ESSAYS IN THE ECONOMICS OF CRIME AND CORRUPTION

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DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.
ABSTRACT

The purpose of the thesis is to offer an examination of the economics of crime and corruption. By stressing the importance of Becker’s seminal paper, we show how criminal behaviour is no longer considered the result of mental illness, but a decision largely based on a cost-benefit comparison from the possible legal and illegal actions. The puzzle that countries, with seemingly identical characteristics, display different corruption levels can be explained by considering the role of social stigma in the decision-making process. Additionally, we also examine the way that corruption is practised, by assuming that two regimes are possible, namely, collusive corruption and non-collusive corruption regimes. In the second part of the thesis, we examine the interrelationships between crime, fertility and economic growth. We link these variables of interest with the probability of avoiding apprehension, which is considered as one of the most important deterrence factors in crime decisions. In line with current literature, results show that a higher probability of avoiding apprehension increases crime rates, has a non-monotonic effect on fertility rates and an ambiguous impact on growth. The contribution of the model is that the relationship between the probability of avoiding apprehension and crime is not linear, but becomes positive after a threshold value of the parameter. In the subsequent part we provide an econometric analysis that examines these empirical regularities. We find that there exists a positive relationship between the probability of escaping apprehension, the rates of crime and fertility. The relationship is not linear but is subject to threshold effects. The finding of a positive impact of the probability of escaping arrest on both crime and fertility implies that the positive link between fertility and crime is an equilibrium outcome, rather than a causal one running from fertility to crime. In addition, we find that the probability of escaping apprehension has a negative effect on economic growth, an effect that becomes more notable when the probability exceeds a threshold value. Lastly, we consider the interrelationships among the three endogenous variables of crime, fertility and growth. In accordance with the theoretical section, we find that the probability of avoiding detection has a positive effect on both crime and fertility. In addition, these two variables negatively affect economic growth.
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This thesis is part of years of research that has been done since I joined the Department of Economics at the University of Manchester. Up to now, I have worked with people whose contribution in various ways to the research and the making of the thesis deserves special mention. It is a pleasure to express my gratitude to all of them in my acknowledgement.

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1 Introduction

Crime is a global problem that remains without a doubt one of the most troubling and pressing issues for all countries. Literature has identified crime as one of the major obstacles to growth and social development. In particular “crime ranks sixth over 14 factors which firms see as severe or major obstacles to firms’ growth and operations” (Mauro and Carmeci 2007). This is not only because it creates uncertainty and undermines the quality of life but also because it makes people risk-averse and slows down entrepreneurial activity. From a macro perspective it reduces investment and hence economic development. It also diverts resources from productive purposes to other policies and strategies designed to fight crime. Despite the fact that various measures have been adopted to combat this phenomenon, crime is quite persistent over time. According to Jacob, Lefgren and Moretti (2004), a 10 per cent rise in violent crime in a city this week is associated with 1.6 per cent more violence the following week. This serial correlation is even higher for other types of crime.

The incidence of crime has attracted attention from a vast range of disciplines. The earliest ecological theories that emerged in the field of sociology emphasized the effect of poverty and social deprivation on crime rates. Shaw and McKay’s ‘social disorganisation’ theorem (1942), widely known as the Chicago school of criminology, found that crime was likely to depend on neighbourhood dynamics, and not on the individuals within specific neighbourhoods. The theory proposed that crime was more likely to occur in areas where the mechanisms of social control were weaker. Such local institutions that can encourage social ties include churches, social clubs, labour unions and voluntary community organizations. The analysis was concentrated on socio-economically deprived areas that, as a result of this, exhibited high rates of residential mobility and racial heterogeneity. Hence, these neighbourhoods were generally regarded as being socially disorganized. The idea is that as social capital deteriorates it becomes more difficult for the society to efficiently address problems, and crime is thus encouraged. In addition, Merton’s stray theory (1938) argues that unsuccessful individuals feel frustration when faced with the success of others around them. If individuals are deprived of economic opportunities it becomes more difficult for them to
accept the economic success of those around them. The greater the income inequality, the greater the strain and, hence, the greater the incentive for those low-income individuals to commit crime.

Criminal acts constitute an example of extreme behaviour that economic theory has been trying to rationalize for some time now. Bentham (1931) and Beccaria (1797) were the first to propose the assumption of rational choice in criminal decisions. However, in the 1950s and 1960s, criminal behaviour was thought to be purely the result of mental illness and social oppression in such a way that criminals were seen as “helpless victims” (Becker 1993).

The economics of crime date back to the American economist Gary Becker and his seminal paper of 1968, which was the first attempt to incorporate the assumption of rationality into crime models. He became interested in crime literature in the 1960s after personal experience of a minor offence. The story is that, one day, while driving to Columbia University, he had to quickly decide whether to park his car legally in a parking spot or illegally in the street with the risk of getting a parking ticket. He calculated the probability of getting a ticket and the size of the fine and compared it with the cost of putting the car in the parking space. Based on this calculation, he decided not to use the parking space and took the risk of leaving his car in the street. In the end he did not get a ticket. This experience led him to the conclusion that all economic agents think in a similar way and, when faced with a decision, they are likely to make rational comparisons.

According to Becker’s analytical framework, agents are treated as rational utility maximizers. They will tend to weigh up the expected costs and benefits before deciding to engage in criminal acts. The costs are the positive probability of detection and hence punishment, whilst the benefits are the monetary rewards resulting from the act. If the costs exceed the benefits then the agent will not engage in criminal activities. Similarly, if the benefits exceed the costs involved the agent will go ahead with the criminal activity. In this sense, rationality, according to Becker, implied that some agents would become criminals due to the financial and other rewards of crime compared to legitimate work, taking into consideration the probability of apprehension and conviction, and the severity of punishment. As a result, the consideration of a police presence, the conviction rate and the severity of punishment became important and led to the development of
deterrence theories (see, for example, Ehrlich 1973).

Since then a large body of literature has followed, examining the causes and the consequences of crime. Variables such as income inequality, poverty, wage rates, education and institutional policies have all been considered in detail. For example, a range of studies has used income inequality measures as indicators of the difference between the benefits resulting from crime and its opportunity cost (Ehrlich 1973; Kelly 2000). Fleisher (1963; 1966) examined the effect of unemployment rates and income on the incidence of crime. He found a significant crime-inducing effect of unemployment and low incomes.

Research in the area of criminology has also revealed that there is a strong relationship between age and crime. The age distribution of the criminal is supported by the age-crime curve that was developed in the 1880s (for an explanation see, for instance, Quetelet 1931; Hirschi and Gottfredson 1983). This curvilinear relationship is well documented by a range of studies arguing that those who are most likely to commit crime are on average young males (Beirne 1993; Farrington 1986; Freeman 1996; Levitt 1998; Lochner 2004). On average, crime rates increase with age during adolescence, reach a peak during the late teenage years and start to decline afterwards (see, for instance, the report of UNOCD No. 37820). For this reason, in the thesis, when we construct the theoretical crime model, we assume that only economically active agents engage in crime.

Empirical data on crime have been growing over the last decade. The majority of the available data come from European Union countries, the United States and Latin America. However, data on developing countries are very limited and are not considered reliable enough to be used for econometric purposes. It is also worth noting that the definition of crime varies between countries, as well as across time, making cross-country and cross-time comparisons difficult in some cases. For reporting purposes crime can be broadly divided into property and violent crime. According to the Uniform Crime Reporting (UCR) programme, property crime involves the offences of arson, burglary, larceny-theft and motor vehicle theft whereas violent crime includes the offences of aggravated assault, forcible rape, murder and robbery. The most commonly used crime variable in empirical studies is homicide rates followed by property crime rates. This is because these categories are
very unlikely to be under-reported or manipulates, whereas certain other categories of crime such as rape, theft and burglaries are commonly under-reported by individuals. For those countries where uniform data exist, crime appears to be quite persistent and is growing over time. The general trend is that criminal rates vary over time, and display geographical concentration and a broad dispersion across countries that possess seemingly identical economic characteristics.

The relationship between crime and economic growth is well recognised. Crime impedes growth through channels such as lower investment, distortion of property rights and the misallocation of resources. At the same time, development theorists emphasize the role of a demographic transition as a mechanism for moving from a near-zero steady growth regime to a positive steady-state growth regime. The World Bank observes that today’s low-income countries still have the world’s highest birth rates. This negative correlation between the two has been examined by various empirical studies (see, for example, Galor and Weil 2000; Blackburn and Cipriani 2002; Levitt 2004; Azarnet 2006; Becker et al. 1990). In particular Becker (1960) offers support for this observation with a theory related to the quantity-quality trade-off for children. According to the theory, a family must determine not only the quantity of children but also the amount spent on them in terms of human capital accumulation. In this way, higher quality refers to higher spending for children. Because both rearing and educating children are costly actions, a trade-off between these two activities arises. In this way, a decline in fertility rates will induce higher levels of human capital accumulation as parents substitute child quantity for child quality. The simultaneous accumulation of human capital and the decline in fertility provides a link between the transition in demography and growth.

One reason why Becker’s (1968) analytical crime model became so important is that the same economic method, the assumption of rationality, can be used to approach other problems. A similar concept related with crime is the incidence of corruption. According to Aidt (2003), corruption is a persistent phenomenon in all human societies over time and space. It remains high on the agenda of institutions such as the World Bank, the United Nations development programme and the International Monetary
Fund (IMF). For example, after a series of regional financing crises, the IMF has promoted institutional reforms in borrower countries to encourage transparency and prevent corruption practices. According to the U4 Anti-corruption Resource Center, since 1996 the World Bank has supported more than 600 anti-corruption programs and governance initiatives developed by its member countries. Additionally, in the year 2011, the World Bank provided 11 per cent of its lending, or approximately US$4.7 billion, to help countries improve the performance and accountability of their core public sector institutions and the rule of law.

Based on the Transparency International Corruption Perception Index results in 2010, Denmark, New Zealand and Singapore are at the top of the list and regarded as the “cleanest” countries whereas Somalia, Myanmar and Afghanistan are at the bottom of the list and categorized as highly corrupt countries. Nevertheless, while corruption has been easily recognised when revealed, it has been remarkably difficult to define due to its multifaceted nature. Economists tend to analyse corruption in terms of market corruption or public sector corruption. A basic definition of corruption is given by Jain (2001) who defines it as “an act in which the power of public office is used for personal gain in a manner that contravenes the rules of the game”. Corruption may occur in a number of different shapes. For example, misuse of power would normally include the following: the sale of government property by public officials; kickbacks of public procurement; bribery and embezzlement of government funds; peculation and nepotism by public officials. However, the boundaries of corruption are not always clear. Huntington (1968) argues that behaviour that is “acceptable and legitimate according to traditional norms becomes unacceptable and corrupt when viewed by modern eyes”. For example, in some countries, it is socially acceptable for citizens to offer gifts or tips in return for some public official service. Hence, due to the differences in local laws and cultures, the point where the gift becomes a bribe is difficult to determine.

2 http://www.u4.no/helpdesk/faq/faqs3e.cfm
Early research in the field of corruption has suggested that, in the presence of cumbersome regulations, corruption may be actually growth-enhancing, by helping to bypass institutional obstacles in the bureaucratic process, reduce uncertainty, promote competition and foster investment (see, for example, Leff 1964; Huntington 1968; Leys 1970) In such models, corruption has been seen as the much needed grease for the squeaking wheels of a rigid regulation. Several queuing models can be found in the literature to explain this theory. The Kleinrock model (1967), assumes that the customer who pays a bribe can overtake those in the queue who cannot pay as much, but will remain behind those who can pay more. However, according to Myrdal (1968), corrupt officials may actually cause greater administrative delays in order to attract more bribes. Lui (1985) has examined Myrdal’s (1968) hypothesis by considering an equilibrium queuing model of bribery where customers have different values of time and are ranked according to their bribe payments. The bribe strategies form a Nash equilibrium that reduces inefficiency in the public sector by the minimization of the average value of the waiting costs. Hence, if bribes are allowed in return for bypassing burdensome regulations that work against efficiency, a bureaucrat will speed up the process. Within this framework, bribes act as “speed money” in the economy.

Nevertheless, the arguments that bribes may serve as “lubricants” in a slow-moving economy and may improve efficiency have been looked at with suspicion. This is because corrupt behaviour is not legally enforceable. As a result, the agent may eventually refuse to pay the bribes in the end or the bureaucrat may ask for more bribes. Accepting the bribe also involves transaction costs as public officials incur monetary and time costs in concealing their illegal acts. Over the years the availability of data grew and new theories emerged. Data have shed light on the theory of “corruption as oil” that originated in the 1960s and, today, corruption is perceived to be so prevalent and pervasive that is unlikely to have any positive net effects. On the contrary, corruption is seen to distort price signals, dissipate resources, compromise public policy and create uncertainty. In addition, the war against corruption itself is costly as high rates of corruption imply the allocation of resources to sub-optimal uses such as anti-corruption campaigns and monitoring systems. This has led to inefficiency and corruption blending
together. Corruption increases income inequality by allowing public officials to take advantage of their discretionary powers at the expense of the rest. It also intensifies poverty by reducing the amount of public services offered to the poor (Rose-Ackerman 1997). An increase of one standard deviation in corruption increases the Gini coefficient of income inequality by about 11 percentage points and income growth of the poor by about 5 percentage points per year (Gupta et al. 2002).

Apart from the above costs, corruption can be detrimental to economic development. This is because it negatively affects the investment potential of a country. For instance, corruption in India is threatening foreign investment after the revelation of the $40bn telecom scandal in the allocation of mobile phone licenses in 2011. According to Mauro (1995), a corrupted country has about 5 per cent less investment rates than a relatively uncorrupted country. The author finds a negative and significant correlation between corruption and the investment rate. A one standard deviation improvement in the corruption index will increase GDP by as much as 3 per cent in the investment rate and produce a 1.3 per cent increase in the annual per capita rate of GDP growth. More importantly, not only does corruption affect development but the level of development will also affect corruption. This reverse causality is a feature of many studies such as the models by Blackburn et al. (2006), Blackburn and Forgues-Puccio (2007) and Blackburn and Sarmah (2008).

Many theories have attempted to explain the motives behind corruption. Corruption and crime share the common economic framework that was developed by Gary Becker (1968). As Klitgaard (1988) points out, “corruption is a crime of calculation, not passion”. Agents will weigh up the expected benefits, the probability of getting caught, the punishment and the opportunity cost involved in corruption. The lower the probability of detection or the higher the gains from corruption, the higher the incentive to be corrupt. Similarly, lenient punishments provide a fertile ground for corruption to thrive.

Despite the growing amount of literature at both theoretical and empirical levels there are many questions that remain unanswered. Most importantly, questions persist as to why the observations of crime and corruption levels vary significantly among countries, even amongst those with similar stages of development and seemingly identical institutional characteristics
and structure. Findings suggest that some people never evade taxes or never engage in crime even when the benefits from doing so exceed the costs. Baldry (1986) finds that tax evasion is neither a gamble nor a simple portfolio decision based on economic motives. The rate of people who comply with tax plans is actually very high in most countries, even though the expected punishment for tax evasion is typically quite small (e.g., Graetz and Wilde 1985; Skinner and Slemrod 1985). Research points in other directions to explain these puzzles.

One such direction is the effect of social influences on the individuals’ decision-making process. A number of studies have suggested that, when calculating the potential costs involved in corruption, one must take into account formal and informal sanctions. The social stigma experienced by an individual when exposed, getting arrested and going to jail has attracted a lot of attention from various disciplines. According to Wrong (1961), individuals are status seekers in the sense that they aim to gain acceptance and approval in the eyes of others. In the area of economics much research has been conducted to incorporate the concept of social stigma in the decision-making process (e.g., Akerlof 1980; Moffitt 1983; Gordon 1989; Besley and Coate 1992; Cole et al. 1992; Bernheim 1994; Lindbeck et al. 1999). The portfolio approach to tax evasion developed by Allingham and Sandmo (1972) has been extended in order to explain inconsistencies between theory and data. In the case of Gordon (1989), social stigma is incorporated into the standard model of tax evasion as an endogenous reputation cost. These and other studies suggest that the effect of non-pecuniary costs in deterring criminal acts might be greater than the effect of going to jail or paying a penalty. For example, Yaniv (1997), by examining a model of dishonest claiming of welfare benefits, finds that social stigma may act as a stronger deterrent than the expected punishment.

To the best of our knowledge hardly any macroeconomic research has been undertaken with the aim of examining the effects of social stigma in the context of public sector corruption. Likewise, we are unaware of any analysis that links the effects of social stigma to the way that corruption is practised. Yet, there are good reasons for believing that these issues may be important. Corruption may arise in many different shapes and forms. One notable distinction is between collusive and non-collusive corruption. An ex-
ample of the former is when public officials conspire with private individuals in a process of bribery and tax evasion. An example of the latter is when public officials alone are corrupted at the expense of the rest of the citizens – for instance, when officials engage in the embezzlement of public funds. The importance of making this distinction lies in the fact that each type of corruption implies a different population of offenders. Because of social stigma, this means that how others behave may play a role in determining how many agents engage in illegal behaviour. In particular, the higher the number of people who choose such behaviour, the lower the social stigma. Since social stigma is influenced by how others are behaving, the collusive regime will result in lower social stigma as both parties participate in corruption, whereas in the non-collusive regime social stigma will be higher as it is only public officials who engage in corruption.

In section 2 of the thesis, we present a theoretical analysis of corruption in public finances that seeks to explore the above issues. Specifically, we offer an equilibrium model of corruption and social stigma by allowing both variables to be jointly endogenously determined. Public officials (or bureaucrats) are responsible for collecting taxes from private individuals (or households). First we consider the collusion regime where both bureaucrats and households collude with each other in a process of tax evasion and bribery. Households receive an exemption from taxation and bureaucrats are paid a bribe in return. In the non-collusive regime, bureaucrats simply steal the tax revenue and no conspiracy is taking place between the two parties. In both instances, we consider the monetary and non-monetary costs involved. Bureaucrats incur a monetary cost that arises from their attempts to hide their illegal proceeds. As in other analyses, we further assume that a bureaucrat must spend more resources on his deception the greater the number of other public officials who are acting in the same manner (e.g., Blackburn et al. 2006). The non-monetary cost involved is the social stigma that is related to the corrupt activity, which presumably depends positively on the number of other offenders.

For each corruption regime we derive the equilibrium outcomes and compare the results. We identify an equilibrium value of corrupt agents given the corruption regime under which the economy operates. The results indicate that, in the case of collusive corruption, if social stigma effects are relatively
weak, there is a unique equilibrium level of corruption for any particular configuration of parameters. For low values of tax it pays not to be corrupt, whereas for high values of tax it pays to be corrupt. For intermediate values there is always a unique equilibrium fraction of corrupt bureaucrats. In the case of relatively strong social stigma effects, there is the possibility of multiple equilibria, in which the incidence of corruption can be different for the same configuration of parameters. Similarly, in the scenario of non-collusive corruption, if there is a relatively weak social stigma effect there is again a unique equilibrium. A relatively strong social stigma effect implies the possibility of multiple equilibria, where either everyone chooses to be corrupt or everyone chooses not to be corrupt, depending on how others are behaving. Hence, under a weak social stigma effect, whether there is collusion or not, the result is the same: there is always a unique equilibrium, but possibly a multiplicity of equilibria when social stigma effects are strong.

The results of the model help explain why there is diversity in the corruption levels in countries that operate under either the same or different corruption regimes. Social stigma results in different thresholds levels of taxation at which corruption may or may not occur. Hence, the model proposes that these differences are explained by the social influences on the incentive to engage in corruption, and that these influences are in turn affected by the extent of such behaviour. This interdependence can account for why countries with seemingly similar structural characteristics may exhibit different levels of corruption both across and within alternative corruption regimes.

The third section of the thesis focuses on the incidence of crime. It develops a theoretical model of crime that examines the interrelationships of crime, fertility and economic growth. The model builds on Agénor’s (2009) paper, even though he did not deal explicitly with crime-related issues. Generally speaking, crime in the model consists of stealing and it takes place between individuals. Individuals allocate time between crime, child-rearing and leisure. We analyse the impact of a change in the probability of detection and how this affects crime and fertility decisions as well as growth in the model. We focus on this crime parameter because, according to early research, the probability of apprehension is important determining whether an agent engages in crime or not (e.g., Smigel-Leibowitz 1965; Ehrlich 1967; Becker 1968; Imrohoroglu et al. 2000, 2004). In addition, in line with de-
velopment theory we consider the role of fertility decisions on crime and how this affects growth. Hence, this section can be seen as combining the two pioneering works of Becker (1960; 1968) as discussed in the beginning. The relationship between crime and economic growth is still quite limited and country-specific (see, for example, Cárdenas and Rozo 2008; Scorcu and Cellini 1998; Detotto and Otrando 2010). So far, crime and fertility variables have been treated as separate and unrelated factors in the process of growth. In the third -and fourth- chapter of the thesis we aim to fill this gap in the literature.

The results of section 3 show that a higher probability of avoiding detection and arrest has a non-linear effect on crime. The finding that a higher probability of escaping arrest leads to higher crime rates is standard in the literature, starting from Becker’s (1968) crime model. The model takes this relationship a step further by proposing that this positive relationship takes shape only above a threshold value, which we define in the model. This arises as a consequence of the value that agents attach to other activities. In order for them to allocate more time to crime activities and reduce the time they spend in child-rearing and leisure activities, an assurance of a minimum income through such an activity is required. Moreover, the model finds that an increase in the probability of avoiding apprehension leads to a non-monotonic impact on the rate of fertility. For high values of the deterrence parameter, fertility rates increase, whereas for values below a threshold level fertility rates decrease. The analysis illustrates that crime and fertility are jointly determined by the probability of escaping apprehension. Furthermore, the model shows that an increase in the probability of escaping detection has an ambiguous effect on economic growth. This is mainly due to the conflicting effects on growth that arise through different channels. Agents may decide to devote less time to raising their children and more time to criminal acts. This will lower the health status of children, which in turn reduces economic growth. At the same time, an increase in the probability of avoiding detection has a positive effect on government revenue, which finances health services, which enhances health status and productivity. This effect depends on the size of the probability of avoiding apprehension. If it is relatively low the effect will be positive whereas if it is relatively large the effect will be negative. The last channel is through
the effect on the saving rates which again depends on the magnitude of the probability. For example, if the probability is relatively large, savings and growth will increase, while they both decline with relatively lower values.

The fourth chapter extends the research by examining certain empirical regularities related to the crime literature. Specifically, it examines the effect of the probability of avoiding detection on the rates of crime, fertility and economic growth, while controlling for other potential explanatory variables. The contribution of the fourth chapter is to examine the existence of the non-monotonic effects of the probability of avoiding apprehension on crime and fertility, as found previously in the theoretical chapter. Panel data studies on crime are very limited in the literature as there is a lot of inaccuracy in crime data and inconsistency in the definition of crime across time and between countries. We are unaware of any empirical studies that examine the impact of the risk of apprehension on economic growth. Most studies tend to focus on the impact of crime on growth. In this sense, we provide empirical evidence based on 90 countries from the period 1970-2008 in order to fill this gap in the empirical literature. A variety of econometric procedures are used to estimate the equations of interest. Firstly, we estimate the equations of crime, fertility and growth independently of one another. This means that, for all three equations, we use the probability of avoiding apprehension directly as a determinant. In this way, the growth regression corresponds to the reduced form equation of our model. Then we examine the structural relationship among the three endogenous variables of crime, fertility and growth, and estimate them jointly as a system. By doing so, in the growth regression we add directly as determinants the rates of crime and fertility, and exclude as a control the probability of escaping apprehension. We also include various demographic, socioeconomic and institutions-related variables identified in the literature as main determinants for each considered variable. In all regressions we control for country-specific effects, given the importance of country-specific factors in controlling for unobserved country-specific characteristics. Then, we also add time fixed effects so as to take into account common variations in the three variables across time. The probability of avoiding apprehension is an endogenous variable in the crime equation, as the numerator of the dependent variable (number of recorded thefts) is the denominator in the probability of avoiding arrest. To ad-
dress the issue of endogeneity, we replace its contemporaneous values with two-period lagged values. Another approach we use is to instrument the potentially endogenous variables with their second lagged values and apply instrumental variable techniques (static GMM and dynamic GMM). Our results have been subjected to a number of robustness checks in terms of different definitions of crime and fertility, the use of alternative proxies for the probability of avoiding arrest, and the addition of further explanatory variables. None of these alternations changes our findings.

Findings show that there exists a positive relationship between the probability of escaping apprehension and the rates of crime. In accordance with the theoretical model this relationship is not linear but it is subject to threshold effects. This suggests that criminal activities become appealing only if they pay off, in terms of the probability being above a threshold value. As concerns the effect on fertility, we do find evidence to support the non-monotonic relationship, which is positive only after a critical value effect of the probability of avoiding apprehension on fertility rates. The finding of a positive impact of the probability of escaping arrest on both crime and fertility implies that the positive link between fertility and crime is an equilibrium outcome, rather than a causal one running from fertility to crime as some studies have suggested (Gaviria and Pagés 2002). In addition, by estimating the reduced form growth equation we find that the probability of escaping apprehension has a negative effect on economic growth, an effect that becomes more notable when the probability exceeds a threshold value. Lastly, this section considers the interrelationships among the three endogenous variables of crime, fertility and growth. In accordance with the theoretical section, we find that the probability of avoiding detection has a positive effect on both crime and fertility. In addition, these two variables negatively affect economic growth. Our results are not affected by the robustness checks that we have conducted.

This thesis is organized as follows. Firstly, section 2 presents a theoretical analysis of corruption. Section 3 offers a theoretical analysis of crime and section 4 examines the case of crime empirically as described above. In section 5 we provide the conclusions. At the end of the thesis we offer the technical appendices, tables and figures used throughout the thesis.
2 Social Stigma and Corruption Regimes

Recent years have witnessed a burgeoning literature on the economics of corruption. Underlying this has been a growing awareness amongst academics and policy makers of the importance of governance in determining the functioning of society’s public institutions. Both empirically and theoretically, much research has been devoted towards understanding the causes and consequences of corrupt activity, which seems to pervade so many countries. Nowadays, corruption is an issue that lies at the forefront of the international development agenda, and the struggle to improve governance is a vital part of the global quest to alleviate poverty around the world. This chapter seeks to make a contribution to the theoretical literature on corruption by offering some further thoughts that have not, to our knowledge, been considered before.

Corruption has been found difficult to define due to its multi-faceted nature. The concept of corruption has been described to be like an elephant because though it may be difficult to describe, it is generally not difficult to recognise when observed (Tanzi 1998). The most commonly used definition of corruption is the abuse of authority by public officials to make personal gains. There are many different shapes and forms that this can take: it can be the payment of a bribe, the embezzlement of public funds or the submission of fraudulent information; it can be the misuse of power by political leaders, or the illegal profiteering by bureaucrats; it can be a collusive arrangement between public and private agents, or a non-collusive act of opportunism by just the former; and it can be a coordinated strategy amongst a well-connected network of officials, or a non-coordinated set of actions in a more fragmented bureaucracy. Likewise, there are many different ways in which corruption can impact on economic and social behaviour: it can damage incentives and destroy opportunities; it can dissipate resources and distort price signals; it can create uncertainty and compromise public policy; and it can foster alienation and fuel political unrest. The general presumption is that the ultimate effect of corruption is to impede economic

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4The concept of governance is broader than that of corruption, though there is an intimate connection between the two: just as bad governance fosters corruption, so corruption undermines good governance.
growth and development, a presumption for which there is a good deal of theoretical and empirical support.\textsuperscript{5} There is also the view that a major determinant of corruption is a country’s level of prosperity, a view that is similarly well-supported by theory and evidence.\textsuperscript{6} Yet in spite of this broad consensus, there are still many questions that can be asked. Not least of these is why the incidence of corruption varies so markedly across countries, even amongst those that at similar stages of development and with other apparent similarities. What factors - other than differences in per capita incomes, institutional structures, and pro-governance policies - might account for such diversity? This is a question which the chapter seeks to address.

Fundamental to answering the above question is an understanding of the incentives that govern individuals’ decisions about whether or not to engage in corrupt behaviour. In approaching this issue, contemporary research on the economics of corruption follows closely the pioneering work of Becker (1968) on the economics of crime. The major contribution of that work was the modelling of criminal activity as the outcome of individuals’ rational cost-benefit analysis of undertaking such activity. Likewise, the extent of corruption is viewed as a reflection of the optimising behaviour of public officials who seek to maximise their expected utility by weighing up the prospective gains and losses from illegal profiteering: on the one hand, there is the possibility of extra (illicit) earnings if a transgressor succeeds in avoiding detection; on the other hand, there is the risk of diminished (possibly zero) earnings in the event that an offender is caught and punished.

As Klitgaard (1988) puts it, corruption is treated as a crime of calculation which depends primarily on the monetary incentives of potential wrongdoers. This approach has been useful in many respects, but there is one aspect that it noticeably ignores - namely, the role of social influences on personal behaviour. It has been argued for many years by sociologists that humans


\textsuperscript{6}This reverse causality is a feature of the models of Blackburn et al. (2006), Blackburn and Forgues-Puccio (2007) and Blackburn and Sarmah (2008). Evidence to support it can be found in Fisman and Gatti (2002), Husted (1999), Montinola and Jackman (1999), Paldam (2002), Rauch and Evans (2000) and Treisman (2000).
are strongly motivated by a need to establish a positive self-image and high self-esteem through attitudes and actions which gain the acceptance (or avoid the disapproval) of those around them (e.g., Wrong 1961). Whether or not a person chooses to commit an offence may depend importantly on the hostility shown by others towards that offence. Feelings of moral shame or social stigma associated with certain activities may serve as a powerful deterrent against those activities being undertaken. Conversely, when these non-pecuniary costs are small, the incentives to transgress may be tempered only mildly (if at all) by an individual’s meagre sense of guilt and social conscience. One may argue that such considerations are especially pertinent in the context of corruption - for this is an offence which, unlike other types of crime and misdemeanour, is perpetrated by individuals who have supposedly been appointed to serve in the interests of society but who contravene these interests by abusing their privileged positions. For this reason, corruption can incur considerable public resentment and the incentives to engage in it may be seen as being particularly susceptible to the external pressures of society.

There are other areas of economic research in which factors such as image, esteem and reputation have been appealed to in explaining why people might behave one way rather than another. A particularly fertile area of investigation has involved the study of tax evasion and benefit fraud (e.g., Besley and Coate 1992; Gordon 1989; Kim 2003; Yaniv 1996). Amongst other implications, this research indicates how stigma effects can act as a strong restraint (possibly stronger than any pecuniary punishment) on individuals’ incentives to avoid tax obligations and falsify welfare claims. There is evidence that these effects do, indeed, exist and may have an important role to play in inducing good citizenship. For example, it has been observed that the rate of tax compliance is actually very high in most countries, even though the expected punishment for tax evasion is typically quite small (e.g., Graetz and Wilde 1985; Skinner and Slemrod 1985). Experimental studies have also suggested that some people never evade taxes, even when the gamble is better than fair (e.g., Alm et al. 1992; Baldry 1986). Related findings for the case of welfare have been uncovered in survey data and econometric investigations (e.g., Moffit 1983; Rainwater 1982).

In addition to the above, there is evidence of a wholly different nature
which points towards the importance of non-economic factors in influencing personal behaviour. A recent example is provided by Fisman and Miguel (2006) who study incidents of parking violations by diplomats in New York. The privileged status of such individuals means that they are essentially exempt from prosecution as any penalties for illegal parking cannot be enforced. Intriguingly, it is found that only some diplomats (those from highly corrupt countries) seem willing to exploit this immunity with frequent regularity, whilst others are surprisingly well-behaved in their reluctance to do likewise. Why this should be so is an interesting question which may well find an answer linked to differences in social backgrounds that account for differences in attitudes towards what is considered to be acceptable behaviour. Individuals who are used to a culture of corruption may feel little remorse in acting corruptly themselves, whether they do this in their own country or somewhere else.

The foregoing discussion hints at an important characteristic of factors like social stigma: the influence exerted by these factors on a person’s behaviour is liable to depend on how others are behaving. Thus it is plausible to conceive that the greater (fewer) is the number of people who indulge in corrupt activity, the lower (higher) will be the sense of any guilt or shame that each one of them may feel. Under such circumstances, the incentive of a person to be corrupt will be stronger when others are corrupt and vice versa. In this way an individual’s compliance or non-compliance in corruption may depend critically on the compliance or non-compliance of others. This type of behavioural interaction has been studied by others who offer different explanations for why it may emerge: for instance, the more corrupt people there are, the less might be the chance that each one will be caught, the less might by the penalty that each one could incur and the greater might be the payoff that each one can look forward to (e.g., Andvig and Moene 1990; Blackburn et al. 2010; Cadot 1987). Whatever the reason, the key implication is the same - namely, the possibility of multiple equilibria in which the incidence of corruption can be high or low (or possibly somewhere in between). Such equilibria are said to be frequency-dependent in the sense that they arise because of a complementarity between individual and aggregate behaviour: that is, the expected reward to an individual from choosing to be corrupt depends (positively) on the number of others who are expected
to be corrupt. This conjures up the idea of contagion effects and, with this, the notion that countries with seemingly similar characteristics may end up with completely different levels of corruption that are self-sustaining.

With the above considerations in mind, the objective of this chapter is to incorporate explicitly the concept of social stigma into an analysis of public sector corruption. One implication of doing this is the aforementioned possibility of multiple, frequency-dependent equilibria. Whilst this result is notable by itself, our analysis goes further by taking on board other considerations of potential significance. As mentioned earlier, corruption can be practised in many different ways, and there is no reason to presume that the effects will be the same in each case. Differentiating between alternative forms of corrupt behaviour is therefore important, though relatively little attention has been given to this. In what follows we seek to address the issue by focusing specifically on the distinction between collusive and non-collusive corruption. Generally speaking, this distinction relates to the extent to which public officials pursue their illegal profiteering by conspiring with private citizens. In the case of collusion there is compliance by both parties, each of whom stands to gain from their illicit joint venture: the payment of bribes in exchange for favours is the classic example of this. In the case of non-collusion it is only the former who are guilty of transgressing, often at the expense of the latter: embezzlement and extortion are the prime examples in this instance. The reason why we focus on this distinction is that it is particularly relevant for the issue of social stigma. This is due to the fact that different types of corruption regime involve different populations of guilty participants: a collusive regime entails participation by both public and private agents, whilst a non-collusive regime entails participation by only the former. As a consequence, different regimes are generally associated with different stigma-induced costs of utility through which the behaviour of an individual is affected by the behaviour of others. The implication is that the extent to which social stigma influences corrupt activity may depend importantly on the way in which corruption is practised.

Our analysis provides an equilibrium theory of corruption and social stigma by allowing for the joint, endogenous determination of both phenomena. The specific context of our investigation is corruption in public finances. We consider a scenario in which public officials (bureaucrats) are delegated
the task of collecting taxes from private individuals (households). By collusive corruption, we mean the case in which both bureaucrats and households seek to make themselves better off by conspiring with each other in bribery and tax evasion. By non-collusive corruption, we mean the situation in which only bureaucrats transgress by simply pocketing the tax revenues that they collect. In both instances there are pecuniary and non-pecuniary costs of engaging in illicit activity. The pecuniary cost is the expenditure that must be incurred in trying to conceal this activity. The non-pecuniary cost is the disutility that results from the social stigma attached to such activity. Each of these costs involves externality effects, meaning that there are interactions between individual and aggregate behaviour. We compare and contrast the equilibrium outcomes that may transpire under alternative corruption regimes. In particular, we identify the conditions under which each regime gives rise to a unique or non-unique equilibrium. Our results demonstrate how the incidence of corruption can vary markedly both within and across regimes.

The remainder of the section is organised as follows. Section 2.1 sets out the basic model. Section 2.2 focuses on the case of collusive corruption. Section 2.3 turns to the case of non-collusive corruption. Section 2.4 presents a detailed comparison of the two regimes and discusses the implications. Section 2.5 contains the concluding remarks. Proofs of the propositions and the relevant figures can be found in Appendix A.

2.1 The Basic Framework

We consider an economy in which there is a constant population of agents who are divided into two groups of citizens - private individuals (or households), of whom there is a fixed measure of mass $m$, and public officials (or bureaucrats), of whom there is a fixed measure of mass $n < m$.

Households, indexed by $H$, work for firms in the production of output, whilst bureau-
crats, indexed by $B$, work for the government in the administration of public policy. We assume that households are differentiated according to their skills or labour endowments which determine their relative incomes and their relative propensities to be taxed. Specifically, there is a fraction, $\mu \in (0, 1)$, of high-income households that are liable to pay tax, and a remaining fraction, $1 - \mu$, of low-income households that are exempt from taxation. Taxes are collected by bureaucrats whom we assume to be differentiated according to their propensities to engage in corruption. Specifically, there is a fraction, $\eta \in (0, 1)$, of corruptible bureaucrats, and a remaining fraction, $1 - \eta$, of non-corruptible bureaucrats. For simplicity, we suppose that bureaucrats do not pay any taxes and that each one of them has jurisdiction over the same number, $\frac{\mu m}{n}$, of high-income households.

The main objective of our analysis is to determine the incidence of corruption under alternative corruption regimes. To this end, we denote by $\theta \in (0, 1)$ the fraction of corruptible bureaucrats who actually engage in corrupt activity. In the case of collusive corruption there is also a fraction, $\phi \in (0, 1)$, of high-income households with which these bureaucrats conspire: the former pay bribes to the latter in return for avoiding their tax obligations by being reported as low-income types. In the case of non-collusive corruption there are no tax evaders ($\phi = 0$) and no payment of bribes: corrupt bureaucrats collect taxes as instructed and simply pocket the proceeds for themselves.

Any individual who engages in illicit behaviour incurs disutility from the social stigma (moral shame, public hostility, low esteem, etc.) attached to this behaviour. Following our earlier discussion, we assume that such non-pecuniary (psychic) costs depend positively on the number of people who are honest. This number, denoted by $\pi$, comprises the population of non-tax-evading households plus the population of non-corrupt bureaucrats. The former consists of low-income households, of which there are $(1 - \mu)m$, together with high-income households that pay taxes, of which there are

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8Such heterogeneity may reflect differences in proficiencies at being corrupt or differences in moral attitudes towards being corrupt (e.g., Acemoglu and Verdier 2000; Besley and McLaren 1993; Tirole 1996). The main purpose of this assumption is simply to ensure that the government receives at least some tax revenue (for purposes on which we comment latter), as well as precluding the rather perverse scenario in which the government knowingly appoints only corrupt public officials.
$(1 - \phi)\mu m$. The latter consists of non-corruptible bureaucrats, of whom there are $(1 - \eta)n$, together with corruptible bureaucrats who do not transgress, of whom there are $(1 - \theta)\eta n$. Collecting these terms together yields $\pi = m + n - \phi \mu m - \theta \eta n$. Given this, then any household or any bureaucrat who participate in corruption incurs a stigma-induced disutility cost of $s_i = \sigma_i \pi$, or

$$s_i = \sigma_i (m + n - \phi \mu m - \theta \eta n), \quad \sigma_i > 0, \; i = H, B.$$  

(1)

As assumed, this cost is decreasing in both the number of corrupt bureaucrats, $\theta \eta n$, and the number of tax-evading households, $\phi \mu m$. As such, there is a complementarity between individual and aggregate behaviour: the cost to an agent of committing an offence is lower the greater is the number of other offenders. In addition, since both $\theta$ and $\phi$ can be different under different corruption regimes, then so too can there be differences in $\pi$ and, with this, differences in $s_i$. For example, even if both regimes entailed the same positive value of $\theta$ (i.e., the same number of corrupt bureaucrats), the value of $\phi$ (i.e., the number of tax-evading households) would obviously still differ, being positive in the case of collusion but zero in the case of non-collusion; from the perspective of bureaucrats, bribery attracts less social stigma than embezzlement because it involves the complicity of others. It is therefore apparent how the influence exerted by social stigma may depend on the way in which corruption is practised.

In addition to the above, bureaucrats incur a real resource cost of engaging in corrupt activity. This is the cost which arises from trying to conceal such activity in one way or another - for example, by hiding illegal income, by investing this income differently from legal income and by altering patterns of expenditure. For simplicity, we assume that, by incurring this cost, a corrupt bureaucrat is able to avoid any risk of being detected (otherwise, he is caught with certainty).\textsuperscript{9} As in other analyses, we further assume that

\textsuperscript{9}It is straightforward to incorporate some probability that an offender will be apprehended and punished in some way. Experience might suggest that this probability is often fairly small, especially in developing countries where the will and wherewithal to combat corruption are relatively weak, and where perpetrators of corrupt practices seem able to ply their trade with a good deal of confidence of impunity. In any event, allowing for some risk of prosecution has no material bearing on our main results, which are geared more towards understanding the differences between given types of corruption regime, rather than towards issues of fighting corruption (though we return to this briefly in our concluding remarks).
a bureaucrat must spend more resources on his subterfuge the greater is the number of other bureaucrats who are behaving in the same way (e.g., Blackburn et al. 2006). The idea behind this is that there is congestion in the concealment of illegal income: the more people who are doing this the more visible, more difficult and more costly it becomes for everyone.\footnote{For the purposes at hand, one may think simply of each bureaucrat as having access to some costly laundering technology, where the cost increases with the total amount of illegal funds that are trying to be concealed. One scenario underlying this might be the following. Suppose that, in order to conceal their ill-gotten gains, bureaucrats require assistance from some other individuals who specialise in this type of practice. These individuals are experts at directing funds into areas where they are difficult to trace by the government, such as the underground economy and overseas bank accounts. In return for this service a bureaucrat must pay a commission which increases with the total amount of funds being laundered because of the greater difficulty and greater costs of doing this.} This is another source of interaction between individual and aggregate behaviour. In contrast to the above, however, this interaction takes the form of negative, rather than positive, externalities in corrupt activity: each bureaucrat who engages in such activity increases the pecuniary cost incurred by other offenders.\footnote{It is possible that there could be positive externalities in this case as well, though we ignore these as being dominated by the negative spillovers. In addition, the existence of positive externalities is already accounted for in social stigma.} Formally, we specify this cost as

\[ c = \gamma \theta \eta n, \quad \gamma > 0. \] (2)

All agents are risk neutral, deriving linear utility from their consumption, or income. We shall derive expressions for income in our subsequent analysis, where we study in detail the behaviour of our two key groups of players - high-income households and corruptible bureaucrats. For the moment, we note the following. Each high-income household earns a wage of \( w_H \) from supplying its labour to firms, whilst each corruptible bureaucrat earns a salary of \( w_B \) from supplying his labour to the government. The former is obliged to pay lump sum taxes of \( t \) which the latter is instructed to collect and return to the government. Whether or not these events occur depends on whether or not there is corruption in one form or another, which determines the final income of agents.

This completes our description of the economic environment. The remainder of the analysis is aimed at determining the equilibrium outcomes...
that may transpire under alternative scenarios by studying the incentives of agents to indulge in illicit behaviour.

2.2 Collusive Corruption

The first scenario that we consider is one in which both public and private agents may seek to enrich themselves illegally by conspiring with each other against the government. Specifically, high-income households may offer bribes to corruptible bureaucrats in return for being exempt from taxation by having their income status falsified. We denote by $b$ the size of bribe that exchanges hands in each such corrupt transaction.

2.2.1 Individual Incentives

A household’s final income is $w_H - t$ if it does not pay a bribe and $w_H - b$ if it does pay a bribe. In the event of the latter, the household incurs a social stigma cost of $s_H$. The utility of a household is therefore given by

$$u_H = \begin{cases} 
  w_H - t & \text{if } b = 0 \\
  w_H - b - s_H & \text{if } b > 0.
\end{cases} \tag{3}$$

The household is willing to pay a bribe if doing so makes him no worse off than not doing so. The maximum bribe that the household is willing to concede is determined by strict equality of this condition. From (3), this maximum bribe payment is deduced as

$$b = t - s_H. \tag{4}$$

Intuitively, the household is prepared to bribe a bureaucrat by no more than what it saves in taxes less the stigma that it incurs from doing this.

A bureaucrat’s final income is $w_B$ if he does not accept any bribes and $w_B + \left(\frac{um}{n}\right)b - c$ if he does accepts bribes, where $\left(\frac{um}{n}\right)b$ is the total bribe payment of all households under his jurisdiction. In the event of the latter the bureaucrat incurs a social stigma cost of $s_B$. The utility of a bureaucrat
is therefore given by

\[ u_B = \begin{cases} w_B & \text{if } b = 0 \\ w_B + \left( \frac{\mu m}{n} \right) b - c - s_B & \text{if } b > 0. \end{cases} \tag{5} \]

The bureaucrat is willing is to accept a bribe if doing so leaves him at least as well off as he would otherwise be. From (5), this requires that

\[ \left( \frac{\mu m}{n} \right) b \geq c + s_B \tag{6} \]

Accordingly, the bureaucrat demands a bribe payment that is at least sufficient to cover his pecuniary and non-pecuniary costs of illicit activity.

For bribery and tax evasion to occur, both (4) and (6) must be satisfied simultaneously. This yields the condition

\[ \left( \frac{\mu m}{n} \right) t \geq s_B + \left( \frac{\mu m}{n} \right) s_H + c. \tag{7} \]

A final version of this condition is obtained by substituting the expressions for \( s_i \) and \( c \) from (1) and (2). In doing this, we note that the fraction of tax-evading households, \( \phi \), is equal to the fraction of bribe-taking bureaucrats, \( \theta \eta \).\footnote{This follows from the fact that the total population of corrupt bureaucrats is \( \theta \eta m \), each of whom is assigned to \( \frac{\mu m}{n} \) high-income households, of which \( \phi \mu m \) are tax-evaders - hence \( \theta \eta \left( \frac{\mu m}{n} \right) = \phi \mu m \), or \( \theta \eta = \phi \).}

It then follows that (7) may be written as

\[ \left( \frac{\mu m}{n} \right) t \geq \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] [m + n - \theta \eta (\mu m + n)] + \gamma \theta \eta m \equiv F(\theta). \tag{8} \]

### 2.2.2 Equilibrium Outcomes

Our equilibrium analysis centres on the condition in (8), from which we seek to determine the equilibrium value of \( \theta \), the fraction of corruptible bureaucrats who are corrupt, which we denote by \( \hat{\theta} \). We proceed to do this as follows. Let \( \Omega = \{ t, \sigma_B, \sigma_H, \gamma \} \). For any given triplet of these parameters, and any given \( \theta \), we may deduce a value for the remaining parameter such that (8) holds with equality. To fix ideas, we shall focus on \( t \), which is arguably the most natural parameter to choose since it is the level of taxes that governs the size of ill-gotten gains from corruption (though the analysis
could be presented in terms of any other of the elements of Ω). Accordingly, let \( \hat{t}_0 \) and \( \hat{t}_1 \) be the threshold values of \( t \) for which \( \left( \frac{\mu m}{n} \right) \hat{t}_0 = F(0) \) and \( \left( \frac{\mu m}{n} \right) \hat{t}_1 = F(1) \). Then \( t \geq \hat{t}_0 \) is the condition for an individual bureaucrat to be corrupt, given that no other bureaucrat is corrupt, whilst \( t \geq \hat{t}_1 \) is the condition for an individual bureaucrat to be corrupt, given that all other bureaucrats are corrupt. Observe that \( F(\theta) \) is increasing or decreasing in \( \theta \) depending on whether \( \gamma n - \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n) \) is positive or negative, which depends on the relative strengths of the pecuniary and non-pecuniary costs. If social stigma effects are relatively weak, then \( \gamma n > \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n) \) so that \( F_\theta(\theta) > 0 \), implying that \( F(0) < F(1) \) and \( \hat{t}_0 < \hat{t}_1 \). Conversely, if social stigma effects are relatively strong, then \( \gamma n < \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n) \) so that \( F_\theta(\theta) < 0 \), implying that \( F(0) > F(1) \) and \( \hat{t}_0 > \hat{t}_1 \).

Given the above, we may deduce the following result.

**Lemma 1** Assume that \( \gamma n > \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n) \). Then the equilibrium fraction of corrupt corruptible bureaucrats is given by the following: (i) \( \hat{\theta} = 0 \) for \( t < \hat{t}_0 \); (ii) \( \hat{\theta} = 1 \) for \( t > \hat{t}_1 \); and (iii) \( \hat{\theta} = f(\Omega) \in (0,1) \) for \( t \in (\hat{t}_0, \hat{t}_1) \), where \( f_\ell(\cdot) > 0 \), \( f_{\sigma_B}(\cdot) < 0 \), \( f_{\sigma_H}(\cdot) < 0 \) and \( f_\gamma(\cdot) < 0 \).

**Proof.** Suppose, first, that \( t < \hat{t}_0 \), in which case \( \left( \frac{\mu m}{n} \right) t < F(0) < F(1) \). If all bureaucrats were to choose not to be corrupt \( (\theta = 0) \), then none of them would have an incentive to deviate from this since \( \left( \frac{\mu m}{n} \right) t < F(0) \). Conversely, if all bureaucrats were to choose to be corrupt \( (\theta = 1) \), then each one of them would have an incentive to deviate since \( \left( \frac{\mu m}{n} \right) t < F(1) \). Thus \( \theta = 0 \) is the unique equilibrium. Next, suppose that \( t > \hat{t}_1 \), in which case \( \left( \frac{\mu m}{n} \right) t > F(1) > F(0) \). If all bureaucrats were to choose to be corrupt \( (\theta = 1) \), then none of them would have an incentive to deviate from this since \( \left( \frac{\mu m}{n} \right) t > F(1) \). Conversely, if all bureaucrats were to choose not to be corrupt \( (\theta = 0) \), then each one of them would have an incentive to deviate since \( \left( \frac{\mu m}{n} \right) t > F(0) \). Thus \( \theta = 1 \) is the unique equilibrium. Finally, suppose that \( t \in (\hat{t}_0, \hat{t}_1) \), in which case \( F(0) < \left( \frac{\mu m}{n} \right) t < F(1) \). If all bureaucrats were to choose not to be corrupt \( (\theta = 0) \), then it would be optimal for each one to deviate since \( \left( \frac{\mu m}{n} \right) t > F(0) \). Likewise, if all bureaucrats were to choose to be corrupt \( (\theta = 1) \), then it would also be optimal for each one to deviate since \( \left( \frac{\mu m}{n} \right) t < F(1) \). Thus neither \( \theta = 0 \) nor \( \theta = 1 \) can exist as an
equilibrium. Consider, however, a \( \theta \in (0, 1) \) such that \( F(0) < F(\theta) < F(1) \). Then there exists a unique value of this \( \theta \) which supports an equilibrium with \( (\frac{\mu m}{n}) t = F(\theta) \). Since \( F_\theta(\theta) > 0 \), it follows that this \( \theta \) satisfies \( \theta = f(\Omega) \) where \( f_t(\cdot) > 0 \), \( f_{\sigma_B}(\cdot) < 0 \), \( f_{\sigma_H}(\cdot) < 0 \) and \( f_\gamma(\cdot) < 0 \).

This result establishes that, in the case where social stigma effects are relatively weak, there is a unique equilibrium incidence of corruption for any particular configuration of parameters. We illustrate the result in Figure 1 which is drawn on the basis of (8) under the assumption that \( F_\theta(\theta) > 0 \).

For any \( t < \hat{t}_0 \), the amount of bribe income that a bureaucrat can extract is never enough to make him want to do this. He is always worse off by being corrupt, irrespective of whether others are corrupt or non-corrupt: that is, \( (\frac{\mu m}{n}) t < F(1) \) and \( (\frac{\mu m}{n}) t < F(0) \). Consequently, the only equilibrium is one in which all bureaucrats choose not to be corrupt \( (\theta = 0) \) since only in this instance is there no incentive for any of them to behave otherwise. Conversely, for any \( t > \hat{t}_1 \), a bureaucrat can demand bribe payments that are more than sufficient to induce him to do so. He is now always better off by being corrupt, regardless of whether others are corrupt or non-corrupt: that is, \( (\frac{\mu m}{n}) t > F(1) \) and \( (\frac{\mu m}{n}) t > F(0) \). Accordingly, the only equilibrium is when all bureaucrats choose to be corrupt \( (\theta = 1) \), being the only profile of behaviour from which there is no incentive to deviate. To see what happens when \( t \in (\hat{t}_0, \hat{t}_1) \), consider a \( \theta \in (0, 1) \) for which either \( (\frac{\mu m}{n}) t > F(\theta) \) or \( (\frac{\mu m}{n}) t < F(\theta) \). Neither of these situations can be an equilibrium: in the first case some bureaucrats are choosing not to accept bribes when it pays them to do so, implying that \( \theta \) would rise until (8) held with equality; in the second case some bureaucrats are choosing to accept bribes when it does not pay them to do so, implying that \( \theta \) would fall until (8) held with equality. The equilibrium in both cases is therefore given by a \( \theta \in (0, 1) \) such that \( (\frac{\mu m}{n}) t = F(\theta) \) which makes the marginal bureaucrat indifferent between being corrupt and non-corrupt. The precise value of this \( \theta \) depends on the particular values of parameters, \( \theta = f(\Omega) \), being positively related to \( t \) and negatively related to \( \sigma_B, \sigma_H \) and \( \gamma \): intuitively, the incidence of corruption is higher the greater is the bribe payment that bureaucrats can extract and the lower are the costs that they incur in doing this.

\[^{13}\text{See Appendix A.}\]
Lemma 2 Assume that $\gamma n < \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n)$. Then the equilibrium fraction of corrupt corruptible bureaucrats is given by the following: (i) $\tilde{\theta} = 0$ for $t < \tilde{t}_1$; (ii) $\tilde{\theta} = 1$ for $t > \tilde{t}_0$; and (iii) $\tilde{\theta} = \{0, 1\}$ for $t \in (\tilde{t}_1, \tilde{t}_0)$.

Proof. Suppose, first, that $t < \tilde{t}_1$, in which case $(\frac{\mu m}{n}) t < F(1) < F(0)$. If all bureaucrats were to choose to be corrupt ($\theta = 1$), then each one of them would have an incentive to deviate from this since $(\frac{\mu m}{n}) t < F(1)$. Conversely, if all bureaucrats were to choose not to be corrupt ($\theta = 0$), then none of them would have an incentive to deviate since $(\frac{\mu m}{n}) t < F(0)$. Thus $\theta = 0$ is the unique equilibrium. Next, suppose that $t > \tilde{t}_0$, in which case $(\frac{\mu m}{n}) t > F(0) > F(1)$. If all bureaucrats were to choose not to be corrupt ($\theta = 0$), then each one of them would have an incentive to deviate from this since $(\frac{\mu m}{n}) t > F(0)$. Conversely, if all bureaucrats were to choose to be corrupt ($\theta = 1$), then none of them would have an incentive to deviate since $(\frac{\mu m}{n}) t > F(1)$. Thus $\theta = 1$ is the unique equilibrium. Finally, suppose that $t \in (\tilde{t}_1, \tilde{t}_0)$, in which case $F(1) < (\frac{\mu m}{n}) t < F(0)$. If all bureaucrats were to choose to be corrupt ($\theta = 1$), then none of them would find it optimal to deviate from this since $(\frac{\mu m}{n}) t > F(1)$. Likewise, if all bureaucrats were to choose not to be corrupt ($\theta = 0$), then none of them would find it optimal to deviate from this since $(\frac{\mu m}{n}) t < F(0)$. Thus both $\theta = 1$ and $\theta = 0$ are possible equilibria.

This result shows that, in the case where social stigma effects are relatively strong, there is the possibility of multiple equilibria in which the incidence of corruption can be different for the same configuration of parameters. The result is illustrated in Figure 2\textsuperscript{14} which is again based on (8), but which now entails the assumption that $F_\theta(\theta) < 0$. As before, at sufficiently low or sufficiently high values of $t$, there is a unique equilibrium in which a bureaucrat’s incentive to behave one way or another is unaffected by how other bureaucrats are behaving. For $t < \tilde{t}_1$, the gains from corruption are never enough to compensate for the costs so that the condition in (8) is never satisfied: that is, $(\frac{\mu m}{n}) t < F(1)$ and $(\frac{\mu m}{n}) t < F(0)$. As such, each and every bureaucrat chooses not to be corrupt ($\theta = 0$) in a unique

\textsuperscript{14}See Appendix A.
equilibrium from which there is no incentive to deviate. Conversely, for $t > \hat{t}_0$, the gains from corruption are always greater than the costs, meaning that the condition in (8) is always satisfied: that is, $(\frac{\mu m}{n}) t > F(1)$ and $(\frac{\mu m}{n}) t > F(0)$. Accordingly, all bureaucrats choose to be corrupt ($\theta = 1$) in a unique equilibrium where none of them has an incentive to behave otherwise. In contrast to these scenarios, a bureaucrat’s temptation to transgress when $t \in (\hat{t}_1, \hat{t}_0)$ depends critically on the exploits of others as the influence of social stigma becomes important. The more (less) widespread is corruption, the lower (greater) is the stigma that a bureaucrat incurs from participating in such activity and so the more (less) likely it is that the condition in (8) will be satisfied. As above, any $\theta \in (0,1)$ for which either $(\frac{\mu m}{n}) t > F(\theta)$ or $(\frac{\mu m}{n}) t < F(\theta)$ cannot be an equilibrium, but the final outcome is different: in both cases the gap becomes wider as $\theta$ either increases or decreases until $\theta = 1$ or $\theta = 0$. These are two candidate equilibria that are frequency-dependent in the following sense: each bureaucrat will choose to be corrupt if others are corrupt ($(\frac{\mu m}{n}) t > F(1)$), and will choose not to be corrupt if others are not corrupt ($(\frac{\mu m}{n}) t < F(0)$). In this way, both good and bad behaviour can be contagious as a bureaucrat’s compliance in corruption depends critically on the compliance of others.

2.3 Non-collusive Corruption

The second scenario that we consider is one in which public officials, alone, may seek to enrich themselves illegally, there being no duplicity on the part of private agents. Specifically, corruptible bureaucrats may embezzle public funds by pocketing the tax revenues that they collect from high-income households. We denote by $e$ the amount of embezzlement that each bureaucrat undertakes.

Since no household ever evades its taxes, responsibility for corruption lies solely with bureaucrats. The final income of a bureaucrat is $w_B$ if he is non-corrupt and $w_B + e - c$ if he is corrupt. In the event of the latter the bureaucrat incurs a social stigma cost of $s_B$. The utility of a bureaucrat is
therefore given by

\[ u_B = \begin{cases} 
  w_B & \text{if } e = 0 \\
  w_B + e - c - s_B & \text{if } e > 0.
\end{cases} \]  

The bureaucrat will embezzle tax revenues if doing so leaves him no worse off than he would otherwise be. From (9), this requires that

\[ e \geq c + s_B. \]  

(10)

Naturally, the bureaucrat needs his ill-gotten gains to be large enough so as to at least compensate him for his costs of transgressing.

The total amount of funds that each bureaucrat embezzles is simply the total amount of taxes that he collects from households: that is, \( e = \left( \frac{\mu m}{n} \right) t \). Given this, we may proceed as before to establish a final condition for corruption to occur by using the expressions for \( s_B \) and \( c \) in (1) and (2). Of course, \( \phi = 0 \) under present circumstances because of the absence of any tax evaders. The final version of (10) is therefore given as

\[ \left( \frac{\mu m}{n} \right) t \geq \sigma_B (m + n - \theta \eta n) + \gamma \theta \eta n \equiv G(\theta). \]  

(11)

2.3.1 Equilibrium Outcomes

As previously, we proceed to determine the equilibrium incidence of corruption by determining the equilibrium value of \( \theta \), denoted in the present case by \( \tilde{\theta} \), from an analysis of the incentive condition in (11). Thus we define \( \Delta = \{t, \sigma_B, \gamma\} \), and denote by \( \tilde{t}_0 \) and \( \tilde{t}_1 \) the threshold values of \( t \) for which \( \left( \frac{\mu m}{n} \right) \tilde{t}_0 = G(0) \) and \( \left( \frac{\mu m}{n} \right) \tilde{t}_1 = G(1) \). Then \( t \geq \tilde{t}_0 \) is the condition for an individual bureaucrat to be corrupt, given that no other bureaucrat is corrupt, whilst \( t \geq \tilde{t}_1 \) is the condition for an individual bureaucrat to be corrupt, given that all other bureaucrats are corrupt. The function \( G(\theta) \) is increasing or decreasing in \( \theta \) depending on whether \( \gamma - \sigma_B \) is positive or negative, which again depends on the relative strengths of pecuniary and non-pecuniary costs. If social stigma effects are relatively weak, then \( \gamma > \sigma_B \) so that \( G_\theta(\theta) > 0 \), implying that \( G(0) < G(1) \) and \( \tilde{t}_0 < \tilde{t}_1 \). Conversely, if social stigma effects are relatively strong, then \( \gamma < \sigma_B \) so that \( G_\theta(\theta) < 0 \),
implying that $G(0) > G(1)$ and $\tilde{t}_0 > \tilde{t}_1$.

Analogous to Lemma 1, we deduce the following result.

**Lemma 3** Assume that $\gamma > \sigma_B$. Then the equilibrium fraction of corrupt corruptible bureaucrats is given by the following: (i) $\tilde{\theta} = 0$ for $t < \tilde{t}_0$; (ii) $\tilde{\theta} = 1$ for $t > \tilde{t}_1$; and (iii) $\tilde{\theta} = g(\Delta) \in (0, 1)$ for $t \in (\tilde{t}_0, \tilde{t}_1)$, where $g_r(\cdot) > 0$, $g_{\sigma_B}(\cdot) < 0$ and $g_\gamma(\cdot) < 0$.

**Proof.** The result is established by following the proof of Lemma 1.

Thus, as before, the existence of relatively weak social stigma effects ensures the existence of a unique equilibrium. The reasoning is the same and can be illustrated using Figure 1 with appropriate changes in notation. For $t < \tilde{t}_0$, the amount of public funds that a bureaucrat can embezzle is never sufficient to make him want to do this. He is always worse off by engaging in corruption, irrespective of whether others are corrupt or non-corrupt: that is, $(\frac{um}{n})t < G(1)$ and $(\frac{um}{n})t < G(0)$. Consequently, the only equilibrium from which there is no incentive to deviate is one in which all bureaucrats abstain from corruption ($\theta = 0$). Conversely, for $t > \tilde{t}_1$, a bureaucrat can pocket more than enough funds to make it worth his while to do so. He is now always better off by engaging in corruption, regardless of whether others are corrupt or non-corrupt: that is, $(\frac{um}{n})t > G(1)$ and $(\frac{um}{n})t > G(0)$. It follows that the only equilibrium in which there is no incentive to change behaviour is when all bureaucrats choose to be corrupt ($\theta = 1$). Finally, for $t \in (\tilde{t}_0, \tilde{t}_1)$, the equilibrium level of corruption takes some intermediate value ($\theta \in (0, 1)$) which makes bureaucrats indifferent between being corrupt and non-corrupt: that is, $(\frac{um}{n})t = G(\theta)$ which implies $\theta = g(\Delta)$. This value of $\theta$ increases with $t$ (i.e., the amount of funds that can be stolen) and decreases with $\sigma_B$ and $\gamma$ (i.e., the costs of stealing).

Analogous to Lemma 2, we can also establish a different result under different circumstances.

**Lemma 4** Assume that $\gamma n < \sigma_B \eta$. Then the equilibrium fraction of corrupt corruptible bureaucrats is given by the following: (i) $\tilde{\theta} = 0$ for $t < \tilde{t}_1$; (ii) $\tilde{\theta} = 1$ for $t > \tilde{t}_0$; and (iii) either $\tilde{\theta} = \{0, 1\}$ for $t \in (\tilde{t}_1, \tilde{t}_0)$.

**Proof.** The result is established by following the proof of Lemma 2.
Like before, the existence of relatively strong social stigma effects implies the possibility of multiple equilibria. The same intuition applies, as may be illustrated with a simple re-labelling of Figure 2. For $t < \tilde{t}_1$ or $t > \tilde{t}_0$, there is a unique equilibrium in which no bureaucrat has an incentive to change his behaviour. In the case of the former all bureaucrats are non-corrupt ($\theta = 0$) as each one finds this to be the optimal strategy irrespective of whether others behave likewise or not: that is, $(\frac{\eta m}{n}) t < G(0)$ and $(\frac{\eta m}{n}) t < G(1)$. In the case of the latter all bureaucrats are corrupt ($\theta = 1$) as each one finds this strategy to be optimal, regardless of what others are doing: that is, $(\frac{\eta m}{n}) t > G(0)$ and $(\frac{\eta m}{n}) t > G(1)$. By contrast, for $t \in (\tilde{t}_1, \tilde{t}_0)$, there is non-uniqueness due to the influence of social stigma. Since $(\frac{\eta m}{n}) t > G(1)$ and $(\frac{\eta m}{n}) t < G(0)$, then the equilibrium is one in which all bureaucrats are either corrupt ($\theta = 1$) or non-corrupt ($\theta = 0$) as each of them chooses to behave one way or another according to how others are behaving.

### 2.4 Implications

The main objective of our analysis is to explain why the incidence of corruption varies so markedly across countries, even when one considers countries that are similar in their levels of development and institutional structures, or when one controls for differences in these aspects. There are two dimensions along which we examine this issue - variations that may arise for the same corruption regime and variations that may occur under different regimes. As we shall see, the key element in both cases is the influence of social stigma.

As a precursor to our investigations, it is worth commenting briefly on our choice of measure of corruption. An obvious candidate for this is $\theta$, the fraction of corruptible bureaucrats who are corrupt. This may not be quite the same as other possible measures that quantify corruption in monetary terms. One of these is the total illegal income of all corrupt officials, which is equal to $\theta \eta \mu m (t - s_H)$ (the total amount of bribe payments) in the case of collusive corruption and $\theta \eta \mu m t$ (the total amount of embezzled public funds) in the case of non-collusive corruption. Evidently, these quantities could be the same even if $\theta$ is different between regimes, or they could be different even if $\theta$ is the same across regimes. Alternatively, one might refer to the
total amount of tax revenue that goes missing, which is equal to $\theta \eta \mu m t$ under both regimes. Clearly, this quantity could be the same or different across regimes only if $\theta$ is the same or different. Of these two monetary measures, the latter seems the more appropriate, not only because it involves least ambiguity when comparing different scenarios, but also because it quantifies the direct impact of corruption on public finances. Adopting this measure is obviously equivalent to simply using $\theta$ as a basis of comparison.

2.4.1 Diversity Within Corruption Regimes

Our previous analysis showed how social stigma can be important in determining the equilibrium outcome of any type of corruption regime. Whether there is collusion or non-collusion, the result is the same: there is always a unique equilibrium when stigma effects are weak (Lemmas 1 and 3), but possibly a multiplicity of equilibria when stigma effects are strong (Lemmas 2 and 4). The key implication of the latter is stated as follows.

Corollary 1 Given Lemma 2 (Lemma 4), the equilibrium incidence of corruption for any $t \in (\tilde{t}_1, \tilde{t}_0)$ ($t \in (\tilde{t}_1, \tilde{t}_0)$) may be different across countries that share the same corruption regime.

As we have seen, both $\theta = 0$ (zero corruption) and $\theta = 1$ (maximum corruption) are possible equilibria when $t \in (\tilde{t}_1, \tilde{t}_0)$ in the case of collusive corruption and $t \in (\tilde{t}_1, \tilde{t}_0)$ in the case of non-collusive corruption. Under such circumstances, two identical economies may display completely different levels of corruption, depending on which equilibrium they settle in.

As indicated earlier, there are other analyses of corruption which establish the possibility of non-uniqueness due to complementarities between individual and aggregate behaviour (for reasons other than social stigma). Like those analyses, we do not provide a theory as to why one economy may find itself in one equilibrium and another economy may find itself in another. One typically thinks of this as reflecting differences in cultural and ideological factors that shape society’s attitudes towards corruption in a way that makes this activity more or less acceptable and more or less self-sustaining. Whatever the explanation, the potential for multiple equilibria to exist pro-
vides one reason why countries that are similar in other respects (including corruption regime) may be very different in their qualities of governance.

2.4.2 Diversity Across Corruption Regimes

The potential for corruption to vary across economies increases substantially if one considers cross-country differences in the way that corruption is predominantly practised. This may be due to a number of factors, and the one that we reveal and focus on here is the influence of social stigma. It is this factor, alone, that accounts for differences between corruption regimes in our model. To be sure, suppose that social stigma is absent, in which case \( \sigma_i = 0 \) (i.e., \( s_i = 0 \)). Under such circumstances, a bureaucrat earns the same illegal income from bribery as he does from embezzlement (i.e., \( \left( \frac{\mu m}{n} \right) t \)), and his incentive to engage in either offence is governed by the same condition (i.e., \( \left( \frac{\mu m}{n} \right) t \geq \gamma \theta \eta n \)). The outcome in both cases is identical, being a unique equilibrium in which \( \theta \in (0, 1) \) for \( t < \tilde{t} \) and \( \theta = 1 \) for \( t > \tilde{t} \), where \( \left( \frac{\mu m}{n} \right) \tilde{t} = \gamma \eta n \). Such is not the case, however, when stigma effects are present. Neither the income \(( \left( \frac{\mu m}{n} \right) (t - s_H) \)) nor the cost \( (s_B + c, \) where \( s_B = \sigma_B[m + n - \theta \eta (\mu m + n)] \)) associated with bribery is the same as the income \(( \left( \frac{\mu m}{n} \right) t \)) or the cost \( (s_B + c, \) where \( s_B = \sigma_B(m + n - \theta \eta m) \)) associated with embezzlement, and the condition governing participation in each type of offence ((8) in the case of the former and (11) in the case of the latter) is also now different. This means that, in general, \( \tilde{t}_i \neq \tilde{t}_i \) (i = 0, 1) and the equilibrium value of \( \theta \) is different across regimes. Our detailed analysis of this yields several further results, the proofs of which are contained in Appendix A.\(^{15} \)

Consider, first, a situation in which each corruption regime is characterised by a unique equilibrium, as described in Lemmas 1 and 3. Note that if this is true for a collusive regime (\( \gamma n > [\sigma_B + \frac{\mu m}{n} \sigma_H] (\mu m + n) \)), then it must also be true for a non-collusive regime (\( \gamma > \sigma_B \)). Given this, we may state the following.

\(^{15} \text{The differences between corruption regimes continue to exist if one assumes that only bureaucrats incur social stigma (i.e., } s_H = 0). \text{ Whilst the amount of illegal income is the same in both cases, the costs are generally different because of different populations of honest agents (the presence or absence of tax-evading households) on which bureaucrats’ stigma-induced disutility, } s_B, \text{ depends. As such, the incentive condition governing corrupt behaviour is generally different as well.} \)
Proposition 1 Assume that $\gamma n > \left[ \sigma_B + \left( \frac{\mu m}{n} \right) \sigma_H \right] (\mu m + n)$. Then for any given $\{\sigma_B, \sigma_H, \gamma\}$, the threshold values of $t$ under different corruption regimes satisfy the following: (i) $\hat{t}_0 < \tilde{t}_0$; (ii) $\tilde{t}_1 \geq \tilde{t}_1$; and (iii) $\tilde{t}_1 - \hat{t}_0 > \hat{t}_1 - \tilde{t}_0 > 0$.

Each threshold value of $t$ denotes a boundary between different levels of corruption: the lower threshold, $\hat{t}_0$ or $\tilde{t}_0$, gives the border between $\theta = 0$ and $\theta \in (0, 1)$, whilst the upper threshold, $\tilde{t}_1$ or $\hat{t}_1$, gives the border between $\theta \in (0, 1)$ and $\theta = 1$. The above results show how different corruption regimes involve different levels of thresholds and therefore different ranges of $t$ over which various outcomes occur. We may give some intuition for our findings. At low values of $t$, the amount of illegal income that can be earned from either form of corruption is relatively small, which is why no bureaucrat chooses to engage in corrupt behaviour in these circumstances. It is still true, however, that income from embezzlement ($\left( \frac{\mu m}{n} \right) t$) is greater than income from bribery ($\left( \frac{\mu m}{n} \right) (t - s_H)$) so that the incentive not to be corrupt is weaker in the case of the former than in the case of the latter. As a consequence, it takes a lower value of $t$ to motivate non-collusive corruption than it does to motivate collusive corruption - hence $\hat{t}_0 < \tilde{t}_0$. On the other hand, whilst embezzlement pays more than bribery, it attracts greater social stigma for the same level of corruption because more of the population is honest (i.e., there are no tax-evading households). This means that, depending on circumstances, the value of $t$ at which all bureaucrats choose to be corrupt may be lower or higher in a non-collusive regime than in a collusive regime - hence $\tilde{t}_1 \geq \hat{t}_1$. Finally, it turns out that, whatever the circumstances, the range of $t$ over which some corruptible bureaucrats are corrupt and others are non-corrupt is always greater under non-collusion than under collusion - that is, $\tilde{t}_1 - \hat{t}_0 > \hat{t}_1 - \tilde{t}_0$.

Based on the above, we can establish the following.

Proposition 2 Given Proposition 1, the equilibrium levels of corruption in collusive and non-collusive regimes compare as follows: (i) $\hat{\theta} = \tilde{\theta} = 0$ for $t < \hat{t}_0$; (ii) $\bar{\theta} = 0$ and $\tilde{\theta} = g(\Delta) \in (0, 1)$ for $t \in (\tilde{t}_0, \hat{t}_0)$; (iii) $\bar{\theta} = f(\Omega) \in (0, 1)$ and $\tilde{\theta} = g(\Delta) \in (0, 1)$ for $t \in (\hat{t}_0, \min\{\tilde{t}_1, \hat{t}_1\})$; (iv)
either $\bar{\theta} = 1$ and $\bar{\theta} = g(\Delta) \in (0, 1)$, or $\bar{\theta} = f(\Omega) \in (0, 1)$ and $\bar{\theta} = 1$ for $t \in (\min\{\hat{t}_1, \tilde{t}_1\}, \max\{\hat{t}_1, \tilde{t}_1\})$; and (v) $\bar{\theta} = \bar{\theta} = 1$ for $t > \max\{\hat{t}_1, \tilde{t}_1\}$.

There is an immediate implication of these findings.

**Corollary 2** Given Proposition 2, the equilibrium level of corruption for any $t \in (\hat{t}_0, \max\{\hat{t}_1, \tilde{t}_1\})$ is different across economies that have different corruption regimes.

We illustrate these results in Figure 3\textsuperscript{16} for the case in which $\tilde{t}_1 > \hat{t}_1$. Consider two economies that are identical in every respect, except for the corruption regime that might prevail in each one of them. Suppose that country A is prone to collusive corruption, whilst country B is prone to non-collusive corruption. For any $t < \tilde{t}_0$ and any $t > \hat{t}_1$, there is no difference between these economies in terms of their levels of corruption: both exhibit zero corruption ($\bar{\theta} = \bar{\theta} = 0$) in the case of the former and maximum corruption ($\bar{\theta} = \bar{\theta} = 1$) in the case of the latter. For $t \in (\hat{t}_0, \tilde{t}_1)$, however, the two economies display different levels of misgovernance. If $t \in (\hat{t}_0, \tilde{t}_0)$, country A enjoys zero corruption ($\bar{\theta} = 0$), but country B suffers from some positive level of corruption ($\bar{\theta} = g(\Delta)$). If $t \in (\hat{t}_0, \tilde{t}_1)$, both countries experience positive corruption, but to different degrees ($\bar{\theta} = f(\Omega)$ and $\bar{\theta} = g(\Delta)$). And if $t \in (\tilde{t}_1, \tilde{t}_1)$, country A is fully corrupt ($\bar{\theta} = 1$), whilst country B is still only partially corrupt ($\bar{\theta} = g(\Delta)$). These observations provide a further explanation of the diversity of corruption.

Our next port of call is a situation in which both corruption regimes display the possibility of multiple equilibria, as described in Lemmas 2 and 4. Observe that, in this case, if such a possibility exists for non-collusive corruption ($\gamma < \sigma_B$), then it must also exist for collusive corruption ($\gamma n < [\sigma_B + (\mu m/n) \sigma_H] (\mu m + n)$). Given this, we may deduce the following.

**Proposition 3** Assume that $\gamma < \sigma_B$. Then for any given $\{\sigma_B, \sigma_H, \gamma\}$, the threshold values of $t$ under different corruption regimes satisfy the following:

(i) $\hat{t}_1 > \tilde{t}_1$; (ii) $\hat{t}_0 > \tilde{t}_0$; and (iii) $\hat{t}_0 - \hat{t}_1 > \tilde{t}_0 - \tilde{t}_1 > 0$.

\textsuperscript{16}See Appendix A.
As before, each of the thresholds demarcates regions of $t$ over which different levels of corruption occur: the lower threshold, $\hat{t}_1$ or $\tilde{t}_1$, is the boundary between $\theta = 0$ and $\theta = \{0,1\}$, whilst the upper threshold, $\hat{t}_0$ or $\tilde{t}_0$, is the boundary between $\theta = \{0,1\}$ and $\theta = 1$. The above results demonstrate once more how different corruption regimes involve different levels of thresholds and therefore different ranges of $t$ over which various outcomes occur. Again, we may provide some intuition for the results. At relatively low (high) values of $t$, the illegal income from corruption is so small (large) that each bureaucrat chooses to be honest (dishonest) irrespective of what others are doing so that $\theta = 0$ ($\theta = 1$) is the unique equilibrium. At intermediate values of $t$, however, the activities of others become the decisive factor through the influence of social stigma. In terms of generating herd-type behaviour (whether for the good or for the bad), this influence is stronger under collusive corruption than under non-collusive corruption because the number of potential offenders is greater due to the participation of tax-evading households. This means that the level of $t$ at which stigma effects begin to dominate (dissipate) tends to be lower (higher) in a collusive regime. At the same time, the illegal income from embezzlement is greater than the illegal income from bribery, and this tends to offset (reinforce) the effects of stigma on the lower (higher) threshold level of $t$. Accordingly, $\hat{t}_1 \geq \tilde{t}_1$, whilst $\hat{t}_0 > \tilde{t}_0$. It turns out that, in spite of the former ambiguity, the range of $t$ over which multiple equilibria occurs is always greater under collusion than under non-collusion so that $\hat{t}_0 - \hat{t}_1 > \tilde{t}_0 - \tilde{t}_1$.

Having established the above, we are now led to a further deduction.

**Proposition 4** Given Proposition 3, the equilibrium levels of corruption in collusive and non-collusive regimes compare as follows: (i) $\hat{\theta} = \tilde{\theta} = 0$ for $t < \min\{\hat{t}_1, \tilde{t}_1\}$; (ii) either $\hat{\theta} = 0$ and $\tilde{\theta} = \{0,1\}$, or $\hat{\theta} = \{0,1\}$ and $\tilde{\theta} = 0$, for $t \in (\min\{\hat{t}_1, \tilde{t}_1\}, \max\{\hat{t}_1, \tilde{t}_1\})$; (iii) $\hat{\theta} = \{0,1\}$ and $\tilde{\theta} = \{0,1\}$ for $t \in (\max\{\hat{t}_1, \tilde{t}_1\}, \hat{t}_0)$; (iv) $\hat{\theta} = \{0,1\}$ and $\tilde{\theta} = 1$ for $t \in (\hat{t}_0, \tilde{t}_0)$; and (v) $\hat{\theta} = \tilde{\theta} = 1$ for $t > \hat{t}_0$.

As previously, an immediate implication can be drawn.
Corollary 2 Given Proposition 4, the equilibrium level of corruption for any \( t \in (\min\{\tilde{t}_1, \tilde{t}_1\}, \tilde{t}_0) \) may be different across economies that have different corruption regimes.

These results are illustrated in Figure 4\(^{17}\) for the case in which \( \tilde{t}_1 < \tilde{t}_1 \). Consider, again, two economies, A and B, that are identical in all respects, except for the way that corruption is practised - collusively in the case of the former and non-collusively in the case of the latter. For any \( t < \tilde{t}_1 \) and any \( t > \tilde{t}_0 \), the incidence of corruption is the same in the two countries, being at its minimum (\( \hat{\theta} = \tilde{\theta} = 0 \)) and maximum (\( \hat{\theta} = \tilde{\theta} = 1 \)) values, respectively. For \( t \in (\tilde{t}_1, \tilde{t}_0) \), however, the economies may display different levels of corruption. If \( t \in (\tilde{t}_1, \tilde{t}_1) \), then country B exhibits zero corruption (\( \hat{\theta} = 0 \)), whilst country A may show either zero or positive corruption (\( \hat{\theta} = \{0, 1\} \)). If \( t \in (\tilde{t}_1, \tilde{t}_0) \), both countries may exhibit either zero or positive corruption (\( \hat{\theta} = \{0, 1\} \) and \( \hat{\theta} = \{0, 1\} \)). And if \( t \in (\tilde{t}_0, \tilde{t}_0) \), country A may be either corrupt or non-corrupt (\( \hat{\theta} = \{0, 1\} \)), whilst country B is surely corrupt (\( \hat{\theta} = 1 \)). Like before, these findings demonstrate how the incidence of corruption may vary according to the way that corruption is practised.

There is one final case to consider, which is a situation in which different corruption regimes display different equilibrium properties. As we have seen, the existence of a unique equilibrium (multiple equilibria) under a collusive (non-collusive) regime necessarily implies the existence of a unique equilibrium (multiple equilibria) under a non-collusive (collusive) regime. This means that the only feasible mixture of scenarios is a collusive regime with multiple equilibria (\( \gamma n < [\sigma_B + (\frac{\mu m}{n}) \sigma_H] (\mu m + n) \)) and a non-collusive regime with a unique equilibrium (\( \gamma > \sigma_B \)). Given this, we may state the following.

Proposition 5 Assume that \( \sigma_B n < \gamma n < [\sigma_B + (\frac{\mu m}{n}) \sigma_H] (\mu m + n) \). Then for any given \( \{\sigma_B, \sigma_H, \gamma\} \), the threshold values of \( t \) under different corruption regimes may satisfy any of the following: (i) \( \tilde{t}_0 < \tilde{t}_1 < \tilde{t}_1 < \tilde{t}_0 \); (ii) \( \tilde{t}_0 < \tilde{t}_1 < \tilde{t}_1 < \tilde{t}_0 \); (iii) \( \tilde{t}_0 < \tilde{t}_1 < \tilde{t}_0 < \tilde{t}_1 \); (iv) \( \tilde{t}_1 < \tilde{t}_0 < \tilde{t}_0 < \tilde{t}_1 \); (v) \( \tilde{t}_1 < \tilde{t}_0 < \tilde{t}_1 \).

\(^{17}\)See Appendix A.
Unsurprisingly, there is now a greater mixture of possibilities relative to the previous scenarios. This is reflected in the following.

**Proposition 6** Given Proposition 5, the equilibrium levels of corruption in collusive and non-collusive regimes compare as follows: (i) $\bar{\theta} = \hat{\theta} = 0$ for $t < \min\{\tilde{t}_0, \tilde{t}_1\}$; (ii) $\bar{\theta} = \hat{\theta} = 1$ for $t > \max\{\tilde{t}_0, \tilde{t}_1\}$; and (iii) $\bar{\theta} = 0$, $\hat{\theta} = \{0, 1\}$ or $\bar{\theta} = 1$, and $\hat{\theta} = 0$, $\bar{\theta} \in (0, 1)$ or $\bar{\theta} = 1$ for $t \in (\min\{\tilde{t}_0, \tilde{t}_1\}, \max\{\tilde{t}_0, \tilde{t}_1\})$, with $\bar{\theta} \neq \hat{\theta}$ in general.

The usual implication is inferred.

**Corollary 3** Given Proposition 6, the equilibrium level of corruption for any $t \in (\min\{\tilde{t}_0, \tilde{t}_1\}, \max\{\tilde{t}_0, \tilde{t}_1\})$ is generally different across economies that have different corruption regimes.

Once again, the diversity of corruption can be readily explained within the context of this model.

### 2.5 Discussion and Conclusions

Why some countries are more corrupt than others is a question that is typically answered by appealing to differences in such factors as the level of development, structure of institutions and quality of governance. Whilst there is surely some truth in this answer, it does not explain why one still observes variations in corruption when one controls for these differences, or when one looks at countries that are seemingly similar in many respects. We have sought to provide such an explanation by taking on board certain considerations that have hitherto received relatively little attention. One of these is the idea that individuals’ incentives to engage in corrupt behaviour may be susceptible to social influences which, in turn, may depend on the extent of such behaviour. Another is the notion that countries may differ in the predominant way that corruption is practised, which may also be a factor that affects social attitudes. Together, these considerations have allowed us to identify a number of scenarios in which the incidence of corruption
may vary across otherwise identical economies.

As it stands, our analysis does not make any predictions about the consequences of corruption for macroeconomic outcomes. It is possible, however, to think of extensions to the model that would deliver such predictions. A simple example is the following. Suppose that firms hire labour, \( l \), from households to produce output, \( y \), according to \( y = Al \) (\( A > 0 \)). Suppose also that productive efficiency is enhanced by the provision of public goods and services, \( g \), such that \( A = a(g) \), where \( a_g(g) > 0 \). Finally, suppose that these publicly-provided inputs are financed from the taxes, \( t \), on the population of high-income households, \( \mu m \). As stated previously, both collusive and non-collusive forms of corruption lead to a loss of tax revenues of \( \theta \eta \mu m t \), implying that the actual amount of public funds available is \( (1 - \theta \eta) \mu m t \). If \( g \) is some fraction, \( \varepsilon \in (0, 1) \), of these funds (the remaining fraction being used for any other government outlays), then we may write \( A = a(\varepsilon(1 - \theta \eta) \mu m t) \) which shows how corruption adversely affects output through its adverse effect on public goods provision. In addition, our equilibrium analysis of corruption can be used to infer the equilibrium level of output under any of the scenarios that we have considered.

Another issue worth commenting on concerns the distinction between corruption regimes. Our analysis does not seek to explain why one form of corrupt practice may predominate in one country and another form may predominate in another, and we are unaware of any other analysis that seeks to do this. Nevertheless, the fact that such differences are observed poses an interesting question that merits attention. Some preliminary thoughts on this are as follows. Based on the model that we have used, it might appear at first glance that practitioners of corruption would always choose to ply their trade non-collusively through embezzlement, rather than collusively through bribery, since the payoff from the former \( \left( \frac{\mu m}{n} \right) t \) is always greater than the payoff from the latter \( \left( \frac{\mu m}{n} \right) (t - s_H) \). But this presumption would be misguided because the costs of corruption are different in each case due to the influence of social stigma: \textit{ceteris paribus}, non-collusive corruption attracts a greater degree of stigma than collusive corruption because there is less of the population involved in the looting of public funds than there is in the exchange of bribes. Thus, even within the context of the present framework, the question of which regime dominates is not trivial, and there may be
circumstances under which individuals are indifferent between regimes, in which case both could co-exist separately in separate environments. Moving beyond our model, there are other considerations that one might wish to take account of. Not least of these is the notion that the powers of detecting and prosecuting corrupt activity may depend on what form this activity takes. Whether these powers are likely to be stronger or weaker against one form of corruption than another is debatable: when the exchange of bribes is involved, the fact that benefits accrue to both bribe takers and bribe payers means that no-one is compelled to dissent and expose the offence; when the embezzlement of public funds is involved, the fact that no private property is seized or stolen means that individuals have little opportunity to protest and seek compensation. For these and other reasons, the difficulty in fighting corruption could be greater or less in each case, implying a similar ambiguity about that the relative incentives to engage in one form of malpractice or the other. Finally, we note that all of this discussion is based on a pure economic analysis of the benefits and costs of alternative corruption regimes. Like other questions about corruption, the answer to why different regimes exist may have as much to do with culture and tradition as has it has with payoffs and incentives.
3 Crime, Fertility and Economic Growth

During the last three decades the economics of crime has developed into a new, interesting area of investigation for academics. This has been the case due to the increase in crime rates across numerous countries. Crime imposes a significant economic and social burden and remains high on the agenda of policy-makers and institutions. This is because crime forms a significant obstacle to the rate of economic growth and damages the competitiveness and investment prospects of any given country. Moreover, it leads to the misallocation of resources, deteriorates the standard of living and imposes a threat to human life and security. At the same time the unified growth theory has emphasized the role of demographic transition as an important determinant of the transition of economic growth regimes. The channels through which a change in fertility could influence growth are as follows: by having an effect on the dilution of the stock of capital and land; influencing the investment of human capital; and causing an alteration in the age distribution of the population which temporarily increases the size of the labour force relative to the whole population (Galor 2005). The observation that countries with high fertility rates have high crime rates is not new. Despite this connection, fertility and crime have been treated as independent and unrelated variables in the process of economic growth. To account for this stylized fact, this section examines the link between crime and fertility and, subsequently, their joint influence on economic growth. This link is offered by the probability of crime apprehension or, inversely, the likelihood of escaping criminal arrest.

The economics of crime date back to the seminal paper by Becker (1968), where agents were treated as expected-utility maximizers. In the paper presented, Becker argues that the criminal should be viewed as a rational economic agent. The criminal will compare the potential benefits and costs of engaging in crime, just as in any other activity. The expected monetary reward and the opportunity cost will constitute the benefits, whereas the probability of getting caught and the severity of the punishment will play a crucial role when the individual is considering the costs of engaging in a criminal act. If the costs exceed the benefits then the agent will not engage in criminal activities. Similarly, if the benefits exceed the costs in-
volved the agent will proceed with the criminal activity. The majority of research in this area, both theoretical and empirical, tends to explore the causes and consequences of crime as well as the effectiveness of deterrence factors in preventing crime. More recently, Imrohoroglu et al. (2004; 2006) and Engelhardt et al. (2008), by calibrating their models to U.S. property crime data, have found that the most important factor for observed changes in crime rates is the apprehension probability. This result has also received strong empirical support both for the U.S. and across other countries. Many studies have shown that increases in the probability of apprehension and punishment, achieved by greater government expenditure on security or a greater number of security officers, decrease the expected returns from crime and, therefore, crime itself (Marvell and Moody 1996; Corman and Mocan 2000, 2005; Levitt 2002, 2004; Di Tella and Schargrodsky 2004; Klick and Tabarrok 2005; Evans and Owens 2007; Lin 2009; Draca et al. 2011; and Harbaugh et al. 2011). Therefore, in accordance with these studies we examine how the likelihood of arrest influences economic growth via its effect on crime rates.

From the perspective of development theorists, a demographic transition represents the underlying mechanism for moving from a near-zero steady growth regime to a positive steady state growth regime. Empirical studies show that there is a negative correlation between the fertility and the growth rates (Galor and Weil 2000; Blackburn and Cipriani 2002; Levitt 2004; Azarnet 2006; Becker et al. 1990). According to the World Bank, today’s low-income countries still have the world’s highest birth rates. An explanation for this observation is that when health conditions improve, parents prefer to have smaller families, as there is a higher probability of children surviving childhood. The trade-off between quantity and quality for children is certainly not a new idea as it dates back to the contribution by Becker (1960) which features the quantity-quality trade-off for children. The author asserts that this trade-off arises because of the assumption that the parental utility depends both on the number of children and on the quality of these children. The latter is represented by costly human capital investments such as education. Since both rearing and educating children are costly, a trade-off between these two activities arises. In this way, a decline in fertility induces higher levels of human capital accumulation as parents
substitute child quantity for child quality. The simultaneous accumulation of 
human capital and the decline in fertility provides a link between transition 
in demography and growth. Various versions of this argument have been 
developed by Galor and Weil (1999; 2000), Kalemi-Ozcan (2003), Soares 
(2005), Tamura (2006) and Soares and Falcão (2008). In addition to this 
framework, recent work has considered the case where human capital accu-
mulation is a function of investment in health (Bhattacharya and Qiao 2007; 
Tang and Zhang 2007; Agénor 2009).

The purpose of this section is to study the connection between crime 
and fertility rates and the way in which these two variables have an impact 
on economic growth. In this way, we present a theoretical model, where 
the results combine the two pioneering works by Becker (1960; 1968), so as 
to illustrate that crime and fertility are jointly determined by the proba-
bility of avoiding apprehension. Our theoretical model comprises two basic 
relationships. The first relates the probability of escaping apprehension to 
the level of crime. The second connects the probability of escaping appre-
hension to child-bearing decisions. In this way, the model illustrates the 
idea that crime rates and fertility rates are equilibrium outcomes. Their re-
lation ship depends on the individual (time allocation) and the institutional 
actors (probability of arrest) that determine outcomes on an individual level 
aggregate across the population.

In particular, this model is an extension of Agénor’s (2009) paper. One 
of the main modifications is that we also study crime-related issues. We ex-
amine a model of overlapping generations, where agents live through three 
periods: childhood, adulthood and old age. Adult agents allocate their 
non-work unit of time between crime, child-rearing and leisure. Govern-
ment spending is made up of productive spending on health services and 
unproductive spending that is financed by taxes and any confiscated stolen 
resources. The analysis as discussed above is focused on the change in a 
crime variable, namely the probability of not getting caught, and how this 
will affect the equilibrium values. This crime variable provides an impor-
tant implication for the time allocation problem of agents. According to 
Becker (1968), the expected payoffs and the costs involved in the activity 
are the main determinants of criminal behaviour. In our model this cost 
is represented by the probability of getting arrested and losing all illegal
income.

Our results are in accordance with Becker’s (1968) hypothesis showing that an increase in the probability of avoiding apprehension increases the time agents allocate to criminal acts and subsequently decreases the time they devote to the remaining activities. The first contribution of the model is that, by taking into account the potential threshold effects, it indicates that this relationship is not linear. It takes shape after a particular threshold value of the probability of escaping detection, which arises because of the value agents attach to each activity. Their incentive to switch from allocating time to their children or leisure to criminal activities must be the assurance of a minimum income. The model’s second contribution is to show that the probability of escaping apprehension has a positive effect on fertility. Our analysis illustrates that crime and fertility are jointly determined by the probability of escaping apprehension. Lastly, the model shows that an increase in the probability of escaping detection has an ambiguous effect on economic growth.

The remainder of this section is organized as follows. The first part describes the basic set-up of the model. What follows is the model’s solution for the equilibrium values of the variables of interest. Then we provide an analysis of how these values will be affected if there is a change in the probability of avoiding apprehension. Finally, the last part gives the concluding remarks. The solution of the model is derived in Appendix B.

3.1 The Basic Framework

In this section we describe the basic set-up of the model, in terms of the characteristics of the population, the households, the firms, the health status and productivity and the government.

3.1.1 Population and Labor Supply

Let $N_t$ be the number of adults in period $t$. Given that at the beginning of their adult life in $t$, each individual bears $n_t$ children, the total number of children born at the beginning of that period is $n_tN_t$.\footnote{For tractability, the number of children is assumed to be continuous. Integer restrictions are thus neglected.} To avoid convergence
of population size toward zero, we assume that $n_t \geq 1$. Thus, children and adult population at the beginning of period $t$ is $(1 + n_t) N_t$. Moreover, the number of old agents in period $t$ is the number of adults from period $t - 1$, $N_{t-1}$, whereas the number of adults in period $t$ is equal to the number of children born in the previous period, that is, $N_t = N_{t-1} n_{t-1}$.

Aggregate population at the beginning of period $t$, $L_t$, is thus

$$L_t = [1 + (1 + n_t) n_{t-1}] N_{t-1}. \quad (12)$$

### 3.1.2 Households

As noted above, at the beginning of their adult life in $t + 1$, each agent bears $n_{t+1}$ children. Raising a child involves two types of costs. First, parents spend $\varepsilon_{t+1} \in (0, 1)$ units of time on each of them to take care of their health (breast-feeding, taking children to medical facilities for vaccines, etc.). Thus, each adult allocates $\varepsilon_{t+1} n_{t+1}$ total units of time to that activity. Second, raising children involves costs in terms of marketed goods. These costs could include feeding children, taking them to medical facilities, buying medicines, etc. Specifically, each individual spends a fraction $\lambda \in (0, 1)$ of his disposable income on each child’s health. Hence, although access to “out of home” health services per se is free, families incur an opportunity cost in terms of foregone wage income and consumption.

In addition to raising children and supplying a unit of labour inelastically to firms, adults allocate time (in proportion $\theta_{t+1}$) engaging in criminal activities.\textsuperscript{19} We assume that the nature of crime consists of theft. The amount of resources that can be stolen, $x_{t+1}$, corresponds to a fraction of the victim’s after-tax income from legitimate activities, in line with Imrohoroglu et al. (2000; 2004), that is increasing in the time agents invest in this activity, as in Lochner (2004; 2011). The specification is given by

\textsuperscript{19}We could instead assume that a single unit of time is allocated among work, crime, child-rearing, and leisure. This would yield a trade-off between time spent on legal and illegal activities that is consistent with most of the studies in the literature. The decision to disentangle work time from crime time hinges, as will become clear below, on the capacity of child-rearing time to contribute to better health status and higher productivity for future adults. In this way, a trade-off between productive and unproductive use of time is in place. This consideration has similar properties to the division of time between work and crime.
\[ x_{t+1} = (1 - \tau)a_{t+1}w_{t+1}\theta_{t+1}, \]  

(13)

where \(a_{t+1}\) is individual labour productivity, and \(w_{t+1}\) is the real wage rate.

Furthermore, it is only adult agents that are assumed to be both perpetrators and victims of crime. This implies that only the economically active share of the population engages in criminal activities. This assumption is consistent with evidence on the age profile of offenders, which are typically of younger age (see Freeman 1999; Levitt and Lochner 2001; Levitt 2004; Buonanno et al. 2011). It is further supported by the higher victimization rates experienced by adults as this is documented in official crime and victimization surveys (see various issues of the US National Crime Victimization Survey, Demography of victims, Table 3; the British Crime Survey; the Irish Crime and Victimization Survey, Table 4).\(^{20}\) The assumption is also in line with theoretical studies (see, for instance, Lochner 2004; Capasso 2005), where agents do not enter into criminal behaviour during old age. This may reflect a stage in their careers at which time they are done with crime and enjoy retirement.

The above assumption (that adults are both offenders and subjects of crime) has one further implication. Given the agent’s homogeneity with respect to potential earnings, productivity, and inclination to commit crime, it is implied that each adult individual acts both as a perpetrator and a victim with probability one. Agent homogeneity and the joint participation in the criminal and legal markets is consistent with the analysis in Mocan et al. (2005) and Mauro and Carmeci (2007), while it agrees with Fagan and Freeman (1999) who state that “crime and legal work are not mutually exclusive choices but represent a continuum of legal and illegal income-generating activities.”\(^{21}\)

Once an adult individual acts illegally, he faces the likelihood of getting caught and punished at the end of period \(t + 1\). The probability of appre-

\(^{20}\)Assuming that both the adult and the old generations, or only the latter as in Josten (2003), are subject to crime, does not alter the analysis or our findings.

\(^{21}\)See Engelhardt et al. (2008) for a model where both employed and unemployed agents act as victims and offenders at the same time.
hension and conviction is \((1 - \pi)\).\(^{22}\) If apprehended, the stolen resources by an individual are confiscated and used by the government to finance its expenses, with no additional penalties.\(^{23}\)

There is an actuarially fair annuity market that channels savings to investment in physical capital, \(K_t\), for production in the next period. Let \(r_{t+2}\) denote the rental rate of private capital.

Assuming that consumption of children in the first period of life is subsumed in their parents’ consumption, lifetime utility at the beginning of period \(t+1\) of an agent born at \(t\) is specified as

\[
U_{t+1} = \ln(c_{t+1}^t) + \ln(1 - \varepsilon_{t+1} n_{t+1} - \theta_{t+1})
\]

\[
+ \ln(n_{t+1} h_{t+1}^C) + \frac{\ln(c_{t+2}^t)}{1 + \rho},
\]

where \(c_{t+j}^i\) denotes consumption of generation \(i\) individuals at date \(t+j\) and \(\rho > 0\) is the discount rate. The term \(1 - \varepsilon_{t+1} n_{t+1} - \theta_{t+1}\) measures leisure. Since young and old agents are not engaged in any activity, leisure is a choice variable only in adulthood. The term \(n_{t+1} h_{t+1}^C\) is equal to the fertility rate multiplied by the health status of a child, \(h_{t}^C\). In the standard literature, parents derive utility from the ‘raw’ production of offspring, whereas here it is the number of healthy children that matters. Although adult health status does not provide any direct utility benefit to the household, as discussed later it affects it indirectly through wages.

Since there is no consumption in childhood, the period-specific budget constraints are

\(^{22}\)Following Josten (2003), Imrohoroglu et al. (2004; 2006) and Engelhardt et al. (2008), we assume that the probability of apprehension is independently determined. We could easily incorporate into our analysis this probability being an increasing function of public expenditure devoted to security and policing. But this assumption would not alter our solution as it has no impact on the individual’s optimizing behaviour. It would only unnecessarily complicate the analysis for the derivation of the steady-state growth rate of output. Also note that we do not allow for private insurance or private protection expenditure against theft. See Prohaska and Taylor (1973) for a model of insurance coverage against burglary.

\(^{23}\)Allowing for a harsher penalty in the form of confiscation of (part of) the legal income of the criminal, or even having him spend time in prison, would not alter the main results of the analysis and of the underlying mechanism. According to Josten (2003), however, additional monetary penalties may even give rise to a bankruptcy problem so that criminals might end up with no current or future income for consumption.
where \( s_{t+1} \) is saving, \( \pi \) the probability of escaping apprehension once committing crime, and \( Z_{t+1} \) the loss adult agents suffer by being subject to crime.\(^{24}\)

Combining equations (15) and (16) yields the consolidated budget constraint\(^{25}\)

\[
c_{t+1} + s_{t+1} = (1 - \lambda n_{t+1})(1 - \tau)a_{t+1}w_{t+1} - Z_{t+1} + \pi x_{t+1}, \tag{15}
\]

\[
c_{t+2} = (1 + r_{t+2})s_{t+1}, \tag{16}
\]

\[
c_{t+1} + \frac{c_{t+2}}{1 + r_{t+2}} = (1 - \lambda n_{t+1})(1 - \tau)a_{t+1}w_{t+1} - Z_{t+1} + \pi x_{t+1}. \tag{17}
\]

Note that although \( \lambda \) itself is not a decision variable, it could be made a function of the health status of children. A sick child would normally require more health care, so that \( \lambda = \lambda'(h_{t+1}^C) \), with \( \lambda' < 0 \). This would offer yet another way through which parental time allocation may affect crime and growth. However, for simplicity, \( \lambda \) will be kept constant throughout the analysis.

### 3.1.3 Firms

There is a continuum of identical firms, indexed by \( i \in (0, 1) \). They produce a single nonstorable good, which is used either for consumption or investment. Production requires the use of private inputs in the form of effective labour and private capital, the latter of which firms rent from the currently old agents. In particular, assuming a Cobb-Douglas technology, the production

\(^{24}\)It is clear that the loss of agents due to crime is not a choice variable for them. It is simply an exogenous shock that they have no control of. In equilibrium, however, the loss of victims has to equal the gains of perpetrators, i.e., \( Z_{t+1} = x_{t+1} \).

\(^{25}\)In the absence of a mechanism by the government to detect the origin of the resources of an agent, other than those adults caught during the act of crime, individuals use both their legal and illegal income in the loan market for intertemporal consumption smoothing. See Josten (2003) for a discussion.
function of firm \( i \) takes the form

\[
Y_i^t = \left( \frac{K_t}{N_t} \right)^\alpha (A_t N_i^t)^\beta (K_i^t)^{1-\beta},
\]  

(18)

where \( K_i^t \) denotes the firm-specific stock of capital, \( \bar{K}_t = \int_0^1 K_i'di \) the aggregate private capital stock, \( A_t \) average, economy-wide labour productivity (which is the same for all firms), \( N_i^t \) the number of adult workers employed by firm \( i \), \( N_t \) the total number of adults, and \( \alpha, \beta \in (0, 1) \). Thus, production exhibits constant returns to scale in firm-specific inputs, effective labour \( A_t N_i^t \) and capital \( K_i^t \).

By contrast, the aggregate private capital stock is exogenous to each firm’s production process and affects all individual producers in a uniform manner. It, thus, acts as an externality in the production of output, similar to the types of externality considered by Shell (1966) and Romer (1986). Its productivity effects, however, are diminished by the size of the adult population. Thus, to eliminate any scale effects the associated productivity of aggregate private capital stock is subject to congestion.\(^{26}\)

Markets for both private capital and labour are competitive. Each firm’s objective is to maximize profits, \( \Pi_i^t \), with respect to labour services and private capital, taking \( A_t \) and \( \bar{K}_t \) as given:

\[
\max \Pi_i^t = Y_i^t - r_t K_i^t - w_t A_t N_i^t,
\]  

(19)

where \( r_t \) is the rental rate of private capital.

Profit maximization yields

\[
w_t = \beta Y_i^t / A_t N_i^t, \quad r_t = (1 - \beta) Y_i^t / K_i^t,
\]  

(20)

so that private inputs are paid at their marginal product.

Given that all firms and workers are identical, in a symmetric equilibrium \( N_i^t = N_t \) and \( K_i^t = K_t = \bar{K}_t \), \( \forall i \). Thus, the competitively-determined wage rate and the rental rate of capital become

\[
w_t = \beta Y_i / A_t N_t, \quad r_t = (1 - \beta) Y_i / K_t.
\]  

(21)

\(^{26}\)See Eicher and Turnovsky (2000) for a detailed discussion of alternative specifications of congestion.
Because the number of firms is normalized to 1, aggregate output is given by

\[ Y_t = \int_0^1 Y_t^i di = (N_t)^{\beta-\alpha}(A_t)^{\beta}(K_t)^{1-\beta+\alpha}. \]  

(22)

As shown below, \( A_t \) is constant in the steady state. To ensure steady-state growth (linearity of output in the private capital stock) and eliminate the scale effect associated with population requires the following assumption:27

**Assumption:** \( \alpha = \beta. \)

This also allows us to reduce the model to the simplest form of endogenous growth model in which the externality exactly offsets the diminishing marginal returns to private capital in the production process. Under this assumption, equation (22) yields aggregate output as

\[ Y_t = (A_t)^{\beta}K_t. \]  

(23)

Finally, to reduce notational clutter, we assume that private capital depreciates fully in the production of output so that capital accumulation is driven by

\[ K_{t+1} = I_t, \]  

(24)

where \( I_t \) is private investment.

### 3.1.4 Health Status and Productivity

The health status of children, \( h_t^c \), depends on the share of income spent on goods for each child, the parent’s health status, \( h_t^a \), the time allocated by their parent to rearing them, and access to public health services:28

\[ h_t^c = \lambda(h_t^a)^{\kappa}(\xi_t)^{\nu_c}\left(\frac{H_t^G}{Y_t}\right)^{1-\nu_c}, \]  

(25)

---

27 A similar assumption has been used by Bose et al. (2007).

28 This section largely draws from Agénor (2009).
where $H_t^G$ is the supply of public health services (subject to congestion), and $\kappa, \nu_C \in (0, 1)$. First, a child’s health status depends linearly on the fraction of resources spent by the parent, $\lambda$, because it helps to improve his health and nutrition, thereby reducing the likelihood to contract diseases (see, for instance, Pelletier et al. 2003; Caulfield et al. 2004). Second, a child’s health depends on the parent’s health. This may be related to the impact of parents’ mental distress and anxiety on children’s life satisfaction (see Larson and Gillman 1999; Downey et al. 1999) but also on their physical ability to take care of their children (which may require walking long distances, on difficult terrain, to take them to medical facilities).\(^{29}\) Third, the health status of a child depends on the time allocated to him by his parent.\(^{30}\) Finally, access to public health services has a direct effect on a child’s health status. The congestion effect on health services can be justified by assuming that a greater deterioration of the environment (i.e., higher $CO_2$ emissions), induced by a more intensive aggregate economic activity, diminishes the effectiveness of health services. In other words, the delivery of health services is hampered by excessive private sector activity.\(^{31}\)

For adults, health status depends linearly on their health status in childhood in line with life-course models of health. There is a general consensus that children who experience poor health have on average significantly poorer health as adults. According to Fogel (1994), better nutrition in childhood in the first half of the twentieth century, had an effect on the health and life-span during the adult years of life. Similarly, Roseboom et al. (2001) have shown that children born just after the Dutch famine at the end of World War II had a higher probability of suffering coronary heart disease at

\(^{29}\)It could also reflect Barker’s (1998) ‘fetal origins hypothesis’ which suggests that conditions \textit{in utero} have long lasting effects on an individual’s health. Almond (2006) finds that cohorts \textit{in utero} during the influenza epidemic of 1918, which affected a third of women of child-bearing age, were more likely to be too disabled to work compared to cohorts immediately before or after the epidemic. This channel, however, would require including $h_{t-1}^A$ instead of $h_t^A$ in equation (25). If so, then, one would need to assume that adult health in $t + 1$ generates direct utility.

\(^{30}\)Health status at birth, which could be accounted for by adding a linear term $h_t^C > 0$ in (25), is ignored for tractability. For such an analysis, see Agénor (2011).

\(^{31}\)Alternatively, the congestion factor could be measured in terms of the number of adults in period $t$, $N_t$, or in terms of the total population, $L_t$. The specification used here, however, is more tractable analytically. Note also that, given the linearity of aggregate output in $K_t$, using $K_t$ as the congestion factor in (25) would not alter the results in any fundamental way.
age 50. Given this evidence of health persistence, also considered in De la Croix and Licandro (2007) and Osang and Sarkar (2008), we specify:

\[ h_{t+1}^A = h_t^C. \]  

(26)

Substituting (25) in (26) yields

\[ h_{t+1}^A = \lambda (h_t^A)^{\kappa} (\varepsilon_t)\nu C \left( \frac{H_t^C}{Y_t} \right)^{1-\nu C}. \]  

(27)

Therefore, due to the fact that a parent’s health affects his children’s health, or equivalently because adult health depends on own health in childhood, there is serial dependence in \( h_t^A \). In line with Grossman’s (1972) approach, health is therefore viewed as a durable stock. Here an agent’s health can be increased not only by spending more on goods but also by allocating more time to taking care of one’s brood as well as by improving access to public health services early in life.\(^{32}\)

In line with empirical evidence, adult productivity is taken to be positively related to health status. Following Agénor (2009), we assume a linear relationship:

\[ a_t = h_t^A. \]  

(28)

3.1.5 Government

The government obtains revenue by applying a constant tax rate \( \tau \) on the effective wage of adult agents and by confiscating the stolen resources of the adults that have been apprehended committing criminal activities.\(^{33}\) It spends a total of \( G_t^H \) on health and \( G_t^U \) on unproductive services.\(^{34}\) As the

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\(^{32}\)See Becker (2007) for a recent overview of Grossman’s approach and the subsequent literature. The analysis could be extended to account for the possibility that the stock of health depreciates with age.

\(^{33}\)The tax rate is assumed to be announced at the beginning of time and the government commits fully and credibly to it; there is therefore no fundamental time-consistency problem.

\(^{34}\)We could have assumed another type of government spending in the form of security and policing. This expenditure would increase the probability of apprehension and punishment as supported by a series of empirical studies (Corman and Mocan 2000, 2005, Levitt 2002; Di Tella and Schargrodsky 2004; Klick and Tabarrok 2005; Evans and Owens
government cannot issue bonds, it must run a balanced budget:

\[ G_t = G^H_t + G^U_t = N_t \tau A_t w_t + N_t (1 - \pi) x_t, \quad (29) \]

which, with the use of (13), becomes

\[ G^H_t + G^U_t = [\tau + (1 - \pi)(1 - \tau)\theta_t] N_t A_t w_t, \quad (30) \]

where we remind that \((1 - \pi)\) is the probability of apprehension.\(^{35}\)

In equilibrium the shares of government spending are constant fractions of revenue:

\[ G^h_t = \upsilon_h [\tau + (1 - \pi)(1 - \tau)\theta_t] N_t A_t w_t, \quad h = H, U \quad (31) \]

where \(\upsilon_h \in (0, 1)\). Combining (30) and (31) therefore yields

\[ \upsilon_H + \upsilon_U = 1. \quad (32) \]

Finally, the production of health services depends linearly on government spending on health: \(^{36}\)

\[ H^G_t = G^H_t. \quad (33) \]

### 3.2 Market Clearing and Equilibrium

The asset market-clearing condition requires tomorrow’s private capital stock to be equal to today’s aggregate savings by adults:

\[ K_{t+1} = N_t s_t \quad (34) \]
The following definition may therefore be proposed:

**Definition 1.** A competitive equilibrium for this economy is a sequence of prices \( \{w_t, r_t\}_{t=0}^{\infty} \), allocations \( \{c_{t+1}^i, c_{t+2}^i, s_t, \varepsilon_{t+1}, \theta_{t+1}\}_{t=0}^{\infty} \), private capital stock \( \{K_{t+1}\}_{t=0}^{\infty} \), health status of children and adults \( \{h_t^C, h_t^A\}_{t=0}^{\infty} \), and a constant tax rate \( \tau \) and constant spending shares \( \upsilon_H, \upsilon_U \), such that, given the initial capital stock \( K_0 > 0 \) and initial health statuses \( h_0^C, h_0^A > 0 \), individuals maximize utility, firms maximize profits, markets clear, and the government budget is balanced.

In equilibrium, individual productivity must be equal to the economy-wide average productivity, so that \( a_t = A_t \). In addition, in equilibrium, since all adult agents (i) have identical effective labour income, and (ii) spend the same time on illegal activities, the criminal proceeds of each individual are equal to the fraction of income they lose by being a victim of crime. That is, \( x_{t+1} = Z_{t+1} \). Therefore, crime in our model can be viewed as a redistribution problem that yields no deadweight loss for the economy.\(^{37}\)

The following definition characterizes the balanced growth path:

**Definition 2.** A balanced growth equilibrium is a competitive equilibrium in which \( c_t, c_{t+1}, Y_t, K_t \), all grow at the constant rate \( 1 + \gamma \), health statuses in childhood and adulthood \( h_t^C \) and \( h_t^A \) are constant, and the rate of return on private capital \( r_t \) is constant.

It is not unrealistic to assume that health status is constant in the steady state (e.g., Osang and Sarkar 2008; Agénor 2011) as there are limits in the long run as to how much private behaviour and medical science can improve individual health status. This implies that health (unlike education) cannot by itself be an engine of permanent growth.

\(^{37}\)This can be seen by consolidating the household and government budget constraints (17) and (30): \( Y_t = C_t + K_{t+1} + G_t^H + G_t^U \), where \( C_t = N_t(c_t^i + \lambda_{it}\alpha_t w_t) + N_{t-1}c_{t-1}^i \) is total consumption spending at \( t \). If we were to assume instead that committing crime requires use of resources (in terms of planning the hit, hiding the loot, getting a fraction of its value for use, say due to money laundering, etc), then crime would lead to an economic deadweight loss. It is straightforward to incorporate such costs. However, their introduction would not influence the main message of the paper.
3.3 Crime, Fertility and Growth

Each adult maximizes (14) subject to (17), (13), (25), (26), (33), (27), and (28), with respect to \( c_{t+1}, c'_{t+1}, \varepsilon_{t+1}, \theta_{t+1} \) and \( n_{t+1} \), taking \( \tau \) and \( H_t^G \) as given. At the same time, agents take into account the impact of their decisions regarding \( \varepsilon_{t+1} \) on their own health status (and productivity) and that of their children.

The solution of the household problem is provided in Appendix B. It shows that in equilibrium, \( \theta_{t+1}, n_{t+1}, \) and \( \varepsilon_{t+1} \) are all constant:

\[
\tilde{\theta} = \frac{\pi[1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)}{\pi[1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)} < 1, \tag{35}
\]

\[
\tilde{n} = \frac{(1 - \nu C)(1 - \sigma)\pi^2}{\lambda \{\pi[1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)\}}, \tag{36}
\]

\[
\tilde{\varepsilon}n = \frac{\pi\nu C(1 - \sigma)}{\pi[1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)} < 1, \tag{37}
\]

\[
\tilde{\varepsilon} = \frac{\lambda\nu C}{\pi(1 - \sigma)}, \tag{38}
\]

\[
1 - \tilde{\varepsilon}\tilde{n} - \tilde{\theta} = \frac{\pi(1 - \sigma)}{\pi[1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)} < 1, \tag{39}
\]

where \( \sigma \) is the marginal propensity to save. The following assumption must be imposed to ensure that the above endogenous variables are positive in equilibrium:

**Assumption 1:** \( \pi > \pi^* \), where \( \pi^* \equiv (1 + \nu C)(1 - \sigma)/[1 + (1 - \nu C)(1 - \sigma)] \).

This implies that if the probability of escaping apprehension exceeds a threshold value, \( \pi^* \), agents allocate a positive share of their time toward crime-related activities.\(^{38}\) In equilibrium, this assumption trickles down to the other endogenous variables as well (caring for children, leisure, and fertility). This suggests that the solutions in equilibrium are well-defined only if \( \pi > \pi^* \).\(^{39}\) For \( \pi^* \) to be meaningful, however, it needs to be less than one.

\(^{38}\)Technically, a positive \( \tilde{\theta} \) requires both the numerator and the denominator in equation (35) to be positive. Note though that this is satisfied with the single condition that the numerator is positive as described in Assumption 1.

\(^{39}\)As shown in Appendix B, Assumption 1 implies that \( (1 - \lambda\tilde{n}) - (1 - \pi)\tilde{\theta} > 0 \), so that consumption and savings are also positive in equilibrium.
This is satisfied with the following (mild) assumption concerning the size of $\nu_C$:

**Assumption 2:** $\nu_C < 1/2(1 - \sigma)$.

This means that the elasticity of children’s health status with respect to the time parents allocate to them cannot be too large. In addition, even though Assumption 1 represents a sufficient condition to generate a positive fertility rate, to avoid convergence of population size toward zero, $\bar{n} \geq 1$ needs to hold. This is satisfied if:

**Assumption 3:** $\lambda \leq (1 - \nu_C)(1 - \sigma)\pi^2/\{\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)(1 - \pi)\}$.

Thus, the fraction of income spent on caring for each child cannot be too large. From equations (35)-(39), the following proposition can be established:

**Proposition 1.** If $\pi > \pi^*$, an increase in the probability of escaping apprehension increases the time agents allocate to criminal activities. It lowers total and per-child time allocated to child-rearing, as well as leisure time, while it has a non-monotonic effect on the rate of fertility.

The result that an increase in the probability of escaping apprehension raises criminal activity, by decreasing the opportunity cost of doing crime, is standard in the analytical literature since Becker’s (1968) seminal work. It is also consistent with the empirical evidence on the crime-deterrent effect of the apprehension likelihood (for recent studies, see Di Tella and Schargrodsky 2004; Evans and Owens 2007; Draca et al. 2011; Harbaugh et al. 2011). An important qualification of our result, however, is that the positive relationship between the probability of avoiding apprehension and crime takes shape only above a threshold value of $\pi$. This, in turn, implies the existence of a non-linear relationship between the two variables. The presence of a minimum value of $\pi$ as a requirement for criminal activity arises because of the value agents attach to both child-rearing activities and leisure. For them to invest time in crime, and thus cut down on child-rearing and leisure, a minimum income through such an activity must be likely. Once this happens, higher values of $\pi$ induce agents to spend more time committing crime.
and less time on other activities.\footnote{Engelhardt \textit{et al.} (2008) have also illustrated a negative effect of the apprehension probability on crime rates (related to larceny, burglary, and motor vehicle theft) with a non-linear feature. As in Imrohoroglu \textit{et al.} (2004; 2006), however, the relationship at hand is operational throughout the \((0, 1)\) interval of the arrest likelihood, thus not taking into account potential threshold effects.}

In addition, an increase in avoiding apprehension leads to a non-monotonic impact on the rate of fertility. In particular, it lowers fertility when \(\pi^* < \pi < \pi^{**}\) and raises fertility for \(\pi > \pi^{**}\), where \(\pi^{**} \equiv 2(1 + \nu_c)(1 - \sigma)/[1 + 2(1 - \sigma)]\).\footnote{Note that under Assumption 2, both \(\pi^{**} < 1\) and \(\pi^{**} > \pi^*\).} This U-shaped effect materializes through the way the probability of escaping apprehension changes the agent’s total disposable income. A higher \(\pi\) (above \(\pi^*\)) increases the amount of criminal proceeds, which in turn raises disposable income. But at the same time the increase in \(\pi\) diminishes the time agents distribute to the well-being of their children, leading to their lower health status. As this coincides in equilibrium with a decline in adult health status and a drop in their productivity, effective income decreases. Thus, for values of \(\pi \in (\pi^*, \pi^{**})\), the negative effect dominates so that disposable income decreases, leading to lower fertility (recall the decrease of \(\bar{\varepsilon}\)). For values of \(\pi > \pi^{**}\), the positive effect dominates raising fertility. In other words, when escaping apprehension is very likely, the higher realised income reduces the ‘quantity cost’ of children, thereby shifting resources from the quality of children to the quantity of children. This mechanism draws from Becker (1960)’s quantity–quality trade-off for children. The identified relationship is negative for small values of \(\pi\), while switches to positive for higher values.

Our analysis can also be viewed as offering an alternative interpretation to the findings of Gaviria and Pagés (2002), who for 17 Latin American countries have suggested the positive relationship between city growth and crime levels to be causal running from population growth to crime. In our model, this positive relationship is not causal but is jointly driven by the lower effectiveness of law enforcement. In other words, in Latin America, where the rate of escaping apprehension is relatively high, the positive relationship between crime and fertility is endogenously determined.

The balanced growth rate of the economy is derived in Appendix B, where it is shown that the model can be condensed into an autonomous, first-order
linear difference equation in $\tilde{h}_t^A = \ln h_t^A$, whose steady-state solution is

$$\tilde{h}_t^A = \Gamma^{\frac{1}{1-\kappa}},$$

(40)

where $\Gamma \equiv \lambda (\beta v_H)^{1-\nu C}(\bar{\epsilon})^{\nu C} \left[ \tau + (1 - \pi)(1 - \tau)\bar{\theta} \right]^{1-\nu C}$. Stability of this equation requires $\kappa < 1$, which is always satisfied. Thus, given concavity, there is a unique, nontrivial and globally stable steady state $\tilde{h}_t^A$, to which $h_t^A$ converges monotonically.

From (23), (28), and the solution for the growth rate of private capital given in Appendix B, the steady-state growth rate of output is

$$1 + \gamma = (\tilde{h}_t^A)^{\beta} \beta \sigma (1 - \tau) \left[ (1 - \lambda \bar{n}) - (1 - \pi)\bar{\theta} \right],$$

(41)

where $\tilde{h}_t^A$, $\bar{\theta}$, $\bar{n}$, and $\bar{\epsilon}$ are the solutions of (40), (35), (36) and (38).

The equilibrium solution can be used to examine the impact of a higher probability of escaping apprehension on long-run growth. In particular, the following result can be established:

**Proposition 2:** If $\pi > \pi^*$, an increase in the probability of escaping apprehension has an ambiguous effect on the steady-state growth rate of output.

The reason why an increase in the likelihood of avoiding apprehension has an unclear effect on growth has to do with the conflicting effects that arise through three channels, as shown in Appendix B. Firstly, through the negative effect of avoiding apprehension on the child-rearing time that adults allocate to each of their children, which lowers their health status. This, in turn, reduces health status in adulthood, and subsequently the rate of economic growth. Secondly, by the impact of an increase in $\pi$ on the revenue collected by the government that finances health spending, which enhances health status and productivity. From equation (40) it can be shown that this effect is ambiguous and depends on the size of $\pi$, where for $\pi < \pi^{**}$ ($\pi > \pi^{**}$), the growth effect is positive (negative). The third channel through which $\pi$ influences growth is by its effect on savings. This happens due to the income redistribution effect of $\pi$ as it essentially acts like a tax. Once again the effect depends on the size of $\pi$ so that savings and growth increase when $\pi$ is relatively large to start with ($\pi > \pi^{**}$), while they both decline.
for lower values ($\pi < \pi^*$). Given these offsetting effects, the net effect on the steady-state growth rate, $d(1 + \gamma)/d\pi$, cannot be determined \textit{a priori}.

Overall, the analytical results yield some testable implications about the effect of escaping apprehension on criminal activity and on the rates of fertility and economic growth. Specifically, the described effects appear to be of a non-monotonic nature for crime and fertility, while they could go in any direction (positive or negative) with respect to growth. In section 4 we evaluate empirically the validity of these implications.

### 3.4 Discussion and Conclusions

The reasons why people appear to be more or less law-abiding vary. Nevertheless, the theory that views agents as rational expected-utility maximizers seems to perform well in explaining criminal behaviour. In such frameworks the role of the expected costs and benefits has been emphasized. The crime literature has identified the probability of apprehension as one of the most important determinants of crime. Crime imposes a threat to growth as it discourages investment and distorts the allocation of resources and property rights. Hence, crime is considered detrimental to growth. At the same time fertility and growth appear to be negatively associated. This relationship can be explained using Becker’s (1968) theory which supports the view that there is a quantity-quality trade-off in fertility decisions. The lower the number of children a parent has, the greater the investment in their education whereas the greater the number of the children a parent has, the less expenditure is undertaken toward their human capital accumulation.

The aim of this section has been to establish a link between crime and fertility and examine how these two variables influence economic growth. The factor that links the decisions of crime and fertility is the probability of escaping criminal apprehension, or inversely, the likelihood of criminal arrest. We focus on this variable given its importance as a determinant of crime-related activities, stressed both in the theoretical and the empirical literature.

We have built up an extension of the Agénor’s (2009) theoretical paper bringing together all the above variables of interest. The model is based on an OLG economy where reproductive individuals live through three pe-
periods: childhood, adulthood and retirement. As adults, agents are allocated two units of time, one of which is supplied inelastically to firms as labour. The other non-working unit of time is split between crime, child-rearing and leisure activities. Even though working time is exogenously determined, individuals optimally choose their time allocation to the remaining activities. This involves taking into account the returns from crime and the health status of children. These two jointly influence decisions regarding the levels of crime and fertility, which in turn guide the course of economic growth given the linear dependence of adult health status (labour productivity) and children’s health status.

Our theoretical contribution is threefold. First, we show that the effect of the probability of escaping arrest on criminal activity (in the form of theft) is non-monotonic. Specifically, only after a critical probability threshold does the likelihood of escaping apprehension have a positive effect on crime. This finding adds to the existing literature which reports a linear positive effect. Second, fertility rises with relatively high values of the probability of escaping arrest, thus giving rise to a positive relationship between crime and fertility. Worthy of note is that this relationship is not causal, as suggested in the literature, but arises endogenously through the impact of the arrest probability. Third, the impact of the apprehension probability on economic growth is not straightforward due to the non-linearities and the multitude of channels of influence. Thus, in theory it is plausible that higher crime and fertility rates, due to higher likelihood of avoiding apprehension, have a positive growth effect.
An Empirical Evaluation of Crime

Following the vast body of theoretical literature on crime, there has been a huge increase in the amount of empirical data over the last decade, allowing us to infer some important trends regarding the exact nature of crime. Even though there is a large amount of data for European Union countries, the United States and Latin America, data on developing countries are still very limited, as they are not considered reliable enough to be used for econometric purposes. It is also worth noting that, because the definition of crime varies between countries and across time, empirical comparisons are sometime difficult to make. Even so, for those countries where uniform data exist, crime appears to be quite persistent and is growing over time. Generally speaking, criminal acts are considered to be subject to temporal variation, are often geographically concentrated, and display a broad dispersion across countries that possess seemingly identical economic characteristics.

One of the most prevalent relationships examined by economists in this field is the link between crime and economic growth. Crime is negatively related to the level of a country’s economic development. This is because crime discourages investment and capital accumulation (Josten 2003). Lloyd and Marceau (2003) argue that crime creates uncertainty and distorts property rights. The idea is that since one of the most powerful incentives to invest is the security of the return on an investment, an increase in crime rates will lead to an increase in the level of insecurity causing a decrease in the rate of capital accumulation and hence growth. Moreover, there is a strong correlation between a country’s level of development and crime, as developing countries exhibit higher rates of crime when compared with developed ones. Even though the empirical literature has examined the impact of crime on growth, a few studies exist at the national level, while there is a lack of studies at the cross-country level, mainly because of the inaccuracy inherent in the crime data and the problems associated with the definition of crime across countries (Powell et al. 2010). Nevertheless, the evidence from the existing studies on the effect of criminal activities on growth is quite strong, revealing a strong negative effect. Single-country studies include Cárdenas and Rozo (2008) for Colombia, Peri (2004) and Detotto and Otranto (2010) for Italy, and Rincke (2010) for US Metropolitan Statistical Areas, while
cross-country work has been conducted by Gaibulloev and Sandler (2008) for 18 Western European countries and by the World Bank (2006) for up to 43 countries.

Unlike the above-mentioned literature, in this section we focus on the impact of avoiding apprehension on economic growth. In the previous chapter, we have presented a theoretical model that examines the interrelationships between crime, fertility and economic growth. This has been achieved by considering a deterrence variable, namely the probability of avoiding apprehension, and how it relates to the level of crime, to child-bearing decisions and economic growth. The theoretical model has generated three important results. First, it has identified a non-linear effect of avoiding the probability of arrest on criminal activity, so that the likelihood of escaping apprehension has a positive effect on crime only after a critical probability threshold. Second, it has shown that fertility responds positively to higher values of the probability of escaping arrest. Third, the effect of the apprehension probability has an ambiguous effect on economic growth due to the different channels that it operates through.

According to the literature, demographic and socioeconomic variables are also important in explaining the variation in crime rates. Early studies have revealed that there is a strong relationship between age and crime. At the same time, a higher adult population share is associated with higher crime rates (Neumayer 2003, 2005; Bianchi et al. 2011; Buonanno et al. 2011). This is justified in the sense that this fraction of the population has more materialistic needs than children or retired agents. Hence, in line with this literature and our theoretical model, we only consider the active labour-supplying share of the population. In addition, a major prediction of crime theories is that higher urbanization rates (the ratio between urban population and total population) lead to higher crime rates (Bianchi et al. 2011; Fajnzylber et al. 1998, 2002; Kendal and Tamura 2010). An explanation is that a high urbanization level, which is translated as a rural-to-urban migration, encourages crime as criminals have fewer chances to be arrested in large cities (Glaeser and Sacerdote 1999). Therefore, it is argued that crime is predominantly practised in large urbanized cities (Brennan-Galvin 2002; Gaviria and Pagés 2002). The level and growth of economic activity in a society are also important determinants, as they define to a large extent the
employment opportunities in the legal sector, but also because they improve the wealth of individuals, so that the size of the potential resources that can be stolen also increases. Based on past research the first effect dominates the other so that an increase in GDP per capita reduces crime rates. Moreover, studies show that unemployment is an important determinant of crime. This rationale started with Ehrlich (1973), who viewed unemployment as the foregone income opportunities from the legal sector and hence increased the crime rates. Unemployment is associated with a decrease in the wealth of an individual, which is translated as a lower opportunity cost of engaging in crime. Another effect is that an unemployed individual is prone to a decline in human capital accumulation, due to the period of absence from the labour market. Thus, the longer the time period an individual is without a job, the lower the probability of finding a job and the higher the incentive to engage in crime. Therefore, we use the percentage of the population in the 15-64 age group, the urbanization rate, the logarithm of per capita GDP and its square, the growth rate of GDP and the unemployment rate as explanatory variables in the crime equation.

For the variations in the studies of fertility, the demographic research has identified infant mortality rates as an important variable in explaining the nature of fertility. A decline in the mortality rates is followed by a decline in the fertility rates\footnote{This positive relationship is also evident in studies such as Angeles (2010) and Herzer et al. (2010).}. Demographers consider these matching falls in mortality and fertility as components of a single “demographic transition” (Kalemli-Ozcan 2002). The link between the two has multiple dimensions that have proved difficult to explain both empirically and theoretically. This is because mortality rates affect the fertility rates through a variety of channels, and many competing theories have been developed in support. As documented by Palloni and Rafalimanana (1999), through the first mechanism, the psychological one, “the death of an infant leads to sudden termination of breast-feeding, which in turn, triggers resumption of menses and ovulation and thus increases the period of exposure to a new conception”. The second mechanism, described as the replacement effect, is related to deliberate attempts “to replace” a child that has died at an early age, as a strategy by parents to obtain a preferred number of children by the end of their
productive life (Palloni and Rafalimana 1999). The third mechanism, also called the insurance or hoarding effect (Kalemli-Ozcan 2002), prescribes an environment where parents have more children that their optimal number in order to ensure that the target number of surviving children is achieved. In addition to the effect of child mortality on fertility, mortality is also significant for the human capital investment decision taken by parents. Becker (1960) argues that high mortality rates induce parents to invest less in the human capital of children and more in their quantity, thus raising fertility. Recently, Galor and Weil (1999), have supported the notion that an increase in the return to skills induces a quantity-quality trade-off for children and causes a decline in fertility rates.

Nevertheless, mortality rates are not the only determinant of fertility proposed by the unified growth literature. The literature recognizes raising GDP per capita (Becker and Lewis 1973) or technological progress (Galor and Weil 2000; Hansen and Prescott 2002) as explanations for the declining fertility rates. A more developed and technologically advanced economy will encourage parents to invest in the human capital of their children, causing a simultaneous decline in fertility rates. At the same time, if children are considered “normal goods”, higher income will encourage an increase in fertility rates. Furthermore, urbanization, seen as the process of modernization, leads to lower fertility rates (Schultz 1994) as it changes perceptions regarding fertility. It can be seen as shifting the traditional role of children-bearing housewives by giving them better employment opportunities, thus causing a postponement or reduction in the number of children. Finally, the last variable we consider is the unemployment rate. Microeconomic theory argues that temporary unemployment is associated with a fall in the opportunity costs of childbearing, leading to a rise in fertility rates. However, long-run unemployment, particularly amongst young workers and female workers of all ages, could have the effect of decreasing fertility rates (Adserá 2005). This is because being unemployed penalizes the worker as it decreases human capital accumulation and reduces the probability of any future employment. This negative income effect is more evident among the younger population. According to Adserá (2005), “since maternity demands may require a short (partial) withdrawal from the market, women would rather postpone child-bearing until they accumulate sufficient human capital”, so
unemployment and fertility are negatively related. Hence, taking into consideration the effect of the above-mentioned variables in the literature, we include infant mortality rate, logarithm of per capita GDP, urbanization rate and unemployment rate as the main determinants of fertility rates.

Finally, for the economic growth equation we consider various demographic and socioeconomic variables that the literature has recognized as important determinants. Despite the lack of a unifying theory, several partial theories exist that examine the role of various factors in determining economic growth. For example, the neoclassical theory based on Solow’s growth model has emphasized the importance of investment in fostering economic growth. Investment is also the most fundamental determinant of economic growth in endogenous growth models. However, in the neoclassical model investment has a transitional impact, while the endogenous growth models support the view that it has long-lasting effects. Several empirical studies have examined the positive relationship between investment and economic growth (e.g., Kormendi and Meguire 1985; De Long and Summers 1991; Levine and Renelt 1992; Mankiw et al. 1992; Barro and Sala-i-Martin 1995; Sala-i-Martin 1997; Bond et al. 2001; Podrecca and Carmeci 2001).

Human capital is the main source of growth in several endogenous growth models as well as one of the key extensions of the neoclassical growth model. For this reason, when we check for the robustness of our results, amongst other parameters, we also include education. Regarding the issue of convergence/divergence, the Solow model predicts convergence in growth rates on the basis that poor economies will grow faster than rich ones. In other words, the lower the starting level of real per capita GDP, relative to the long-run or steady-state position, the faster the growth rate.

Furthermore, economic policies and macroeconomic conditions affect economic growth through a variety of channels (e.g., Grier and Tullock 1989; Barro 1991, 1997; Fischer 1993; Easterly and Rebelo 1993; Barro and Sala-i-Martin 1995). For example, they can have an effect on human capital, public infrastructure, and on the formations of political institutions (Petrakos et al. 2007). Among a variety of macroeconomic parameters, inflation, fiscal policy, budget deficits and tax burdens have been classified as having a considerable impact on economic growth (Petrakos et al. 2007). According to empirical studies, growth is negatively related to inflation (De Gregorio
1992; Fisher 1993; Barro 1995) and large budget deficits and positively related to good fiscal performance (e.g., Fischer 1993; Easterly and Rebelo 1993). In general, a stable macroeconomic environment in terms of low inflation and stable fiscal policy encourages growth through a reduction of uncertainty whereas, in the opposite case, instability will increase the risk associated with investment, reduce productivity and have a negative impact on growth. Lastly, there is a strong and positive link between openness and growth. Openness (normally measured by the ratio of exports to GDP) has a positive effect on economic growth as it allows countries to benefit from any comparative advantage, promotes technology transfer and diffusion of knowledge, creates benefits from economies of scale and exposes economies to competition. A substantial and growing body of empirical literature argues that economies that are more open to trade and capital flows have higher GDP per capita and grow faster than more closed economies (Dollar 1992; Sachs and Warner 1995; Edwards 1998; Dollar and Kraay 2000). As a result, we use the logarithm of per capita GDP, private investment, and indicators of fiscal (budget balance), monetary (inflation) and trade (openness) policies as the main determinants of growth.

The purpose of this chapter of the thesis is to evaluate the predictions of the theoretical model, presented in the previous chapter, by providing an econometric analysis. Specifically, we evaluate the impact of the likelihood of escaping apprehension on the rates of crime, fertility and economic growth, while controlling for other potential determinants of these variables, as discussed in detail above. Additionally, we also examine the existence of non-monotonic effects of the probability of avoiding apprehension on crime and fertility. We provide a panel data analysis consisting of 90 countries from the period 1970-2008. A variety of econometric procedures are used to estimate the equations of interest in order to take into consideration country-specific factors and possible endogeneity problems. The methodology uses both reduced-form estimations and joint estimations of the crime, fertility and growth equations. The results have been subjected to a number of robustness checks in terms of using different measures for crime, the use of alternative proxies for the probability of avoiding arrest, and the addition of further explanatory variables. None of these considerations affects our findings.
The results offer support for the theoretical implications of the previous chapter as they show a non-monotonic effect of the likelihood of avoiding arrest and conviction on crime, with the effect turning positive above a probability in the range of 10-30%. Above this threshold value, we also find evidence of a positive impact of the probability of avoiding apprehension on fertility. Further, the effect of this probability on growth is negative, corroborating the studies that document a negative relationship between crime and economic performance. When we jointly examine the three variables we find that both crime and fertility are affected in the same way by the probability of apprehension whereas they both have a negative effect on growth.

Section 4 is organized as follows. First, in section 4.1 we describe our data sources and characteristics. In section 4.2 we analyze the estimation methodology and in section 4.3 we present our results. To assess the robustness of these results, we conduct a wide range of sensitivity tests that, inter alia, involve alternative estimation methods and changes in the definition of variables. Lastly, section 4.4 contains a few concluding remarks. Appendix C offers the set of countries, the definition and sources of all the variables and regression tables involved in the empirical analysis.

4.1 Data Sources and Characteristics

We construct a dataset containing information on criminal activity, fertility outcomes and output growth across 90 countries for the period 1970-2008. This implies a maximum sample size of more than 3,500 annual observations. Due to missing data, however, we end up working with an unbalanced panel of 457, 443 and 386 observations for the following equations (42), (43) and (44) respectively. Even though our analysis is originally conducted with annual data, the number of observations is reduced further in the growth regression when we construct five-year period averages so as to minimise business cycle effects (1970-74, 1975-79, ..., 2005-08). Table 1, in Appendix C, gives a detail picture of all the data sources used for the analysis. We proxy for the incidence of crime in a country with the use of its rate of total recorded theft rates. To test for the robustness of the results we use the total recorded burglaries rate as a second proxy for the incident of crime. Data is

\footnote{For a list of the countries please see Appendix C.}
taken from the United Nations Survey on Crime Trends and the Operations of Criminal Justice System (CTS). These rates are taken in respect to the country’s population: specifically they are per 100,000 inhabitants. We define the probability of escaping apprehension as one minus the probability of being apprehended by the police, the latter being proxied by the number of arrests per recorded theft. We also use demographic and socioeconomic variables from a variety of sources, as described in Table 1.

Table 2 presents summary the statistics of the data. It is interesting to note the high mean value and variability of the crime rate as well as the high mean value of the probability of escaping theft apprehension. Finally, Figure 5, in Appendix C, shows a scatter plot of theft rates against the likelihood of avoiding apprehension for this type of crime. The plot is suggestive of a non-linear relationship with crime rates becoming more prevalent at higher levels of the probability of escaping arrest. Thus, the figure offers visual support to the thesis of our theoretical analysis as to the presence of a threshold value $\pi^*$ only above which crime rates increase. We now turn to a formal empirical analysis.

4.2 Empirical Methodology

The theoretical analysis in the previous section has examined the effects of the likelihood of escaping apprehension, $\pi$, on crime, fertility and growth. In accordance with this rationale in this section we employ an empirical specification that conforms to these considerations. In particular, we estimate three equations corresponding to the crime equation (35), the fertility equation (36), and the growth equation (41). Taking into account the absence of data on the share of time individuals allocate toward crime-related activities ($\theta$), the estimated crime equation uses as a dependent variable the number of recorded theft rates. This is a natural choice given that more time engaging in criminal activities leads to higher crime and since crime in our model consists of theft. In estimating these three equations independently of each other, the growth equation (41) is first estimated in its reduced form where the probability of escaping apprehension is directly used as a determinant. This implies the substitution of equations (40), (35), (36) and (38) into equation (41). Then, we also consider the structural relationship among the
endogenous variables (crime, fertility and growth) and estimate equations (35), (36) and (41) jointly as a system where the rates of theft and fertility appear as determinants in the growth equation.

According to the results of the theoretical model, the probability of escaping apprehension has a positive impact on crime only above a threshold value, $\pi^*$. To empirically identify this value, the estimated crime equation controls both for the level of $\pi$ and its square. Similarly, we add both $\pi$ and its square in the fertility equation to assess the presence of any non-linearity, in the form of a threshold value $\pi^{**}$ as suggested by the model. Further, consistent with the implications of the model as to the effect of $\pi$ on fertility and growth, for the regressions of these two equations we restrict our dataset to values of $\pi > \pi^*$. For comparison purposes we also provide the results for the entire sample.

Given the above, our benchmark empirical setup is represented by

$$c_{it} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 \pi^2_{it} + \sum_{k=1}^{m} \delta_k X_{k,it} + \mu_i + \nu_t + \varepsilon_{it}, \quad (42)$$

$$n_{it} = \beta_0 + \beta_1 \pi_{it} + \beta_2 \pi^2_{it} + \sum_{l=1}^{n} \lambda_l Z_{l,it} + \mu_i + \nu_t + u_{it}, \quad (43)$$

$$g_{it} = \gamma_0 + \gamma_1 \pi_{it} + \sum_{j=1}^{q} \zeta_j W_{j,it} + \mu_i + \nu_t + v_{it}, \quad (44)$$

where the notation is as follows: $i$ ($t$) is the country (time) index; $c_{it}$ denotes total recorded theft rates (per 100,000 inhabitants); $n_{it}$ represents the fertility rate; $g_{it}$ stands for the growth rate of per capita real GDP; $\pi_{it}$ is the probability of escaping apprehension after conducting the crime of theft; while $\{X_{k,it}\}_{k=1}^{m}$, $\{Z_{l,it}\}_{l=1}^{n}$, and $\{W_{j,it}\}_{j=1}^{q}$ represent vectors of conditioning variables that have been identified to explain a substantial variation in the data in studies of crime, fertility, and growth, respectively. Specifically, $\{X_{k,it}\}_{k=1}^{m}$ includes demographic and socioeconomic variables proxied by the percentage of the population in the age group between 15 and 64, urbanization rate, logarithm of per capita GDP and its square, growth rate of GDP, 

\[\text{For the choice of these variables, see the studies in the literature discussed in the introduction of section 4.}\]
and unemployment rate; \( \{Z_{i,t}\}_{i=1}^{n} \) includes infant mortality rate, logarithm of per capita GDP, urbanization rate, and unemployment rate; \( \{W_{j,it}\}_{j=1}^{q} \), finally, incorporates the logarithm of per capita GDP, private investment, and indicators of fiscal (budget balance), monetary (inflation) and trade (openness) policies. The crime and fertility rates are also included as controls, with the simultaneous exclusion of \( \pi_{i,t} \), when equations (42)-(44) are jointly estimated. Finally, the regressions account for common deterministic trends by incorporating dummies for the different time periods, \( \nu_{t} \), as well as time-invariant country-specific dummies, \( \mu_{i} \), whereas \( \varepsilon_{it}, u_{it}, \) and \( v_{it} \) are the error terms. Appendix C and Table 1 offer the set of countries and the definition and sources of all the variables involved in the empirical analysis.

The coefficients of interest are related to the effects of the likelihood of escaping apprehension, summarised by \( \alpha_{1}, \alpha_{2}, \beta_{1}, \beta_{2}, \) and \( \gamma_{1} \). The first two will illustrate whether avoiding apprehension has a non-linear impact on crime, and if so, identify the threshold value of \( \pi^{*} \). According to the results of the theoretical model, this would correspond to a positive estimate on \( \alpha_{2} \). The second two coefficients will show if there exists a non-linear impact of \( \pi \) on fertility and thus locate the value of \( \pi^{**} \), once the threshold value \( \pi^{*} \) is taken into account. That is, by using values of \( \pi > \pi^{*} \). This would be in line with the theoretical illustration if \( \beta_{1} \) is negative and \( \beta_{2} \) is positive. The final coefficient estimate, \( \gamma_{1} \), reflects the growth effect of escaping apprehension, for \( \pi > \pi^{*} \), the sign of which is theoretically ambiguous.

A variety of econometric procedures are used to estimate equations (42)-(44). Given the importance of country-specific factors advanced in the related literatures, we start with the fixed effects estimator that controls for unobserved country-specific effects in all our regressions. Then, we also add time fixed effects that capture common variations in crime, fertility and growth across countries. The rest of the estimation procedures are based on techniques that address potential endogeneity of the right-hand-side variables. The main variable of interest is the probability of escaping apprehension. This variable is endogenous by construction as the numerator of the dependent variable (number of theft incidents) is the denominator in the probability of avoiding arrest. This artificially induces a negative correlation between the two variables, a phenomenon known as “ratio bias” in the literature (see Dills et al. 2008).
One standard approach to deal with endogeneity is to replace contemporaneous variables with two-period lagged variables. Another approach uses as instruments lagged values of the potentially endogenous variable and applies an instrumental variable technique like static GMM and dynamic GMM. We also estimate equations (42)-(44) as a system that considers only the endogeneity of the key variables (crime and fertility) on the growth equation (3SLS).

Use of all the above single-equation techniques is made so as to control for endogeneity. From these, dynamic GMM requires some explanation. There are two versions of this procedure namely, difference-GMM and system-GMM. The first has been developed by Arellano and Bond (1991) and the second by Arellano and Bover (1995) and Blundell and Bond (1998). The endogenous variables in the difference-GMM estimator are instrumented with lags of their levels, while system-GMM employs a richer set of endogenous instruments, treating the model as a system of equations in first differences and in levels. In the latter, the endogenous variables in the first-difference equation are instrumented with lags of their levels as in difference-GMM, while the endogenous variables in the level equations are instrumented with lags of their first differences. An advantage of these GMM estimators is that they avoid a full specification of the serial correlation and heteroskedasticity properties of the error, or any other distributional assumptions.

An important consideration associated with the two dynamic GMM estimators relates to the number of instruments. According to Roodman (2009), an excessive number of instruments can result in overfitting of the instrumented variables, thereby biasing the results towards those obtained by OLS. As a rule of thumb, therefore, the number of instruments is suggested not to exceed the number of countries. To abide with this condition, we cannot treat all explanatory variables in our regressions as endogenous due to the relatively small number of observations in our sample. For this reason we are selective and instrument for a subset of the control variables that have been pointed out as likely endogenous in the related literatures.45 This strat-

45Other than the probability of avoiding arrest (and its square where it appears), these variables are GDP per capita and its square in the crime equation, infant mortality, GDP per capita and urbanization in the fertility regression, and GDP per capita and investment in the growth equation. The coefficient estimates of these variables appear in bold type in the tables of results.
egy, however, is only feasible for difference-GMM as the system counterpart requires more instruments per instrumented variable. For this reason, we present the results of difference-GMM.

The validity of the instruments is checked under difference-GMM by applying two specification tests. The first test is the Hansen (1982) J-test of overidentifying restrictions, which we use to examine the exogeneity of the instruments. The null hypothesis is that the model is correctly specified. The second test is the Arellano and Bond (1991) test for serial correlation of the disturbances up to second order. This test is useful because serial correlation can cause a bias to both the estimated coefficients and standard errors. Given that first differencing induces first order serial correlation in the transformed errors, the appropriate check relates only to the absence of second-order serial correlation. Furthermore, we perform the correction proposed by Windmeijer (2005) for the finite-sample bias of the standard errors of the two-step GMM estimator.

4.3 Results

We begin the analysis by estimating equations (42)-(44) one at a time and independently of each other with the single-equation estimation techniques described above. Then, we allow for a simultaneous estimation of all three equations with 3SLS. Recall that according to the theoretical mechanisms of the preceding section, the likelihood of escaping apprehension has a non-linear impact on crime and fertility, while its effect on output growth is ambiguous. We present the results in this order (crime, fertility, growth), starting with the benchmark crime regressions of equation (42) in Table 3. For each section we also conduct robustness checks of the results, in terms of a different crime specification, the use of alternative proxies for the probability of avoiding arrest, different measures of fertility and the addition of further explanatory variables.

4.3.1 Crime

The first two columns of Table 3, in addition to controlling for country fixed effects, involve as determinants of crime only the probability of escaping arrest. Column (1) in levels and column (2) adding its square. The first
column shows the positive relationship between escaping the arrest likelihood and rates of crime. The second column makes clear that this relationship is not linear but subject to threshold effects. In particular, the relationship becomes positive when the probability escaping arrest exceeds 20%. This turning point is given at the bottom of the table before the diagnostics.

Moving further to the right of Table 3, we add more determinants of crime, control for time fixed effects, and also consider the potential endogeneity of some of the control variables. Once again, the main message of columns (3)-(8) is the presence of a threshold value $\pi^*$ only above which the effect of $\pi$ on crime is positive. This value is determined to lie between 9% and 32% depending on the estimation technique. Moreover the coefficient estimate of $\alpha_2$ is always significant at least at the 5% level –1% level for difference-GMM. As described in the theory section, the positive influence of the probability of escaping apprehension on criminal activity is a typical finding of the empirical literature that examines the determinants of crime. The empirical result that this effect takes shape only above a threshold corroborates the theoretical finding which suggests an opportunity cost of committing crime expressed in terms of the allocated time for child-rearing and leisure. Given the value attached to these activities, crime becomes appealing only if it pays off, with the relative payoff proxied by the size of $\pi$.

Turning to the other control variables, the demographic variables have effects in line with expectations. Specifically, a higher adult population share is associated with higher theft rates. This result conforms with the findings of Neumayer (2003), Bianchi et al. (2011) and Buonanno et al. (2011) for total and violent crime rates, but also with Neumayer (2005) for robbery and theft rates. This finding can also be viewed as justifying our assumption in the theory model about crime being mainly an activity that relates to the economically active share of the population. The second demographic variable, the urbanization rate, when significant also appears to positively influence theft rates and accord with Bianchi et al. (2011) with respect to total and car theft rates, Fajnzylber et al. (2002) for robbery rates, and Kendall and Tamura (2010) for assaults.

The effects of the socioeconomic variables are also intuitive and supportive of the general findings in the literature. The level of development, when
properly instrumented, diminishes theft rates (with the effect being smaller in magnitude in more developed economies) and the same applies for the growth rate of an economy’s aggregate output. The negative effects of economic activity on crime are related to the legal income opportunities created through higher income and economic growth. As both these variables act as proxies for the expected gains of legal activities, their higher values decrease illegal activities as the opportunity cost of committing crime increases. This cost of crime increases further if one considers the high incomes foregone when incarcerated. Empirical support of these negative effects on both violent and non-violent types of crime is offered, among others, by Fajnzylber et al. (2002), Neumayer (2003), Lin (2007), Kelaher and Sarafidis (2011). The last socioeconomic variable, the rate of unemployment, has an effect that turns negative under difference-GMM. This effect, consistent with the findings of Bianchi et al. (2011), can be explained by a standard assumption of decreasing absolute risk aversion, which suggests that illegal activity decreases with increasing unemployment. The intuition is that unemployment implies a lower income and higher risk aversion, thus leading to lower expected utility of crime.

The final column of Table 3 also accounts for the dynamics of theft rates by including the lagged dependent variable in the set of regressors. This inclusion is justified by the possibility of criminal hysteresis stressed by Glaeser et al. (1996) and Fajnzylber et al. (2002). This inertia could be an outcome of learning-by-doing by criminals so that the accumulation of crime-related knowledge decreases the cost of carrying out criminal acts over time.

To assess the robustness of the findings related to the determinants of crime described so far, we present a set of sensitivity tests in Table 4. All the regressions correspond to the estimation technique reported in column (7) of Table 3, difference-GMM, with the use of alternative proxies for the probability of avoiding apprehension, a different measure of crime, and the addition of further controls.\textsuperscript{46} None of these considerations, however, alter the main implication of our findings: a positive crime effect of $\pi$ for $\pi > \pi^*$. \textsuperscript{46}

Column (1) replaces the probability of avoiding arrest for committing

\textsuperscript{46}The description of each of these additional variables is given in Table 1.
theft with the probability of escaping conviction for committing theft. The fact that the estimated size of $\pi^*$ is consistent with the values obtained in Table 3, conforms to our theoretical assumption that $\pi$ corresponds to the probability of escaping both apprehension and conviction. Column (2) considers a different category of non-violent crime. Replacing both the dependent variable with recorded burglary rates and $\pi$ with the probability of escaping arrest for burglary, does not alter the main message of our findings. This is also true when we add more control variables in columns (3)-(5). These additional variables that relate to demographics (sex ratio and female labour force participation), political institutions (democracy and human rights violations), and the economy (education and income inequality) are all significant (except for inequality) and take up signs consistent with intuition and past empirical studies (see, for instance, Neumayer 2003, 2005; Soares 2004; Lin 2007; Kendall and Tamura 2010).

Finally, we have to state that the specification tests in both Table 3 and 4 corroborate the validity of the instruments. Hansen’s J-statistic cannot reject the hypothesis that the instruments are uncorrelated with the error term at a standard confidence level. Additionally, the Arellano and Bond (1991) test fails to reject the hypothesis of no second-order serial correlation in the error term in all regressions at any conventional level of significance.

### 4.3.2 Fertility

Table 5 presents the benchmark findings of estimating equation (43). The order of the columns follows that of Table 3 in terms of estimation techniques. Column (1) shows a positive association between fertility and the probability of avoiding arrest when there is no restriction on the size of $\pi$ (i.e., when all available data are used). Next, consistent with our theoretical model, we constrain the value of $\pi$ to exceed $\pi^*$. We choose this value to be located at 20% because this is the average value of the thresholds identified in Table 3. Column (2) reports a higher coefficient estimate for $\pi$. Further, we impose a non-linear relationship between fertility and $\pi$ in column (3) to examine if a threshold value of $\pi^{**}$ exists. The addition of squared $\pi$ as a control illustrates the absence of a non-monotonic relationship. This findings does not offer support to our theoretical result as both variables
appear with statistically insignificant coefficients. This could mean either that the threshold value $\pi^\ast$ is close to $\pi^\ast$ so that a regression fails to unveil this non-linearity, or that a higher probability of escaping arrest monotonically increases disposable income, which leads to higher fertility. Given the absence of identifying a non-linearity, the rest of the estimations revert to a linear specification.

Adding more fertility regressors and controlling for time effects and endogeneity in columns (4)-(9), does not alter the main finding of a positive impact of $\pi$ on fertility. The magnitude of the coefficient estimate implies that an increase of a one-standard-deviation in the probability of escaping apprehension (22.24) is associated with a 0.044 percent increase in fertility rates.\textsuperscript{47} Clearly, this does not represent a large impact on fertility, but an impact nevertheless. This finding further corroborates our earlier claim on the results obtained by Gaviria and Pagés (2002) regarding the channel through which crime and fertility are interrelated. The finding of a positive impact of the probability of escaping arrest on both crime and fertility suggests that the positive link between fertility and crime is endogenously determined, rather than running from fertility to crime.

Shifting attention to the other determinants of fertility, probably the most important reflects mortality rates. In theory, higher mortality leads to higher fertility through a variety of channels. These channels include factors that relate to the physiological and replacement effect, the hoarding effect, and the quantity-quality trade-off. The physiological channel (Palloni and Rafalimanana 1999) stresses that the death of a child increases the probability that parents will have a new birth, while the hoarding channel (Kalemli-Ozcan 2002) prescribes that an environment of high mortality leads parents to insure themselves by having more children. According to the last channel (Becker 1960; Galor and Weil 1999), high mortality makes investments in children’s human capital less attractive by reducing the expected time horizon over which such capital can be used, leading parents to chose child quantity over child quality. The positive relationship between mortality and fertility is strongly confirmed in our results, in line with the contributions of Angeles (2010) and Herzer et al. (2010).

\textsuperscript{47}With a coefficient of 0.002 from column (8), the effect on fertility is calculated as $0.002 \times 22.24 = 0.044$.\textsuperscript{84}
The remaining three determinants, described by economic development, urbanization and unemployment, have all figured in the literature as offering explanations of fertility changes. A more developed and technologically advanced economy may offer a higher remuneration for human capital and, thus, induce parents to invest in the education of their children at the expense of their number. At the same time though, children can be regarded as “normal goods,” so that higher incomes would lead parents to increase fertility. Urbanization, viewed as an output of modernization, leads to a change in fertility behaviour through changes in people’s attitudes and preferences. These relate to perceptions towards fertility control and the role of women during the transition from a traditional paternal society to a modern society. Thus, higher urbanization should be followed by lower fertility. Further, unemployment is thought of leading to lower fertility due to the uncertainty and insecurity it causes regarding the levels of present and future income. Controlling for endogeneity, our results support a positive effect of economic development on fertility, while the impact of urbanization and unemployment are largely insignificant. Finally, column (9) indicates that fertility is subject to strong hysteresis effects that is suggestive of the long time required for people to change their attitudes and values regarding childbearing decisions.

Table 6 shows that the benchmark fertility findings remain robust when we subject them to a number of sensitivity tests. Column (1) uses the probability of escaping conviction for theft as a proxy for π, while column (2) defines crime by burglary rates. Columns (3)-(5) use various measures of fertility (crude birth rate, net fertility rate, and population growth), while columns (6)-(7) change the measure of mortality (under-5 child mortality and life expectancy). Finally, column (8) includes education and the female labour force participation rate as additional controls. Consistent with empirical findings in the literature (Adserá 2004; Angeles 2010) education diminishes fertility while the increasing financial security of women via participation to the paid labour market increases the number of children.

\footnote{For instance, Angeles (2010) uses life expectancy since it incorporates mortality rates at all stages in life. In this way, it is viewed as better accounting for the full effects of mortality changes on fertility.}
4.3.3 Economic Growth

The empirical literature has not examined directly the impact of the risk of apprehension on economic growth, but has rather focused on the growth impact of crime. Even this relationship, however, is not well documented. A few studies exist at the national level, while there is a lack of studies at the cross-country level, mainly due to two reasons: the inaccuracy inherent in crime data and the inconsistency in the definition of crime across countries (Powell et al. 2010). Nevertheless, the evidence from the existing studies as to the growth effect of criminal activities is quite compelling, as they generally reveal a strong negative effect. Single-country studies include Cárdenas and Rozo (2008) for Colombia, Peri (2004) and Detotto and Otranto (2010) for Italy, Rincke (2010) for US Metropolitan Statistical Areas, while cross-country work has been conducted by Gaibulloev and Sandler (2008) for 18 Western European countries and by the World Bank (2006) for up to 43 countries.

In contrast with the existing literature on this topic, the analysis focuses on the impact of avoiding apprehension on economic growth. For this reason, the reduced-form growth rate equation (44) is estimated, the results of which appear in Table 7. Starting with the variables included in the set $W_j$, they are supportive of the general findings in the literature. Specifically, higher levels of private investment, a more outward-oriented trade policy, and a fiscal surplus promote economic growth, while a higher rate of inflation distorts growth. In addition, there is only weak evidence of conditional convergence. Finally, the likelihood of escaping apprehension exerts a negative effect on growth, which is more sizeable when $\pi > 20\%$ and highly significant when instrumented for. This result provides support to the dominance of the effects that materialize via the declines in child-rearing time and government revenue which reduce health status and labour productivity, compared to the effect that takes shape through rising savings. The magnitude of the coefficient estimate from column (6) implies that an increase of a one-standard-deviation in the probability of escaping apprehension is asso-

\footnote{Studies typically use intentional homicide rates as measure of crime because they are thought to be least subject to variation in definition and reporting to authorities.}

\footnote{The sole exception is Mauro and Carmeci (2007) who found crime not to have a statistically significant effect on Italian output per capita growth.}
associated with a 1.6 percent decrease in growth rates\footnote{With a coefficient of 0.074 from column (6), the effect on fertility is calculated as $0.074 \times 22.24 = 0.044$.}. This is a non-negligible effect.

Following in the steps of the robustness checks conducted with respect to crime and fertility, once again we consider changing the proxy for $\pi$ (column (1)), the category of non-violent crime (column (2)), and the addition of further control variables (column (3)-(4)). None of these considerations impact upon our core findings. The additional controls also have the expected signs, with education and democracy positively associated with growth (the latter at a diminishing rate). One could argue that the use of annual data in the growth regressions distort the long-run growth impact of the right-hand-side variables, and of $\pi$ in particular, as there is no control of business cycle effects. Taking this into account, we re-estimate the growth regression by using 5-year period averages of the data. The difference-GMM results appear in columns (5) and (6) and illustrate that our benchmark outcomes remain intact despite the smaller number of observations. This is also true in columns (7) and (8) when we estimate with the system-GMM approach.\footnote{The use of system-GMM is plausible with the averaged data due to the smaller number of instruments required for each instrumented variable. This allow us to instrument for all of the right-hand-side variables.}

### 4.3.4 Joint Regressions

The final set of regressions we run considers the inter-relationships among the three endogenous variables of our analysis. This amounts to simultaneously estimating the structural equations of our model (35), (36) and (41), treating them as a system. This implies that the probability offenders face in escaping apprehension is not included directly in the growth equation, but its effect on growth materializes through the rates of crime and fertility now incorporated in the growth regression.

Table 9 reports the results of the 3SLS regressions. Conforming to the non-linearities unveiled above, the first set of columns restrict the data to values of $\pi > 20\%$. We find that the likelihood of avoiding arrest positively influences both crime and fertility. At the same time, these two variables distort economic growth. These results corroborate the findings
of the single-equation estimations and, once again, confirm the implications of our theoretical model. Further, the estimated effects of the remaining control variables of all three equations do not disprove the earlier results.

The second set of columns utilizes the entire set of observations by including all available data. Now the effect of $\pi$ is separately considered for values below and above the threshold of 20%. This is done with the introduction of two dummy variables where the first (second) takes the value of 1 when $\pi < 20\%$ ($\pi > 20\%$) and zero otherwise. Then, these dummies are interacted with $\pi$ to produce its non-linear effect on crime and fertility. Indeed, the results show the statistically significant effect of the high $\pi$ values only (at the 1% level). These results are matched by the growth-diminishing effects of crime and fertility.

The final set of columns re-runs the restricted version of column (1) by replacing $\pi$ with its second lagged value to control for endogeneity. This action appears to have no bearing on the sign, significance, and size of the coefficients of interest.

4.4 Discussion and Conclusions

The purpose of this chapter is to examine the interrelationships between crime, fertility and economic growth. Specifically, we establish the probability of avoiding apprehension as the linking factor between crime and fertility and examine how these two variables jointly influence economic growth. Hence, the aim of this chapter is to provide an empirical extension of the theoretical model discussed in the previous chapter. To achieve this we have constructed a dataset, containing information on criminal activity, fertility outcomes and output growth, across 90 countries covering the period 1970-2008. We use total recorded theft rates as a proxy for the incidence of crime.

The estimation method is as follows. First we estimate the equations of crime, fertility and growth independently of one another so that, for all three equations, the probability of avoiding apprehension is used directly as a determinant. Then we examine the structural relationship between the three endogenous variables of crime, fertility and growth, and estimate them jointly as a system. By doing so, in the growth regression we add directly
as determinants the rates of crime and fertility, and exclude as a control
the probability of escaping apprehension. In addition, we also include a
range of demographics and socioeconomic and institutions-related variables
that have been identified in the literature as important determinants for
each considered variable. In all regressions we control for country-specific
effects, given the importance of country-specific factors in controlling for
unobserved country-specific characteristics. Then, we add time-fixed effects
in order to take into account common variations in the three variables across
time. The probability of avoiding apprehension is an endogenous variable
in the crime equation, as the numerator of the dependent variable (number
of recorded thefts) is the denominator in the probability of avoiding arrest.
To address the issue of endogeneity, we replace its contemporaneous values
with two-period lagged values. Another approach we use is to instrument
the potentially endogenous variables with their second lagged values and
apply instrumental variable techniques (static GMM and dynamic GMM).
Our results have been subjected to a number of robustness checks in terms
different measures for crime and fertility, the use of alternative proxies for
the probability of avoiding arrest, and the addition of further explanatory
variables. Our results are not affected by the robustness checks that we have
conducted.

Our results are broadly in support of the theoretical model results. First,
we find evidence of a positive and non-linear relationship between the prob-
ability of avoiding apprehension and crime. An increase in the likelihood
of avoiding arrest encourages agents to engage in criminal activities only if
the probability is above a threshold value that lies between 20-30%. This
suggests that criminal activities become appealing only if they pay off, in
terms of the probability being above a threshold value. Secondly, we find a
positive non-linear relationship between the probability of avoiding appre-
hension and fertility, an effect that becomes positive when the probability
again exceeds the threshold value of 20%. The finding of a positive impact of
the probability of escaping arrest on both crime and fertility implies that the
positive link between fertility and crime is an equilibrium outcome, rather
than a causal one running from fertility to crime. In addition, the likelihood
of escaping apprehension has a negative effect on growth, supporting studies
which argue that crime is detrimental to growth. Lastly, we consider the
interrelationships among the three endogenous variables of crime, fertility and growth. In accordance with the theoretical section, in the joint regressions, we find that the probability of avoiding detection has a positive effect on both crime and fertility and that these two variables negatively affect economic growth.
5 Conclusion

In the last three decades there has been a significant amount of studies and policy recommendations attempting to alleviate the incidence of corruption and crime. Despite the fact that corruption has been difficult to define, there is no doubt that it has adverse effects, not just at the political level but also at the economic and social level of a country. The rate of crime itself has followed a steady and persistent path over the years. From Eastern Europe to the developing countries of Latin America, crime has become a major concern, as it is widely considered an obstacle to growth. Generally speaking, the incidence of corruption and crime leads to the misallocation and waste of resources, damages the efficiency and quality of life, threatens the security of people, and disturbs the investment potential of a country. Far from being a victimless crime, corruption is estimated that can cost many governments as much as 50% of their tax revenues. According to the Home Office, the cost of crime in the U.K. in 2000 was estimated at £60 billion (Brand and Price 2000). The social costs of corruption and crime are even less quantifiable.

In economics the study of corruption has turned into a very fertile area in the last decade. The vast bulk of the crime literature is based on Becker’s model (1968), where individuals are assumed to be rational, expected utility maximizers. Within this analytical framework crime rates depend on deterrence factors such as the risk and punishment associated with apprehension but also on the difference between the potential benefits and the opportunity cost related to crime activities. As a result, the observation that some countries are more corrupt than others has characteristically been attributed to differences in the level of development, the quality of governance, the structure of institutions and other characteristics. However, differences in crime rates persist even when controlling for these variables.

Research in other areas has indicated that factors such as social influences play a crucial role in explaining criminal behaviour in the decision-making process. In particular, social stigma has proved to be an important determinant of illegal activity. The first chapter of the thesis offers such an explanation of corruption practised at the political level. It examines the

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impact of informal sanctions in the context of different corruption regimes. Since corruption has a complex nature and can take many different shapes, we make the distinction between two corruption regimes. Firstly, we consider the case of collusive corruption where public officials conspire with private households in tax evasion and bribery. Secondly, we examine the case of non-collusive corruption where public officials embezzle tax revenue. In each case we derive the equilibrium values and compare and contrast the results. We identify an equilibrium value of corrupt agents given the corruption regime under which the economy operates. The results show that, under a weak social stigma effect, whether there is collusion or not, the result is the same: there is always a unique equilibrium, but possibly a multiplicity of equilibria when social stigma effects are strong. The model provides an explanation supporting the notion that social stigma influences the incentive to engage in corruption, and that these influences are in turn affected by the extent of such behaviour. This type of interdependence would be a variable to account for the diversity both across and within alternative corruption regimes.

In the subsequent section we switch the analysis to the incidence of crime, in the form of stealing. We present a theoretical model of crime that builds on Agénéor’s (2009) paper. We have extended the model in order to also consider crime-related issues. The analysis focuses on how changes in the probability of apprehension will affect the decision to commit crime. Previous research has found evidence that an increase in such deterrence factors leads to a decrease in crime rates. The contribution of this section is not simply to confirm this relationship, but to also propose that the relationship between crime and its associated costs is possibly non-linear. An increase in the probability of avoiding apprehension leads to an increase in the time devoted to crime activity and a decrease in other activities, such as child-rearing and leisure. We find that this effect takes place when the probability exceeds a certain threshold value. In addition, by examining the effect of the crime parameter on fertility and growth we find that an increase in the probability of avoiding detection has a non-monotonic effect on the fertility rate and an ambiguous effect on the steady state of output.

The last chapter addresses the theory of crime by providing an econometric analysis. In particular, we provide an empirical link to the theoretical
model discussed in the previous section, by examining the proposed findings. We start by examining the existence of non-monotonic effects of the probability of avoiding apprehension on crime and fertility. Then we examine the effect of this probability on economic growth. The last part analyses the interrelationships among these three endogenous variables by jointly estimating them. We also include several demographic and socioeconomic variables that the literature has identified as important in providing an explanation for the variation in the studies of crime, fertility and growth. A variety of econometric methods has been used to account for country-specific effects and endogeneity problems. The analysis finds a positive relationship between the probability of avoiding apprehension and crime rates. In accordance with the theoretical model, this relationship is not linear but becomes positive for values above 20 per cent. We also find that the probability of avoiding apprehension has a positive effect on fertility. The finding of a positive impact of the probability of escaping arrest on both crime and fertility implies that the positive link between fertility and crime is an equilibrium outcome, rather than a causal one running from fertility to crime. In addition, we find that an increase in the probability of avoiding apprehension has a negative effect on economic growth. Lastly, we consider the interrelationships among the three endogenous variables of crime, fertility and growth. In accordance with the theoretical section, we find that the probability of avoiding detection has a positive effect on both crime and fertility and that these two variables negatively affect economic growth. Our results are not affected by the robustness checks that we have conducted.

The contribution of the thesis to the literature is firstly to examine the social influences of social stigma in the context of corruption. With this work we aim to provide an explanation of why the incidence of corruption varies between countries with seemingly identical characteristics. Subsequently, the contribution of the remaining chapters is to analyse the interrelationships between crime, fertility and economic growth within a unified theoretical and empirical model. This is because, so far, crime and fertility have been treated as separate and unrelated variables in the growth process. We offer a link to the two famous theories of Becker (1960; 1968) by considering the probability of avoiding apprehension. We make use of Becker’s (1960) theory of expected utility maximizer agents in the crime decision pro-
cess. The second theory supports that there is a quantity-quality trade-off for children so that when mortality rates increase parents invest less in the quality of their children and more in the quantity, so that fertility rates increase. Our results are in accordance with theories and we take the research a step further by proposing that the relationship between the probability of avoiding apprehension and crime is not linear. In addition, we find that fertility rises with relatively high values of the probability of escaping arrest, thus giving rise to a positive relationship between crime and fertility. It is important to note that this relationship is not causal as suggested in the literature, but arises endogenously through the impact of the arrest probability. The impact of the apprehension probability on economic growth is not straightforward due to the non-linearities and the number of different channels of influence. Hence, in theory it is possible that higher crime and fertility rates, as a result of a higher probability of avoiding apprehension, have a positive effect on growth.

Studies on the analysis of crime and corruption emphasize the role of governance in adopting successful policies to eliminate illegal activities. Bad governance can foster corruption, and corruption can also deteriorate the quality of a government. In terms of policy implications, the thesis proposes that social stigmatization of individuals would act as a strong crime deterrent were it to be applied in a relatively clean economy, measured in terms of a low corrupt population. This is because social stigma influences are affected by the extent of corrupt behaviour. The greater the incidence of corruption in a society, the smaller the effect of social stigma. For the analysis of crime reduction, the thesis proposes that the government needs to reduce the probability of escaping arrest below 20 per cent, or to increase the probability of arrest for theft to above 80 per cent. Like many other studies, our research does not suggest how this can be achieved but, according to the literature, more policing on the streets or higher government spending on law enforcement would be among the feasible suggestions.
References


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Appendix A

Propositions 1 - 6 are established on the basis of Lemmas 1 - 4, together with the expressions for \( \hat{t}_i \) and \( \tilde{t}_i \) \((i = 0, 1)\). These expressions, obtained from (8) and (11), are given by

\[
\left(\frac{\mu m}{n}\right) \hat{t}_0 = \left[\sigma_B + \left(\frac{\mu m}{n}\right) \sigma_H\right] (m+n) \equiv F(0), \quad (A1)
\]
\[
\left(\frac{\mu m}{n}\right) \hat{t}_1 = \left[\sigma_B + \left(\frac{\mu m}{n}\right) \sigma_H\right] [m+n - \eta(\mu m + n)] + \gamma \eta n \equiv F(1), \quad (A2)
\]
\[
\left(\frac{\mu m}{n}\right) \tilde{t}_0 = \sigma_B (m+n) \equiv G(0), \quad (A3)
\]
\[
\left(\frac{\mu m}{n}\right) \tilde{t}_1 = \sigma_B (m+n - \eta n) + \gamma \eta n \equiv G(1). \quad (A4)
\]

As stated in the main text, the following properties are immediately observed:

\[
\hat{t}_0 < (>) \hat{t}_1 \text{ if } \left[\sigma_B + \left(\frac{\mu m}{n}\right) \sigma_H\right] (\mu m + n) < (>) \gamma n, \quad (A5)
\]
\[
\tilde{t}_0 < (>) \tilde{t}_1 \text{ if } \sigma_B < (>) \gamma. \quad (A6)
\]

Proof of Proposition 1

(A1) and (A3) give \( \hat{t}_0 > \tilde{t}_0 \), whilst (A2) and (A4) yield \( \hat{t}_1 \geq \tilde{t}_1 \). Since

\[
\left[\sigma_B + \left(\frac{\mu m}{n}\right) \sigma_H\right] (\mu m + n) < \gamma n,
\]
and therefore \( \sigma_B < \gamma \), (A5) and (A6) imply \( \hat{t}_1 - \tilde{t}_0 > \tilde{t}_1 - \tilde{t}_0 > 0 \). These are the results in (i) - (iii).

Proof of Proposition 2

Recall Lemmas 1 and 3, together with Proposition 1. It follows that \( \hat{\theta} = \tilde{\theta} = 0 \) for \( t < \tilde{t}_0 \), whilst \( \hat{\theta} = 0 \) and \( \tilde{\theta} = g(\Delta) \) for \( t \in (\hat{t}_0, \tilde{t}_0) \). Two alternative scenarios are then possible:

a) if \( \hat{t}_1 < \tilde{t}_1 \), then \( \hat{\theta} = f(\Omega) \) and \( \tilde{\theta} = g(\Delta) \) for \( t \in (\hat{t}_0, \tilde{t}_1) \), \( \hat{\theta} = 1 \) and \( \tilde{\theta} = g(\Delta) \) for \( t \in (\tilde{t}_1, \hat{t}_1) \), and \( \hat{\theta} = \tilde{\theta} = 1 \) for \( t > \hat{t}_1 \);

b) if \( \hat{t}_1 > \tilde{t}_1 \), then \( \hat{\theta} = f(\Omega) \) and \( \tilde{\theta} = g(\Delta) \) for \( t \in (\hat{t}_0, \tilde{t}_1) \), \( \hat{\theta} = f(\Omega) \) and \( \tilde{\theta} = 1 \) for \( t \in (\tilde{t}_1, \hat{t}_1) \), and \( \hat{\theta} = \tilde{\theta} = 1 \) for \( t > \tilde{t}_1 \).

Collecting these observations together leads to the results in (i) - (v).

Proof of Proposition 3
(A1) and (A3) give $\tilde{t}_0 > \tilde{t}_0$, whilst (A2) and (A4) yield $\hat{t}_1 \geq \tilde{t}_1$. Since $\sigma_B > \gamma$, and therefore $[\sigma_B + (\frac{\mu m}{n}) \sigma_H] (\mu m + n) > \gamma n$, (A5) and (A6) imply $\hat{t}_0 - \hat{t}_1 > \tilde{t}_0 - \tilde{t}_1 > 0$. These are the results in (i) - (iii).

Proof of Proposition 4

Recall Lemmas 2 and 4, together with Proposition 3. It follows that $\hat{\theta} = \hat{\tilde{t}} = 1$ for $t > \hat{t}_0$, whilst $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = 1$ for $t \in (\hat{t}_0, \hat{t}_0)$. Two alternative scenarios are then possible:

a) if $\hat{t}_1 < \hat{t}_0$, then $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = \{0, 1\}$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = 0$ for $t \in (\hat{t}_1, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_1$;

b) if $\hat{t}_1 > \hat{t}_0$, then $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = \{0, 1\}$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = 0$ and $\hat{\tilde{t}} = \{0, 1\}$ for $t \in (\hat{t}_1, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_1$.

Collecting these observations together leads to results in (i) - (v).

Proof of Proposition 5

(A1) and (A3) give $\hat{t}_0 > \tilde{t}_0$, whilst (A2) and (A4) yield $\hat{t}_1 \geq \tilde{t}_1$. Since $[\sigma_B + (\frac{\mu m}{n}) \sigma_H] (\mu m + n) > \gamma n$, but $\sigma_B < \gamma$, (A5) and (A6) imply $\hat{t}_0 - \hat{t}_1 > 0$ and $\tilde{t}_1 > \tilde{t}_0$, with $\hat{t}_0 - \hat{t}_1 \geq \tilde{t}_1 - \tilde{t}_0$. Further comparisons of $\hat{t}_i$ and $\tilde{t}_i$ reveal that any of the rankings in (i) - (v) are possible.

Proof of Proposition 6

Recall Lemmas 2 and 3, together with Proposition 5. There are four possible scenarios:

a) if $\hat{t}_0 < \hat{t}_1 < \hat{t}_0$, then $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_0$, $\hat{\theta} = 0$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_0, \hat{t}_1)$, $\hat{\theta} = 0$ and $\hat{\tilde{t}} = 1$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = 1$ for $t \in (\hat{t}_1, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 1$ for $t > \hat{t}_0$.

b) if $\hat{t}_0 < \hat{t}_1 < \hat{t}_0$, then $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_0$, $\hat{\theta} = 0$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_0, \hat{t}_1)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = 1$ for $t \in (\hat{t}_1, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 1$ for $t > \hat{t}_0$.

c) if $\hat{t}_0 < \hat{t}_1 < \hat{t}_0 < \hat{t}_1$, then $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_0$, $\hat{\theta} = 0$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_0, \hat{t}_1)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = 1$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_1, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 1$ for $t > \hat{t}_0$.

d) if $\hat{t}_1 < \hat{t}_0 < \hat{t}_0 < \hat{t}_1$, then $\hat{\theta} = \hat{\tilde{t}} = 0$ for $t < \hat{t}_1$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = 0$ for $t \in (\hat{t}_1, \hat{t}_0)$, $\hat{\theta} = \{0, 1\}$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_0, \hat{t}_1)$, $\hat{\theta} = 1$ and $\hat{\tilde{t}} = g(\Delta)$ for $t \in (\hat{t}_0, \hat{t}_1)$, and $\hat{\theta} = \hat{\tilde{t}} = 1$ for $t > \hat{t}_1$. 

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e) if $\tilde{t}_1 < \tilde{t}_0 < \tilde{t}_1$, then $\hat{\theta} = \tilde{\theta} = 0$ for $t < \tilde{t}_1$, $\hat{\theta} = \{0, 1\}$ and $\tilde{\theta} = 0$ for $t \in (\tilde{t}_1, \tilde{t}_0)$, $\theta = \{0, 1\}$ and $\tilde{\theta} = g(\Delta)$ for $t \in (\tilde{t}_0, \tilde{t}_1)$, $\hat{\theta} = \{0, 1\}$ and $\tilde{\theta} = 1$ for $t \in (\tilde{t}_1, \tilde{t}_0)$, and $\hat{\theta} = \tilde{\theta} = 1$ for $t > \tilde{t}_0$.

Collecting these observations together leads to the results in (i) - (iii).
Figure 1
Equilibrium Collusive Corruption
(Weak Stigma Effects)
Figure 2
Equilibrium Collusive Corruption
(Strong Stigma Effects)
Figure 3
Comparison of Corruption Regimes
(Weak Stigma Effects)
Figure 4
Comparison of Corruption Regimes
(Strong Stigma Effects)
Appendix B

Before solving the individual’s maximization problem, rewrite equation (25), with the use of (33), for \( t + 1 \) as

\[
h_{t+1}^C = \lambda(h_{t+1}^A)^{\kappa}(\varepsilon_{t+1})^{\nu_C}(G_{Y_{t+1}}^{H})^{1-\nu_C},
\]

and combine with (26) to get

\[
h_{t+1}^C = \lambda(h_{t}^C)^{\kappa}(\varepsilon_{t+1})^{\nu_C}(G_{Y_{t+1}}^{H})^{1-\nu_C}.
\] (B1)

From (14), which we rewrite here, each individual maximizes

\[
U_{t+1} = \ln(c_{t+1}^t) + \ln(1 - \varepsilon_{t+1}n_{t+1} - \theta_{t+1})
\]

\[
+ \ln(n_{t+1}h_{t+1}^C) + \frac{\ln(c_{t+2}^t)}{1 + \rho},
\]

with respect to \( c_{t+1}^t, c_{t+2}^t, \varepsilon_{t+1}, \theta_{t+1} \) and \( n_{t+1} \), subject to (B1), (27), (28) and (13), as well as (17), which is rewritten here for convenience:

\[
(1 - \lambda n_{t+1})(1 - \tau)a_{t+1}w_{t+1} - Z_{t+1} + \pi x_{t+1} - e_{t+1}^t - \frac{c_{t+2}^t}{1 + r_{t+2}} = 0. \] (B3)

First-order conditions yield the familiar Euler equation\(^{54}\)

\[
\frac{c_{t+2}^t}{c_{t+1}^t} = \frac{1 + r_{t+2}}{1 + \rho},
\] (B4)

together with

\[
\frac{n_{t+1}}{1 - \varepsilon_{t+1}n_{t+1} - \theta_{t+1}} = \frac{\nu_C}{\varepsilon_{t+1}},
\] (B5)

\[
\frac{1}{1 - \varepsilon_{t+1}n_{t+1} - \theta_{t+1}} = \frac{\pi(1 - \tau)a_{t+1}w_{t+1}}{c_{t+1}^t},
\] (B6)

\[
\frac{\varepsilon_{t+1}}{1 - \varepsilon_{t+1}n_{t+1} - \theta_{t+1}} + \frac{1}{n_{t+1}} = \frac{(1 - \tau)\lambda a_{t+1}w_{t+1}}{c_{t+1}^t}.
\] (B7)

\(^{54}\)Recall that \( Z_{t+1} \) is not a choice variable for the individuals as it is out of their control.
Substituting (B4) into the intertemporal budget constraint (B3) yields

\[ c^t_{t+1} = \left( \frac{1 + \rho}{2 + \rho} \right) \left[ (1 - \lambda)n_{t+1}(1 - \tau) a_{t+1} w_{t+1} - Z_{t+1} + \pi x_{t+1} \right], \quad (B8) \]

which with the use of (13), and the fact that in equilibrium \( x_{t+1} = Z_{t+1} \), produces

\[ c^t_{t+1} = (1 - \sigma) \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right] (1 - \tau) a_{t+1} w_{t+1}, \quad (B9) \]

where \( \sigma = \frac{1}{2 + \rho} < 1. \)

Equation (B9) implies that saving, \( s_{t+1} = (1 - \lambda)n_{t+1}(1 - \tau) a_{t+1} w_{t+1} - Z_{t+1} + \pi x_{t+1} - c^t_{t+1} \), is equal to

\[ s_{t+1} = \sigma \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right] (1 - \tau) a_{t+1} w_{t+1}. \quad (B10) \]

A necessary condition for positive values of first-period consumption and saving is \( (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} > 0 \), which as shown below is satisfied in equilibrium.

Substituting (B9) in (B6) and (B7) yields respectively

\[ \frac{1}{1 - \varepsilon_{t+1} n_{t+1} - \theta_{t+1} \varepsilon_{t+1}} = \frac{\pi}{(1 - \sigma) \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right]}, \quad (B11) \]

\[ -\varepsilon_{t+1} n_{t+1} - \theta_{t+1} + \frac{1}{n_{t+1}} = \frac{\lambda}{(1 - \sigma) \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right]}. \quad (B12) \]

Now divide (B5) by (B11) to get

\[ n_{t+1} = \frac{v_C (1 - \sigma) \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right]}{\pi \varepsilon_{t+1}}, \quad (B13) \]

so that

\[ \varepsilon_{t+1} n_{t+1} = \Lambda, \quad (B14) \]

where

\[ \Lambda \equiv \frac{v_C (1 - \sigma) \left[ (1 - \lambda)n_{t+1} - (1 - \pi) \theta_{t+1} \right]}{\pi}. \quad (B15) \]

Rearrange (B5) to obtain

\[ \frac{\varepsilon_{t+1} n_{t+1}}{1 - \varepsilon_{t+1} n_{t+1} - \theta_{t+1}} = v_C. \]
Substituting (B14) back in this expression yields
\[
\frac{\Lambda}{1 - \Lambda - \theta_{t+1}} = \nu_C, \tag{B16}
\]
which, with further rearranging, yields an equation in \(\theta_{t+1}\) and \(n_{t+1}\):
\[
\nu_C\theta_{t+1} = \nu_C - (1 + \nu_C)\Lambda. \tag{B17}
\]
Substituting (B14) in (B12), and using (B16), yields a second equation in \(\theta_{t+1}\) and \(n_{t+1}\):
\[
\lambda n_{t+1}[1 + (1 - \nu_C)(1 - \sigma)] = (1 - \nu_C)(1 - \sigma)[1 - (1 - \pi)\theta_{t+1}]. \tag{B18}
\]
Combining equations (B17) and (B18), along with (B15), we jointly solve for the optimal values of \(\theta_{t+1}\) and \(n_{t+1}\):
\[
\tilde{\theta} = \frac{\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)}{\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)(1 - \pi)} < 1, \tag{B19}
\]
\[
\tilde{n} = \frac{(1 - \nu_C)(1 - \sigma)\pi^2}{\lambda \{\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)(1 - \pi)\}}. \tag{B20}
\]
Equation (B19) implies that agents allocate a positive share of their time toward crime-related activities if
\[
\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)(1 - \pi) > 0, \tag{55}
\]
This, in turn, holds only if the probability of escaping apprehension (\(\pi\)) exceeds a threshold, defined as
\[
\pi > \frac{(1 + \nu_C)(1 - \sigma)}{1 + (1 - \nu_C)(1 - \sigma)} \equiv \pi^*. \tag{B21}
\]
For \(\pi^*\) to be meaningful, it needs to be less than one. This is satisfied with a mild assumption concerning the size of \(\nu_C\); \(\nu_C < 1/2(1 - \sigma)\). This means that the elasticity of children’s health status with respect to the time parents allocate to them cannot be too large.

In addition, equation (B20) shows that \(\pi > \pi^*\) represents a sufficient condition to generate a positive fertility rate. However, for \(\tilde{n} \geq 1\), so to avoid convergence of population size toward zero, an additional assumption is required:
\[
\lambda \leq \frac{(1 - \nu_C)(1 - \sigma)\pi^2}{\pi[1 + (1 - \nu_C)(1 - \sigma)] - (1 + \nu_C)(1 - \sigma)(1 - \pi)}. \tag{B22}
\]

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\(^{55}\)A positive \(\tilde{\theta}\) requires both the numerator and the denominator in equation (B19) to be positive. Note however that this is satisfied with the single condition that the numerator is positive.
Thus, the fraction of income spent on caring for each child cannot be too large. Substituting the equilibrium values of $\theta_{t+1}$ and $n_{t+1}$, from (B19) and (B20), into (B14), gives rise to the optimal shares of time parents allocate to all their children and to each child individually, $\varepsilon_{t+1}n_{t+1}$ and $\varepsilon_{t+1}$:

\begin{align*}
\tilde{\varepsilon}n &= \frac{\pi \nu C (1 - \sigma)}{\pi [1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)}, \quad (B23) \\
\tilde{\varepsilon} &= \frac{\lambda \nu C}{\pi (1 - \sigma)}. \quad (B24)
\end{align*}

From (B23) it can be shown that a sufficient condition for $0 < \tilde{\varepsilon}n < 1$ is $\pi > \pi^*$. From equations (B19) and (B23), it can also be shown that leisure is positive in equilibrium as long as (B21) holds:

\begin{align*}
1 - \tilde{\varepsilon}n - \tilde{\theta} &= \frac{\pi (1 - \sigma)}{\pi [1 + (1 - \nu C)(1 - \sigma)] - (1 + \nu C)(1 - \sigma)(1 - \pi)}. \quad (B25)
\end{align*}

Finally, from (B19) and (B20) one can show that $(1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} > 0$ so that consumption and saving are positive in equilibrium. Equations (B19), (B20), (B23), (B24) and (B25) have the following implications as to the effect of a change in the probability of escaping apprehension:

\begin{align*}
\frac{d\tilde{\theta}}{d\pi} &> 0, \\
\frac{d\tilde{n}}{d\pi} < 0 \text{ if } \pi^* < \pi < \pi^{**} \equiv \frac{2(1 + \nu C)(1 - \sigma)}{1 + 2(1 - \sigma)}, \\
\frac{d\tilde{n}}{d\pi} &> 0 \text{ if } \pi > \pi^{**}, \\
\frac{d(\tilde{\varepsilon}n)}{d\pi} &< 0, \\
\frac{d\tilde{\varepsilon}}{d\pi} &< 0, \\
\frac{d(1 - \tilde{\varepsilon}n - \tilde{\theta})}{d\pi} &< 0.
\end{align*}

Thus, for $\pi > \pi^*$, an increase in the probability of escaping apprehension raises the time agents allocate to criminal activities $\tilde{\theta}$, while it lowers total $\tilde{\varepsilon}n$ and per-child time $\tilde{\varepsilon}$ allocated to childrearing, as well as leisure time $1 - \tilde{\varepsilon}n - \tilde{\theta}$. 

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At the same time, a higher probability of escaping apprehension, has a non-linear impact on the fertility rate $\tilde{n}$, in the sense that it lowers fertility when $\pi^* < \pi < \pi^{**}$ and raises fertility for $\pi > \pi^{**}$.\(^{56}\)

To study the dynamics in this economy, substitute (B10) in (34) with $n_t = \tilde{n}$ and $\theta_t = \tilde{\theta}$ $\forall t$, to get

$$K_{t+1} = \sigma \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right] (1 - \tau) N_t a_t w_t, \quad \text{(B26)}$$

and further substitute for $w_t$ from (21),

$$K_{t+1} = \beta \sigma (1 - \tau) \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right] Y_t. \quad \text{(B27)}$$

The next step is to calculate $G^H_t / Y_t$, to determine the dynamics of $h_t^A$ in (27). From (21) and (31),

$$\frac{G^H_t}{Y_t} = \beta v_H \left[ \tau + (1 - \pi)(1 - \tau)\tilde{\theta} \right]. \quad \text{(B28)}$$

The above equation can be substituted into (27) to give,

$$h_{t+1}^A = \lambda (\beta v_H)^{1 - \nu_C (\tilde{\varepsilon})^{\nu_C} \left[ \tau + (1 - \pi)(1 - \tau)\tilde{\theta} \right]^{1 - \nu_C} (h_t^A)^{\kappa}. \quad \text{(B29)}$$

Equation (B29) is an autonomous, first-order linear difference equation in $\hat{h}_t^A = \ln h_t^A$, whose steady-state solution is

$$\hat{h}^A = \Gamma^{\frac{1}{1 - \kappa}}, \quad \text{(B30)}$$

where $\Gamma = \lambda (\beta v_H)^{1 - \nu_C (\tilde{\varepsilon})^{\nu_C} \left[ \tau + (1 - \pi)(1 - \tau)\tilde{\theta} \right]^{1 - \nu_C}$.

Solving equation (B29) yields

$$\hat{h}_0^A = \left( \frac{1 - \kappa^t}{1 - \kappa} \right) \kappa \ln \Gamma + \kappa^t \hat{h}_0^A.$$  

Therefore, for stability we require $\kappa < 1$, which is satisfied by assumption. Thus, $h_t^A$ converges monotonically to $\tilde{h}_0^A$, and the equilibrium is unique.

The production function equation (23) implies that aggregate output in $t + 1$ is

$$Y_{t+1} = A_t^{\beta} K_{t+1}, \quad \text{(B31)}$$

\(^{56}\)Note that under the assumption discussed above $\nu_C < 1/2(1 - \sigma)$, both $\pi^{**} < 1$ and $\pi^{**} > \pi^*$.
or equivalently, using (28) and (B27),

\[ Y_{t+1} = (h_{t+1}^A) \beta \sigma (1 - \tau) \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right] Y_t. \]  

\( \text{(B32)} \)

Thus, the steady-state growth rate of output is

\[ 1 + \gamma = (\tilde{h}^A) \beta \sigma (1 - \tau) \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right], \]

\( \text{(B33)} \)

where \( \tilde{h}^A \) is given by (B30), and \( \tilde{\theta}, \tilde{n}, \text{ and } \tilde{\varepsilon} \) are the solutions of (B19), (B20) and (B24).

Equation (B33) implies that a change in the probability of escaping apprehension has an ambiguous effect on steady-state output growth:

\[ \frac{d(1 + \gamma)}{d\pi} = \Gamma \frac{\beta}{1 - \kappa} \sigma (1 - \tau) \left\{ \frac{\beta}{1 - \kappa} \frac{\nu C}{\tilde{\varepsilon}} \frac{d\tilde{\varepsilon}}{d\pi} \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right] \right\} \]

\[ -\beta \frac{1}{1 - \kappa} \frac{(1 - \nu C)(1 - \tau)}{\tau + (1 - \pi)(1 - \tau)\tilde{\theta}} \left[ \tilde{\theta} - (1 - \pi) \frac{d\tilde{\theta}}{d\pi} \right] \left[ (1 - \lambda \tilde{n}) - (1 - \pi)\tilde{\theta} \right] \]

\[-\lambda \frac{d\tilde{n}}{d\pi} + \tilde{\theta} - (1 - \pi) \frac{d\tilde{\theta}}{d\pi} \right\}. \]

\( \text{(B34)} \)

This is a result of the negative sign of the first expression in the brackets and the ambiguous signs of the expressions in the following two rows. In particular, the expression in the second row is positive (negative) for \( \pi < \pi^{**} \) (\( \pi > \pi^{**} \)), while the expression in the last row is positive (negative) for \( \pi > \pi^{**} \) (\( \pi < \pi^{**} \)).
Appendix C

Country Sample Used for Section 4: (90)
Andorra, Australia, Austria, Argentina, Azarbaijan, Bahrain, Belarus, Bermuda, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Denmark, Ecuador, El Salvador, Egypt, Estonia, Fiji, Finland, France, Georgia, Germany, Greece, Guyana, Hong-Kong, Hungary, Iceland, Ireland, India, Iraq, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Korea Rep., Kuwait, Kyrgyz Rep., Latvia, Lithuania, Macedonia FYR, Madagascar, Malaysia, Maldives, Malta, Marshall Islands, Mauritius, Moldova, Montserrat, Netherlands, New Zealand, Nicaragua, Norway, Occupied Palestinian Territory, Oman, Panama, Papua New Guinea, Paraguay, Peru, Poland, Portugal, Qatar, Romania, Russian Federation, Sao Tome and Principe, Saudi Arabia, Singapore, Slovenia, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Syrian Arab Rep., Tajikistan, Tanzania, Thailand, Tonga, Tunisia, Turkey, Ukraine, United Kingdom, Uganda, Uruguay, Zambia, Zimbabwe.
Table 1  
Variables Description and Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
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<tbody>
<tr>
<td><strong>Basic Set</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total recorded theft rates</td>
<td>Total recorded thefts per 100,000 inhabitants.</td>
<td>United Nations Surveys on Crime Trends and the Operations of Criminal Justice Systems (CTS)</td>
</tr>
<tr>
<td>Probability of escaping apprehension for theft ( (\alpha) )</td>
<td>Defined as 1 minus the probability of being apprehended by the police, the latter proxied by the number of arrests per recorded theft.</td>
<td>CTS</td>
</tr>
<tr>
<td>Population share of ages 15-64</td>
<td>Population ages 15-64 (% of total).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Urbanization rate</td>
<td>Urban population (% of total).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>GDP per capita in constant 2000 US$.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>GDP growth rate</td>
<td>Annual percentage growth rate of GDP based on constant local currency.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>Unemployment, total (% of total labor force).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Fertility rate</td>
<td>Fertility rate (births per woman), total.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Infant mortality rate</td>
<td>Mortality rate, infant (per 1,000 live births).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>GDP p.c. growth rate</td>
<td>Annual percentage growth rate of GDP per capita based on constant local currency.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>Inflation, consumer prices (annual %).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Trade openness</td>
<td>Trade as % of GDP.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Investment</td>
<td>Gross fixed capital formation (% of GDP).</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td><strong>Sensitivity Set</strong></td>
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<td>Probability of escaping conviction for theft</td>
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<td>CTS</td>
</tr>
<tr>
<td>Total recorded burglaries rates</td>
<td>Total recorded burglaries per 100,000 inhabitants.</td>
<td>CTS</td>
</tr>
<tr>
<td>Probability of escaping burglary</td>
<td>Defined as 1 minus the probability of being apprehended by the police, the latter proxied by the number of arrests per recorded burglary.</td>
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</tr>
<tr>
<td>Sex ratio</td>
<td>Ratio of male-to-female population.</td>
<td>World Bank, WDI</td>
</tr>
<tr>
<td>Metric</td>
<td>Description</td>
<td>Source</td>
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<td>--------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
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<td>Female labour force participation rate</td>
<td>Labour participation rate, female (% of female population ages 15+).</td>
<td>World Bank, <em>WDI</em></td>
</tr>
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<td>Democracy</td>
<td>Sum of two indices that assess the extent to which a country effectively respects political rights and civil liberties, both measured on a 1 to 7 scale. The index is reversed, such that it ranges from 2 (least democratic) to 14 (most democratic).</td>
<td>Freedom House</td>
</tr>
<tr>
<td>Human rights violations</td>
<td>Two scales are reported in the source. One is based upon a codification of country information from Amnesty International’s annual human rights reports on a scale from 1 (best) to 5 (worst). The second scale is based upon information from the US Department of State’s Country Reports on Human Rights Practices. The present study uses the simple average of the two scales.</td>
<td>Purdue Political Terror Scales</td>
</tr>
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<td>Education</td>
<td>School enrollment, tertiary (% gross).</td>
<td>World Bank, <em>WDI</em></td>
</tr>
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<td>Income inequality</td>
<td>Gini coefficient: measures the concentration of incomes between 0 (absolute equality) and 100 (maximum inequality).</td>
<td>UN-WIDER</td>
</tr>
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<td>Crude birth rate</td>
<td>Birth rate, crude (per 1,000 people).</td>
<td>World Bank, <em>WDI</em></td>
</tr>
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<td>Net fertility rate</td>
<td>As the total fertility rate is expressed in births per woman while the mortality rate is expressed in terms of 1,000 live births, the rate of mortality is adjusted in order to be expressed in terms of live births per woman: net fertility rate = total fertility rate – (total fertility rate) *(mortality rate)/1000.</td>
<td>World Bank, <em>WDI</em> based on own calculations.</td>
</tr>
<tr>
<td>Population growth rate</td>
<td>Population growth (annual %).</td>
<td>World Bank, <em>WDI</em></td>
</tr>
<tr>
<td>Under-5 mortality rate</td>
<td>Mortality rate, under-5 (per 1,000).</td>
<td>World Bank, <em>WDI</em></td>
</tr>
<tr>
<td>Life expectancy</td>
<td>Life expectancy at birth, total.</td>
<td>World Bank, <em>WDI</em></td>
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<td>Variable</td>
<td>Mean</td>
<td>Std. Dev.</td>
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<td>Fertility rate</td>
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Notes: All variables are based on annual data. A detailed description of the variables and their sources appears in Table 1.
## Table 3
Crime Regressions: Benchmark Findings

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<th>(1) FE(i)</th>
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<th>(4) FE(i,t)</th>
<th>(5) IV-FE(i,t)</th>
<th>(6) GMM-DIFF</th>
<th>(7) GMM-DIFF</th>
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<td>-96.95</td>
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<td>(0.001)</td>
<td>(0.334)</td>
<td>(0.151)</td>
<td>(0.189)</td>
<td>(0.354)</td>
<td>(0.145)</td>
<td>(0.171)</td>
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<td>$\pi$ squared</td>
<td>0.126</td>
<td>0.222</td>
<td>0.210</td>
<td>0.186</td>
<td>1.49</td>
<td>0.069</td>
<td>0.140</td>
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<td>(0.009)</td>
<td>(0.014)</td>
<td>(0.027)</td>
<td>(0.021)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<td>(0.000)</td>
<td>(0.014)</td>
<td>(0.091)</td>
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<td></td>
<td>(0.786)</td>
<td>(0.418)</td>
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<td>3018</td>
<td>3791</td>
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<tr>
<td></td>
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<td>(0.711)</td>
<td>(0.066)</td>
<td>(0.316)</td>
<td>(0.054)</td>
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<td>107.8</td>
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<td></td>
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<td>(0.173)</td>
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<td>GDP growth rate</td>
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<td>21.59</td>
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<td>Implied probability threshold (%)</td>
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<td>32.32</td>
<td>9.14</td>
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</tbody>
</table>

Countries / Observations | 88 / 656 | 88 / 656 | 71 / 457 | 71 / 457 | 64 / 403 | 48 / 309 | 63 / 359 | 54 / 319 |

$R^2$ | 0.229 | 0.322 | 0.277 | 0.278 | 0.368 | 0.54 | 0.422 |

Number of Instruments | 54 | 54 |

Hansen J-statistic ($p$-value) | 0.230 | 0.422 |

AR(1) test ($p$-value) | 0.030 | 0.090 |

AR(2) test ($p$-value) | 0.806 | 0.665 |

Notes: $p$-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (6)-(8): second lagged values. Regression (5): as regression (4) but uses as a control the second lagged value of $\pi$. 

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<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
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<tr>
<td>$\pi$</td>
<td>-15.26</td>
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<td>Implied probability threshold (%)</td>
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</table>

Notes: p-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. All regression results based on GMM-DIFF technique. Instrumented variables are in bold type. Instruments: second lagged values.
Table 5
Fertility Regressions: Benchmark Findings

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<th></th>
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<th>(6) IV-FE(i,t)</th>
<th>(7) GMM-DIFF</th>
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<tr>
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Notes: p-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (7)-(9): second lagged values. Regression (6): as regression (5) using as a control the second lagged value of \( \pi \). Regressions (8)-(9): not controlling for endogeneity of unemployment to avoid overfitting of too many instruments.
Table 6
Fertility Regressions: Robustness Checks

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<td>0.063</td>
<td>0.007</td>
<td>0.003</td>
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</table>

Notes: \( p\)-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. All regression results based on GMM-DIFF technique. Instrumented variables are in bold type. Instruments: second lagged values.
### Table 7
Growth Regressions: Benchmark Findings

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<th>(1) FE(i)</th>
<th>(2) FE(i)</th>
<th>(3) FE(i,t)</th>
<th>(4) FE(i,t)</th>
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<th>(6) GMM-DIFF</th>
<th>(7) GMM-DIFF</th>
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<tr>
<td>Lagged growth rate</td>
<td>-0.052</td>
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<td>( \pi )</td>
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<th>Yes</th>
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Notes: p-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (6)-(8): second lagged values. Regression (4): as regression (3) using as a control the second lagged value of \( \pi \).
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<td>0.124</td>
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<td>(0.001)</td>
<td>(0.037)</td>
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<td><strong>Democracy</strong></td>
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<td>(2.56)</td>
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<td><strong>Democracy squared</strong></td>
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<tr>
<td>(-0.244)</td>
<td>(0.004)</td>
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<table>
<thead>
<tr>
<th>(\pi &gt; 20%)</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
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<tr>
<td><strong>Countries / Observations</strong></td>
<td>40/192</td>
<td>47/207</td>
<td>46/226</td>
<td>46/226</td>
<td>34/51</td>
<td>34/46</td>
<td>68/121</td>
<td>67/115</td>
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<tr>
<td><strong>Number of Instruments</strong></td>
<td>35</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>31</td>
<td>31</td>
<td>48</td>
<td>57</td>
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<td><strong>Hansen J-statistic (p-value)</strong></td>
<td>0.204</td>
<td>0.290</td>
<td>0.175</td>
<td>0.137</td>
<td>0.183</td>
<td>0.271</td>
<td>0.413</td>
<td>0.717</td>
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<tr>
<td><strong>AR(1) test (p-value)</strong></td>
<td>0.231</td>
<td>0.146</td>
<td>0.023</td>
<td>0.026</td>
<td>0.130</td>
<td>0.506</td>
<td>0.538</td>
<td>0.536</td>
</tr>
<tr>
<td><strong>AR(2) test (p-value)</strong></td>
<td>0.840</td>
<td>0.724</td>
<td>0.446</td>
<td>0.441</td>
<td>-</td>
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</table>

Notes: p-values in parentheses based on robust standard errors. Constant term and country and time dummies not reported. Regressions (1)-(4) based on annual data, while regressions (5)-(8) based on 5-year averaged data. Regressions (1)-(6) based on GMM-DIFF technique and (7)-(8) based on GMM-SYS technique. Instrumented variables are in bold type. Instruments for GMM-DIFF: second lagged values. Instruments for GMM-SYS: second-to-fourth lagged values.
Table 9
System of Equations Regressions (3SLS)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<tbody>
<tr>
<td></td>
<td>Crime</td>
<td>Fertility</td>
<td>Growth</td>
</tr>
<tr>
<td>( \pi &lt; 20% )</td>
<td>30.73</td>
<td>-0.002</td>
<td>(0.244)</td>
</tr>
<tr>
<td>( \pi &gt; 20% )</td>
<td>11.69</td>
<td>0.004</td>
<td>8.98</td>
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<tr>
<td>(0.005)</td>
<td>(0.034)</td>
<td>(0.009)</td>
<td>(0.005)</td>
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<tr>
<td>Population share of ages 15-64</td>
<td>-24.27</td>
<td>-20.36</td>
<td>-26.77</td>
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<tr>
<td>Urbanization rate</td>
<td>15.31</td>
<td>-0.001</td>
<td>15.07</td>
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<td>(0.001)</td>
<td>(0.822)</td>
<td>(0.001)</td>
<td>(0.700)</td>
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<td>GDP per capita (log)</td>
<td>-3003</td>
<td>0.076</td>
<td>0.593</td>
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<tr>
<td>(0.000)</td>
<td>(0.055)</td>
<td>(0.115)</td>
<td>(0.000)</td>
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<tr>
<td>GDP per capita squared (log)</td>
<td>211.2</td>
<td>212.5</td>
<td>219.3</td>
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<tr>
<td>(0.000)</td>
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<tr>
<td>GDP growth rate</td>
<td>-246.7</td>
<td>-240.1</td>
<td>-163.7</td>
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<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<td>Unemployment rate</td>
<td>-9.44</td>
<td>-0.033</td>
<td>-10.88</td>
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<td>(0.489)</td>
<td>(0.000)</td>
<td>(0.410)</td>
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<tr>
<td>Infant mortality rate</td>
<td>0.046</td>
<td>0.044</td>
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<tr>
<td>(0.000)</td>
<td>(0.000)</td>
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<tr>
<td>Total recorded theft rates</td>
<td>(-0.002)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<tr>
<td>Fertility</td>
<td>(-0.642)</td>
<td>(0.037)</td>
<td>(0.058)</td>
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<tr>
<td>Inflation rate</td>
<td>-0.007</td>
<td>-0.007</td>
<td>-0.010</td>
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<tr>
<td>(0.002)</td>
<td>(0.004)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<tr>
<td>Budget balance</td>
<td>0.138</td>
<td>0.158</td>
<td>0.211</td>
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<tr>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.000)</td>
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</tr>
<tr>
<td>Trade openness</td>
<td>0.001</td>
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131
<table>
<thead>
<tr>
<th>Investment</th>
<th>(0.641)</th>
<th>(0.671)</th>
<th>(0.919)</th>
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<td>0.011</td>
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<td>(0.804)</td>
<td>(0.842)</td>
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<td>R²</td>
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<td>0.684</td>
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<td>0.428</td>
<td>0.673</td>
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<td>0.470</td>
<td>0.653</td>
<td>0.317</td>
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Notes: p-values in parentheses based on standard errors. Constant term and country and time dummies not reported. All regression results based on 3SLS technique with annual data. Instrumented variables are in bold type. Regression (2): as regression (1) introducing values for $\pi$ below and above 20% with the use of dummies interacted with $\pi$. Regression (3): as regression (1) using as a control the second lagged value of $\pi$. 
Figure 5
Probability of Escaping Apprehension for Theft and Recorded Theft Rates