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ENVIRONMENTAL CRIME REVENUES, CORRUPTION AND MONEY LAUNDERING: THE ROLE OF THE REAL-ESTATE

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Abstract

We offer a theoretical and empirical analysis of the intertwined relationships among environmental crime revenues, corruption, and money laundering, when the illegal cleaning process is implemented via the real-estate sector. Modelling such as relationships through a logistic function, we estimate the overall environmental crime revenues using Italian regional data from 1995 to 2020.

Keywords: environmental crime, corruption, money laundering, real-estate sector, Italy

JEL codes: D7, F18, K4, R30

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1. Introduction

In recent years, environmental crime has spread globally, causing significant harm and risk to the environment and human health (European Commission, 2021). The low likelihood of punishment combined with the potential to collect huge profits make environmental crime a magnet for organized criminal groups, which have traditionally engaged in other illicit activities (Hyatt and Trexler, 1996). In many European countries (e.g., Malta, Germany, Sweden, Bosnia), environmental damages are treated as administrative offences that carry no criminal penalties, even though law-enforcement investigations confirmed decades ago that criminal organizations had begun engaging in environmental crime alongside their other criminal activities (Colantoni et al., 2022; Europol, 2022). Other countries (e.g., Hungary, Italy, Spain) are oriented towards the penal code. In the United States, where environmental crime is labelled "white-collar" crime, the government has implemented a complex scheme of statutes and introduced an agency (the Environmental Protection Agency – EPA) to regulate activities that affect the environment.

These differences make the definition of environmental crime contentious and ambiguous (White, 2010). The lack of uniformity among regulations in various countries, and the resulting room for free regulatory interpretation, facilitates the commitment of environmental crime. However, the international community has recently begun to focus on transnational environmental crime. In 2010, the United Nations Office on Drugs and Crime (UNODC) included environmental crime among the types of crime worthy of attention in its Transnational Organized Crime Threat Assessment. In fact, it devoted a whole chapter to this issue (United Nations Office on Drugs and Crime, 2010). In the 2009 Annual Report, the UNODC's Executive Director Antonio Maria Costa wrote: "the Office is stepping up its work against other emerging forms of crime, like environmental crime" (United Nations Office on Drugs and Crime, 2009; Elliot, 2012). In 2012, INTERPOL took some actions that highlighted its concerns about the extent of environmental crime and its connection to other organized crimes (INTERPOL and UNEP, 2012).

Nevertheless, much remains to be done to counteract environmental crime. To date, one of the main challenges for law enforcement remains the identification of the organized crime groups behind environmental offences (Europol, 2022).

In this paper, we focus on one possible scheme behind environmental crime, and identify a common thread with other crimes, such as corruption and money laundering (see Figure A1).

The nexus between corruption and environmental crime is recognized at the institutional level and in the economic literature. However, the relationships among environmental crime, corruption and money laundering - especially in the real-estate sector case - remain opaque. We shed light on this link and make two contributions to our extant knowledge. First, we observe how it is possible to categorize environmental crimes into two groups: those that generate illegal profits that require money laundering into legal activities (such as illegal waste disposal or the illegal trade in ozone-depleting substances) and those that can also be used to facilitate money laundering, such as arson, illegal logging, deforestation, and illegal building. With reference to the first type of environmental crimes, the behavior of criminals can be like that of other crimes, such as drug trafficking, prostitution, and smuggling. In the second type environmental crimes cease to be predicate crimes and become instrumental in carrying out activities to clean up dirty money coming from other crimes.

Corruption plays a key role in performing environmental crimes and precisely we identify two phases. Initially, corruption serves as a gateway to an environmental crime (the start-up phase). The

profits resulting from environmental crime can create demand for money laundering. We suggest that the real-estate sector may serve as a money-laundering channel in this regard.

Corruption plays a key role in facilitating complex money-laundering schemes. Given the necessity of hiding their "dirty" money, criminals may corrupt financial institutions in order to minimize the probability of being detected, thereby increasing the effectiveness of money laundering (Barone et al., 2022; Dalla Pellegrina et al. 2022). Moreover, money laundering through the real-estate sector may involve new environmental crimes (e.g., illegal logging, deforestation for land-change use, arson, illegal building), which may be facilitated through the corruption of local officials (the re-entry phase).

Money laundering that occurs through the construction and real-estate sector is widespread in Italy, as reported by Italy's Anti-Mafia Investigation Directorate. This is the case, for example, in the Campania region, where the Zagaria clan has carried out cleaning activities in Romania through the construction sector (DIA, 2020). The Papa, Ligato and Moccia clans are also involved in money laundering through the real-estate sector (DIA, 2019; 2021b). Nevertheless, as we show in detail in section 4, this phenomenon is widespread throughout the country. In carrying out its activities, organized crime benefits from the degree of "capture" among local public administrations. The existence of a network of friendships and common interests among municipal administrators, public officials and organized crime allows for the acquisition of public contracts, the assignment of municipal assets and a failure to carry out required checks on illegal construction (DIA, 2021b).

To capture this relationship, we propose a theoretical model. We assume that the accumulated illegal capital that originates from environmental crime follows a logistic growth rate with a sinusoidally time-dependent carrying capacity. For the empirical analysis, we use custom routines written using the Python programming language and fit data gathered by Legambiente (2021) on illegal revenue gained from environmental crime.

The paper is organized as follows. After a general discussion in section 2 on actors and patterns in environmental crime, in section 3 we zoom on the dynamic links among such as crime, corruption and money laundering through the real-estate sector. In section 4, the Italian case is analysed, while the corresponding estimates are presented in section 5. Section 6 concludes.

2. Environmental Crime: Actors and Patterns

Notably, we lack a univocal definition of environmental crime, and different definitions are used in the literature and by various institutions (e.g., Elliot, 2007; Pečar, 1981; Bačić, 1999; Odar, Dobovšek and Eman, 2012; Wright, 2011). Despite the lack of a universally agreed definition, we define "environmental crime" as illegal activities that harm the environment, and are aimed at benefiting individuals or groups (including organized crime) through the exploitation of, damage to, trade in or theft of natural resources (UNEP, 2016, 2018).

The main typologies of environmental crime include illegal trade and poaching in wildlife and plants; illicit trade of hazardous waste; pollution crimes, including the smuggling of ozone-depleting substances (ODS); illegal, unregulated and unreported fishing; illegal logging and trade in timber; and illegal land clearing through the intentional destruction of vegetation (Europol, 2022). In Italy, these crimes are closely connected to the illegal cement cycle in illegal construction, the exploitation of illegal hiring in the agri-food sector ("*caporalato*"), the looting of cultural heritage, and arsons. Often, behind these environmental crimes are organized-crime organizations that have been active for many years in other illicit activities, such as drug trafficking, money laundering, corruption (with less involvement of women; Torgler and Valev, 2010) and fraud (Elliot, 2007). These organizations

began committing environmental crime as an extra source of income (Banks et al., 2008; INTERPOL, 2006, 2009; UNEP, 2018). In Italy, most environmental crimes occur in the four regions with mafia traditions: Campania, Sicily, Apulia and Calabria (Legambiente, 2021).

The involvement of organized crime is not an accident. Generally, organized crime is found where making money is possible and environmental crime is an illicit activity that can lead to profit. Therefore, many networks active in environmental crime are criminal networks (United Nations Office on Drugs and Crime, 2012). Environmental crime generates significant profits worldwide. In fact, it is the fourth-largest form of transnational organized crime (UNEP, 2018). In 2016, INTERPOL and UNEP estimated the value of environmental crime at USD 91–259 billion annually, which represented a 26% increase from the estimate in 2014 (Nellemann et al., 2016). In the EU alone, the profits of some criminal networks involved in environmental crime are estimated at millions of EUR every year (Europol, 2022). Table 1 provides some details on the size of the phenomenon and the social costs.

Table 1. Environmental Crime Size

Environmental crime	Organized crime profits	State and social costs	Source
Global environmental crime	USD 213 billion/year		United Nations (2014)
Illegal fishing, illegal mining, timber trafficking, endangered animal poaching, and trafficking in hazardous waste or ozone-depleting materials	USD 200 billion/year		Bergenas and Knight (2015)
Illegal, unreported and unregulated (IUU) fishing	USD 23 billion/year	USD 9-15 billion/year	Bergenas and Knight (2015)
Illicit mineral industry (any unlicensed mining activity)	USD 17 million/year (in Afghanistan) USD 1 billion/year (in DRC) USD 3 billion/year (in Perù)	USD 12-48 billion/year	Bergenas and Knight (2015)
Illegal logging	USD 100 billion/year	USD 250 million (Peruvian government) USD 7 billion/year (Indonesian government in 2007-2011) USD 1.9 billion/year (African government)	Bergenas and Knight (2015)
Animal poaching	USD 19 billion/year		Bergenas and Knight (2015)

Different forms of environmental crime	USD 91–259 billion/year		Nellemann et al. (2016)
Forestry crime (illegal logging and illegal land clearing)	USD 51-152 billion/year	USD 6-9 billion/year (from illegal logging alone)	For illicit proceeds: FATF (2021); INTERPOL (2019). For costs for governments: World Bank (2019)
Illegal mining	USD 12-48 billion/year		For illicit proceeds: FATF (2021); Nellemann et al. (2018)
Wildlife trafficking, illegal logging and EU fishing	USD 1-2 trillion		World Bank (2019)
Waste trafficking	USD 10-12 billion/year		FATF (2021)
Wildlife	USD 7-23 billion/year		Mitsilegas, Fasoli, Giuffrida and Fitzmaurice (2022)

Source: Own elaboration based on the cited sources

3. Environmental Crime, Corruption and Money Laundering: The Real-estate Sector

Since 2016, the international community has increasingly recognised the relationship between environmental crime and corruption in multiple international forums, including the 2016 Convention on International Trade in Endangered Species, the 2019 UN Convention against Corruption, the 2020 UN Convention against Transnational Organised Crime and priorities under the Financial Action Task Force (Micallef, 2022). Academics have also shown an interest in the effects of corruption on environmental goods and services (Lopez and Mitra 2000; Fredriksson et al., 2003; Damania et al., 2003; Lisciandra and Migliardo, 2017). The question is how corruption and environmental crime are intertwined.

Corruption may occur in two phases of the environmental-crime process. In the "**start-up phase**", organized crime commits an environmental crime. In this phase, organized crime uses corruption to facilitate its environmental crime. This relationship between crimes will be better explained in section 3.1. In the "**re-entry phase**", organized crime must "clean" the dirty money accumulated through criminal activities. One possibility is to launder the money through real estate. To do so, organized crime can commit a specific environmental crime, such as arson, illegal logging, illegal land clearing to ensure a change in land use or illegal construction. In this phase, corruption is necessary to achieve the goal. Moreover, corruption helps maximize the probability that anti-money laundering activities will be ineffective, as we discuss in section 3.2.

Therefore, there is a special relationship among corruption, money laundering and environmental crime. More specifically, they are intertwined in a dynamic process (Figure 1).

3.1 Stage One: Environmental Crime and Corruption: the Start-up Phase

Corruption and organized crime are two significant elements of environmental criminality. Environmental crime produces costs for the state (see UNEP, 2018; Europol, 2022). In addition, the threat to the environment is relevant for residents and the economic sectors tied to the focal environment. Moreover, the damage to environment produced by criminality negatively affects

sustainable development. Crime and corruption produce negative effects on waste management and related health risks as well as on forest management and conservation (Callister, 1999; Welsch, 2004; Carter, 2006; Pellegrini, 2011), and natural resources, such as wildlife and plants. Environmental crime also robs governments of income, compromises the rule of law, fosters corruption, brings violence to local communities, and puts those who work against this form of criminal activity in danger (Elliott, 2012). The negative consequences of environmental crime can also reach beyond national borders (Eman et al., 2013; Mekinc, Kociper and Dobovšek, 2015).

The perpetrators of environmental crime make the greatest use of corruptive measures to fulfil their criminal business aims (i.e., **the start-up phase**). Often, corruption acts as a "door opener" for environmental crime (Williams, 2019). Environmental crime seems to be particularly prominent in regions where corruption is high and production capacity is low (Bergenas and Knight, 2015).

Corruption may occur in conjunction with any environmental crime. For instance, in the waste sector, it may take place at several stages in the management, transboundary movement and disposal of hazardous waste, thereby affecting a variety of actors, including harbour officials, police, customs officials, traders, brokers, shipping lines, importers and exporters (Terekhova, 2012; United Nations Office on Drugs and Crime, 2012).

Although still under-researched, a relationship exists between corruption and trade in ozone-depleting substances (in contravention of domestic laws and international conventions) (Martini, 2012). Corruption is also endemic in the illegal timber trade in such countries as Indonesia, Burma, Laos and Cambodia (Elliott, 2007). Similarly, Siegel (2009, 2011, 2020) has studied the various ways in which the diamond supply chain is vulnerable to organized crime and corruption.

Duri (2020) provides an overview of corruption and environmental crime in Latin America. The low risks and high profits associated with environmental crime (illegal logging, wildlife crime, dumping and illegal transport of hazardous waste, illegal mining) have attracted organized criminal groups in Latin America that have traditionally engaged in illegal drug trafficking (Duri, 2020; Global Initiative against Transnational Organized Crime, 2016; Bargent 2014). Government officials responsible for the administration and monitoring of environmental regulations (Leitao, 2016; Damania et al., 2003, Duri, 2020) may, for instance, intentionally underestimate the negative impact of a zoning project on the environment due to the pressure of corruption. Despite the presence of strong environmental laws and policies in Latin America, their implementation remains poor in many countries. Without effective law enforcement, criminals have inflicted physical violence on indigenous communities, environmental activists and human-rights defenders who fight against environmental crime (Duri, 2020).

Notably, the phenomenon of "crime convergence" or "cross-over crime" (i.e., the intersection of environmental crime with other serious crimes, such as smuggling, corruption, fraud, tax evasion, money laundering or murder) is particularly prevalent in the Asia-Pacific region (White, 2016; INTERPOL and UNEP, 2012).

In Italy, corruption was again one of the main tools for committing environmental crime in 2021, as has been the case since at least 2010. According to Legambiente (2021), the regions that hold the record in this regard are Campania (13.3%), Sicily (13.2%), Calabria (12%), Lazio (12%) and Lombardy (10.6%).

3.2 **Stage Two: Environmental Crimes, Real Estate Money Laundering and Corruption**

When organized crime engages in illicit activities, it collects significant profits that need to be laundered.

It is acknowledged that the housing market is a primary avenue for money laundering stemming from various organized activities such as drug trafficking, prostitution, and smuggling.

The abuse of the real-estate sector has been described as one of the oldest-known ways to launder ill-gotten gains stemming from various organized criminal activities (European Parliament, 2019; OECD, 2007; FATF, 2007; Financial Crimes Enforcement Network FinCEN, 2008; ESAAMLG, 2013, Australian Government AUSTRAC, 2015). The European Parliament has reported examples of money laundering through real estate in several European Union countries, including the Czech Republic, France, Finland, Germany, Greece, Portugal and the Netherlands. Those cases have been based on information collected from the press and reports (European Parliament, 2019).

In Italy, the real-estate market is often the destination for illicit funds, according to law enforcement (La Gala, 2000). From 1984 to 2015, 6.9% of the companies confiscated from mafia-type organized crime were real-estate firms (Savona and Riccardi, 2017, p. 74).

In the United Kingdom (UK), the real-estate market is widely considered to be attractive for both legal and illicit financial flows. Regarding the latter, it is estimated that more than GBP 90 billion is laundered illegally through the UK property market each year (Willems, 2021). Illicit funds help sustain the UK's inflated property market through the purchase of homes, which are frequently left unoccupied, thereby emptying the wealthier parts of London of residents (Norton, 2019). Moreover, criminals are targeting property in university towns across the UK to launder dirty money. As reported by Chapman (2018), "Mark Hayward, chief executive of NAEA Property mark, said that investment in University towns is secure because it protects against any price downward".

In the US, the habit of paying cash for luxury residential real properties makes the real-estate market a good way to launder large amounts of money. Such purchases are common, for instance, in Manhattan, Miami, Florida, California, New York state and Texas. The Canada Revenue Agency has pointed to a risk of money laundering though real estate in several areas, including Toronto, Vancouver and Quebec. A study undertaken by the Canadian federal government has also identified charitable industries as possible targets of organized crime (Press, 2016). In Canada, moreover, nominee owners are the primary technique used to launder criminal proceeds through real-estate sector (Schneider, 2004).

Given the spread of the phenomenon, international organizations have launched projects to develop a better understanding of this issue (FATF, 2007). The economic literature has also recognized the role of the real-estate sector in money laundering (Barone, 2022; Maloney et al., 2019; Van Duyne and Soudijn, 2009; Ritzen and Nelen, 2011; Naheem, 2017; Saul and Levine, 2015; Teichmann, 2018).

Purchases of income-generating property, real-estate flips and under-invoicing are other techniques used to launder money through the real-estate sector. Maloney, Somerville and Unger (2019) provided the Ministry of Finance with a report on real-estate based money laundering in British Columbia, which included several recommendations for improving regulatory measures.

Unger and Ferwerda (2011) list 17 characteristics associated with criminal investments ("red flags") in the literature (OECD 2007; FATF 2007). McPherson (2017) and Boles (2017) underline the fact that a lax regulatory attitude towards the acceptance of large sums of cash together with anonymity

and the intensive use of shell companies has fostered the diffusion of money laundering through real-estate transactions.

But what is the specificity of environmental crimes in money laundering through the real estate sector?

The Financial Action Task Force (FATF) officially recognises environmental crime as associated with money laundering (Walters, 2013). Since 2019, the FATF has published a report focused on the laundering of money derived from this type of crime. The report shows that criminals use front and shell companies to comingle gains from environmental crime with their legitimate business accounts, and to simulate legitimate services and payments. Moreover, criminals use the formal financial system to launder dirty money from environmental crime. Other techniques used include the falsification of documentation, false invoicing, and international trade transactions to justify moving money across borders (FATF, 2021).

In 2006, the Asia Pacific Group on Money Laundering held a special seminar that looked at money-laundering issues in the illegal logging industry. It identified several problems as well as opportunities for action (Banks et al., 2008).

We assume that environmental crimes, in particular arson, illegal logging, deforestation, illegal construction, play a key role in facilitating the cleaning of dirty money through the real estate sector.

The construction of new building whether for recreational (parks), or transport (road and railway), agriculture (farm), residential (housing and settlements) and commercial (business and factories) purposes, requires an expansion of the urban area and sometimes a change in land use.

These steps can be achieved illegally through environmental crimes, such as arson, illegal logging and illegal construction. Nearly half of all tropical deforestation is the result of illegal logging undertaken to convert the use of the land to other purposes. Such destructive practices alter the natural ecosystem (Rendana et al., 2015; Sonter et al., 2017; Razaly et al., 2018; Brisman et al., 2015) contributing to climate change and its impacts, such as extreme weather, drought, resource scarcity and population movements, and have substantial negative effects on biodiversity (Walker, 2021; UNEP, 2011, 2020; Lee et al., 2015).

In Italy, the anti-mafia investigation department has carried out several investigations into cases of illegal building, illegal logging and arsons caused by organized crime (DIA, 2022b). Such attacks presumably are aimed at both securing a “service of protection” imposed on production structures, and on the management of companies attractive for money laundering opportunity that they could offer and for the revenues deriving from public funding they could enjoy (DIA, 2022a).

These cases are most common in southern Italy (i.e., in Calabria, Sicily, Sardinia and Puglia), although they also occur in central Italy, especially in Lazio. The Neapolitan Camorra through violence perpetrated by organized crime, may impact also on housing prices (Battisti et al. 2022).

3.3 Stage Three: Money Laundering, Real Estate and Corruption. The Re-entry Phase

The likelihood that these environmental crimes facilitator of money laundering can occur is higher the higher the degree of corruptibility of local officials (i.e., **the re-entry phase**).

Often, corrupt officials, including law enforcement officers, financial institutions, and private persons, are involved in illegal logging (Setiono, 2007; see also Bisschop, 2015; Callister, 1999; Contreras-Hermosilla, 2002; Palmer, 2001). For example, Smith et al. (2007) show that the weak, fragmented nature of the government during the transition from the autocratic Suharto regime in

Indonesia to a more democratic regime made it easier for illegal logging, supported by collusive corruption, to flourish.

Siebert and Elwert (2004) deal with the relationship between corruption and illegal logging in Benin. Although Benin does not seem likely to be a candidate for intense corruption in the forestry sector, it has a national timber market. In fact, an estimated 80% to 90% of Benin's timber resources are illegally logged with the consent of state forest officers (Siebert and Elwert, 2004). The effects are detrimental for the environment, climate change and biodiversity. Other studies have analysed the relationship between corruption and illegal logging in Costa Rica, Ghana, the Congo Basin, Cameroon, Honduras and Nicaragua, Vietnam, and Russia (Miller, 2011; Teye, 2013; Piabuo et al., 2021; Alemagi and Kozak, 2010; Richards et al., 2003; Sikor and Xuan To, 2011; Vandergert and Newell, 2003; Stoecker and Shakirova, 2013).

Corruption in the land sector can generally be characterised as pervasive. Findings from a 2009 Transparency International survey suggest that government bodies that oversee the land sector are one of the public entities most plagued by service-level bribery. Moreover, Transparency International suggests that there is a strong correlation between corruption in the land sector and overall public sector corruption in a country (Transparency International, 2011, 3). Transparency International's 2013 survey notes that "around the world, one in five people report that they had paid a bribe for land services" (Transparency International, 2013, 11).

Organized crime can establish effective control over local communities by posing as an alternative form of authority and taking advantage of weak governmental institutions and law-enforcement agencies (Emmers, 2002; Elliott, 2007). Countries considered to be more corrupt are likely to have fewer environmental guidelines in place, have less land protected and participate in fewer international environmental agreements (Williams and Dupuy, 2017). Corruption not only exacerbates environmental degradation but also contributes to poverty and food insecurity in local communities, where basic needs, such as access to clean water, adequate housing, good sanitation, and basic healthcare (Martini, 2012; Leitao, 2016), are often not met.

Several types of corruption activities are used to influence the decisions of local politicians. For instance, local communities, influenced by organized crime, use opaque environmental-/urban-planning procedures to change farmland into building areas. Under the pressure of corruption and organized crime, natural resources, cultural and historic heritage, national parks, and the general common good, which should be protected by urban planning laws, are exploited (Mekinc, Kociper and Dobovšek, 2015; Cole, 2007). A great deal of empirical research analyses the role of corruption in many countries' construction and natural-resource sectors (Neu et al., 2015, Kolstad and Søreide, 2009; Williams and Dupuy, 2017; Dougherty, 2013, 2015; Paliwal, 2006; Branis, 1994; Momtaz, 2002). In the environmental impact assessment stage of a project, there is a risk of corruption, such as bribery aimed at encouraging assessors to downplay the negative impact on the environment (Williams and Dupuy, 2017: 121; Canter, 1996; Jay et al., 2007). The illegal circuit then starts again. An example of this type of corruption is found in the Barro Blanco dam project in Panama. Such as project was nearly completed allegedly due to corruption in the government and the construction company. In that project, legally required assessments were not undertaken, and protests from local communities regarding the project's environmental and social impact were disregarded (Giraldo 2016). In Brazil, mining authorities are investigating the Vale SA mining company over a possible cover-up regarding safety procedures. The investigation was triggered by the death of more than 300 people when a dam burst at the Córrego do Feijão mine (Lima, 2019).

Moreover, once the money laundering activity has begun, corruption plays a key role in facilitating complex schemes (see Europol, 2022, p.41 and Barone et al., 2022 for an in-depth analysis of the

nexus between money laundering and corruption). The money laundering activity is costly. The costs are the technical cost of money laundering procedures and the cost of anti-money laundering regulations. The effectiveness of anti-money regulation may be undermined by corruption. A higher level of corruption makes the AML regulation less effective. Corruption can be an effective way to maximize the likelihood that anti-money-laundering activities will be ineffective, as organized crime may corrupt financial institutions – both regulators and regulated firms – with the aim of preventing crime detection and, thereby, facilitate money laundering. Therefore, the cost of the AML regulation decreases.

4. The Italian Case

Despite the enactment of Law n. 68 of May 28, 2015, in the Italian penal code, environmental crime has steadily increased in recent years in Italy. According to the annual analysis performed by Legambiente, the five regions with the highest number of crimes and charges for environmental crimes in 2020 were Campania, Sicily, Apulia, Lazio, and Calabria. Those with the lowest rates were Valle d'Aosta, Trentino Alto Adige, Molise, Friuli Venezia Giulia, and Umbria. Among the various environmental crimes (e.g., related to the waste cycle, cement, archaeomafia, crimes against fauna, fires, and atmospheric, acoustic, light and electromagnetic pollution), the most widespread are those connected to cement (i.e., development plans, land-planning exceptions and illegal construction) and illegal waste disposal.[1] These crimes, together with others such as drug trafficking, infiltration in public tenders, money laundering, extortion and usury, constitute the main areas in which organized crime is active, especially the Camorra and Cosa Nostra organized crime organizations, but also in the Pontine region.

A key example is the connections among money laundering, real estate and illegal building involving the Mallardo clan, which operates in the Neapolitan region and has activities in other Italian regions, such as Molise, Abruzzo, Lazio, Basilicata, Tuscany, and Emilia-Romagna. Various money-laundering operations are attributable to this clan (DIA, 2021a). As part of the "Domus Aurea 2" operation, the Financial Police sheds light on the investments, made by the Mallardo clan in some municipalities north of the capital (i.e., Mentana, Guidonia Montecelio, Monterotondo, Capena and Fonte Nuova), where the clan has carried out systematic purchases of land instrumental for building speculation. This has been possible due to the complacency of public officials, who allow the building of residential complexes on land with an agricultural designation, in competition with affiliates of the Casalesi. Similar cases have occurred in Caltanissetta, where the Cosa Nostra and the Stidda clans have infiltrated the socio-economic structure, especially in the real-estate sector and the waste cycle through the awarding of private and public contracts. The clan launders and reinvests illicit profits in the legal economy under fictitious headings. Similar behaviours occur in the Zagaria faction, which originates from Casapesenna. This faction has also carried out laundering activities in the real-estate sector with activities in Romania.

Illegal construction, illegal waste disposal and arson are reported by the Anti-Mafia Investigation Directorate (DIA, 2021a). Often, an arson attack reflects the will of organized crime to exercise control over a territory through acts of intimidation with the aim of satisfying interests linked to building speculation, poaching or arable land expansion. This was the case, for example, for the Emilian 'Ndrangheta consortium, which carried out various malicious acts to seize several business

[1] For an in-depth analysis of this environmental crime as well as its relationship with environmental policy enforcement and monitoring efforts, see D'Amato et al. (2018) and Dell'Anno et al. (2020).

activities registered to compliant frontmen in the real-estate, transport and catering sectors. Building speculation also often involves the crime of unauthorized construction.

The spread of this phenomenon is facilitated by the involvement of politicians and local officials, who fail to carry out checks, do not sanction such crimes and do not stop them. This is often the case in southern Italy, where 48.7% of confirmed crimes are concentrated (Legambiente, 2021) and where the percentage of building demolitions is clearly lower than in northern Italy.

From a legislative point of view, some progress was made with Parliament's approval of law n. 120 of September 11, 2020, art. 41 (L). The law assigns the prefectures the task of proceeding with the demolition of illegal buildings if the municipality does not intervene within 180 days of the discovery of an abuse.

Typically, the problem in the enforcement of the law in relation to cement crimes lies in the complicity of local politicians. In the illegal cement cycle investigations conducted by the Organized Crime Investigation Group (GICO) of the financial police, the involvement of public officials and municipal officials, who are sometimes connected to organized crime, stands out. In 2022 alone, investigations were conducted by the fiscal police of Messina against the Municipalities of Moio Alcantara and Malvagna – centres in the Ionian belt of the Peloritan province – which are connected to the Sicilian Cosa Nostra (Ministero dell'Economia e delle Finanze, 2022). Moreover, the "Cumbertazione" and "Waterfront" operations were carried out by the Economic and Financial Police Unit (PEF)/GICO Unit of the financial police of Reggio Calabria and the Central Organized Crime Investigation Service (SCICO) of Rome in 2021. These operations involved the seizure of assets held by a former public official valued at approximately EUR 700,000 (Ministero dell'Economia e delle Finanze, 2021a). Other cases of public officials' involvement in cement-related crimes not strictly connected to the mafia were seen in in the "Fantasia al Potere" and "Bad Village" operations (Ministero dell'Economia e delle Finanze, 2021b, 2021c).

Table 2 covers the illegal construction rate based on data provided by Italian National Statistics Institute (ISTAT). Moreover, Table 3 shows the average number of municipalities dissolved by the mafia from 1991 to 2021.

Table 2. Illegal Construction Rate, Italy, 2004-2021

NUMBER OF ILLEGAL BUILDINGS FOR EVERY 100 AUTHORIZED	AVERAGE VALUE	MEDIAN VALUE
REGIONS		
Piedmont	4.69	4.60
Valle d'Aosta/Vallée d'Aoste	4.69	4.60
Liguria	12.76	13.15
Lombardy	4.83	4.60
NORTHWEST	6.74	4.60
Trentino-Alto Adige/Südtirol	2.35	2.40
Veneto	5.67	5.60
Friuli-Venezia Giulia	2.66	2.50
Emilia-Romagna	4.86	4.55

NORTHEAST	3.89	3.52
Tuscany	9.66	9.95
Umbria	13.23	13.71
Marche	11.04	12.45
Lazio	15.51	12.85
CENTER	12.36	12.65
Abruzzo	27.49	28.95
Molise	43.76	35.83
Campania	54.13	55
Apulia	28.84	24.75
Basilicata	43.84	49
Calabria	49.56	51.5
SOUTH	41.27	42.42
Sicily	45.55	45.25
Sardinia	21.74	21.25
ISLANDS	33.65	33.25
Italy	14.73	14.73

Source: Own elaboration based on equitable and sustainable well-being data from ISTAT

Table 3. Share of Municipalities Dissolved by Mafia, 1991-2021

MUNICIPALITIES DISSOLVED BY MAFIA FROM 1991 TO 2021	NUMBER	% OF THE TOTAL
REGIONS		
Piedmont	3	0,009
Valle d'Aosta/Vallée d'Aoste	1	0,003
Liguria	2	0,006
Lombardy	1	0,003
NORTHWEST	7	0,021
Trentino-Alto Adige/Südtirol	0	0,000
Veneto	0	0,000
Friuli-Venezia Giulia	0	0,000
Emilia-Romagna	1	0,003
NORTH EAST	1	0,003
Tuscany	0	0,000
Umbria	0	0,000
Marche	0	0,000
Lazio	1	0,003
CENTER	1	0,003
Abruzzo	0	0,000
Molise	0	0,000
Campania	103	0,307

Apulia	21	0,063
Basilicata	2	0,006
Calabria	115	0,343
SOUTH	241	0,719
Siciliy	85	0,254
Sardinia	0	0,000
ISLANDS	85	0,254

Source: Own elaboration based on Openpolis (2021) data

5. The Model

In this section, we analyse the behaviour of a criminal who has committed an environmental crime, achieving a profit I_0 at time $t = 0$. Legambiente (2021) estimates that the illegal capital derived from environmental crime ranged from EUR 8 billion to EUR 22.6 billion annually from 1995 to 2020.

A share "θ" of the capital derived from environmental crime needs to be laundered. This behaviour is common to several crimes, but when the money laundering activity takes place through the real estate sector, environmental crimes play a key role as facilitators of the clean-up activity. Therefore, the share "θ" is influenced by the transaction costs associated with the probability of crime discovery and, therefore, incrimination, and by the opportunity to launder through the real-estate sector (including illegal construction, especially in coastal areas). Given these microeconomic decisions, we consider the share "θ" that the criminal decides to launder, as proxied by the degree of illegal construction. A share "γ" of the laundered money will be reinvested in the illegal market at the illegal interest rate "r_i" where it will be used to carry out a new environmental crime. This percentage is increased by the degree of environmental corruption as follows: to the corresponding average environmental corruption for the period 1991 to 2021, we add the number of municipalities dissolved by the mafia in each region divided by the total number of infiltrated municipalities.

At the same time, a portion "$(1 - \theta)$" of illegal capital must be reinvested in the illegal market prior to being laundered and, consequently, spent on consumption goods and invested in the legal and illegal market. Reinvestment in criminal markets is an increasingly common feature of organized crime groups given their tendency toward specialization. Organized crime tends to acquire specialized functions to improve the profitability of illegal businesses.

Based on Barone et al. (2022), we can assume that the growth of environmental-crime capital must have limits, which implies that a sound description can be made using a logistic growth path, rather than an exponential path. The logistic function states that the growth rate decreases as the illegal capital increases. In other words, the hypothesis of a saturation effect (or "carrying capacity") for a maximum amount of illegal capital that the corresponding market can sustain is valid. This perspective is based on two different, but consistent, motivations.

First, the standard theoretical assumption that growth in output, capital and labour go hand in hand and follow an exponential path cannot be taken for granted. The underlying motivation is as follows: when demand is increasing, the market's capacity to match that growing demand may be limited ("market saturation"), such that capital growth eventually encounters constraints (Knyviene et al., 2010; Koltan et al., 2013). In other words, market saturation triggers maximum capital capacity. Scientists have empirically proven that by extending the Sato exponential growth model, it is possible to derive a logistic model to replace the traditional Cobb-Douglas production function. That

model better fits the data (Aoki and Yoshikawa, 2002; Girdzijauskas et al., 2012; Smirnov and Wang, 2020).

Notably, economists only recently began to apply the logistic function (Englmann, 1994; Reati, 1998; Foster and Wild, 1999). Kuznets (1930a) found that the logistic function described long-term movements of growing industries (for an in-depth analysis of S-shaped growth paths in technological innovation, see Andersen, 1999; Griliches, 1957; Mansfield, 1961; Metcalfe, 1981, 2003). Andersen (1999) used Kuznets' (1930b, 1940) research on the technology growth cycle and synthetized it with Schumpeter's (1939) views to prove that the evolution of technological growth tends to follow a logistic curve. The diffusion of new technologies as well as demographic, scientific, political, and cultural advancements drive economic growth.

Boretos (2009) fitted the world's real GDP to a logistic curve. Following Modis's (1993) seasons metaphor, the author divided the logistic curve into five seasons of equal duration: winter, spring, summer, fall and another winter. Technological advancements and innovation are evident in the spring, which is characterized by high growth. In the summer, the growth rate is steady, and it is the time to harvest the fruits of previous years' innovation and investments. Thereafter, in the fall, a period of saturation follows as well as a decrease in the growth rate. In other words, market saturation limits capital accumulation and its growth decelerate. The latter winter is a period of low growth as well as novelty.

Second, the concepts of market saturation and maximum capital capacity have already been applied to explain the relationship between business cycles and growth in illegal activities. Such studies have also taken the probability of detection and sanction into account (Barone et al., 2018). However, there are many situations in which the carrying capacity changes over time. It may depend, for instance, on variations in the number of criminals, changes in the regulatory system or innovation in the technologies criminals' use.

On the one hand, corruption opens the door for environmental crime. On the other hand, competition among corruptors increases both cases of corruption and corruption pricing (Barreto, 2000; Beets, 2005). All else equal, anti-corruption attitudes are likely to increase, which triggers an increase in the probability of detection. Multiple drivers can explain different levels of anti-corruption attitudes with its ups (e.g., whistleblowing) and downs (e.g., endemic corruption). For example, the literature devotes a significant amount of attention to the relationship between corruption and culture, or religiosity (Paldam, 2001; Liu, 2016; Beets, 2007; Kingston, 2008; North et al., 2013; Barr and Serra, 2010; Samanta, 2011). Moreover, a decrease in corruption reduces the possibility of illegal construction and speculation. However, the endemic nature of corruption means that this positive effect of counteraction policies will be a short-term phenomenon (Damania et al., 2004; Ventelou, 2002), after which corruption will once again open the door to new crimes.

To capture this path for environmental crime's profits, we assume that the carrying capacity is time dependent and that it is sinusoidally variable. This hypothesis is interesting in economics because many growth processes are cyclical in nature. For example, Goodwin (1946) used the sine curve to analyse the role of variations in exciting expenditures in the irregularity of the economic cycle. Later, Goodwin (1967) reasoned about how to integrate the growth theory and the cycle theory. He found the solution in the models of Lotka (1926) and Volterra (1926).

The general solution to the problem of time dependent carrying capacities is given by:

$$I(t) = \frac{I_0 e^{\alpha t}}{1+\alpha I_0 \int_0^t \frac{e^{\alpha z}}{I^*(z)} dz}. \quad (1)$$

Considering the case in which the carrying capacity is sinusoidally variable over time, we have the following equation for $I^*(t)$:

$$I^*(t) = I_0^* + I_a \sin \omega t, \tag{2}$$

in which I_0^* is the average value of the carrying capacity, while I_a is the amplitude of the carrying capacity. The frequency of the oscillation is $\omega = \frac{2\pi}{T}$, where T Is the period of oscillation.

We assume that the growth coefficient, α, is constant with $\alpha = \ln\ [\gamma\theta(1-C) + (1-\theta)]\,(1 + r_i)$, where C is the cost of money-laundering activities. By substituting (2) into (1), we obtain:

$$I(t) = \frac{I_0 e^{\alpha t}}{1+\alpha I_0 \int_0^t \frac{e^{\alpha z}}{I_0^* + I_a \sin \omega z} dz}. \tag{3}$$

Equation (3) can be rewritten as:

$$I(t) = \frac{I_0 e^{\alpha t}}{1+\alpha \frac{I_0}{I_0^*} \int_0^t e^{\alpha z}\,(1+\frac{I_a}{I_0^*} \sin \omega z)^{-1} dz}. \tag{4}$$

At this point, if the ratio $\frac{I_a}{I_0^*}$ is small compared to unity, we can take advantage of the binomial series expansion:

$$(1+z)^{-1} = 1 - z + z^2 - z^3 + \cdots \tag{5}$$

After neglecting the quadratic and higher-order terms, Equation 4 becomes:

$$I(t) \cong \frac{I_0 e^{\alpha t}}{1+\alpha \frac{I_0}{I_0^*} \int_0^t e^{\alpha z}\,(1-\frac{I_a}{I_0^*} \sin \omega z) dz}. \tag{6}$$

After some rearrangement, the solution of the integral is:

$$\int_0^t e^{\alpha z}\,(1 - \frac{I_a}{I_0^*} \sin \omega z)\, dz = \left[\frac{e^{\alpha z}}{\alpha^2+\omega^2}(\alpha \sin \omega z - \omega \cos \omega z)\right]_0^t. \tag{7}$$

In other words:

$$\int_0^t e^{\alpha z}\,(1 - \frac{I_a}{I_0^*} \sin \omega z)\, dz = \frac{\omega}{\alpha^2+\omega^2}\left[\frac{e^{\alpha t}}{\omega}(\alpha sin\omega t - cos\omega t) - 1\right]. \tag{8}$$

Therefore, the equation for illegal capital produced by environmental crime is:

$$I(t) \cong \frac{I_0^*}{\left(\frac{I_0^*}{I_0} - \frac{I_a}{I_0^*}\frac{\omega\alpha}{\omega^2+\alpha^2} - 1\right)e^{-\alpha t} + \left[1 - \frac{I_a}{I_0^*}\frac{\omega\alpha}{\omega^2+\alpha^2}\left(\frac{\alpha}{\omega}\sin \omega t - \cos \omega t\right)\right]}. \tag{9}$$

6. The Empirical Analysis

With regard to the growth factor, we note that the choice of the share of illegal capital that needs cleaning ("θ") depends on the probability of discovery and prosecution of the crime and, in this study, on the possibility of laundering through the real estate sector, therefore also on the possibility of carrying out illegal buildings.

According to Walker (2007) the percentage of dirty money that the criminal decides to launder depends on the country of reference and varies between 5% and 83%.

Smekens and Verbruggen (2004) suggest that for the proceeds of drug trafficking this share amounts to 75%, while for other crimes it is much lower. To provide a conservative estimate, we considered a minimum threshold equal to 50%, to which we added the degree of illegal building in Italy, which amounts to an average value of 15%.

"γ" is the share of illegal capital reinvested in the illegal sector at the rate "r_i". Based on the literature (see Unger, 2007) this shares amounts to 32% of the total illegal capital.

In this study this percentage is increased by the degree of "capturability" of local officials, measured by the number of municipalities dissolved by the mafia in Italy and the environmental corruption index ($\gamma = 0{,}32 + 0{,}05 + 0{,}04$).

Laundering activities are not free. Moreover, their costs may be influenced by corruption (Barone et al., 2022, defined this relationship as the "accelerator effect"). FATF (2011) reports several cases of weakness in financial institutions' due diligence related to allowing suspected proceeds of corruption to flow freely through accounts.

To take this relationship into account, Barone et al. (2022) assume that the cost, C, of money-laundering activities is composed of two parts: the technical cost, C_0, of money-laundering procedures and the cost, R, of anti-money laundering regulations. The latter can be affected by corruption – a higher level of corruption makes the anti-money laundering regulation more ineffective. Therefore, the cost of the anti-money laundering regulation R decreases. According to Barone et al. (2022), the cost of anti-money laundering regulation or the actual probability of being discovered "R" is equal to 0.46, while the "*de jure*" probability of being discovered is equal to 0.94.

Table 4. Model parameters and their sources

PARAMETERS	SOURCE
$\boldsymbol{\theta = 0.65}$ (share of illicit capital to be laundered)	Own elaboration based on data in Smekens and Verbruggen (2004), Walker (2007), and ISTAT (2022)
$\boldsymbol{\gamma = 0.36}$ (share of the laundered money reinvested in the illegal activity)	Own elaboration based on data in Unger (2007), Openpolis (2021) and Legambiente (2021)
alpha	Result of fit calculations
$\boldsymbol{C_0 = 0.1}$ (technical cost of money laundering)	Reuter and Truman (2004); Barone and Masciandaro (2011)
$\boldsymbol{R = 0.46}$	The actual probability of being discovered (the de facto anti-money laundering cost)

$I^* = €\ ?$ billion (the carrying capacity of the illegal revenue arising from environmental crime)	Result of fit calculations
I_0 (the starting illegal revenue arising from environmental crime)	Result of fit calculations
a (the amplitude of the sine wave)	Result of fit calculations

Source: Own elaboration based on the empirical analysis and the economic literature

Using the Python programming language, we developed a code that performed a logistic fit with a sinusoidally variable carrying capacity against the data we collected from Legambiente (2021). To account for some noise in Legambiente's (2021) data, we introduced a background parameter constant in the model.

The Python code uses standard SciPy and NumPy library functions.[2] To perform the fit, we considered the general equation (4) and left out the simplification of the parameters because we initially had no information about the values of I_a and I_0^*. According to the fit calculation (Figure 1), 1944 is the starting time (t_0) of the hoarding process; the environmental crime illegal capital (I_0) is worth EUR 2.042 billion; the growth rate α is equal to 0.192; the frequency of the oscillation ω is equal to 0.34; the average value of the carrying capacity (I_0^*) is equal to EUR 22.710 billion; and the amplitude of the carrying capacity I_a is EUR 17.408 billion.

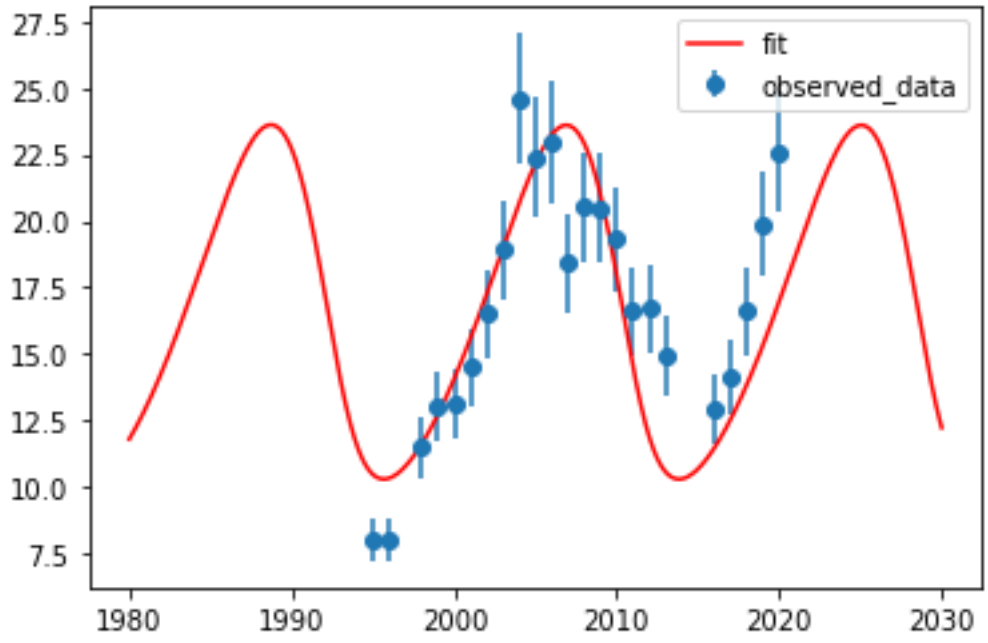


FIGURE 1 Cumulative illegal environmental crime capital – logistic path with sinusoidally variable carrying capacity

As a robustness check, we tested whether the predicted values of illegal capital derived through environmental crime and observed values could originate from different distributions (H_1) or not

[2] SciPy is a library of numerical routines that provides fundamental building blocks for modelling and solving scientific problems. It is built on top of NumPy, which provides array data structures and related fast numerical routines (see Virtanen et al., 2020, for more details).

(the null hypothesis, H_0). To answer this question, we used Welch's t-test. The specification passed the test with a result of 0.55 and a p-value of 0.58.

Moreover, we performed a chi-squared test that used the following null and alternative hypotheses:

H_0: A variable follows a hypothesized distribution.

H_1(alternative hypothesis): A variable does not follow a hypothesized distribution.

The statistic of the test is $3.8\overline{3}$, with a p-value of 0.429. As the p-value is not less than 0.05 (the confidence interval is 95%), we fail to reject the null hypothesis. This means we do not have sufficient evidence to say that the distribution of observed data is different from the distribution of the fit.

To evaluate the accuracy of the other estimated parameters of the logistic fit, we generated 1,000 synthetic residuals. These residuals were sampled from the (normal) distribution of the true residuals, calculated as the difference between Legambiente's (2021) data (corrected with a margin of error of 10%) and the fit. Then, we obtained values from the fit functions for each of the 1,000 times between 1995 and 2020. Finally, we generated 1,000 synthetic observations (Figure 2) summing the 1,000 fit values and the synthetic residuals. Thereafter, using the bootstrap method, we sampled a subset of 100 random synthetic observations and, for each of those observations, we again undertook the fit calculations. We obtained 100 different estimations for each fit parameter and then calculated a 95% confidence interval for each of them. This procedure provided us with an error margin for each of the parameters estimated by the fit calculations. More specifically, for the parameters, we obtained the following margins of error:

$$I_0 = 2.042 \pm 0.066,$$

$$t_0 = 1944 \pm 1,$$

$$\alpha = 0.192 \pm 0.019,$$

$$I_0^* = 22.710 \pm 1.299,$$

$$\omega = 0.346 \pm 0.003,$$

$$I_a = 17.408 \pm 2.060 \text{ and}$$

$$K = -2.076 \pm 0.104.$$

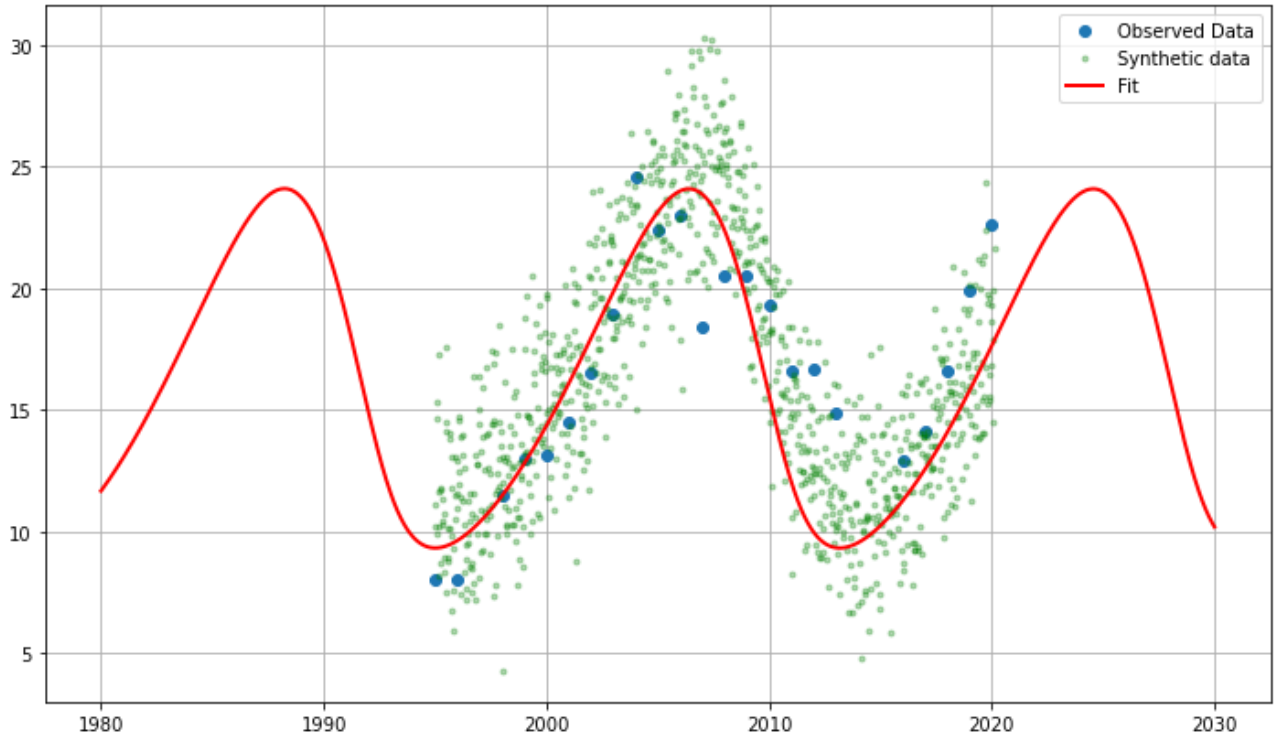


FIGURE 2 Cumulative illegal environmental crime capital obtained from the fit parameters, 1980 to 2030. The figure shows the logistic curve with a sinusoidally variable carrying capacity for the illegal capital accumulated through environmental crime.

According to the results of the fit we observe that the frequency of the sinusoid ($f = \omega/2\pi$), i.e. the number of times that the criminal pattern is repeated, is very low ($f = 0{,}055 years^{-1}$). It follows that the minimum time interval after which the wave repeats itself is almost 18 years. The criminal behaviour is therefore rather slow.

7. Conclusion

In recent years, the spread of globalization and the use of the internet have created new opportunities for organized crime. Beyond their traditional criminal activities, these criminal organizations began to commit environmental crime to derive extra profit. In many European Union member states and abroad, environmental offences do not yet fall within the framework of the penal code. Therefore, the low risk of incrimination and the opportunity to benefit financially attract criminals.

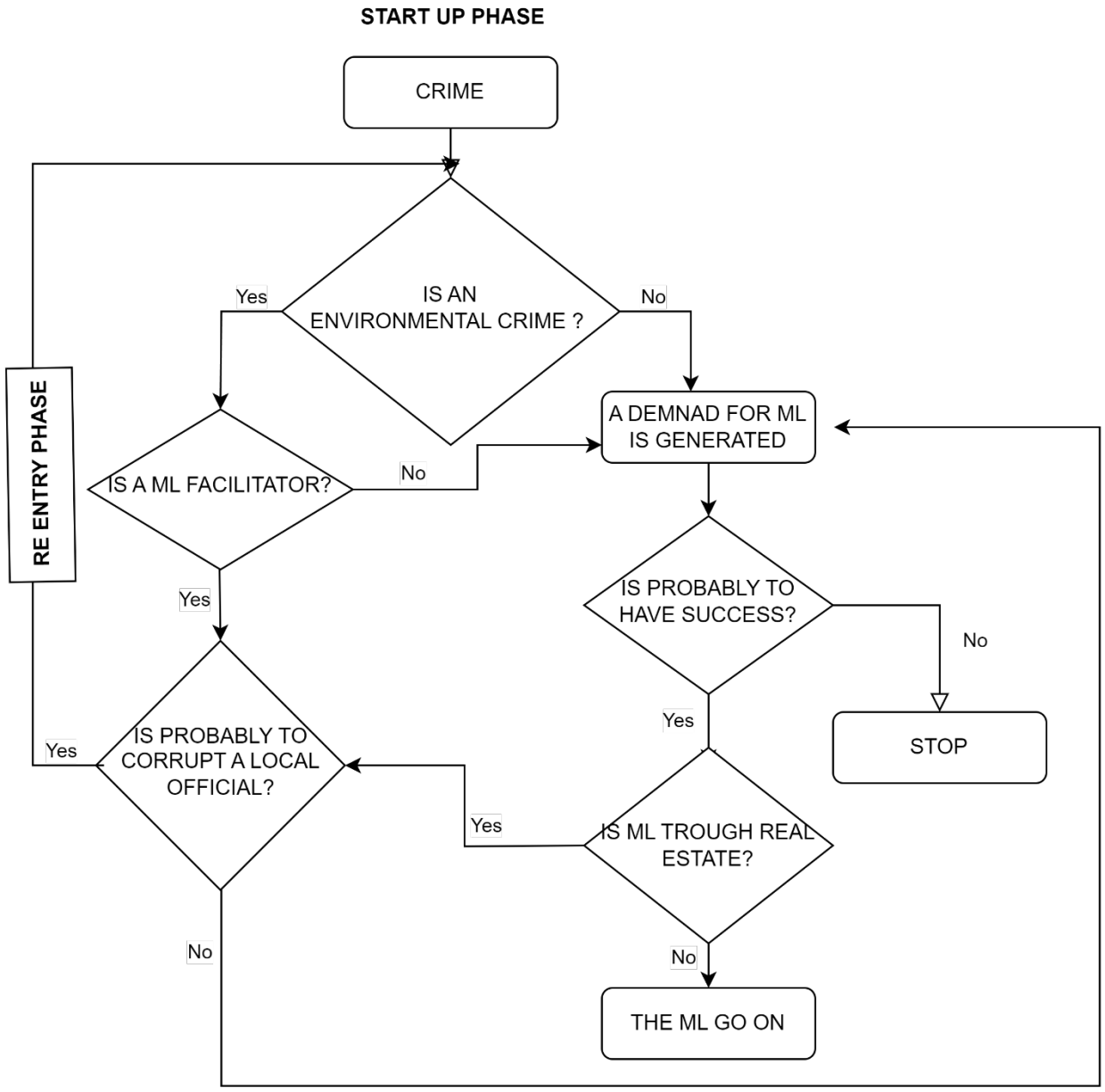
Despite the improvements in environmental law, one of the main challenges for law enforcement remains the identification of the organized crime groups behind environmental offences. Moreover, while legislative uncertainties can contribute to the spread of the phenomenon, they can also be a consequence of it, as the costs of implementing some forms of legislation might exceed the benefits of crime reduction.

The results of the empirical analysis show that the illegal capital resulting from environmental crime is growing slowly and it appears that the phenomenon has not yet "exploded". We see two possible explanations. First, some environmental crimes are likely to be local or national phenomena with few international connections, unlike other crimes, such as arms and drug trafficking, or prostitution. Second, the money-laundering activities associated with environmental crime are less cash-based than for other financial crimes. In the case of environmental crime, these activities

require more formal legalization – a practice requiring the involvement of public officials and, therefore, corruption. In this regard, policy measures should be more oriented towards prevention of the phenomenon than towards repression. One possible solution may be the more frequent rotation of staff.

Appendix

Figure A1: Environmental crime, money laundering and corruption scheme



Source: *own elaboration*

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