

THE DIGITAL PARADOX: UNRAVELING THE NEXUS BETWEEN DIGITAL EFFICIENCY AND FINANCIAL CRIME IN THE GLOBAL CONTEXT

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Abstract

With the rise of digital transactions, opportunities for illicit financial activity have expanded, underscoring the need for innovative strategies to combat financial crime. This study highlights the influential role of digitalization in financial crime. Financial crime is treated as a dependent variable, measured using three proxies (Corruption Perceptions Index, Shadow Economy, Money Laundering), while digitalization is treated as an independent variable measured through the E-Government Development Index. The study uses a fixed-effects model and generalized method of moments for panel data from 134 countries from 2012 to 2023. The study finds that digitalization enhancement significantly reduces financial crime in the sample region. Digitalization reduces opportunities for illicit activities, thereby discouraging corruption, the shadow economy, and money laundering worldwide. This study contributes to the growing literature on financial crime by offering a comprehensive cross-country analysis and providing policy-relevant insight. It underscores the need for policymakers to strengthen digital mechanisms and harmonize international standards to curb financial crime.

Introduction

Digital efficiency, through advanced technologies such as artificial intelligence, blockchain, and automation, optimizes processes and enhances transparency in financial systems. Historically, manual operations led to inefficiencies, errors, and vulnerabilities. It revolutionizes operations by enabling real-time monitoring, secure data management, and seamless cross-border transactions. Digital efficiency is particularly effective in combating financial crimes like fraud, money laundering, and cybercrime. It reduces systemic vulnerabilities and creates robust defenses against illicit activities. AI-driven fraud detection

systems and blockchain reduce fraud and data breaches, enhance transparency, and strengthen cross-border collaboration, enabling effective transnational crime prevention (McAfee, 2021; Levi, 2021). Digital efficiency is linked to reducing financial crime through institutional, network, and economic theories of crime. Institutional theory suggests that digital efficiency strengthens governance structures by establishing norms and frameworks (North, 1990; Levi, 2021). Network theory emphasizes that it facilitates interconnectedness among financial institutions and regulatory bodies, enabling coordinated efforts to combat financial crimes (OECD, 2020).

Becker's cost-benefit model illustrates that digital efficiency increases the cost of financial crime by improving detection rates and ensuring swift prosecution (Becker, 1968; Madina & Schneider, 2021).

Digital efficiency significantly reduces financial crime, with institutions using AI and blockchain technologies reporting 70% fewer instances of fraud. (Sun et al., 2023; Chen et al., 2023). Countries with high digital efficiency, such as Estonia, have successfully reduced cybercrime rates through robust digital infrastructure and transparent governance. Blockchain systems combat money laundering by providing traceable and tamper-proof transaction records (Levi, 2021; World Bank, 2022). Conversely, jurisdictions with limited digital capabilities experience higher rates of financial crime (UNODC, 2023; OECD, 2020). Digital efficiency, through automation, transparency, and collaboration, reduces opportunities for financial crime and strengthens institutional capacity to detect and prevent it, making it crucial for safeguarding financial systems, reducing economic losses, and maintaining global economic stability.

Digital transformation, including e-government platforms, digital payments, big data analytics, and artificial intelligence, can minimize vulnerabilities. Logically, digital efficiency can mitigate corruption by simplifying bureaucratic processes, closing loopholes, and automating decision-making systems. Online service delivery platforms and digital auditing tools can reduce informal payments or favoritism (Ritu & Baniamin, 2024). Low digital efficiency can limit these anti-corruption gains and even introduce new vulnerabilities (OECD, 2020). Theoretically, institutional theory and socio-technical systems theory explain how digital efficiency affects corruption. Institutional theory posits that digital transformation strengthens institutional frameworks, reduces ambiguity, and enforces compliance (North, 1990; Bozhenko & Petrenko, 2021). Socio-technical theory emphasizes technology-people interaction, enabling effective corruption monitoring (Merhi & Ahluwalia, 2025).

Digital efficiency has been shown to reduce corruption in various countries, including Kazakhstan and Ghana, as well as in Ghana's retail sector. Studies indicate a significant correlation between the digitalization of public administration and lower levels of corruption (Bozhenko & Petrenko, 2021). In Kazakhstan, a high correlation ($R^2 = 0.8988$) was found between the digitalization of public services and improvements in the Corruption Perceptions Index (Kuanaliyev, 2021). However, the effectiveness of digital efficiency depends on political will, institutional capacity, and ethical governance. Digital efficiency, using advanced technologies like automation, blockchain, and AI, can significantly reduce the shadow economy, a form of unregulated, illegal economic activity that often thrives outside formal systems to evade taxes, regulations, and oversight. It simplifies compliance, enhances transparency, strengthens enforcement, and reduces informal economic activities. Efficient digital systems reduce barriers to formalization in the shadow economy by automating processes such as business registration and tax filing (OECD, 2020; Schneider, 2018). Blockchain technology enables transparent, tamper-proof records and discourages underreporting. Digital platforms also promote financial inclusion through mobile banking and payment systems, enabling previously excluded populations to transition into the formal economy (Chen et al., 2023; Levi, 2021). Countries with efficient digital systems, such as mobile banking and blockchain-based tax systems, report significantly smaller shadow economies.

The Evolution of Technology and Digitalization

Digitalization transforms business models by integrating digital technology to create new revenue and value-creation opportunities. Digitalization is also the process of transforming businesses into digital businesses (Brennen & Kreiss, 2016). In general, digitalization refers to incorporating digital technologies, such as those in the consumer electronics industry, into everyday life, as well as transforming sectors, governments, and economies. The digital revolution has brought major changes to the financial system. The rise of

online banking is a prime example of how customers can now conduct financial transactions remotely, without visiting a bank. In addition, fintech innovations such as mobile banking apps, digital wallets, peer-to-peer payment systems, and blockchain technology have greatly reshaped the financial services landscape (Arner et al., 2016). The digital transformation of the financial system has increased, leading to increased efficiency, transparency, and financial inclusion, especially in emerging nations where physical banking infrastructure was lacking (Suri & Jack, 2016). Nevertheless, the pandemic has driven digital transformation across sectors, particularly in finance, which has given rise to new threats, such as hacking, identity theft, and web scams, necessitating robust regulatory frameworks and cybersecurity measures (Kravet & Muslu, 2013). The outbreak of the novel coronavirus pandemic in 2019 served as a major catalyst for accelerating digitalization across sectors, especially finance. Physical distancing measures, home quarantines, and closures of offices and bank branches forced businesses and government agencies to hastily migrate to online operations (Brem et al., 2021). Internet banking, digital payments, contactless services, and online banking consultations are now not just options but prerequisites.

Opportunities and threats of Digitalization

Digitalization is undoubtedly one of the biggest factors that has changed the governance structure, including improving transparency, accountability, and efficiency. The emergence of e-government platforms, the use of online databases, and digital identity verification systems have made the government more powerful in detecting, identifying, and preventing financial crimes (Wu et al., 2021). With electronic governance tools, the situation regarding records has improved greatly, allowing governments to rely less on the individual decisions of their officials and be less likely to face corruption (Tsutskiridze & Bereza, 2020). Digital channels such as e-filing of taxes and open procurement systems have provided citizens with greater financial transparency, reducing the risk of illegal practices such as bribery and embezzlement.

Chief data analytics, blockchain technology, and artificial intelligence have become significant in fraud detection and money laundering prevention (Sadgali et al., 2019). Governments and banks are using monitoring tools that offer real-time fraud detection to employees within their departments, who can intervene and address it immediately and directly. Not only that, but it also allows citizens to come forward and actively participate in the community, such as through online petitions and digital feedback systems (Kitsios et al., 2022), thus ensuring that governments remain accountable and act in the public interest. In addition, one of the factors that has played a significant role in reducing identity crimes is the triumph of biometric technologies and smart identity management solutions, which have helped reduce cases of impersonation and unauthorized access (W. A. Al-Khater et al., 2020).

While digital solutions offer many benefits, they also create a new way for criminals to commit crimes. Cybercrime is the most obvious example of these threats, which have grown exponentially due to the availability of digital systems. Criminals look for vulnerabilities in these systems to negatively impact ordinary people and organizations. Identity theft is one of the biggest threats, in which private details such as SSNs, bank account information, or credit card information are stolen and misused (Lanková et al., 2019). With the advent of paperless operations in banks, the emergence of digital banking, and the growth of e-commerce, etc. Cybercriminals have developed new and old attacks, such as spam, viruses, and ransomware, to target both individuals and organizations (W.A. Al-Khater et al., 2020). In recent years, online fraud has increased, including e-commerce fraud, various online investment scams, and digital Ponzi schemes. Typically, the aforementioned criminals exploit loopholes in the local regulatory system, which is especially seen in the situation of countries that are only just entering the global stage of internet banking and other financial systems and, unlike developed countries, the laws in such places are not as advanced and fully established (K. Bondarenko et al., 2022). Furthermore, the increasing reliance on cloud

storage and online databases exposes governments and corporations to cyberterrorism and significant data breaches (Ibrahim & Abdulazeez, 2021). Such incidents can compromise sensitive information, disrupt public services, and cause significant economic losses.

The Union of Digitalization Technology and Financial Crime

The financial industry is now heavily influenced by digitalization, which provides a better-organized, more accessible infrastructure, lower costs and waste, and thus higher efficiency. On the other hand, the ongoing digital revolution is also making the sector increasingly vulnerable to crime. Traditional fraud and embezzlement have given way to online attacks, as a new wave of cybercriminals has turned to tactics such as phishing, identity theft, ransomware, and online money laundering (Levi & Soudijn, 2020). Digitalization has enabled an online edge in combating financial crime by significantly reshaping how traditional assets are transacted. Several factors, including consumer privacy, online security, digital currencies, and the widespread expansion of e-commerce, have increased opportunities for international criminals to carry out illegal activities with little or no notice from law enforcement authorities. The high-speed transactions facilitated by digital technology contribute greatly to such fraud and theft because most occur in real time and without external monitors capable of detecting or preventing it. This inevitably triggers chain reactions that will likely lead to increased reports of fraud and crime in emerging markets (Reurink, A. 2018).

Corruption, originating in the digital world, has truly transcended borders. The outbreak of the COVID-19 pandemic last year enabled cybercriminals to reach new heights in online scams and fraud, with government assistance programs and the healthcare sector targeted (OECD, 2021). A clear example is the Bangladesh Bank robbery in 2016, in which the gang attempted to steal 1 billion USD from the SWIFT network and ultimately succeeded in taking 81

million USD (Popoola & Alhassan, 2022). In contrast, Europol's 2023 Internet Organized Crime Threat Assessment (IOCTA) reported a sharp increase in ransomware attacks on financial institutions in Europe (Europol, 2023). The emergence of financial crime threats such as deepfake fraud, AI-based scams, and crypto-based money laundering has further reinforced the importance of investigating the relationship between digitalization and crime. Although advanced cybersecurity tools and digital forensics are widely adopted, they often miss the adaptive strategies used by criminal networks (Marcum & Higgins, 2019).

Empirical Evidence for Digital Efficiency and Financial Crime

As digital transactions grow, opportunities for illicit financial activity have expanded, underscoring the need for innovative strategies to combat financial crime. (Agorbia-Atta, 2024). Cutting-edge technologies such as artificial intelligence, machine learning, and blockchain are increasingly used to enhance fraud detection, promote transparency, and mitigate money-laundering risks (Agorbia-Atta, 2024; Kurshan & Shen, 2020). Graph-based methods have demonstrated potential in identifying financial crimes, though their practical implementation still faces certain obstacles (Kurshan & Shen, 2020). Research shows that the digitalization of public services generally contributes to a decline in economic and financial crimes, especially in developed nations (Brici & Achim, 2023). However, the link between digitalization and financial crime is nuanced, as some criminal activities have adapted to the digital environment (Brici, 2022). To address these evolving threats effectively, regulators need flexible frameworks, greater investment in advanced technologies, and stronger public-private collaboration.

Moreover, digital transformation, particularly through digital payments, supports the financial sector's sustainable development by promoting financial inclusion and improving operational efficiency (Mavlutova et al., 2022). At the same time, digital assets are reshaping traditional

financial fraud schemes, posing new challenges for regulators (Dupuis et al., 2023). Increased investment in technology and research and development has been shown to reduce economic and financial crime, especially in lower-income countries (Achim et al., 2021). Digital transformation can significantly reduce corruption, with socio-technical and socio-political factors playing key roles in its effectiveness (Merhi, 2022). The global adoption of technologies such as artificial intelligence, machine learning, and big data analytics in anti-corruption systems is increasing, and studies have found a strong correlation between higher levels of digital technology development and lower perceived corruption. Increased digitalization of public sector operations is associated with reduced corruption levels (Bozhenko & Petrenko, 2021). Digital government initiatives play a crucial role in combating corruption by enhancing transparency and accountability in governance processes (Karinda et al., 2023). The digital shadow economy refers to unreported economic activities in digital environments, distinguishing it from traditional shadow economies (Coca & Nistor, 2021). Digital finance and payment systems can play a significant role in reducing the size of informal economies in Southeast Asian nations, thereby potentially increasing official GDP and tax revenues (Syed et al., 2021; Truong, 2024).

However, the expansion of digital finance also introduces risks of financial instability due to systemic vulnerabilities (Syed et al., 2021). In Lithuania, attempts to assess the digital shadow economy have been limited, as conventional approaches often overlook digital components. The complexity of detecting illicit economic activities in digital spaces continues to challenge the development of effective monitoring and enforcement tools (Gasparėnienė et al., 2016). As a relatively new research domain, the digital shadow economy is closely linked to cybercrime and warrants deeper exploration (Coca & Nistor, 2021). Incorporating shadow economy estimates into official economic output has been shown to raise average technical efficiency across countries. A novel methodology for estimating the digital

shadow economy, based on the MIMIC model, incorporates indicators such as internet access, adoption of non-cash payments, and cryptocurrency use (Vaithilingam et al., 2015; Wronka, 2022). To overcome these challenges, experts suggest enhancing banks' IT infrastructure, fostering cooperation between financial institutions and law enforcement, improving cybercrime prevention, and reinforcing financial monitoring systems (Reznik et al., 2020). Graph databases are also seen as a valuable tool for modern AML strategies, enabling the modelling of financial networks, anomaly detection, and in-depth analysis (Muminovic & Halili, 2024). Additionally, there is a growing need for Australia's AML laws and enforcement strategies to evolve in response to emerging risks posed by digital assets and the expanding digital economy (Goldbarsht, 2023).

Methodology

In this study, financial crime (FC) is the dependent variable proxied by the Corruption Perception Index (CPI), shadow economy (SE), and anti-money laundering (AML). The current study's independent variable is digital efficiency. We use the E-Government Development Index (EGDI), developed by the United Nations (2021), as a proxy for measuring digital efficiency. This index measures each country's government's ability to adapt to technological change and work more efficiently. This indicator was created to provide a comparative analysis of government performance across states worldwide. The E-Government Development Index (EGDI) is the weighted average of three components. The first one is the Online Services Index (OSI), which shows the level of national online presence. The second is the Telecommunications Infrastructure Index (TII), which assesses the size and quality of the infrastructure that underpins technology adoption. The third is the Human Capital Index (HCI), which measures the extent of technology use and its promotion. The E-Government Development Index (EGDI) is particularly well-suited to this research because it provides a global, comparative measure of how countries leverage

digitalization in public administration. Countries with higher E-Government Development Index (EGDI) scores tend to experience lower levels of financial misconduct because increased transparency, automation, and reduced human

discretion in service delivery reduce opportunities for misconduct (Bondarenko et al., 2022; Haruna & Alhassan, 2022). The data are taken from the United Nations Database (Ding et al., 2024).

Table 1: Description of Variables

<i>Variable</i>	<i>Measurement</i>	<i>Sources</i>	<i>References</i>
CPI	Corruption Perception Index (CPI)	Transparency International	(Brici & Achim, 2023; Domashova & Politova, 2021)
Shadow Economy	Shadow Economy (% of GDP)		(Achim et al., 2024)
Money Laundering	Basel Anti-money Laundering Index (AML)	Basel Institute on Governance	Achim et al., 2021; Brici & Achim, 2023)
Digital Efficiency	E-government development index	United Nation Database	(Ding et al., 2024)
Inflation	Inflation, consumer prices (annual %)	World Development Indicators (WDI)	(Ahmad et al., 2021; Sun et al., 2025)
Population	Population, total	World Development	(Sun et al., 2025)
Economic Growth	GDP per capita growth (annual percentage)	World Development Indicators (WDI)	(Kanwal et al., 2023)

Result and Discussion

Table 2: Descriptive statistics

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
<i>CPI</i>	1608	45.62749	18.97635	13	92
<i>SE</i>	1608	26.80989	11.14102	5.1	58.2
<i>AML</i>	1608	5.695043	1.25335	2.356658	8.610344
<i>DE (e-gov)</i>	1608	0.5720661	0.2145538	0	0.9758
<i>INF</i>	1608	6.558459	18.43847	-4.294873	254.9485
<i>POP</i>	1608	5.19e+07	1.71e+08	320716	1.43e+09
<i>EG</i>	1608	1.647949	4.734132	-34.83117	62.11102

Table 2 presents statistical information, including the number of observations, mean, standard deviation, and the minimum and maximum values for all variables used in the current study.

Table 3: Correlation Matrix

	<i>CPI</i>	<i>SE</i>	<i>AML</i>	<i>DE (e-gov)</i>	<i>INF</i>	<i>POP</i>	<i>EG</i>
<i>CPI</i>	1.0000						
<i>SE</i>	-0.701*	1.0000					
<i>AML</i>	-0.683*	0.4730*	1.0000				
<i>DE (e-g)</i>	0.742*	-0.6083*	-0.7622*	1.0000			
<i>INF</i>	-0.226*	0.1434*	0.1072*	-0.0871*	1.0000		
<i>POP</i>	-0.065*	-0.1301*	0.0455	0.0125	-0.0095	1.0000	
<i>EG</i>	-0.0159	0.0189	-0.0157	-0.0419	-0.1212*	0.0569*	1.0000

Table 3 presents the findings from the correlation matrix used to detect multicollinearity in the dataset. The findings show that none of the relationships between explanatory variables exceed

the threshold required for perfect correlation. This means the data are free of multicollinearity and satisfy the basic assumption of the CLRM.

Table 4: Pooled Ordinary Least Squares, Fixed Effect Model, and Generalized Method of Moments (GMM) for Financial Crime (CPI) and Digital Efficiency

	<i>Pooled OLS</i>		<i>Fixed Effect</i>		<i>GMM</i>	
	<i>Coef.</i>	<i>P> z </i>	<i>Coef.</i>	<i>P> z </i>	<i>Coef.</i>	<i>P> z </i>
<i>CPI</i>						
<i>LI</i>					0.5319332	0.000***
<i>DE (e-gov)</i>	2.797128	0.000***	3.288878	0.000***	-1.616043	0.076*
<i>INF</i>	-0.006896	0.069*	-0.00457	0.225	-0.004858	0.582
<i>POP</i>	3.17e-10	0.592	-4.66e-1	0.289	1.03e-08	0.504
<i>EG</i>	-0.017039	0.237	-0.01341	0.410	-0.012130	0.455
<i>_cons</i>	43.19349	0.000***	42.77056	0.000***	16.7591	0.010***
<i>Hausman Test</i>						
<i>Chi²</i>	1.21		Probability		0.000***	

Note: ***, **, * represents significance at 1%, 5%, and 10%.

With the rise of digital transactions, opportunities for illicit financial activities have expanded, prompting the need for innovative strategies to combat financial crimes. (Agorbia-Atta, 2024). Cutting-edge technologies such as artificial intelligence, machine learning, and blockchain are increasingly used to enhance fraud detection, promote transparency, and mitigate money-laundering risks (Agorbia-Atta, 2024; Kurshan & Shen, 2020). Graph-based methods have demonstrated potential in identifying financial crimes, though their practical implementation still

faces certain obstacles (Kurshan & Shen, 2020). Research shows that the digitalization of public services generally contributes to a decline in economic and financial crimes, especially in developed nations (Brici & Achim, 2023). However, the link between digitalization and financial crime is nuanced, as some criminal activities have adapted to the digital environment (Brici, 2022). Addressing these evolving threats effectively requires flexible regulatory frameworks, greater investment in advanced technologies, and stronger public-private collaboration. Moreover,

digital transformation, particularly through digital payments, supports the sustainable development of the financial sector by promoting financial inclusion and improving operational efficiency (Mavlutova et al., 2022).

At the same time, digital assets are reshaping traditional financial fraud schemes, posing new challenges for regulators (Dupuis et al., 2023). Increased investment in technology and research and development has been shown to reduce economic and financial crime, especially in lower-income countries (Achim et al., 2021). According to OLS results, digital efficiency (DE) has a coefficient value of 2.797128 and a p-value of 0.000** across 135 countries. In developed countries, the coefficient value is 4.521326, and the p-value is 0.012***, which is statistically significant. In developing countries, the coefficient is 2.234503, and the p-value is 0.000***, indicating statistical significance. The fixed-effects results show that, in 135 countries, digital efficiency (DE) has a statistically significant coefficient ($p=0.000***$) of 3.288878. The coefficient is -4.767876, and the p-value is 0.029***, indicating statistical significance across developed countries. In developing countries, the coefficient is 2.499368, with a p-value of 0.000***,

indicating statistical significance. Conversely, the GMM results indicate that digital efficiency (DE) has a negative but statistically significant relationship with CPI. With a p-value of 0.000*** in 135 countries, the coefficient is -1.616043. The coefficient value is 4.349602, and the p-value is 0.017***, which is significant across developed countries. In developing countries, the coefficient is 2.255624, with a p-value of 0.001***, indicating statistical significance.

Digital transformation has the potential to significantly reduce corruption, with socio-technical and socio-political factors playing key roles in its effectiveness (Merhi, 2022). The global adoption of technologies such as artificial intelligence, machine learning, and big data analytics in anti-corruption systems is increasing, and studies have found a strong correlation between higher levels of digital technology development and lower perceived corruption. Increased digitalization of public sector operations is associated with reduced corruption levels (Bozhenko & Petrenko, 2021). Digital government initiatives play a crucial role in combating corruption by enhancing transparency and accountability in governance processes (Karinda et al., 2023).

Table 5: Pooled Ordinary Least Squares, Fixed Effects Model, and Generalized Method of Moments (GMM) Regression for Financial Crime (Shadow Economy) and Digital Efficiency

	<i>Pooled OLS</i>		<i>Fixed Effect Model</i>		<i>GMM</i>	
	Coef.	P> z	Coef.	P> z	Coef.	P> z
<i>SE</i>						
<i>L1</i>					0.0738398	0.052*
<i>DE (e-gov)</i>	-7.257083	0.000***	1.931742	0.000***	1.128996	0.003***
<i>INF</i>	-0.002522	0.812	0.0159099	0.000***	0.002384	0.828
<i>POP</i>	-4.96e-09	0.003***	5.30e-09	0.415	-4.54e-09	0.007***
<i>EG</i>	0.0150135	0.709	-0.019712	0.008***	0.0335501	0.469
<i>_cons</i>	36.49697	0.000***	25.59219	0.000***	20.95126	0.000***

Note: ***, **, * represents significance at 1%, 5%, and 10%.

According to the OLS results, digital efficiency (DE) has a coefficient of -7.257083 and a p-value of 0.000** across 135 countries. In developed countries, the coefficient is -29.02811, and the p-value is 0.000***, indicating statistical significance. In developing countries, the coefficient value is -3.706236, and the p-value is

0.037**, which is significant. The fixed-effects results show that, across 135 countries, digital efficiency (DE) is statistically significant ($p\text{-value} = 0.000***$); the coefficient is 1.931742. The coefficient value is -40.996, and the p-value is 0.000***, indicating statistical significance across developed countries. In developing countries, the

coefficient is -6.015765, and the p-value is 0.002***, indicating statistical significance. Conversely, the GMM results indicate that digital efficiency (DE) is positively and statistically significantly associated with the shadow economy. The p-value is 0.000*** in 135 countries, and the coefficient is 1.128996. The coefficient value is 5.489006, and the p-value is 0.036***, which is significant across developed countries. In developing countries, the coefficient value is -6.975919, and the p-value is 0.001***, which is statistically significant.

The digital shadow economy refers to unreported economic activities occurring in digital environments, setting it apart from traditional shadow economies (Coca & Nistor, 2021). Digital finance and payment systems can play a significant role in reducing the size of informal economies in Southeast Asian nations, thereby potentially

increasing official GDP and tax revenues (Syed et al., 2021; Truong, 2024). However, the expansion of digital finance also introduces risks of financial instability due to systemic vulnerabilities. (Syed et al., 2021). In Lithuania, attempts to assess the digital shadow economy have been limited, as conventional approaches often overlook digital components. The complexity of detecting illicit economic activities in digital spaces continues to challenge the development of effective monitoring and enforcement tools. (Gasparėnienė et al., 2016). As a relatively new research domain, the digital shadow economy is closely linked to cybercrime and warrants deeper exploration. (Coca & Nistor, 2021). Incorporating shadow economy estimates into official economic output has been shown to raise average technical efficiency across countries.

Table 6: Pooled Ordinary Least Squares, Fixed Effects Model and Generalized Method of Moments (GMM) for Financial Crime (Anti-Money Laundering) and Digital Efficiency

	<i>Pooled OLS</i>		<i>Fixed Effect Model</i>		<i>GMM</i>	
<i>AML</i>	Coef.	P> z	Coef.	P> z	Coef.	P> z
<i>L1</i>					-0.136037	0.000***
<i>DE (e-gov)</i>	-3.882881	0.000***	-3.976917	0.000***	5.489006	0.036***
<i>INF</i>	0.0002142	0.844	0.0005477	0.615	0.0867613	0.330
<i>POP</i>	-2.70e-10	0.112	1.04e-11	0.935	-3.01e-08	0.000***
<i>EG</i>	-0.011389	0.006***	-0.010780	0.022***	0.0288084	0.637
<i>_cons</i>	7.872414	0.000***	7.933893	0.000***	23.14091	0.000***

Note: ***, **, * represents significance at 1%, 5%, and 10%.

According to the OLS results, digital efficiency (DE) has a coefficient of -3.882881 and a p-value of 0.000** across 135 countries. In developed countries, the coefficient is -4.842517, and the p-value is 0.000***, indicating statistical significance. In developing countries, the coefficient is -3.420457, with a p-value of 0.000***, indicating statistical significance. The fixed-effects results show that, in 135 countries, digital efficiency (DE) has a statistically significant coefficient (-3.976917; p=0.000***). The

coefficient value is -3.708919, and the p-value is 0.000***, indicating statistical significance across developed countries. In developing countries, the coefficient is -3.584933, and the p-value is 0.000***, indicating significance. Similarly, the GMM results show that digital efficiency (DE) has a negative but statistically significant relationship with anti-money laundering. In 135 countries, the p-value is 0.000***, and the coefficient is -3.961041. The coefficient is -3.585286, and the p-value is 0.000***, indicating significance across

developed countries. In developing countries, the coefficient is -3.552246, with a p-value of 0.000***, indicating statistical significance. A novel methodology for estimating the digital shadow economy using the MIMIC model incorporates indicators such as internet access, non-cash payment adoption, and cryptocurrency usage (Gasparéniené et al., 2017; Reznik et al., 2020; Vaithilingam et al., 2015; Wronka, 2022). To overcome these challenges, experts suggest enhancing banks' IT infrastructure, fostering cooperation between financial institutions and law enforcement, improving cybercrime prevention, and reinforcing financial monitoring systems (Reznik et al., 2020). Graph databases are also seen as valuable tools for modern AML strategies, enabling financial network modeling, anomaly detection, and in-depth analysis (Muminovic & Halili, 2024). Additionally, Australia's AML laws and enforcement strategies need to evolve in response to emerging risks posed by digital assets and the expanding digital economy (Goldbarsht, 2023).

Conclusion

This study examined the influential role of digital efficiency in financial crime globally. The study uses panel data collected from 134 countries globally from 2012 to 2023. The study proxies financial crime with the Corruption Perceptions Index, the shadow economy, and anti-money laundering. The results consistently indicate that greater digital efficiency is associated with improved financial integrity and reduced illicit economic activity. Digitalization can enhance transparency, strengthen monitoring and reporting mechanisms, reduce opportunities for corruption and informal transactions, and improve financial institutions' and regulatory authorities' ability to detect suspicious activities. These findings highlight the importance of digital transformation not only as a technological development but also as an important institutional mechanism for strengthening economic governance and financial accountability. Overall, the study demonstrates that improving digital efficiency can contribute

meaningfully to the global fight against financial crime. The consistent relationship across multiple proxies suggests that investments in digital infrastructure, digital public services, data integration, and technology-enabled regulatory systems can strengthen countries' capacity to prevent and detect financial misconduct. Policymakers should therefore consider digital efficiency as part of broader financial-crime prevention and governance strategies, particularly in an increasingly interconnected global economy. Nevertheless, digitalization's effectiveness depends on institutional capacity, regulatory quality, cybersecurity, and effective implementation. Future research could further investigate these channels and examine whether the impact of digital efficiency differs across income groups, regions, and institutional environments.

Furthermore, the findings underscore the importance of adopting a coordinated and inclusive approach to digital transformation at the international level. Since financial crime increasingly transcends national borders, improvements in digital efficiency within individual countries can have broader implications for global financial transparency and regulatory cooperation. Strengthening digital capabilities should therefore be accompanied by robust data-protection frameworks, interoperable financial systems, effective institutional coordination, and greater international cooperation in information sharing and enforcement. By integrating technological advancement with sound governance and regulatory institutions, countries can better limit corruption, reduce informal economic activities, and strengthen anti-money-laundering efforts. In this regard, digital efficiency represents not merely a tool for economic modernization but a strategic component of building more transparent, accountable, and resilient financial systems worldwide.

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