Assessing the nexus among Digitalisation, Security Spending and Economic Growth in Africa

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Abstract

The African continent has experienced notable technological progress in digitalization. Simultaneously, security spending has risen within national budgets of several African countries. As these nations modernize their border security, it is crucial to explore the relationship between digitalization and security expenditure and their effect on economic growth. This study investigates the connection between digitalization, security spending, and economic growth in Africa, a relationship not extensively examined in existing literature. Previous studies have mostly examined this relationship in isolation or through average-based models, neglecting its non-linear and asymmetric nature. This research fills this gap by exploring data from 2000 to 2021 and using the method of moments quantile technique, which resists outliers and captures different effects across various levels of economic growth. The results show that the joint impact of digitalization and security spending is consistently positive at all levels of economic growth, with strongest effects in higher-growth economies. This underscores the need for coordinated policies incorporating digitalization into national security strategies, ensuring investments support each other to promote economic development. The findings offer valuable insights into economic development, security, and digital transformation in Africa.

Key words: *Economic growth, Digitalisation, Security spending, Method of moments quantile Regression, Africa*

1.0 INTRODUCTION

Africa is one of the fastest-growing regions in the world, yet it faces numerous challenges that hinder sustainable economic development. Factors such as political instability, inadequate infrastructure, and limited access to technology can impede growth (World Bank, 2020; Coughlan, 2024; Barnard et. al 2024). Understanding the dynamics of economic growth in Africa is essential for policymakers and stakeholders aiming to foster development as observed by Adeleye & Eboagu, (2019), Ogunjobi, et. al., (2025). Digitalisation, is widely defines as the integration of digital technologies into everyday life and business practices (Rachinger, 2019). In Africa, mobile technology and internet access have rapidly expanded, transforming various sectors, including finance (mobile banking), agriculture (smart farming), and education (e-learning) (ITU, 2021). This paper posits that digitalisation can enhance productivity, create new markets, and improve service delivery, thereby contributing positively to economic growth (OECD, 2019). Security spending encompasses expenditures on defence, law enforcement, and public safety. In many African countries, security threats such as terrorism, civil unrest, and crime can have detrimental effects on economic activities (Tsitouras & Tsounis, 2024; Imran Rafiq, 2024; Ben Youssef, 2025).

Security spending in Africa is characterized by a significant upward trend, with cumulative military budgets reaching $52.1 billion in 2024, a 3% increase from the previous year and an 11% increase since 2015 (SIPRI, 2025; Ecofin Agency, 2025). This growth is largely driven by intense localized conflicts; for instance, the Democratic Republic of the Congo saw a global-high budget surge of 105% due to regional tensions, while North African giants Algeria and Morocco dominate the continent's total expenditure with projected 2025 budgets of $25 billion and $13.4 billion, respectively (Africa Defense Forum, 2025; Businessday NG, 2025). Alongside traditional hardware, cybersecurity investment has hit approximately $15.3 billion as nations race to protect digital infrastructure, although a persistent "resilience gap" remains as the continent continues to lose roughly $5 billion annually to cybercrime (CIO Africa, 2025).

This research contends that both digitalisation and security spending may not only directly influence economic growth but also interact with each other in a moderating capacity to jointly propel economic growth. For instance, increased security spending might enhance the effectiveness of digital initiatives by providing a stable environment for technology adoption and innovation (Park & Choi, 2019). The prognosis in this paper is particularly founded on the fact that in Africa, the proliferation of mobile technology, increased internet connectivity, and the rise of digital platforms have opened new avenues for economic activities (Xia et. al., 2024). Simultaneously, heightened security concerns have led many African nations to allocate substantial resources to bolster their military capabilities (Akume and Akadiri, 2025). According to Salminen, et. al., (2020) and Khairi & Petlach, (2023), an empirical examination of how these two phenomena interact to influence economic growth is crucial for crafting informed policies that can harness the potential benefits of digitalization while managing the fiscal implications of security expenditure.

Previous studies such as Saeed, (2025); Budhathoki, et. al. (2024); Hanson, & Jeon, (2024) have primarily focused on exploring relationship between only military expenditure and economic growth, military expenditure and employment or unemployment by Ceyhan, & Köstekçi, (2021); Raifu, & Afolabi, (2023), military expenditure and the environment by Erdogan, et. al. (2022), Konuk, et. al. (2024) and Idroes, et. al. (2024), military expenditure and labour by Holcner, et. al. (2021) and Fedotenkov, & Gupta, (2021) as well as military expenditure and democracy by Hauenstein, et. al. (2021); Wang, et. al. (2023); Dizaji, S. F. (2024). None of the prior studies examined the combined effects of both digitalisation and security spending on economic growth particularly within the African context. Furthermore, the role of digitalisation as a moderating factor in the overly research relationships between military expenditure and economic growth remains unexplored in existing literature. The closest studies by Rusu, & Oprean-Stan, (2025) examined the impact of digitalisation, only on inclusive growth with European evidence, hence did not investigate the combined effect. The other related studies also looked at the impact of digitalisation on military expenditure but even focused on European and Asian countries (Spitsina, et. al. 2022; Khairi, & Petlach, 2023). This leads to a substantial gap in the literature that this study seeks to fill by examining separately, the impact of digitalisation and security spending on economic growth, then afterwards investigating the moderating role of digitalisation on the nexus between security spending and economic growth. Addressing these gaps is pivotal for developing effective policy frameworks and strategic initiatives that advance sustainable development and elevate economic security across African economies. Moreover, most of the models employed in prior literature have employed have largely been mean-based models or linear without considering the non-linear context or the heterogenous and asymmetric nature of the relationship. Meanwhile, digitalisation, security spending and

economic growth like many economic variables exhibits swings as economies go through recessions and booms. Such extreme events are better captured by models that consider outliers and tail movements. As observed by Dunne and Tian (2015), more pulsating digitalisation and security spending policies would necessarily not impact economic outcomes in the same magnitude and scale as when the policies on digitalization, security expenditure regulations are weak. To view the relationship in a linear context is to miss the point entirely. Additionally, completely missing in the existing literature are the threshold effects of both digitalisation and security spending on economic growth. Studies into the threshold effect of digitalization on economic growth and security spending on economic growth are important for because, such research can help identify the tipping points at which digitalization and security spending begin to significantly influence economic growth in a measurable way. Understanding these thresholds is crucial for policymakers and practitioners, as it can provide insights into the optimal levels of investment in digital infrastructure and security to maximize economic benefits while minimizing potential negative externalities.

In light of these constraints, the present study positions the conversation surrounding digitalisation, security spending and economic growth within the African context. Furthermore, our research ventures into uncharted territory by employing the novel moment quantile technique to unveil the complex interplay between digitalisation, security spending and economic growth in an asymmetric and heterogenous manner, equipped to capture the unpredictable fluctuations and anomalous occurrences that are inherent to economic growth processes and outcomes. The method of moment quantile considers the heterogeneity in the distribution of economic growth (the dependent variable). The technique is robust to conditions of non-normality in the data and structural variations. Unlike the basic quantile regression technique which is incapable of dealing with estimates of non-crossing nature, the method of moment quantile technique utilizes its scale and location parameters to deliver non-crossing estimates. Moreover, the technique is unearthing the non-linearities in the relationships between the variables of interest (Almulhim et.al., 2025).

The results show that the combined effect of security spending and digitalization is consistently positive and significant across all quantiles, reinforcing the idea that digitalization, when paired with security investment, can have a strong positive effect on growth. The coefficients are particularly high across all quantiles, with the largest effect observed at the highest quantile (0.712 in quantile 9). This indicates that digitalization can offset some of the challenges it poses when combined with robust security spending, facilitating stable and sustainable growth even in the highest-growing economies. The other sections of the paper include section two which covers the literature review; section three the methods employed in conducting the empirical investigation; section four deals with the results and discussion while section five entails the conclusions and policy implications of the study, the final section looks at the limitations and future recommendations.

2.0 LITERATURE REVIEW

The theoretical framework for examining the nexus between digitalization, security spending, and economic growth in Africa is primarily anchored in Endogenous Growth Theory, which posits that long-term economic expansion is driven by internal factors such as innovation and technological progress (Romer, 1990; ResearchGate, 2025). This theory suggests that digitalization acts as a catalyst for growth by reducing transaction costs and information asymmetries, thereby enhancing total factor productivity (World Bank, 2024; AU, 2020). Complementing this, Wagner's Law provides a basis for understanding security spending as an endogenous response to economic development;

it argues that as African nations modernize and grow, public demand for "law and order" and institutional protection naturally increases, leading to higher government security expenditures (Ecofin Agency, 2025; RSIS International, 2025). Furthermore, the Solow-Swan Neo-Classical Model, when augmented with ICT and security variables, emphasizes that while technological adoption can lead to "leapfrogging" in developing economies, the sustainability of this growth is contingent upon a secure environment that protects digital and physical assets (AUDA-NEPAD, 2025; IMF, 2025). Together, these theories suggest a reinforcing cycle where digitalization fuels growth, which in turn necessitates and funds the security spending required to protect a modernizing state.

Empirically, the nexus between security spending, digitalization, and economic growth is a multifaceted issue that has garnered significant attention in recent academic discourse. Security expenditures, particularly military and defence spending, have been shown to have both direct (Amjad, 2015; Heo & Ye, 2016) and indirect effects (Heo & Ye, 2005; McDonald & Eger, 2010) on economic growth. As revealed by Amjad, 2015 in Pakistan, defence expenditure was found to directly hinder economic growth, but in United states Heo & Eger, (2005) show that indirectly, military spending can dampen private investment and exports, leading to negative growth outcomes. Adding to the discourse, Elveren et. al., 2023, in their study highlight that military spending has both direct and indirect effects on economic growth, emphasizing that it influences income distribution and differs from civilian spending in its impact on profit and wage shares, ultimately affecting productive capacity. Again, studies indicate that in contexts of heightened security threats, such as in South Korea, increased defence spending correlates positively with economic growth despite the immediate negative impacts associated with military expenditures (Park & Jung, 2015). This phenomenon is echoed in other regions, such as Malaysia, where a significant relationship between security expenditure and economic growth was established through time-series analysis, using ARDL estimation technique (Sidek, 2022). Similarly, in Nigeria, security spending has been linked to economic growth, although the relationship is complex and varies over time (Ayange et al., 2020; Abu & Marvelous, 2020). Indeed, Ayange et al. (2020) and Abu & Marvelous (2020) in their respective studies, highlight that while security expenditure can influence the economic environment, its direct impact on growth is less clear. Ayange et al. (2020) argue that security spending is often viewed as non-contributive to economic development, while Abu and Marvelous found that government security expenditure in Nigeria had a positive relationship with economic growth, albeit with varying degrees of significance depending on the economic context. Furthermore, the relationship between security spending and economic growth is not merely linear; it is influenced by various factors, including the geopolitical landscape and the specific economic context of a country. For instance, as observed in Atuahene et. al., (2020), in the case of China, military expenditure has been analyzed for its long-term causal relationship with economic growth, revealing that while military spending can stimulate growth, the reverse relationship, where economic growth drives military expenditure has also been established (Gokmenoglu et. al., 2015). These diverse empirical results highlights the complexity of the relationship and suggests that the effects of security spending on economic growth can vary significantly based on external conditions and internal economic policies (Legass & Akkas 2024; Shi,2025; Hahm, et al., 2025; Soque, 2025; Otchia, Fon, 2025; Azam, et. al. 2025). This also implies that while military spending can have detrimental effects on economic growth through various channels, its impact may vary significantly based on regional and contextual factors, highlighting the need for nuanced policy considerations. Zhang et al. (2019) further elucidate this by demonstrating that social security can have a threshold effect on productivity, suggesting that its impact on economic growth is contingent upon the level of human capital within a region.

In the context of Africa, security spending, particularly military and defence expenditures, has also been shown to have varying effects on economic growth across different contexts in Africa (Aye, et al., 2014; Saba & Ngepah, 2020; Iheonu & Ichoku, 2023). Studies indicate that increased military spending often does not translate into economic growth, as it diverts resources from essential sectors such as education and health, which are critical for long-term development. For instance, Azam (2020) argues that military spending in non-OECD countries, including many African nations, tends to stifle economic growth due to reduced investment in productive sectors. Similarly, Olayiwola, (2024)'s research on Nigeria highlights that defence spending adversely affects income growth both in the short and long run, emphasizing the need for a reallocation of resources towards more productive areas such as education and health. The findings from Oriavwote & Eshenake, (2013), further suggest that internal security spending can positively influence economic growth, indicating that while military expenditures may be detrimental, investments in internal security can foster a more stable environment conducive to economic activities. This distinction underscores the importance of the type of security spending and its alignment with broader economic objectives. An analysis of public spending in West African countries also further supports this notion, indicating that government expenditures, when effectively managed, can stimulate economic growth (Ndiaye, 2018).

Another stream of literature also examines the economic repercussions of various aspects of digitalization, which stands as one of the principal issues concerning its impact on productivity. For instance, Ballestar et al. (2021) find positive outcomes on labor-saving expenses and productivity enhancement following automation in Spanish companies. However, the authors suggest that while robotization elicits positive effects, digitalization itself did not show the same influence, potentially due to incomplete transfer of e-commerce's impact. Studies like Gaglio et al. (2022) further support the association between innovation and digitalization, on one hand, and productivity, on the other, within small- and medium-sized firms in South Africa. However, this research also highlights the significant variance in digital technology access, with substantial companies demonstrating a comparative advantage. Additionally, persistent barriers in developing countries, such as low digital aptitude, subpar infrastructure, and limited funding for small companies, exist. Echoing these findings, Fernandez-Portillio et al. (2022) submit the significance of innovation in harnessing company performance, asserting that access to digitalization and the scope of digitized operations are notable determinants. The literature frequently concludes that digitalization engenders fresh business models that gain impetus from the level of innovation and digitalization that amplifies connectivity, expertise, and adaptability, among other aspects. In a study on the automotive and media sectors, Rachinger et al. (2018) evidenced that there are variances regarding the extent to which digitalization contributes to innovation, acknowledging that numerous hurdles persist in realizing the complete benefits of digitalization through adopting the new business model. Similarly, a comprehensive study by Gal et al. (2019) ascertains the significance of digitalization at the company level vis-à-vis productivity gains, integrating cross-country data. Their investigation corroborates the general inference that digitalization propels heightened productivity, albeit unevenly across all companies. Furthermore, numerous authors like Arnold et al. (2016) appraise the impact of the internet of things across a broad scope of manufacturing enterprises, emphasizing the pertinent concerns within the considered fields, from skilled staff to suppliers. In Szalavetz (2022), the author scrutinizes the convergence of new technologies with traditional ones, underscoring the affirmative influence of digitalization, which prompts fresh business strategies. Asserting the channels through which digital technologies engender productivity repercussions, Australian Government, Department

of Arts (2017) contends that productivity mismeasurement underestimates digitalization effects, particularly on smaller components, in addition to the present structure of GDP measurements that do not encompass the complimentary internet-based services. In a broad analysis, Borowiecki et al. (2021) set forth the significance of intangible features and digitalization in Dutch firms, validating the sector-wide benefits accruing to firms that enhance digital skills, proving advantageous for productivity escalation. Digitalisation has been also shown to have a positive and significant effect on economic growth, particularly within the European Union. Mura & Donath (2023) utilized an econometric model to analyze data from 2000 to 2021, concluding that digitalisation contributes positively to economic growth even when controlling for various factors. This is further supported by (Yalçın, 2021), who employed data envelopment analysis to demonstrate that digitalisation enhances economic performance across EU countries. In same measure, a confirmation of the extension of benefits of digitalisation to the emerging and developing countries was noted by Niebel (2018) when the research finds that information and communication technologies (ICT) positively influence GDP growth across different country classifications.

Digitalization emerges as a critical factor in enhancing economic growth in Africa, particularly in the context of security spending. The integration of advanced digital technologies can significantly bolster economic security and efficiency within enterprises, as highlighted by Kukhar, (2023), who notes that digital transformation is essential for achieving strategic economic goals. This is particularly relevant in African economies, where digitalization can improve service delivery in sectors such as health and education, thereby enhancing overall productivity and economic growth. The relationship between digitalization and economic growth is further supported by the works of Bétila, (2024) and Yusufu et al., (2022), which illustrates how health expenditures, when coupled with digital advancements, can lead to improved economic outcomes in Sub-Saharan Africa. Adding to the African narratives, Mazwane et al., (2022) and Andreoni et al., (2021) with supporting evidence from South Africa have demonstrated how advancements in information and communication technology (ICT) have been pivotal in driving economic development, evidenced by the country's leading position in various digitalization indices. Lottu, (2023) and Ndemo & Weiss, (2017) observe similar conditions in Nigeria where the integration of digital banking technologies in Nigeria has facilitated access to credit for small and medium-sized enterprises (SMEs), thereby promoting business growth and job creation.

However, Masters, (2021) and Kaggwa, (2023) are among those who have empirically posited that challenges such as inadequate infrastructure and skills shortages hinder the full realization of digitalization's potential across the continent. Supported by studies such as Chimbo, (2020) and Achieng & Malatji, (2022), who emphasizes that while digital transformation can catalyze economic change, its benefits are unevenly distributed, necessitating targeted policies to bridge the digital divide and enhance human capital development. Safe to contend that, the relationship between digitalization and economic growth in Africa underscores the need for strategic investments in ICT to harness its transformative power effectively which implies that, the economic growth responses of security spending is often moderated by the broader economic environment, including the level of digitalization. The digital economy plays a crucial role in enhancing economic security and promoting growth. For example, the integration of digital technologies into economic activities has been shown to bolster national economies and their security frameworks (Spivakovskyy et al., 2021). The digital economy facilitates improved efficiency and productivity, which are vital for sustainable economic growth. In this context, social security expenditures, which are increasingly influenced by

digitalization, can also play a significant role in enhancing human capital and productivity, thereby contributing to economic growth (Zhang et al., 2019; McKinnon, 2019).

It is therefore within this context, that this study looks at the heterogeneity and asymmetry in the nuanced relationship between security spending, digitalisation and economic growth in Africa, a dimension of the discourse, thus far, no research in the literature has addressed.

3.0 METHODOLOGY

3.1. Data

Data for this study is secondary data gathered from the world bank spanning 2000 to 2021, and the variables of study constitute the main dependent variable which is economic growth represented by GDP growth, the main independent variables will be security spending proxied by military expenditure per GDP and digitalisation proxied by the principal component analysis (PCA) of broad band, telephone, internet and mobile phone subscription and users. The control variables include inflation, foreign direct investment, employment and population, these were also taken from World.

3.2 Variables

Economic growth represents the annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. **Digitalisation** has been utilized as one of the independent variables, encompassing mobile subscriptions, internet users, and broadband subscriptions for digitalisation. Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of post-paid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services. Fixed broadband subscriptions refers to fixed subscriptions to high-speed access to the public Internet (a TCP/IP connection), at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fiber-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. This total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It should include fixed WiMAX and any other fixed wireless technologies. It includes both residential subscriptions and subscriptions for organizations. Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. **Security Spending** proxied by military expenditure data from SIPRI following the NATO definition, encompassing all current and capital expenditures on the armed forces, including peacekeeping forces, defence ministries, and other government agencies involved in defence projects. It also includes paramilitary forces trained and equipped for military operations and military space activities. These expenditures cover military and civil personnel, retirement pensions, social services for personnel, operation and maintenance, procurement, military research

and development, and military aid (included in the donor country's military expenditures). Exclusions are civil defence and ongoing expenses from past military activities, such as veterans' benefits, demobilization, conversion, and weapon destruction. However, this definition is not uniformly applicable across all countries due to the lack of detailed information on what is included in military budgets and off-budget military expenditure items. For example, military budgets might vary in covering civil defence, reserves, auxiliary forces, police and paramilitary forces, dual-purpose forces, military grants in kind, pensions for military personnel, and social security contributions between government departments. **Inflation**, represented by consumer prices (annual %) as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. **Gross fixed capital formation** (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. **Population** shows the total population which is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates. **Foreign direct investment** are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP. The rets of the details is discussed in Table 1 as follows:

Table 1: Variable Measurement

Variable	Unit of measurement	Source	Sign
Economic Growth	GDP growth (annual %)	World Bank	Not applicable
Security Spending	Military expenditure (% of GDP)	World Bank	+(-)
Digitalisation	Mobile cellular subscriptions, Fixed broadband subscriptions (per 100 people) and Individuals using the Internet (% of population)	World Bank	+(-)
Inflation	consumer prices (annual %)	World Bank	+(-)
Gross fixed capital formation	Gross fixed capital formation (% of GDP)	World Bank	+(-)
Population	Population, total	World Bank	+(-)
Foreign Direct Investment	Foreign direct investment, net inflows (% of GDP)	World Bank	+(-)

Table 3.1 presents a description of variables in the study, the sources and expected signs of their impact in the relationships.

3.3 Model Specification

The empirical analysis is divided into two parts. In the first part, the impact of security spending on economic growth has been examined and in the second part the effect of digitalisation would also be investigated using the following basic model as:

$$Economic\ Growth_{it} = \alpha + \alpha_1 \text{Security Spending}_{it} + \alpha_2 \text{Inflation}_{it} + \alpha_3 \text{Trade}_{it} + \alpha_4 \text{Population}_{it} + \alpha_5 \text{FDI}_{it} + \mu_{it} \quad (1)$$

$$Economic\ Growth_{it} = \alpha + \alpha_1 \text{Digitalisation}_{it} + \alpha_2 \text{Inflation}_{it} + \alpha_3 \text{Trade}_{it} + \alpha_4 \text{Population}_{it} + \alpha_5 \text{FDI}_{it} + \mu_{it} \quad (2)$$

$$Economic\ Growth_{it} = \alpha + \alpha_1 \text{Digitalisation}_{it} + \alpha_{21} \text{Security Spending}_{it} + \alpha_3 (\text{Digitalisation}_{it} \text{ X Security spending}_{it}) + \alpha_4 \text{Inflation}_{it} + \alpha_5 \text{Trade}_{it} + \alpha_6 \text{Population}_{it} + \alpha_7 \text{FDI}_{it} + \mu_{it} \quad (3)$$

3.2 Estimation strategy

This segment outlines the statistical procedures utilized to obtain the empirical results for the aforementioned model. The process begins with preliminary checks, before employing the Method of Moments Quantile Regression, which constitutes the primary model of interest. Subsequently, a simultaneous bootstrap quantile regression is conducted to assess the robustness of the results. The detailed steps are delineated as follows:

3.2.1 Preliminary Checks

A systematic approach was adopted to investigate the relationship between the variables. The initial step involved conducting several preliminary tests, including descriptive statistics and correlation analysis among the variables. The normality of the data was assessed using the QQ plot. Indeed, it was these preliminary checks that gave the researcher the lead as to the most appropriate model based on the structure of the data series. In order to prevent biased and spurious estimates, the researchers a panel stationarity or unit root.

3.3.2 Method of moments quantile regression (MMQR)

In investigating the asymmetric and nonlinear nexus among the key variables of study, i.e., digitalisation, security spending and economic growth in Africa, this study empirically employs the Method of Moments Quantile Regression (MMQR) estimation technique, developed by Machado & Santos Silva (2019). The MMQR is a model that can assist to properly explain the dynamics of the nexus. This is to ensure that the research nuances in the relationship among the variables of interest and to appropriate proffer policy recommendations that will engender economic growth in Africa. The MMQR model was chosen given its ability to deal with a number of limitations found in the traditional regression models (Ma, 2022). Firstly, it provides accurate and vigorous results when the distribution of the dataset is non-parametric, particularly when the data entails outliers, minimal or no correlation and non-normality. Secondly, the technique can determine the distributional and unique properties of several quantile values, therefore the problem of uneven distribution is

appropriately addressed. Thirdly, MMQR allows for individual fixed effects across the conditional distribution enabling the predictors to accommodate the location and scale functions (Alhassan et al., 2020). Again, MMQR is robust in discerning the conditional heterogeneous covariance effects of GDP, trade, population density, globalization, and environmental tax on resource depletion, thus resolves the problem of unobserved heterogeneity. It also permits for not only a location-based asymmetry, because the parameters may depend on the position of the predicted variables which is natural resource depletion, but also produces good estimates in diverse conditions, even if the model is non-linear. MMQR is described as a practice-based approach in view of its ability to simultaneously deal with heterogeneity and endogeneity via moment restrictions, hence, appeals to both asymmetric and non-linear estimations. A distinguishing factor of MMQR is its instinctiveness for handling non-crossing estimates, without giving invalid responses. In line with Machado & Santos Silva, (2019). The conditional quantile of the random variable in the panel data for the location and scale $Q_{yit}\ (\delta|x_{it})$ is specified in equation (4) as follows:

$$y_{it} = \alpha_i + x'_{it}\beta + (\partial_i + N'_{it}\theta)v_{it} \qquad (4)$$

where Y_{it} is the dependent variable, x'_{it} is an i.i.d endogenous variable, and (α, β, ∂, and θ) are parameters to be assessed. The probability, $P\ \{\partial_i + N'_{it} > 0\} = 1$. v_{it} is an i.i.d unobserved random variable distributed across individuals and is orthogonal to x'_{it} satisfying the c, moment conditions (see Ma, 2022; Sun, 2022). i = 1 … n, denotes the individual i fixed effects and is a k-vector of known components of X. Again, x'_{it} is orthogonal to cross-sections (i) and time (t) in the expression as captured in Machado & Santos Silva, (2019). Thus, reserves and external variables stabilize. Hence, equation (1), (2), (3) and (4) might be rewritten as follows:

$$Q_{y(\delta|x_{it})} = \big(\alpha_i + \partial_i r(\delta)\big) + x'_{it}\beta + X_{it}\theta r(\delta) \qquad (5)$$

Where $Q_{y_{it}(\delta|x_{it})}$ is the quantile distribution of the dependent variable, Yit. $\alpha_i(\delta) \equiv \alpha i + \partial_i r(\delta)$ is the scalar coefficient andth is the sample quantile. Z denotes a k-vector of known components of Xit which is normalized to satisfy the Machado & Santos Silva, (2019) moment conditions E(U) = 0 and E(|U|) = 1 (see Ike et al., 2020).

4.0 RESULTS AND DISCUSSIONS

This section presents the results and discussion, specifically touches on the descriptive statistics, correlation matrix, unit root test, cross sectional dependence prior to the base line results using the method of moments quantile regression as well as the robustness results from the simultaneous bootstrap quantile regression.

4.1 Descriptive statistics

The descriptive statistics in Table 2 provides an insightful overview of the dataset related to economic growth, security spending, digitalization, and other relevant variables. Economic growth shows a high mean of 50 billion, with a substantial standard deviation (SD) of 10 billion, indicating wide variability among countries or regions. This is also reflected in the significant difference between the minimum value of 49 billion and the maximum value of 57 billion. The skewness (2.9) and kurtosis (10.399) show that economic growth is positively skewed and leptokurtic, suggesting

that a few observations are far larger than the rest.

Security spending has a mean of 1.753 with an SD of 1.594, indicating moderate variability. The positive skewness (1.758) and kurtosis (6.581) suggest that most countries spend relatively less on security, but a few spend significantly more, with outliers pushing the data to the right. Digitalization shows an average of nearly zero, a high SD of 1.000, and extreme skewness (6.012) and kurtosis (41.159), indicating that most countries have low levels of digitalization, while a few are highly digitalized, creating a heavy right tail in the distribution.

Fixed capital formation has a mean of 19.399 and a moderately high SD of 9.016, showing substantial investment variability across countries. However, the skewness (-0.347) indicates a slight left skew, suggesting that more countries tend to have lower than average levels of capital formation, while the kurtosis (6.053) indicates a heavy-tailed distribution. Inflation displays a mean of 11.701, but with a very high SD (45.852), suggesting that inflation rates vary drastically across observations. Its extreme skewness (6.790) and kurtosis (65.798) indicate the presence of severe outliers with exceptionally high inflation rates. FDI has a mean of 4.612 and an SD of 9.509, showing high variability in foreign direct investment across countries, with large positive skewness (7.082) and high kurtosis (61.533), reflecting that a few countries receive much higher FDI than others. Finally, population density shows a mean of 2.542 and a smaller SD of 1.044, indicating less variation compared to other variables. However, the negative skewness (-1.085) and relatively high kurtosis (8.294) suggest that while most countries have low to moderate population densities, a few highly densely populated countries pull the distribution to the left, with notable outliers. These insights highlight the economic diversity and varying development levels across the countries in the dataset.

Table 2 Descriptive Statistics

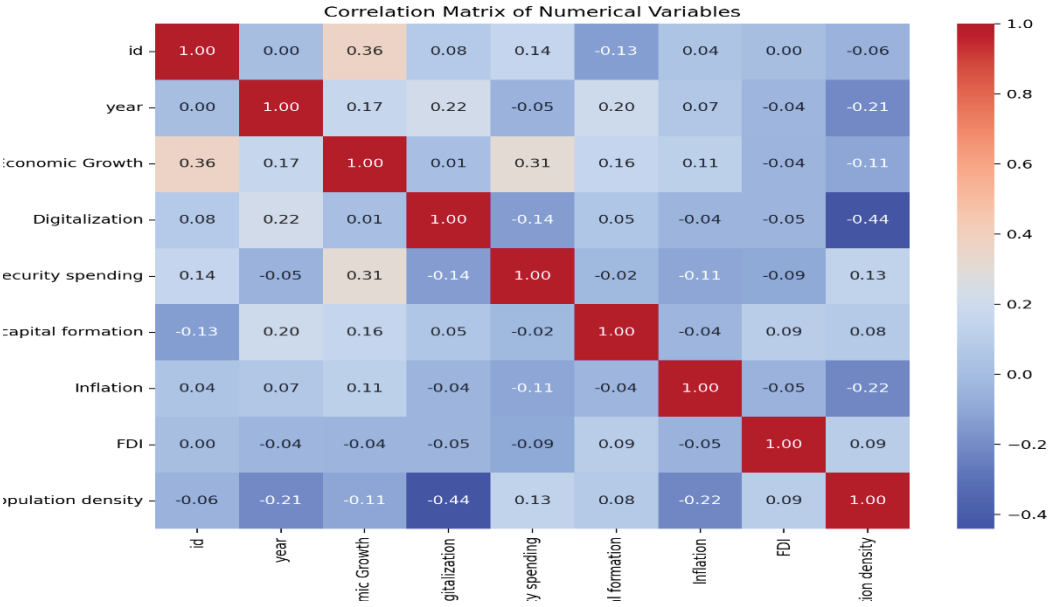
Stats	Economic growth	Security spending	Digitalisation	Fixed capital formation	Inflation	FDI	Population density
Count	396	396	396	396	396	396	396
Mean	5.1E+10	1.753	0.000	19.399	11.701	4.612	2.542
SD	1.1E+11	1.594	1.000	9.016	45.852	9.509	1.044
Min	4.9E+08	0.142	-0.429	-22.786	-150.965	-4.846	-3.755
Max	5.7E+11	8.909	7.999	59.723	513.907	103.337	5.785
Skewness	2.900	1.758	6.012	-0.347	6.790	7.082	-1.085
Kurtosis	10.399	6.581	41.159	6.053	65.798	61.533	8.294

4.2 Correlation

The correlation matrix reveals several interesting relationships among the numerical variables. Economic Growth shows a strong positive correlation with Security spending, suggesting that as economies grow, there is a tendency to increase spending on security. Digitalization has a weak correlation with most variables, indicating that its impact or relationship with other economic indicators is not straightforward. Security spending and Fixed capital formation are moderately correlated, which might imply that investments in infrastructure and security often go hand in hand. Inflation has a weak negative correlation with Economic Growth, suggesting that higher inflation might slightly hinder economic growth. FDI shows a moderate positive correlation with Economic Growth, indicating that foreign investments are likely to increase as economies expand. Population density has a weak correlation with most variables, suggesting that it does not directly influence

or is influenced by the other economic indicators in this dataset. The correlation between year and Economic Growth is positive, reflecting a general trend of economic expansion over time. The weak correlations of Digitalization and Population density with other variables suggest that these factors might be influenced by or influence other non-economic factors not captured in this dataset. Overall, the matrix highlights the interconnectedness of economic growth, security spending, and foreign investments, while also pointing out areas where relationships are less clear.

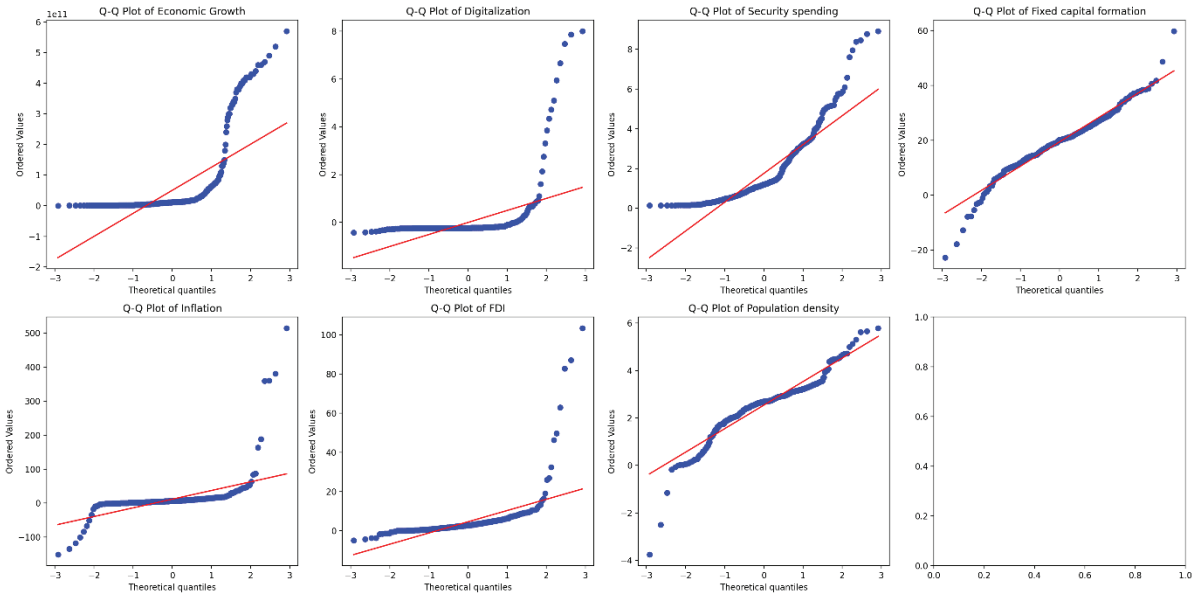
Figure1: Correlation Matrix



4.3 Normality Test using QQ plot

The QQ plots for the selected variables as shown in Figure 2 below allow us to visually assess how well each variable's distribution aligns with a normal distribution. In these plots, the data points are plotted against a theoretical normal distribution in such a way that if the data is normally distributed, the points will approximately lie on a straight line. For Economic Growth, the QQ plot shows significant deviations from the line, especially in the tails, indicating that the distribution is not normal and is likely skewed or has heavy tails. Digitalization's QQ plot also shows deviations, particularly in the lower tail, suggesting a departure from normality, possibly due to skewness. Security spending exhibits a similar pattern, with deviations in both tails, indicating potential outliers or a non-normal distribution. The QQ plot for fixed capital formation demonstrates a closer alignment with the reference line, suggesting a distribution that approximates normality, although some deviations persist. In contrast, the QQ plot for inflation exhibits significant deviations, particularly in the upper tail, indicating a skewed distribution. The QQ plot for FDI displays a pattern akin to that of economic growth, with notable deviations in the tails, suggesting non-normality. Lastly, the QQ plot for population density reveals deviations in both tails, indicating a non-normal distribution potentially influenced by outliers or skewness. Collectively, these QQ plots imply that the majority of the selected variables do not conform to a normal distribution, a consideration of critical importance when selecting appropriate statistical methods for analysis.

Figure 2: QQ-plot of all variables



4.4 3D analysis of the relationship between the main variables of interest

Analysing the 3D surface plot of Digitalization, Security spending, and Economic Growth as shown in Figure 3 reveals several interesting patterns and relationships. The general shape of the surface suggests a complex, non-linear interaction between these three variables as argued by Becha, et al 2023 and Zhang et al., 2023. At first glance, we can observe that the surface is not uniform, indicating that the relationship between these variables varies across different levels of Digitalization and Security spending. There appears to be a general upward trend in Economic Growth as both Digitalization and Security spending increase, as evidenced by the gradual rise in the surface from the lower left corner to the upper right corner of the plot. However, this trend is not consistent across all levels, showing areas of both steep inclines and plateaus.

Notably, there's a prominent peak in Economic Growth at moderate to high levels of both Digitalization and Security spending, suggesting that there might be an optimal range for these factors in relation to economic performance. This peak is surrounded by areas of lower Economic Growth, forming a sort of "mountain" in the surface plot. The presence of this peak implies that simply maximizing both Digitalization and Security spending may not always lead to the highest Economic Growth; instead, there might be a "sweet spot" where the balance between these factors is most conducive to economic prosperity.

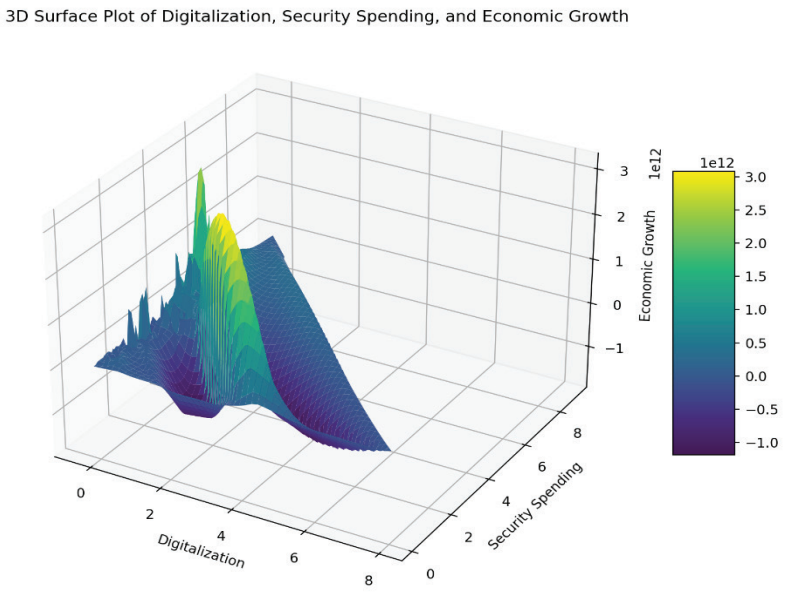
Interestingly, we can observe some valleys or depressions in the surface, particularly at low levels of Digitalization combined with varying levels of Security spending. These areas of lower Economic Growth might represent scenarios where insufficient digital infrastructure or adoption hinders economic performance, regardless of security investments. On the other hand, at very high levels of Digitalization, the surface seems to show a more consistent positive relationship with Economic Growth across different levels of Security spending, suggesting that highly digitalized economies might be more resilient to variations in security expenditures.

The edges of the surface plot, especially at extreme values of Digitalization or Security spending, show some irregularities and sharp changes. These could be artifacts of the interpolation method used to create the surface, or they might represent actual outliers or extreme cases in the dataset.

It's important to interpret these edge cases with caution and possibly investigate them further to ensure they're not unduly influencing the overall interpretation of the relationships.

The colour gradient of the surface provides additional insight into the magnitude of Economic Growth across the plot. The transition from cooler colors (blues and greens) to warmer colors (yellows and reds) as we move towards areas of higher Economic Growth helps to visually reinforce the patterns we've observed. This color scheme makes it easier to identify regions of high and low economic performance and how they correspond to different combinations of Digitalization and Security spending levels.

Figure 3: 3D-plot of the relationship between the main variables of interest



4.4 Unit Root Test

The ADF test results in Table 3 below indicates that all the variables are stationary, as evidenced by their p-values being less than 0.05. This suggests that the data does not have a unit root and is suitable for time series analysis without the need for differencing. The ADF statistics for each variable are more negative than the critical values at the 1%, 5%, and 10% levels, further confirming stationarity. Given these results, we can proceed with further analysis, such as building time series models or conducting cointegration tests, without needing to transform the data for stationarity. The next steps will involve planning and executing analyses that leverage the stationarity of these variables to explore relationships and trends over time.

Table 3: Unit root test

Variable	ADF Statistic	p-value	1% Critical Value	5% Critical Value	10% Critical Value
Economic Growth	-3.5906	0.0059	-3.4473	-2.869	-2.5708
Digitalization	-4.7636	0.0000638	-3.4471	-2.8689	-2.5707
Security spending	-4.6655	0.0000976	-3.4472	-2.869	-2.5707
Fixed capital formation	-6.8887	1.37E-09	-3.4471	-2.8689	-2.5707

Inflation	-6.5542	8.7E-09	-3.4471	-2.8689	-2.5707
FDI	-5.605	0.00000124	-3.4473	-2.869	-2.5708
Population density	-5.4177	0.00000311	-3.4471	-2.8689	-2.5707

The panel unit root test results reveal a mixed picture of stationarity across variables and countries, with some variables showing more consistent patterns than others. For Economic Growth, most countries exhibit non-stationarity (p-values > 0.05), except for Ethiopia and Burkina Faso, suggesting that economic growth trends may not be easily predictable or may follow random walks in most of the analyzed countries. Digitalization shows a similar pattern of non-stationarity for most countries, with Chad and Ethiopia being exceptions, indicating that the digital transformation process might be following different trajectories across the analyzed nations. Security spending and Fixed capital formation display more instances of stationarity across countries, which could imply that these variables might be more predictable or follow more stable patterns over time. Interestingly, Population density shows extreme variability in stationarity across countries, with some nations like Central African Republic showing strong stationarity (p-value < 0.05) while others like Burkina Faso and Ethiopia display clear non-stationarity (p-value = 1.0), highlighting the diverse demographic dynamics in the region.

4.5 Cross Sectional Dependence

The cross-sectional dependence test using Pesaran's CD test as shown in Table 4 below was performed on seven variables: Economic Growth, Digitalization, Security spending, Fixed capital formation, Inflation, FDI, and Population density. The results show strong evidence of cross-sectional dependence for all variables, with p-values of 0.0 across the board, indicating that the countries in the dataset are interconnected and shocks to one country are likely to affect others. Economic Growth exhibited the highest CD statistic (61.96), suggesting the strongest cross-sectional dependence, while Inflation had the lowest CD statistic (9.09), though still indicating significant cross-sectional dependence. These findings have important implications for econometric modeling, suggesting that standard panel data methods assuming cross-sectional independence may not be appropriate, and methods that account for cross-sectional dependence, such as Common Correlated Effects (CCE) estimator or Cross-sectionally augmented Im, Pesaran and Shin (CIPS) test for unit roots, should be considered. The presence of cross-sectional dependence in all variables, including those that might be expected to be more country-specific like Population density, indicates underlying regional or global trends affecting various aspects across countries in the sample.

Table 4: Cross Sectional Dependence

Variables	**CD Statistic**	**p-value**	**Cross-sectional Dependence**
Economic Growth	61.95729	0.000	Present
Digitalization	44.37245	0.000	Present
Security spending	45.22451	0.000	Present
Fixed capital formation	17.16665	0.000	Present
Inflation	9.08666	0.000	Present
FDI	19.37983	0.000	Present
Population density	33.55801	0.000	Present

4.6 Baseline Results

The results of the Method of Moments Quantile Regression in Table 5 highlight the varying impact of digitalization on economic growth across different levels of growth. Digitalization has a consistently positive impact on economic growth across all quantiles, with stronger effects observed as the level of economic growth increases. This is evident from the coefficients, which start at 0.240 in the lowest quantile (quantile 1) and increase progressively to 0.513 in the highest quantile (quantile 9). The significance of these results, particularly at the 1% level (***), suggests that the effect of digitalization is robust and plays a crucial role in boosting economic growth, especially in higher-growth economies. This as noted by Sturgeon, (2021) implies that economies that are already growing tend to benefit more from digitalization, as digital tools and infrastructure likely enhance productivity, innovation, and connectivity, leading to further economic expansion.

Regarding the lower quantiles (quantiles 1 to 3), which represent economies with lower levels of growth, digitalization still has a positive and significant effect, but its impact is more modest. This could be because economies at these stages might have less developed digital infrastructure, and the benefits of digitalization are not fully realized. However, as posited by Liu & Waqas, (2024) the fact that digitalization still contributes to growth even in these contexts is important, as it suggests that investments in digital infrastructure could serve as a catalyst for economic improvement in less developed or slower-growing economies. As we move to the middle quantiles (quantile 5, representing moderate economic growth), digitalization continues to have a positive and significant impact, with a coefficient of 0.371. This suggests that as economies advance and their digital infrastructure becomes increasingly integrated across various sectors, the advantages of digitalization begin to accumulate, resulting in more pronounced growth effects. In line with the empirical positions of studies such as Yaqub & Alsabban, (2023), Zhang et. al., (2022), Mayer, (2021), and Matyushok et. al., (2021), this could be due to the fact that digital technologies enhance efficiencies in production, reduce transaction costs, and open up new markets, which are particularly important for economies that are transitioning from low to moderate growth levels. At the higher quantiles (quantiles 6 to 9), which represent the highest levels of economic growth, the impact of digitalization becomes even more pronounced. The coefficients range from 0.392 to 0.513, with all values being highly significant at the 1% level. This suggests that economies with high growth are better positioned to leverage the full potential of digitalization, perhaps due to more advanced infrastructure, better digital literacy, and more integrated digital systems in their economies. These economies may also be benefiting from network effects, where the widespread adoption of digital technologies leads to exponential improvements in productivity and economic performance. Again, empirical literature has shown that, digitalization significantly enhances economic growth by fostering innovation, improving productivity, and facilitating industrial restructuring. The digital economy has emerged as a crucial driver of economic development, with evidence indicating that it creates millions of jobs and promotes high-quality economic transformation (Chen et al., 2023; Li, 2023).

Concerning the control variables, fixed capital formation exhibits a positive and highly significant association with economic growth across all quantiles. This finding as corroborated by Sarwar, et al, 2021, underscores the critical role of investments in physical assets, such as machinery, infrastructure, and buildings, as key drivers of economic growth. The coefficients demonstrate relative stability across quantiles, indicating that fixed capital investments are universally significant, irrespective of the level of economic growth. Inflation presents a mixed but generally positive effect on economic growth, with significance observed at various quantiles, particularly at higher levels

of growth. This might indicate that moderate levels of inflation are associated with rising prices in growing economies, reflecting demand-driven growth. However, the impact of inflation is weaker compared to digitalization and fixed capital formation. Foreign direct investment (FDI), interestingly, has a negative but insignificant effect on economic growth across all quantiles as evidenced in Thao, et al., (2025) and Abd Alah & Ojekemi, (2025). This result could suggest that the role of FDI in driving growth might be limited in the context of the specific economies studied, or that the effects of FDI are more long-term and not immediately reflected in the data. Finally, population density has an inconsistent and generally insignificant relationship with economic growth. At lower quantiles, it shows a slight positive impact, but this diminishes and becomes negative at higher quantiles. This might suggest that while higher population density could initially support economic growth through larger labor markets and consumer bases, it may also lead to congestion and strain on resources in more developed economies, thereby limiting further growth.

Thus, the results of the analysis demonstrate that digitalization is a powerful driver of economic growth, particularly as economies move from low to high levels of growth. Investments in digital infrastructure and technologies are essential for fostering sustained economic growth, especially in higher-performing economies. Additionally, the role of fixed capital formation remains crucial across all growth levels, while inflation and FDI play more complex roles. Overall, digitalization's increasing impact at higher quantiles highlights its transformative potential in accelerating economic growth, particularly in already expanding economies.

Table 5: The effect of digitalization on economic growth- Method of moments quantile regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	location	scale	qtile__1	qtile__2	qtile__3	qtile__4	qtile__5	qtile__6	qtile__7	qtile__8	qtile__9
Digitalisation	0.376***	0.0815	0.240**	0.285***	0.324***	0.346***	0.371***	0.392***	0.414***	0.455***	0.513***
	(0.0959)	(0.0612)	(0.122)	(0.104)	(0.0947)	(0.0932)	(0.0951)	(0.0994)	(0.107)	(0.124)	(0.157)
Fixed capital formation	0.0421***	-0.000811	0.0435***	0.0430***	0.0426***	0.0424***	0.0421***	0.0419***	0.0417***	0.0413***	0.0407***
	(0.00837)	(0.00535)	(0.0107)	(0.00904)	(0.00825)	(0.00813)	(0.00831)	(0.00868)	(0.00930)	(0.0108)	(0.0137)
Inflation	0.00397**	0.000547	0.00306	0.00336	0.00362*	0.00377**	0.00394**	0.00407**	0.00423**	0.00450*	0.00489
	(0.00192)	(0.00122)	(0.00244)	(0.00207)	(0.00189)	(0.00186)	(0.00190)	(0.00199)	(0.00213)	(0.00248)	(0.00313)
FDI	-0.00530	-0.00325	0.000119	-0.00168	-0.00324	-0.00411	-0.00512	-0.00593	-0.00684	-0.00845	-0.0108
	(0.00583)	(0.00372)	(0.00743)	(0.00629)	(0.00574)	(0.00566)	(0.00578)	(0.00604)	(0.00648)	(0.00755)	(0.00953)
Population density	0.0480	-0.0689	0.163	0.125	0.0915	0.0731	0.0518	0.0346	0.0155	-0.0186	-0.0678
	(0.0869)	(0.0555)	(0.111)	(0.0940)	(0.0858)	(0.0844)	(0.0862)	(0.0901)	(0.0966)	(0.113)	(0.142)
Constant	22.29***	1.330***	20.08***	20.81***	21.45***	21.81***	22.22***	22.55***	22.92***	23.58***	24.53***
	(0.272)	(0.174)	(0.357)	(0.314)	(0.280)	(0.268)	(0.271)	(0.282)	(0.312)	(0.371)	(0.489)
Observations	396	396	396	396	396	396	396	396	396	396	396

Standard errors in parentheses

****** p<0.01, ** p<0.05, * p<0.1***

4.7 The effect of security spending on economic growth.

Analysing the outcome of the objective two in Table 6 below which is the base line results of the impact of security spending on economic growth. Starting with the location column, security spending has a positive and highly significant effect on economic growth, with a coefficient of 0.312 at the 1% significance level (***). This indicates that on average, increased security spending contributes positively to economic growth across the dataset. The scale column shows a smaller positive but still significant effect of security spending (0.163), suggesting that while security spending generally boosts economic growth, the dispersion of economic growth outcomes is affected less by variations in security spending.

At the lowest quantile (quantile 1), representing economies with the least level of economic growth, security spending has a small positive effect (0.0393), but this impact is insignificant, suggesting that in economies with minimal growth, security spending alone may not significantly stimulate growth. However, at quantile 2, which represents slightly higher levels of economic growth, security spending becomes significant at the 10% level (*), with a coefficient of 0.131. This indicates that for economies with low but slightly better growth than the lowest group, security spending begins to show some potential in boosting growth, likely because improved security fosters a stable environment for economic activities. Moving to quantile 3 (low growth economies), security spending is positive and highly significant (0.198), marking a turning point where its impact on growth becomes clearer and stronger. Security spending may encourage investments, protect infrastructure, and foster a conducive environment for businesses in these slightly growing economies. By quantile 4, the impact of security spending grows further, with a coefficient of 0.255 (significant at the 1% level), showing that the returns from security spending increase as economies move towards moderate growth. At quantile 5 (representing moderate levels of economic growth), security spending is again highly significant (0.312), reinforcing the idea that in economies with steady growth, investments in security directly contribute to sustaining and accelerating this growth. The importance of security spending becomes even more pronounced at quantile 6, where the coefficient rises to 0.361. This highlights that as economies transition to higher growth phases, security investments ensure the protection of assets and help maintain law and order, which are crucial for uninterrupted growth. In higher quantiles (quantiles 7, 8, and 9), which represent economies with the highest levels of economic growth, the positive impact of security spending continues to increase. At quantile 7, the coefficient is 0.406, indicating that security spending plays a vital role in safeguarding the economic gains of these fast-growing economies, in sync with findings from Tahir et. al., (2022) and Sibt e Ali et. al., (2025). As we move to quantile 8, security spending becomes even more important, with a significant coefficient of 0.482. This suggests that as economies grow rapidly, security becomes even more essential to ensure that growth is sustainable, protecting economic infrastructure and minimizing disruptions. At quantile 9, representing the economies with the highest level of economic growth, security spending has the largest effect, with a coefficient of 0.611, significant at the 1% level (***). This strong positive relationship between security spending and economic growth at the highest growth levels suggests that for economies already experiencing high growth, security is a key factor in maintaining stability, attracting further investment, and ensuring that growth continues at a fast pace. These economies are likely investing heavily in security infrastructure to safeguard their economic achievements and continue expanding. The above findings is in sync with for instance, Chidinma (2024) who argues that recurrent expenditure on internal security in Nigeria has a direct impact on economic growth by encouraging aggregate demand, creating new savings, and

reallocating resources from potential civilian investments. This assertion is supported by findings from Dudzevičiūtė et al., (2016), who note that when a portion of defence spending is allocated to education and training, it can lead to the development of a skilled workforce, thereby enhancing productivity and economic output. The positive effects of security spending on aggregate demand can lead to increased consumption and investment, which are critical drivers of economic growth.

Regarding the control variables, Fixed capital formation shows a consistently positive and highly significant effect across all quantiles, indicating that investments in physical assets such as infrastructure, machinery, and buildings are important drivers of economic growth across different levels of growth. Inflation also has a positive impact on growth in the higher quantiles (from quantile 6 to 9), where moderate inflation may reflect a healthy, growing economy. FDI (foreign direct investment) shows a generally negative or insignificant effect across quantiles, with a marginally significant negative effect at quantile 9, which suggests that in fast-growing economies, FDI may not be contributing as positively as expected. Lastly, population density has a negative and significant impact on economic growth at higher quantiles (from quantile 7 to 9), indicating that higher population densities may strain resources and limit economic growth in fast-growing economies.

Table 6: Baseline Results from Method of Moments Quantile Regression on the effect of security spending on economic growth.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	location	scale	qtile__1	qtile__2	qtile__3	qtile__4	qtile__5	qtile__6	qtile__7	qtile__8	qtile__9
Security Spending	0.312***	0.163***	0.0393	0.131*	0.198***	0.255***	0.312***	0.361***	0.406***	0.482***	0.611***
	(0.0663)	(0.0382)	(0.0906)	(0.0792)	(0.0722)	(0.0685)	(0.0672)	(0.0679)	(0.0711)	(0.0808)	(0.0981)
Fixed capital formation	0.0538***	0.00863*	0.0394***	0.0442***	0.0478***	0.0508***	0.0538***	0.0564***	0.0589***	0.0629***	0.0697***
	(0.00835)	(0.00482)	(0.0115)	(0.00986)	(0.00897)	(0.00851)	(0.00837)	(0.00851)	(0.00887)	(0.00989)	(0.0123)
Inflation	0.00449*	0.00187	0.00136	0.00241	0.00318	0.00384	0.00449*	0.00505**	0.00558**	0.00645**	0.00794**
	(0.00244)	(0.00141)	(0.00335)	(0.00287)	(0.00262)	(0.00248)	(0.00244)	(0.00248)	(0.00259)	(0.00288)	(0.00359)
FDI	-0.00367	-0.00508*	0.00484	0.00197	-0.000118	-0.00189	-0.00367	-0.00520	-0.00663	-0.00898	-0.0130*
	(0.00494)	(0.00285)	(0.00680)	(0.00582)	(0.00530)	(0.00503)	(0.00495)	(0.00503)	(0.00524)	(0.00584)	(0.00727)
Population density	-0.151*	-0.0641	-0.0440	-0.0802	-0.107	-0.129	-0.151*	-0.171**	-0.189**	-0.218**	-0.269**
	(0.0854)	(0.0492)	(0.117)	(0.101)	(0.0916)	(0.0869)	(0.0855)	(0.0870)	(0.0906)	(0.101)	(0.126)
Constant	22.01***	0.861***	20.57***	21.05***	21.41***	21.71***	22.01***	22.27***	22.51***	22.91***	23.60***
	(0.282)	(0.162)	(0.389)	(0.336)	(0.306)	(0.290)	(0.286)	(0.289)	(0.302)	(0.340)	(0.419)
Observations	396	396	396	396	396	396	396	396	396	396	396

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4.8 The combined effect of security spending and digitalisation on economic growth

In Table 7 below where the results of the combined effect of both security spending and digitisation is depicted, the location results, which represent the average effect of the independent variables, indicate that security spending has a significant positive impact on economic growth (0.407), while digitalization has a negative but insignificant average effect (-0.0619). The combined effect of security spending and digitalization is strongly positive (0.659), suggesting that digitalization can enhance the positive effect of security spending when both are considered together. The scale results indicate that security spending increases the dispersion in economic growth outcomes (0.112), while digitalization significantly reduces the dispersion (-0.165), showing that it helps stabilize economic growth.

Focusing on the quantile results, security spending consistently shows a strong and statistically significant positive impact across all quantiles, from the lowest level of economic growth (0.222 in quantile 1) to the highest level of economic growth (0.603 in quantile 9). This implies that security spending is a robust driver of economic growth across the entire distribution, with its effect intensifying at higher levels of economic growth. The escalating coefficient values across the quantiles unequivocally demonstrate that as economies expand, security spending becomes an indispensable pillar in not only sustaining but also propelling higher levels of growth (Zakari & Musibau, 2024; Cardenas, 2025). This compelling evidence underscores the critical importance of security investment, particularly in more developed or rapidly advancing economies, where it plays a pivotal role in enhancing infrastructure, ensuring stability, and bolstering investor confidence. It is imperative to recognize that without robust security investment, the very foundation of economic growth could be jeopardized, making it an essential strategy for any forward-thinking economy.

On the other hand, the effect of digitalization is more nuanced. At the lowest levels of economic growth (quantile 1), digitalization has a positive and significant impact (0.210), indicating that at initial stages, technological advancements can spur economic growth by enhancing productivity and connectivity. However, its effect diminishes as we move to higher quantiles, becoming negative and statistically significant at higher levels of growth. For instance, in quantile 9 (the highest economic growth level), digitalization has a significant negative effect (-0.350). This suggests that digitalization may introduce certain challenges, such as technological unemployment or adaptation costs in higher-growth economies, where traditional sectors might struggle to adjust to digital advancements.

The combined effect of security spending and digitalization is consistently positive and significant across all quantiles, reinforcing the idea that digitalization, when paired with security investment, can have a strong positive effect on growth. The coefficients are particularly high across all quantiles, with the largest effect observed at the highest quantile (0.712 in quantile 9). This indicates that digitalization can offset some of the challenges it poses when combined with robust security spending, facilitating stable and sustainable growth even in the highest-growing economies. Certainly empirical research has that effective allocation of defence expenditures can stimulate human capital formation and socio-economic infrastructure, thereby promoting growth (Dudzevičiūtė et al., 2016; Wadjdi, 2023).

For the control variables, fixed capital formation is positively associated with economic growth across all quantiles, with stronger effects at higher quantiles (0.0702 in quantile 9). This is consistent

with the literature, as investment in capital typically drives growth by increasing productive capacity. Inflation has a weak and mostly insignificant effect, though it becomes slightly positive in higher quantiles, suggesting that mild inflation may accompany growth. Foreign direct investment (FDI) has a small but inconsistent impact, with a positive effect at lower quantiles (0.0108 in quantile 1) and a negative effect at higher quantiles, reflecting the volatility and potential challenges of FDI in influencing sustained economic growth in certain contexts. Population growth has no significant effect across most quantiles, indicating that demographic factors may not directly influence economic growth in this sample.

In conclusion, these results underscore the importance of security spending as a key driver of economic growth, while the role of digitalization is more complex, with its benefits realized mostly in conjunction with other factors like security investments. The findings highlight the need for balanced and context-specific policies to harness the full potential of digitalization in driving economic growth across different levels of economic development. This clearly depicted in Figure 4 below.

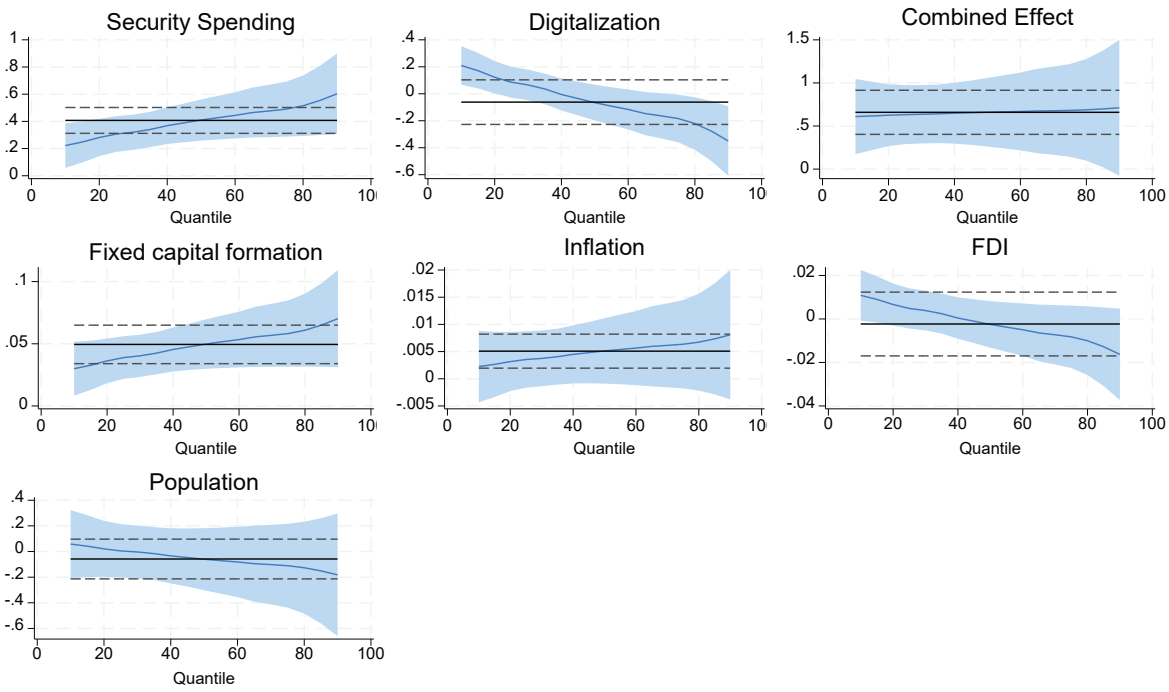
Table 7: Combined effect of security spending and digitalisation on economic growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	location	scale	qtile__1	qtile__2	qtile__3	qtile__4	qtile__5	qtile__6	qtile__7	qtile__8	qtile__9
Security Spending	0.407***	0.112**	0.222***	0.282***	0.320***	0.369***	0.410***	0.444***	0.477***	0.515***	0.603***
	(0.0765)	(0.0565)	(0.0839)	(0.0700)	(0.0661)	(0.0689)	(0.0772)	(0.0867)	(0.0981)	(0.114)	(0.151)
Digitalization	-0.0619	-0.165***	0.210***	0.123**	0.0657	-0.00519	-0.0657	-0.116	-0.164*	-0.220**	-0.350***
	(0.0664)	(0.0491)	(0.0730)	(0.0611)	(0.0578)	(0.0603)	(0.0676)	(0.0756)	(0.0855)	(0.0993)	(0.132)
Combined Effect	0.659***	0.0301	0.610***	0.626***	0.636***	0.649***	0.660***	0.669***	0.678***	0.688**	0.712*
	(0.201)	(0.149)	(0.222)	(0.183)	(0.173)	(0.180)	(0.203)	(0.230)	(0.261)	(0.301)	(0.403)
Fixed capital formation	0.0495***	0.0119	0.0300***	0.0362***	0.0403***	0.0454***	0.0498***	0.0534***	0.0569***	0.0609***	0.0702***
	(0.0100)	(0.00742)	(0.0110)	(0.00917)	(0.00865)	(0.00903)	(0.0101)	(0.0114)	(0.0129)	(0.0150)	(0.0199)
Inflation	0.00508*	0.00172	0.00224	0.00315	0.00375	0.00449*	0.00512*	0.00565	0.00615	0.00674	0.00809
	(0.00304)	(0.00225)	(0.00336)	(0.00277)	(0.00261)	(0.00273)	(0.00307)	(0.00347)	(0.00394)	(0.00454)	(0.00607)
FDI	-0.00232	-0.00801**	0.0108*	0.00662	0.00387	0.000430	-0.00251	-0.00494	-0.00727	-0.0100	-0.0163
	(0.00540)	(0.00399)	(0.00594)	(0.00493)	(0.00466)	(0.00486)	(0.00546)	(0.00615)	(0.00696)	(0.00806)	(0.0107)
Population	-0.0582	-0.0708	0.0582	0.0209	-0.00349	-0.0339	-0.0599	-0.0814	-0.102	-0.126	-0.182
	(0.122)	(0.0904)	(0.135)	(0.111)	(0.105)	(0.110)	(0.123)	(0.140)	(0.158)	(0.183)	(0.244)
Constant	21.83***	0.890***	20.36***	20.83***	21.14***	21.52***	21.85***	22.12***	22.38***	22.68***	23.38***
	(0.376)	(0.278)	(0.415)	(0.346)	(0.327)	(0.341)	(0.383)	(0.430)	(0.487)	(0.565)	(0.750)
Observations	396	396	396	396	396	396	396	396	396	396	396

Standard errors in parentheses

****** p<0.01, ** p<0.05, * p<0.1***

Figure 4: Graphical view of the method of moments quantile regression



4.8 Robustness Test

Similar results have been recorded using Simultaneous Bootstrap Quantile Regression as captured in Table 8, the findings reinforce the robustness of the relationship between security spending, digitisation and economic growth across different levels of growth. Bootstrap quantile regression, which generates more reliable estimates by resampling data, helps ensure that the identified effects are not due to random variation or sample-specific characteristics.

In this case, the positive and significant impact of both digitalisation and security spending across quantiles different levels of growth suggests that their roles in promoting economic stability and fostering a conducive environment for business is consistent across various economic contexts. The strong effects indicate that security they become more critical as economies expand, safeguarding investments, infrastructure, and economic assets.

The bootstrap method increases confidence in these findings, suggesting that they hold true even after accounting for potential variability in the data. Therefore, the overall conclusion remains that digitalisation and security spending are an essential driver of economic growth, particularly in higher-growth economies, where the stability and protection of economic assets are critical for continued growth.

Table 8: The effect of digitalization on economic growth- Simultaneous Bootstrap quantile regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	q10	q20	q30	q40	q50	q60	q70	q80	q90
Digitalisation	0.197	0.321**	0.374***	0.328***	0.301***	0.260**	0.376***	0.805***	0.641***
	(0.125)	(0.132)	(0.0932)	(0.0781)	(0.107)	(0.129)	(0.145)	(0.178)	(0.152)
Fixed Capita	0.0474**	0.0529**	0.0381**	0.0367***	0.0390***	0.0345***	0.0451***	0.0392***	-0.00170
	(0.0233)	(0.0221)	(0.0183)	(0.00877)	(0.0106)	(0.0121)	(0.0107)	(0.00680)	(0.0320)
Inflation	0.00353*	0.00281	0.00468	0.00477	0.00806	0.00760	0.0126**	0.00562	0.00448
	(0.00190)	(0.00245)	(0.00311)	(0.00369)	(0.00497)	(0.00621)	(0.00637)	(0.00547)	(0.00660)
FDI	-0.00525	0.00567	-0.00445	0.00104	-0.00406	-0.00529	-0.00794***	-0.0118**	-0.00996
	(0.0300)	(0.0352)	(0.0192)	(0.0110)	(0.0122)	(0.00347)	(0.00303)	(0.00596)	(0.0291)
Population	-0.0978	-0.0366	0.184***	0.171***	0.242***	0.214	0.223	0.153	-0.688***
	(0.119)	(0.133)	(0.0563)	(0.0503)	(0.0780)	(0.131)	(0.168)	(0.313)	(0.135)
Constant	20.77***	20.97***	21.31***	21.63***	21.73***	22.16***	22.16***	23.22***	27.12***
	(0.491)	(0.429)	(0.408)	(0.204)	(0.296)	(0.421)	(0.474)	(0.949)	(0.934)
Observations	396	396	396	396	396	396	396	396	396

Standard errors in parentheses

****** p<0.01, ** p<0.05, * p<0.1***

Table 9: The effect of security spending on economic growth- Simultaneous Bootstrap quantile regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	q10	q20	q30	q40	q50	q60	q70	q80	q90
Security Spending	0.255***	0.212***	0.164**	0.135***	0.117*	0.165	0.578***	0.709***	0.631***
	(0.0561)	(0.0430)	(0.0661)	(0.0466)	(0.0691)	(0.198)	(0.128)	(0.117)	(0.112)
Fixed Capita	0.0242	0.0688***	0.0581***	0.0393***	0.0365***	0.0488***	0.0671***	0.0716***	0.0536***
	(0.0167)	(0.0106)	(0.0196)	(0.0146)	(0.0106)	(0.0118)	(0.00732)	(0.00630)	(0.0179)
Inflation	0.00418**	0.00324	0.00304	0.00207	0.00106	0.00841	0.00721	0.0123	0.00782
	(0.00204)	(0.00228)	(0.00376)	(0.00484)	(0.00653)	(0.00951)	(0.0105)	(0.00857)	(0.00796)
FDI	0.0183	-0.00637	0.00419	-0.000282	-0.00266	-0.00529***	-0.00869***	-0.0115**	-0.0187***
	(0.0166)	(0.0208)	(0.00762)	(0.00513)	(0.00308)	(0.00159)	(0.00127)	(0.00584)	(0.00342)
Population	-0.148	-0.167*	-0.0841	-0.0688	-0.0121	-0.00790	-0.152**	-0.155	-0.307
	(0.0902)	(0.0878)	(0.0911)	(0.0476)	(0.0738)	(0.0985)	(0.0754)	(0.124)	(0.217)
Constant	20.70***	20.61***	21.18***	21.97***	22.29***	22.21***	22.13***	22.16***	23.95***
	(0.276)	(0.192)	(0.578)	(0.408)	(0.301)	(0.331)	(0.186)	(0.354)	(0.767)
Observations	396	396	396	396	396	396	396	396	396

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 10: The combined effect of security spending, digitalisation on economic growth- Simultaneous Bootstrap quantile regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	q10	q20	q30	q40	q50	q60	q70	q80	q90
Security Spending	0.349***	0.343***	0.293***	0.329***	0.304***	0.311***	0.501***	0.738***	0.576***
	(0.0656)	(0.0864)	(0.0844)	(0.0912)	(0.0759)	(0.100)	(0.155)	(0.0936)	(0.0909)
Digitalization	0.191***	0.133*	0.0862	-0.0441	-0.0655	-0.0824	-0.105	-0.0941	-0.249**
	(0.0500)	(0.0700)	(0.0595)	(0.0716)	(0.0674)	(0.0676)	(0.0820)	(0.0781)	(0.125)
Combined effect	0.484**	0.516*	0.582**	0.908**	0.888***	0.885***	0.797***	0.551*	0.264
	(0.216)	(0.286)	(0.289)	(0.351)	(0.307)	(0.286)	(0.255)	(0.282)	(0.253)
Fixed capital formation	0.0278***	0.0463***	0.0419***	0.0269***	0.0349***	0.0406***	0.0570***	0.0690***	0.0472***
	(0.0107)	(0.0140)	(0.0151)	(0.00869)	(0.0127)	(0.0104)	(0.00955)	(0.00782)	(0.0146)
Inflation	0.00425***	0.00340**	0.00379	0.00336	0.00890	0.00868	0.00751	0.0130	0.00817
	(0.000948)	(0.00153)	(0.00370)	(0.00463)	(0.00613)	(0.00719)	(0.00789)	(0.0104)	(0.00683)
FDI	0.0183**	0.0122	0.00659	0.00291	-0.00218	-0.00553	-0.00870	-0.0106	-0.0188***
	(0.00715)	(0.0161)	(0.00735)	(0.00450)	(0.00470)	(0.00421)	(0.0157)	(0.0125)	(0.00315)
Population	-0.0859	-0.0918	0.0325	0.00569	0.0847	0.131	0.0274	-0.126	-0.276
	(0.0590)	(0.0822)	(0.0709)	(0.0705)	(0.0839)	(0.119)	(0.233)	(0.224)	(0.257)
Constant	20.48***	20.66***	21.03***	21.88***	21.94***	22.00***	22.03***	22.11***	24.05***
	(0.246)	(0.303)	(0.396)	(0.264)	(0.255)	(0.321)	(0.642)	(0.604)	(0.998)
Observations	396	396	396	396	396	396	396	396	396

Standard errors in parentheses

****** p<0.01, ** p<0.05, * p<0.1***

5.0 CONCLUSION

The analysis of the results provides compelling evidence that security spending plays a pivotal role in driving economic growth across all levels, from the least developed economies to the highest-growth nations. The consistent and significant positive impact of security spending, especially at higher levels of economic growth, suggests that investments in security are crucial for fostering a stable environment that supports economic activities. Digitalization, while beneficial at lower levels of economic growth, presents a more complex picture as its effect diminishes and becomes negative at higher growth levels. When security spending is combined with digitalization, it has a strong and positive impact on economic growth, indicating that digitalization and security are mutually reinforcing economic development factors. The control variables, including fixed capital, continue to show regular signs while inflation, and Foreign Direct investment (FDI) have varying level of effects rather depending on the level of economic development. The results therefore emphasize the importance of adopting balanced policies which account for the different effects of digitalization and security spending in various development phases.

5.1 Policy Implications

Policymakers should prioritize security spending as a fundamental driver of economic growth, particularly in higher-growth economies. The consistent positive impact of security investment across quantiles underscores the need for governments to maintain robust security infrastructure for local and foreign businesses. For developing countries, where economic growth is in early stages, targeted security investments can help create the foundation for sustained growth. This includes physical and cybersecurity, especially as economies become more digitally oriented. The role of digitalization suggests that while technological advancement is essential, it should not be viewed as a universal solution. In early stages of development, digitalization can provide substantial growth benefits through improved efficiency and connectivity. However, in advanced economies, the negative effects of digitalization on growth, seen in higher quantiles, indicate adjustment challenges like technological unemployment or skills mismatch. To address these challenges, policymakers should focus on upskilling the workforce through education and training programs that prepare workers for technological shifts.

The combined effect of security spending and digitalization on economic growth presents key policy implications for economies transitioning from lower to higher development levels. The findings suggest that security investments made alongside digitalization efforts magnify positive impacts on economic growth, especially at higher growth levels. This indicates policymakers should view security and digitalization as complementary forces that reinforce each other to drive development. For effective policy, governments should prioritize an approach integrating digitalization into national security strategies. Digital security infrastructure, including cybersecurity measures and data protection protocols, is critical in safeguarding digital advancement benefits. As countries invest in e-governance, digital financial services, and smart infrastructure, they must strengthen cybersecurity frameworks to prevent cyberattacks that could derail economic progress. This alignment between digitalization and security ensures technological innovations remain resilient and conducive to sustained economic growth.

In practice, enhancing digital infrastructure, like broadening broadband access, must be accompanied by investments in security to foster an environment conducive to the flourishing of digital technologies. Without sufficient security measures, digitalization can leave economies

vulnerable to threats such as cybercrime, data breaches, and disruptions to essential services, potentially undermining growth benefits. Consequently, governments should formulate policies that stimulate private sector investment in both digital and security infrastructure, offering incentives like tax reductions or public-private partnerships to maintain this equilibrium. Furthermore, the beneficial combined impact highlights the necessity for inclusive digital policies that ensure all economic sectors, especially those that are vulnerable and underserved, gain from digitalization. Governments should prioritize bridging the digital divide by ensuring that rural and marginalized communities have access to digital tools and resources. This approach would allow the advantages of security and digitalization to be more evenly distributed, fostering widespread economic growth. Additionally, the combined effect emphasizes the significance of regulatory frameworks that encourage both digital innovation and security. Policymakers need to craft regulations that create a secure digital environment without hindering innovation. For instance, regulatory sandboxes that permit tech companies to test new digital solutions under close supervision could offer a secure space for innovation while ensuring adherence to security protocols. This strategy would help mitigate risks while maximizing the economic potential of digitalization. Finally, governments should consider incorporating digitalization and security into their education and workforce development strategies. As the economy becomes increasingly digitized, there will be a growing demand for a workforce proficient in both digital and security-related skills. Investing in education and training programs focused on cybersecurity, data management, and digital skills will not only address the current labor market gap but also ensure the long-term sustainability of the benefits from digitalization and security investments.

Fixed capital formation, demonstrating a positive impact on growth, underscores the need for ongoing infrastructure investment. Governments should prioritize investments in physical infrastructure including roads, ports, and power grids, and digital infrastructure, including broadband internet and mobile networks, to ensure sectors can leverage technological advancements. Meanwhile, inflation's insignificant role highlights the importance of maintaining macroeconomic stability to prevent disruption from price volatility. Although foreign direct investment (FDI) shows mixed results, it suggests foreign capital can benefit early growth stages but may present challenges at advanced levels. Therefore, policymakers should design FDI policies promoting long-term investments in sectors aligned with national development goals, rather than short-term, speculative investments that may not contribute to sustainable growth.

In conclusion, these findings call for a multifaceted approach to economic policy that balances security, digitalization, and capital investments to drive long-term economic growth. By addressing the unique challenges and opportunities at each stage of development, policymakers can ensure that their economies are well-positioned to harness the benefits of both technological advancements and security investments.

5.2 Limitations of the Study and Future Research Areas

While the study elucidates the impact of digitalization and security expenditures on economic growth, it is important to acknowledge its limitations. The presence of incomplete or inconsistent data may restrict the inclusion of numerous countries, thereby constraining the representation of diverse economic landscapes across different nations. The study offers a broad overview without providing insights specific to individual sectors. Future research could focus on the effects of digitalization and security spending on particular sectors such as agriculture, manufacturing, or

services, which would facilitate more targeted policy recommendations. Furthermore, the study does not account for cultural and institutional factors that may affect the success of digitalization and security spending. Subsequent research could investigate how these elements influence the relationship between the primary variables and economic growth, offering a deeper understanding of the unique challenges and opportunities within various contexts. Evaluating the effectiveness of specific policy measures in promoting digitalization and security spending would also be beneficial. Understanding which policies are most effective in different contexts could guide future policy development and implementation strategies.

The study does not consider the impact of digitalization in informal economies, which are significant in many developing countries. Exploring how digital financial inclusion can benefit informal workers and businesses is an important area for future research, as it could lead to more inclusive economic growth. As digitalization grows, cybersecurity risks become a greater concern; thus, future studies should explore the trade-offs between the benefits of digitalization and the risks associated with increased exposure to cyber threats. Lastly, the environmental implications of increased infrastructure development, security spending, and digitalization warrant further exploration. Investigating how these factors impact environmental sustainability could provide insights into balancing economic growth with environmental preservation. The role of governance structures in influencing the effectiveness of digitalization and security spending on economic growth is another area that merits further investigation, as strong governance may enhance the positive impacts of these investments.

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Author Contributions

Conceptualisation: MI; Data acquisition: MI; Analysis: MI; Interpretation: MI; Writing of original draft: MI, AA; Critical revision for important intellectual content: MI, AA; All authors read and approved the final version of the manuscript.

Ethics Approval and Consent to Participate

Consent to participate or ethical approval is not needed since aggregated data from secondary sources are used for this study.

Consent for Publication

Not applicable.

Availability of Data and Materials

The data employed in carrying out this study can be obtained for free from the website of the World Bank (https://databank. worldbank.org.

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