ministry of Social Development, the institute is in charge of the evaluations of social development initiatives, as well as the measurement of poverty in Mexico.

The social gap index is a multidimensional measure that aggregates information of deficits in education, health, basic services, and housing. The index increases in value with the level of social deprivation. The index is constructed using the 4 indicators using the principal components method to aggregate the information. The indicator for education takes into account the percentages of population over 15 years of age that is illiterate, of ages between 6 and 14 years that does not attend school, of households with members between 15 and 29 years o age that posses less than 9 years of formal education, and the percentage of the population of 15 years of age or more with less incomplete primary education. For health services uses the percentage of the population that lacks the right to access health services; and with respect to the quality of household spaces, it takes into account the percentage of homes with dirt floor, the average number of people per room for households in private occupied dwellings. For household access to basic services incorporates the percentage of households without toilet, the percentage not connected to the water network, not connected to the sewer network, and without access to an electric power supply. Finally, for the household assets measure includes the percentage of households without washing machine, and without refrigerator.

Although this index does not include measures of income, and access to social security or food, it offers disaggregated information at a municipality level for the years 2005 and 2010. The use of this index is favoured as it provides a measure of the level of deprivation in which individuals live, taking into account different important aspects that directly affect human well-being, which is useful for the purposes of the present work, that is, including a measure of individuals' experienced social deprivation and its effect on their levels of trust. Notice that the values of the index social gap, at a municipality level, are imputed to subjects. Thus what will be measured is the effect of social gap at a municipality level on individuals' trust, and not the effect of individuals' social gap on individuals' trust.

Additionally, an assumption is made with respect to the time at which the social gap index is calculated. The years for which the index is calculated correspond to a lagged period for which data from the ENCASU and ENCAS surveys correspond, thus it is assumed that the values of either the index or the information on the surveys do not vary much from one year to another.[16] The index was used to produce an indicator variable that identifies individuals inhabiting municipalities with low, medium and high social gap. For this, the original index was collapsed from 5 to 3 values which resulted in 10.64% of the subjects being allocated to the medium social gap group, 7.87% to the high social gap group, and 81.49% to the low social gap class. Participation in each group in the data base do not match the percentages at a national level, whose

[16]The assumption of small variability on trust is supported by Uslaner (2002), Bjørnskov (2007), and Bjørnskov (2008), these latter when comparing data from the WVS for different periods of time.

distribution roughly assigns 53% of the population to the low social gap group, 21% to medium social gap, and 25% for high social gap. Clearly the low social gap group is over represented in the sample, and the discrepancy is acknowledge when deciding to keep the whole sample for the analysis.

TABLE 5: Number of homicides per capita (times 100000).

Year	Observations	Mean	Maximum	Standard Deviation
2006	2132	7.380	40.764	7.7249
2011	2572	9.611	59.373	11.968
Total	4704	8.600	59.373	10.323

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

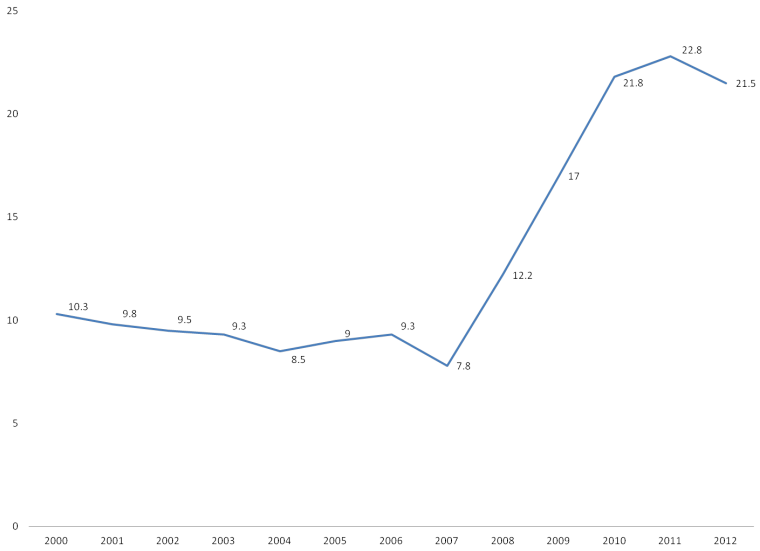
As a proxy for violence and crime, the number of homicides per capita is used. The data comes from two sources, for the year 2006 the data is collected from the National Office of Health Information of the Mexican Ministry of Health. The information for the year 2011 was taken from the Executive Secretary of the National System of Public Security. Both sources report official data on this variable. In the data collected from the Mexican Ministry of Health, homicide rates are recorded under categories X85 to X99, and Y89 in the source. These identifiers follow the international classification of diseases of the World Health Organisation.

Homicide rates were chosen as proxy of violence and crime for two main reasons: firstly, homicide cases have to be reported by civilians and by the authorities, secondly, this type of crime together with kidnapping and extortion is amongst those that impact more on the civil population, but the two last ones tend to be highly under reported. The data indicate the average number of homicides per capita is 8.60 in the municipalities, with a minimum of 0 and a maximum of 59.37 homicides per capita, the standard deviation is 10.32 for this variable. Table 5 shows the number of homicides per capita inhabitants increased from 2006 to 2011 from an average of 7.38 to 9.61, and the maximum frequency from 40.76 to 59.37. This increasing trend can be seen in Figure 1 , notice that homicide rates increase steeply after 2006 and reach a peak in 2011, the years for which survey data is available.

Table 23 in the Appendix presents the polychoric correlation matrix.[17] Two categorical variables could be a source of multicollinearity. First, high social gap has a relatively high correlation with the southern part of the country (0.63), and indigenous extraction (0.72), and to a less extent being recipient of Oportunidades subsidy (0.54). Likewise,

[17]Polychloric correlation is deemed as appropriate to test for collinearity among variables of dichotomous, ordinal, and continuous nature.

FIGURE 5: Intentional homicides (per 100,000 people), 2000-2012



Source: DGIS (2015), CNS (2015).

the categorical variable that indicates indigenous extraction shows worrisome correlation values with Oportunidades subsidy (0.51), North (-0.50), and South (0.55).

According to INEGI (2009), indigenous populations are heavily concentrated in the south and the centre of Mexico, and in rural areas. This is clearly reflected in the correlation results. The states with the highest percentage of indigenous population are Oaxaca (18.1%), Chiapas (15.8%), Veracruz (10.1%), Puebla (9.1%) and Yucatan (9%). All these states but Puebla (centre) are located in the south of the country and concentrate 53% of the indigenous population. The states of Guerrero, Hidalgo y Mexico together have 26% of all indigenous language speakers in the country. This indicates that less than 21% of the members of this group are located in the north of Mexico. In summary, this strong concentration helps to explain the high correlation indices obtained. Additionally, poverty incidence among indigenous people in Mexico is considerably higher relative to the national prevalence. For the year 2012, 76.8% of indigenous people where living under poverty conditions, compared to 43% of the national population (CONEVAL, 2014). In summary, the indigenous population in Mexico tend to concentrate in southern states, live under poverty conditions and live in non-urban areas, this trend can help explain the correlation values encountered.

3.5 Estimation strategy

In the strategy followed, the response variables, generalised trust and trust towards institutions, are modelled as monotonic censoring processes of a naturally ordered

continuous variable. Thus, an appropriate empirical strategy consist on estimating ordinal choice models (Greene and Hensher, 2010), where it is assumed the choices made by individuals are produced by some latent variable y_i^* whose functional form depends on a set of covariates and a stochastic error, and where the relationship is linear in parameters.

When considering alternative ways of coding the information to generate the dependent variables trust and trust in public institutions, both dichotomous and polytomous specifications emerge as possible options. For example, the measures of trust can be defined as 2-value, 3-value, or 10-value indicator variables. Use of a number of choices higher than two is favoured to respect the freedom of choice already present in the responses, and to preserve the richness of information that choices higher than two provide. Thus, polytomous rather than dichotomous variables are constructed to take advantage of the additional information. To facilitate the interpretation of results the possible values that the variables can take are restricted to 3 for all cases.

Selection of a particular distribution for the error term determines the type of estimation model to be used, usually an ordered logit or a probit model are chosen. The decision on selection of a particular distributional function is more of a debate, with selection resolved by taste or judgement in applications. As studies regularly find that estimates do not vary much when choosing one alternative over the other (Greene (2008, p. 832), and Long (2015)), a logistic distribution is assumed for the error term, and thus ordered logit models will be estimated.

The ordered logit model is derived as follows. Let τ_i be an unobserved, continuous, measure of trust. A linear regression model for this variable can be specified as

$$\tau_i = \beta_0 + X'\boldsymbol{\beta} + \varepsilon_i \tag{3.1}$$

Where X' is a vector of covariates, β_0 is an constant term, and $\boldsymbol{\beta}$ is a coefficient vector for the vector of covariates, and ε_i is a random error.

Trust, as described by Equation (3.1), can be modelled via an ordered choice model by constructing ranges of values $\mu_1, \mu_2, \ldots, \mu_J$, and by imposing some intuitive restrictions. A standard assumption in ordered choice models imposes the restriction on the variable of interest to be representable by a linear function separable in its arguments. As shown in Equation (3.1) the level of trust, τ_i, regarded as a continuous variable over its domain, is linearly determined by a set of observable variables X, that are independent of τ_i, and an unobservable random term, ε_i. Additionally, the random error is assumed to

follow a logistic distribution, with expectation value equal to zero and given variance $\frac{\pi^2}{3}$.[18]

Furthermore, if values of τ_i, ranging in $[min(\tau), max(\tau)] := T$, can be censored into responses $t_i \in \{0, 1, 2, \cdots, \bar{t}\}$, that are order preserving, and that divide trust values into cells defined as ranges of values of the form $\tau_i \in [\mu_{k-1}, \mu_k) := \mu_k \subset T$, such that cells $\mu_k \in T$ form a partition of T. Then a representation model can be constructed with the property that

$$t_i = k \text{ if } \tau_i \in [\mu_{k-1}, \mu_k) \subset T \tag{3.2}$$

As stated by (Greene and Hensher, 2010, p. 12), an underlying assumption in this representation is that, for each i, a known (monotone) mapping exists between t_i and τ_i. The index, t_i lies in the range, or cell, if the value of trust, τ_i, coincides with a value contained in such range.

We can now specify the model as

$$t_i = \begin{cases} 0 \text{ if } \tau_i < \underline{\tau} \\ 1 \text{ if } \tau_i \in [\underline{\tau}, \overline{\tau}] \\ 2 \text{ if } \tau_i > \overline{\tau} \end{cases} \tag{3.3}$$

To complete the specification of the model as an ordered choice, it is necessary to impose assumptions on the distribution of the error term ε_i. Assume then that ε_i follows a distribution F with known density f, then the log-likelihood function can be stated as any i is then

$$\ell(t_i \mid X) = \begin{cases} ln\ F(\underline{\tau} - \beta_0 + X'\boldsymbol{\beta} + \varepsilon_i) & \text{if } t_i = 0 \\ ln\left[F(\overline{\tau} - \beta_0 + X'\boldsymbol{\beta} + \varepsilon_i) - F(\underline{\tau} - \beta_0 + X'\boldsymbol{\beta} + \varepsilon_i)\right] & \text{if } t_i = 1 \\ ln\ F(\overline{\tau} - \beta_0 + X'\boldsymbol{\beta} + \varepsilon_i) & \text{if } t_i = 2 \end{cases} \tag{3.4}$$

for given threshold or cut point values and (exogenous) vector X of variables.

By imposing the error term follows a Logistic probability distribution function Λ, with mean 0 and variance $\frac{\pi^2}{3}$, the estimators correspond to an ordered logit model. Assuming the thresholds are $\tau_0, \ldots, \tau_J$ the fitted equation is of the form

[18] One can assume instead that $\varepsilon_i \sim N(0, \sigma^2)$, and estimate an ordered probit model.

$$Pr[t_i \leq k \mid x_i] = \Lambda(\tau_k - \beta_0 - \boldsymbol{X'\beta}) - \Lambda(\tau_{k-1} - \beta_0 - \boldsymbol{X'\beta}),\ k = 0, 1, 2. \tag{3.5}$$

Equation 3.5 presents an unidentified model, for the parameters of the model to be identified, location and scale of the model have to be fixed, which is achieved by fixing the constant parameter $\boldsymbol{\beta_0}$ (McCullagh, 1980, p. 181).

$$Pr[t_i \leq k \mid x_i] = \Lambda(\tau_k - \boldsymbol{X'\beta}) - \Lambda(\tau_{k-1} - \boldsymbol{X'\beta}),\ k = 0, 1, 2. \tag{3.6}$$

Equation 3.6 returns the estimated probability for each level k of trust, and specifies the model to be estimated. There $\boldsymbol{X}$ is a vector of explanatory variables that has as elements measures of social gap, homicide rates, age, formal education, gender, discrimination, social protection, regional indicators, indigenous condition, and social capital. The vector also includes an indicator variable to identify which survey the subjects belong to. The two surveys were pooled and are treated as a repeated cross-section, with individual observations as units of analysis.

3.6 Estimation results

This section presents the estimation results of the empirical models of trust. Alternative specifications are estimated separately for generalised trust and for trust in public institutions, focusing on two main explanatory variables, social gap and homicide rates, and with each specification considering the same set of control variables. For each outcome variable, an unrestricted model including both homicide rates and social gap is estimated, proceeded by two restricted models, one with social gap as sole main explanatory variable, and another one that includes only homicide rates. These exercises are implemented to test consistency on estimates. As a further test parsimonious estimation models are included. Additionally, a re-specification of the variable of interest, trust, is implemented to test asymmetries between trust and distrust among individuals. Main results are reported and analysed in the main body of the text, with supplementary results shown in the Appendix.

Estimations were done in Stata version 13, using the built-in command for ordered logit estimations (ologit). Additionally, the user-written program gologit2 (Williams, 2006) was used to estimate generalised ordered logit models. To consider the fact that the data were produced from clustered, stratified samples, and probabilities of selection may differ among observations, all estimations were done using survey weights provided with the data base for appropriate population representation. Notice that,

as individual observations were not sampled independently, measures of goodness of fit such as the pseudo-R^2 are not entirely appropriate and thus should be interpreted with caution. As mentioned before, only urban observations are included in the analysis. Estimated ordered logit coefficients are presented first. Although these are not directly interpretable, they are used to describe the significance and direction of the correlation between the dependent variable and the corresponding covariate. Marginal effects are also discussed and subsequently possible issues emerging from the estimated models are addressed, focusing on endogeneity and proportionality odds issues. Alternative estimation models are presented, including two-stage estimation with instruments, and the estimation of generalised ordered choice models. The section concludes with a discussion on the findings.

Generalised trust

Results from the maximum likelihood estimation for the variable *generalised trust* (henceforth *trust*) are shown in Table 6. The first column presents the results for the estimated ordered logit model with social gap and crime as main explanatory variables. In the second and third columns the results from the estimation of two restricted models are shown, with results for the model with social gap as main explanatory presented in the second column, and for crime as principal explanatory in the third one. A total of 4585 observations were used for all estimated models. Table 6 also presents the Bayesian information criterion (BIC) and Akaike information criterion (AIC), these two criteria are used to compare the goodness of fit between the unrestricted and the restricted models. Compared to the unrestricted model, the BIC and AIC differences are respectively 85403.711 and 18.628 for the restricted social gap model, and 610404.307 and 133.134 for the restricted crime model. These differences in BIC and AIC values support the unrestricted model in both cases, and considering the coefficients from the unrestricted and the restricted models do not vary significantly, the analysis focuses on the unrestricted model. The results are consistent with the hypothesis established for the variables social gap and crime presented in Section 3.3, and also for the control variables, although statistical significance is not found for some of them. The results suggests social gap and crime hold an important relation with trust and some novel results are found, particularly for the findings referring to the subgroups formed by the different degrees of social gap.

Generalised trust and social gap

As mentioned above the most striking results are those regarding social gap. The reference group are individuals that reside in areas of low social gap, that is those that live in better off or less deprived areas. The estimators indicate that individuals whose place of residence is in areas with higher levels of social gap report, on average, higher levels of trust in comparison with inhabitants of less deprived environments. The coefficient for the intermediate value of variable *Social gap*, i.e. social gap = 1, is negative, indicating an inverse relationship between intermediate levels of social gap and generalised trust. In contrast, high levels of social deprivation (i.e. social gap = 2) show a positive estimated coefficient, suggesting a direct association between high levels of trust and higher levels of social deprivation. Both coefficients present a strong statistical significance, with p-values smaller than 0.01. These initial results indicate the level of trust is higher at the extremes. Individuals in the intermediate measures of social deprivation are the ones that, on average, report lower levels of trust.

In terms of marginal probabilities, estimated as marginal effects at means and shown in Table 7, the estimations indicate that for an average individual, *ceteris paribus*, belonging to the intermediate social gap group increases the probability of holding a trust value of 0 (the distrust group) by 0.082; compared to the low social gap group; while for those that are part of the high social gap group the probability of being part of the distrust group decreases by 0.130. Results show that, holding all the rest constant, belonging to the intermediate social gap group is associated with a 8.2% higher chance of reporting a trust value of 0, with most of the effect being pulled from the most trusting group (-5.1%) and less so from the intermediate trust values (-3.1%). Regarding the more deprived group (high social gap), being part of this category is related to a decrement in 13% on the probability of reporting distrust (Trust = 0); with most of the effect being linked to an increase in probability of 9.5% of belonging to the group reporting the highest trust value, and a 3.5% increment on the chances of being part of the intermediate value of trust. All together, the results suggest that, relative to the high social gap group, individuals from the low and intermediate social gap groups have a lower probability of being part of the high trust group (trust=2), and secondly to the intermediate level of trust (trust=1), thus belonging to these groups mainly affect the chances of reporting high levels of trust. The contrary happens for the high social gap group, for them most of the result arises from being less likely to report lower levels of trust (trust = 0), and being more likely to report higher values of trust. These relations emerge as the sum of the marginal effects add up to zero for each variable, but the distribution of the effects across the different values of the dependent variable are still informative regarding how probabilities are distributed for each reported value.

These results are interesting as they suggest that the segment of society for which trust is at the lowest level are those that find themselves at intermediate levels of social deprivation. That is, they are not those that experience greatest scarcity of health, education, basic services, and house quality/assets; nor those in the most favourable situation. The argument presented in Section 3.3 suggested that individuals holding lower levels of trust would be those with lower interaction satisfaction. The results imply that individuals at the higher levels of social gap perceive higher utility from interacting with others in comparison with those with lower levels of social gap, and even more so relative to those at intermediate values.

One possible explanation for this result is that individuals in the highest and lowest social gap groups tend to be more involved in interactions with individuals of their own groups in comparison with those that belong to the group with intermediate levels of social deprivation. As interactions take place with less heterogeneous individuals for those in the extreme groups, they tend to report higher levels of trust. Another possible explanation is that individuals are more inclined to have interactions with members of the contiguous group in terms of social deprivation. In this case, besides interacting within their own groups, individuals from the low and high social gap group will primordially participate in interactions with those in the intermediate group, while those in the intermediate group will do so with both the low and high social gap groups; this higher heterogeneity for the intermediate group leading to lower levels of trust. Certainly, a combination of both effects could also be at place.

Generalised trust and crime

Considering the effect of crime rate (measured as the rate of homicides per 1,000 habitants), the results reveal a statistically significant relation between the rate of crime and generalised trust. As expected, the sign of the relationship is negative, with a estimated coefficient equal to -0.702. Crime rate shows a higher probability of being in the distrust group, from a unit increase in crime per 1,000 habitants. The marginal effects are 0.162, -.054, and -0.107 for levels of trust 0,1, and 2 respectively (Table 7). All these coefficients are significant at a 5% level. From the marginal effects it can be seen that the group with highest variation is the distrust group, followed by the high trust group. Thus a unitary increment in the homicide rate increases the probability of belonging to the distrust group by 16.2%, with this increment balanced principally by a decrease in the probability of belonging to the high trust group in 10.7%.

TABLE 6: Ordered logit estimated coefficients for generalised trust, unrestricted and restricted models

	Unrestricted	Restricted: Social gap	Restricted: Crime
Intermediate social gap	−0.382 * **	−0.350 * *	
	(0.137)	(0.136)	
High social gap	0.536 * **	0.551 * **	
	(0.175)	(0.174)	
Crime	−0.702 * *		−0.595 * *
	(0.307)		(0.302)
Social capital	0.170*	0.173*	0.155*
	(0.090)	(0.090)	(0.090)
Age	−0.017	−0.016	−0.017
	(0.011)	(0.011)	(0.011)
Age squared	0.000 * *	0.000 * *	0.000 * *
	(0.000)	(0.000)	(0.000)
Education	0.007	0.008	0.003
	(0.027)	(0.027)	(0.027)
Education squared	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Gender	−0.116	−0.112	−0.113
	(0.074)	(0.074)	(0.074)
Discrimination	−0.153 * *	−0.158 * *	−0.158 * *
	(0.076)	(0.075)	(0.076)
Indigenous	−0.284*	−0.279*	−0.109
	(0.167)	(0.167)	(0.159)
Health services	0.084	0.087	0.079
	(0.086)	(0.086)	(0.086)
Subsidies	−0.035	−0.027	0.02
	(0.108)	(0.108)	(0.106)
North	0.376 * **	0.321 * **	0.367 * **
	(0.086)	(0.082)	(0.086)
South	0.337 * **	0.321 * **	0.348 * **
	(0.090)	(0.090)	(0.086)
Year 2011	0.459 * **	0.445 * **	0.458 * **
	(0.083)	(0.082)	(0.082)
Cut 1	0.653 * *	0.708 * *	0.639 * *
	(0.304)	(0.303)	(0.302)
Cut 2	1.536 * **	1.591 * **	1.518 * **
	(0.303)	(0.302)	(0.301)
Observations	4585	4585	4585
Pseudo-R^2	0.0185	0.018	0.0151
AIC	38103.387	38122.015	38236.521
BIC	1.747E+08	1.748E+08	1.753E+08

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

Higher homicides rates increase the subjective probability of a negative outcome rising from interacting with other members of society. As violence and crime have a direct effect on insecurity perception, it is easy to observe that the rate of homicides in the municipality in which individuals live should have a high impact on their levels of trust.

TABLE 7: Marginal effects at means for Generalised Trust: Unrestricted model

Marginal effects $\binom{\beta}{(se)}$	$Pr(Trust = 0)$	$Pr(Trust = 1)$	$Pr(Trust = 2)$
Intermediate social gap	0.082***	−0.031***	−0.051***
	(0.028)	(0.011)	(0.017)
High social gap	−0.130***	0.035***	0.095***
	(0.043)	(0.009)	(0.035)
Crime	0.162 **	−0.054 **	−0.107 **
	(0.071)	(0.024)	(0.047)
Social capital	−0.039*	0.013*	0.026*
	(0.021)	(0.007)	(0.014)
Age	−0.001	0.000	0.000
	(0.001)	(0.000)	(0.000)
Education	−0.001	0.000	0.001
	(0.002)	(0.001)	(0.001)
Gender	0.027	−0.009	−0.018
	(0.017)	(0.006)	(0.011)
Discrimination	0.035 **	−0.012 **	−0.023 **
	(0.017)	(0.006)	(0.011)
Indigenous	0.063*	−0.023*	−0.040*
	(0.035)	(0.014)	(0.022)
Health services	−0.019	0.007	0.013
	(0.020)	(0.007)	(0.013)
Subsidies	0.008	−0.003	−0.005
	(0.025)	(0.008)	(0.016)
North	−0.088***	0.028***	0.060***
	(0.020)	(0.006)	(0.014)
South	−0.079***	0.025***	0.055***
	(0.022)	(0.007)	(0.015)
Year 2011	−0.105***	0.035***	0.069***
	(0.018)	(0.007)	(0.012)
Observations	4585		
Pseudo-R^2	0.0185		
AIC	38103.387		
BIC	1.747e+08		

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

Control variables

The measure of social capital employed, number of voluntary memberships, has a positive and significant statistical association with the level of trust. The probable channel through which this effect is transmitted is social cohesion and bonding. The intuition is that the higher the social capital the greater the interaction, integration, and

bonding individuals experience. These in turn result in higher levels of trust towards other individuals.

A unitary increase in social capital, *ceteris paribus*, is associated on average with an increase in 2.6% on the probability of belonging to the most trusting group, a 1.3% increment in the chances of reporting intermediate levels of trust, and decreases the probability of reporting distrust in 3.9%. Compared with the effects of social gap and crime the magnitude of the estimates are less prominent.[19] Social capital holds an important association with trust, even more so if one considers that this is related to voluntary participation in one additional organisation, which one can expect to produce additional benefits as well.

Regarding the variables that identify the effect of discriminatory experiences, and being part of the indigenous population, both are statistically significant and with the expected negative results. Experiencing discriminatory treatment increases the chances of a negative outcome emerging from interactions with others, negatively affecting trust. The estimated contributions to the predicted probabilities for the dichotomous variable discrimination indicate that there is a 3.5% higher probability of being distrustful for individuals reporting discriminatory experiences. The contribution to the probability of being in the intermediate and the more trusting groups are -1.2% and -2.3% respectively. This is expected if individuals that are subject to discriminatory treatment react with distrust in general.

The marginal effects at means for the indigenous indicator is 0.063 for the lowest trust value, and -0.023 and -0.04 for intermediate and high levels of trust respectively. Indigenous populations have experienced historical segregation and discrimination in Mexico, thus it was expected the coefficient for this variable to be negative. The size of the sub-sample that reports being speaker of an indigenous language are 239 and 190 for the 2006 and 2011 waves respectively, the average trust reported by this group is 0.531 and 0.626 for each wave (almost an 18% increase from wave to wave), while the group that reports not to speak any indigenous language has a mean trust of 0.462 for the 2006 wave and 0.752 for the 2011 wave (a 62% increase between waves). This marked difference in increases may be contributing to the negative sign of the coefficient along with historical discrimination, and could potentially be the one factor driving the effect.

Variables capturing age, education, gender (female), as well as health services and subsides were not statistically significant. Additional specifications including squared

[19] One has to take into account the upper bound in the possible number of memberships though. As it is highly unlikely that belonging to tens of organisations may render high returns in terms of social capital and its benefits.

values of age and education were also not statistically significant and did not affect the results of the model presented. The signs of the coefficients, if significant, would suggest a positive effect of age and education on generalised trust, although the former is not supported by other results in the literature (see Alesina and La Ferrara (2002). The signs of the other coefficients agree with the hypothesis previously presented and with findings elsewhere, nevertheless the lack of statistical support do not allow the results to be interpretable.

Subjects whose place of residence is located in the north of the country report higher levels of trust relative to residents of the south, and the latter with respect to residents of the centre of the country. This result may be produced by cultural differences that prevail across the country. Mexico is a very diverse country, with marked differences between the three regions considered here. The north reports the lowest poverty rates, followed by the centre, and the south behind. Ethnic composition is also distinct, with the higher concentration of indigenous populations located in the south, followed by the centre. Later on separate equations will be considered for each region to further explore these differences.

The variable indicating a time varying component is also significant and of positive value. This result indicates a positive effect not captured by any of the controls or the explanatory variables of interest. As previously mentioned, this variable was included to take into account a time varying trend in the level of trust, although its coefficient might be capturing the effect of omitted variables in the model. The level of trust can change across time for different reasons, the premise here is that a reaction response to the extreme violence environment prevalent within the years in which the two survey waves took place may be playing a role which is not entirely captured by homicide rates. However, the higher levels of trust and trust in public institutions reported for year 2011, as can be seen in Table 19, indicate all levels of trust, except for trust in the church which decreased from 8.025 to 7.73, increased from the 2006 to the 2011 survey. The hypothesis that crime has a negative effect on trust, together with the observed increase in reported trust, suggests other factors, not present in the model, are pushing trust upwards, and is worth of further exploration.

Regional and year effects

It has been argued before that significant differences are present across regions in Mexico, in fact the motivation to introduce regional indicators in the estimation models was to test these regional differences. Also, it was noticed (see Figure 4 above and Table 22 in the Appendix) that a sharp increase in crime happened between the years the two

surveys where carried out. Results presented in Tables 6 and 7 show regional and sample year coefficients are highly significant and among those of considerable magnitude. This results suggest these variables are important in the estimated models, and there could be further interesting effects, in particular with respect to the two correlates of interest. To examine this possibility parsimonious estimation of the models was implemented. The results are shown in Table 8 for the unrestricted model, results for the restricted models are pretty similar thus the analysis concentrates on the unrestricted model. Results for the restricted models can be seen in Tables 26 and 27 of the Appendix of this chapter.[20]

As can be seen in Table 8, the statistical significance of the variable social gap remains stable across the different specifications. For the middle levels of social gap there is a decrease in the significance for models 2 to 3 and then a recovery for model 4. High values of social gap remain significant at a 1% level for all estimated models. The estimated parameters preserve their sign and their magnitude remains within a considerable range for intermediate levels of social gap, and present more variation for its higher levels. Although the coefficients are not directly interpretable, the variations in the size of the coefficients suggest some interaction among covariates may be present.

The coefficient of crime tells a different story, it remains not significant for all estimated models except for the last specification, which adds the year of sample indicator. To examine further for regional and year of sample differences an additional set of models were estimated separately for each region and for each of the surveys. Table 9 shows the results of the estimations. Columns 1 to 3 show the results for the North, South, and Centre regions, while columns 4 and 5 contain the estimations for the years 2006 and 2011 respectively.

These results confirm the relation between crime and trust differs across regions, and suggests other interesting differences with respect to other covariates. The coefficient of variable crime is significant for the North and South regions, but not for the Centre. The magnitude of the coefficients suggest the negative effect of crime on trust was more marked in the South. Additionally, the coefficient of age and its squared value become significant for the Centre, suggesting a negative relationship, at a decreasing rate, with trust. The coefficient for gender turns significant, with a negative sign, for the South, which indicates females reports lower levels of trust relative to males in this region.

[20] All models where estimated introducing one variable at a time. To save space, the tables present only the models that show the most relevant results, but the results remain practically the same for all omitted specifications.

TABLE 8: Parsimonious estimation of ordered logit for generalised trust
Whole sample

	Model 1	Model 2	Model 3	Model 4
Intermediate social gap	−0.351***	−0.258*	−0.316**	−0.382***
	(0.129)	(0.134)	(0.136)	(0.137)
High social gap	0.425***	0.671***	0.613***	0.536***
	(0.153)	(0.170)	(0.175)	(0.175)
Crime	0.203	0.145	−0.451	−0.702**
	(0.290)	(0.297)	(0.311)	(0.307)
Social capital		0.098	0.090	0.170*
		(0.087)	(0.088)	(0.090)
Age		−0.013	−0.013	−0.017
		(0.011)	(0.011)	(0.011)
Age squared		0.000*	0.000*	0.000**
		(0.000)	(0.000)	(0.000)
Education		0.025	0.026	0.007
		(0.027)	(0.027)	(0.027)
Education squared		−0.001	−0.001	0.000
		(0.001)	(0.001)	(0.001)
Gender		−0.115	−0.118	−0.116
		(0.074)	(0.074)	(0.074)
Discrimination		−0.228***	−0.209***	−0.153**
		(0.075)	(0.075)	(0.076)
Indigenous		−0.309*	−0.380**	−0.284*
		(0.169)	(0.169)	(0.167)
Health services		0.240***	0.195**	0.084
		(0.082)	(0.084)	(0.086)
Subsidies		0.031	0.018	−0.035
		(0.107)	(0.108)	(0.108)
North			0.364***	0.376***
			(0.086)	(0.086)
South			0.323***	0.337***
			(0.091)	(0.090)
Year 2011				0.459***
				(0.083)
Cut 1	0.512***	0.520*	0.617**	0.653**
	(0.052)	(0.298)	(0.302)	(0.304)
Cut 2	1.375***	1.392***	1.493***	1.536***
	(0.058)	(0.297)	(0.301)	(0.303)
Observations	4585	4585	4585	4585
Pseudo-R^2	0.0028	0.0094	0.0129	0.0185
BIC (E+08)	1.775	1.763	1.757	1.747
AIC	38711.871	38458.065	38322.973	38103.387

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

Discrimination has a negative impact on trust in the South and Centre, while being of indigenous origin shows a negative and significant effect only in the North of Mexico. These are interesting results as most of the indigenous populations are located in the South and Centre of the country. Together the results suggest that discrimination affects trust more in the South precisely because the poorest and some of the most discriminated groups are concentrated in that region. Regarding the coefficient of the indigenous indicator, this group is less representative in the North and negative experiences may presumably be more frequent for them there in comparison to the

TABLE 9: Ordered logit estimates for crime by region and year of survey

	North	South	Centre	2006	2011
Crime	-0.976**	-1.556***	1.378	-2.028***	-0.426
	(0.390)	(0.553)	(1.328)	(0.747)	(0.342)
Social capital	0.114	0.161	0.171	0.205*	0.084
	(0.165)	(0.128)	(0.138)	(0.112)	(0.145)
Age	-0.001	0.000	-0.031*	-0.028	-0.003
	(0.017)	(0.019)	(0.018)	(0.017)	(0.015)
Age squared	0.000	0.000	0.000**	0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	-0.072	0.026	0.026	0.037	-0.050
	(0.050)	(0.046)	(0.042)	(0.039)	(0.038)
Education squared	0.003	-0.001	-0.001	-0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Gender	0.016	-0.213*	-0.162	-0.181	-0.081
	(0.114)	(0.128)	(0.119)	(0.121)	(0.095)
Discrimination	-0.013	-0.216*	-0.225*	-0.084	-0.266***
	(0.119)	(0.129)	(0.122)	(0.121)	(0.100)
Indigenous	-1.158**	0.246	-0.143	0.441**	-0.602**
	(0.500)	(0.202)	(0.322)	(0.221)	(0.247)
Health services	0.272*	-0.223	0.128	-0.026	0.234**
	(0.151)	(0.137)	(0.129)	(0.126)	(0.118)
Subsidies	-0.529**	0.309**	0.036	0.019	0.002
	(0.213)	(0.155)	(0.180)	(0.175)	(0.140)
Year 2011	0.790***	1.153***	0.128		
	(0.139)	(0.133)	(0.128)		
North				0.147	0.553***
				(0.140)	(0.112)
South				-0.296**	0.803***
				(0.140)	(0.116)
Cut 1	0.499	0.905*	0.422	0.366	0.324
	(0.490)	(0.491)	(0.478)	(0.476)	(0.408)
Cut 2	1.674***	1.762***	1.172**	1.016**	1.392***
	(0.495)	(0.496)	(0.474)	(0.473)	(0.407)
Observations	1428	1570	1587	2113	2472
Pseudo-R^2	0.0252	0.0082	0.0442	0.0096	0.0204
BIC (E+07)	5.01	3.19	9.10	7.30	9.99
AIC	35089.959	20310.215	57361.699	34572.524	40399.078

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), DGIS (2015), CNS (2015).

other two regions where they are more representative. Health services is significant and positive only in the North, while subsidies are significant in the North and South, showing a positive effect in the former and a negative one in the latter.

The estimations by survey year render a negative coefficient for crime in both cases, but the coefficient is significant only for the year 2006. Another noticeable result are the coefficients for the variable indigenous which is statistically significant for both years, and changes sign from positive for 2006 to negative in 2011. There is no clear explanation for this switch given the available data. Dividing the sample by year of survey weakens the power to disentangle existent relationships between trust and the explanatory variables. This may be because a large part of the variation in homicide rates comes from changes across time, rather that differences in crime in cross-section.

3.6.1 Estimation issues

Estimation of ordered choice models are not free of problems. Greene and Hensher (2010, p. 128) name four common and important problems that arise in addition to issues with the parallel lines assumption. These problems are the existence of omitted variables in the specification (or latent heterogeneity), heteroscedastic error terms, wrong choice of model in terms of the assumed distribution, and endogeneity in the explanatory variables. The assumption on parallel lines is addressed in Section 3.9. Issues related to heterogeneity derived from the error term are not dealt with as improvements in this line tend to generate limited benefits in terms of providing better estimates (Greene et al., 2014, p. 113). As stated before, distributional assumptions are not addressed in full as estimates do not vary much when choosing one alternative over the other (Greene (2008, p. 832), and Long (2015)). Concerns about endogeneity focus on the variable crime, as social gap, is not considered to present reverse causality issues, and it is not clear how trust can cause social deprivation at an individual level.

As stated before, trust is assumed to be affected by the levels of crime present in the environment where individuals reside, with higher levels of crime inducing more uncertain interaction outcomes. Nonetheless, it can also be the case that the level of trust(distrust) leads individuals to be less(more) willing to participate in criminal activities, or to facilitate illegal activities when reinforcing intra-group relationships. Lederman et al. (2002) suggest that trust can have a positive relation with crime when it is related to intra-group effects, and negatively related to crime when it refers to the presence of the asset in society as a whole. A summary of arguments that justify a relationship between trust and crime from the point of view of criminology is offered in Rosenfeld et al. (2001). The authors explain how *disorganisation in society*, which can

be linked to civic engagement and trust, can help crime to emerge; they also elaborate on the ways *anomie*[21] presumably favours crime and holds a negative relation with trust. The authors also mention *strain*, which accounts for the effect that the absence of resources (human and physical capital for example) has on crime, considering social capital as a resource, a negative relation between the stock of social capital and crime rates emerges. All these arguments suggest a causal effect of trust on crime, which brings up the importance of corroborating the existence of a reverse causality effect.

Inconsistency of parameters due to endogeneity problems are approached implementing instrumental variables (IV) methods. Two procedures are considered to introduce the use of IV in the estimation strategy, these are *two stage predictor substitution (2SPS)* and *two stage residual inclusion (2SRI)*. As noted by Terza et al. (2008) these two techniques are commonly used in the literature implementing non-linear models as estimation strategy. The authors compare consistency in estimates computed with these two methodologies when implementing instrumental variables in non-linear models. Their results indicate that *2SRI* renders consistent estimates while *2SPS* does not, leading them to favour the former over the latter.[22] For the present analysis both methodologies are used to estimate the empirical model of trust, and the results are compared as a robustness check.

Population size is proposed to instrument crime. The assumption imposed is that if trust and population size are associated, the effect derives from mediation of crime but not by direct relationship. In this regard, Chamlin and Cochran (2004) mention three channels through which population size affects the incidence of crime: the social control perspective (larger populations make more difficult to effect social control); the structuralist perspective (population size promotes the number of interactions, some of which may involve situations related to crime); and the subcultural perspective (larger populations spur the emergence of "deviant subcultures").

Studies that find associations between crime and measures of population size, density, and urbanisations suggest population size may be a good candidate to instrument for homicide rates. In a highly cited paper, Glaeser and Sacerdote (1999) investigate why crime rates tend to be higher in large cities. The authors present statistics that show that crimes of violent nature are considerably different for cities of varied size in the United States. They proceed by decomposing effects to identify channels through which

[21] Defined as "social instability resulting from a breakdown of standards and values" in Anomie (2015)

[22] The authors replicate a previous study and also use simulated data to reach these results. The non-linear models studied by them include an ordinal logit model, and a exponential regression model.

cities relate to crime.[23] Their analysis leads them to conclude that roughly between 21% and 54% of the relation between city size and crime is produced by economic returns to crime and the probability of capture and punishment. They also find that attraction and/or production effects can be in place for individuals with higher tendency to become criminals, which account for about 30% of the effect.

Among other works that study the relation between population size and crime, evidence tends to be conclusive regarding the existence of an association between these two variables. Results for Latin American countries by Gaviria and Pagés (2002), using data from Latinobarometro, indicate that the size of cities and victimisation are positively related, even when controlling for a set of correlates, their most relevant result indicates that household characteristics do account for a small part of the effect of city size on victimisation. This relation is also found between population growth and victimisation. Results for cross-country studies show mixed results in the literature, for example Fajnzylber et al. (2002) find no statistical relation between crime and urbanisation in a cross-country study; but evidence found by Blake (2014) for a similar number of countries indicates a positive effect of urbanisation on homicide rates. Investigating covariates of crime rates for the USA, Chamlin and Cochran (2004) find a positive association between population size, violent crimes and property crimes. Murder rates are found to have an association with population size in metropolitan areas of the USA. This last result emerges as a by-product of an investigation on urban inequality by Glaeser et al. (2008). Again using data for the United States Brush (2007) researches the effect of income inequality of crime rates, finding that population growth has a negative association with growth in crime rates, while population density has an effect on crime levels.

In an analysis by Scorzafave and Soares (2009) for the São Paulo State in Brazil, the authors find that population density has a positive effect on pecuniary crimes when investigating the relation between income inequality and crimes that generate a monetary gain. Cotte Poveda (2012) analyses crime and violence in 7 Colombian cities using data that ranges from 1984 to 2006. Using generalised method of moments for a dynamic panel, and instrumenting to control for unobservable variables, the author finds that population size has a positive and highly significant relation with homicides. Additional evidence on the effect of population size on homicides rates is offered by Menezes et al. (2013). Exploiting neighbourhood data for a large Brazilian city, the authors find that lagged values of population size have a positive and significant effect on homicide rates.

[23] Categories are named as: "higher pecuniary returns to crime in urban areas", "lower probability of arrest in urban areas", and "urban areas' attraction (or creation) of crime-prone individuals." They make use of data from the National Crime Victimization Survey, the National Longitudinal Survey of Youth, and the Uniform Crime Reports for the USA.

Evidence of associations between trust and population size is not conclusive. As mentioned in Section 3.3, results by Galea et al. (2002) for the USA do not allow for causality to be determined between these two variables. La Porta et al. (1997) argue that in large organisations, trust must be more prominent given the smaller probability of repeated encounters, and thus the smaller chance of reciprocity or retaliation. Their findings show a positive relation between trust and participation of large organisations in national GDP. Using data from the third wave of the World Values Survey, Uslaner (2004) finds that the effects of the size of the community in which individuals live has distinct effects on generalised trust depending on the set of countries for which the effects are estimated. When the author uses data for countries located in Central and Eastern Europe estimates indicate higher levels of trust in big cities, while the opposite is found for Western countries. Nevertheless, this seems to be an indirect effect caused by population heterogeneity, more prominent in larger cities, affecting generalised trust and not by the size of the population per se (Uslaner, 2004, p. 91).

Perhaps the only work that explicitly studies the relationship between trust and size of population in a theoretical framework is Bidner and Francois (2011). The authors develop a model that states an association between trust and institutions' functionality. In their model, returns of functional institutions are more prominent when populations are larger, this in turn spurs a positive relation between trust and population size. In their model, bigger countries are able to reach better institutions, and institutions become functional at a lower quality level as honesty levels are higher. These results lead the authors to conclude that a relationship must exist between trust and country size, but not necessary between the latter and institutional quality in the steady state. When testing their model using cross-country data on generalised trust and other variables from five waves of the WVS and other sources, they find that correlation between trust and population size (natural logarithm of country population) is statistically significant only when including other explanatory variables such as GDP per capita. The work also investigates associations of trust and country population size controlling for different measures of institutional quality, first using an international property rights index, and then the three components of the index: physical property rights, legal and political environment, and intellectual property rights. Their findings indicate a statistically significant correlation emerging between trust and population size. However, these associations do not necessarily emerge from a statistical relation among the variables of interest, but from collinearity between population size and other covariates present in the model, as the lack of statistical significance in the univariate model presumes.

This review of the literature and arguments presented justify the use of population size as instrument for homicide rates. Although some suspicion may arise regarding a relation between trust and population size, it is considered rather weakly grounded.

The polychoric correlation between trust and population size (in natural logarithms) conditional on homicide rates being zero is -.040, which is sufficiently low to deem both variables as uncorrelated. Furthermore, as Bidner and Francois (2011) state "there are no a priori grounds to expect population size to exert a positive influence on trust, no grounds for expecting trust to... affect population size,..., and no theories we are aware of other than the one we have presented which would predict a positive relationship, either conditional upon institutions or unconditionally."

3.6.2 IV estimators

Table 10 shows the first stage estimation of the variable crime on the instrument population size (in natural logarithms), and the remaining variables, which are assumed to be exogenous. The coefficient of the instrument is negative and highly significant. To check if population size is a weak instrument the criteria suggested by Staiger and Stock (1997) is used. This involves a rule of thumb where an instrument is declared as weak if the F statistic from the first stage estimations is less than 10. As can be seen in Table 10 the computed value for F is significantly larger than the value of reference with the exception of the Centre.[24] The rest of the analysis focuses on whole sample estimations, the results for all estimations are presented in Table 28 of the Appendix.[25]

Second stage results are shown in Table 11. The first column shows the estimated equations for the original ordered logit model, while the second and third columns present the 2SRI and 2SPS respectively. These results suggest the association between generalised trust and crime is not spurious. Comparing the three models, the coefficients for both 2SRI and 2SPS are practically the same, showing a marked difference with those reported by the ordered logit estimates for social gap (both intermediate and high), crime, and social capital, and do not differ much from the ordered logit estimates for the rest of the explanatory variables. In terms of goodness of fit, both BIC and AIC criteria favour the 2SRI model, and the ordered logit estimation over the 2SPS, thus the remaining of the instrumental analysis focuses on the 2SRI estimates and how they compare to the orderd logit model. This reflects results found by Terza et al. (2008), which indicate that 2SRI estimations are less inconsistent.

Table 12 shows the marginal effects at means for the 2SRI model. The coefficients for crime and crime residuals are both significant at a 0.10 level, a decrease in significance from the original model for the variable crime, which preserves the negative association

[24] Exogeneity of instruments could not be tested given that the model is exactly identified.

[25] The analysis concentrates on the whole sample for reasons of space. The results do not vary significantly if one restricts the analysis to each region. Additionally, the rule of thumb suggests the instrument is weak for the South lowering the relevance of the results for that region.

TABLE 10: First stage OLS Estimates for homicides rates: whole sample and by regions

	All	North	Centre	South
Population size (ln)	0.009***	0.028***	0.015***	-0.002
	(0.001)	(0.003)	(0.003)	(0.001)
Intermediate social gap	-0.039***	-0.134***	-0.001	-0.045***
	(0.003)	(0.006)	(0.005)	(0.003)
High social gap	-0.013***	0.000	-0.002	-0.005
	(0.004)	(0.000)	(0.005)	(0.005)
Social capital	-0.006**	-0.009	-0.007**	0.000
	(0.002)	(0.007)	(0.003)	(0.002)
Age	0.000	-0.001	-0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.000)
Age squared	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Education	-0.002**	-0.005*	0.000	0.000
	(0.001)	(0.003)	(0.001)	(0.001)
Education squared	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Gender	-0.007**	-0.007	-0.002	-0.005**
	(0.003)	(0.007)	(0.005)	(0.002)
Discrimination	0.002	-0.002	0.030***	0.000
	(0.003)	(0.007)	(0.005)	(0.002)
Indigenous	-0.007*	0.027	-0.013**	-0.002
	(0.004)	(0.027)	(0.005)	(0.005)
Health services	0.006**	0.002	-0.020***	-0.002
	(0.003)	(0.008)	(0.005)	(0.002)
Subsidies	-0.006*	-0.009	-0.005	-0.003
	(0.003)	(0.012)	(0.004)	(0.003)
Year 2011	0.019***	0.061***	0.018***	-0.003
	(0.003)	(0.007)	(0.005)	(0.002)
Constant	-0.009	-0.179***	-0.094**	0.088***
	(0.018)	(0.049)	(0.038)	(0.015)
Observations	4585	1428	1570	1587
R-squared	0.0644	0.1451	0.1033	0.0951
Adjusted R-squared	0.062	0.137	0.095	0.087
BIC	−9376.874	−1907.557	−3202.69	−5915.192
AIC	-9473.332	-1981.253	-3283.072	−5995.736
Df	14	13	14	14
F-value	35.13	110.72	6.12	137.27

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are shown in parenthesis. Variables included are population size of municipalities and distance from the municipality to the border with the USA, both variables are in logarithmic values. Also included are exogenous variables from the ordered logit model for generalised trust. Regional indicators are not included as they will be collinear with the instruments. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

with trust. Compared to the ordered logit estimates (Table 7), the 2SRI coefficients for crime vary considerably. The marginal effects are 1.489 for the distrust value, -0.504 for the intermediate value of trust, and -0.985 for high trust, which indicate the order of effects is preserved in terms of absolute magnitude. Notice that these variations are close to a 9 fold increase from the value reported by the ordered logit estimates. Increases in the magnitude of the coefficients of instrumented variables are not rare as observed in Wooldridge (2013, pp. 523-525). However, the marked increase in the crime coefficient suggests caution should be taken when interpreting size of the marginal effects.

TABLE 11: Second stage estimates for trust, 2SRI and 2SPS instrumenting for crime (Whole sample)

	O logit	2SRI	2SPS
Intermediate social gap	-0.382***	-0.670***	-0.675***
	(0.137)	(0.219)	(0.219)
High social gap	0.536***	0.368*	0.361*
	(0.175)	(0.198)	(0.198)
Crime	-0.702**	-6.480*	
	(0.307)	(3.526)	
Crime residuals		5.882*	
		(3.557)	
Crime predictor			-6.543*
			(3.518)
Social capital	0.170*	0.135	0.134
	(0.090)	(0.094)	(0.093)
Age	-0.017	-0.018	-0.018
	(0.011)	(0.011)	(0.011)
Age squared	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Education	0.007	-0.003	-0.003
	(0.027)	(0.028)	(0.028)
Education squared	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Gender	-0.116	-0.150*	-0.150*
	(0.074)	(0.078)	(0.078)
Discrimination	-0.153**	-0.147*	-0.151**
	(0.076)	(0.076)	(0.075)
Indigenous	-0.284*	-0.320*	-0.320*
	(0.167)	(0.170)	(0.170)
Health services	0.084	0.12	0.127
	(0.086)	(0.089)	(0.089)
Subsidies	-0.035	-0.092	-0.091
	(0.108)	(0.112)	(0.112)
North	0.376***	0.367***	0.321***
	(0.086)	(0.086)	(0.082)
South	0.337***	0.317***	0.302***
	(0.090)	(0.091)	(0.090)
Year 2011	0.459***	0.553***	0.552***
	(0.083)	(0.100)	(0.100)
Cut 1	0.653**	0.067	0.047
	(0.304)	(0.464)	(0.463)
Cut 2	1.536***	0.951**	0.931**
	(0.303)	(0.463)	(0.462)
Observations	4585	4585	4585
Pseudo-R^2	0.0185	0.0186	0.0181
BIC	1.747E+08	1.746E+08	1.747E+08
AIC	38103.387	38098.354	38121.109

Note: 2SRI = 2 stage residual inclusion, 2SPS = 2 stage predictor substitution. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are shown in parenthesis. Variables included are population size of municipalities and distance from the municipality to the border with the USA, both variables are at levels, as instruments. Also included are exogenous variables from the ordered logit model for generalised trust. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

Variations for social gap are also important. They range between 38.6 and 42.6% for intermediate levels, and for high social gap between 40 and 50.8%. However, the direction of the effects also hold for the 2SRI model, that is, the high social gap group reports higher levels of trust than the intermediate and the low social gap counterparts. The new estimates for social capital, and gender are also noticeable. Social capital loses its statistical significance as a predictor of trust in the 2SRI model, considering that

TABLE 12: Marginal effects at means for 2SRI model: Unrestricted model

Marginal effects $\binom{\beta}{(se)}$	$Pr(Trust = 0)$	$Pr(Trust = 1)$	$Pr(Trust = 2)$
Intermediate social gap	0.137***	−0.054***	−0.083***
	(0.040)	(0.017)	(0.022)
High social gap	−0.089*	0.025 * *	0.063*
	(0.049)	(0.012)	(0.037)
Crime	1.489*	−0.504*	−0.985*
	(0.807)	(0.277)	(0.532)
Crime residuals	−1.351*	0.457	0.894*
	(0.815)	(0.279)	(0.537)
Social capital	−0.031	0.011	0.021
	(0.022)	(0.007)	(0.014)
Age	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)
Education	0.000	0.000	0.000
	(0.002)	(0.001)	(0.001)
Gender	0.034*	−0.012*	−0.023*
	(0.018)	(0.006)	(0.012)
Discrimination	0.034*	−0.011*	−0.022*
	(0.017)	(0.006)	(0.011)
Indigenous	0.070 * *	−0.026*	−0.045 * *
	(0.035)	(0.014)	(0.021)
Health services	−0.027	0.009	0.018
	(0.020)	(0.007)	(0.013)
Subsidies	0.021	−0.007	−0.014
	(0.025)	(0.009)	(0.016)
North	−0.086***	0.027***	0.059***
	(0.020)	(0.006)	(0.014)
South	−0.075***	0.023***	0.051***
	(0.022)	(0.007)	(0.015)
Year 2011	−0.126***	0.043***	0.083***
	(0.022)	(0.008)	(0.014)
Observations	4585	BIC	1.746E+08
Pseudo-R^2	0.0186	AIC	38098.354

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Marginal effects for factor levels is the discrete change from the base level, computed at covariates mean values, and show the effect of discrete changes in dichotomous indicator variables. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

the significance in the original model was at a 10% level this wakens its explanatory power over trust. The gender coefficient is now statistically significant, although only at a 0.1 level, preserving the direction of the effect and increasing its size between 20.58 and 25%. The coefficient indicates that females report lower levels of trust, and that being female, other things constant, increases the probability of reporting being distrustful in 3.4%. The rest of the coefficients remain relatively stable in comparison

to the original model estimated. The coefficients for discrimination, indigenous, and the regional and year indicators preserve their significance level, except for the marginal effect on intermediate trust values of the indigenous indicator.

Overall, the results obtained via implementation of instruments are instructive in terms of helping distinguish the true statistical significance of the association between crime and trust. In general, the results for the majority of the coefficients are preserved with respect to the ordered logit model, in particular for the main explanatory variables. Nevertheless, considerable increases in marginal effects magnitude call for caution.

3.7 Asymmetries between trust and distrust

The results from the estimation of the trust models are contradictory regarding gender effects on trust outcomes. While gender lacked statistical significance in the orderd logit estimations, it presents as significant in both 2SRI and 2SPS models. The results of the ordered logit model also contradict findings by other authors (see the section about discrimination in Section 3.3), that show evidence of lower levels of trust among female subjects. To study this discrepancy further, a new pair of dichotomous variables are constructed from the WVS question on trust. In one of them the lower bound of the responses is set to one, with the other two possible values captured as zero, this variable aims at measuring distrust, rather than trust, reported by the subjects. The inverse is done to get a new measure of trust as a binary response, assigning a value of one to the upper bound of the response, while the other two lower values are set equal to zero. The estimation results obtained from the logit model fitted with these new pair of variables suggest the presence of asymmetries in the level of trust and distrust reported by the subjects not only for gender, but for other explanatory variables as well.

The results for the estimated logit model are shown in Table 13, where the coefficients presented are the odds ratios. Notice that the odds ratios coefficients are very similar for all models, thus the interpretation and discussion concentrate on the unrestricted model. As can be seen from the table, the coefficient for social gap is statistically significant at a 1% level for intermediate values, and at a 5% for high values of social gap in the distrust model, while for the trust model it is only significant for high levels of social gap at a 1% level in. The odds ratios are consistent with the direction off the effects found in the previous ordered logit estimations.[26] These results indicate

[26]The interpretation of the odds ratios is the following. An odds value of 1 indicates that both values of the dependant variable are at equal odds of happening. If the value of the odds ratio is less than 1 then a unitary variation in the corresponding variable decreases the odds of characteristic been present. If the odds ratio is higher than 1, then an increase in the value of the explanatory variable increases the likelihood of the characteristic being present. As the analysis of the effects has already

individuals in the group with highest levels of social gap are less likely to report being distrusting in comparison to other subjects in the sample, with those in the intermediate level of social gap being the ones that are more likely to report distrust. For the trust model, the group with high social gap are more likely to report trusting behaviour than the group of reference (low social gap), this result at a 1% significance level.

For the variable crime, the estimates are statistically significant only for the trust model at a 1% level. The value of the odds ratio in the trust model also agrees with the direction of the coefficients in the hypothesis presented and found for the ordered logit estimates. The results indicate higher crime lowers the probability of individuals reporting trust towards other subjects. This findings suggest that, for this sample, crime is affecting the odds of those that report trusting others, and is not associated with reporting distrust. Said in another way, experiencing higher levels of crime can be associated with decreasing the probabilities of individuals reporting trusting attitudes, but not for those reporting distrusting ones.

A similar result is found for social capital, gender and discrimination. While the odds ratio for social capital is significant only for the trust model, gender and discrimination have coefficients that show statistical significance only for the distrust model. Social capital increases the odds of reporting being trusting, while gender and discrimination are associated with higher odds of reporting distrust behaviour. The coefficient for the variable age is significant at a 5% level, however, the size of the odds ratio indicates equal probability of the variable contributing to either outcome of the dependant variable.

With respect to the regional and year of wave indicators, the results for North show the odds ratios are significant for the trust and the distrust model, and both values are consistent. Living in the North of the country increases the odds of reporting trust by 1.24 while decreasing the odds of reporting being distrustful by 0.642. The coefficient for the variable South is only significant for the distrust model, with a negative effect that changes the odds of reporting distrust by 0.677. Concerning the year indicator, the odds ratios are significant for both models, at a 10% level for the trust model, and at a 1% for the distrust one. The odds are bigger than 1 for the former and lower than 1 for the latter, suggesting that in the second wave individuals show to be more trusting, and less likely to be distrusting. Finally, the coefficients for education, indigenous, and health services are not statistically significant in either model.

In summary, the binary models for trust and distrust agree to a large extent with those encountered in the ordered logit estimations. An interesting addition to the

been carried out for the ordered logit estimates, unless the results contradict previous results in this chapter, this analysis in no longer developed here, and the discussion focuses on the level of agreement with previous results.

TABLE 13: Logit odds ratios. Results for unrestricted, restricted model for social gap, and restricted model for crime

	Unrestricted		Restricted: Social gap		Restricted: Crime	
	Trust	Distrust	Trust	Distrust	Trust	Distrust
Intermediate social gap	0.812	1.538***	0.875	1.514***		
	(0.128)	(0.209)	(0.137)	(0.204)		
High social gap	2.344***	0.707**	2.418***	0.702**		
	(0.412)	(0.118)	(0.425)	(0.117)		
Crime	0.140***	1.438			0.151***	1.253
	(0.071)	(0.522)			(0.074)	(0.451)
Social capital	1.287**	0.88	1.295***	0.879	1.260**	0.889
	(0.130)	(0.081)	(0.130)	(0.081)	(0.126)	(0.082)
Age	1.004	1.024**	1.005	1.024*	1.004	1.024**
	(0.014)	(0.013)	(0.014)	(0.013)	(0.014)	(0.013)
Age squared	1.000	1.000**	1.000	1.000**	1.000	1.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	1.026	0.997	1.029	0.996	1.017	0.999
	(0.033)	(0.028)	(0.033)	(0.028)	(0.032)	(0.028)
Education squared	0.999	1.000	0.999	1.000	0.999	1.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gender	0.921	1.141*	0.931	1.138*	0.921	1.137*
	(0.084)	(0.088)	(0.085)	(0.088)	(0.084)	(0.088)
Discrimination	0.869	1.161*	0.86	1.164*	0.867	1.173**
	(0.081)	(0.091)	(0.080)	(0.091)	(0.080)	(0.091)
Indigenous	0.76	1.299	0.769	1.296	1.05	1.162
	(0.142)	(0.210)	(0.144)	(0.209)	(0.185)	(0.177)
Health services	1.094	0.92	1.104	0.918	1.084	0.924
	(0.113)	(0.081)	(0.114)	(0.081)	(0.112)	(0.081)
Subsidies	0.933	1.016	0.945	1.012	1.024	0.98
	(0.119)	(0.115)	(0.121)	(0.115)	(0.128)	(0.109)
North	1.239**	0.642***	1.084	0.660***	1.211*	0.644***
	(0.135)	(0.059)	(0.113)	(0.057)	(0.131)	(0.059)
South	1.188	0.677***	1.159	0.682***	1.297**	0.688***
	(0.128)	(0.062)	(0.124)	(0.062)	(0.132)	(0.060)
Year 2011	1.193*	0.579***	1.162	0.583***	1.219**	0.583***
	(0.118)	(0.048)	(0.114)	(0.048)	(0.119)	(0.048)
Constant	0.159***	1.706*	0.137***	1.756*	0.169***	1.706*
	(0.061)	(0.552)	(0.052)	(0.565)	(0.064)	(0.549)
Observations	4585	4585	4585.000	4585.000	4585	4585
Pseudo-R^2	0.0191	0.0297	0.0158	0.0296	0.0120	0.0262

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. The coefficients presented correspond to the odds ratios. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

previous results is the evidence found for the variable crime, social capital, gender, and discrimination. For these variables, the results suggest the existence of asymmetries in effects towards trust and distrust. These differentiated results highlight the relevance of the manner in which variables are constructed. For example, if only the distrust model was estimated, the results would suggest crime bears no association with distrust. However, the way in which the variable is constructed (either as a trust or a distrust measure) influences the estimation output, at least in terms of statistical significance. The lack of statistical evidence on crime's relation with trust, this result could lead to misinterpretation of the association between these two variables via simple, but perhaps convincing, conjecture. Therefore coverage of alternative models is crucial for mapping the relationships between trust, crime, and social inequality.

3.8 Trust in public institutions

The analysis presented in previous sections developed around generalised trust. This section focuses on public institutions. Recall that the trust index includes reported trust in the government, the police, the judicial system (judges), and political parties. Table 14 shows the marginal effects of the ordered logit and 2SRI estimations for trust in public institutions.[27] The independent variables are the same as the ones introduced in the model for *Trust*, and the same instrumental strategy is adopted.

Concerning the two variables of primary interest, social gap and crime, notice that the direction of the marginal effects coincides with those found for generalised trust, although the order of magnitudes and the size of the marginal effects vary. Regarding the indicators of intermediate and high social gap, all coefficients are significant at standard levels, with the weakest statistical significance (10%) found for the marginal effect of Intermediate social gap on medium levels of trust in public institutions (trust=1). Higher levels of social gap are associated with higher trust in public institutions, again the intermediate levels of social gap report the lowest levels of trust in institutions. The corresponding estimates for the 2SRI model show intermediate social gap has no statistical significance for mid levels of trust in public institutions. The rest of the marginal effects for intermediate and high social gap preserve their significance or observe a decrease but remain significant. The directions of the effect remain the same, however, the magnitude of the effects decreases for high social gap and increases for intermediate values of the variable once the IV strategy is implemented.

With respect to the variable crime, the estimated marginal effect in the ordered logit model indicates that crime has a negative effect on high and medium level of trust, in public institutions, and a corresponding positive effect on the lowest value of the trust index. However, the 2SRI model shows the statistical significance of the crime coefficients vanishes. Similarly, the crime predictor in the 2SPS estimation, presented in Table 29 of the Appendix, is also not statistically significant. These results suggest the relation between crime and trust in public institutions found in the ordered logit model estimation is spurious. Similarly, social capital is significantly associated with trust in public institutions under the ordered logit model, but not significant at standard levels for the IV estimations. Its statistical significance was low for the ordered logit estimation and only for the marginal effects of the extreme values of trust (trust=0 and trust=2). Education is significant at a 0.1 level in both ordered logit and 2SRI models, for both values of zero and 2 of trust in public institutions, but is insignificant for medium values of trust. These results indicate that an additional year of education

[27] Table 29 of the Appendix presents these results and 2SPS estimations, which render very close results to the ones obtained by 2SRI.

from its mean value, all other variables kept at mean values, increases la probability of distrusting public institutions by 0.3%, and decreases the probability of reporting high levels of trust in public institutions by the same amount. This effect is rather small in size, nevertheless, it suggests that more educated individuals tend to trust less in public institutions than their less educated counterparts.

For those subjects reporting being of indigenous extraction, or having experienced some type of discrimination, the marginal effects indicate a lower probability of trusting pubic institutions. The significance remains the same for the 2SRI model and the size of the coefficient does not vary much between models. Individuals that have experienced discrimination are 8.7% more likely to report not trusting public institutions, and 8.1% less likely to declare high trust in them. For the indigenous indicator variable the effect is similar if we observe the 2SRI estimates, increasing the probability of reporting distrust in public institutions by 10.2%, and decreasing the likelihood of reporting high levels of trust in these organisations by 8.2%. Health services and Subsidies are not statistically significant in either model, and the regional and year indicators preserve the direction of the effects, with those in the North showing higher levels of trust, relative to those in the Centre, followed by the residents in the South. The year variable coefficient suggests higher levels of trust are observed in the second wave of the survey, confirming the statistical observations made previously. Observe that only North presents statistical significance for the coefficients of all values of trust, while South and year lack significance for medium values of trust in public institutions.

In summary, a profile of the average individual that tends to trust more in public institutions can be depicted from the results obtained. A person with low levels of education, that has experienced discrimination, and whose place of residence is located in areas with high social deprivation in the North of the country tends to show, on average, higher levels of trust in public institutions in comparison to their counterparts whose level of education is higher, live in less deprived neighbourhoods in the Centre of Mexico.

3.9 Further estimation issues: parallel lines test

When estimating ordered choice models, a key assumption imposes equality on the β parameters across thresholds. This assumption can be too restrictive if some of the β coefficients are not invariant for different threshold values. In an ordinal model, changes in the covariates induce an effect on the latent variable (index), but do not change the cut-points, which implies that any change in the explanatory variables leads to a parallel shift in all the thresholds that define the categorical variable, preserving their relative

TABLE 14: Second stage estimates for trust in public institutions. Ordered logit, 2SRI. Instrumenting for crime (Whole sample)

	Ordered logit			2SRI		
	Trust=0	Trust=1	Trust=2	Trust=0	Trust=1	Trust=2
Intermediate social gap	0.072**	-0.014*	-0.058***	0.093*	-0.02	-0.073**
	(0.028)	(0.008)	(0.021)	(0.048)	(0.015)	(0.033)
High social gap	-0.137***	-0.037**	0.174***	-0.129***	-0.033*	0.161***
	(0.026)	(0.018)	(0.042)	(0.030)	(0.019)	(0.047)
Crime	0.507***	-0.029	-0.478***	0.894	-0.052	-0.842
	(0.083)	(0.022)	(0.077)	(0.678)	(0.057)	(0.636)
Crime residuals				-0.393	0.0230	0.370
				(0.683)	(0.044)	(0.642)
Social capital	-0.029*	0.002	0.027*	-0.027	0.002	0.025
	(0.018)	(0.002)	(0.017)	(0.018)	(0.002)	(0.017)
Age	0.001	0.000	-0.001	0.001	0.000	-0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Education	0.003*	0.000	-0.003*	0.004*	0.000	-0.003*
	(0.002)	(0.000)	(0.002)	(0.002)	(0.000)	(0.002)
Gender	0.011	-0.001	-0.01	0.013	-0.001	-0.013
	(0.015)	(0.001)	(0.014)	(0.015)	(0.001)	(0.015)
Discrimination	0.087***	-0.006	-0.081***	0.087***	-0.006	-0.081***
	(0.015)	(0.004)	(0.014)	(0.015)	(0.004)	(0.014)
Indigenous	0.099***	-0.019	-0.080***	0.102***	-0.02	-0.082***
	(0.037)	(0.012)	(0.025)	(0.037)	(0.013)	(0.025)
Health services	-0.024	0.002	0.023	-0.027	0.002	0.025
	(0.017)	(0.002)	(0.016)	(0.018)	(0.002)	(0.016)
Subsidies	-0.023	0.001	0.022	-0.019	0.001	0.018
	(0.022)	(0.001)	(0.022)	(0.023)	(0.001)	(0.023)
North	-0.187***	-0.025***	0.213***	-0.187***	-0.025***	0.212***
	(0.016)	(0.009)	(0.019)	(0.016)	(0.009)	(0.019)
South	-0.089***	-0.006	0.095***	-0.088***	-0.005	0.094***
	(0.016)	(0.004)	(0.018)	(0.016)	(0.004)	(0.018)
Year 2011	-0.069***	0.005	0.064***	-0.076***	0.005	0.070***
	(0.016)	(0.003)	(0.015)	(0.020)	(0.004)	(0.018)
N		4335			4335	
Pseudo-R^2		0.0401			0.0401	
BIC		1.90E+08			1.901e+08	
AIC		43859.673			43859.673	

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Marginal effects for factor levels is the discrete change from the base level, computed at covariates mean values, and show the effect of discrete changes in dichotomous indicator variables. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's Adj pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

position. Thus, under this assumption, changes in the marginal probability of reporting a given response value correspond to symmetric changes in the marginal probabilities of reporting other possible values. This is known as the proportional odds assumption.

If this assumption is not met, the estimated coefficients for the marginal effects can be misleading. If the effects of the covariates do not affect all outcomes symmetrically, an alternative consists on relaxing this restriction by allowing the coefficients of the covariates to differ across values of the dependant variable. In this case, the use of

Generalised Ordered models is recommended. These types of models differ from the Ordered models in their construction, while the latter are described as index shift models, the Generalized Ordered Models are cutpoint shift models, with a key variation that permits the cutoff functions to diverge from each other.

To asses this problem, parallel lines tests can be implemented to verify the presence or not of parameter heterogeneity. Two methods are readily available to test this assumption: the Likelihood Ratio test and the Wald test. The strategy followed in this section consists in first testing the validity of the proportional odds assumption. Then generalised ordered models are estimated, and a comparison of these estimations with the results previously obtained is offered.

Results of the Wald test are shown in Table 15. The first column presents the Wald test for generalised trust, and the second column for trust in public institutions. The table indicates the P values for each variable, and the symbol (∦) is placed next to the P values of those variables that did not pass the test. A routine developed by Williams (2006) was implemented with an *autofit* specification at a 0.05 significance level.[28] Results of the test indicate that the assumption of parallel lines is met for all the variables in the model for trust in public institutions. Thus, the generalised ordered model and the ordered logit model will produce the same estimated coefficients. The model for generalised trust presents a different story. The variables that did not pass the test were high social gap, crime, age, the regional indicators north and south, and the year indicator variable. Although the procedure specified for the test is based on statistical arguments, it lacks of any theoretical grounds based on the problem at hand, thus it is important to estimate the generalised ordered model in order to identify which variables are problematic.

The year indicator variable (*Year 2011*) is expected to fail the test if a change in the level of trust from one period to the other happens and is not accounted for in the specification of the empirical model. This result is not regarded as problematic, as the variable was introduced in the estimation model precisely to account for this difference. On the other hand, the variable age was not statistically significant in the ordered logit models estimated, the fact that the variable did not pass the proportional odds assumption test may be an indicator of differences across reported values of trust that must be taken into consideration, this is explored in more detail further below. Similarly, both regional variables failing to pass the test may be an indicator of heterogeneity in the perception of trust, probably owing to socio-cultural differences that are manifest

[28]The *Autofit* specification uses a "backward stepwise selection procedure, starting with the least parsimonious model and gradually imposing constraints" Williams (2006, p. 66). A commonly used parallel lines test is the Brant test, unfortunately this test is non-valid for weighted survey data, which is the present case.

TABLE 15: Parallel lines test: adjusted Wald test statistics and probability values. The results are from generalised ordered logit estimates

	Generalised trust	Trust in public institutions
Test statistics	F(23, 4562) = 8.84	F(16, 4319) = 16.95
	P values	
Health services	0.9086	0.81
Gender	0.8238	0.6478
Indigenous	0.6363	0.4648
Subsidies	0.5038	0.1311
Discrimination	0.5997	0.0754
Social capital	0.3222	0.3231
Education	0.4247	0.0677
Education squared	0.1755	0.8229
Intermediate social gap	0.0513	0.9922
High social gap	0.00031 ∦	0.2243
Crime	0.00062 ∦	0.2255
Age	0.0217 ∦	0.1169
Age squared	0.0322 ∦	0.8396
North	0.00255 ∦	0.4988
South	0.03688 ∦	0.6765
Year 2011	0.000 ∦	0.5509

Note: Test was run using GOLOGIT2 programme for STATA. An *Autofit* routine was specified for practicality. (∦) indicates the variable did not pass the test at a 0.05 significance level. Test statistics are presented for the adjusted Wald test ran only for the variables that pass the *Autofit* routine. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

across Mexico. The fact that crime and high social gap do not pass the test requires more consideration, and comments about this issue are placed in the discussion of the generalised model estimations.

Generalised ordered choice model estimations

An alternative to the ordered choice models when the parallel lines assumption is not fulfilled is the generalised ordered models. However, there exist some caveats in implementing generalised ordered models. For example, given the lack of restrictions imposed on the thresholds, there is the possibility of predicted probabilities being outside the [0,1] range. The results from generalised model estimated for trust does not indicate the existence of such cases, thus this does not represents a problem.

Table 16 presents the results for the generalised logit, 2SRI, and 2SPS models. Non significant coefficients are not shown in the table. The direction of the effects is preserved in comparison to previous estimations. Although significance is lost for some of the marginal effects (see for example for the marginal effect of crime for trust equal to zero.) the same results arise as in previous models.

High social gap is associated with higher levels of trust, and crime negatively affects it, even after introducing both IV strategies. Experiencing discrimination and the indigenous identifier preserve their statistical significance and suggest a negative relation with trust. Gender on the other hand gains statistical significance only after introducing the instruments into the estimation, suggesting the effect of gender may have been confounded with that of crime.

Social capital, on the other hand, shows a positive and significant association with trust. However, its marginal effects lose their significance in the 2SRI and 2SPS models. The indicators North and South, as well as the year variable also present effects that are consistent with those of the models estimated before. Relative to those living in the Centre, individuals with residence in the North and South, on average, tend to report lower levels of generalised trust. The year variable again confirms the increase in reported trust from the 2006 to the 2011 wave.

Over all the magnitude of the coefficients is close to that of the ordered logit estimates. High social gap, crime and the regional variables presenting the highest variations when comparing the models. The upper levels of social gap have a larger effect on the higher trust values, while before it was the lower values that presented the marginal effects with higher absolute magnitude.

There seems to be a reassignment of affects, now being part of the group that resides in places with high levels of social gap affects more the probability of reporting high levels of trust, while before a negative effect on the probability of reporting the lower level of trust was the most affected. For crime the story is similar, but the exchange in magnitudes are experienced between the upper and intermediate level of trust, increasing for the later and decreasing for the former. Nevertheless, even with this reassignment the direction of the effects of the variables suggest the same type of associations with trust.

TABLE 16: Second stage estimates for generalised trust. Generalised ordered logit, 2SRI and 2SPS. Instrumenting for crime (Whole sample)

	Ordered logit			2SRI			2SPS		
	Trust=0	Trust=1	Trust=2	Trust=0	Trust=1	Trust=2			
Intermediate social gap	0.083***	-0.029***	-0.053***	0.139***	-0.052***	-0.087***	0.151***	-0.089***	-0.062**
	(0.028)	(0.011)	(0.017)	(0.040)	(0.017)	(0.023)	(0.038)	(0.020)	(0.029)
High social gap	-0.095**	-0.051**	0.146***	-0.053	-0.057**	0.110***	-0.046	-0.077***	0.123***
	(0.041)	(0.023)	(0.039)	(0.047)	(0.023)	(0.042)	(0.047)	(0.025)	(0.043)
Crime	0.085	0.223***	-0.307***	1.442*	-0.199	-1.243**			
	(0.082)	(0.083)	(0.079)	(0.815)	(0.269)	(0.564)			
Crime residuals				-1.382*	0.428*	0.954*			
				(0.821)	(0.259)	(0.565)			
Crime predictor							1.538*	-0.469*	-1.068*
							(0.816)	(0.254)	(0.564)
Social capital	-0.038*	0.012*	0.026*	-0.030	0.009	0.020	-0.029	0.009	0.020
	(0.020)	(0.006)	(0.014)	(0.021)	(0.007)	(0.015)	(0.021)	(0.006)	(0.015)
Age	0.000	-0.001	0.001**	0.000	-0.001*	0.001	0.000	-0.001*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gender	0.027	-0.008	-0.019	0.035*	-0.011*	-0.024*	0.035*	-0.011*	-0.024*
	(0.017)	(0.005)	(0.012)	(0.018)	(0.005)	(0.012)	(0.018)	(0.005)	(0.012)
Discrimination	0.035**	-0.011**	-0.024**	0.033*	-0.010*	-0.023*	0.034**	-0.010*	-0.024**
	(0.017)	(0.005)	(0.012)	(0.017)	(0.005)	(0.012)	(0.017)	(0.005)	(0.012)
Indigenous	0.064*	-0.021*	-0.042*	0.071**	-0.024*	-0.047**	0.072**	-0.024**	-0.048**
	(0.034)	(0.012)	(0.022)	(0.034)	(0.012)	(0.021)	(0.033)	(0.012)	(0.021)
North	-0.106***	0.073***	0.033*	-0.104***	0.072***	0.032*	-0.097***	0.082***	0.015
	(0.021)	(0.016)	(0.018)	(0.021)	(0.016)	(0.017)	(0.020)	(0.016)	(0.017)
South	-0.092***	0.055***	0.037**	-0.087***	0.054***	0.034*	-0.089***	0.068***	0.021
	(0.022)	(0.016)	(0.018)	(0.022)	(0.016)	(0.018)	(0.022)	(0.017)	(0.018)
Year 2011	-0.124***	0.090***	0.034**	-0.145***	0.097***	0.048***	-0.147***	0.103***	0.044***
	(0.018)	(0.013)	(0.015)	(0.022)	(0.014)	(0.017)	(0.022)	(0.014)	(0.017)
Observations		4585			4585			4585	
F		8.84			8.46			8.410	
Prob > F		0.000			0.000			0.000	

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Marginal effects for factor levels is the discrete change from the base level, computed at covariates mean values, and show the effect of discrete changes in dichotomous indicator variables. Standard errors are presented in parenthesis. The F statistics computed are F(23, 4562), F(24, 4561), and F(23, 4562) for the ordered logit, 2SRI, and 2SPS models respectively. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, the software Stata does not allows to force reporting of the statistic. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

3.10 Discussion and comments

This chapter presented results that contribute to the literature with evidence on the associations between generalised trust and trust in public institutions, with indicators of crime and social deprivation, and a group of controls that aim at capturing the effects of individual characteristics, including social capital, indicators of discrimination, regional differences, and a year indicator. The results obtained are for Mexico, a country that faces historical struggles with poverty and inequality, and that has recently experienced a marked increase in violence and crime. The effects of the two indicators of interest, social deprivation and crime, in the ordered logit estimation remain statistically significant and show consistency in the direction of their relationship with generalised trust for different specifications, including IV estimations, and the use of generalised ordered models. The results for trust in public institutions is less consistent, remaining for social gap across specifications, but the statistical significance of the coefficients for crime does not survive the instruments strategy.

Results indicate that the level of trust is higher for those individuals whose place of residence is located in municipalities with higher levels of social deprivation. Those in the intermediate values of social deprivation show, on average, lower levels of trust, indicating that some relevant effect is more prominent for this group relative to the other two groups. Based on the formal justification offered in the chapter, this effect for individuals on intermediate levels of deprivation may be given by higher levels of interaction with members of different groups, those of lower and higher levels of social deprivation, although this is only a hypothesis that needs further investigation to be confirmed. If we interpret the social index gap as an indicator of economic development, probably related to the benefits generated by economic growth, the direction of the relationship contradicts common findings in the literature.

A middle income country like Mexico, with high levels of poverty, and with regional wealth levels that vary between those of a rich European county and those of poorer countries in Africa, can generate results that vary depending on the characteristics of the group to which the analysis is carried on. Comparisons of results for individuals with the highest levels of social deprivation and those in a less disadvantaged situation indicate that cultural, social, and perceptive components can influence the levels of trust reported. These findings do not necessarily oppose evidence of a positive relation between growth and trust found in the literature. However, they raise the question of what the channels are through which trust and growth are related, and which sector of the society should be particularly targeted when implementing trust improving policies.

The evidence found also suggests crime holds a negative relation with both generalised trust and trust in public institutions. Nevertheless, significance is less consistent, not surviving when instrumental estimators are computed for trust in public institutions. These results offer weak evidence to support the hypothesis that public institutions are held responsible for crime activity in society, affecting the level of trust that individuals have on them, although the results could emerge from the characteristics of the data, which report high levels of trust held for these organisations (see Tables 19 and 21 of the Appendix).

In general, the results for the regional and year indicators are consistent across different specifications, including parsimonious estimations, and the inclusion of instrumental variables. These associations remain when generalised ordered models are estimated. The North and South regions present higher levels of generalised trust than the Centre, with the North having the more trusting individuals. This result also holds for trust in public institutions.

Asymmetries between generalised trust and generalised distrust constructs were also studied. Estimations of models of trust and distrust indicate there are asymmetries between these two measures, as different associations emerge with the explanatory variables. In particular, the results suggest social gap affects distrust more consistently than trust, and evidence of associations with crime are present for trust (negative) but not for distrust (positive).

Additionally, associations with the control variables present results that are comparable to previous studies. Briefly, those in a more disadvantaged position consistently report lower levels of trust to members of society in general and to public institutions. They report having experienced discrimination, being part of an ethnic minority with a discriminatory past, being residents in the Centre, and to a lesser extent to the south of Mexico (both of these regions being less economically affluent). Weak evidence suggests that females may report higher levels of distrust, and that social capital may have a positive effect on trust. These latter results are not consistent across specifications, thus the result should be carefully interpreted.

Results suggest careful consideration should be taken when studying the effects of trust across highly diverse regions, like it is the case for Mexico. The marked differences between the three regions considered in this work seem to be playing an important role in the results obtained. Thus, policy design should consider these differences, with further investigation required to uncover their extent and to determine how important they are for research results and policy implementation.

All together, the results show trust is an important asset for those experiencing higher economic disadvantage. This information can be relevant when designing interventions, as trust can constitute a channel through which policies can be delivered, or at least facilitated. As results are less conclusive for crime in public institutions, and for both measures of trust with respect to variables that proxy experiencing some degree of discrimination, including females, further research and data collection would be recommendable to help determine the validity of the results that suggest a negative relation between variables. Also, further research is needed to explore causality between the variables of interest in a deeper way, and to identify the mechanisms at play in the relation between social deprivation and crime with trust in a finer way.

3.11 Appendix

3.11.1 Note on the cumulative root frequency method

When constructing strata for a population P consists in partitioning P in I mutually exclusive sub-populations P_i.

$$P = \sum_{i=1}^{I} P_i,\ P_i \cap P_j = \emptyset,\ \forall\, i \neq j \tag{3.7}$$

For a given population P, let the population mean be represented by $\bar{X}$, and the stratified sample mean be $\bar{x}$. In Cochran (1977, Theorem 5.1, pp. 91) it is proved that, if every stratum sample mean estimate is unbiased, then $\bar{x}$ is an unbiased estimator of $\bar{X}$. An objective of stratification is to set the boundaries for the strata in a way such that the variance of $\bar{x}$ in minimised. Dalenius (1950) presents a property for such boundaries that satisfies minimum variance of $\bar{x}$, however, the solution of the problem has not been reached due to interdependency among parameters present in the required condition. Thus, approximate solution methods have been implemented over the years to reach solutions that minimise such variance. An approximation algorithm widely used in the literature is presented in Dalenius and Hodges (1957). Such approximation is called the cumulative root frequency method. The algorithm is the following:

i Divided the frequency of the variable of interest in a number of classes C

ii For each interval $c_i \in C, i = 1, 2, \ldots, C$, count the number of observations $\#c_i$.

iii Compute $(\#c_i)^{\frac{1}{2}}$

iv Construct strata s_j to be equal to the union of adjacent intervals, reducing the C classes to S strata, conditioning on $\sum_{s_{j'}} (\#c_j)^{\frac{1}{2}} \simeq \sum_{s_{j''}} (\#c_j)^{\frac{1}{2}}$.

As noticed by Hedlin (2000), the boundaries depend on the initial number of classes, and no formal argument exists for how to best select such number.

3.11.2 Statistics tables

TABLE 17: Dependant and explanatory variables statistics

Variable	N	mean	min	max	sd
Trust (= 0, 1, 2)	4883	0.623	0	2	0.818
Trust in public institutions (= 0, 1, 2)	4615	1.014	0	2	0.780
Medium social gap (1 if belongs to group)	4889	0.106	0	1	0.308
Low social gap (1 if belongs to group)	4889	0.815	0	1	0.388
Homicides per 100,000 habitants	4704	8.601	0	59.374	10.324
Age	4889	41.189	18	97	16.347
Age squared	4889	1963.671	324	9409	1549.196
Formal education in years	4879	9.448	0	24	5.040
Formal education in years squared	4879	114.666	0	576	101.392
Gender (1 if female)	4889	0.575	0	1	0.494
Has experienced discrimination (1 if so)	4889	0.466	0	1	0.499
Has no social security (1 if so)	4858	0.326	0	1	0.469
Resident of the northern region	4889	0.308	0	1	0.462
Resident of the southern region	4889	0.346	0	1	0.476
Indigenous condition (1 if speaker)	4888	0.088	0	1	0.283
Social capital (# of memberships)	4821	0.207	0	4	0.445

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

TABLE 18: Trust in close social agents

	Family	Friends	Church	Compadres	Teachers	Work fellows	Neighbours
Obs.	4869	4833	4822	4297	4599	4599	4846
mean	8.987	6.920	7.863	7.205	7.441	7.441	6.737
min	0	0	0	0	0	0	0
max	10	10	10	10	10	10	10
sd	1.671	2.494	2.440	2.463	2.188	2.188	2.584

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011). Trust values range from 0 to 10.

TABLE 19: Mean values for measures of trust per year

	2006	2011	Total		2006	2011	Total
Trust	0.4711	0.7439	0.6232				
Business owners	4.704	5.374	5.099	Close friends*	7.102	7.272	7.205
Government	5.036	5.315	5.192	Work fellows	7.246	7.588	7.441
Judicial system	4.840	5.425	5.169	Family	8.756	9.171	8.987
Police	4.434	5.564	5.062	Neighbours	6.219	7.150	6.737
Political Parties	3.844	4.636	4.289	Friends	6.374	7.348	6.920
Church	8.025	7.735	7.863	Teachers	7.246	7.588	7.441

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011). Trust has values of 0, 1, and 2; all other trust measures range from 0 to 10. *Close friends is used as a translation for the concept *compadres*, used to refer to ones child's godfather.

Table 20: Trust statistics

	Frequency	Percent	Cumulative	Overall statistics
0	2,900	59.39	59.39	Mean = 0.623
1	923	18.9	78.29	Obs. = 4,883
2	1,060	21.71	100	Std dev = 0.818

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011). Trust values range from 0 to 2.

Table 21: Statistics for trust in public institutions

	Trust in				
	Judicial	Political parties	Police	Government	Public Inst.
Mean	1.167	1.110	1.113	1.140	1.014
Std dev	0.807	0.847	0.810	0.813	0.779
Observations	4889	4889	4889	4889	4615

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011). Trust values range from 0 to 2.

Table 22: Number of homicides per capita.

Year	Observations	Mean	Maximum	Standard Deviation
2006	2113	73.56	407.64	77.249
2011	2472	94.58	593.73	119.68
Total	4585	84.8	593.73	103.23

Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

TABLE 23: Polychoric correlation matrix

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
(a)	1																		
(b)	0.125	1																	
(c)	-0.017	-0.400	1																
(d)	0.040	0.010	-0.041	1															
(e)	0.040	0.009	-0.039	0.981	1														
(f)	0.031	-0.259	0.043	-0.409	-0.418	1													
(g)	0.028	-0.251	0.029	-0.295	-0.302	0.948	1												
(h)	-0.047	0.030	-0.048	-0.010	-0.010	-0.079	-0.085	1											
(i)	-0.079	0.085	-0.006	0.052	0.058	-0.165	-0.156	0.026	1										
(j)	-0.103	0.137	-0.051	-0.117	-0.108	-0.161	-0.172	-0.036	0.116	1									
(k)	0.039	0.537	-0.201	0.021	0.013	-0.383	-0.440	0.257	0.172	-0.044	1								
(l)	0.042	0.175	0.007	0.263	0.222	-0.285	-0.336	-0.258	0.106	0.153	0.198	1							
(m)	0.018	0.118	-0.140	0.159	0.159	-0.141	-0.126	0.181	-0.004	-0.188	0.133	0.104	1						
(n)	-0.062	-0.740	0.208	-0.043	-0.046	0.235	0.224	0.007	-0.116	-0.101	-0.488	-0.290	-0.087	1					
(o)	0.072	NA	0.421	-0.016	-0.022	0.130	0.104	-0.074	-0.171	-0.326	-0.378	-0.094	-0.153	0.332	1				
(p)	0.027	0.631	-0.207	-0.031	-0.028	-0.181	-0.158	0.028	0.093	0.135	0.476	0.168	0.083	-0.454	NA	1			
(q)	-0.050	0.716	-0.377	0.115	0.113	-0.374	-0.354	-0.005	0.187	0.123	0.513	0.329	0.105	-0.522	-0.504	0.547	1		
(r)	0.033	0.001	-0.118	0.071	0.062	0.016	0.050	0.006	0.112	-0.054	0.162	0.052	0.074	-0.119	-0.131	0.185	0.084	1	
(s)	0.267	0.072	0.141	-0.071	-0.077	0.211	0.165	0.017	-0.205	-0.399	-0.039	-0.222	0.116	0.029	0.127	-0.100	-0.240	-0.254	1

Note: Letters correspond to: Trust=(a), High social gap=(b), Homicides per 100,000 habitants= (c), Age=(d), Age squared=(e), Formal education in years=(f), Formal education in years squared=(g), Gender (1 if female)=(h), Has experienced discrimination (1 if so)=(i), Has no social security (1 if so)=(j), Oportunidades subsidy=(k), Procampo subsidy=(l), Other subsidies=(m), Resident of the northern region=(o), Resident of the southern region=(p), Indigenous condition (1 if speaker)=(q), Number of memberships= (r), Year 2011=(s). Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011).

Estimations tables

TABLE 24: Marginal effects at means for generalised trust
Restricted model, social gap

Marginal effects $\binom{\beta}{(se)}$	$Pr(Trust = 0)$	$Pr(Trust = 1)$	$Pr(Trust = 2)$
Intermediate social gap	0.076***	−0.028 **	−0.047***
	(0.028)	(0.011)	(0.017)
High social gap	−0.134***	0.035***	0.098***
	(0.043)	(0.009)	(0.035)
Social capital	−0.040*	0.013*	0.026*
	(0.021)	(0.007)	(0.014)
Age	−0.001	0.000	0.000
	(0.001)	(0.000)	(0.000)
Education	−0.002	0.001	0.001
	(0.002)	(0.001)	(0.001)
Gender	0.026	−0.009	−0.017
	(0.017)	(0.006)	(0.011)
Discrimination	0.036 **	−0.012 **	−0.024 **
	(0.017)	(0.006)	(0.011)
Indigenous	0.062*	−0.022	−0.040*
	(0.035)	(0.014)	(0.022)
Health services	−0.020	0.007	0.013
	(0.020)	(0.007)	(0.013)
Subsidies	0.006	−0.002	−0.004
	(0.025)	(0.008)	(0.016)
North	−0.075***	0.024***	0.051***
	(0.019)	(0.006)	(0.013)
South	−0.076***	0.024***	0.052***
	(0.021)	(0.007)	(0.015)
Year 2011	−0.102***	0.034***	0.067***
	(0.018)	(0.007)	(0.012)
Observations	4585		
Pseudo-R^2	0.018		
AIC	38122.015		
BIC	1.748E+08		

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

TABLE 25: Marginal effects at means for generalised trust
Restricted model, crime

Marginal effects $\binom{\beta}{(se)}$	$Pr(Trust = 0)$	$Pr(Trust = 1)$	$Pr(Trust = 2)$
Crime	0.137 ∗ ∗	−0.046 ∗ ∗	−0.091∗
	(0.070)	(0.023)	(0.046)
Social capital	−0.036∗	0.012∗	0.024∗
	(0.021)	(0.007)	(0.014)
Age	−0.001	0.000	0.000
	(0.001)	(0.000)	(0.000)
Education	−0.001	0.000	0.001
	(0.002)	(0.001)	(0.001)
Gender	0.026	−0.009	−0.017
	(0.017)	(0.006)	(0.011)
Discrimination	0.036 ∗ ∗	−0.012 ∗ ∗	−0.024 ∗ ∗
	(0.017)	(0.006)	(0.011)
Indigenous	0.025	−0.009	−0.016
	(0.036)	(0.013)	(0.023)
Health services	−0.018	0.006	0.012
	(0.020)	(0.007)	(0.013)
Subsidies	−0.005	0.002	0.003
	(0.025)	(0.008)	(0.016)
North	−0.086∗∗∗	0.027∗∗∗	0.059∗∗∗
	(0.020)	(0.006)	(0.014)
South	−0.082∗∗∗	0.025∗∗∗	0.057∗∗∗
	(0.020)	(0.006)	(0.014)
Year 2011	−0.105∗∗∗	0.035∗∗∗	0.069∗∗∗
	(0.018)	(0.007)	(0.012)
Observations	4585		
Pseudo-R^2	0.0151		
AIC	38236.521		
BIC	1.753E+08		

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

TABLE 26: Parsimonious estimation of ordered logit
Restricted model social gap

	Model 1	Model 2	Model 3	Model 4
Intermediate social gap	−0.362***	−0.266**	−0.297**	−0.350**
	(0.128)	(0.132)	(0.135)	(0.136)
High social gap	0.417***	0.667***	0.621***	0.551***
	(0.152)	(0.170)	(0.175)	(0.174)
Social capital		0.097	0.094	0.173*
		(0.087)	(0.088)	(0.090)
Age		−0.013	−0.013	−0.016
		(0.011)	(0.011)	(0.011)
Age squared		0.000*	0.000*	0.000**
		(0.000)	(0.000)	(0.000)
Education		0.025	0.026	0.008
		(0.027)	(0.027)	(0.027)
Education squared		−0.001	−0.001	0.000
		(0.001)	(0.001)	(0.001)
Gender		−0.115	−0.115	−0.112
		(0.074)	(0.074)	(0.074)
Discrimination		−0.228***	−0.211***	−0.158**
		(0.075)	(0.075)	(0.075)
Indigenous		−0.310*	−0.375**	−0.279*
		(0.169)	(0.169)	(0.167)
Health services		0.242***	0.195**	0.087
		(0.082)	(0.084)	(0.086)
Subsidies		0.030	0.022	−0.027
		(0.107)	(0.108)	(0.108)
North			0.330***	0.321***
			(0.082)	(0.082)
South			0.313***	0.321***
			(0.091)	(0.090)
Year 2011				0.445***
				(0.082)
Cut 1	0.494***	0.506*	0.653**	0.708**
	(0.040)	(0.296)	(0.301)	(0.303)
Cut 2	1.357***	1.377***	1.529***	1.591***
Observations	4585	4585	4585	4585
Pseudo-R^2	0.0028	0.0093	0.0127	0.0180
BIC (E+08)	1.775	1.7638	1.757	1.748
AIC	38713.68	38458.97	38330.70	38122.02

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010).

TABLE 27: Parsimonious estimation of ordered logit
Restricted model crime

	Model 1	Model 2	Model 3	Model 4
Crime	0.240	0.175	−0.373	−0.595**
	(0.283)	(0.293)	(0.307)	(0.302)
Social capital		0.085	0.075	0.155*
		(0.087)	(0.088)	(0.090)
Age		−0.013	−0.013	−0.017
		(0.011)	(0.011)	(0.011)
Age squared		0.000*	0.000*	0.000**
		(0.000)	(0.000)	(0.000)
Education		0.019	0.022	0.003
		(0.027)	(0.027)	(0.027)
Education squared		−0.001	−0.001	0.000
		(0.001)	(0.001)	(0.001)
Gender		−0.113	−0.116	−0.113
		(0.074)	(0.074)	(0.074)
Discrimination		−0.229***	−0.212***	−0.158**
		(0.075)	(0.075)	(0.076)
Indigenous		−0.055	−0.163	−0.109
		(0.158)	(0.159)	(0.159)
Health services		0.236***	0.192**	0.079
		(0.082)	(0.083)	(0.086)
Subsidies		0.106	0.079	0.020
		(0.106)	(0.106)	(0.106)
North			0.355***	0.367***
			(0.085)	(0.086)
South			0.350***	0.348***
			(0.086)	(0.086)
Year 2011				0.458***
				(0.082)
Cut 1	0.411	0.480	0.597**	0.639**
	(0.291)	(0.295)	(0.300)	(0.302)
Cut 2	1.275***	1.346***	1.468***	1.518***
	(0.290)	(0.294)	(0.299)	(0.301)
Observations	4585	4585	4585	4585
Adj. pseudo-R^2	0.0001	0.0057	0.0094	0.015
BIC (E+08)	1.78	1.77	1.76	1.75
AIC	38819.2	38599	38459	38237

Note: The omitted category is low social gap. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), DGIS (2015), CNS (2015).

TABLE 28: Second stage estimates for generalised trust, 2SRI and 2SPS, whole sample and by regions

	Whole sample			North			Centre			South		
	Ologit	2SRI	2SPS	Ologit	2SRI	2SPS	Ologit	2SRI	2SPS	Ologit	2SRI	2SPS
Intermediate social gap	-0.382***	-0.670***	-0.675***	-0.884**	-0.943*	-0.923*	0.18	-0.836**	-0.912***	-0.877***	-1.078**	-1.087**
	(0.137)	(0.219)	(0.219)	(0.428)	(0.485)	(0.482)	(0.138)	(0.344)	(0.340)	(0.325)	(0.447)	(0.430)
High social gap	0.536***	0.368*	0.361*				0.486***	-0.011	-0.037	0.782**	0.648*	0.647*
	(0.175)	(0.198)	(0.198)				(0.178)	(0.241)	(0.239)	(0.326)	(0.381)	(0.379)
Crime	-0.702**	-6.480*		-1.136***	-2.443		-1.372**	-21.628***		0.245	-3.786	
	(0.307)	(3.526)		(0.400)	(4.991)		(0.559)	(6.320)		(1.412)	(6.334)	
Crime residuals		5.882*			1.34			20.672***			3.964	
		(3.557)			(5.080)			(6.398)			(5.898)	
Crime predictor			-6.543*			-4.743			-22.764***			-3.999
			(3.518)			(4.806)			(6.279)			(5.843)
Social capital	0.170*	0.135	0.134	0.113	0.107	0.097	0.187	0.029	0.026	0.189	0.166	0.166
	(0.090)	(0.094)	(0.093)	(0.166)	(0.167)	(0.166)	(0.129)	(0.138)	(0.139)	(0.138)	(0.144)	(0.144)
Age	-0.017	-0.018	-0.018	-0.003	-0.003	-0.002	-0.002	-0.007	-0.006	-0.032*	-0.033*	-0.033*
	(0.011)	(0.011)	(0.011)	(0.017)	(0.017)	(0.017)	(0.020)	(0.020)	(0.020)	(0.018)	(0.018)	(0.018)
Age squared	0.000**	0.000**	0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.007	-0.003	-0.003	-0.07	-0.073	-0.075	0.028	-0.014	-0.019	0.033	0.027	0.027
	(0.027)	(0.028)	(0.028)	(0.050)	(0.051)	(0.051)	(0.046)	(0.048)	(0.048)	(0.043)	(0.043)	(0.043)
Education squared	0.000	0.000	0.000	0.003	0.003	0.003	-0.001	0.000	0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Gender	-0.116	-0.150*	-0.150*	0.025	0.016	-0.001	-0.220*	-0.355***	-0.364***	-0.165	-0.185	-0.187
	(0.074)	(0.078)	(0.078)	(0.114)	(0.118)	(0.117)	(0.127)	(0.134)	(0.134)	(0.120)	(0.125)	(0.124)
Discrimination	-0.153**	-0.147*	-0.151**	-0.028	-0.025	-0.015	-0.227*	-0.213*	-0.242*	-0.196	-0.194	-0.193
	(0.076)	(0.076)	(0.075)	(0.119)	(0.119)	(0.119)	(0.129)	(0.129)	(0.127)	(0.124)	(0.124)	(0.123)
Indigenous	-0.284*	-0.320*	-0.320*	-1.085**	-1.098**	-1.161**	0.03	-0.151	-0.156	-0.02	-0.04	-0.041
	(0.167)	(0.170)	(0.170)	(0.529)	(0.531)	(0.532)	(0.198)	(0.205)	(0.204)	(0.341)	(0.344)	(0.344)
Health services	0.084	0.12	0.127	0.269*	0.277*	0.290*	-0.158	-0.008	0.023	0.099	0.123	0.123
	(0.086)	(0.089)	(0.089)	(0.152)	(0.156)	(0.155)	(0.137)	(0.147)	(0.144)	(0.131)	(0.136)	(0.136)
Subsidies	-0.035	-0.092	-0.091	-0.536**	-0.546**	-0.541**	0.260*	0.053	0.045	-0.037	-0.081	-0.082
	(0.108)	(0.112)	(0.112)	(0.213)	(0.212)	(0.213)	(0.158)	(0.180)	(0.180)	(0.185)	(0.194)	(0.193)
North	0.376***	0.367***	0.321***									
	(0.086)	(0.086)	(0.082)									
South	0.337***	0.317***	0.302***									
	(0.090)	(0.091)	(0.090)									
Year 2011	0.459***	0.553***	0.552***	0.820***	0.839***	0.829***	1.154***	1.524***	1.551***	0.118	0.183	0.184
	(0.083)	(0.100)	(0.100)	(0.140)	(0.151)	(0.151)	(0.134)	(0.187)	(0.188)	(0.131)	(0.164)	(0.163)
Cut 1	0.653**	0.067	0.047	0.434	0.299	0.136	1.013**	-0.979	-1.095	0.354	-0.044	-0.06
	(0.304)	(0.464)	(0.463)	(0.491)	(0.724)	(0.715)	(0.492)	(0.787)	(0.782)	(0.483)	(0.763)	(0.735)
Cut 2	1.536***	0.951**	0.931**	1.613***	1.479**	1.311*	1.875***	-0.111	-0.228	1.111**	0.715	0.698
	(0.303)	(0.463)	(0.462)	(0.495)	(0.728)	(0.719)	(0.496)	(0.786)	(0.781)	(0.478)	(0.759)	(0.730)
Observations	4585	4585	4585	1428	1428	1428	1570	1570	1570	1587	1587	1587
Pseudo R^2	0.0185	0.0186	0.0181	0.027	0.0277	0.0243	0.0476	0.0501	0.0484	0.0153	0.0153	0.0153
BIC	1.747E+08	1.746E+08	1.747E+08	5.00E+07	5.00E+07	5.02E+07	3.18E+07	3.17E+07	3.17E+07	9.036E+07	9.036E+07	9.036E+07
AIC	38103.387	38098.354	38121.109	35026.762	35002.639	35124.64	20236.909	20183.465	20219.551	56947.121	56946.377	56947.344

Note: 2SRI = 2 stage residual inclusion, 2SPS = 2 stage predictor substitution. Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are shown in parenthesis. Variables included are population size of municipalities and distance from the municipality to the border with the USA, both variables are at levels, as instruments. Also included are exogenous variables from the ordered logit model for generalised trust. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

TABLE 29: Second stage estimates for trust in public institutions. Ordered logit, 2SRI and 2SPS. Instrumenting for crime, whole sample

	Ordered logit			2SRI			2SPS		
	Trust=0	Trust=1	Trust=2	Trust=0	Trust=1	Trust=2	Trust=0	Trust=1	Trust=2
Intermediate social gap	0.072**	-0.014*	-0.058***	0.093*	-0.020	-0.073**	0.094*	-0.02	-0.074**
	0.028	0.008	0.021	0.048	0.015	0.033	0.048	0.015	0.033
High social gap	-0.137***	-0.037**	0.174***	-0.129***	-0.033*	0.161***	-0.126***	-0.031*	0.157***
	0.026	0.018	0.042	0.030	0.019	0.047	0.030	0.018	0.047
Crime	0.507***	-0.029	-0.478***	0.894	-0.052	-0.842			
	0.083	0.022	0.077	0.678	0.057	0.636			
Crime residuals				-0.393	0.023	0.37			
				0.683	0.044	0.642			
Crime predictor							0.826	-0.045	-0.781
							0.683	0.053	0.644
Social capital	-0.029*	0.002	0.027*	-0.027	0.002	0.025	-0.026	0.001	0.025
	0.018	0.002	0.017	0.018	0.002	0.017	0.018	0.001	0.017
Age	0.001	0.000	-0.001	0.001	0.000	-0.001	0.001	0.000	-0.001
	0.001	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001
Education	0.003*	0.000	-0.003*	0.004*	0.000	-0.003*	0.004*	0.000	-0.003*
	0.002	0.000	0.002	0.002	0.000	0.002	0.002	0.000	0.002
Gender	0.011	-0.001	-0.01	0.013	-0.001	-0.013	0.013	-0.001	-0.013
	0.015	0.001	0.014	0.015	0.001	0.015	0.015	0.001	0.015
Discrimination	0.087***	-0.006	-0.081***	0.087***	-0.006	-0.081***	0.089***	-0.005	-0.083***
	0.015	0.004	0.014	0.015	0.004	0.014	0.015	0.004	0.014
Indigenous	0.099***	-0.019	-0.080***	0.102***	-0.020	-0.082***	0.100***	-0.019	-0.081***
	0.037	0.012	0.025	0.037	0.013	0.025	0.037	0.012	0.025
Health services	-0.024	0.002	0.023	-0.027	0.002	0.025	-0.032*	0.002	0.030*
	0.017	0.002	0.016	0.018	0.002	0.016	0.018	0.002	0.016
Subsidies	-0.023	0.001	0.022	-0.019	0.001	0.018	-0.019	0.000	0.018
	0.022	0.001	0.022	0.023	0.001	0.023	0.023	0.001	0.023
North	-0.187***	-0.025***	0.213***	-0.187***	-0.025***	0.212***	-0.156***	-0.016**	0.172***
	0.016	0.009	0.019	0.016	0.009	0.019	0.015	0.007	0.018
South	-0.089***	-0.006	0.095***	-0.088***	-0.005	0.094***	-0.079***	-0.004	0.083***
	0.016	0.004	0.018	0.016	0.004	0.018	0.016	0.004	0.018
Year 2011	-0.069***	0.005	0.064***	-0.076***	0.005	0.070***	-0.075***	0.005	0.070***
	0.016	0.003	0.015	0.020	0.004	0.018	0.020	0.004	0.018
N		4335			4335			4335	
Pseudo-R^2		0.0400			0.0401			0.0356	
BIC		1.90E+08			1.90E+08			1.91E+08	
AIC		43861.996			43859.673			44065.149	

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Marginal effects for factor levels is the discrete change from the base level, computed at covariates mean values, and show the effect of discrete changes in dichotomous indicator variables. Standard errors are presented in parenthesis. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, McFadden's pseudo-R^2 is presented for informational purposes only. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

TABLE 30: Second stage estimates for generalised trust. Generalised ordered logit, 2SRI and 2SPS Instrumenting for crime, whole sample

	Ordered logit			2SRI			2SPS		
	Trust=0	Trust=1	Trust=2	Trust=0	Trust=1	Trust=2			
Intermediate social gap	0.083***	-0.029***	-0.053***	0.139***	-0.052***	-0.087***	0.151***	-0.089***	-0.062**
	(0.028)	(0.011)	(0.017)	(0.040)	(0.017)	(0.023)	(0.038)	(0.020)	(0.029)
High social gap	-0.095**	-0.051**	0.146***	-0.053	-0.057**	0.110***	-0.046	-0.077***	0.123***
	(0.041)	(0.023)	(0.039)	(0.047)	(0.023)	(0.042)	(0.047)	(0.025)	(0.043)
Crime	0.085	0.223***	-0.307***	1.442*	-0.199	-1.243**			
	(0.082)	(0.083)	(0.079)	(0.815)	(0.269)	(0.564)			
Crime residuals				-1.382*	0.428*	0.954*			
				(0.821)	(0.259)	(0.565)			
Crime predictor							1.538*	-0.469*	-1.068*
							(0.816)	(0.254)	(0.564)
Social capital	-0.038*	0.012*	0.026*	-0.030	0.009	0.020	-0.029	0.009	0.020
	(0.020)	(0.006)	(0.014)	(0.021)	(0.007)	(0.015)	(0.021)	(0.006)	(0.015)
Age	0.000	-0.001	0.001**	0.000	-0.001*	0.001	0.000	-0.001*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Education	-0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Gender	0.027	-0.008	-0.019	0.035*	-0.011*	-0.024*	0.035*	-0.011*	-0.024*
	(0.017)	(0.005)	(0.012)	(0.018)	(0.005)	(0.012)	(0.018)	(0.005)	(0.012)
Discrimination	0.035**	-0.011**	-0.024**	0.033*	-0.010*	-0.023*	0.034**	-0.010*	-0.024**
	(0.017)	(0.005)	(0.012)	(0.017)	(0.005)	(0.012)	(0.017)	(0.005)	(0.012)
Indigenous	0.064*	-0.021*	-0.042*	0.071**	-0.024*	-0.047**	0.072**	-0.024**	-0.048**
	(0.034)	(0.012)	(0.022)	(0.034)	(0.012)	(0.021)	(0.033)	(0.012)	(0.021)
Health services	-0.019	0.006	0.013	-0.028	0.009	0.019	-0.030	0.009	0.020
	(0.019)	(0.006)	(0.013)	(0.020)	(0.006)	(0.014)	(0.020)	(0.006)	(0.014)
Subsidies	0.010	-0.003	-0.007	0.023	-0.007	-0.016	0.022	-0.007	-0.015
	(0.024)	(0.008)	(0.017)	(0.025)	(0.008)	(0.017)	(0.025)	(0.008)	(0.017)
North	-0.106***	0.073***	0.033*	-0.104***	0.072***	0.032*	-0.097***	0.082***	0.015
	(0.021)	(0.016)	(0.018)	(0.021)	(0.016)	(0.017)	(0.020)	(0.016)	(0.017)
South	-0.092***	0.055***	0.037**	-0.087***	0.054***	0.034*	-0.089***	0.068***	0.021
	(0.022)	(0.016)	(0.018)	(0.022)	(0.016)	(0.018)	(0.022)	(0.017)	(0.018)
Year 2011	-0.124***	0.090***	0.034**	-0.145***	0.097***	0.048***	-0.147***	0.103***	0.044***
	(0.018)	(0.013)	(0.015)	(0.022)	(0.014)	(0.017)	(0.022)	(0.014)	(0.017)
Observations		4585			4585			4585	
F		8.84			8.46			8.410	
Prob > F		0.000			0.000			0.000	

Note: Significance levels denoted by: * p<0.10, ** p<0.05, *** p<0.01. Marginal effects for factor levels is the discrete change from the base level, computed at covariates mean values, and show the effect of discrete changes in dichotomous indicator variables. Standard errors are presented in parenthesis. The F statistics computed are F(23, 4562), F(24, 4561), and F(23, 4562) for the ordered logit, 2SRI, and 2SPS models respectively. As stated before, use of pseudo-R^2 is not appropriate for non-independent sampled observations, the software Stata does not allows to force reporting of the statistic. Source: SEDESOL-PNDU (2005), SEDESOL-PNDU (2011), Coneval (2005), Coneval (2010), DGIS (2015), CNS (2015).

Chapter 4

Competition in Illegal Markets: Criminal Organisations *versus* the Government

This chapter looks at competitive interaction between a government and an crime organisation when they involve in Cournot competition in a crime market aiming at capturing as much rents from society as they can. In the model, authorities invest in eradicating criminal activities using resources that society is willing to provide for the combat of crime, while the criminal organisation seeks to capture the same resources with criminal activities. This allows to analyse the actions of the government when it is a competitor of th e criminal organisation in pursuing extraction of rents from society. An additional feature of the model is that the magnitude of the rents that can be extracted are endogenised, and result from the interaction of authorities and criminal organisations, and the preferences of society towards crime. The chapter presents characterisations of the possible solutions that can emerge within the setting, and equilibira are distinguished into equilibrium aggression areas. Comparative statics analysis is presented to study public policy implications of increases in punishment, exogenous shocks to defence costs, and incursion investments.

4.1 Introduction

Crime is an activity that has been and is part of every society, and has many implications for the way they function and develop. The effect crime has on individuals and societies has caught the attention of social scientists, particularly economists, over the years. In economics, an important seminal point in research on crime was marked by Becker

(1968), whose work on the rationality behind individuals decision to participate in criminal activities has been the source of a vast production of theoretical analysis of crime from the economics perspective, along with an equally significant volume of empirical literature. This theoretical and empirical economic work has played an active role influencing our understanding of individuals' participation in crime activities, and the design of crime deterrence policies, including the way in which resources are assigned to implement such policies.

Although an important part of research on crime has orbited around the study of rational individual behaviour, following the agenda set by Becker (1968), there are other approaches to the study of crime that have focused on criminal organizations, embracing the study of criminal firms and theories of competition with the state (see Fiorentini and Peltzman (1997), chapter 10 of Albertson and Fox (2011), and Abadinsky (2013)). One of the earliest modern attempts to study crime from an organisational perspective is Schelling (1967). In his work, Schelling calls for the possibility of theories of the firm in economics, *mutatis mutandis*, to be applicable to the study of the activities in the "underworld", and indeed economics has illuminated the understanding and the design of policy on crime. As noted by Liddick (1999), the *enterprise model* takes a look at organised crime from a point of view in which actors act as firms that participate in economic markets, aiming at extracting economic rents in activities that are socially defined as illegal. This line of work investigates the emergence of such organisations, the forms in which they operate, and the possible options available to combat them. In an extended survey on organised crime, Abadinsky (2013) describes how cumbersome establishing a definition of organised crime is, both in academia and in the legal practice of its combat. Although the author evades offering a precise definition for organised crime, he enumerates characteristics shared by most of its entities, stating that organised crime "has no political goals, is hierarchical, has a limited or exclusive membership, constitutes a unique subculture, perpetuates itself, exhibits a willingness to use illegal violence, is monopolistic, and is governed by explicit rules and regulations" (Abadinsky, 2013, p. 17).

The illegal status of organised crime generates a problem of sufficiency of information to develop quantitative and qualitative analyses to provide empirical results and inform policy. This problem is even more acute in the case of criminal firms compared to the case of individual's participation in criminal activities, as for the latter there is at least information generated by those who have been captured by the judicial system. This condition stresses the importance of theoretical work to inform the possible avenues for policing and the different scenarios that can emerge when such policy candidates are applied.

Additionally, the advent of globalization, widespread access to high technology and communications, the appearance of new criminal products and markets, and the marked sophistication of criminal organisations have generated a renewed interest in the topic. These factors have allowed criminal organizations to evolve into complex firms, that diversify their products and markets, and that have access to newer technologies and state of the art organisational strategies. As criminal organizations become more relevant in economic, political, and social terms, these organisations transform into more sophisticated and powerful agents. Hence, the attention of scholars, governmental agencies, the private sector and the public in general has focused on their development and the policies directed to control them. Examples of recent efforts can be found in studies and reports that focus on the recent criminal activity escalation in Latin America (Di Tella et al., 2010), the measurement of the economic impact of criminal organizations in the United Kingdom (Dubourg and Prichard, 2007), the diversification of activities carried out by illegal firms (Europol, 2013), and the creation of new economic units and research initiatives for the study of crime (Cook et al., 2014).

On the other hand, persistence of crime, which implies the coexistence of the state and criminal organisations, is ubiquitous to societies and is regarded as part of the *status quo*. The incapacity of the state to eradicate criminal organisations like mafias, drug trafficking organisations, and criminal syndicates has historical roots in the rejection of power by legitimate entities, disproportionate bureaucracy, and the possibility for illegal markets to exist (Anderson, 1995). For the present work, the assumption that the state competes with a criminal organisation is parallel to other settings in the literature which the state is modelled as a rent extraction entity, and so is its competing rival, being it a criminal organisation or other forms of opposition. This point of view is also defended in Powell (2013), Moselle and Polak (2001), and Grossman (1997) for example. In this regard, the fact that those in charge of security are unable to eliminate crime may be related to the policies at which such entities aim, and that can be related to regulation and not to extermination. Skaperdas (2001) shares this view on the impossibility of total eradication of crime by the state and on policies oriented to its control instead. Quoting Friedman (2008) "the problem faced is not how to defeat the aggressor but only how to make aggression unprofitable". In the same line, Kumar and Skaperdas (2008) argue that organised crime emerges when the state is weak. They highlight that the state's inability to have full monopolistic control of force is more salient when distance, physical and ideological, of the state with geographical places and the population in more marked, as it creates a vacuum that criminal organisations advantage to stablish their presence.

Competition over control of violence is at the heart of certain research on crime and violence. In these settings, the government values attaining full control over violence,

a situation that leads to conflicting scenarios. Studies of crime from the perspective of criminal organisations that operate for the monopoly of violence, to accumulate power or economic rents and that generate violent conflicts, lay close to the treatment of criminal organisations as firms that compete with the state within societies. This view of the government as an entity seeking to maintain a monopoly of violence can be found in Weber et al. (2004). In his lectures, Weber sustains that "nowadays, in contrast, we must say that the state is the form of human community that (successfully) lays claim to the monopoly of legitimate physical violence within a particular territory" (Weber et al., 2004, p. 33). On the other hand, it can also be convenient for the state and society to create conditions for the existence of criminal organisations, so they can provide goods and services that the state or society cannot deliver, as Kumar and Skaperdas (2008) affirm "the state itself can create such conditions by effectively ceding control of contract enforcement through the prohibition of production and distribution of certain goods and services"(Kumar and Skaperdas, 2008, p. 5).

A clear attempt at modelling this view from a theoretical stand can be found in Powell (2013), who presents a model of conflict in which the monopoly of violence is at stake. In an infinite-horizon setting, a government confronts an opposed force to keep its unanimous control over violence. Two possible policies are examined in his work, one in which the government can opt for sharing control over violence, and another one where it can confront the opponent, aiming at gaining full control. When choosing to gain control, Powell shows that the lack of commitment on both parties leads to armed conflict, coercive power on the side of the government, produces small opportunity costs of fighting, and creates incentives to consolidate its domain over violence by force instead of reaching agreements via economic transfers.

Although the roots of the state makes it natural for it to seek full control over violence, the dominant character of criminal organisations within their territories, places the state in a disadvantaged position. As Skaperdas and Syropoulos (1997) discuss, the relation between the state and criminal organisations is a "live-and-let-live arrangement", which leads to the coexistence of authorities and criminal organisations we commonly observe. Moreover, the authors argue that with shared control over violence, the ones that dominate are criminal organisations. This observation reinforces the hypothesis on the incapacity on the side of the authorities regarding total extermination of crime. In his treatment on the origins of the state and its evolution through time, Barzel (2002) shares the same view of criminal organisations having an advantage over the state in its areas of domain. The author argues that "states can neither easily overpower criminal organisations nor effectively compete with them in their domain" (Barzel, 2002, p. 228). Notice that the illegal nature of the operations of criminal organisations does not allow for judicial contractual enforcement, as observed by Garoupa (2007)

and Gambetta (1994), who analyse the behaviour of mafias that cannot recur to legal instances for inscrutable markets. This is also noted by Polo (1995, p. 87), when defining a criminal organisation as one that "cannot rely on the external enforcement of the judicial institutions and... are not constraint by the law". Competition of the state with criminal organisations to capture rents from society is researched in models in which the state is considered a rent extracting institution. One example of such approach can be found in Grossman (1997). There, the author presents a model of competition between the state and the mafia in the provision of public services like property rights and contract enforcement. The author finds that criminal organisations can be of benefit to society, by increasing net income, if there is competition between the criminal organisation and the state, and this can be maintained as long as the power of the former can be controlled by the latter.

Other studies focus on the effects that organised crime has on society, and on how policies directed to reduce their activity can affect welfare. For example, to study hierarchical criminal organisations, and to compare them with competitive criminal markets, Garoupa (2000) builds a model of organised crime with hierarchical structures. The hierarchy is composed by a principal (mafia) that organises, via extortion, a number of individual criminal firms that are directly involved in criminal activities. His results indicate that no intervention by authorities can be welfare improving in the case of hierarchical structures in criminal organisations compared to a situation where there is competition amongst criminal firms. However, if the operation costs of the mafia are high, then society is better off if the authorities regulate crime more severely. Also, when studying organised crime and corruption, Kugler et al. (2005) find that policies directed to reduce crime can produce higher crime rates when the state is institutionally weak, this case emerges because the existence of complementarities between crime and corruption contribute to increase criminal's rents when anti-crime policing intensifies.

In this chapter, a model is developed to evaluate strategic behaviour that emerges between a criminal firm and the government when they compete for rents in a crime market. The interaction involves three players: society's representative individual, the authorities, and a criminal organisation. Authorities and the criminal organisation are modelled as payoff maximising entities that participate in criminal markets seeking to capture rents from society by securing or capturing agents. The authorities invest in eradicating criminal activities using resources that society is willing to provide to combat of crime. This allows to analyse the actions of the government when it is a competitor of the criminal organisation in pursuing extraction of rents from society. The analysis also permits to analyse policies based on the distribution of resources, and penalties applicable to the criminal organisation. The interaction between criminal firms and authorities is modelled as a Cournot competition game, where resources are

allocated to a criminal market, affecting the probability of success for each player when engaging in a battle.

The chapter follows the approach of Liddick (1999), Garoupa (2000), Grossman (1997), and Chang et al. (2013) of treating criminal organisations as firms. Similarly, the assumption of the government as a rent extracting entity, organised as an enterprise, is similar to the approach of Moselle and Polak (2001), Grossman and Noh (1990), and Grossman (1997). In these and other related work, a rent extracting state is defined as a *kleptocratic state* is understood as one in which "the state is controlled and run for the benefit of an individual, or a small group, who use their power to transfer a large fraction of society's resources to themselves" (Acemoglu et al., 2004, p. 1).

Different from these approaches, in this chapter the state is modelled as a competitor of the criminal organisation in an illegal market. Although it does not produces crime in itself, the state *secures* potential victims of crime in the market. As capture of individuals is mutually exclusive, competition emerges between the two participants when they aim at capturing individuals to maximise expected payoffs. By treating the authorities and the criminal organisations as extractors of resources from society, the present analysis aims to understand crime emergence, and why it is so persistent in some societies. Additionally, in order to introduce a hierarchical structure of criminal organisations and governmental authorities, these players are modelled as two-layered organisations.[1] In the model, the price of crime (the amount that can be extracted from society from each unit of crime) is endogenised as a result of the interaction of authorities and criminal organisations, taking into account the preferences of society.

To the best of the author's knowledge, there has been no attempt to analyse the behaviour of organised criminal groups based on competition in criminal markets with the state, at least from a theoretical perspective. There certainly are examples of interaction between the state and criminal organisations, the latter usually in the form of mafias or gangs, but competition in those works is rather indirect (see for example Grossman (1997), Garoupa (2000), Garoupa (2007)). The aim of this chapter is to contribute in this regard with a model that helps analyse the interaction between a rent extracting government and criminal organisations operating in criminal markets.

4.2 Model

The setting of the model is the following. There are three agents in the model: society, a criminal organisation, and the authorities. The three agents interact in a crime market,

[1] See Adamoli et al. (1998), Kumar and Skaperdas (2008) and Chang et al. (2013) for arguments about the hierarchical structures in criminal organisations.

with society participating in a passive manner while the criminal organisation and the authorities play an active role. Both authorities and the criminal organisation know the utility function of the representative agent, and use this information to find society's willingness to pay for crime, which will be considered as the price of crime in the model. The price of crime is the amount that can be extracted from society per unit of crime committed (by the criminal organisation) or prevented (by the authorities) in the crime market. As the price of crime emerges from individuals' maximisation of expected utility, this price is endogenously determined in the model.

In the model, authorities and the criminal organisation act as competitors that see individuals as "units of production". That is, the actions capturing an individual with crime and securing one from crime are equivalent to producing one unit in the market, the former produced by the criminal organisation, and the latter by the authorities. The authorities and the criminal organisation get involved in a Cournot competition seeking to maximise expected payoffs by capturing a share of the crime market. Both entities are constituted as two layered organisations, a first layer decides the competition policy, which consists on determining the probability of success the organisation will aim at, while the second layer implements the technology available to implement the policy. It is assumed that both agents and their respective layers act simultaneously.

4.2.1 Model preliminaries

Assume a society in which a criminal activity that negatively affects society is present. In this economy, there are two active agents: a criminal organisation denoted by D, and the authorities denoted by P; and a passive agent: society, which is formed by identical individuals that share the same probability of experiencing crime and are represented by a representative agent. Player D intends to undertake the criminal activity, while P aims at preventing D of doing so. Crime can be related to illegal drugs or kidnapping for example, with each unit of crime representing an individual captured (as drug consumer or as a kidnapping victim) by D, or as an individual held safe (from drug consumption or from being kidnapped) by P. Thus, D can be regarded as the criminal operating in the economy, and P as the authorities which defend the interest of society by providing defence fighting the criminals.

The expected level of welfare perceived by society is given by the representative agent's expected utility $\underset{\varphi}{E}\big[U(C,k)\big]$, where C denotes consumption of a normal good, k is the number of crimes happening in the crime market, and $\underset{\varphi}{E}$ is the expectations operator under probability distribution φ. Both the authorities and the criminal organisation know the representative agent's utility function and use this information to derive

the price of crime and define their payoff functions given by $\underset{q}{E}\big(\pi_k^P(k, r, p_k, \gamma_k^P, C_k^P|q)\big)$ and $\underset{q}{E}\big(\pi_k^D(k, r, p_k, \gamma_k^D, C_k^D|q)\big)$ respectively, where $\underset{q}{E}$ is the expectations operator under probability distribution q, and r is the punishment for crime, p_k the price of crime, γ_k^P and γ_k^D the incursion investments in the crime market, and $C_k^j,\ j = \{D, P\}$ is the cost of securing or capturing a unit of k for P and D.[2]

Both players compete in this economy by "capturing" as many units as possible in the crime market using defence resources. Non of the competitors can select the number of units to get in the criminal market, instead they aim at reaching a certain probability of winning in the crime market, which can be thought as the fraction of the market dominated by each agent. Thus, both the authorities and the criminal organisation select the optimal probability of winning a battle in the crime market, and select the level of resources needed to reach that probability contingent on their rival's resource assignment.

As the two players interact in the economy competing for the units available, it seems appropriate to model their interaction as both players engaging in a competition game. In this game, players' choices are assumed to be made simultaneously, each player determining the optimal probabilities of winning a unit in the crime market, and ensuring this probability is reached implementing a given technology that has as inputs the amount of force assigned by each player. Additionally, players' interaction is assumed to emerge in the market in a Cournot-type competition, where they seek to reach their aimed probabilities, or secure a share of the market, and with Cournot-Nash equilibrium as solution concept emerging from this interaction. For simplicity, it is assumed that the resources used are proportional to the units in possession of each player, and the production process in the economy, which generates income I to society, is regarded as independent and thus as been solved separately.

Additionally, it is assumed that both P and D are multi-layered organisations (of two layers in the case modelled in this chapter), each layer is exclusively in charge of one of the stages of the game. Denote by P_1 the first layer of P, and by D_1 the first layer of D. These first two layers are in charge of designing the market policy. Similarly, let P_2 and D_2 denote the second layers of P and D respectively. With these last two in charge of implementing the market policy. That is, P_1 and D_1 determine the probabilities of winning in stage one of the game (the probability policies), while P_2 and D_2 are the levels in charge of implementing the available technology to fulfil the probability policies. This multi-level organisation setting, with separate roles in each stage, is introduced in the model to mimic the presence of hierarchical organisations in both governmental

[2]We will call individuals units, and will be referring to them as k. But the word individual might be used when more appropriate.

authorities and criminal organisations. It also allows to keep the model tractable once more structure is added to it later in the chapter.

4.2.2 Agents behaviour

The authorities the criminal organisation have as their prime objective to maximise their total payoff, which are partially determined by how much crime affects individuals well-being. The other components of the payoff functions are the penalties r imposed on the criminal firm in case P wins a battle, and their respective costs of securing or capturing a unit of S in any of the markets. In order to determine their strategies, players need information on how much society values (the absence of) crime. Thus, on a first step the inverse demands for crime for the representative member of society are estimated. These valuations indicate the price the criminal organisation can charge, or the premium the authorities perceive from society, for each unit of k captured or secured. The information contained in such valuations is used in the payoff function specification as analogous of prices.

Representative individual

By assumption all members of society are equal and experience crime with the same probability, so the analysis can be restricted to a representative member of society. Assume the utility perceived by such a representative individual is $U(C, k)$, where C is a consumption good that provides her with positive utility, and k is the number of crimes committed that lower her level of satisfaction. Let C have unitary price (numeraire), and let it be sold in a competitive market, thus there are no income effects and the analysis can focus on the crime market. Also, assume crime does not exhibits increasing marginal disutility, this assumption is distinct to that imposed in Becker (1974), and is substituted with constant marginal disutility to account for phenomena related to hedonic adaptation effects of the type suggested by Frederick and Loewenstein (1999). Thus an implicit assumption is made on increasing disutility and hedonic adaptation compensating for each other.

Let φ be a known probability distribution function from which the probability of crime derives, with $1 - q_k^P$ being the probability of any individual experiencing crime, and q_k^P the probability of not being a victim of crime. Assume the probability of an individual experiencing crime more than once is negligible and can be ignored. Let α_k be the disutility caused by crime k to any individual, this can be thought of as the negative psychological burden that crime causes to the individual. Given the probability of

experiencing crime, assume the representative agent has a quasi-linear utility function and let it be represented as

$$\underset{\varphi}{E}\big[U(C,k)\big] = \alpha_c C - \frac{1}{2}\beta_c C^2 - (1 - q_k^P)\alpha_k k \tag{4.1}$$

In Equation (4.1), $\underset{\varphi}{E}$ is the expectations operator under φ, $\dfrac{\partial U(\cdot)}{\partial C} > 0$, $\dfrac{\partial^2 U(\cdot)}{\partial C^2} < 0$, and $\dfrac{\partial U(\cdot)}{\partial k} < 0$, $\dfrac{\partial^2 U(\cdot)}{\partial k^2} = 0$, for all k. The parameters $\alpha_c > 0, \alpha_k > 0$ indicate the level of utility (positive for C, and negative for k) perceived in the margin. Notice that, consumption enters in a non-linear fashion, and k in a linear way, thus there is no account for increasing marginal disutility in k.[3]

Let I be the total amount of resources available to society. In principle, these resources are used to acquire a consumption bundle C. However, when there is crime in society, these resources also cover the costs imposed on society when facing crime k. If the unitary costs imputed to the individual when experiencing crime is p_k the budget constraint is $I = p_c\, C + p_k k$. Assuming the budget constraint is binding, society's welfare optimisation problem can be summarized as follows

$$\begin{aligned} &\max_{C,k} \left\{ \underset{\varphi}{E}\big[U(C,k)\big] \right\} \\ &\textit{Subject to} \\ &I = p_c\, C + p_k k \end{aligned} \tag{4.2}$$

The first results derived describe the amount of resources that society is willing to use to combat crime and its sensitivity to its parameters. This result emerges form society looking to maximize its well-being, taking into account the incidence of crime. This willingness to pay constitutes the price of crime in the crime market. This results are summarised in the following proposition.

Proposition 1. ***[Willingness to pay for defence and sensitivity indifference towards crime by society]*** *Let the preferences of a representative individual be defined by Equation 4.1, and the budget constraint being equal to $I = p_c\, C + p_k k$. Then, the problem society faces is the one stated in Equation 4.2. Under the assumptions of the model, society's willingness to pay to avoid crime is given by*

[3] Consistency demands restricting the model in such a way that $\dfrac{\partial U(\cdot)}{\partial C} \neq 0$. This assumption discards the possibility of undefined values later on.

$$p_k = -\big(\frac{\alpha_k}{\alpha_c - \beta_c C}\big)(1 - q_k^P) \tag{4.3}$$

Assuming C is a normal good the following holds:

i) Strong preferences for consumption imply a higher tolerance to crime.

ii) Lower income individuals will be less willing to contribute to defence.

iii) Higher disutility of crime increases the disposition to pay for security.

iv) Higher crime probability produces higher disposition to expend in security.

Proof of Proposition 1. The first part of the proof derives the optimal price of crime stated in Equation 4.3 as follows. The utility function of the representative individual, as expressed in Equation 4.1, is $\underset{\varphi}{E}\big[U(C, k \in K)\big] = \alpha^c C - \frac{1}{2}\beta_c C^2 - (1 - q_k^P)\alpha_k k$, and her budget constraint is $p_c\, C + p_k k = I$. Society's optimisation problem is solved with respect to variables C and k; although C is the only choice variable for the individual, she treats k as the quantity she expects to be "consuming" of crime. Under these assumptions, the optimisation problem becomes

$$\begin{aligned} &\max_{C,k\in K} \Big\{ \underset{\varphi}{E}\big[U(C,k)\big] \Big\} \\ &\textit{Subject to} \\ &I = p_c\, C + p_k k \end{aligned} \tag{4.4}$$

From which we obtain the following first order conditions

$$\mathcal{L}_C :\ \alpha_c - \beta_c C - \lambda p_c = 0 \tag{4.5}$$

$$\mathcal{L}_k :\ -\alpha_k(1 - q_k) - \lambda p_k = 0 \tag{4.6}$$

$$\mathcal{L}_\lambda :\ p_c\, C + p_k k - I = 0 \tag{4.7}$$

From Equation (4.5) we get that $\lambda = \dfrac{\alpha_c - \beta_c C}{p_c}$, assuming C is a numeraire good, $p_c = 1$, and substituting λ into equation (4.6) we obtain the following result for p_k

$$p_k = -\left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)(1 - q_k^P) \tag{4.8}$$

The negative result indicates that individuals will have to be compensated in as much as is indicated in Equation (4.8) to "consume" the bad k. Thus, the willingness to pay for security against crime k is $\mid p_k \mid = \left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)(1 - q_k^P)$.

To see why claim i) holds, notice that the sensitivity of the price of crime with respect to preferences over consumption can be estimated as $\frac{\partial p_k}{\partial \frac{\partial U(\cdot)}{\partial C}} \cdot \frac{\partial \frac{\partial U(\cdot)}{\partial C}}{\partial C}$, which reduces to $\frac{\partial p_k}{\partial C} = \alpha_k \beta_c \frac{(1 - q_k^P)}{(\alpha_c - \beta_c C)^2} \geq 0$. Thus, higher consumption leads to higher willingness to pay for defence against crime. The marginal utility with respect to C equals $\frac{\partial U(C,k)}{\partial C} = (\alpha_c - \beta_c\, C)$, thus as the marginal utility of consumption increases, the amount society is willing to destine to defence expenditures decreases.

Claim ii) is shown to be true indirectly. Equation (4.8) does not has income as argument, however, the partial derivative of p_k with respect to C is positive, $\frac{\partial p_k}{\partial C} = \frac{\alpha_k \left(1 - q_k^P\right) \beta_c}{\left(\alpha_c - \beta_c C\right)^2} > 0$. Thus, comparing two individuals each with different consumption bundles, say $C^{'} < C^{''}$, we will obtain $\frac{\partial U(C^{'}, \cdot)}{\partial C} > \frac{\partial U(C^{''}, \cdot)}{\partial C}$ this given decreasing marginal utility in consumption, thus $p_k(C^{'}) < p_k(C^{''})$. Assume $\frac{\partial C}{\partial I} \geq 0$, that is C is a normal good, then those with lower income are willing to pay less for security.

For iii), the marginal disutility caused by crime equals the parameter α_k, a variation in the size of the parameter causes a change $\frac{\partial p_k}{\partial \alpha_k} = \frac{\left(1 - q_k^P\right)}{(\alpha_c - \beta_c C)} > 0$ in p_k. Finally, claim iv) comes from the partial derivative $\frac{\partial p_k}{\partial q_k^P} = \frac{-\alpha_k}{\alpha_c - \beta_c\, C} < 0$, that shows that the marginal effect of an increase in q_k^P on p_k is negative. The inverse effect is thus obtained for $\frac{\partial p_k}{\partial q_k^D} = \frac{\partial p_k}{\partial q_k^P}\frac{\partial q_k^P}{\partial q_k^D} = \frac{-\alpha_k}{\alpha_c - \beta_c\, C}(-1) > 0$, which is clearly positive.

□

Equation (4.3) provides the inverse demand for defence against crime, or the indirect demand for crime. The interpretation of p_k is similar to the concept "derived demand for crime" introduced in Ehrlich (2010). This amount is what society is willing to spend in security to avoid a unit of crime k. The negative value of p_k represents the expected transfer an individual would need to compensate for a unit of crime experienced. Thus, this is the amount the authorities will be able to "tax" from society to secure its members from being victims of a unit of k. These secured quantities, together with a possible

penalty imposed on crime perpetrators, is how much value P assigns to each unit of k when competing with D for them. Additionally, notice that p_k is also the expected amount that the criminal firm D will be able to charge to each individual when they are victims of crime, as individuals optimise taking into account the level of crime they will be experiencing, given the existent probabilities of crime.

The results derived in Proposition 1 show that society's willingness to pay for security against crime is directly proportional to the level of disutility crime causes to individuals, and indirectly proportional to the marginal utility of consumption. It also shows that a higher probability of being victim of crime increases society's willingness to expend on security. These observations are formally stated in the proposition as claim i) to claim iv). Claim i) in the proposition indicates that the price of crime, society's willingness to pay for avoiding a unit of crime, has a positive relation with consumption, and a negative one with its marginal utility. From Equation 4.1 we have $\frac{\partial U(C,k)}{\partial C} = (\alpha_c - \beta_c C)$. This is the marginal utility with respect to C, which is the divisor in $p_k = \big(\frac{\alpha_k}{\alpha_c - \beta_c C}\big)(1 - q_k^P)$, one can directly observe that a higher marginal utility decreases the amount society is willing to destine to defence against crime. As consumption and its marginal utility have an inverse relation, U exhibits decreasing marginal utility, higher C increases society's willingness to pay for security.

Claim ii) states that income and the price of crime are directly associated. That implies that those with higher income are willing to pay more for security than their counterparts. Although income cannot be implicitly found in the inverse demand for crime in Equation (4.3), we can conjecture about the linkage between income and the willingness to pay for security via another known linkage: that between the marginal utility of consumption and the level of income available for an individual. Comparing two individuals each with different consumption bundles, say $C' < C''$, decreasing marginal utility in consumption implies $\frac{\partial U(C',\cdot)}{\partial C} > \frac{\partial U(C'',\cdot)}{\partial C}$. Now notice that the derivative of $\mid p_k \mid$ with respect to C is positive, $\frac{\partial p_k}{\partial C} = \frac{\alpha_k \left(1 - q_k^P\right) \beta_c}{\left(-\beta_c C + \alpha_c\right)^2} > 0$, thus higher levels of consumption increase the willingness to contribute to defence, $p_k(C') < p_k(C'')$, which implies that those individuals with inferior levels of consumption are willing to pay a lesser amount for security. The intuition behind this result is the following, from Claim i) we know that p_k has a negative relation with marginal utility, thus those with higher consumption, whose marginal utility is lower, are willing to pay a higher price to avoid crime as their basic needs, represented by consumption, tend to be more satisfied than those with higher marginal utility. If we assume a positive relation between consumption and the amount of income available, that is if C is a normal good, then those with lower income are willing to pay less for security.

The last two claims are directly observed from Equation 4.3. An increase in the marginal disutility of crime, α_k, leads to an increase in p_k equal to $\frac{1-q_k^P}{\alpha_c - \beta_c C} > 0$. Additionally, the effect of increases in probability of victimisation equals $\frac{\alpha_k}{\alpha_c - \beta_c C} dq_k^D$, which is positive, showing that an increase in q_k^D causes p_k to also increase. The intuition of these results is straightforward: higher relative disutility of crime increases the willingness to contribute to avoid crime from happening. Similarly higher probability of being a victim increases the value of p_k.

In summary, the willingness to pay for defence, on the part of society, is directly proportional to the probability of crime happening, and to the disutility caused by crime. Additionally, societies with higher income tend to see their basic needs covered, and thus are willing to direct a higher amount of resources to avoid the negative effects of crime in comparison with lower income societies.

4.2.3 Authorities behaviour

Authorities (P) participate combating crime as a way of capturing rents by exploiting society's willingness to pay to avoid crime. P is a payoff maximising entity that operates at two levels: P_1 and P_2, and whose decision problem resides on choosing its optimal participation in the crime market. The first level P_1 is in charge of designing policies to fight criminal organisations, and a second level P_2 is responsible of making those policies effective. The set of P's optimal strategies is defined by maximising payoffs with respect to the probability of winning battles against organised crime. This assumption is not far apart from reality, if authorities knew where criminals will attack, they will respond with more efficiency than we observe today, even if authorities are colluding with criminals this information will be used to minimise the cost of defence.

P's payoffs are assume to proceed from three different sources, first P receives a payoff per unit secured in market k are described by Equation (4.3), second there is the initial investment that society is willing to place regardless of the existence of crime, and third P can secure resources from the criminal organisation by imposing penalties when a battle is won. The first component is precisely what individuals are willing to contribute to avoid one unit of k being captured by criminals, which translates into valuations for each unit of k secured by P. For the second source of payoff observe that, in many cases, institutions dedicated to the combat of crime exist whether or not there is a particular crime being committed. For example, police stations can be placed in an area to combat all types of crimes, and the force is ready to react to incursions of criminals in a given market. Denote this initial investment by γ_k^P. Regarding the third payoff component, P can impose penalties on D each time P secures a unit of k from

D. This is an approximation to the seized resources for unit captured by P. Let this value be equal to r_k per unit of k captured. On the other hand, participation in the market is costly for P, who disburses an amount derived from the costs of conflict equal to $C(q_k^P) := C_k^P q_k^P$, which is the cost incurred in aiming at reaching a probability of success q_k^P, and where C_k^P is a scalar that indicates the resources needed to reach the aimed probability of winning per-unit of k.

Using this information the first layer of the authorities, P_1, determines the optimal probability (q_k^P) of securing a unit of k. This part of the solution provides the "desirable crime incidence" in form of probabilities. Two possible scenarios unfold when P engages in competition with D in the criminal market: P either loses of wins the battle with corresponding payoffs given by

$$\pi^P(k,\cdot) = \begin{cases} \left(\dfrac{\alpha_k}{\alpha_c - \beta_c C}\right)(1 - q_k^P) + r_k - C_k^P q_k^P & \text{with probability} \quad q_k^P \\ -C_k^P q_k^P & \text{with probability} \quad 1 - q_k^P \end{cases} \tag{4.9}$$

And the total expected payoff for P, when participating in the criminal market is

$$\underset{q}{E}\left(\pi^P(\cdot)\right) = \gamma_k^P + q_k^P k\left[\left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)\left(1 - q_k^D\right) + r_k\right] - C_k^P q_k^P k \tag{4.10}$$

Once the probabilities are determined from the maximisation of payoffs described by Equation 4.10, the policy is implemented by P_2, the second layer of the organisation. P_2 produces q_k^P using a technology that depends on the assignment of inputs by both P_2 and D_2, the second layer of the criminal organisation.

Let e_k^P be the amount of resources that P directs to market k, and assume the technology available to P_2 to produce probability q_k^P is given by a contest success function as the following[4]

$$q_k^i = \begin{cases} \dfrac{e_k^j}{e_k^j + e_k^{j'}} & \text{if} \quad e_k^j \neq e_k^{j'},\ j \neq j' \\ \dfrac{1}{2} & \text{if} \quad e_k^j = e \ \text{ for } j, j' \end{cases} \tag{4.11}$$

[4]Appendix A elaborates on contest success functions. See Corchón and Dahm (2010), Konrad (2009), and Corchón and Dahm (2010) for extensive accounts on the literature on contests.

In Equation 4.11 the probability of winning for individual j is equal to the ratio of the amount of resources employed by that individual to the sum of all the resources used by all contesting participants. Notice that the assignment of resources affects the probabilities of winning, and a higher assignment of resources does not directly determine success, only increases the probabilities of being successful. This is a good approximation of confrontation between authorities and criminal organisations, where success not only depends on the amount of resources directed to the conflict.

Again, notice that γ_k^P is independent of the probability of P winning or losing a battle against D. Thus, this component of the profits is not being competed for. These resources must depend on D's technology, and P's relative effectiveness in the application of the resources to such technology, and translate in society's willingness to contribute to it. The following result illustrates the amount of resources required by P to be able to respond in case of an incursion of D into market k.

Lemma 2. ***[Counter incursion resources]*** *Assume the aggression technology of player $j = P, D$ is given by $q_k^j = \dfrac{e_k^j}{e_k^j + e_k^{j'}}$. Then the amount of resources needed, at market value, by P to counter player D's incursion in market k is given by*

$$\gamma_k^P = f_k^P \frac{q_k^P}{e_k^P + e_k^D} \left(\frac{\alpha_k}{\alpha_c - \beta_c C} + C_k^P - r_k \right) \tag{4.12}$$

Where f_k^P is a measure of P effectiveness at assigning resources to the aggression technology.

Proof of Lemma 2. By assumption the aggression technology for player $j = P, D$ is given by $q_k^j = \dfrac{e_k^j}{e_k^j + e_k^{j'}}, j \neq j'$. When player j enters the market it does so by marginally increasing its assignment of resources e_k^j, which increases its probability of winning in $\dfrac{\partial q_k^j}{\partial e_k^{j'}} = -\dfrac{e_k^j}{\left(e_k^j + e_k^{j'}\right)^2}$. Noticing that $\dfrac{e_k^j}{\left(e_k^j + e_k^{j'}\right)} = q_k^j$, we obtain the amount of force needed by P to counter D's assignment of force is $\dfrac{q_k^P}{e_k^P + e_k^D}$.

The marginal increase in willingness to pay by society when D incursions in k is $\dfrac{\partial p_k}{\partial q_k^D} = \dfrac{\alpha_k}{\alpha_c - \beta_c C}$, which is equivalent to the disutility caused by a marginal increase in crime to the representative agent. The cost of combating crime is C_k^P, and r_k represents what can be recovered, by P, from the criminal organisation. Thus the total cost net of what can be recovered equals $\left(\dfrac{\alpha_k}{\alpha_c - \beta_c C} + C_k^P - r_k \right)$. This amount multiplied by the resources needed to counter an initial level of aggression by D, and weighted by

a measure of effectiveness, f_k^j, of j's application of resources to counter D's incursion renders the stated result

$$\gamma_k^P = f_k^P \frac{q_k^P}{e_k^P + e_k^D} \left(\frac{\alpha_n}{\alpha_c - \beta_c C} + C_n^P - r \right) \tag{4.13}$$

□

The result in Lemma 2 indicates the value of the resources, in terms of the cost of crime to society, that P needs to assign to counter the impact on probability of winning when D decides to marginally increase its input, that is to incursion in the market. The marginal cost of crime to society is equal to the disutility it generates, plus the cost of combating crime, minus what P is able to seize from the criminal firm when a battle is won, that is $\frac{\alpha_k}{\alpha_c - \beta_c} + C_k^P - r_k$. When D decides to enter in the market, it does so assigning a unit of resources e_k^D, which increases the probability of D winning a battle in $\frac{q_k^P}{e_k^P + e_k^D}$. This is the total force needed by P to conter D's incursion. Finally, the first component on the right-hand side of Equation 4.12, the term f_k^P, represents the degree of relative efficiency in the use of resources by P, to react to the aggression of D, per unit of k. This can be interpreted as the fraction of the total net cost that society is willing to transfer to P for it to be ready to combat D.

P_1's choice problem consists on finding the optimal probability of success for the payoffs expressed by Equation (4.10), taking into account the result from Lemma 2. The solution to such problem renders the following result

Proposition 3. ***[Optimal winning probability for*** P***]*** *The optimal intervention policy for P in crime market k is given by the optimal probability of winning a battle*

$$q_k^P = \frac{\hat{\gamma}_k^P + \alpha_{kc} + r_k - C_k^P}{2\alpha_{kc}} \tag{4.14}$$

$$\textit{Where } \hat{\gamma}_k^P = f_k^P \frac{\left(\alpha_{kc} + C_k^P - r_k\right)}{e_k^P + e_k^D};\ \alpha_{kc} = \frac{\alpha_k}{\alpha_c - \beta_c C}$$

Proof of Proposition 3. P's problem consists on finding an optimal crime policy intervention, which is represented by the probability of winning a battle in the crime market, maximising its payoffs with respect to q_k^P.

This objective is reached when P finds $q_k^P \in \underset{q}{\text{argmax}} \left\{ \underset{q}{E} \left(\pi^P(k \mid q) \right) \right\}$, which is the solution to the following optimisation problem

$$\underset{q}{Max} \left\{ \underset{q}{E}\big(\pi_k^P(k|q)\big) = \gamma_k^P + q_k^P \Big[\big(\frac{\alpha_k}{\alpha_c - \beta_c C}\big)(1 - q_k^P) + r_n \Big] - C_k^P q_k^P \right\} \tag{4.15}$$

The first order conditions render

$$\begin{aligned} \frac{\partial \underset{q}{E} \left(\pi^P(k|q) \right)}{\partial q_k^P} = f_k^P \frac{q_k^P}{e_k^P + e_k^D} \left(\frac{\alpha_k}{\alpha_c - \beta_c C} + C_k^P - r \right) + k \left(\frac{\alpha_k}{\alpha_c - \beta_c C} \right) \left(1 - q_k^P \right) \\ + r_k k - q_k^P k \left(\frac{\alpha_k}{\alpha_c - \beta_c C} \right) - C_k^P k = 0 \end{aligned} \tag{4.16}$$

The second order condition is

$$\frac{\partial^2 \underset{q}{E} \left(\pi^P(k|q) \right)}{\partial {q_k^P}^2} = -2k \left(\frac{\alpha_k}{\alpha_c - \beta_c C} \right) \tag{4.17}$$

From the first and second order conditions we observe that P will attain a maximum as long as $\alpha_c - \beta_c C \neq 0$. Solving for q_k^P and letting $\alpha_{kc} = \dfrac{\alpha_k}{\alpha_c - \beta_c C}$ we obtain

$$q_k^P = \frac{\frac{f_k^P}{e_k^P + e_k^D} \left(\alpha_{kc} + C_k^P - r \right) + \alpha_{kc} + r_k - C_k^P}{2\alpha_{kc}} \tag{4.18}$$

Which is the stated result □

From the result stated in Proposition 3, the optimal probability depends on the net affectation of crime to society, how much P obtains in case of winning a battle, and also on how much of the initial investment needed is society is willing to allocate to the combat of the criminal organisation. It can be observed directly form the result that the higher the efficiency level, the cost to society of crime k, or the amount P can extract from society when winning a battle, the higher the optimal probability of success. Thus, a trade off emerges between being efficient at winning battles and allowing crime to persist, as P's payoff is affected by both in a positive way.

Once P_1 (the policy maker) has determined the optimal probability for market k, P_2 (the policy implementer) receives this information and uses its technology to determine the assignment of resources to participate in the crime market. The optimal assignment is described in the following proposition.

Proposition 4. ***[Allocation of defence resources to market*** k***]*** *Suppose the combat technology for P takes the form of a ratio contest success function, $q_k^P = \dfrac{e_k^P}{e_k^P + e_k^D}$, and the optimal probability of winning for P is the one given in Proposition 3. Then the optimal level of resources e_k^P is given by*

$$e_k^P = f_k^P + e_k^D \left(\frac{\alpha_{kc} + r_k - C_k^P}{\alpha_{kc} + C_k^P - r_k} \right) \tag{4.19}$$

Proof of Propositon 4. P_2's takes the optimal probability computed in Proposition 3 as given, then uses its combat technology to determine how many resources to assign to market k. That is

$$q_k^P = \frac{e_k^P}{e_k^P + e_k^D} = \frac{\dfrac{f_k^P}{e_k^P + e_k^D} \left(\alpha_{kc} + C_k^P - r \right) + \alpha_{kc} + r_k - C_k^P}{2\alpha_{kc}} \tag{4.20}$$

Solving for e_k^P gives

$$e_k^P = f_k^P + e_k^D \left(\frac{\alpha_{kc} + r_k - C_k^P}{\alpha_{kc} + C_k^P - r_k} \right) \tag{4.21}$$

Which is the stated result

□

Lemma 5. ***[Reaction proportionality]*** *The reaction by P_2 to an increase in resources assigned by D will be more than proportionate, $\Delta e_k^P \geq \Delta e_k^D$, when*

$$0 \leq r_k - C_k^P \tag{4.22}$$

That is, when the amount that can be seized from the criminal organisation is bigger than the cost of combating it, the policy enforcers will respond with a force more than proportional to the one applied by the criminal organisation.

The result stated in Lemma 5 is directly observable from Proposition 4, and can be obtained from condition $1 < \frac{\partial e_k^P}{\partial e_k^D}$. This result implies there is a threshold, $r_k - C_k^P = 0$, that determines if the change in the assignment of resources to k by P_2 is below or above the resources assigned by D. Thus, P_2 will "over-react" to the assignment of resources by D if $r_k > C_k^P$. The opposite, a less than proportional reaction, will hold if the inequality sign reverses in the latter expression.

The incentive determining the intensity of counter defence depends on the size of the disutility that crime causes to society relative to the marginal utility of consumption (α_{ck}). The excess of α_{kc} over the difference $r_k - C_k^P$ indicates if P_2 will react adding to the initial assignment f_k^P or not. If the disutility caused to society is not large enough, then P_2 will not assign resources, but consume those initially assigned. Only if α_{kc} is large enough will P_2 respond with increasing resources in the market. Thus, unless α_{kc} overweights $r_k - C_k^P$, P_2's reaction will be against what society wants in terms of authorities' participation in the market. If r_k is very large, then there are incentives to let the criminal organisation take a bigger share of the market. If on the other side C_k^P is too large, then it is too costly to combat crime, and there will be a sub-participation of the authorities as it is less profitable to intervene.

4.2.4 Criminal firm behaviour

The criminal organisation, on the other side, faces a decision problem where it ponders the benefits that participating in crime generates, together with the costs and the risk involved, and taking into account the possible penalties in case of losing against P. As in the case of the authorities, it is assumed that D functions as a two layer organisation, with D_1 in charge of determining the probability of winning, and D_2 using the aggression technology at hand to assign resources to reach that probability.

Also, the criminal organisation should be able to cover the cost of incursion in the crime market, this quantity should be enough to cover the reaction of P to D's incursion, and this at market value. Notice that this amount should be expected to be recovered by D if it decides to participate in the market, and thus must be part of its expected profits, otherwise it would not participate in the market. The initial investment D needs to make when entering into market k is given by the following lemma

Lemma 6. ***[Incursion resources]*** *Assume the aggression technology of player D is given by $q_k^D = \frac{e_k^D}{e_k^P + e_k^D}$. Then the amount of resources, at market value, needed by D to face counter resources by player P when entering the crime market are given by*

$$\gamma_k^D = \frac{(1-q_k^D)}{e_k^P + e_k^D} f_k^D(\alpha_{kc} + C_k^P - r_k) \tag{4.23}$$

Proof of Lemma 6. The proof of Lemma 6 is similar to that for Lemma 2. Notice that on the right-hand side of Equation 4.23, the term $(\alpha_{kc}+C_k^P-r_k)$ appears, this term represents the amount of resources P is getting from society to counter D's intervention in the market, these resources are scaled by the effect that an increase in e_k^D has on the probability of P winning, $\frac{\partial q_k^P}{\partial e_k^D} = -\frac{e_k^P}{\left(e_k^j + e_k^{j'}\right)^2} = \frac{1-q_k^D}{e_k^P + e_k^D}$, which is the expected increase in P's resources. The efficiency parameter of D also enters weighting the efficiency of D's assignment relative to P's efficiency. This gives the stated result

$$\gamma_k^D = \frac{(1-q_k^D)}{e_k^P + e_k^D} f_k^D(\alpha_{kc} + C_k^P - r_k) \tag{4.24}$$

□

The intuition behind Equation 4.23 is parallel to that of γ_k^P. The right-hand side of the equation represent the amount society is willing to transfer to P to counter crime. This amount is weighted by the effect of D's incursion on the probability of success for P, and by D's efficiency parameter.

As in the case of the authorities, in each battle against P, the criminal organisation faces the possibility of losing or winning a battle. Let q_k^D be the probability of D winning a battle in k and $1-q_k^D$ be the probability of D losing. The expected payoff for D of engaging on a battle with P are given by

$$\Pi^D(k,\cdot) = \begin{cases} \left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right) q_k^D - C_k^D q_k^D & \text{with probability} \quad q_k^D \\ -C_k^D q_k^D - r_k & \text{with probability} \quad 1-q_k^D \end{cases} \tag{4.25}$$

The total payoff for D, consisting on the sum of the incursion resources and the expected payoff, can then be expressed as follows

$$\begin{aligned} \underset{q}{E}\left(\pi^D(k|q)\right) = &\left(\frac{1-q_k^D}{e_k^P + e_k^D}\right) f_k^D\left(\alpha_{kc} + C_k^P - r_k\right) + q_k^D\left(\alpha_{kc} - q_k^D C_k^D\right) \\ &+ \left(1-q_k^D\right)\left(-r_k - q_k^D C_k^D\right) \end{aligned} \tag{4.26}$$

Notice that in Equation 4.26 all initial resources are consumed (the first term on the right-hand side) if $q_k^D = 1$. The solution to the optimisation problem by D_1 renders the following result

Proposition 7. ***[Optimal probability of winning a battle by*** D***]*** *Assume the payoff function for D is of the form stated in Equation 4.26. D's optimal probability of winning, when competing with P is given by*

$$q_k^D = \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{2\left(e_k^D + e_k^P\right)\alpha_{kc}} - \frac{r_k - C_k^D}{2\alpha_{kc}} \qquad (4.27)$$

$$Where \;\; \alpha_{kc} = \frac{\alpha_k}{\alpha_c - \beta_c C}$$

Proof of Propositon 7. The problem of player D consists on maximising its payoff $\underset{q}{E}\big(\pi^D(k \mid q)\big)$. As in the case of P, D cannot choose the values of k, what it can do is influence the probability of winning units of k, this objective is reached when D finds $q_k^D \in \underset{q}{\text{argmax}}\left\{\underset{q}{E}\big(\pi^D(k \mid q)\big)\right\}$. This optimal value is found by solving the following optimisation problem

$$\underset{q}{Max}\left\{\underset{q}{E}\big(\pi_k^D(k|q)\big) = \gamma_k^D + q_k^D\left(\alpha_{kc} - q_k^D C_k^D\right) + \left(1 - q_k^D\right)\left(-r_k - q_k^D C_k^D\right)\right\} \qquad (4.28)$$

The first order condition renders

$$\frac{\partial \underset{q}{E}\big(\pi^D(k|q)\big)}{\partial q_k^D} = \\ -\frac{f_k^D\left(\left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right) + C_k^D - r_k\right)}{e_k^D + e_k^P + \left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)q_k^D} + q_k^D\left(\left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right) - C_k^D\right) + r_k - \left(1 - q_k^D\right)C_K^D = 0 \qquad (4.29)$$

Solving for q_k^D and fixing $\alpha_{kc} = \left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)$ we obtain

$$q_k^D = \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{2\left(e_k^D + e_k^P\right)\alpha_{kc}} - \frac{r_k - C_k^D}{2\alpha_{kc}} \tag{4.30}$$

The stated result.

□

Given the optimal probability found by D_1, described in Proposition 7, D_2 uses its aggression technology to implement D_1's objective q_k^D. The following result summarizes this process

Proposition 8. ***[Allocation of aggression resources by** D**]*** *Given an aggression technology specified by* $q_k^D = \dfrac{e_k^D}{e_k^D + e_k^P}$. *The assignment of resources to the crime market by* D_2 *will be given by*

$$e_k^D = \frac{\left(C_k^D - r_k\right)e_k^P}{r_k + 2\,\alpha_{kc} - C_k^D} + \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D} \tag{4.31}$$

Proof of Proposition 8. The poof follows from Proposition 7, from where we know that

$$q_k^P = \frac{e_k^D}{e_k^D + e_k^P} = \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{2\left(e_k^D + e_k^P\right)\alpha_{kc}} - \frac{r_k - C_k^D}{2\alpha_{kc}} \tag{4.32}$$

Solving for e_k^D renders the proposed result

$$e_k^D = \frac{\left(C_k^D - r_k\right)e_k^P}{r_k + 2\,\alpha_{kc} - C_k^D} + \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D} \tag{4.33}$$

□

The resources assigned by D at the optimum have two components, the first one on the right-hand side shows the assignment of resources by P at market k, e_k^P, scaled by a the costs, the size of the punishment, and the cost that crime creates to society. Notice that even if e_k^P equals zero, D assigns resources to the market, these are represented by the second term on the right-hand side of Equation 4.31, which is related to the initial incursion investment by D. If $C_k^D - r_k < 0$ increases in e_k^P will lead to a reduction in e_k^D, as the cost of losing a battle against the authorities is relatively high with respect to the cost of increasing the probabilities of winning the battle.

4.2.5 Market interaction

The Cournot-Nash equilibrium in the crime market is found analysing the interaction of the reaction curves of both players, these are presented in Proposition 4 and in Proposition 8. Notice that the assignment of resources to the market will determine the probability of success for each player, but also the level of aggression, and thus violence, prevalent in the criminal market. As will be shown below, non-existence, and extreme and corner solutions cannot be discarded, and some interesting results arise when interior equilibria conditions are established. Corner solutions are also illustrative as they relate to crime eradication and highly violent crime.

An equilibrium in a crime market will be characterised by the level of resources assigned by players P and D, and by the emerging price of crime at equilibrium. An interior solution emerges under certain parameter values, and the shape of the reaction functions ensures single crossing when the conditions needed are fulfilled, the existence of this solution is stated in the following result

Proposition 9. ***[Interior equilibrium for market*** k***]*** *An interior equilibrium exists in the crime market under the following conditions:*

$$\gamma_k^P \neq 0 \text{ or } \gamma_k^P \neq 0, \text{ or both} \tag{4.34}$$

$$\frac{r_k + \alpha_{kc} - C_k^P}{\alpha_{kc} + C_k^P - r_k} < \frac{C_k^D - r_k}{r_k + 2\alpha_{kc} - C_k^D} \tag{4.35}$$

Such an equilibrium is given by the following resource assignments

$$e_k^P = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(\left(r_k + 2\,\alpha_{kc} - C_k^D\right) f_k^P + f_k^D\left(r_k + \alpha_{kc} - C_k^P\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + c_k^P - C_k^D\right)} \tag{4.36}$$

$$e_k^D = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(f_k^P\left(C_k^D - r_k\right) + f_k^D\left(\alpha_{kc} - r_k - C_k^P\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.37}$$

And equilibrium price in crime k market

$$p_k = \alpha_{kc}\frac{\left(r_k + 3\,\alpha_{kc} - 2\,C_k^P\right) f_k^D + f_k^P\left(C_k^P - r_k\right)}{2\alpha_{kc}\left(f_k^P + f_k^D\right) - f_k^D C_k^P} \tag{4.38}$$

Proof of Proposition 9. From Proposition 4, and Proposition 7 we can obtain the optimal resource assignments for player P and D respectively. These are the reaction functions of each player. Assume $\gamma_k^P \neq 0$ *or* $\gamma_k^P \neq 0$, *or both* , and $\frac{r_k + \alpha_{kc} - C_k^P}{\alpha_{kc} + C_k^P - r_k} < \frac{C_k^D - r_k}{r_k + 2\alpha_{kc} - C_k^D}$. Substituting the optimal values for e_k^D and e_k^P into the respective reaction function we obtain

$$e_k^P\left(e_k^D\right) = f_k^P + \left(\frac{\left(C_k^D - r_k\right)e_k^P}{r_k + 2\,\alpha_{kc} - C_k^D} + \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D}\right)\left(\frac{\alpha_{kc} + r_k - C_k^P}{\alpha_{kc} + C_k^P - r_k}\right) \tag{4.39}$$

$$e_k^D(e_k^P) = \frac{\left(C_k^D - r_k\right)\left(f_k^P + e_k^D\left(\frac{\alpha_{kc} + r_k - C_k^P}{\alpha_{kc} + C_k^P - r_k}\right)\right)}{r_k + 2\,\alpha_{kc} - C_k^D} + \frac{f_k^D\left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D} \tag{4.40}$$

From where we obtain

$$e_k^{P*} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(\left(r_k + 2\,\alpha_{kc} - C_k^D\right)f_k^P + f_k^D\left(r_k + \alpha_{kc} - C_k^P\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.41}$$

and

$$e_k^{D*} = \frac{\left(f_k^P\left(-C_k^D + r_k\right) + f_k^D\left(r_k - \alpha_{kc} + C_k^P\right)\right)\left(-\alpha_{kc} - C_k^P + r_k\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.42}$$

Which are the first stated results. Form Proposition 1 we know that

$$p_k = -\left(\frac{\alpha_k}{\alpha_c - \beta_c C}\right)(1 - q_k^P);\ k = n, m \tag{4.43}$$

Substituting the equilibrium levels of effort in to the price equation we obtain

$$p_k^* = \alpha_{kc}\frac{\left(r_k + 3\,\alpha_{kc} - 2\,C_k^P\right)f_k^D + f_k^P\left(C_k^P - r_k\right)}{2\alpha_{kc}\left(f_k^P + f_k^D\right) - f_k^D C_k^P} \tag{4.44}$$

Which is the price of crime k at equilibrium

□

Remark 1. The equilibrium probabilities of winning for P and D add up to one.

Proof. The equilibrium probabilities of winning are:

For P

$$q_k^{P*} = \frac{e_k^{P*}}{e_k^{P*} + e_k^{D*}} = \frac{\left(r_k + 2\,\alpha_{kc} - C_k^D\right) f_k^P + f_k^D \left(r_k + \alpha_{kc} - C_k^P\right)}{2\alpha_{kc}\left(f_k^P + f_k^D\right)} \tag{4.45}$$

For D

$$q_k^{D*} = \frac{e_k^{D*}}{e_k^{P*} + e_k^{D*}} = \frac{f_k^P \left(C_k^D - r_k\right) + f_k^D \left(-r_k + \alpha_{kc} + C_k^P\right)}{2\alpha_{kc}\left(f_k^P + f_k^D\right)} \tag{4.46}$$

Adding both probabilities renders

$$q_k^{P*} + q_k^{D*} = \frac{\left(2\,\alpha_{kc}\right) f_k^P + f_k^D \left(\alpha_{kc}\right)}{2\alpha_{kc}\left(f_k^P + f_k^D\right)} = 1 \tag{4.47}$$

□

The solution stated in Proposition 9 is the unique interior solution for market k. The existence of such solution is dependant on either $\gamma_k^P \neq 0$ or $\gamma_k^D \neq 0$ or both, with only one of the conditions being strictly needed, indeed $\gamma_k^j \approx \varepsilon$ for some $j = \{P, D\}$ suffices for an interior solution to exists. The fact that initial investments are different from zero at interior solutions indicate both society and the criminal organisation are willing to invest in aggression infrastructure. If this is the case, then the market must be exploitable, in the sense that it is either attractive to D or valuable enough to society, and thus P. Acknowledging this leads either P, D or both to assign $\gamma_k^P > 0$, or $\gamma_k^D > 0$.

Besides the interior solution, corner and extreme solutions can emerge in the model. A corner solution emerges if both $\gamma_k^P = 0$ and $\gamma_k^D = 0$, or if both players assign all their resources to the market, that is if $(e_k^P, e_k^D) = (max\{e_k^P\}, max\{e_k^D\})$ where $max\{e_k^j\}$ is the maximum amount of resources j can assign to market k. Under the former equilibrium, there is no aggression produced from both players, and the market ends up empty. The latter possibility emerges when full aggression arises within confined limits. Another possibility for a non-interior solution are extreme equilibria. Under these equilibria, one of the players assigns all its resources to the market while the other assigns just a fraction of them. The following proposition formalises these results.

Proposition 10 (**Corner and extreme solutions**). *For aggression levels of players P and D given by the reaction functions presented in Proposition 4 and Proposition 8.*

Assuming that, without lose of generality, $max\{e_k^j\} = 1$*, non interior solutions emerge under the following conditions*

i) Corner solution at $(e_k^P, e_k^D) = (0, 0)$ *if*

$$\gamma_k^P = 0, \gamma_k^D = 0 \tag{4.48}$$

For $\gamma_k^P \neq 0, \gamma_k^D \neq 0$ *the following results emerge:*

ii) Corner solution at $(e_k^P, e_k^D) = (max\{e_k^P\}, max\{e_k^D\}) = (1, 1)$ *if*

$$\begin{aligned}\left(slope\{e_k^P\}, slope\{e_k^D\}\right) &= \left(\frac{\alpha_{kc} + C_k^P - r_k}{r_k + \alpha_{kc} - C_k^P}; \frac{C_k^D - r_k}{r_k + 2\alpha_{kc} - C_k^D}\right) \\ &= \left(\left(1 - f_k^P\right), \frac{\left(\alpha_{kc} + C_k^P - r_k\right) f_k^D}{r_k + 2\alpha_{kc} - C_k^D}\right)\end{aligned} \tag{4.49}$$

iii) Extreme solutions at $e_k^P = max\{e_k^P\} = 1$ *or* $e_k^D = max\{e_k^D\} = 1$*:*

$(e_k^P, e_k^D) \equiv \left\{(e_k^P, e_k^D) \mid \left[(e_k^P, 1), e_k^P \in (0, 1)\right] \text{ or } \left[(1, e_k^D), e_k^D \in (0, 1)\right]\right\}$ *if*

For $e_k^P = max\{e_k^P\} = 1$

$$e_k^D < \frac{\left(1 - f_k^P\right)\left(\alpha_{kc} + C_k^P - r_k\right)}{r_k + \alpha_{kc} - C_k^P} \tag{4.50}$$

For $e_k^D = max\{e_k^D\} = 1$

$$e_k^P < \frac{\left(\alpha_{kc} + C_k^P - r_k\right) f_k^D - 2\alpha_{kc} - r_k + C_k^D}{r_k - C_k^D} \tag{4.51}$$

Proof of Proposition 10. Form Proposition 4 and Proposition 8 we know that

$$e_k^P = f_k^P + \frac{e_k^D\left(r_k + \alpha_{kc} - C_k^P\right)}{\left(C_k^P + \alpha_{kc} - r_k\right)} \tag{4.52}$$

and

$$e_k^D = \frac{\left(C_k^D - r_k\right) e_k^P}{r_k + 2\alpha_{kc} - C_k^D} + \frac{f_k^D \left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D} \tag{4.53}$$

The results for $\gamma_k^P = 0, \gamma_k^D = 0$ in Equation (4.52) and Equation (4.53) are equivalent to f_k^P and $\frac{f_k^D \left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D}$ being equal to zero. Substituting Equation 4.53 in Equation 4.52 and solving for the optimal assignment of resources we get

$$e_k^P = \left(\frac{\left(C_k^D - r_k\right) e_k^P}{r_k + 2\,a_{kc} - C_k^D}\right)\left(\frac{r_k + \alpha_{kc} - C_k^P}{C_k^P + \alpha_{kc} - r_k}\right) \tag{4.54}$$

With solution

$$e_k^P = 0, e_k^D = 0 \tag{4.55}$$

Which emerge on their own, or if $C_k^D = r_k$, or $r_k + \alpha_{kc} = C_k^P$ hold and conform a corner equilibrium. This result corresponds to case i) in the Proposition.

Another corner solution emerges at $(e_k^P, e_k^D) = (max\{e_k^P\}, max\{e_k^D\})$. The conditions needed for this case are found fixing both assignment of resources for the players to be simultaneously equal to their maximum, which is assumed to be equal to one for both players.

$$\begin{aligned} e_k^P = 1 &= f_k^P + \frac{e_k^D \left(r_k + \alpha_{kc} - C_k^P\right)}{\left(C_k^P + \alpha_{kc} - r_k\right)} \\ e_k^D = 1 &= \frac{\left(C_k^D - r_k\right) e_k^P}{r_k + 2\alpha_{kc} - C_k^D} + \frac{f_k^D \left(\alpha_{kc} + C_k^D - r_k\right)}{r_k + 2\alpha_{kc} - C_k^D} \end{aligned} \tag{4.56}$$

From where we obtain

$$\begin{aligned} \frac{\alpha_{kc} + C_k^P - r_k}{r_k + \alpha_{kc} - C_k^P} &= 1 - f_k^P \\ \frac{C_k^D - r_k}{r_k + 2\alpha_{kc} - C_k^D} &= 1 - \frac{\left(\alpha_{kc} + C_k^P - r_k\right) f_k^D}{r_k + 2\alpha_{kc} - C_k^D} \end{aligned} \tag{4.57}$$

This is case ii) in the Proposition.

The extreme cases where either e_k^P or e_k^D are equal to one are found fixing the value of one of the resources allocated by one player equal to one in the reaction function of the other player. Thus, for $e_k^P = max\{e_k^P\} = 1$ we get

$$e_k^D \leq \frac{\left(1 - f_k^P\right)\left(\alpha_{kc} + C_k^P - r_k\right)}{r_k + \alpha_{kc} - C_k^P} \tag{4.58}$$

And fixing $e_k^D = max\{e_k^D\} = 1$ we obtain

$$e_k^P \leq \frac{\left(\alpha_{kc} + C_k^P - r_k\right) f_k^D - 2\alpha_{kc} - r_k + C_k^D}{r_k - C_k^D} \tag{4.59}$$

Which are the conditions for which resource assignments locate at a maximum value for one of the players, and at a maximum or less for the other player. This corresponds to case *iii*).

□

Claim 1 (**Equilibrium non-existence**). *No equilibrium emerges from the interaction of players P and D when the slopes of the reaction curves are such that*

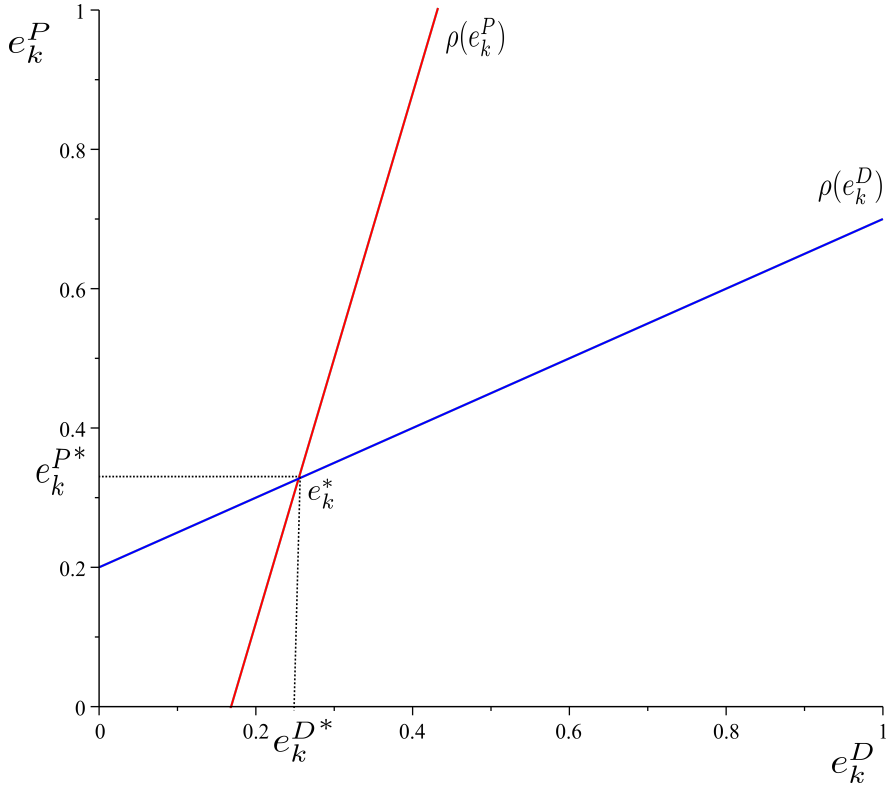
$$\begin{aligned} \frac{\alpha_{kc} + C_k^P - r_k}{r_k + \alpha_{kc} - C_k^P} &< \left(1 - f_k^P\right) \\ \\ \frac{C_k^D - r_k}{r_k + 2\alpha_{kc} - C_k^D} &< \frac{\left(\alpha_{kc} + C_k^P - r_k\right) f_k^D}{r_k + 2\alpha_{kc} - C_k^D} \end{aligned} \tag{4.60}$$

Proof of Claim 1. The proof derives directly from proof of Proposition 10. Notice that the conditions stated in that proposition negate the assertion in the present claim, thus depleting the existence of equilibria. For both reaction curves the slopes are lower than the $e^P = e^D$ ray that departs from the origin, which prevent them from crossing in the space $e^P \times e^D$. Intuitively, the reaction of each of the players is more than proportional at all levels, which leads them to reach the highest levels of aggression at a relatively fast pace. □

The former cases, stated in Proposition 10, imply the equilibrium strategy is for both P and D to direct no resources to market k, producing a corner solution at $\{e_k^P, e_k^D\} = \{0, 0\}$, or total assignment of resources to market k for one player and in the range $(0, 1]$ for the other, which are identified here as extreme and corner solutions. The last result, Claim 1, presents the conditions that produce no equilibrium. Notice that

the corner equilibrium at $\{0,0\}$ requires no initial investment exists for both players, that is, society is not willing to assign resources to market k, nor does the criminal organisation, then it must be the market is of no interest to either side. However, any infinitesimal increment in initial resources would lead to direct appropriation of a share of the market, thus a player just needs small incentives to participate in the market with some positive assignment of resources.

FIGURE 6: Interior equilibrium for market k



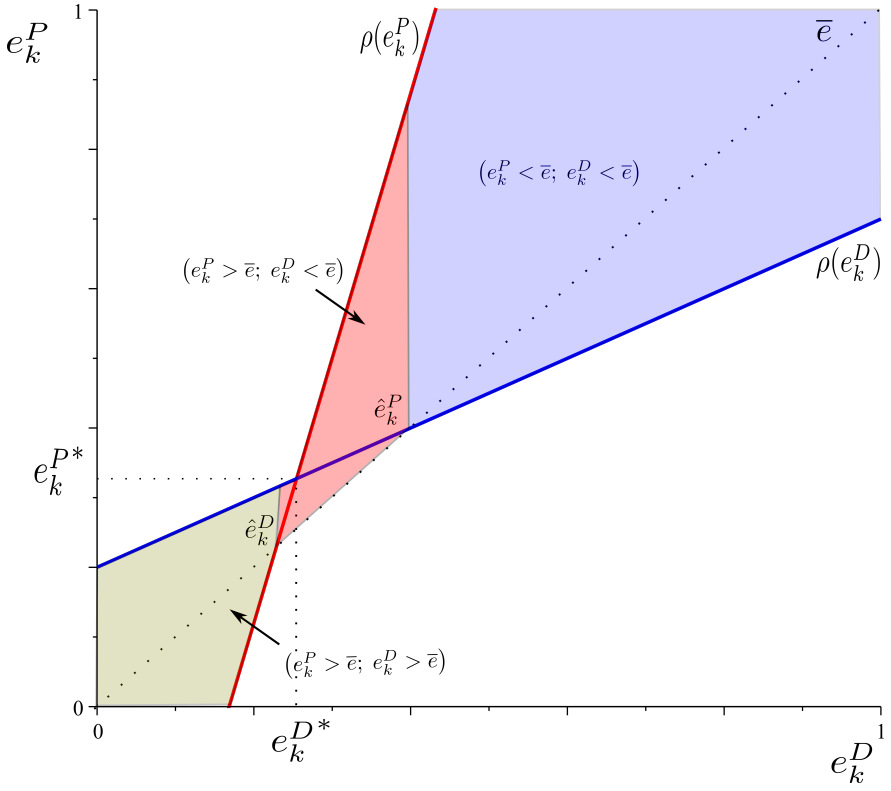
Note: . Figure produced using Maple software, for parameter values: $r = 0.3; f_k^P = 0.2; f_k^D = 0.2; C_k^P = 0.7; C_k^D = 0.8; \alpha_{kc} = 1.2$.

Extreme equilibria, with $e_k^j = 1$ for one of $j = \{P, D\}$, appears along maximum use of resources for one of the players and zero to its maximum for the other. For these equilibria, the measure of efficiency is the one that determines where the equilibrium will be set. The higher f_k^P, the more important market k is for P, the lower e_k^D will be. Intuitively, higher efficiency of P disincentives D to participate in the market, lowering its participation. The opposite happens with e_k^P, if D's effectiveness is high, it leads P to participate with higher resource assignments to counter D's incursion. This latter result is given to two incentives working for P, on the one hand it profits from the existence of crime, but on the other its function is to combat crime, which leads to increases in resources when D is more effective. This incentives are not present for D, thus its reaction to more efficiency on P's side. Regarding the result from Claim 1, as

both reaction curves are flatter than required for them to cross in the space $e^P \times e^D$ no equilibrium emerges. For this case, the reaction of each of the players is more than proportional at all levels, this leads them to reach high levels of aggression, with no equilibrium emerging.

Figure 6 graphically shows the solution stated in Proposition 9. Besides the interior solution, it is easy to see how the corner solutions can emerge, and also why restrictions on the slope of the curves are necessary for the interior outcome. The equilibrium is given at e_k^*, with resources assigned equal to e_k^{P*} and e_k^{D*}, by P and D respectively.

FIGURE 7: Relative aggression levels for P and D in market k



Note: Reaction functions plotted correspond to e_k^P and (e_k^D).

Relative levels of aggression can be determined by analysing the slope and the segments of the reaction functions of each player, and areas can be delimited to illustrate if the aggression response of each of the players is more than or less than proportional than the aggression of its rival. These areas of relative aggression reaction are shown in Figure 7. In the graph $\overline{e}$ indicates the segment line for which $e_k^P = e_k^D$, the areas are distinguished by colours in red: with $e_k^P > \overline{e}$, $e_k^D < \overline{e}$, that is, where P's aggression is more than proportional than the level of aggression of D, and D's aggression is less than proportional than that of P; green: where both D's and P's aggressions are more than

proportional than that of their rivals, that is, $e_k^P > \overline{e},\ e_k^D > \overline{e}$; and blue: where both levels of aggression by P and D are less than proportional than the level of aggression of the other player. A final possibility arises when both levels of aggression are equal: $e_k^P = e_k^D = \overline{e}$, this case is not depicted in the figure but will emerge if the reaction curves are displaced to the south and east until the equilibrium lies at $\overline{e}_k$.

The areas for which $e_k^P, e_k^D > \overline{e}$ are delimited by coordinate value $\hat{e}_k^P$ for player P at $\frac{f_k^P\left(1.2 + C_k^P - r_k\right)}{2C_k^P - 2r_k}$, and at $\frac{\left(1.2 + C_k^P - r_k\right) f_k^D}{2r_k + 2.4 - 2C_k^D}$ for player's D coordinate $\hat{e}_k^D$. The area delimited by the ray $\{0, \hat{e}_k^D\}$ marks the area where both players respond to aggression more than proportionally to that of the other player. In the segment $\{0, \hat{e}_k^D\}$ player D reaction is more than proportional to levels of aggression of P, after that point the response of D will be to assign a lower level of aggression to any level of resources placed by P (as long as resources have not been exhausted). Along the ray segment $\{\hat{e}_k^P, 1\}$ lies the area where both players response is less than proportional to the resources placed by their rival.

The segment of the ray $\{\hat{e}_k^P, \hat{e}_k^D\}$ shows the interaction between the two players where, in this case in particular, the equilibrium point is enclosed. In this area aggression is asymmetric, with P reacting more than proportional and D less than proportional to the aggression of the rival. In direction down-left of this segment (the green area) the levels of aggression are more than proportional for both parts. The opposite happens to the up-right direction of the segment where mutual aggression is less than proportional to that of the other player.

Thus, the section of the graph $\left(0, \hat{e}_k^D\right)$ represents the stages at which levels of aggression interaction by both players are more than proportional. Segment $\left(\hat{e}_k^D, 1\right)$, on the contrary, presents the less aggressive interaction between players. The distinctive behaviour of the players in different stages of aggression has implications for the stability of equilibria, this is analysed in the following section.

Equilibrium stability

The model presented is static in nature, nevertheless, it can still be informative when analysing the stability of equilibria in a quasi-dynamic analysis. The results from deviations from equilibrium are consistent and independent of the type of game being played in terms of the role of each player, that is, if player P or player D deviates from equilibrium the analysis does not changes. Thus, without loss of generality, when looking at stability and convergence outside equilibrium it is assumed the criminal organisation is the first to engage in aggression deviations from it, but it can be easily

seen that the results are symmetric when P deviates first. Before proceeding, define stability in the context of the model as follows

Definition 1. Let aggression digression be defined as the difference between aggression at equilibrium and a level of aggression shown by any player outside of equilibrium once equilibrium has been reached. An aggression equilibrium is stable if players behaviour when facing an aggression digression by their rival leads them to follow actions that pull them back to the departing equilibrium.

Let $D(e_k^j)$ represent aggression digression by player j, and let it be equal to the distance from equilibrium to the deviation value, that is [5]

$$D(e_k^{j'}) =\mid e_k^{j*} - e_k^{j'} \mid \tag{4.61}$$

Where $e_k^{j'}$ is the aggression level, shown by player j, deviating from equilibrium. The equilibrium is stable if

$$\frac{dD(e_k^{j'})}{de_k^{-j}} < 0 \tag{4.62}$$

Where e_k^{-j} is the level of aggression shown by player $-j$ when facing digression $D(e_k^j)$ by player j.

The following result shows the interior equilibrium presented in Proposition 9 is stable in the sense just defined above.

Lemma 11. ***[Equilibrium stability]*** *Under conditions stated in Proposition 9, a unique equilibrium exists, and this equilibrium is stable in the sense of Definition 1, that is, any deviation from it generates incentives for both players to follow strategies that converge to this equilibrium.*

Proof of Lemma 11. First notice that the functions $\rho(e_k^P), \rho(e_k^D)$ are continuous, strictly increasing in e_k^D and e_k^P respectively, and the inverse of each exists. Existence of equilibrium is shown in Proposition 9. The condition stated in Equation (4.34) guarantees that corner solutions can be discarded, and Equation (4.35) assures a single crossing of both reaction curves, $\rho(e_k^D)$ laying above $\rho(e_k^P)$ to the left of e_k^*, and below $\rho(e_k^P)$ to the right of the equilibrium point. Restricting to these conditions an interior equilibria emerges.

[5] As the model is static in nature, all the analysis refers to static stability. I follow (Gandolfo, 1997, pp. 169-175) to construct the definition and the analysis of stability.

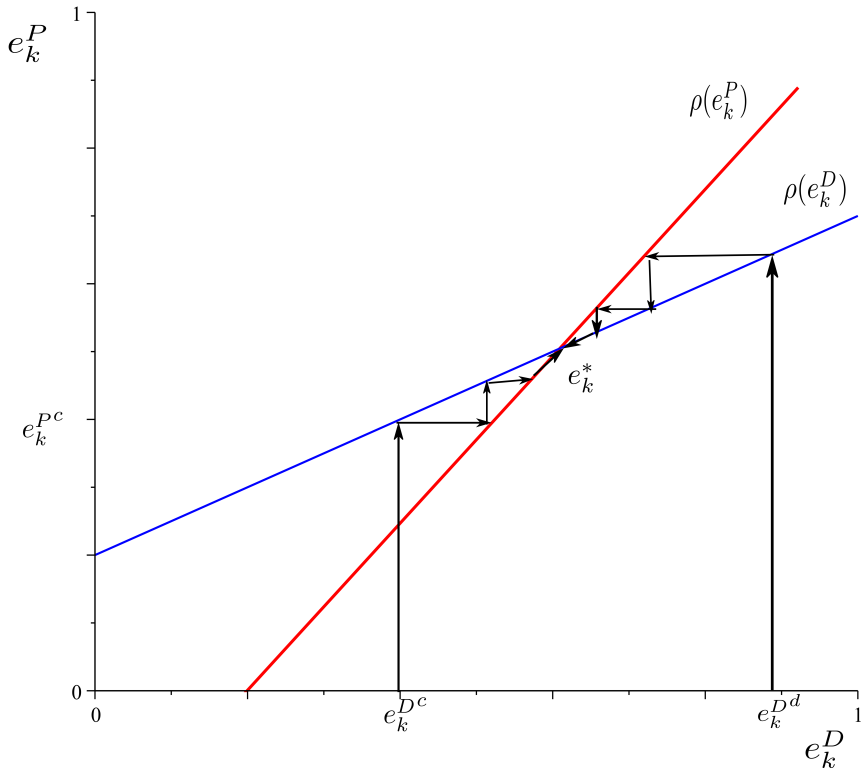
To prove equilibrium stability we divide the proof in two parts, each showing stability for deviations to either the left or right of the equilibrium point. Figure 7 will be used as reference. To begin with lets first consider the interval $[0, e_k^*)$, where e_k^* is the equilibrium point, this range corresponds to the set of points in the quadrant $e_k^P \times e_k^D$ that are located to the left of the equilibrium. Focus on the subset of points that lie in the reaction curves $\rho(e_k^P), \rho(e_k^D)$, in particular, take a point $e_k^{Dc} \in [0, e_k^{D*})$ that produces $D(e_k^{Dc}) > 0$ to the left of e_k^*. At that point $\rho(e_k^{Pc})$ is below $\rho(e_k^{Dc})$, which implies that $e_k^{Pc} = \rho(e_k^{Dc})$ corresponds to a higher level of aggression than that which would produce e_k^{Dc} as a reaction of player D, that is $\rho^{-1}(e_k^{P'}) < e_k^{Pc}$ where $e_k^{P'}$ is such that $e_k^{Dc} = \rho(e_k^{P'})$. The aggression level by P, e_k^{Pc}, produced as a reaction to aggression level e_k^{Dc} by D, in turn generates $\rho(e_k^{Pc}) > e_k^{Dc}$, which again produces a higher level of aggression on the part of P. Thus condition $\dfrac{dD(e_k^{jc})}{de_k^{-j}} < 0$ holds for all aggression levels laying in the players reaction functions along the segment $[e_k^{Dc}, e_k^{D*})$. The process repeats until players reach the equilibrium point e_k^*, point at which $\rho(e_k^{Dc}) = \rho(e_k^{Pc})$.

Similarly, for the interval $(e_k^*, max\{e_k^D\}]$ to the right of the equilibrium point, take a point e_k^{Dd} in that interval. At that level of aggression $D(e_k^{Dd}) > 0$. e_k^{Dd} generates a lower level of aggression on P than the one that would produce e_k^{Dd}, that is $\rho^{-1}(e_k^{P'}) > e_k^{Pd}$ where $e_k^{P'}$ is such that $e_k^{Dd} = \rho(e_k^{P'})$. In turn $\rho(e_k^{Pd})$ generates a reaction on D that involves less aggression than e_k^{Dd}. Again, $\dfrac{dD(e_k^{jc})}{de_k^{-j}} < 0$ for all points laying in the reaction curves of both players in the segment $(e_k^*, max\{e_k^D\}]$. The process continuous until the equilibrium point is reached. The analysis is the same if the crossing of the reaction functions takes place at different coordinates, and when P is the one that deviates from equilibrium.

□

Lemma 11 shows how stability arises under interior equilibria in the model. Take for example the equilibrium $e_k^* := \{e_k^{P*}, e_k^{D*}\}$ presented in Figure 6, the equilibrium is stable for any $e_k^{Dd} > e_k^{D*}$. As can be seen in Figure 8, the strategy of P to any such value is to respond with lower levels of aggression, and so is the strategy of D, thus the behaviour of the players converges towards $\{e_k^{P*}, e_k^{D*}\}$. The same is observed for $e_k^{Dc} < e_k^{D*}$, in this case the strategic response of both players consists in increasing levels of aggression, for any corresponding aggression level shown by the other player until the equilibrium is reached. Observe that, for the cases studied in this section, the slope of the reaction function of player D is higher than that of player P, this condition is stated in Equation 4.35, and guarantees the two reaction functions cross at some point e_k^*.

FIGURE 8: Stable equilibrium convergence in market k



Note: Reaction functions plotted correspond to e_k^D and $(e_k^P)^{-1}$. Parameter values are: $r = 0.3; f_k^P = 0.2; f_k^D = 0.2; C_k^P = 0.7; C_k^D = 0.8; \alpha_{kc} = 1.2$.

As it can be observed in Figure 7, to the left of the equilibrium point, it is sufficient for one of the players to show higher levels of aggression, relative to the ones that generate the other player's behaviour, to lead the interaction to equilibrium. Similarly, to the right of the equilibrium point, as long as one of the players exhibits lower levels of aggression relative to those that correspond to the other player's reaction, their behaviour will converge to the equilibrium. If confrontation starts at $e_k^{D^c}$ the strategies of both players consist on increasing levels of aggression until they reach the equilibrium point. If instead the confrontation starts at a point beyond equilibrium, such as $e_k^{D^d}$, the strategies of both players, as expressed by the reaction functions, indicate to respond with lower levels of aggression, relative to ones shown by them at the previous stage. Thus, both initial levels of aggression lead players to the equilibrium point, and any deviation from it will see players moving back to the aggression values indicated by the equilibrium strategy.

Crime eradication

The conditions that lead to crime eradication for a given market have been described only for corner solutions with zero assignment of resources by both players ($\rho(e_k^P) =$

$\rho(e_k^D) = 0$). Nevertheless, there is another possible result that leads to zero crime without zero resource assignment by both players. Assume the authorities are present in the market, $e_k^P \neq 0$, then the question is under which conditions D will assign zero resources? The following lemma states such conditions

Lemma 12. ***(Crime eradication with policing)*** *If P participates in the crime market, there will be a null assignment of resources by D if the following conditions hold for initial investment or punishment values*

$$f_k^P = \frac{f_k^D \left(\alpha_{kc} - C_k^P - r_k\right)}{C_k^D - r_k} \tag{4.63}$$

or

$$r_k = \alpha_{kc} + C_k^P \tag{4.64}$$

With $f_k^P < f_k^D$ if $C_k^P > \alpha_{kc} - C_k^D$.

Proof of Lemma 12. From Proposition 9, equilibrium conditions are given by:

$$e_k^{P*} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(\left(r_k + 2\,\alpha_{kc} - C_k^D\right) f_k^P + f_k^D \left(r_k + \alpha_{kc} - C_k^P\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.65}$$

$$e_k^{D*} = \frac{\left(f_k^P \left(-C_k^D + r_k\right) + f_k^D \left(r_k - \alpha_{kc} + C_k^P\right)\right)\left(-\alpha_{kc} - C_k^P + r_k\right)}{2\alpha_{kc}\left(a_{kc} + C_k^P - C_k^D\right)} \tag{4.66}$$

Setting $e_k^D = 0$ and rearranging we obtain

$$0 = \left(f_k^P \left(-C_k^D + r_k\right) + f_k^D \left(r_k - \alpha_{kc} + C_k^P\right)\right)\left(-\alpha_{kc} - C_k^P + r_k\right) \tag{4.67}$$

From the above equation we can see the conditions for zero assignments by D require

$$f_k^P = f_k^D \left(\frac{\alpha_{kc} - r_k - C_k^P}{C_k^D - r_k}\right) \tag{4.68}$$

or

$$\alpha_{kc} + C_k^P = r_k \tag{4.69}$$

□

Lemma 12 indicates that in order to deter D from participating in the crime market, initial investments by P need to be of a proportional magnitude to that of D. If $\alpha_{kc} = C_k^P + C_k^D$, then the cost of crime to society equals the total cost of confrontation between authorities and the criminal organisation. In this case, it will be required f_k^P to equal f_k^D, that is, P shows the same level of efficiency as D. Recall that f_k^P is assigned by society, thus it indicates what fraction of initial investments would be required from society to respond with in order to eliminate crime. If $\alpha_{kc} > C_k^P + C_k^D$ then the requirement will be $f_k^P > f_k^D$, that is, if the cost of crime to society is higher than society's total cost of engaging in combating the crime, then society has incentives to respond with more than proportional efficiency to that of the criminal organisation. The opposite holds if it is the case that $\alpha_{kc} < C_k^P + C_k^D$, in this case society's cost of engaging in conflict is higher than the cost of crime itself, thus it will respond with less efficiency than that shown by D.

The second condition, $\alpha_{kc} + C_k^P = r_k$, requires the criminal organisations to be fully liable of the cost caused to society. The level of punishment should in this case be equal to the cost of crime to society, plus the cost of combating the criminal organisation. These condition is stricter as it holds only if authorities are capable of recovering the whole cost to society, which can be cumbersome in most cases. However, if full liability is possible, it will be an effective way of keeping crime at zero, under this scenario the payoff perceived by P equal $f_k^P = f_k^D \left(\frac{2C_k^P}{\alpha_{kc} + C_k^D - C_k^D} \right)$, which is what society has to assign to maintain crime at a zero level.

4.3 Comparative statics for more than one market

In this section, comparative statics analysis is used to study the effect of parameter variations on the behaviour of the authorities and the criminal organisation. The analysis concentrates on changes in initial participation investments, and two variables of particular interest: variations in the penalties imposed to the criminal organisation, and cost reducing shocks. Penalties are a constant in crime deterrence discussions, and cost reducing shocks have become an important issue with increasing access to technology and globalisation. The analysis takes into account the direct effects of parameter variations on the primarily affected market, and indirect effects on secondary crime markets.

Up to this point the analysis has focused on a single market, however, societies are affected by a number of crimes not only one. Of all crimes present in society, some are fought, others do not, and those that are fought are so at different intensities. In a way it appears authorities decide which crimes are worth fighting and to what

extent they are worth fighting, combating crime in as much as they can (or want), selecting those they deem of higher importance first and then combating subsequent crimes in order of importance. Also, criminal organisations do not start operations in many markets at once, it seems more intuitive to think of them incursioning in the market they find more suitable, subsequently expanding to those markets that follow in order of importance. To resemble this observations, it is assumed both P and D follow lexicographic optimisation methods in which first they rank in order of importance each crime, and then they find the optimal amount of resources to assign to each single market, proceeding sequentially.

A phenomenon often referred to in Spanish speaking countries as the *cockroach effect*, and in Australasia as the cockroach bomb, refers to the situation in which interventions in one criminal market, defined as a region or a market in particular, lead to decreases in crime in that market while crime spurs in other markets, this last reaction caused by the initial intervention. In this section, when doing comparative statics, the analysis will take into account both the effect on the market where the initial intervention is made, and also the effect that can be expected on the rest of the markets as they experience indirect effects.

4.3.1 Initial intervention investments

Initial intervention investments are investments that P and D make to participate in the market. To illustrate how a variation in initial investments affects the equilibrium outcomes assume a positive change in f_k^P due to an increase in the importance of market k to society (and thus P), keeping all the remaining parameters constant. Variations on the importance of a crime can respond to internal pressure or changes. For example, an increase can respond to a change in the perception of certain crimes due to awareness campaigns, or to the pressure of groups that seek to push certain agenda influencing society and the policies against crime. The following result summarises this effect

Proposition 13. *Assume an increase in f_k^P takes place, then the change in resource assignment values at equilibrium is higher for player P than for player D if the criminal organisation is not fully liable of the cost of crime to society condition, and condition $\alpha_{kc} > \dfrac{C_k^D - C_k^P}{2}$ holds.*

Proof of Proposition 13. From Proposition 9 we know the equilibrium values for e_k^j are given by

$$e_k^{P*} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(\left(r_k + 2\,\alpha_{kc} - C_k^D\right) f_k^P + f_k^D\left(r_k + \alpha_{kc} - C_k^P\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.70}$$

and

$$e_k^{D*} = \frac{\left(f_k^P\left(-C_k^D + r_k\right) + f_k^D\left(r_k - \alpha_{kc} + C_k^P\right)\right)\left(-\alpha_{kc} - C_k^P + r_k\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.71}$$

The sensitivity of the reaction functions with respect to f_k^P are given by $\frac{\partial e_k^j}{\partial f_k^P}$

$$\frac{\partial e_k^P}{\partial f_k^P} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(r_k + 2\alpha_{kc} - C_k^D\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.72}$$

and

$$\frac{\partial e_k^D}{\partial f_k^P} = \frac{\left(-\alpha_{kc} - C_k^P + r_k\right)\left(r_k - C_k^D\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.73}$$

From Equation 4.72 and Equation 4.73, condition $abs\left(\frac{\partial e_k^P}{\partial f_k^P}\right) > abs\left(\frac{\partial e_k^D}{\partial f_k^P}\right)$ implies $\left(\alpha_{kc} + C_k^P - r_k\right)\left(r_k + 2\alpha_{kc} - C_k^D\right) > \left(\alpha_{kc} + C_k^P - r_k\right)\left(r_k - C_k^D\right)$ which is equivalent to $\left(-\alpha_{kc} - C_k^P + r_k\right)\left(r_k + \alpha_{kc} - C_k^D\right) < 0$. This result holds if $\left(-\alpha_{kc} - C_k^P + r_k\right) < 0$ and $\left(r_k + \alpha_{kc} - C_k^D\right) > 0$ or $\left(-\alpha_{kc} - C_k^P + r_k\right) > 0$ and $\left(r_k + \alpha_{kc} - C_k^D\right) < 0$

Conditions $\left(-\alpha_{kc} - C_k^P + r_k\right) > 0$ and $\left(r_k + \alpha_{kc} - C_k^D\right) < 0$ can be discarded as $\left(r_k + \alpha_{kc} - C_k^D\right) < 0$ implies $\left(\alpha_{kc} - C_k^D\right) < -r_k$. These leaves conditions $-\alpha_{kc} - C_k^P + r_k < 0$ and $r_k + \alpha_{kc} - C_k^D > 0$ to be satisfied. From these conditions we have $r_k < \alpha_{kc} + C_k^P$ and $\alpha_{kc} > \frac{C_k^D - C_k^P}{2}$.

□

This result shows under which circumstances a change in f_k^P will produce an effect of higher magnitude on the resources assigned by P than those assigned by D. Given that $\left(r_k + \alpha_{kc} - C_k^D\right) < 0$ implies $\left(\alpha_{kc} - C_k^D\right) < -r_k$, conditions $\left(-\alpha_{kc} - C_k^P + r_k\right) > 0$ and $\left(r_k + \alpha_{kc} - C_k^D\right) < 0$ can be discarded, as its sure gain net of costs is negative and the crime market is not profitable for the criminal organisation. This leaves conditions $\left(-\alpha_{kc} - C_k^P + r_k\right) < 0$ and $\left(r_k + \alpha_{kc} - C_k^D\right) > 0$ to be considered. From these conditions we have $r_k < \alpha_{kc} + C_k^P$, that is, D is not fully liable of the costs crime generates to society. Additionally, both conditions together require the marginal disutility for society to be bigger than half the difference between the cost of defence of the criminal organisation and the authorities, $\alpha_{kc} > \frac{C_k^D - C_k^P}{2}$. That is, the weighted marginal disutility of crime must satisfy a minimum threshold to provide incentives to P in order to increase its participation more than D.

The intuition behind this result is the following. If the criminal organisation cannot be made fully liable of the costs of its criminal actions, a higher order of importance for market k will lead P to reassign resources to that market as Equation 4.72 is positive, and the criminal organisation will have incentives to also increase its participation as long as $r_k > C_k^D$ in Equation 4.73. Ceteris paribus, both players will pull out resources from other criminal markets, these reassignments will leave other markets less protected as the reassignment by P will be higher than that of D, which makes the positions held by D easier to hold at other markets, and harder to hold at k. This leads to a reassignment of resources by D that is lower in magnitude than that of P to market k, as D reacts retracting, in relative terms, from this market as it becomes more competitive in the other markets. Under these premises, an increased intervention by authorities into a crime market will produce a cockroach effect, as the reassignment of resources by P and D is disproportional, producing a decrease in expected levels of crime in the directly affected market at the expense of increases in expected levels of crime in other markets.

4.3.2 Variations in r_k

r_k represents penalties or seized resources that authorities secure from the criminal organisation. Variations in the value of r_k can respond to external pressure similar to the ones international organisations or countries exert to guide or direct internal policies aiming at crime combat, or to address human rights and security issues. A typical example is the influence that the United States has had sponsoring the *war on drugs*, which has guided policies like the one implemented by the Mexican government against drug trafficking organisations. Variations on penalties can also respond to internal pressure. During electoral times there is a tendency to use crime policies to gain political capital, and criminal groups also use their power to influence policies. The following result informs on the effect of changes in r_k on criminal markets.

Proposition 14 (**Equilibrium variation from changes in** r_k)**.** *Changes in the equilibrium values of* e_k^P *and* e_k^D *as a response to a change in* r_k *are given by the following expressions*

$$\frac{\partial e_k^{P*}}{\partial r_k} = \frac{f_k^P \left(C_k^P + C_k^D - \alpha_{kc} - 2\, r_k\right) - 2\, f_k^D \left(r_k - C_k^P\right)}{2\, \alpha_{kc} \left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.74}$$

$$\frac{\partial e_k^{D*}}{\partial r_k} = \frac{f_k^P \left(2\, r_k - C_k^P - C_k^D - \alpha_{kc}\right) - 2\, f_k^D \left(r_k - \alpha_{kc}\right)}{2\, \alpha_{kc} \left(\alpha_{kc} + C_k^P - C_k^D\right)} \tag{4.75}$$

To illustrate the implications of a variation on fines imposed to the criminal organisation assume an increase in r_k. The following condition guarantees the level of resources assigned to market k by P will increase, while those assigned by D will decrease

$$f_k^P < \frac{2\ \alpha_{kc} f_k^D}{(2\ r_k + \alpha_{kc}) - \left(C_k^P + C_k^D\right)} \tag{4.76}$$

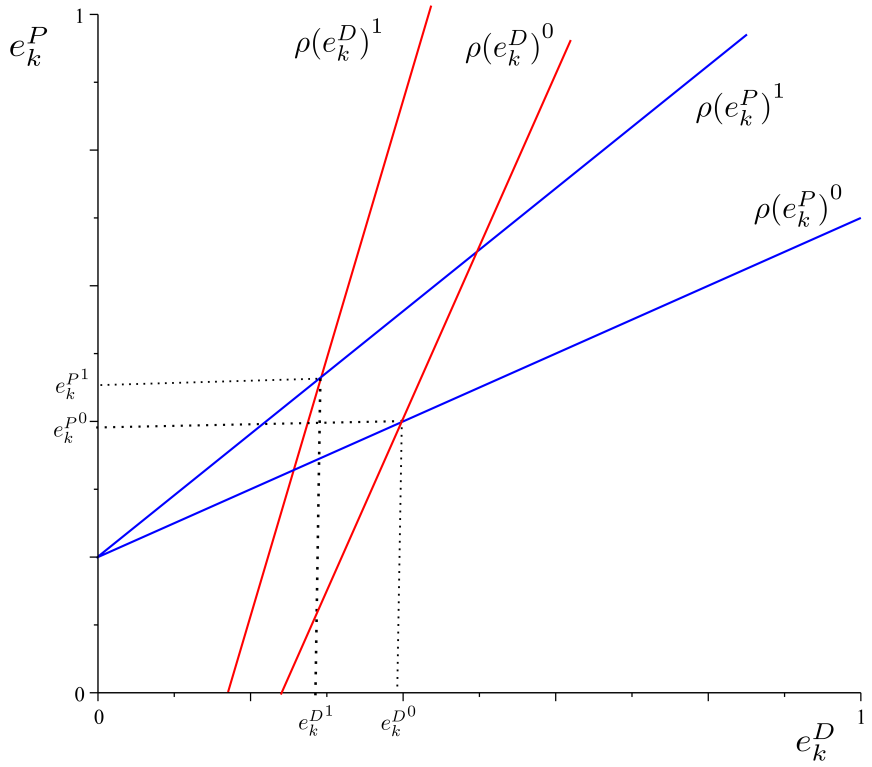
$$f_k^D < \frac{f_k^P\ \left(\alpha_{kc} + C_k^P + C_k^D - 2\ r_k\right)}{2\ (r_k - \alpha_{kc})} \tag{4.77}$$

Proof of Proposition 14. The proof derives directly from the partial derivatives of e_k^j with respect to r_k shown in the Proposition.

□

It is important to observe that a change in r_k only affects the slope in P's reaction function, but both the slope and the intercept in the case of D. That is, $\rho(e_k^P)$ changes its inclination and displaces when r_k varies, while $\rho(e_k^D)$ only shows a change in its steepness. Thus, for D a change in r_k has two effects, one on the sensitivity to e_k^P, and another that displaces k in order of importance.

FIGURE 9: Equilibrium variation by change in r_k



This case is illustrated in Figure 9, where the assignment of resources by P to the market increases while that of D decreases. This result emerges as, when facing an increment in r_k, the market becomes more profitable for P, and at the same time the prospects in case of losing a battle become more cumbersome for D.

The increase in resources used in market k by P proceed from the resources previously assigned to other crime markets, thus a decrease in resources should be expected in at least another crime market. If the criminal firm reassigns the resources freed from market k to the other markets, then the presence of D relative to P in other markets will increase, leading to a rise in the expected levels of crime.

4.3.3 Defence cost variations

Another interesting case that has gained relevance regarding efforts to combat organised crime relates to the cost structure of these organisation and their access to newer technologies. Recent developments in trade, technological accessibility, and armament trafficking have lead to considerable decrease in operational and defence costs of criminal organisations. To analyse the effect of changes in the cost structure assume a decline in C_k^D.

Proposition 15. *A change on the operation costs of the criminal organisation spurs a higher reassignment of resources by D than by P if the following condition holds*

$$f_k^P < f_k^D \frac{r^k}{r^k - C_k^P} \tag{4.78}$$

There will be an increase in the assignment of resources by both players if

$$f_k^P > f_k^D \frac{\left(C_k^P + r_k - \alpha_{kc}\right)}{\alpha_{kc} + C_k^P - r_k} \tag{4.79}$$

Proof of Proposition 15. First, the sensitivity of equilibrium values for the reaction functions need to be computed. Taking the first partial derivatives of each reaction function with respect to C_k^D we obtain

$$\frac{\partial \rho\left(e_k^{D^*}\right)}{\partial C_k^D} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(f_k^P\left(\alpha_{kc} + C_k^P - r_k\right) + f_k^D\left(\alpha_{kc} - C_k^P - r_k\right)\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)^2} \tag{4.80}$$

$$\frac{\partial \rho\left(e_k^{P*}\right)}{\partial C_k^D} = \frac{\left(\alpha_{kc} + C_k^P - r_k\right)\left(f_k^P + f_k^D\right)\left(r_k + \alpha_{kc} - C_k^P\right)}{2\alpha_{kc}\left(\alpha_{kc} + C_k^P - C_k^D\right)^2} \tag{4.81}$$

Equation (4.81) is positive under parameter assumptions $\alpha_{kc} + C_k^P - r_k > 0$. The condition under which Equation 4.80 is also positive requires $f_k^P\left(\alpha_{kc} + C_k^P - r_k\right) + f_k^D\left(\alpha_{kc} - C_k^P - r_k\right)$ to be higher than zero, which reduces to $f_k^P > f_k^D \frac{\left(C_k^P + r_k - \alpha_{kc}\right)}{\alpha_{kc} + C_k^P - r_k}$.

If the condition assuring increases in assignments by both players is met, the requirement for $\frac{\partial \rho\left(e_k^{P*}\right)}{\partial C_k^D} < \frac{\partial \rho\left(e_k^{D*}\right)}{\partial C_k^D}$ can also be obtained from Equation (4.81) and Equation (4.80). The divisor is positive and equal in both cases, thus it suffices to determine under which case the condition holds for the numerator, that is, when is it that the value $\left(\alpha_{kc} + C_k^P - r_k\right)\left(f_k^P + f_k^D\right)\left(r_k + \alpha_{kc} - C_k^P\right)$ is smaller in absolute value than $\left(\alpha_{kc} + C_k^P - r_k\right)\left(f_k^P\left(\alpha_{kc} + C_k^P - r_k\right) + f_k^D\left(\alpha_{kc} - C_k^P - r_k\right)\right)$. This difference holds if condition $f_k^P < f_k^D \frac{r^k}{r^k - C_k^P}$ is met, which is the stated result.

□

This result implies that, if both players increase the resources assigned to market k, D will reassign more resources than P to market k if P's initial investment is smaller than D's initial investment weighted by the inverse of the *net direct profit margin* of P.[6] Causing an increase in the general levels of aggression. Notice that the weighting factor is bigger than one, thus the condition states that f_k^P needs to be smaller than f_k^D scaled up by a factor equal to the inverse of the net direct profit margin.

The case shown here provides an example of how an external policy that affects the cost structure of criminal organisations can affect the levels of crime in favour of the criminal organisations. A recent case that illustrates this is the *Fast and Furious* gunwalking policy pursued by the United States Bureau of Alcohol, Tobacco, Firearms and Explosives office in Arizona, which facilitated the access to fire arms to Mexican criminal organisations, decreasing their operational costs and contributing to the rise in criminal activities in the border between Mexico and the USA.[7]

[6] The expression in Equation 4.78 resembles the net profit margin in production theory. In this context the *profit* derived by P from directly competing with D when being successful is $\frac{r^k - C_k^P}{r^k}$.

[7] A gunwalking strategy is a policy in which the authorities allow the distribution and (illegal) trade of fire arms in order to track them and locate criminals.

4.4 Discussion of main results and further extensions

This chapter presented a theoretical model of a rent extracting state and its competition against a criminal organisation to extract resources from society in crime markets. The model endogenises the price of crime, and introduces resource assignment policies in a setting where players are constituted as multi-level organisations. This setting allows to consider resource assignment strategies, government and criminal organisations with hierarchical structures, and competition for societal resources between legal and illegal institutions. The model presents a formal analysis of the contemporaneous problematic of crime, and a government looks to fulfil its mandate as guardian of law and order, but also seeks to extract rents from society by competing in crime markets with criminal organisation.

The results show the equilibrium strategies of the players, and the conditions that hold for interior equilibria, extreme solutions, and equilibrium non-existence. Interior solutions emerge under mild assumptions, and the stability of equilibrium is shown to unfold also for non-demanding cases. The results obtained by comparative statics analysis show how cockroach effects, a kind of crime migration reaction, can emerge when crime deterrence policies are implemented, and also when external forces cause a change in cost structure.

The analysis presented differentiates the case of total elimination of crime ($e_k^D = 0$), and the case when it is optimal for the authorities to allow certain level of crime to exist ($e_k^D \neq 0$). This is a relevant result as it suggests it may be profitable for a rent extracting institution to participate in criminal markets without fully annihilating it among the reasons for crime to persist. For interior equilibria, total elimination of crime is not an optimal strategy for the authorities, given that a benefit can be directly extracted from the existence of crime, as society is willing to direct resources to combat it. Corner solutions display either no use or total use of resources by both players, the former case indicates disappearance of the market (zero crime), while the latter refers to the presence of crime under high levels of violence (full use of resources).

Additionally, it was shown that crime is eradicated, under participation by P, only if certain conditions hold regarding full liability for the criminal organisation, or if P's initial investment is of certain proportional level with respect to that of D. However, full liability is often not implementable for criminal organisations; for example when leaders of narcotraffic organisations are captured, they can be sentenced to a limited number of years (even if they are condemned to life imprisonment), and their wealth cannot be fully confiscated, either because family members keep what is under their name, or resources have been spent.

Results show that a corner solution emerges at zero assignment of resources, and thus no market emerging, if initial investments of both players are zero. This result suggests prevention policies directed to stop criminal organisations from making initial investments in criminal markets can be of key importance. Thus, preventing criminal organisations building capacity to participate in criminal markets can be determining why certain types of crimes appear in some societies and not in others.

Comparative statics analysis shows how crime combat policies can lead to cockroach effects in which intervened markets experience a decrease in crime while it increases on others. When initial investments by P are higher, the reassignment of initial resources induces an increase on violence in the directly affected market. Nevertheless, the reassignment is of higher magnitude for P than the one observed for D, this due to market k becoming tougher for D, while at the same time other markets become less so. Similarly, when the penalty in market k is increased, ceteris paribus, market k becomes more risky for D relative to the other markets, leading D to reduce the amount of resources used in k, while P reacts by increasing resources into this market as it becomes *more profitable*. These changes in the assignment of resources negatively affect other markets, increasing the level of crime as the movement of resources weakens P's position in them and strengthens that of D.

The last example presented in the comparative statics section shows conditions for which a decrease in costs for D in a crime market produces an increase in the amount of resources assigned to that market by both players. If the increment is higher for D than for P, then the level of crime will increase in market k and decrease in the other markets, as P moves less resources relative to the ones reassigned by D. This result can be seen as an inverse effect to that of the cockroach effect observed in the previous examples. In this case, D will react by increasing the amount of resources, weakening its position in other markets, while P's reaction will be less than proportional, which strengthens its position in other markets relative to D but weakens its position in market k, producing an increase in crime in k and a decrease in crime in the other markets.

Finally, the equilibrium violence that emerges in a given market is driven by incentives produced by the size of punishment, society's willingness to pay for crime, the cost structure, and the initial investments. The latter directly affects the level of resources assigned to a given market, while the other variables work on both directions, which indicates the importance of initial investments on emerging equilibria. When incentives are high enough, both players tend to respond more than proportionally to levels of aggression in a wider range, which in turn leads to high levels of violence in equilibrium. The contrary happens as incentives become less powerful, leading to equilibrium at low levels of violence in the market.

There are various ways of extending the research presented in this chapter. On the one hand, probability distributions for all types of crimes are independent. If a criminal firm is producing a number of crimes, it is likely that the probabilities of different crimes are not truly independent, and further research considering interdependencies would be recommendable. Also, the effects of policy interventions are analysed for one market, and the corresponding effects on other markets are conjectured. In this regard, similar results could be obtained by introducing substitution and complementary effects across markets right away in the specification of the model. Nevertheless, the level of difficulty increases at a fast pace, potentially turning the model intractable. Additionally, the model could be extended to allow for the existence of cross effects between the k markets, to account for a likely situation in which experiencing more than one type of crime induces an additional negative effect on well-being. Finally, the model presented is static, it would be interesting to replicate the analysis in a dynamic setting, in particular as crime and policies evolve over time, and external shocks usually have long lasting but diluting effects. These modifications can be explored in future research.

4.5 Appendix

Appendix A: conterst success function

Following the contests literature, where the term "success technology" refers to the functional form that produces probabilities of winning for each player involved in a given contest, it is assumed that the probabilities of winning, for both P and D, are given by a contest success function in which the resources assigned to criminal market k by each contender determine the probabilities of winning a battle in that market. One of the most frequently used contest technologies is the ratio-form function, which functional form is

$$p_j = \frac{e_j^R}{\sum\limits_{j \in J} e_j^R}$$

Where $J \ni j$ is the number of contestants, and R is a positive scalar. This functional form is usually referred to as the Tullock success function, although according to Konrad (2009) Tullock (1980) was not the first to use this form, it is usually attributed to him. This is not the only contest function studied in the literature, a number of different specifications have been used to model diverse cases of conflict, with the ratio-form one of the most popular, perhaps because of its easy interpretation. This approach has been successfully applied in different areas of research like all pay auctions, war conflicts, strategic experimentation, among other applications. One caveat, however, is that the level of complexity increases considerably when adding structure to these functions, thus the approach here is to follow well established forms in the literature. It is worth noticing that contest success functions have received two main interpretations in the literature, they can be considered either as the probability of winning the contest, or as the share of the prize among contestants (Corchón and Dahm, 2010). These observation becomes useful as the q_k's can be interpreted as the share of authorities and criminal organisations in criminal markets (see Konrad (2009) and Corchón and Dahm (2010) for extensive accounts on the literature on contests).

Chapter 5

Conclusions

This thesis contributes with three independent chapters motivated by problems that are of critical importance in modern Mexico and other societies: inequality of opportunities and its effect on aspirations and identity adoption; trust and its relation with crime and social deprivation; and competition between organised crime and the State in the extraction of rents from society. These problems are part of long lasting struggles society in Mexico has had to fight over the years, and are also relevant problems in other contemporary societies.

In Chapter 2, individual's type determination is modelled in a way that resembles identity adoption influenced by aspirations. In this model, individuals' characteristics, together with features of the environment to which they belong, are a key part of their type adoption process. By defining when an individual should stop searching for a type and adopt one, thresholds that are influenced by the status quo of the environments, the individual's perception of how far types are from each other, and acquirable characteristics determine what types individuals adopt and take as their true types. The results of the type adoption model are extended to show how adopted types work as frames that influence individual choice.

The model can be linked to the literature on aspirations, identity, and their relation with inequality of opportunities, and frame formation in extended choice problems, contributing to these scarcely explored topics in economics. In the setting, adopted types can be understood as identities that individuals adopt. The chapter shows how identities are shaped by characteristics the individual possesses, but also by those of the ones she shares the environment with, and how difficult moving from one type to another is perceived by the individual. The model proposes a way in which aspirations may influence identity when individuals' social environment contributes to set aspirations, which can be far from what corresponds to them according to their potential.

The type adoption process presented in the model is linked to extended choice problems, offering a way to think on how frames are formed in individuals. It is usually the case that models start their analysis from a point at which frames are already set, without involving much in how they are formed. Type adoption formally illustrates how frames can be formed, and what variables influence the production of frames.

Results from the model illustrate how inequality of opportunities can spur inefficiency traps, and perpetuate differences among individuals. If social environments are formed by members of homogeneous types, moving up in the types scale will be more costly to those at the bottom of the distribution of types, while those at the top will have strong supporting environments that will pull them to the top types even if those are not the ones that correspond to them. Combined, these effects help to perpetuate polarisation and inefficiency traps.

In the chapter, it is also shown how policies that aim to incentive individuals to adopt higher types can have opposite effects to the ones set. If aspirations are not affected, then cost improving policies can lead individuals to adopt types that are even further from the ones that corresponds to them. Even more, these types of policies can exacerbate the mismatching problem pushing individuals to adopt types more towards the extremes.

Chapter 3 investigates the relationship between trust, social deprivation, and violent crime. The war on drugs policy the Mexican government started in 2006 fostered an escalation in crime in various forms all over the country, with intensity of crime reaching its highest point in 2011. These two points in time coincide with the dates of the survey waves used in the analysis which allows for comparison between periods of relatively low and high crime incidence. Also, using data on social gap indices, variations of trust along levels of social gap are investigated.

Results show that social gap holds a statistically strong relationship with trust. The way in which the variable generalised trust is constructed allows to compare results among low, middle, and high levels of social gap. Surprisingly, those individuals in the middle levels show, on average, lesser trust than those at low levels, and even less so in comparison to those experiencing higher levels of social gap. However surprising the result may be, this behaviour is explained by the formalisation offered in the chapter to justify modelling trust as an ordered choice variable. The exchanges argument presented indicates that those holding exchanges with members of groups different from their own would tend to show lower levels of trust. If social gap segregates individuals into different groups, then exchange taking place with contiguous group members places individuals in middle levels of social gap in a position in which they interact with members of the other two groups, while those at the extreme groups only do so with the ones in the

middle group. Higher interaction with different members could be leading those in the middle to report lower levels of trust.

Homicide rates also present a significant relationship with trust, although the results are less consistent in comparison with those obtained for social gap. A negative association between crime and generalised trust is suggested by the results; however, if parsimonious models are estimated, the crime proxy gains statistical significance with the introduction of regional indicators, and turns significant only when the survey year indicator is included. The interpretation offered is that the model is able to identify the effect of crime on trust when regional and specially survey year indicators are introduced. To further test this relation, estimations were done by region and year for restricted models of the crime explanatory variable. The results show crime is statistically significant for North, South, and year 2006, but not for Centre and year 2011. Furthermore, to test for spurious associations between generalised trust and crime an instrumental variables strategy was implemented. The unrestricted and restricted models for crime show that the relationship between crime and trust is statistically significant. With regards to regional differences, the North presents results that indicate individuals with residence in this region report being more trusting, followed by the South in comparison with those living in the Centre.

Examination of asymmetries between trust and distrust reveal interesting results as well. The relationship that these two counterparts hold with social gap and crime indicate differences between the two measures. The results show crime has a strong statistically significant negative relation with trust, and no association with distrust. High social gap has a positive relationship with trust and a negative association with distrust, both statistically significant. Intermediate social gap on the other hand has a positive significant association with distrust, but no relation with trust. These results highlight the importance of considering different measurements of trust, or the lack of it, when investigating its determinants.

With respect to trust in public institutions, estimations indicate a significant and positive association between social gap and trust in these institutions. The effects are statistically weakly significant for intermediate levels of trust in comparison with its lower and higher levels though. Evidence from the estimated models suggests crime holds a negative relation with trust in public institutions, yet, statistical significance vanishes when implementing instrumental estimations. Thus, results do not provide evidence to support trust in public institutions is affected by criminal actions impacting society. Results on regional differences produce the same results obtained for generalised trust, individuals from the North report more trust on public institutions, followed by the South, with Centre presenting the lowest trust levels.

In summary, the results indicate generalised trust and trust in public institutions hold an a strong relationship with social gap, and are inversely associated with crime. A profile of an individual being distrustful and in relative disadvantage emerges from the results obtained, which indicate that having experienced discrimination, being of indigenous extraction, and being resident of the Centre leads individuals to report lower levels of generalised trust and trust in public institutions. The fact that those with higher social gap report higher levels of trust in average, may indicate trust is and important active for these individuals.

In Chapter 4, a model that considers the possibility of authorities seeking to extract resources from society by participating in criminal markets, as regulators of criminal organisations, is built. The model assumes a kleptocratic institution in charge of combating crime on behalf of society competes with a criminal organisation. The authorities do not produce crime per se, but extract resources by securing individuals from it, while criminal organisations seek to capture individuals, leading both players to engage in combat to obtain a share of the crime markets. The price of crime is endogenous, and depends on the probabilities of being victim of a crime, which generates incentives for authorities to regulate more than to eradicate crime. As a result, it is optimal from the point of view of the authorities to allow for some crime to exist.

In the analysis, conditions are obtained for total eradication of crime. A key determinant for crime absence in the model is the lack of initial investments on both participants in the crime market. If players opt for not assigning resources to built a participating capacity for a criminal market, then a corner solution at the origin emerges. Another way in which zero crime emerges but that involves authorities assigning resources to the market arises if initial investments by the authorities are proportionally enough to deter the criminal organisation to incursion in the market. It is also observed that full liability will deter the criminal organisation from participating. However, the usefulness of a policy based on full liability is restricted by the ability of the authorities to implementing it. This result tells of the importance of preventing criminal organisations from being able to construct participation capacity in first instance.

The model identifies areas in which high and low violence predominate at equilibrium. Behind each equilibrium outcome are initial investments, and how sensitive the reaction curves are given the parameter values. If both players have low initial investment capacity built, the equilibrium outcome emerges at low aggression levels, and the contrary happens for high initial investments, for which equilibrium lies at high violence levels. Also, if players' strategies involve asymmetric levels of aggression, equilibrium assigns a higher share of the market to the player that shows relatively higher levels of aggression.

Finally, comparative statics show how cockroach effects can emerge from crime fighting policies directed to a subset of crime markets. External shocks that lead authorities to increase the assignment of aggression resources in a subset of markets decrease crime in the markets where the intervention takes place, but the incentives this reassignment of resources creates for both players increases crime incidence in those markets not directly affected by the policy.

In summary, the model offers an alternative explanation for why crime is so persistent in certain societies. Authorities in charge of combating crime have incentives to keep crime at certain levels so they can extract rents from society. The results suggest initial investments are of high importance with respect to determining emerging equilibria, and thus the level of aggression in each market and the share of it between the two players.

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