TECHNOLOGY AS AN ECONOMIC AND FINANCIAL CRIME DETERMINANT - A QUADRATIC APPROACH FOR THE EUROPEAN UNION

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Abstract
The purpose of this paper is to investigate the influence of various technology proxies on the size of the economic and financial crime. Our study uses data for the member states of the European Union throughout the 2005-2022 time-period. The methodology involves a linear and a quadratic approach of the data as well. This study demonstrates a nonlinear (quadratic) relationship between digitalization and economic and financial crime in the European Union, highlighting the existence of a threshold beyond which technological development reduces crime. Several robustness assessments show that our major findings are generally stable to alternative model specifications and proxy variables. This study might be extremely useful to states' decision-makers, governmental organizations and non-governmental enterprises. Our findings highlight the importance of advancing digital infrastructure alongside regulatory and institutional capacity to effectively combat technology-enabled crime.

Keywords
corruption, shadow economy, money laundering, information and communication technology, digitalization

JEL Classification
K42, O33, C23

Introduction

The fight against economic and financial crime has been an ongoing phenomenon in the business domain since forever. This complex circumstance generated countless attempts to investigate, combat and punish these illegal affairs. It's our firm belief that the continuous uprising information and communication technologies of the current digital revolution have a great impact and may serve as a leverage upon shaping the prevalence of such criminal activities.

The shift towards digitalizing government operations and the widespread use of electronic transactions have opened doors for cybercrimes and electronic fraud, adding layers of

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complexity to the landscape of corruption. With societies becoming increasingly dependent on technology for governance, commerce, and communication, the weaknesses of digital systems can be manipulated by corrupt individuals to undermine democratic processes, subvert regulatory structures, and diminish public confidence in institutions. Therefore, the impact of technologies on corruption underscores the importance of adopting proactive measures to mitigate risks. This paper aims to provide an insight on the influence that technologies hold on European member states. The goal of the various technological methods is to target the reduction of corruption: gathering and monitoring information in order to prevent abuses and individuals that conceal illicit activities in the public sector. These methods of combat are in a continuous process of development and innovation. The intersection of technology and corruption underscores the need for a multifaceted approach that leverages technological advancements to strengthen anti-corruption efforts while also addressing the evolving challenges posed by digitalization. Wickberg (2013) offers several instances of diverse technology advancements aimed at mitigating the phenomenon of corruption: technology is used to report corruption and administrative abuses as well as to make it easier for people to file complaints about bribery and electoral fraud through websites, hotlines, or phone apps. In addition, it is also used to keep an eye on public budgets, social services, politics, the judiciary and illegal logging. Finally, it is used for large-scale data collection, advocacy, social mobilization, and citizen-government interaction. E-government initiatives like e-procurement, e-judiciary, e-taxation, and electronic identification offer significant advantages in streamlining government processes and enhancing citizen engagement. However, these improvements also introduce new vulnerabilities to digital fraud. Gogolin (2010) argues that the universality of digital crime is not solely attributable to a lack of resources or physical infrastructure. Most likely it often stems from the inability of institutions to keep pace with the evolving landscape of digital skills required to combat these sophisticated cyber threats. Significant investments in training and upskilling personnel are crucial to effectively safeguard these e-government systems.

This subject is present in each area of expertise especially when talking about the financial and economic field of activity in our contemporary society. Our study is relevant as it aims to contribute to the understanding of the emerging trends and vulnerabilities in the face of evolving technologies. Using a multivariate data approach for the nexus between technology and economic crime, we aspire to add to the current state of the art in regards to the preventive tactics that would help to keep up with the quickly changing threat environment in a world that is becoming more and more digitalized. Due to the widespread use of digital currencies, online transactions and linked financial networks, conventional criminal activities have changed and evolved into taking advantage of loopholes in these systems. The growing dependence of individuals, organizations and governments on digital technologies for financial transactions and data storage exposes them to a multitude of cyber risks and vulnerabilities. More than ever, European government policies should focus on the importance of cybersecurity that protects against economic and financial crimes.

This paper aims to address the lack of evidence on the nonlinear impact of digitalization on economic and financial crime in the European Union. Although existing studies examine the relationship between technology and corruption or cybercrime, most of them assume a linear effect and focus on isolated aspects of digitalization. There is limited empirical evidence on the potential nonlinear (quadratic) relationship between ICT development and economic and financial crime, particularly within a comprehensive panel of European Union countries. Addressing this gap is important, as the impact of digitalization may evolve across different stages of technological development. Our choice to investigate how technology impacts economic and financial crime stems from the recognition of how it is contouring our modern society. Based on this framework, the study tests the following hypothesis: H: *Technology (ICT/digitalization) impacts economic and financial crime in an asymmetrical manner*. We have structured the remainder of this paper as follows: a literature review to cover the current state of the art, a description of the research methodology we employ, our main results and their discussions, supported by a series of robustness checks and some conclusions in the end.

1. Review of the scientific literature

The literature review explores the multifaceted relationship on how technology influences corruption, the shadow economy and money-laundering. Different definitions have been applied to economic crime. It has been described as an unlawful conduct typically carried out by deceit or distortion by an individual with certain professional or technical skills in order to obtain financial advantage for themselves or their business, or to obtain an unfair advantage over another person or institution (Agu, 2013). While digital advancements have undoubtedly revolutionized financial systems, they have also created new avenues for illegal activities.

Over the years, several studies have analysed the determinants of corruption, mainly based on the historical and economic factors that could have a meaning in diagnosing the causes and commenting the effects of this phenomenon. The capacity of technology to create a transparent and potentially safe environment fosters new avenues for corruption to manifest. Adam and Fazekas (2021) illustrate that Information and Communication Technology (ICT) can enhance transparency by encouraging openness and accountability and promoting the involvement of government-citizens interactions. Dey and Saha (2025) directly link ICT development with both subjectively assessed corruption and control of corruption. However, ICTs also present new potential for corruption through the means of dark web, cryptocurrencies and improper utilization of instruments such as centralized databases. Traditionally, corruption was based on physical interaction and exploiting loopholes in bureaucratic fields. However, the rise of e-government and online transactions has opened new ways for its exploitation.

The public sector has become more difficult to be controlled when it comes to corruption. A multitude of studies have established a strong correlation between corruption and hindered economic development. Mauro (1995) as well as Tanzi and Davoodi (1998) point towards corruption's detrimental effect on both domestic and foreign investment. This lack of investment ultimately restricts economic growth, as evidenced by Mauro (1995), Mo (2001), and Tanzi and Davoodi (1998). Furthermore, corruption has been linked to a worsening of fiscal deficits, increased inequality, and heightened poverty levels (Gupta et al., 2002; Jong-Sung and Khagram, 2005; Alesina and Angeletos, 2005; Glaeser and Saks, 2006; Apergis et al., 2010; Oto-Peralías et al., 2013). In order to better address the corruption phenomenon, political rulers must ascertain its root causes. Some research indicates that there is a direct correlation between the amount of money invested in technology and the extent of financial and economic crime. In addition to providing benefits for the business, the employment of contemporary technologies attracts fraudsters who exploit them for financial gain through cybercrime.

Tax evasion and other financial crimes have constituted themselves as sources of dirty money that criminals attempt to conceal in the financial system. Tax administrations thus can combat tax crimes while identifying and discouraging money laundering. Via the commission of crimes like theft, investment fraud, extortion, drug trafficking, human trafficking, embezzlement, corruption, and tax fraud, criminals amass substantial quantities of money (Agu, 2013). The digital revolution has fundamentally reshaped the landscape of tax evasion, creating the concept of the "digital shadow economy" (Remeikiene et al., 2018). This clandestine ecosystem flourished online, exploiting the anonymity and ease of access offered by technology. The proliferation of digital connectivity allows cybercriminals to execute operations from significant physical distances, frequently assuming different identities and leveraging jurisdictional disparities to evade detection. This exploitation of advanced information and communication technologies poses substantial challenges to law enforcement, as the rapid cross-border nature of these offenses often exceeds the efficacy of traditional, domestically oriented policing frameworks (Broadhurst, 2006).

Summing up, there are two facets for the impact of technology upon the economic and financial crimes. Although it presents new opportunities for illicit activities, it also provides instruments for more effective detection and avoidance, thus ICTs may represent both a direct and an indirect determinant of economic and financial crime phenomena. By fostering collaboration between law enforcement, regulatory bodies, and the sector of technology, governments can harness these advancements in order to create a more secure and robust financial system. Collaborative efforts can lead to the development of innovative solutions that leverage ICTs to disrupt criminal activity, such as blockchain analysis tools for tracing illicit funds and AI-powered risk assessment platforms. Additionally, to these macroeconomic tools, promoting public awareness about the evolving nature of these crimes empowers individuals to become vigilant participants in safeguarding the financial system.

2. Research methodology

This paper provides econometric modelling using the ordinary least squares (OLS) for panel data, i.e. simple regression modelling with forward addition approach of data. Moreover, we have used the parametric approach on data as well, to estimate the impact of ICTs upon various economic and financial crime proxies through a second degree polynomial, as to validate the (inverted) U-shaped relationship between variables, plus controls. Our variables of interest are presented in a detailed manner within Table no. 1. We construct panel regression models in which the dependent variable (financial and economic crime) is explained by a technology proxy and additional control variables. Our model's general form using a quadratic approach is the following:

$$Y_{it} = \alpha X_{it} + \beta X_{it}^2 + \varepsilon_{it} \qquad \text{(Equation 1)}$$

Where:

Y_{it} = dependent variable for country i in year t (financial and economic crime proxy)

X_{it} = independent variable for country i in year t (technology proxy)
ε_{it} = residual

Our study investigates the complex issues of economic and financial crimes by focusing on the corruption perception index (CPI), shadow economy (SE) and anti-money laundering index (AML) as its proxies. The data sources are Word Data Bank, Transparency International (CPI), Basel Institute on Governance (AML) and Medina and Schneider (SE, 2018). The selection of proxy variables is motivated by the multidimensional nature of economic and financial crime, which is not directly observable. The Corruption Perception Index (CPI) is widely used in empirical literature as a reliable indicator of perceived corruption levels, capturing institutional vulnerabilities. The shadow economy (SE) reflects the extent of unreported economic activity, often associated with tax evasion and illicit transactions. The anti-money laundering (AML) index provides a measure of countries' exposure to financial crime risks and the effectiveness of preventive frameworks. However, these proxies are not without limitations. The CPI is perception-based and may not fully reflect actual corruption levels, while shadow economy estimates are subject to methodological approximations. Similarly, the AML index captures risk exposure rather than realized financial crime. These limitations should be considered when interpreting the empirical results. Despite these limitations, the combined use of multiple proxies enhances the robustness of the analysis and provides a more comprehensive assessment of economic and financial crime.

The selected time period (2005–2022) reflects both data availability and the relevance of this interval for capturing the rapid expansion of digitalization across European Union member states. This period encompasses significant technological advancements, including the widespread adoption of broadband Internet, mobile technologies, and digital financial systems, which are central to the analysis of technology-driven economic and financial crime.

At the same time, potential endogeneity issues should be acknowledged. The relationship between technological development and economic and financial crime may be subject to omitted variable bias, as higher levels of crime may also influence the adoption of digital technologies. Although the inclusion of control variables partially mitigates these concerns, the results should be interpreted with caution.

Table no. 1. Description of variables and their proxies

Variable name	Description	Calculation type	Source
Main independent variable: Technology			
Research and development expenditure, as % of GDP (R&D)	Research and development (R&D) spending on a gross domestic product (GDP) basis. Within the four primary sectors of business activity, government, higher education, and private non-profit, they contain both capital and continuous expenditures. R&D covers basic research, applied research and experimental development.	% in GDP	UNESCO Institute for Statistics (UIS). UIS.Stat Bulk Data Download Service. (World Data Bank)
Fixed broadband subscriptions (per 100 people)	Fixed broadband subscriptions (per 100 people) reflect the prevalence of fixed broadband internet connections per 100 individuals in a population. It indicates the capability for individuals to utilize broadband services for communication, education, business, and entertainment. High values signify widespread adoption of fixed broadband technology, while low values may indicate limited access or infrastructure challenges.	(Number of fixed broadband subscriptions / Total population) ×100	International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database (World Data Bank)
High-technology exports (% of manufactured exports)	High-technology exports (% of manufactured exports)" measures the percentage of manufactured exports that are classified as high-tech products. This variable is essential for assessing a country's level of technological sophistication and competitiveness in global markets. A higher percentage suggests a stronger emphasis on high-value, knowledge-intensive industries, which can contribute significantly to	(Value of high-technology exports / Total value of manufactured exports) × 100	United Nations, Comtrade database through the WITS platform.

	economic growth and innovation.		
Fixed telephone subscriptions (per 100 people)	Fixed telephone subscriptions (per 100 people) measure the density of fixed telephone connections per 100 individuals in a population. This metric provides insight into the availability of traditional landline telephone services within a specific area. It reflects the level of telecommunications development and deployment of infrastructure	(Total fixed telephone subscriptions / Total population) × 100	World Data Bank
Secure Internet servers (per 1 million people) (Serversr)	Secure Internet servers track the number of internet servers using encryption protocols like SSL/TLS for secure data transmission. It reflects a country's cybersecurity infrastructure and capability to safeguard online activities.	Number of servers per 1 million people	World Data Bank
Mobile cellular subscriptions (per 100 people) (MCSr)	MCSr indicates the level of mobile phone usage and accessibility within a given area, reflecting the extent of telecommunications infrastructure and adoption of mobile technology.	Subscriptions per 100 people	World Data Bank
Internet	Internet users are people who have accessed the Internet in the past three months, utilizing different devices such as computers, mobile-phones, gaming consoles, digital TVs and similar technologies.	(% of population)	World Data Bank
Dependent variable:			
Corruption perception index (CPI)	It evaluates the public sector's assessed levels of corruption for nations worldwide.	Ranges from 0(highly corrupt) to 100 (very clean)	Transparency International (2025)

Shadow economy (SE)	Shadow economy (SE) is determined as percentage of GDP for the world countries.	% in GDP	Medina and Schneider (2022)
Anti-Money Laundering (AML)	Anti-Money laundering (AML) efforts aim to mitigate the risk of money laundering and terrorist financing. The Basel AML Index is a tool used to assess a country's risk exposure to these activities.	The score goes from 0 (low risk) to 10 (high risk) in the financing of terrorism and money laundering	Basel Institute on Governance (2024)
Control variable:			
GDP per capita	GDP per capita is a measure of gross domestic product divided by the population at the halfway of the year. Deductions for asset depreciation or the depletion and degradation of natural resources are not included in estimations.	GDP per capita (current US$).	World Data Bank
Urban population (% of total population)	Urban population comprises individuals residing in urban areas, defined according to the criteria established by national statistical offices.	Number of individuals	World Data Bank
Unemployment	Unemployment is the proportion of the workforce that is not employed but actively seeking a job.	% of the total labor force	International Labor Organization

Source: Author's conceptualization

Table no. 2. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CPI	504	63.8492	16.2010	30	96
SE	504	16.8095	6.4291	6.1	33.05
AML	305	4.3141	0.7632	1.7786	6.78
FBSa	504	5305608	7910341	31856	$3.75x10^7$
FBSr	503	27.5348	9.7593	1.4407	49.4037
FTSa	503	7747252	$1.23x10^7$	173993	$5.48x10^7$
FTSr	502	36.3485	14.3621	3.3569	67.4664
GDPcap	504	33862.87	22609.84	3899.825	133590.1
HTEr	417	14.8535	8.0729	3.7303	53.0189
HTEa	417	$2.51x10^{10}$	$4.22x10^{10}$	$5.48x10^7$	$2.16x10^{11}$
Internet	501	73.5846	17.0101	19.97	98.8658
MCSa	503	$2.16x10^7$	2.79×10^7	323980	$1.10x10^8$
MCSr	502	120.1759	16.1637	63.3129	172.1508
RDr	437	1.5417	0.8858	0.3672	3.7340
Serversa	308	255123.1	769787.3	307	8109646
Serversr	308	14990.51	30872.84	39.0183	277330.6
Unempl	504	8.1885	4.1836	2.01	27.47
Unempl_	501	8.2240	4.1846	2.02	27.69
Urban	504	72.9422	12.6443	51.533	98.153

Source: Author's processing in Stata

Table no. 2 details the summary statistics of our data, coving the 2005-2022 time period and the EU-27 member states. Considering our 504 observations for Corruption Perception Index (CPI), the indicator has a minimum value of 30 and was obtained in 2005 in Romania and a maximum of 96 obtained in 2006 in Finland. This indicator points the cleanliness from corruption, thus, the higher the CPI score, the cleaner from corruption that country is. Moreover, corruption is reduced in the Northern countries like Finland and corruption is extended in Eastern European countries like Romania and Bulgaria. Shadow Economy (SE) quantifies the illegal activities that are carried on in the digital field. Its minimum value is 6.1 and it was obtained in 2019 in Austria; the maximum value is 33.05 in 2022 in Bulgaria. The shadow economy is expressed as GDP percentages, and indeed, Eastern European countries like Romania and Bulgaria register the highest values of shadow economy as a GDP weight. The Basel AML (Basel Anti-Money Laundering Index), which evaluates the risk of money laundering and terrorist funding, is used for money laundering regarding fraudulent activities. The minimum value of 1.7786 was recorded in 2017 in Finland and the maximum of 6.78 in 2012 in Greece. There are regional differences in the efficiency of law enforcement and the ability of regulatory bodies to keep an eye on and look into questionable transactions. Compared to Greece, Finland might have stronger enforcement tools and more highly qualified staff, which would lead to higher detection rates.

Fixed broadband subscriptions register a minimum value in 2005 in Cyprus meaning that there were few high-speed fixed subscriptions to access the public Internet, while the maximum value was recorded in France in the sense that there is a constant upstream speed of 256 kbit/s or more for high-speed access to the public Internet (a TCP/IP connection). Fixed telephone subscriptions refer to the total number of active analogue fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones. Its minimum value was reported in 2022 in Latvia. High-technology exports are products with high Research and Development intensity, and this variable has 417 observations for relative and absolute values. The mean for HTEr is 14.8535 and the standard deviation is 8.0729. Poland recorded the minimum value in 2007 and the highest value was recorded in Malta, same year. To continue, the Internet variable displays a minimum value of 19.97 for the year 2005 in Bulgaria and a maximum value of 98.8658 in Denmark in 2021. The observed minimum and maximum values show how different countries' adoption and access to the internet varies depending on a number of factors, including sociocultural aspects, economic conditions, legislative frameworks, and the state of the infrastructure. Denmark is renowned for having a highly developed internet penetration rate and sophisticated telecommunications infrastructure. The nation has continuously made investments in innovation and technology, which has led to widespread use of and access to the internet. Then, mobile cellular telephone subscriptions refer to active service plans for mobile phones that utilize cellular network technology to connect to the Public Switched Telephone Networks (PSTN), enabling voice calls and other telecommunication services. The minimum value was recorded in Romania in 2005 and the maximum in 2012 in Finland. The fact that Romania's mobile phone subscriptions had the lowest recorded value in 2005 indicates that, in comparison to other nations and eras, the country's adoption of mobile phones and availability to cellular technology-based services were comparatively low. This might be due to situations such as less developed telecommunications infrastructure and a rather slower economic growth. In opposition, Finland has a high percentage of mobile phone subscribers because of its sophisticated telecommunications infrastructure, high levels of technology innovation, and robust mobile network coverage.

Research and development (R&D) spending on a gross domestic product (GDP) basis encompasses all financial outlays, both ongoing and capital investments, directed towards various activities across four primary sectors: business enterprises, government agencies, higher education institutions, and private non-profit organizations. This variable considers the entire spectrum of R&D efforts, including basic research, applied research, and experimental development. The maximum value is 3.7340 registered in Finland in 2009 and the minimum value of 0.3672 was registered in 2005 in Cyprus.

High-technology exports are products with high Research and Development intensity, and this variable has 417 observations for relative and absolute values. The mean for HTEr is 14.8535 and the standard deviation is 8.0729. In Poland was recorded the minimum value in 2007 and the highest value in Malta, same year. The standard deviation

of 8.0729 indicates the extent of variation or spread of the data points around the mean, implying diversity in the level of high-technology exports across different observations.
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Mobile cellular telephone subscriptions refer to active service plans for mobile phones that utilize cellular network technology to connect to the Public Switched Telephone Networks (PSTN), enabling voice calls and other telecommunication services. The minimum value was recorded in Romania in 2005 and the maximum in 2012 in Finland. The mean value is 120.1759 and the standard deviation strays from the average mean by 16.1637. The fact that Romania's mobile phone subscriptions had the lowest recorded value in 2005 indicates that, in comparison to other nations and eras, the country's adoption of mobile phones and availability to cellular technology-based services were comparatively low. This might be due to situations such as less developed telecommunications infrastructure, slower economic growth. Finland has a high percentage of mobile phone subscribers because to its sophisticated telecommunications infrastructure, high levels of technology innovation, and robust mobile network coverage.
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GDP per capita represents gross domestic product divided by population. Countries with higher GDP per capita generally have more resources available to invest in advanced technological solutions for combating criminal economic activities such as money laundering, fraud, and corruption. Better technology infrastructure, such as widely available internet access, electronic payment methods, and data analytics capabilities, is frequently correlated with higher GDP per capita. These developments in technology have the potential to improve the efficiency with which financial institutions and law enforcement organizations monitor and investigate illicit financial activities.
The percentage of the labor force that has no jobs yet looking for work is referred to as Unemployment, used as a control variable in our study. Unemployment rates had a

maximum of 27.47 in 2013 in Greece and a minimum of 2.01 for 2019 in the Czech Republic. The mean value for the studied time period is 8.1885%. The last control variable from Table 2 is Urban population, referring to individuals residing in citified areas as defined by the statistical offices of a nation. The minimum value was recorded in 2005 in Slovenia meaning that most of the population prefers and resides in rural areas and the maximum was of 98.153 in Belgium in 2022 showing a great incline to the urbanization of Belgian citizens and their lifestyle. The mean value of 72.9422 suggests that, on average, a considerable portion of the European population across the observed dataset resides in urban areas. Variability in urban population values, as indicated by the standard deviation, reflects diverse urbanization patterns and trends among different countries and years.

3. Results and discussions

3.1. Main results for simple regressions

Table no. 3. Regression results for CPI as a function of various technology proxies

CPI							
	(a1)	(a2)	(a3)	(a4)	(a5)	(a6)	(a7)
RDr	14.6809 ***						
HTEr		0.46360 ***					
FBSr			0.8653 ***				
FTSr				0.3388 ***			
Internet					0.5973 ***		
MCSr						0.0996 **	
LogServersr							3.2706 ***
Constant term	40.9212 ***	57.0370 ***	40.0455 ***	51.5176 ***	19.8680 ***	51.8658 **	37.2423 ***
R^2	0.6143	0.0559	0.2715	0.0902	0.3922	0.0099	0.1585
Adj R^2	0.6134	0.0536	0.2700	0.0884	0.3910	0.0079	0.1558
Obs	437	417	503	502	501	502	308

Source: Authors' processing in Stata

Note: Significance levels for the thresholds are 1% (*), 5% (**) and 10% (***).

Table no. 3 contains the estimated coefficients for CPI as a function of seven technology proxies. The results for the Corruption Perception Index (CPI) indicate a consistent positive relationship with all technology-related variables, suggesting that higher levels of digitalization and technological development are associated with lower perceived corruption across EU member states.

Among the explanatory variables, research and development (R&D) expenditure shows the strongest and most robust effect, highlighting the role of innovation capacity in improving institutional quality and transparency. Similarly, high-technology exports exert a positive and significant influence, suggesting that more technologically advanced economies tend to exhibit better governance outcomes.

Digital infrastructure variables, including fixed broadband subscriptions and Internet usage, also display positive and statistically significant effects on CPI. This indicates that increased access to digital technologies enhances transparency, facilitates information flows, and reduces opportunities for corrupt practices. However, the relatively moderate explanatory power of these variables suggests that digital access alone is not sufficient without complementary institutional development.

In contrast, mobile cellular subscriptions and secure Internet servers present weaker relationships with CPI, indicating that basic or passive forms of digitalization have a more limited impact on corruption reduction. This may reflect differences in how these technologies are integrated into governance and monitoring systems.

These findings suggest that advanced and innovation-driven technological development plays a more substantial role in reducing corruption than mere expansion of digital infrastructure. From an economic perspective, this implies that policies aimed at strengthening innovation and institutional capacity are more effective in improving governance outcomes than those focused solely on increasing access to digital technologies.

Table no. 4. Regression results for SE as a function of various technology proxies

SE	(b1)	(b2)	(b3)	(b4)	(b5)	(b6)	(b7)
RDr	-5.0066 ***						
HTEr		-0.1235 ***					
FBSr			-0.2924 ***				
FTSr				-0.0991 ***			
Internet					-0.2183 ***		
MCSr						-0.0642 ***	
LogServersr							-1.0755 ***
Constant term	24.7144 ***	18.4134 ***	24.8477 ***	20.4113 ***	32.9059 ***	24.5338 ***	25.3254 ***
R^2	0.4934	0.0256	0.1971	0.0491	0.3331	0.0261	0.1061
Adj R^2	0.4922	0.0233	0.1955	0.0472	0.3318	0.0242	0.1032

Obs	437	417	503	502	501	502	308

Source: Authors' processing in Stata

For Table no. 4 all the independent variables have a negative relationship with shadow economy SE, implying that as the independent variable increases, the dependent one tends to decrease. It is a reasonable conclusion that if the proxies for technology increase the shadow economy decreases due to lack of obscurity. It is widely known that the shadow economy, corruption, and money laundering concerns become lower when legal institutions and the governance structure operate more efficiently.
The expressed coefficient for RDr is -5.0066, meaning that for a one-unit increase of RDr, SE decreases on average with -5.0066 units, ceteris paribus; 4.6619 is the value for the constant term. R&D highlights the role of innovation-driven economies in limiting shadow activities through improved institutional capacity and transparency.
For High-technology exports in relative values (model b2) the estimated coefficient (-0.1235) and constant term (18.4134) are highly significant for our threshold High-technology exports show a significant and relatively strong negative impact, indicating that more technologically advanced economies tend to experience lower levels of shadow economic activity. This finding supports the argument that technological sophistication enhances monitoring capabilities and reduces opportunities for illicit transactions.
Digital infrastructure variables, such as fixed broadband subscriptions and Internet usage, also display negative and statistically significant effects, although with lower explanatory power. This suggests that while access to digital technologies contributes to reducing the shadow economy, its effectiveness depends on the broader institutional and regulatory environment.
Variables such as mobile cellular subscriptions and Internet servers exhibit weaker relationships, indicating that not all dimensions of digitalization have the same impact on informal economic activity. This may reflect differences in how various technologies are utilized, as well as disparities in digital governance across countries.
To meet the fundamental requirements of multivariate regression modeling, the relative values of the Secure Internet Servers variable required to be logarithmized (LogServers).

3.2. Main results for the quadratic approach

Table no. 5. Regression results for CPI as a function of various technology proxies, a quadratic approach

CPI	(a1')	(a2')	(a3')	(a4')	(a5')	(a6')	(a7')
RDr	21.3202***						
RDr^2	-1.8097***						
HTEr		2.1252***					
HTEr^2		-0.0399 ***					
FBSr			0.9431 ***				
FBSr^2			-0.0015				
FTSr				-0.5915 ***			

FTSr^2				0.0131 ***			
Internet					-0.5255 **		
Internet^2					0.0084 ***		
MCSr						1.2922 ***	
MCSr^2						-0.0048 ***	
LogServersr							18.6980 ***
LogServersr^2							-0.9479 ***
Constant term	36.4037 ***	43.7554 ***	39.1852 ***	65.2264 ***	54.4664 ***	-19.4375	-22.1703
Threshold value	5.8904	26.6315	n/a	22.5763	31.2797	134.604	9.8628
R^2	0.6208	0.137	0.2716	0.1234	0.4215	0.0252	0.2119
Adj R^2	0.6191	0.1328	0.2687	0.1199	0.4192	0.0213	0.2067
Obs	437	417	503	502	501	502	308

Source: Authors' processing in Stata

Table no. 5 presents regression results for CPI using a quadratic approach for each technology proxy. By including both linear and quadratic terms for each technology proxy, these estimated models allow for a more flexible representation of the relationship between technology variables and subjectively assessed corruption (CPI). As such, a positive coefficient for the linear term indicates a direct linear relationship, whereas a negative coefficient for the quadratic term shows a concave relationship.

The coefficients for RDr and RDr2 from model (a1') are significant at the threshold of 1% and also adjusted R^2 has a slight improvement from 61.34% to 61.91% (from Table no. 3, model a1) meaning that the regression model has improved through this parametric approach (the adjusted R^2 offers better results in comparison to the linear approach of the simple regressions). Examining the graph, one might notice that most of the observations are situated on the left side of the vertex, the threshold value for this model being 5.8904. In this segment of the parabola, as research and development increases, the corruption perception index measured by CPI increases as well.

The quadratic model reveals significant coefficients for both HTEr and HTEr2 at 1% threshold. Indeed, parametric regression estimates the sample better, explaining the direct relationship between HTEr and CPI until the maximum theoretical point, in our case 26.6315. This means that as HTEr grows in value, so does CPI until the maximum point and after the threshold is exceeded no matter how much HTEr is still going up, the CPI will begin to go down, which aligns with previous research and our expectations. The decrease is explained by different factors that influence CPI, because our model is explained at a percentage level of 13.28%. This model has a concave graphical representation in relation to the corruption perception of the countries and the technology proxy.

Fixed telephone subscriptions also display a statistically significant convex relationship, with a turning point around 22.58. The results suggest that at lower levels of technological penetration, infrastructure expansion may not be sufficient to reduce corruption; however, once a critical mass is reached, the effect becomes beneficial. For Internet , the coefficients are highly significant. The improvement in the model is clearly seen, the parametric approach provides an amendment of the data through the model; adjusted R^2 grows from 39.10% in model a5, Table no. 3 to 41.92% in model a5’, Table no. 5 The estimated coefficients indicate a convex relationship, with a minimum turning point around 31.38. Below this threshold, increases in Internet penetration are associated with lower CPI values, while beyond it, further digital expansion contributes to improved transparency and reduced corruption. This finding highlights the dual role of digital access, which may initially facilitate illicit activities but become a tool for accountability as adoption deepens.

In the case of mobile cellular subscriptions, the quadratic specification provides a better fit compared to the linear model, revealing a nonlinear pattern with a maximum point around 134.60. This indicates that while initial increases in mobile connectivity may improve transparency, excessive or unregulated expansion may generate vulnerabilities that can be exploited for corrupt practices.

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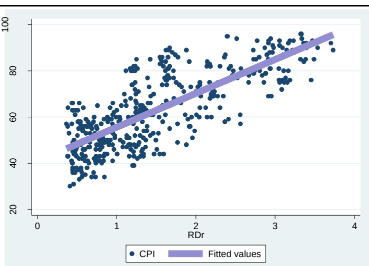
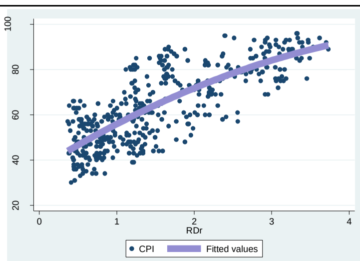
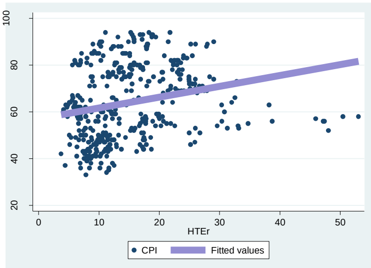
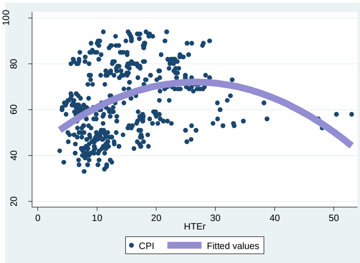
Secure Internet servers (in logarithmic form) exhibit a concave relationship, with a turning point at approximately 9.86. This suggests that improvements in secure digital infrastructure initially enhance institutional transparency, but their marginal contribution decreases beyond a certain level, possibly reflecting diminishing returns to cybersecurity investments.

All the graphical representations of CPI as a function of various technology proxies, through a second degree polynomial function as opposed to linear regressions, are found in Table no. 6.

Table no. 6. Plots of Corruption perception index (CPI) against technology expressed by various independent variables

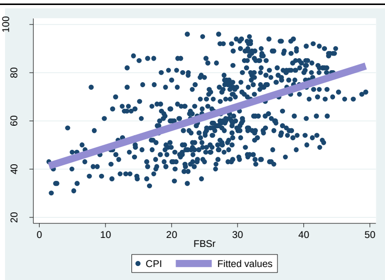
CPI = f(RDr)	CPI = f (RDr, RDr^2)
	
CPI = f(HTEr)	CPI = f (HTEr, $HTEr^2$)

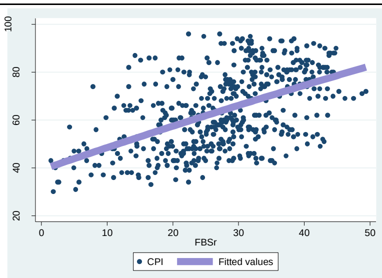




CPI = f(FBSr)

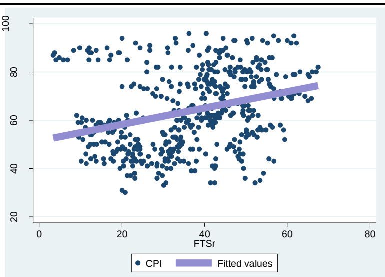
CPI = f (FBSr, FBSr^2)

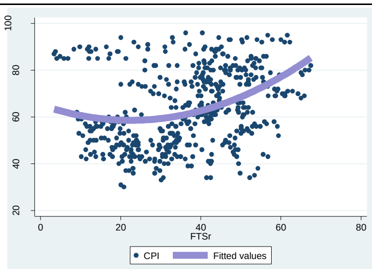




CPI = f(FTSr)

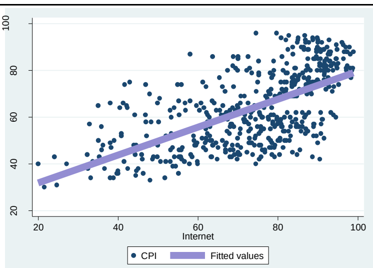
CPI = f (FTSr, FTSr^2)

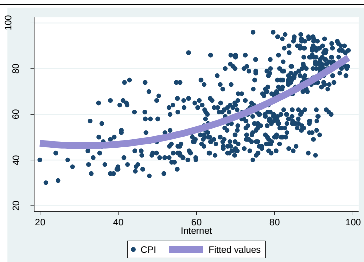




CPI = f(Internet)

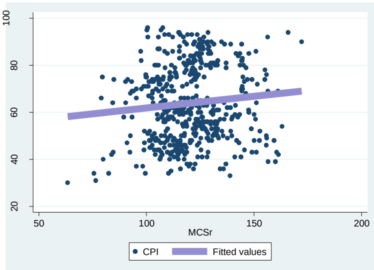
CPI = f (Internet, Internet^2)

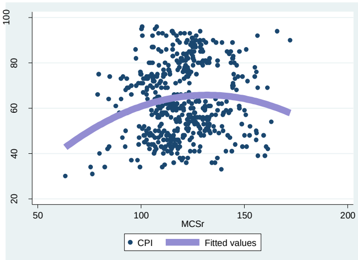




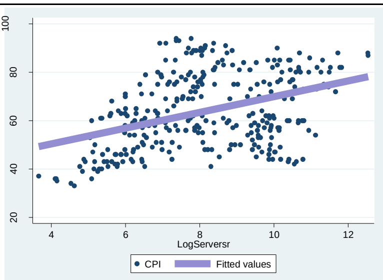
CPI = f(MCSr)

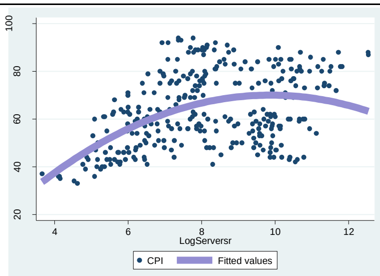
CPI = f (MCSr, MCSr^2)





CPI = f(LogServersr)	CPI = f (LogServersr, LogServersr^2)





Source: Authors' processing in Stata

Table no. 7. Regression results for SE as a function of various technology proxies, a quadratic approach

SE	(b1')	(b2')	(b3')	(b4')	(b5')	(b6')	(b7')
RDr	-11.8914 ***						
RDr^2	1.8766 ***						
HTEr		-0.8834 ***					
HTEr^2		0.1825 ***					
FBSr			-0.2643 **				
FBSr^2			-0.0005				
FTSr				0.2328 ***			
FTSr^2				-0.0046 ***			
Internet					0.0325		
Internet^2					-0.0021 ***		
MCSr						-0.4796 ***	
MCSr^2						0.0017**	
LogServersr							-3.8724

							***
$LogServersr^2$							0.1718*
Constant term	29.3990 ***	24.4872 ***	24.5370 ***	15.5203 ***	24.2221 ***	49.3689 ***	36.0970 ***
Threshold value	3.1683	2.4202	n/a	25.3043	n/a	141.0588	11.2700
R^2	0.5418	0.1351	0.1973	0.0759	0.3449	0.0380	0.1170
Adj R^2	0.5397	0.1309	0.1940	0.0722	0.3423	0.0342	0.1112
Obs	437	417	503	502	501	502	308

Source: Authors' processing in Stata

Table no. 7 models all the linear regressions from Table no. 4 (models b1 – b7) through the quadratic fit, containing the estimated results for SE as a function of various technology proxies. The most robust results are observed for R&D expenditure, where the quadratic model significantly improves explanatory power (adjusted R^2 increasing from 49.22% to 53.97%). The estimated relationship follows a convex pattern, with a minimum turning point at approximately 3.17. This suggests that increases in innovation initially contribute to reducing the shadow economy, but beyond a certain level, the marginal effect weakens, potentially reflecting structural saturation or shifts toward more complex forms of economic activity.

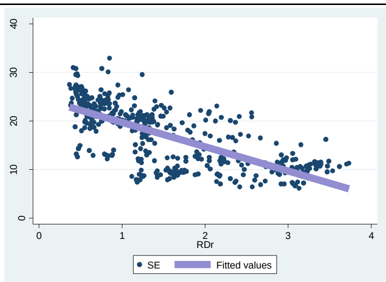
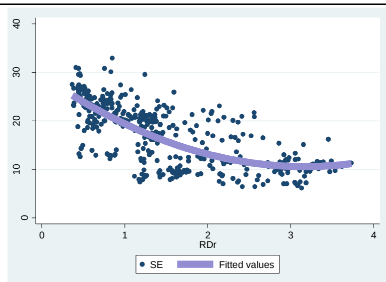
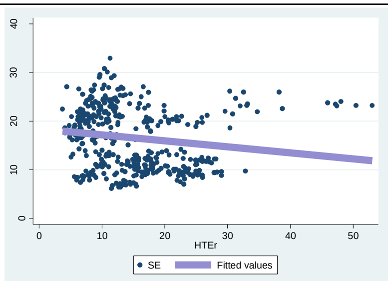
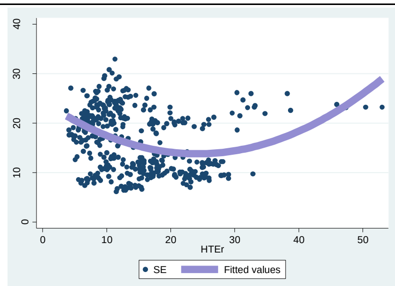
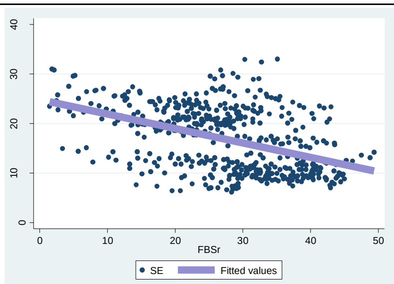
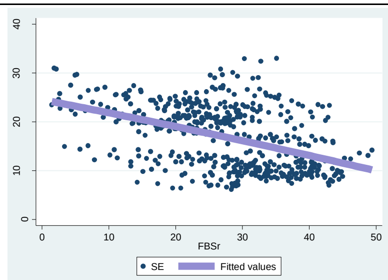
High-technology exports also exhibit a significant nonlinear relationship, with a convex pattern and a minimum threshold around 2.42. This finding indicates that technological sophistication plays an important role in reducing informal economic activity, particularly once a critical level of development is achieved. For the coefficients that are not significant and for which the thresholds are high (out of sample), we won't provide them anymore i.e. n/a.

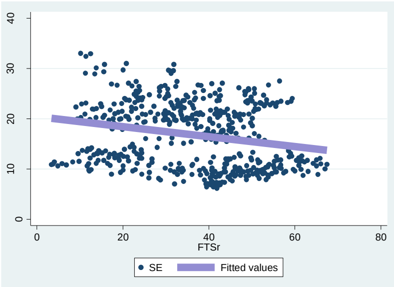
Fixed telephone subscriptions display a concave relationship, although the explanatory power of the model remains limited and the observed values are mostly equally distributed above and under the parabola. The maximum of the parabola is 25.3043 and any values of fixed telephone subscription that exceeds do not influence SE, resulting in the decrease of this variable because it is influenced by other factors; only 7.22% of the model is explained by FTSr which is an increase of the parametric equation from 4.72% (model b4, Table no. 4).

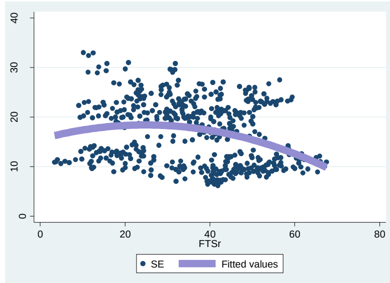
Model b6' represents the mobile cellular subscriptions against SE and the quadratic approach improves the quality of the model with a very small percentage of 1%; nonetheless the regression stands still. Our plots suggest that an increase in MCSr reveals a decrease in SE which is the result expected and wanted. Thus, countries could try to increase their mobile adoption technology and mobile usage in order to minimize the impact of shadow economy.

. Secure Internet servers (log-transformed) also exhibit a convex relationship, with a minimum threshold around 11.27. The results suggest that improvements in secure digital infrastructure contribute to reducing shadow economic activity, particularly at early stages of development, although the effect weakens as the level of technological sophistication increases. All the graphical representations of SE as a function of various technology proxies, through a second-degree polynomial function as opposed to linear regressions, are found in Table no. 8.

Table no. 8. Plots of Shadow Economy (SE) against technology expressed as provided independent variables

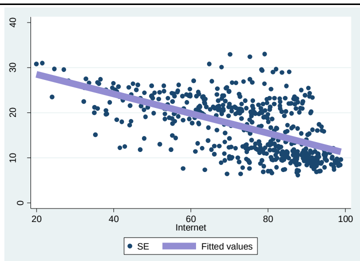
SE = f(RDr)	SE = f (RDr, RDr^2)
	
SE = f(HTEr)	SE = f (HTEr, $HTEr^2$)
	
SE = f(FBSr)	SE = f (FBSr, $FBSr^2$)
	
SE = f(FTSr)	SE = f (FTSr, $FTSr^2$)

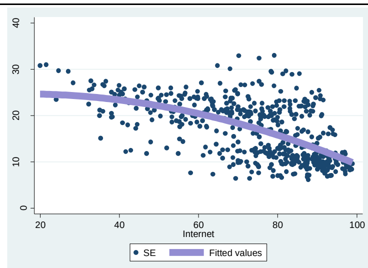




SE = f(Internet)

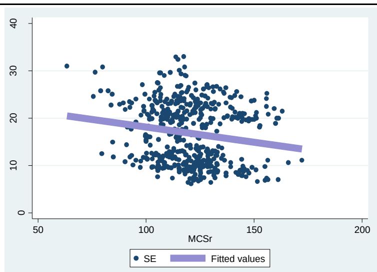
SE = f (Internet, Internet^2)

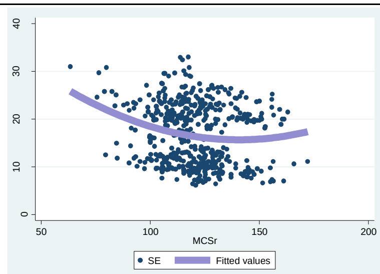




SE = f(MCSr)

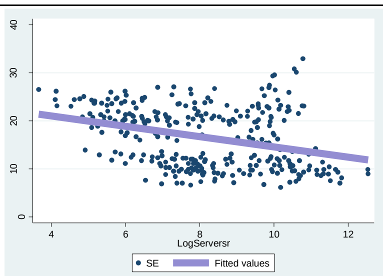
SE = f (MCSr, MCSr^2)

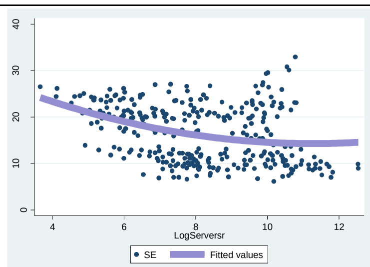




SE = f(LogServersr)

SE = f (LogServersr, LogServersr^2)





Source: Authors' processing in Stata

All in all, our research hypothesis is supported and indeed, information and communication technology impacts financial and economic crime in an asymmetrical manner, clearly depicted graphically as well from Tables no 6 and 8.

3.3 Robustness checks

To reinforce our results, we conducted multiple robustness checks, each addressing one of the following areas, to confirm our findings: integrating three different control variables for extending our models (LogGDP, Unemployment and Urban as depicted from Tables no. 9 and 10) and then considering an alternative variable (AML) for the dependent variable (as depicted from Table no. 11). In order to validate the robustness of our main results, on the linear and quadratic approach of the impact of technology upon financial and economic crime proxies, we have firstly used the addition of supplementary control variables to our models, as follows:

Table no. 9. Robustness checks for CPI as a function of various technology proxies – addition of controls

CPI	(a1'')	(a2'')	(a3'')	(a4'')	(a5'')	(a6'')	(a7'')
RDr	17.1525 ***						
RDr^2	-1.4338 **						
HTEr		0.8674 ***					
$HTEr^2$		-0.0197 ***					
FBSr			1.1973 ***				
$FBSr^2$			-0.0143 ***				
FTSr				-0.3538 ***			
$FTSr^2$				0.0044**			
Internet					-0.2783		
$Internet^2$					0.0063 ***		
MCSr						0.6434*	
$MCSr^2$						-0.0023 *	
LogServersr							8.4931 ***
$LogServersr^2$							-0.4925 ***
LogGDP		17.4755 ***		18.2020 ***			17.0448 ***
Unempl	-0.601 9***	-0.4377 ***	-0.9290 ***	-0.4285 ***	-0.5945 ***	-0.979 ***	-0.4699 ***
Urban	0.3608 ***	0.1511 ***	0.4665 ***	0.1525 ***		0.6239 ***	0.1200 ***
Constant term	20.3734 ***	-129.726 ***	16.7124 ***	-123.812 ***	53.1853 ***	-15.707	-149.937 ***

R^2	0.7091	0.721	0.4144	0.6952	0.4420	0.3518	0.7165
Adj R^2	0.7064	0.7176	0.4097	0.6922	0.4386	0.3466	0.7118
Obs	437	417	503	502	501	502	308

Source: Authors' processing in Stata

The robustness checks confirm the stability of the main results across alternative specifications. In particular, the coefficients associated with R&D and its quadratic term remain statistically significant and maintain both their signs and similar magnitudes. Adjusted R^2 increased from 61.91% in Table no. 6 to 70.64% in Table no. 10 due to the addition of Unemployment and Urbanisation as control variables, remaining relevant variables for the dependent variable. It would be expected that Urbanisation would influence corruption since it brings a sense of openness and wisdom, succeeding in decreasing the estimated CPI. Moreover, Unemployment is a previously validated determinant for corruption in the specialized literature as well.

Similar robustness is observed for high-technology exports, where both linear and quadratic terms retain their statistical significance and direction, indicating that the nonlinear pattern is not sensitive to model specification. The large increase in Adj R^2 is due to the addition of economic prosperity (LogGDP) as one of the control variables, which is a strong explanatory variable of CPI. For fixed telephone subscriptions, the coefficients remain relatively stable across models (linear terms around -0.59 to -0.35 and small positive quadratic terms), suggesting a consistent but relatively weak nonlinear effect.

In the case of mobile cellular subscriptions, the inclusion of control variables leads to a notable improvement in model fit (adjusted R^2 increasing from approximately 2% to over 34%), while preserving the general pattern of coefficients. The coefficients for secure Internet servers remain stable in both sign and magnitude, while the inclusion of controls significantly increases explanatory power, highlighting the importance of economic context in shaping the effectiveness of digital infrastructure. There is a considerable increase in R^2 of approximately 50,46% since all three control variables were added to the model, the economic prosperity being the one with a high explanatory power.

Table no. 10. Robustness checks for SE as a function of various technology proxies – addition of controls

SE	(b1'')	(b2'')	(b3'')	(b4'')	(b6'')	(b7'')
RDr	-6.2194***					
RDr^2	1.0040***					
HTEr		-0.6512***				
$HTEr^2$		0.0160**				
$FBSr^2$						
FTSr				0.1976***		
$FTSr^2$				-0.0021***		
MCSr					-0.3574**	
$MCSr^2$					0.0012*	

LogServersr						-3.3179**
$LogServersr^2$						0.1658*
LogGDP	-5.3940***			-8.3841***		
Unempl	0.1433***	0.3580***		0.0939**		0.3382***
Urban	0.0566***	-0.1584***		0.0541***	-0.1670***	
Constant term	72.9934***	30.2016***		93.9468***	54.1325***	28.9929***
R^2	0.6974	0.2860		0.6286	0.1450	0.1636
Adj R^2	0.6939	0.2791		0.6248	0.1399	0.1553
Obs	437	417		502	502	308

Source: Authors' processing in Stata

In the case of R&D, both the linear and quadratic terms preserve their statistical significance and comparable magnitudes across specifications, reinforcing the validity of the nonlinear relationship. Although some variation in coefficient size is observed, the overall interpretation remains unchanged. Importantly, the explanatory power improves substantially, with adjusted R^2 increasing from approximately 54% to over 69%, indicating that the inclusion of macroeconomic controls enhances the model without altering its core findings. A similar pattern is observed for high-technology exports, where the coefficients retain their signs and statistical significance, confirming that the nonlinear effect is robust to model specification. For fixed telephone subscriptions the coefficients remain relatively stable in both sign and magnitude, although their overall explanatory power remains limited. FTSr in model b4' from Table no. 7 has a coefficient of 0.2328, and in Table no. 10 at model b4'' it has a value of 0.1976, meanwhile $FTSr^2$ has in model b4' a coefficient of -0.0046 and then in model b4'' a value of -0.0021. This indicates that both the direction and general magnitude of the relationship are preserved. At the same time, the explanatory power of the model improves substantially, with the adjusted R^2 increasing from 7.22% to 62.48% following the inclusion of control variables. This suggests that broader economic factors play an important role in explaining variations in the shadow economy, while the effect of FTSr remains consistent.. The inclusion of control variables such as urbanization and unemployment leads to notable improvements in model fit in certain cases. For example, in the models for mobile cellular subscriptions and secure Internet servers, adjusted R^2 increases substantially, highlighting the importance of broader economic conditions in shaping the relationship between digitalization and corruption.

Table no. 11. Regression results for AML as a function of various technology proxies

AML	(c1)	(c3)	(c4)	(c5)	(c7)
RDr	-0.1803***				
FBSr		-0.0122***			
FTSr			0.0209***		
Internet				-0.0131***	
LogServersr					-0.1571***

Constant term	4.6619***	4.7070***	3.6253***	5.3872***	5.7225***
R^2	0.0404	0.0127	0.1544	0.0355	0.1168
Adj R^2	0.0364	0.0095	0.1516	0.0323	0.1133
Obs	243	304	303	302	252

Source: Authors' processing in Stata

As an additional robustness check, we replace the baseline dependent variables with the Anti-Money Laundering (AML) index to assess whether the relationship between technological development and financial crime remains consistent. The AML index, provided by the Basel Institute on Governance, captures countries' exposure to money laundering risks and the effectiveness of preventive frameworks.

Money laundering (ML) is problematic because it gives criminals a chance to reinvest money they have laundered back into their operations and to justify their unlawful earnings. The index assesses the efficiency of the legal frameworks of national initiatives aimed at preventing money laundering and the measures used to combat the funding of terrorism.

The results presented in Table 11 indicate that the relationship between technological variables and AML risk is generally consistent with the main findings, although the explanatory power of the models is lower. In particular, R&D expenditure exhibits a negative and statistically significant coefficient (-0.1803), suggesting that higher levels of innovation are associated with reduced exposure to money laundering risks.

Digital infrastructure variables such as fixed broadband subscriptions and Internet usage display negative coefficients, indicating that increased digitalization contributes to strengthening anti-money laundering capacity. However, the relatively low R^2 values across these models suggest that AML risk is influenced by a broader set of institutional and regulatory factors beyond technological development alone. Fixed telephone subscriptions show a positive relationship with AML, although with only moderate explanatory power.

Internet servers' security, represented as LogServers, underwent logarithmic transformation to meet the assumptions of multivariate regression modeling. The coefficient for LogServers is significant, indicating that a 1% increase in LogServers results in a 0.1571 decrease in AML, holding all other variables constant. The coefficient of determination (R^2) in model c7 suggests a modest correlation between variables, with a value of 0.1168, while the adjusted R2 remains a little lower at 0.1133.

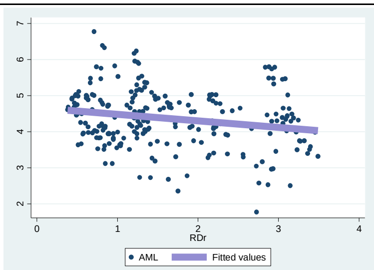
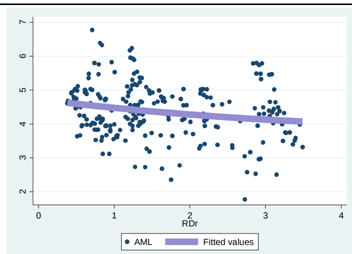
Table no. 12. Regression results for AML as a function of technology proxy, a quadratic approach

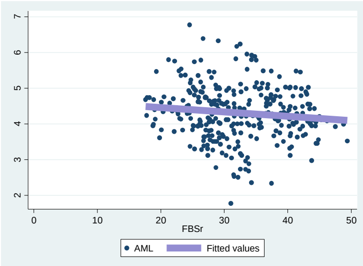
AML	(c4')
FTSr	0.0488***
$FTSr^2$	-0.0004**
Constant term	3.2609***
Threshold value	61
R^2	0.1683
Adj R^2	0.1682
Obs	303

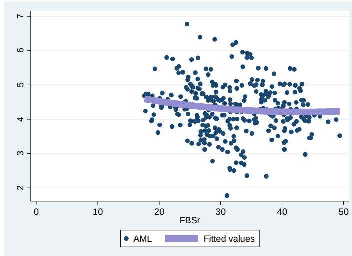
Source: Authors' processing in Stata

Our main results are backed up by model c4' from Table no. 12, the regression for AML stands strong for its robustness checks as well. The estimated coefficients are significant for our thresholds and the adjusted R^2 fits the model better in the quadratic approach with a value of 16.82%, compared to 15.16% in Table no. 11, model c4, the linear regression. The threshold value is 61, being a maximum point on the inverted U shape graph, thus the more fixed telephone subscription i.e. level of telecommunication there are, the AML will rise but only until the threshold value, after that any improvement in FTSr will generate a decrease in AML. The decrease will be explained by other factors since this model explains only 16.82% of the influencing factors over AML. It can be concluded that there is a negative relationship between Fixed telephone subscriptions and the Anti-money laundering variables. The plots of AML regressed against various technology proxies are included in Table no. 13.

Table no. 13. Plots of Anti-money Laundering (AML) against technology expressed as provided independent variables

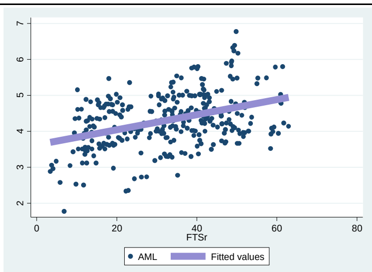
AML = f(RDr)	AML = f (RDr, RDr^2)
	
AML = f(FBSr)	AML = f (FBSr, $FBSr^2$)

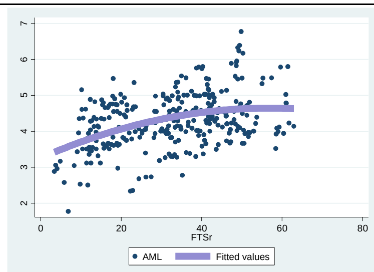




AML = f(FTSr)

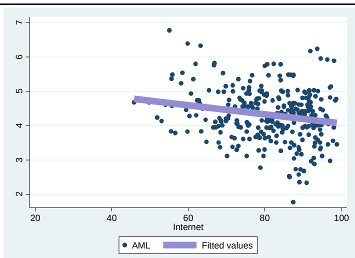
AML = f (FTSr, $FTSr^2$)

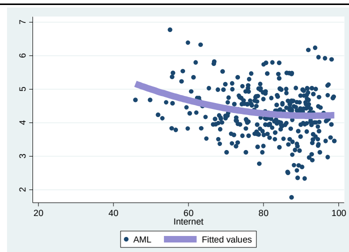




AML = f(Internet)

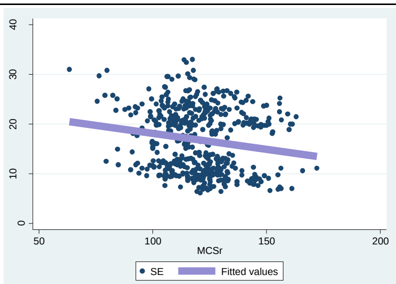
AML = f (Internet, $Internet^2$)

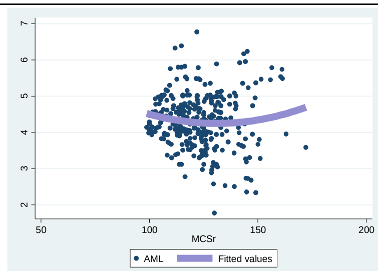




SE = f(MCSr)

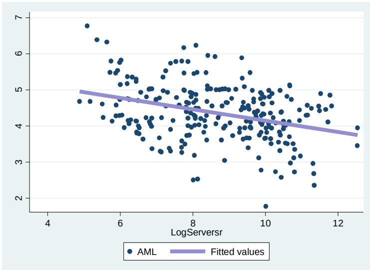
SE = f (MCSr, $MCSr^2$)

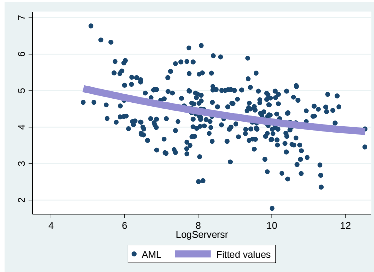




AML = f(LogServersr)

AML = f (LogServersr, $LogServersr^2$)





Source: Authors' processing in Stata

Conclusions

Economic and financial crime can be defined as a group of illegal acts committed by people or organizations with the aim of creating or assisting in the attainment of economic gains. This kind of criminal activity is especially relevant to the business sector and can take many different forms, such as money laundering, tax evasion, fraud, corruption and other related offenses (Achim, Borlea, 2020), as our paper tried to reflect as well. Technology has become an essential weapon over the years in the global fight against all financial crimes. This study has shown the complex relationship between technology on the one hand and economic and financial crime on the other hand, highlighting its multifaceted effects. Through rigorous analysis and empirical investigations, we have found evidence to support the hypothesis and the assumptions that technology plays a significant role in shaping the landscape of this economic field. Our investigations of various technological proxies, starting from Research and Development expenditure to Internet and Fixed Broadband Subscriptions, have yielded valuable insights into the ways through which technology affects the frequency and nature of financial crimes. The quadratic regression models estimated by our analysis have revealed nonlinear relationships, underlining the importance of considering both linear and nonlinear influences in understanding this complex phenomenon.

A comprehensive approach in combating economic crime should include cybersecurity measures, greater transparency in financial transactions and on top of that international cooperation between European and worldwide countries. Moreover, it is crucial to understand that the world is in a constant shape-shifting process, meaning that the technological landscape is in a constant evolving action. This demands continuous adaptation and innovation from law enforcement agencies and financial institutions. As criminals try to find and exploit new technologies approaches for their wicked purposes, so must the security tools evolve. Technology serves as a double-edged sword, making investigators and criminals stronger altogether. The latter exploit technological advancements to conceal their activities, laundering processes and evade detection. Investigators, on the other hand, use technology to gather evidence, track illicit transactions and tear down criminal networks. By fostering international cooperation, prioritizing research and development of cutting-edge solutions and also ensuring immediate implementation that addresses emerging vulnerabilities, it's our firm belief that countries can strive towards a more secure and transparent ecosystem in the economic field. This requires not only technological advancements but a cultural shift towards collaboration and proactive approaches to identifying criminal links and networks. Only through such a comprehensive strategy can we truly mitigate the impact of crimes on economies and societies. Despite presenting many obstacles, technological advancements hold immense potential for strengthening investigative capabilities.

Reducing economic and financial crime is and will be an ongoing process that requires consistent dedication and flexibility to modify tactics as necessary. Beyond the numerous benefits of technological investment and development, this paper suggests another important advantage: reduced economic and financial crime (corruption, shadow economy and money-laundering) may be attained by using technologies as a leverage. This study provides strong evidence for this connection, and it also determines clear inflection points (the tabled threshold values) up to/beyond which the effect of technologies no longer is beneficial to reducing these undesired phenomena.

Despite the robustness of the empirical results, several limitations should be acknowledged. First, the use of proxy variables such as CPI, shadow economy, and AML indices may not fully capture the true extent of economic and financial crime, as these measures are subject to estimation errors and perception biases. Second, the analysis is limited to European Union member states, which may restrict the generalizability of the findings to other institutional contexts. Future research could extend the analysis by employing fixed-effects and random-effects panel data models to better control for unobserved country-specific heterogeneity. This would allow for a more precise identification of the relationship between technological development and economic and financial crime by accounting for time-invariant institutional and structural differences across countries. Nonetheless, future research avenue would include the extension of our sample towards different income levels of nations, as the European Union only includes developed countries. Besides a different methodological approach to these models, we could also consider supplementary control variables.

References

[1] Achim, M. V., and Borlea, S. N. (2020). *Economic and financial crime.* Springer International Publishing.

[2] Achim, M. V., Văidean, V. L., Borlea, S. N., and Florescu, D. R. (2021). The impact of the development of society on economic and financial crime. Case study for European Union member states. Risks, 9(5), p.97.

[3] Achim, M.V., Borlea, S.N. and Văidean, V.L. (2021). Does technology matter for combating economic and financial crime? A panel data study. *Technological and Economic Development of the Economy*, 27(1), pp. 223–261.

[4] Adam, I. and Fazekas, M. (2021). Are emerging technologies helping win the fight against corruption? A review of the state of evidence. *Information Economics and Policy*, 57, p. 100950.

[5] Agu, M. N. (2013). Challenges of Using Information Technology To Combat Economic Crime. *African Journal of Computing & ICT*, 6(4).

[6] Alesina, A. and Angeletos, G. M., (2005). Corruption, inequality, and fairness. *Journal of Monetary Economics*, 52(7), pp. 1227-1244.

[7] Apergis, N., Dincer, O. C., and Payne, J. E. (2010). The relationship between corruption and income inequality in US states: evidence from a panel cointegration and error correction model. *Public choice*, 145(1), pp. 125-135.
[8] Basel Institute on Governance. (2024). Basel AML Index 2024. Basel: Basel Institute on Governance.
[9] Broadhurst, R. (2006). Developments in the global law enforcement of cyber-crime. *Policing: An International Journal of Police Strategies & Management*, *29*(3), pp. 408-433.
[10] Dey, S. andSaha, S.K., (2025). Analyzing the anti-corruption potential of ICT in SAARC countries. *Crime, Law and Social Change*, 83(1)..
[11] Glaeser, E. L. and Saks, R. E. (2006). Corruption in America. *Journal of public Economics*, *90*(6-7), pp. 1053-1072.
[12] Gogolin, G. (2010). The digital crime tsunami. *Digital Investigation*, *7*(1-2), pp. 3-8.
[13] Gupta, S., Davoodi, H., & Alonso-Terme, R. (2002). *Does corruption affect income inequality and poverty? Economics of governance*, *3*(1), pp. 23-45.
[14] Jong-Sung, Y., and Khagram, S. (2005). A comparative study of inequality and corruption. *American sociological review*, *70*(1), pp. 136-157.
[15] Mauro, P. (1995). Corruption and growth. *The quarterly journal of economics*, *110*(3), pp.681-712.
[16] Medina, L. and Schneider, F. (2022). *Shadow economies around the world: what did we learn over the last 20 years?* IMF Working Paper, WP/18/17.
[17] Mo, P. H. (2001). Corruption and economic growth. *Journal of comparative economics*, *29*(1), pp.66-79.
[18] Oto-Peralías, D., Romero-Ávila, D., & Usabiaga, C. (2013). Does fiscal decentralization mitigate the adverse effects of corruption on public deficits? *European Journal of Political Economy*, *32*, pp. 205-231.
[19] Remeikiene, R., Gaspareniene, L., and Schneider, F. G. (2018). The definition of digital shadow economy. *Technological and economic development of economy*, *24*(2), pp. 696-717.
[20] Tanzi, V., and Davoodi, H. (1998). Corruption, public investment, and growth. In *The welfare state, public investment, and growth: selected papers from the 53rd congress of the International Institute of Public Finance* (pp. 41-60). Tokyo: Springer Japan.
[21] Transparency International. (2025). Corruption Perceptions Index 2025. Berlin: Transparency International.
[22] Văidean, V. L., & Achim, M. V. (2022). When more is less: Do information and communication technologies (ICTs) improve health outcomes? An empirical investigation in a non-linear framework. *Socio-Economic Planning Sciences*, *80*, p. 101218.
[23] Wickberg, S. (2013). Technological innovations to identify and reduce corruption. *Transparency International*, (s 8).