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EFFECTS OF DIGITAL TECHNOLOGY ON FISCAL DEFICIT IN GHANA

BRIGHT ASIRIFI ANDOH

MASTER OF PHILOSOPHY

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EFFECTS OF DIGITAL TECHNOLOGY ON FISCAL DEFICIT IN GHANA

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A thesis in the Department of Economics Education Faculty of Social Sciences, submitted to the School of Graduate Studies in partial fulfillment

of the requirements for the award of the degree of Master of Philosophy (Economics) in the University of Education, Winneba

MAY, 2025

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DECLARATION

Student's Declaration

I, **BRIGHT ASIRIFI ANDOH**, declare that this thesis entitled "Effects of Digital Technology on Fiscal Deficit in Ghana", with the exception of quotations and references contained in published works which have been identified and duly acknowledged, is entirely my original work, and it has not been submitted either in part or whole for another degree elsewhere.

Signature: .....

Date: .....

Supervisor's Declaration

I declare that the preparation and presentation of this thesis work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

Supervisor's Name: Dr. Isaac K. Ampah

Signature: .....

Date: .....

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DEDICATION

To my parents, siblings, wife and children.

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Coming this far has not been easy but through it all the creator of the Universe has seen me through and been my Guardian Angel throughout my MPhil programme. I owe Him a great deal of thanks.

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LIS T OF ACRONYMS

FD:	Fiscal Deficit
EG:	E-Governance
EP:	E-Participation
INTS:	Internet Availability
GDPgt:	Economic Growth
MS:	Money supply
INF:	Inflation
NR:	Natural Resources
TO:	Trade Openness
TECH:	Digital Technology

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ABSTRACT

This study investigates the relationship between digital technology adoption and fiscal deficit in Ghana from 2003 to 2021. Employing time series data analysis, the study utilizes the Structural Vector Autoregressive Regression (SVAR) approach to estimate the long-run and short-run dynamics between digital technology variables and fiscal deficit. Unit root tests, such as the Zivot–Andrew and Phillips-Perron (PP) tests, were conducted to ensure the stationarity of the variables. The findings suggest a significant relationship between digital technology adoption and fiscal deficit in both the short run and long run. Specifically, an increase in digital technology adoption, as indicated by metrices such as internet penetration rates and e-government initiatives, is associated with a reduction in fiscal deficit. This underscores the potential of digital governance strategies to enhance government efficiency, transparency, and revenue generation in Ghana. Based on the analysis, the study concludes that leveraging digital technology can be an effective means of addressing fiscal deficit challenges in Ghana. Policy recommendations include the continued investment in digital infrastructure, the expansion of e-government services, and the promotion of digital literacy and inclusion initiatives. These measures can contribute to improved fiscal management, enhanced public service delivery, and sustainable economic development in Ghana.

Keywords: ***Digital technology, Fiscal deficit, E-government. E-participation. Internet availability***

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CHAPTER ONE

INTRODUCTION

1.0. Background to the Study

In the last 30 years, the widespread use of ICT has enabled many countries and their governments to transform information into something that can drive their economy. Several scholars in academic literature have hinted at the importance of information technology in boosting outcomes of economic development. (Veeramacheneni et al. 2008; Tchamyou et al. 2019a, b).

From intuition and empirical evidence, economic growth within a country can be improved through factors such as ICT, which enhances the capacity of economic sectors to facilitate the catch-up process in terms of economic development. (Tchamyou et al 2019a, b). As posited by the attendant literature, ICT is relevant in driving activities of production as well as global value chains because it inter alia mitigates poverty, boosts competitiveness, increases transparency, and consolidates the management of public affairs (Sassi & Goaied, 2013; Tchamyou, 2017).

The African continent is characterized by the lowest ICT penetration rate; however, it equally has the highest growth rate of ICT (Asongu & Odhiambo, 2019a, 2019b). The World Bank (2018), has emphasized the importance of ICT in supporting economic activities and has said that, globally, many countries have observed significant economic development from the use of ICT. Modern theories of growth (Barro 1996b; Barro and Sala-i-Martin 1997; Romer 1990), all postulate that ICT should facilitate economic growth by providing a platform for development and the adoption of innovation in industry. This then indicates that ICT has the potential to develop outcomes such as economic growth and fiscal deficit.

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A fiscal deficit is a shortfall in a government's income compared with its spending and any government that has a fiscal deficit is spending beyond its means which is calculated as a percentage of gross domestic product (GDP), or simply as total dollars spent more than income. The income figure includes only taxes and other revenues and excludes money borrowed to make up the shortfall (Hayes, 2020). A government's fiscal (or budget) deficit is generally the difference between its spending and income from taxes and other revenues, and a "large deficit" basically implies that state sector spending substantially exceeds tax revenues in a given year.

One of Ghana's most topically discussed macroeconomic problems today is the government fiscal deficit. Globally, based on data from 147 nations, the average fiscal balance as a percentage of GDP in 2021 was −4.36 percent. The Maldives had the lowest value at –16.65 percent of GDP, while Libya had the highest value at 13.8 percent of GDP. (International Monetary Fund World Economic Outlook Database, 2022)

In the case of Africa, the fiscal balance as a percentage of GDP in 2021, based on 46 countries, averaged −4.35 percent. Ghana had the lowest value at −12.1 percent of GDP, and Libya had the highest value at 13.8 percent of GDP (International Monetary Fund World Economic Outlook Database, 2022). In Sub–Saharan Africa, with 40 countries where the average fiscal balance as a percentage of GDP in 2021 was −4.65 percent, Ghana recorded the highest value at −12.1 percent of GDP, while Angola had the lowest value of 2.7 percent of GDP. This means that in Africa and Sub–Saharan Africa, Ghana is said to have the highest average fiscal deficit of 12.1 percent as of 2021, which the situation has not changed but rather even worsened. (International Monetary Fund World Economic Outlook Database, 2022)

It is also important to note that the average government debt to GDP for Ghana from 1990 to 2021 was 45.69 percent of GDP, with the highest average debt to GDP reaching 81.80

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percent of GDP in 2021 and the lowest average debt to GDP recording 18.50 percent of GDP in 1991 (IMF, 2022).

Although some economists contend that there may be some advantages to deficit spending in specific situations, a large body of research shows that ongoing fiscal deficits can have detrimental effects on social welfare, financial stability, and economic growth (Alesina & Perotti, 1995).

One of them is the crowding out of private investment, which jeopardizes long-term economic growth prospects, is one of the most well-documented adverse effects of fiscal deficits. Governments that borrow money to cover deficits compete with private sector organizations for available capital, which raises interest rates and discourages private investment (Barro, 1989; Elmendorf & Mankiw, 1999). This problem happens when borrowing by the government raises demand for loanable money without increasing supply, which pushes interest rates higher and deters private investment initiatives.

Also, through a variety of transmission channels, fiscal deficits can produce strong inflationary pressures that threaten price stability and reduce purchasing power. Demand-pull inflation may come from an increase in the money supply brought on by central banks accommodating fiscal expansion through monetary policy or governments financing deficits through money creation (Sargent & Wallace, 1981). As several instances of hyperinflation throughout history have shown, this monetization of fiscal deficits establishes a clear correlation between fiscal imbalances and price level increases. Again, there are serious concerns to the sustainability of government debt and general financial stability when recurrent fiscal deficits lead to the accumulation of government debt. According to Ostry et al. (2010), having a lot of debt makes one more susceptible to outside shocks, changes in market sentiment, and adjustments in financing terms, all of which can lead to debt crises.

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Furthermore, by shifting present consumption expenditures to future generations who will be responsible for debt servicing and repayment, persistent fiscal deficits place a heavy load on generations to come. Fundamental concerns regarding sustainability and fiscal equality are brought up by this generational transition (Kotlikoff, 2002). Higher tax rates, less public services, or ongoing deficit accumulation that makes the issue worse are some ways that the burden is placed on future generations. Additionally, the ability of the government to effectively respond to economic shocks or implement countercyclical policies when necessary is severely limited by high fiscal deficits. When debt levels are high and deficits are ongoing, fiscal space—which is the amount of flexibility a government has to raise spending or lower taxes without jeopardizing financial stability or debt sustainability—becomes limited (Ostry et al., 2010).

To add up to the above, persistent fiscal deficits have the potential to significantly lower exchange rates in nations with flexible exchange rate regimes, which can result in currency depreciation and related economic losses. International investors perceive large budget deficits as an indication of fiscal unviability, which causes capital flight and currency devaluation (Krugman, 1979). Because this devaluation raises the home currency burden of external debts, it can be especially expensive for nations with large foreign currency debt. Moreover, political stability and democratic governance can be threatened by ongoing budget deficits in a number of ways. Politically challenging choices on tax hikes or spending reductions are frequently necessary due to high debt levels and the corresponding need for fiscal adjustment, which can lead to societal unrest and political instability (Alesina & Perotti, 1996).

A large fiscal deficit in addition to uncertainties in economic growth could raise concerns about the inability of a government to service its debts, thus a rise in credit risk (Al-Khulaifi, 2012).

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To overcome the challenges posed by fiscal deficits, governments need to implement measures such as fiscal discipline, expenditure rationalization, revenue enhancement through effective tax policies and structural reforms to promote sustainable economic growth to reduce the fiscal deficit, manage public debt and create a favourable environment for investment and economic stability (The Economic Times; Clear Tax, 2023). These and many other reasons above have therefore made the government introduce many fiscal consolidation strategies and fiscal targeting in Ghana. Among these strategies is the use of digital technology to address the fiscal deficit facing the country. According to Demuyakor (2021), Ghana initiated its digital governance system in 2005. The goal of Ghana's strategic plan is to identify the digital possibilities and strategies that are now accessible, as well as to put in place a plan of action that would assist Ghana in becoming a major center for digital governance through ICT innovation in sub-Saharan Africa by 2023. (Demuyakor, 2020; World Bank Group, 2016). This will therefore aid the government in curbing the fiscal deficit problem in Ghana.

To accomplish these admirable goals, the Ghanaian government adopted digital governance policies in 2017. These included the creation of the digital national identification card, the e-justice system, the e-smart driver's license, the paperless port system, Ghana Post GPS, the electronic renewal of the National Health Insurance Scheme (NHIS), and the e-immigration system (Demuyakor, 2020; Kyereme & Kaur, 2019).

The vehicle registration systems and the e-government interoperability framework (e-GIF) are other examples of the government of Ghana's digital governance projects (Demuyakor, 2020, & Agboh, 2018). The Ghanaian government also introduced the Information and Communication Technology for Accelerated Development (ICT4AD) Policy 2017 as another digital governance strategy (Demuyakor, 2021). Ghana is seen as one of the African

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nations with the highest number of public e-services, according to the United Nations E-Government Survey (2018a).

The question, therefore, is whether the introduction of this technology in the form of digitalization has had effects on Ghana's fiscal deficit? This study, therefore, focuses on the nexus between digital technology and fiscal deficit in Ghana.

1.1. Problem Statement

Since Ghana's independence in 1957, fiscal deficit has dominated the country's economic landscape, and the country's fiscal policy has consistently produced deficits (Adu, 2017). Again, since Ghana's independence in 1957, fiscal deficits have been a persistent challenge in the country's economic management history within two years after independence, Ghana recorded its first negative budget balance in 1959, and since then, fiscal deficits have become an Achilles' heel in Ghana's economic management history (Osei & Telli, 2017). The average budget deficit to GDP ratio was 1.8% in 1959 (Osei & Telli, 2017) whilst the situation worsened in 2015 when Ghana's economy was in trouble, hobbled by widening current account and budget deficits, rampant inflation, and a depreciating currency (Ahinsah-Wobil, 2022). By 2022, Ghana recorded a government budget deficit equal to 10% of the country's Gross Domestic Product, with a projected budget deficit for 2022 of $6 billion (Appiagyei, 2022).

This fiscal deficit has a significant problem in Ghana, with the reasons being that, it negatively impacts economic growth, concerns about debt sustainability, inflationary pressure in the economy, limited fiscal space, external financing dependency as well as macroeconomic instability. The expansionary fiscal policies and deficits have contributed negatively to economic growth, hindering the country's development and progress (Oxford Academic, 2023). Also, excessive government spending and borrowing have resulted in a growing public debt burden, making it challenging to manage and service the debt

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effectively (The Conversation, 2023). Again, it has contributed to Ghana's inflationary pressure, with average CPI inflation reaching 31.5% in 2022 and reaching 54.1% in December of the same year, with the high inflation eroding the purchasing power of the currency and negatively affecting the overall economy ("IMF Lending Case Study: Ghana"; World Bank, 2023). High fiscal deficits limit the government's fiscal space to invest in critical sectors such as infrastructure, education, healthcare, and social welfare thus it restricts the government's ability to allocate resources effectively and address the needs of the population. ("IMF Lending Case Study: Ghana", 2023). Moreover, the dependency on external financial sources can increase vulnerability to external shocks and create a burden of debt repayment in the future (The Conversation, 2023).

Due to these problems, there is a need to overcome this fiscal deficit. This is because overcoming the fiscal deficit is crucial for achieving macroeconomic stability, which involves implementing measures to control government spending, increase revenue generation through effective tax policies, and improve fiscal discipline necessary to restore confidence in the economy and attract investments (Reuters; Ministry of Finance | Ghana, 2023)

Ghana has therefore been unduly ambitious in its use of technology in the fields of digital governance and participation, internet access for its people, and being among the first African countries to implement e-procurement and other digital services, all to improve efficiency in governance. (Demuyakor, 2020 & Agboh, 2018). Could it be that the introduction of this technology is helping the government achieve its aim already stated, or individuals and firms are rather taking advantage of the new system of technology to their advantage, thus affecting government revenue mobilization and thus higher fiscal deficit?

There have also been several empirical studies that have examined the relationship between fiscal deficit or GDP and technology globally, with diverse views. Some are of the view

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that there is a positive relationship between the fiscal deficit or GDP and technology, whilst others hold the view that, mixed or negative relationship, or no relationship.

This paper is justified because government revenue from e-products/services has increased in recent years. For the expenditure side, the government has introduced an e-tax system to reduce expenditure through the reduction of the incidence of fraud. (M. A. Ampah & R. Sudan, 2016). On the revenue side, the government has also introduced the same e-tax system to increase revenue as part of the e-Ghana project with the goals of expanding the tax base, improving compliance and transparency, lowering the rate of fraud, and raising Ghana's business climate's competitiveness. (M. A. Ampah & R. Sudan, 2016). Despite the huge increases in expenditure and the array of services on digital technology, the fiscal deficit keeps increasing. This paper, therefore, aims to investigate the effects of this technology on Ghana's fiscal deficit from the year 2003 to 2021.

This study is justified on the grounds that no such study has been conducted in Ghana to the best of my knowledge in establishing the nexus between the adoption of digital technology and the fiscal deficit situation. The study also advances the understanding of the existing body of literature between technology and government deficit. It also enriches the methodological literature by using (PCA) Principal Component Analysis to create a single digital technology index, offering a more comprehensive way to assess digitalization's impact on fiscal outcomes.

1.2. Objective of the Study

Main objective: To examine the impact of digital technology adoption on Ghana's fiscal deficit.

Specific Objectives of the study by this research are to achieve the following:

1. To analyze the relationship between e-governance and fiscal deficit.
2. To determine the relationship between e-participation and fiscal deficit.

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3. To determine the relationship between internet availability and fiscal deficit.
4. To assess the relationship between digital technology and fiscal deficits in Ghana.

1.3. Research Hypotheses

1. H_0: There is no significant relationship between e-governance and fiscal deficit.

   H_1: There is a significant relationship between e-governance and fiscal deficit.
2. H_0: There is no significant relationship between e-participation and fiscal deficit.

   H_1: There is a significant relationship between e-participation and fiscal deficit.
3. H_0: There is no significant relationship between the availability of internet use and fiscal deficit.

   H_0: There is a significant relationship between internet availability and fiscal deficit.
4. H_0: There is no significant relationship between digital technology and fiscal deficit.

   H_1: There is a significant relationship between digital technology and fiscal deficit.

1.4. Scope of the Research

This work aims to investigate the effects of digital technology on Ghana's fiscal deficit from the year 2003 to 2021. To achieve the set objectives, secondary quarterly data were used. The data focused on variables like fiscal deficit, e-governance, e-participation, and the availability of internet use. The data was gathered from World Development Indicators of the World Bank, the International Monetary Fund World Economic Outlook Database, the United Nations E-government Survey, and the Bank of Ghana Research Department Database.

1.5. Significance of the Study

This study will help improve transparency and accountability in the government budget. Budget transparency and accountability can be improved through the use of technology.

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Citizens and civil society organizations may hold the government responsible for its spending decisions by making budget data and financial reports more publicly accessible online. This, in turn, can lead to a reduction in the fiscal deficit by reducing wasteful spending and corruption.

This work can assist in reducing government inefficiencies that contribute to the fiscal deficit. Technology can also aid in the reduction of government inefficiencies. For instance, the adoption of electronic procurement systems can aid in the reduction of procurement fraud and the improvement of public procurement efficiency. Similarly, digital government technologies can assist in reducing bureaucracy and improving service delivery, which can aid in cost reduction and government efficiency.

Technology reduces fiscal deficits by boosting output and efficiency, which can result in cost savings for the government and reduced deficits. Electronic payment systems and other digital technologies have the potential to lower the amount of currency in circulation, making it more difficult for individuals and corporations to evade paying taxes. Technology can help government entities identify and prevent fraud, waste, and abuse, resulting in cost savings.

By enhancing tax collection, technology can assist in lowering the fiscal deficit. Ghana has a low tax revenue-to-GDP ratio, and raising it could assist in lowering the fiscal imbalance. Technology can help to improve tax collection operations, eliminate corruption, and increase transparency. Digital payment systems, for example, can make it easier for taxpayers to meet their tax duties, whilst data analytics and machine learning can help identify tax evaders and enhance compliance.

However, the cost of implementing and maintaining technology can raise government spending and deficits. In some circumstances, technology may replace workers, resulting in job losses and potentially greater government jobless compensation. Cyberattacks and

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other technological flaws can jeopardize government funds and increase the chance of costly data breaches.

Additionally, there are only a few estimation approaches and the necessary knowledge that may be used to examine data. In Ghana, data collection and management are pretty subpar. These are only a few of the obstacles to conducting this work; there are others.

1.6. Organization of the Study

This study is structured into five chapters. Chapter One has already been presented. Chapter two, the next chapter, presents the overview of fiscal deficit and technology in Ghana. It reviews relevant theoretical and empirical literature underpinning fiscal deficit and technology. Chapter three entails the methodology, which explains the techniques used in conducting the research. The results and discussions are in Chapter Four. It is where the findings are discussed in the literature review. Chapter five, as the last one, concludes and summarizes all the chapters.

1.7. Chapter Summary

The chapter addresses how ICT has revolutionized economic growth over the last three decades, with particular attention to Ghana's fiscal deficit, which is the worst in Africa and Sub-Saharan Africa. Ghana's digital governance initiatives from 2005 to 2017 are presented, emphasizing the negative consequences of budget deficits. Whether digital technology is helping or hindering the elimination of the budget deficit is the research subject. In order to examine the significance of numerous elements associated to digital technology and fiscal deficit, it makes use of secondary quarterly data from reliable sources such as the World Bank and IMF. The study's significance in improving transparency, accountability, and efficiency in government operations is emphasized in the conclusion, which also acknowledges possible difficulties with data availability and estimation techniques.

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CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction

This chapter examines the conceptual framework, some overviews of fiscal deficit and technology, and the theoretical framework, as well as empirical reviews of Ghana's fiscal deficit and digital technology, and any other variables of interest.

2. 1. Conceptual Review

2.1.1. Digital Technology

Overview, Definition, and Foundational Theories

The wide range of electronic tools, systems, resources, and procedures that produce, store, process, and exchange digital data is referred to as digital technology (Negroponte, 1995). The processing, storing, and transmission of information through discrete digital signals as opposed to continuous analog signals has fundamentally changed as a result of digital technology. Digital technology uses discrete binary codes (0s and 1s) instead of continuous signals like analog systems do. This allows for accurate information reproduction, manipulation, and transmission without deterioration (Shannon, 1948). Information theory, digital logic, digitization, and convergence theory are a few of the theoretical underpinnings. Claude Shannon's information theory (1948), which created the mathematical foundation for digital communication and data processing, forms the theoretical basis of digital technology. Shannon's work laid the foundation for all digital systems by proving that any information could be encoded in binary format. The logical basis for digital computation is provided by Boolean algebra, which was created by George Boole in the 19th century and subsequently used by Claude Shannon in electronic circuits (Boole, 1854; Shannon, 1938). By combining AND, OR, and NOT gates, this mathematical framework makes it possible to design digital circuits that carry out logical operations.

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Digitalization is the process of transforming business processes and organizational structures using digital technology, whereas digitization is the conversion of analog information into digital format (Gartner, 2016). According to Jenkins (2006), digital convergence theory describes how formerly separate industries, media forms, and technologies come together to form shared digital platforms. By conceptualizing this convergence through the shift from "atoms to bits," Negroponte (1995) demonstrated how digital representation radically changes the nature of communication, commerce, and information. The rise of digital ecosystems, platform economies, and cross-industry disruption are all explained by this theoretical framework.

Fundamental Features and the Field of Digital Technology

Flexibility and programmability are two of the traits. Programmability is a feature of digital systems that enables the same hardware to carry out a variety of tasks using software instructions (Yoo et al., 2010). Unprecedented flexibility is made possible by this programmability, which permits quick adaptation and ongoing innovation without the need for physical changes. Strong network effects are seen in digital technologies, where a system's value rises as its user base grows (Katz & Shapiro, 1994). This trait has significant effects on social connectivity patterns, platform competition, and market dynamics. Large volumes of data are naturally produced by digital systems as a result of user interactions, system functions, and environmental sensing (Mayer-Schönberger & Cukier, 2013). Data-driven decision-making paradigms emerge as a result of this data becoming a strategic resource for innovation, prediction, and optimization. According to Rifkin (2014), digital products and services frequently have almost zero marginal costs for distribution and replication. Rapid scaling and worldwide reach are made possible by this economic trait, but it also challenges conventional pricing models and produces winner-take-all market dynamics. Data storage and management, communication and networks, computing and

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processing, and user interfaces and interaction are among the domains. Moore's Law, which forecasts exponential growth in processing power, has guided the development of computing (Moore, 1965). Cloud computing, edge computing, and quantum computing are examples of recent innovations that provide distinct methods for addressing computational problems (Armbrust et al., 2010; Preskill, 2018). From straightforward data transfer to intricate, multi-layered network architectures, digital communication technologies have advanced over time. The fundamental framework for international digital communication is provided by the Internet Protocol Suite (TCP/IP) (Cerf & Kahn, 1974). Real-time applications and ubiquitous connectivity are made possible by mobile networks, especially 5G technology (Ericsson, 2020). Traditional hard drives, solid-state drives, cloud storage, and new DNA storage systems are examples of digital storage technologies (Church et al., 2012). Global networks can organize and retrieve large datasets thanks to distributed storage architectures and database management systems. Command-line interfaces have given way to graphical user interfaces, touch interfaces, voice recognition, and newer brain-computer interfaces in the evolution of human-computer interaction (Norman, 2013). These advancements are a result of continuous attempts to improve the usability and accessibility of digital technology.

Digital Technology and Its Effects

In addition to social and cultural change, there is a digital divide and inequality, privacy and surveillance, labor and automation. New types of social stratification are produced by the unequal distribution of digital technology access and proficiency (Norris, 2001). Disparities in digital literacy, device ownership, infrastructure access, and meaningful technology use are all included in the digital divide (van Dijk, 2020). Concerns regarding privacy, surveillance, and individual autonomy are raised by the unprecedented data collection and analysis capabilities made possible by digital technologies (Zuboff, 2019).

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The term "surveillance capitalism" refers to the practice of digital platforms profiting from user data, frequently without the users' knowledge or consent. Automation across industries is fueled by digital technology, which could result in the displacement of human workers and the creation of new job types (Brynjolfsson & McAfee, 2014). In digital economies, the risk of job displacement surpassing job creation is referred to as "technological unemployment." Social interactions, cultural customs, and identity development are all mediated by digital technology (Castells, 2015). While social media platforms, online communities, and virtual environments open up new avenues for cultural expression and social interaction, they also give rise to worries about echo chambers and social fragmentation.

New Trends and Prospects, Difficulties and Constraints

The Internet of Things (IoT) and ubiquitous computing, blockchain and distributed systems, digital twins, cyber-physical systems, and artificial intelligence and machine learning are among them. According to Russell and Norvig (2020), artificial intelligence (AI) signifies a paradigm shift toward intelligent, adaptable digital systems that are capable of learning and making decisions on their own. From healthcare to transportation, machine learning algorithms facilitate pattern recognition, prediction, and optimization in a wide range of applications. IoT creates networks of connected devices that monitor, control, and optimize physical environments by extending digital connectivity to commonplace objects (Atzori et al., 2010). Weiser's (1991) concept of ubiquitous computing, in which digital technology is seamlessly incorporated into everyday life, is realized by this paradigm. Peer-to-peer transactions without centralized authorities are made possible by blockchain technology, which introduces decentralized approaches to digital trust (Nakamoto, 2008). This paradigm allows for new types of digital organization and governance while challenging conventional intermediary models. By building virtual representations of

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physical systems, digital twins make it possible to simulate, track, and improve real-world operations (Grieves, 2014). By bridging the digital and physical realms, these systems open up new possibilities for infrastructure management, urban planning, and manufacturing. Cybersecurity and Resilience, Environmental Impact, and Ethical Considerations are all included in the Challenges and Limitations section. Data breaches, ransomware, and state-sponsored attacks are among the growing cybersecurity risks that digital systems must contend with (Anderson et al., 2019).

Continuous investment in security practices and technologies is necessary to build resilient digital infrastructure. Consuming digital technology has a major impact on the world's energy consumption and carbon emissions (Belkhir & Elmeligi, 2018). Digital systems' environmental sustainability necessitates consideration of renewable energy adoption, device lifecycle management, and energy efficiency. Many ethical concerns about algorithmic bias, autonomous decision-making, and human agency are brought up by the use of digital technology (O'Neil, 2016). It takes interdisciplinary cooperation and constant discussion to develop ethical frameworks for digital technology. According to this study, digital technology is the use of electronic systems for data collection, storage, analysis, and sharing. Digital tools and platforms are used to improve data management, analysis, and communication in governance. The digital technology was measured by using e-governance, e-participation, and internet availability explained below.

2.1.2. E – Governance

Overview, Definitions, Conceptual Underpinnings, and Theoretical Structures

Globally, the relationship between governments and citizens has undergone a fundamental transformation since the onset of the digital age. The idea of e-governance has developed from the straightforward automation of governmental processes to extensive digital transformation projects that seek to establish public administration systems that are more

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effective, transparent, and focused on the needs of the people (Yildiz, 2007). This development is a reflection of larger public sector modernization trends as well as citizens' growing demands for government services that are accountable, responsive, and easily accessible. There are numerous applications and interpretations of e-governance in diverse contexts. E-governance is defined by the United Nations (2020) as "the use of information and communication technologies (ICTs) by government agencies to transform relations with citizens, businesses, and other arms of government." This definition highlights how technology has the power to revolutionize how citizens and the government interact. E-governance, on the other hand, is "the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners, and employees," according to Backus (2001). This definition emphasizes the multi-stakeholder nature of e-governance initiatives and their service delivery component. Once more, e-governance—which is the use of information and communication technologies to improve citizen services and government operations—has become a vital part of contemporary public administration (Heeks, 2006). Beyond just digitizing current procedures, this shift involves a fundamental overhaul of how governments function, provide services, and interact with stakeholders.

A more thorough definition of e-governance can be found in the World Bank (2015), which defines it as "the use by government agencies of information technologies that have the ability to transform relations with citizens, businesses, and other arms of government." Beyond service delivery, this definition recognizes the wider transformative impact. To comprehend the implementation and effects of e-governance, a number of theoretical frameworks have been developed. One of these is the Technology Acceptance Model (TAM), which was first created by Davis in 1989 and has been widely used in e-governance settings to comprehend how citizens adopt digital government services. According to the

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model, two important factors influencing technology adoption are perceived utility and perceived ease of use.

Additionally, e-governance innovations have been used to explain how they spread both within and between government organizations using Rogers' (2003) Diffusion of Innovation Theory framework. According to the theory, relative advantage, compatibility, trialability, complexity, and observability are important variables that influence the adoption of innovations. A theoretical basis for comprehending e-governance as a component of larger public sector reform initiatives targeted at enhancing efficiency, effectiveness, and responsiveness is once more provided by Hood's (1991) conceptualization of New Public Management (NPM).

E-Government Models and Aspects

Four main interaction models are commonly used to conceptualize e-governance. the Government-to-Citizen (G2C) dimension, which is concerned with using digital channels to provide citizens with information and public services. Online license applications, tax filing, and government information access are a few examples (Silcock, 2001). Electronic interactions between government and business entities, such as business registration services, regulatory compliance, and procurement procedures, referred to as government-to-business (G2B) (Moon, 2002). As previously mentioned, the Government-to-Government (G2G) dimension covers internal government operations, such as information sharing, inter-agency coordination, and collaborative processes (Layne & Lee, 2001), while the Government-to-Employee (G2E) dimension concentrates on internal human resource management, including training programs, payroll systems, and employee self-service portals (Fang, 2002).

Several other maturity models, such as the UN E-Government Development Index (2020) and the Layne and Lee Model (2001), have also been created to evaluate the various stages

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of e-governance development. The UN E-Government Development Index (2020) uses a comprehensive index that measures three dimensions: online service provision, telecommunication infrastructure, and human capital development. In contrast, the Layne and Lee Model (2001) uses four-stage models: cataloguing, which involves basic information provision; transaction, which involves online service delivery; vertical integration, which involves local systems integration; and horizontal integration, which involves cross-functional integration.

Advantages, Possibilities, and Obstacles

Initiatives for e-governance have shown a great deal of promise for increasing operational effectiveness and cutting administrative expenses. Schedler and Summermatter (2007) found that digital government services can reduce processing times by up to 80% and administrative costs by 15-20%. Process automation, less paperwork, and more efficient workflows are the causes of these efficiency gains. Through easier access to government data and decision-making procedures, digital technologies facilitate greater transparency. Bertot et al. (2010) argue that e-governance platforms facilitate real-time monitoring of government activities, thereby strengthening accountability mechanisms and reducing corruption risks. E-governance platforms provide new avenues for citizen participation in democratic processes. Macintosh (2004) identifies three levels of citizen engagement through digital platforms: e-information (one-way information provision), e-consultation (two-way interaction), and e-participation (active citizen involvement in policy formulation). By being available around-the-clock, cutting down on wait times, and standardizing service delivery procedures, digital government services can raise the quality of their offerings. According to West (2004), e-governance programs can help underserved communities by giving them alternate ways to access government services. One of the main obstacles to the implementation of inclusive e-governance is the potential

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for the digital divide. Three levels of the digital divide are distinguished by Norris (2001): the global divide, which separates developed and developing nations; the social divide, which separates nations; and the democratic divide, which separates online and offline civic engagement. If e-governance strategies do not sufficiently address these divides, they may worsen already-existing inequalities. Additionally, there are serious privacy and security issues with digital government services. Lips et al. (2005) draw attention to issues with cybersecurity risks, protecting personal information, and fostering public confidence in digital government platforms. Strong technical safeguards and extensive legal frameworks are needed to address these issues. Government workers and organizational cultures that are resistant to change frequently oppose the adoption of e-governance. According to Heeks (2006), a number of factors, such as entrenched bureaucratic practices, skill gaps, and worries about job security, contribute to resistance. Infrastructure and Technology obstacles because successful e-governance implementation requires a sufficient ICT infrastructure and technical capability. Ndou (2004) highlights the significance of dependable electricity supplies, internet connectivity, and technical support systems, especially in developing nations.

2.1.3. E – Participation

With information and communication technologies (ICTs) opening up previously unheard-of avenues for citizen participation in political processes, democratic participation has experienced a substantial transformation in the digital age. Beyond conventional ideas of political participation, the term "e-participation" refers to new digital engagement methods, such as social media activism, online consultations, deliberative forums, and crowdsourced policymaking (Grönlund, 2009). Both technological advancements and shifting public expectations about information availability, decision-making transparency, and chances for meaningful engagement in democratic processes are reflected in this evolution. A number

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of convergent trends have increased the importance of e-participation: the spread of mobile and internet technologies, the waning of faith in traditional democratic institutions, the increasing demands for accountability and transparency from the government, and the rise of new civic engagement activities among digital natives (Norris, 2001; Dalton, 2008). Governments, civil society groups, and scholars are now investigating how digital technologies can revive democratic participation and tackle the problems confronting modern democracy as a result of these developments.

Definitions, Theoretical Underpinnings, and Conceptual Foundations

A variety of digitally mediated citizen engagement with political processes is referred to as e-participation. E-participation is "the use of information and communication technologies to broaden and deepen political participation by enabling citizens to connect with one another and with their elected representatives," according to the Organization for Economic Co-operation and Development (OECD, 2003). This definition highlights e-participation initiatives' technological capabilities as well as their democratic goals. A more thorough definition of e-participation is given by Macintosh (2004), who defines it as "the use of ICTs to support information provision and 'top-down' engagement, i.e., government-led initiatives, or 'bottom-up' initiatives to empower citizens, civil society organizations, and other democratically constituted groups to contribute to and influence political processes." This definition recognizes the various actors involved as well as the reciprocal nature of e-participation. Taking a more comprehensive stance, Saebø et al. (2008) define e-participation as "the use of information and communication technologies to support democratic decision-making." Both official government-led programs and unofficial citizen-driven endeavors that support democratic processes are included in this definition. A crucial element of modern democratic governance is e-participation, which is generally

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defined as the use of digital technologies to encourage citizen participation in democratic decision-making (Macintosh, 2004; Sæbø et al., 2008).

Research on e-participation is influenced by various theoretical traditions. Dahl (1989) and other proponents of the Classical Democratic Theory highlighted the significance of citizen participation for democratic legitimacy. These concepts have been expanded upon by modern academics who have looked at how digital technologies can improve democratic participation and tackle issues like political inequality and civic disengagement (Barber, 2003; Fishkin, 2009). The Habermasian Theory of the Public Sphere; E-participation research has been influenced by Habermas's (1962) idea of the public sphere as a domain of social life where people can develop opinions through reasoned discussion. Researchers have looked into whether digital technologies can restore the conditions for democratic deliberation or create new public spheres (Dahlberg, 2001; Papacharissi, 2002). Theory of Participatory Democracy. More direct citizen participation in political decision-making was promoted by theorists such as Barber (1984) and Pateman (1970). E-participation is frequently seen as a way to use digital technologies to operationalize the principles of participatory democracy. A framework for comprehending how digital technologies are changing social and political relationships, including new forms of citizen engagement and political mobilization, is once again provided by Castells' (2015) Network Society Theory.

Models and Types of Electronic Participation

Digital adaptations have been developed by a number of scholars, including the International Association for Public Participation (IAPP) Digital Spectrum (2014), which adapts the spectrum for digital contexts. These include: Inform (one-way communication through websites and social media), Consult (online surveys, polls, and feedback mechanisms), Involve (online workshops, forums, and deliberative platforms), Collaborate (co-creation and partnership in digital environments), and Empower (citizen-led digital

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initiatives and decision-making). There is also the Macintosh Model (2004) who identified three levels of e-participation (E-enabling: providing information and basic digital literacy, E-engaging: supporting consultation and limited involvement and E-empowering: Enabling active citizen participation in decision-making).

The United Nations (2014) made a distinction between e-decision making (direct citizen participation in decision-making processes), e-consultation (two-way citizen-government engagement), and e-information (one-way government information providing). Top-Down vs. Bottom-Up classification is another option. According to their origin, Saebø et al. (2008) divide e-participation efforts into three categories: hybrid (collaborative initiatives involving many stakeholders), bottom-up (citizen-driven movements and platforms), and top-down (government-initiated platforms and processes).

Many types of participation are also made possible by technology-based typologies, such as government websites and portals (official channels for information and consultation), social media platforms (informal political discussion and mobilization), specialized e-participation platforms (tools specifically designed for consultation and deliberation), and mobile applications (opportunities for location-based and real-time participation).

E-Participation: Advantages, Opportunities, Drawbacks and Restrictions

By offering easily accessible, convenient, and adaptable engagement possibilities, e-participation has the ability to overcome conventional obstacles to political or democratic participation. According to research by Krueger (2002), residents who were previously disengaged may become more involved online, especially younger groups that are more accustomed to using digital devices. Research has demonstrated that e-participation programs can lower spatial obstacles, allow people with disabilities to participate, and offer multilingual assistance to improve the inclusion of different populations (Coleman & Blumler, 2009; Freschi et al., 2009). With features like expert input, controlled debates, and

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the availability of background material, digital platforms can support more organized and knowledgeable discourse. Compared to traditional in-person gatherings, well-designed online deliberative forums can generate political conversation of a better caliber (Wright & Street, 2007). Many digital platforms are asynchronous, which gives participants time to consider problems and come up with intelligent answers. This could enhance the standard of democratic debate (Coleman & Moss, 2012). Increasing the accessibility of government information and establishing avenues for public input and supervision are common components of e-participation programs. By facilitating real-time monitoring of government operations and offering forums for citizen concerns, this can improve government accountability and transparency (Bertot et al., 2010).

Through tools like online petition systems, budget transparency platforms, and real-time policy monitoring systems, digital technology make it possible for new kinds of government accountability to be implemented (Noveck, 2009). The expenses related to conventional consultation techniques like town halls, printed materials, and telephone surveys can be decreased through digital participation. Digital channels allow governments to reach more citizens at a lower cost per capita (OECD, 2003). Ongoing moderation and technical support needs, along with substantial setup and maintenance expenses, are also associated with digital participation (Saebø et al., 2008). It may result in inequality and the digital divide. One of the biggest obstacles to inclusive e-participation is the digital divide. Certain populations may be excluded from opportunities for digital participation due to disparities in internet access, digital skills, and technology adoption (Norris, 2001; Van Dijk, 2006). According to research by Hargittai (2008), the degree and quality of online political involvement can be impacted by variations in technical skills and confidence, even among internet users. Instead of encouraging democratic inclusiveness, these disparities may serve to strengthen current trends of political exclusion. Since participants may not

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accurately represent the demographics or viewpoints of the general community, e-participation programs frequently deal with representativeness difficulties. Certain citizen types are more likely to engage in online political activities, a recurring issue known as self-selection bias (Wright & Street, 2007). Concerns over the frequency of shallow participation, echo chambers, and the power of extreme views have also raised doubts about the caliber of online political conversation (Sunstein, 2001; Wojcieszak & Mutz, 2009). Significant questions of data security, privacy, and public confidence in government are also brought up by digital engagement. Because of worries about political reprisal, data exploitation, and surveillance, citizens may be hesitant to use government-sponsored digital platforms (Lips et al., 2005). The integrity of e-participation projects is continuously threatened by cybersecurity concerns such as hacking, data breaches, and manipulation of online debates (Gibson et al., 2005). Implementation and sustainability challenges are also present. Poor design, insufficient funding, and a lack of integration with real decision-making processes plague many e-participation programs. If citizens' online involvement does not yield apparent policy changes or government replies, they may lose faith in the process (Macintosh & Whyte, 2008). The viability of e-participation projects can be greatly impacted by technical issues such as platform dependability, user interface design, and interaction with current government systems (Phang & Kankanhalli, 2008).

2.1.4. Internet Availability

In the digital age, the availability of the internet has become a crucial factor in determining social, economic, and political development. It has grown to be one of the defining features of the modern world, influencing social connections, political engagement, and economic opportunity. Meaningful access to digital resources and opportunities is determined by a complex ecosystem of infrastructure, affordability, skills, and quality, which goes much beyond simple technological connectivity (ITU, 2020). The

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digitization of basic services, the expansion of the digital economy, the growing significance of telemedicine and online education, and the role of digital platforms in social and political mobilization are some of the convergent trends that have increased the significance of Internet availability (World Bank, 2016). With billions of people depending on digital technology for employment, education, healthcare, and social interaction, the COVID-19 pandemic has further underscored the vital significance of Internet access (OECD, 2020).

Despite tremendous advancements in increasing Internet access worldwide, there are still large differences between and within nations. Around 2.6 billion people worldwide do not have access to the Internet, with the majority living in rural areas and least developed nations, according to the International Telecommunication Union (ITU, 2023). The intricate relationships between technical, economic, social, and political elements are reflected in these connection gaps, necessitating thorough investigation and well-coordinated policy responses.

Definitions, Theoretical Frameworks and Conceptual Foundations

The concept of internet availability is multifaceted and includes different facets of access and connectivity. Internet availability is defined by the ITU (2020) using four main dimensions: Affordability (the economic accessibility of Internet services in relation to income levels and economic conditions), Infrastructure (the technical and physical infrastructure required to provide Internet connectivity, including networks, servers, and access points), Skills (the technical and digital literacy needed to use Internet services and applications effectively), and Relevance (the availability of content, applications, and services that are pertinent and helpful to potential users).

A number of theoretical frameworks have been developed to understand Internet availability and its implications. One such framework is the Digital Divide Theory, which

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was first conceptualized by researchers like Norris (2001) and identifies three levels of the digital divide: democratic (between online and offline political participation), social (within countries), and global (between countries). This hypothesis has expanded to include digital skills and access quality in addition to technological availability. Capability Approach once more. Scholars like Kleine (2013) have used Sen's (1999) capability theory as a basis to comprehend how the availability of the Internet enhances human development by increasing personal freedoms and capabilities. Additionally, Castells (2010) developed the Network Society Theory, which offers a framework for comprehending how the availability of the Internet affects power dynamics, economic ties, and social structures in modern society. Through information exchange and cooperation, Internet availability supports innovation ecosystems and economic development, as explained by the Innovation Systems Theory created by academics such as Lundvall (1992).

Methods of Measurement

To gauge Internet availability, numerous metrics and indicators have been created. The most widely used metric for calculating the proportion of the population with Internet connection is penetration rates. However, because it fails to account for intensity or quality of usage, this indicator has limits (ITU, 2023). Speed and quality metrics are also included. Here, indicators of the quality of Internet connectivity include reliability, latency, and broadband speeds (Akamai, 2023). Once more, groups such as the Alliance for Affordable Internet (A4AI, 2020) have created affordability standards, or affordability indices, which show how much broadband costs as a percentage of monthly income. Additionally, as comprehensive metrics such as the Digital Quality of Life Index, the Digital Inclusion Indices aim to capture several aspects of digital access and experience (Surfshark, 2023).

Obstacles and Difficulties

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Internet availability is restricted by infrastructure-related issues such geographic barriers, which pose both technical and financial difficulties for infrastructure construction due to challenging terrain, distant areas, and sparse people (Salemink et al., 2017). , Power Infrastructure: Internet infrastructure requires a steady supply of electricity, which can be problematic in places with weak power infrastructure (Williams et al., 2015). Spectrum Management: Although it can be difficult and controversial, effective radio spectrum distribution and management are essential for mobile Internet services (Cave et al., 2007). and Cross-Border Connectivity: Political unrest and regulatory obstacles may have an impact on international Internet connectivity, which necessitates collaboration between nations (Weller & Woodcock, 2013). Market failures are among the other financial and economic obstacles. Alternative strategies are necessary since market conditions in many low-income and rural locations do not support economically viable Internet services (Grubesic, 2010). Capital Restrictions: Investing in infrastructure can be prohibitively expensive up front, especially for small businesses and in underdeveloped nations (ITU, 2020). Currency changes can have an impact on the affordability of international equipment procurement and content delivery prices (GSMA, 2023). Regulatory uncertainty may deter investment in Internet infrastructure due to unclear or unstable regulatory frameworks (Wallsten, 2001).

Internet availability and adoption can be hindered by social and institutional barriers, such as digital literacy gaps, which can occur even when access to the Internet is available due to a lack of digital skills and familiarity with technology (Van Dijk & Van Deursen, 2014). Cultural Resistance: In certain situations, resistance to adoption may arise from cultural or religious worries about Internet content and its effects on society (Warschauer, 2003). Institutional Capacity: Inadequate institutional capacity within government organizations and agencies may make it more difficult to implement Internet policies effectively (Heeks,

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2002). & Gender and Social Norms: In traditional civilizations, social norms and gender roles might make it difficult for some groups, especially women, to access and use the Internet (Hilbert, 2011).

2.1.5. Fiscal Deficit

Introduction and Theoretical Underpinnings:

A key idea in public finance, the fiscal deficit is the excess of government spending over revenue and has significant effects on growth, macroeconomic stability, and intergenerational justice. One of the most contentious and politically delicate areas of public finance is the fiscal imbalance. Fiscal deficits, which are defined as the difference between government revenues and expenditures over a specific time period, are a reflection of the government's borrowing needs and have a significant impact on economic performance, the sustainability of debt, and the distribution of welfare over generations (Alesina & Perotti, 1995).

On Theoretical Foundations, one is the Keynesian Perspective (1936). The Keynesian revolution significantly shifted the understanding of fiscal deficits from a necessary evil to a viable policy instrument. Keynes maintained that government deficit spending might boost aggregate demand and bring full employment back during recessions. Through automatic stabilizers and discretionary interventions, this viewpoint highlights the stabilizing function of fiscal policy. The degree of economic slack and the marginal propensity to consume determine how much national income can rise as a result of deficit-financed government expenditure, according to the Keynesian multiplier effect (Krugman, 2013). However, the efficacy of deficit spending depends heavily on economic conditions, particularly the presence of liquidity traps and the degree of capacity utilization.

A more pessimistic view of deficit finance is presented by the neoclassical approach, which is supported by economists such as Barro (1974). According to the Ricardian equivalency

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theorem, when tax cuts are supported by deficits, rational consumers will increase their savings because they expect future tax rises to pay down the resultant debt. According to this concept, deficits may discourage private investment by raising interest rates, but they have no effect on aggregate demand. According to the neoclassical growth model, sustained deficits can hinder long-term growth by discouraging profitable investment and lowering the amount of capital accessible for future generations (Diamond, 1965). This viewpoint highlights the long-term significance of balanced budgets and budgetary restraint.

Through dynamic stochastic general equilibrium (DSGE) models, or New Keynesian Synthesis, contemporary macroeconomic theory aims to bring Keynesian and neoclassical insights into harmony. According to these models, the degree of price stickiness, the monetary policy response, and the overall health of the economy all affect how effective deficit spending is (Christiano et al., 2011). The New Keynesian paradigm recognizes that deficits can be advantageous during recessions when monetary policy is confined by the zero lower bound, while highlighting the significance of fiscal consolidation during economic expansions to maintain debt sustainability.

Measurements and Categorization

Definitional Issues: There are many conceptual and practical difficulties in measuring fiscal deficits. Through the Government Finance Statistics Manual, the International Monetary Fund (2014) offers standardized definitions that differentiate between different deficit ideas. The most widely used metric is the overall deficit, which is calculated by subtracting total revenue from total expenditure. This gives a general idea of how much money the government requires. Additionally, the Operational Deficit accounts for the impact of inflation on the real value of outstanding debt, which is especially important in high-inflation environments (Tanzi et al., 1993), and the Primary Deficit, which does not

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include interest payments on existing debt and offers insight into the underlying fiscal position independent of previous borrowing decisions (Blanchard et al., 1990).

According to Larch and Turrini (2009), modern fiscal analysis also highlights the difference between cyclical and structural deficits, with the former reflecting automatic responses to economic fluctuations and the latter indicating the underlying fiscal stance adjusted for economic conditions. The cyclically adjusted budget balance (CABB) aims to measure what the fiscal balance would be if the economy were operating at potential output. This distinction is important for policy evaluation because structural deficits may indicate unsustainable fiscal policies, while cyclical deficits may be appropriate responses to economic downturns.

The shortcomings of traditional deficit metrics are addressed by a number of alternative measures, including Debt Sustainability Analysis, Fiscal Gap, and Generational Accounting. By calculating the lifetime net tax burden on several generations, Auerbach et al. (1991) developed Generational Accounting, which sheds light on intergenerational fiscal justice. While Debt Sustainability Analysis concentrates on the dynamics of the debt-to-GDP ratio and the prerequisites for stabilization (Escolano, 2010), the Fiscal Gap is the permanent change in taxes or spending required to achieve long-term fiscal sustainability, taking into account demographic shifts and entitlement obligations (Auerbach, 2011).

The Effects of Fiscal Deficits on the Economy

In general, there are three types of consequences: interest rate, growth, and short-term effects. The type of government expenditure and the state of the economy have a significant influence on the immediate effects of fiscal deficits. Deficit spending can be a crucial source of economic stimulus during recessions, halting further contractions and boosting employment (Romer, 2011). According to the literature on fiscal multipliers, when there is economic slack and accommodative monetary policy, multipliers can be especially high.

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On the other hand, deficits during times of full employment could push out private investment and cause inflationary pressures. Deficit expenditure composition is important because infrastructure investment may have bigger multipliers than transfer payments (Ramey, 2011).

Long-term growth and budget deficits continue to be controversial topics. Long-term deficits have the potential to impair future productivity and living standards by reducing national savings and discouraging private investment (Elmendorf & Mankiw, 1999). Long-term development prospects, however, might be improved by deficit-financed investments in research, infrastructure, and education. Depending on the time period, nation sample, and econometric methodology used, empirical data show both positive and negative connections between deficits and growth (Afonso & Jalles, 2013).

Interest rates may rise as a result of large budget deficits because they raise demand for government borrowing. Fiscal stimulus may become less effective as a result of this crowding out private investment and consumption (Gale & Orszag, 2003). However, a number of variables, such as investor confidence, financial market circumstances, and monetary policy stance, affect the relationship between deficits and interest rates. Conventional wisdom on this link has been called into question by the recent experience of low interest rates in advanced economies despite significant deficits. This suggests that global saving gluts and the desire for safe assets may be the dominant variables (Summers, 2014).

Institutional Frameworks, Fiscal Regulations, Financing Mechanisms and Restraints

Debt financing, monetary financing, and external financing are a few of the financing mechanisms and constraints. The majority of fiscal deficits are funded by government borrowing, which results in future debt service and repayment obligations. The interest rate-growth differential, debt maturity structure, and currency composition are some of the

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variables that affect how sustainable debt financing is (Wyplosz, 2005). The debt dynamics equation indicates that when the main balance is equal to the product of the outstanding debt ratio and the interest rate-growth difference, the debt-to-GDP ratio will stabilize. Analysis of debt sustainability is based on this concept. By purchasing government securities, central banks can monetary finance deficits by generating funds to pay for government spending. Although this can offer quick funding, it runs the danger of causing inflationary pressures and compromising the independence of the central bank (Sargent & Wallace, 1981). Although these lines have been blurred by quantitative easing measures during crises, modern central banking procedures often forbid direct monetary financing (Bernanke, 2022). Additionally, developing nations frequently depend on outside funding to cover their fiscal deficits, which can lead to further vulnerabilities including exchange rate risk and abrupt halts in capital flows. These vulnerabilities are made worse by the "original sin" problem, which prevents nations from borrowing in their own currency (Eichengreen & Hausmann, 1999).

Many economies implement fiscal rules and institutional frameworks, such as debt limits and targets, balanced budget rules, and fiscal institutions. To limit deficit expenditure, many governments have implemented balanced budget regulations. These regulations may be applicable at multiple levels of government and take many different forms, ranging from legislative goals to constitutional requirements (Feld et al., 2013). However, the design elements of fiscal regulations, such as coverage, flexibility clauses, enforcement procedures, and emergency escape clauses, determine how effective they are. Well-crafted regulations can maintain the flexibility required for economic stabilization while boosting fiscal credibility. The goal of the debt-based fiscal rules is to limit the growth of public debt in proportion to GDP.

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One well-known example of this strategy is the Stability and Growth Pact of the European Union, which has a debt-to-GDP target of 60% (Buti & Carnot, 2012). While permitting short-term deficit swings, these regulations aim to maintain long-term budgetary sustainability. They do, however, have difficulties, such as determining optimal debt levels and pertinent debt measurements for various nations. Additionally, the quality of fiscal institutions has a big impact on the results of deficits. Transparent reporting, medium-term budget frameworks, and independent fiscal institutions can all aid in reducing deficit bias and enhancing fiscal results (Beetsma & Debrun, 2016). Election systems, government fragmentation, and ideological preferences are all significant political economy issues that impact sustainability and deficit levels (Persson & Tabellini, 2004). As mentioned below, revenue and expenditure are the two components that make up the fiscal deficit.

2.1.6. Revenue

Overview, Measurement, and Theoretical Underpinnings

The foundation of public finance is government revenue, which empowers states to carry out their core duties and carry out policy goals. All funds gathered by public authorities to support public services and governmental operations are collectively referred to as government revenue. According to Musgrave and Musgrave (1989), the three main purposes of government revenue are economic stabilization, income redistribution, and resource allocation. The ability of a country to maintain infrastructure, deliver basic services, and address social and economic issues is strongly impacted by the efficiency of its revenue mechanisms.

Adam Smith's four taxation canons—equity, clarity, convenience, and economy—known as The Classical Tax Theory (Smith, 1776) serve as the theoretical foundation for government income. These ideas still guide the development and assessment of contemporary tax policy. Optimal taxation theory, which aims to reduce deadweight losses

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while increasing required revenue, was presented by economists like Ramsey in 1927. Theoretically, government intervention and tax collection are also justified by modern public finance theory, which was introduced by Samuelson (1954) and further extended by others. According to the theory of public goods, some services must be provided by the government because of market failures, and in order to finance these endeavors, revenue-collecting methods are required.

Revenue Performance Indicators can be used to quantify revenue. Tax-to-GDP ratios, measures of collection efficiency, and revenue elasticity indicators are prominent metrics used to assess revenue systems (Tanzi & Zee, 2000). Policymakers can evaluate system performance and pinpoint areas for development with the aid of these measurements. The application of international comparisons is another. Comparisons between nations show notable differences in performance and revenue patterns. Such assessments are made possible by the extensive data provided by the OECD Revenue Statistics database (OECD, 2022).

Classification of Government Revenue

Government revenue is divided into two main categories: tax revenue and non-tax revenue. In the majority of developed countries, tax revenue is the main source of government revenue. According to the International Monetary Fund (2014), there are numerous main categories of taxes. Depending on their wealth or income, both individuals and corporations are subject to direct taxes. In the majority of OECD nations, personal income tax and corporate income tax make up the majority of direct taxes (OECD, 2022). Value-added tax (VAT), sales tax, excise duty, and other taxes on products and services are examples of indirect taxes. According to Tanzi (1987), indirect taxes have benefits for the effectiveness of collection, especially in developing nations with weak administrative infrastructure. Additionally, there are property taxes. Although their relative importance

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varies greatly among jurisdictions, real estate and personal property taxes give local governments steady sources of income (Bahl & Martinez-Vazquez, 2008).

Non-tax revenues come from a variety of sources outside of traditional taxes. One is the benefit principle of public finance, which justifies the User Fees and Charges, which are payments for particular government services (Buchanan, 1967).

Additionally, especially in countries with abundant natural resources, government income can be significantly derived from oil, gas and mineral revenues. Sachs and Warner (2001), however, show how resource reliance may have detrimental implications on economic growth. Once more, government or state-owned businesses can make money from their activities, while many nations have seen a decline in this source due to privatization trends (Megginson & Netter, 2001). Borrowing is another kind. Government borrowing offers short-term funding that must ultimately be paid back with future revenues, even if it is not official revenue (Blanchard et al., 1990).

Principles of Revenue System Design, Current Issues and Advancements

Efficiency considerations are one of them. Effective revenue systems maximize the possibility for collection while minimizing economic inefficiencies. Harberger (1964) showed how taxes change economic behavior and result in deadweight losses. By paying close attention to tax rates, bases, and structures, modern tax design aims to strike a balance between efficiency concerns and revenue needs. Once more, consideration is given to equity and distributional effects. The distribution of wealth and income is greatly impacted by revenue systems. Society's preference for vertical equity is reflected in progressive taxation, where higher earnings pay proportionately more (Musgrave, 1959). Nonetheless, there are compromises between economic efficiency and fairness goals (Okun, 1975). Administrative feasibility: Bird (2008) highlights that "a good tax that cannot be

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administered is a bad tax," emphasizing the significance of aligning revenue instruments to administrative capabilities. Revenue system design must take implementation capability and compliance costs into account.

According to Wilson (1999), economic globalization has increased tax competitiveness between countries, which could result in a "race to the bottom" in tax rates. This problem makes it difficult to maintain appropriate revenue levels and has a special impact on corporate taxes. Additionally, traditional revenue systems now face additional difficulties as a result of the growth of digital trade (Digital Economy Taxation). Frameworks for taxing digital services and tackling base erosion and profit shifting by multinational firms have been created by the OECD (2021). Another issue is revenue policy and income inequality. Interest in wealth taxes and progressive taxation as revenue tools has increased due to rising economic disparity in many nations (Piketty, 2014). However, the efficacy of these strategies is limited by implementation difficulties and capital mobility limitations. Furthermore, environmental considerations present another difficulty. Emerging revenue streams that address climate change and raise money include carbon taxes and other environmental levies (Stern, 2007). These mechanisms demonstrate the growing convergence of environmental policy with revenue creation.

2.1.7. Government Expenditure

Ideas, Theoretical Underpinnings, and Categorizations

A key tool of fiscal policy, government expenditure is the sum of all public authorities' spending on goods, services, transfers, and debt repayment. It has a significant impact on social welfare, economic growth, and macroeconomic stability (Musgrave & Musgrave, 1989). Over time, the theoretical basis for government spending has changed dramatically. Adam Smith (1776) and other classical economists were skeptical of government expenditure and believed that the state should only be involved in defense, justice, and basic

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infrastructure. Pigou (1928) codified the neoclassical framework, which maintained concerns about crowding out private investment while offering theoretical support for intervention only in situations of market failure.

By proving that government spending has a stabilizing impact through the multiplier effect—where initial spending results in larger increases in total economic output—Keynes (1936) revolutionized thinking. Samuelson (1954) established public goods theory, which offers basic support based on arguments of market failure, especially for products that are non-excludable and non-rival. An inverted U-shaped relationship between government size and economic growth was proposed by the optimal government size theory, also known as the Armey Curve, which was made popular by Armey (1995). Initially, increases in government size boost growth through institutions and infrastructure, but excessive spending eventually slows growth through inefficiency.

There are three main categories into which government spending can be divided. General public services, defense, economic affairs, education, health, and social protection are the categories under which the Functional Classification arranges spending. Every category has a different economic impact and serves a different purpose. The Economic Classification makes a distinction between capital expenditures (equipment, infrastructure), transfer payments, and current expenditures (wages, products, services, transfers). Most people believe that capital expenditures will boost growth more than current spending. Additionally, the Administrative Classification arranges spending by agency or level of government, offering insights into patterns of decentralization and fiscal federalism.

Economic Effects of Government Expenditure

Aggregate Demand Effects are present. Through its effects on investment and consumption, government spending has a direct impact on aggregate demand. The type of expenditure and the state of the economy determine the immediate impact. Government spending can

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offer crucial economic stimulus with potentially significant multiplier effects during recessions when private demand is low (Blanchard & Summers, 2017). Estimates of the fiscal multiplier's size vary widely, ranging from less than one to more than two, depending on the state of the economy, the type of spending, and the response of monetary policy. Recent research suggests multipliers are larger during recessions, when monetary policy is constrained, and when spending focuses on infrastructure or transfers to liquidity-constrained households (Ramey, 2019). In addition to demand-side effects, government spending on infrastructure, education, and research can have supply-side consequences, which affect the economy's potential for production. Although later research has indicated more moderate impacts, Aschauer's (1989) seminal study implied that public infrastructure investment has significant positive effects on private sector productivity (Romp & de Haan, 2007). The makeup of government spending has a big impact on growth outcomes. Kneller et al. (1999) discovered that while non-productive spending (transfers, subsidies) may slow growth, productive spending (health, education, and infrastructure) may boost it.

There is also a Crowding Out vs. Crowding in Effect. Crowding out effects are predicted by conventional neoclassical models, especially during times of full employment (Spencer & Yohe, 1970). There is conflicting empirical data regarding crowding out, though. Some studies show evidence of crowding out, particularly for current expenditures, whereas others find crowding in effects, notably for infrastructure investment that complements private capital (Aschauer, 1989). The type of expenditure, the state of the economy, and the financing method are some of the variables that affect the overall result. Through both direct service delivery and transfer payments, government spending has a major impact on the distribution of income and wealth. According to Lustig et al. (2013), progressive expenditure patterns can lessen inequality and enhance social welfare by giving low-income groups proportionately larger benefits. Beyond demand-side effects, government

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spending can also affect the economy's capacity for production through investments in research, infrastructure, and education (Supply-Side Effects). According to Aschauer's (1989) seminal work, education and healthcare spending generally have progressive distributional effects by providing services that low-income households might not otherwise have, but some spending, like cultural programs and higher education, may disproportionately benefit higher-income groups (Davoodi et al., 2010).

Current Issues and Advancements

A number of new issues are changing the needs and spending habits of the government. Demographic Transitions is one of them. In wealthy nations, aging populations lead to substantial financial strains due to rising pension, healthcare, and long-term care costs. To ensure fiscal sustainability, these demographic shifts necessitate modifications to finance mechanisms and spending programs (OECD, 2019). Because elderly voters may have different spending priorities than younger cohorts, changes in the dependence ratio also have an impact on the political economy of government expenditures. Long-term financial planning requires an understanding of these processes (Razin et al., 2002).

The challenges of green spending and climate change. Demands for government spending on adaptation, mitigation, and green infrastructure are growing as a result of climate change. Although these investments necessitate significant upfront expenses and cross-sector and cross-jurisdictional cooperation, they may yield favorable long-term benefits (Stern, 2007). During the COVID-19 pandemic, green stimulus packages were put into place in an effort to balance environmental goals with economic recovery. According to preliminary data, these initiatives may be successful, but careful planning is necessary to optimize co-benefits (O'Callaghan & Murdoch, 2021).

The challenge of digital transformation is another. Through data analytics, automation, and platforms for citizen participation, digital technologies present chances to enhance the

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efficiency of government spending and service delivery. However, major investments in human resources and technology are also necessary for digital transformation (OECD, 2020). The COVID-19 outbreak hastened the government's digital transformation, bringing to light the benefits and difficulties of using technology to enhance public services while controlling privacy and cybersecurity threats. Once more, there are emergency spending and crisis response. The significance of government spending capacity in times of crisis was highlighted by the COVID-19 epidemic. In several nations, emergency spending initiatives, such as healthcare investments, unemployment assistance, and business support, reached previously unheard-of amounts (Blanchard et al., 2021). These incidents demonstrate the necessity of adaptable spending plans that can react quickly to crises while upholding efficacy and accountability. For a crisis to be handled effectively, creating financial space during regular times becomes essential.

2.1.8. An Overview of the Fiscal Deficit Situation in Ghana Since Independence

Since Ghana gained independence in 1957, the country's fiscal status has drawn attention from policymakers and economists. The early years of independence, economic reform in the 1980s, recent years, and after the COVID-19 pandemic are important periods in Ghana's fiscal deficit condition. Due to the government's aggressive development plans and policies, Ghana had huge fiscal deficits in the early years of its independence. Between 1960 and 1970, Ghana's fiscal deficit averaged 6.2% of GDP, which contributed to high inflation and economic instability, according to a study published in the Journal of Economic Studies. (Baah-Boateng and Asare, 2012).

Ghana started a series of economic reforms in the 1980s with the intention of stabilizing the economy and lowering the budget deficit. These changes included a devaluation of the currency, a reduction in subsidies, and the privatization of state-owned businesses, which contributed to lowering the budget deficit from 9% of GDP in 1983 to 1.5% of GDP in

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1991, according to a report published in the Journal of International Development. (Osei-Assibey and Essel, 2005).

Due to a variety of local and foreign issues such as falling commodity prices, high levels of state debt, and ineffective revenue mobilization, Ghana has recently struggled to keep its budget deficit under control. IMF data shows that Ghana's budget deficit in 2019 was 11.7% of GDP, significantly higher than the government's target of 5%. (IMF, 2019). As a result of the government making considerable expenditures to sustain the economy and lessen the effects of the COVID-19 pandemic, Ghana's budget deficit situation has become much worse. In 2021, the World Bank projected that Ghana's fiscal deficit would increase to 11.4% of GDP, primarily as a result of increased spending on social security, healthcare, and economic stimulus programs. (World Bank, 2021).

To preserve macroeconomic stability and sustainable growth, Ghana's fiscal deficit situation has been a complicated and ongoing challenge that requires careful management and policy measures.

2.2. Trends of Ghana's Fiscal Deficit, E-Governance, E-Participation and Internet Availability

Table 2.1 below shows the trend of Fiscal deficit, E-governance, E- participation, and Internet availability from 2003 to 2021.

Table 2. 1: Fiscal deficit, E-governance, E-participation, and Internet availability from 2003 to 2021.

Year	Fiscal deficit	E-governance	E-participation	Internet availability
2003	-2.14	0.24	0.03	1.19
2004	-2.17	0.24	0.03	1.72
2005	-2.01	0.29	0.03	1.83
2006	-3.33	0.29	0.09	2.72
2007	-5.27	0.30	0.15	3.85
2008	-5.91	0.30	0.20	4.27
2009	-5.32	0.29	0.15	5.44

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2010	-7.47	0.28	0.09	7.80
2011	-5.47	0.30	0.10	9.00
2012	-8.33	0.32	0.11	10.60
2013	-9.12	0.34	0.25	15.00
2014	-7.81	0.37	0.39	19.00
2015	-4.01	0.40	0.42	23.00
2016	-6.75	0.42	0.46	28.00
2017	-2.966	0.48	0.54	37.88
2018	-6.791	0.54	0.63	43.00
2019	-7.285	0.57	0.63	22.07
2020	-15.29	0.60	0.63	58.00
2021	-11.439	0.59	0.54	68.60

Source: ***International Monetary Fund World Economic Outlook Database, United Nations E-government Survey and World Development Indicators of the World Bank***

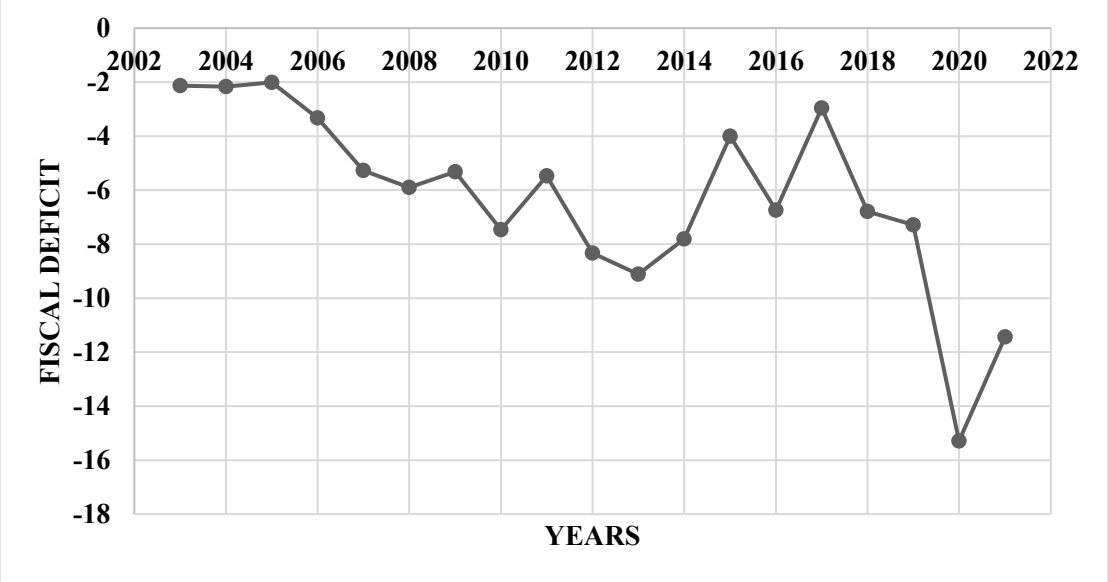

Fig. 2. 1 The trend of Ghana's Fiscal deficit from 2003 to 2021

Source: ***Authors own construction from data obtained from the International Monetary Fund World Economic Outlook Database***

Figure 2.1 above shows the trend of Ghana's Fiscal deficit from the year 2003 to 2021. From the trend, it is seen that Ghana's fiscal deficit was below 5% of GDP from 2003 to 2006. After 2006, Ghana's fiscal deficit started worsening all above 5% of GDP except in the years 2015 and 2017. In the years 2020 and 2021, it even became a double-digit. It can also be observed that Ghana's fiscal balance which is downward trending indicates a fiscal deficit.

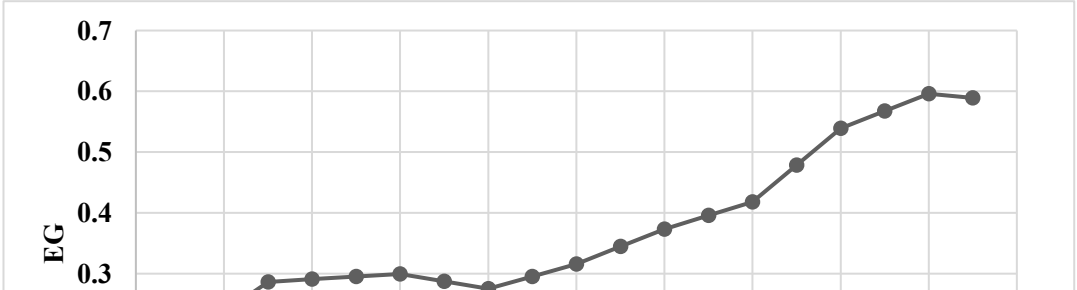

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Fig. 2. 4 The trend of Ghana's E-governance from 2003 to 2021

Source: ***Authors own construction from data obtained from the United Nations E-government Survey***

Figure 2.2 above indicates generally an upward trend of Ghana's E-governance. This means, there is an increase in E-governance in Ghana.

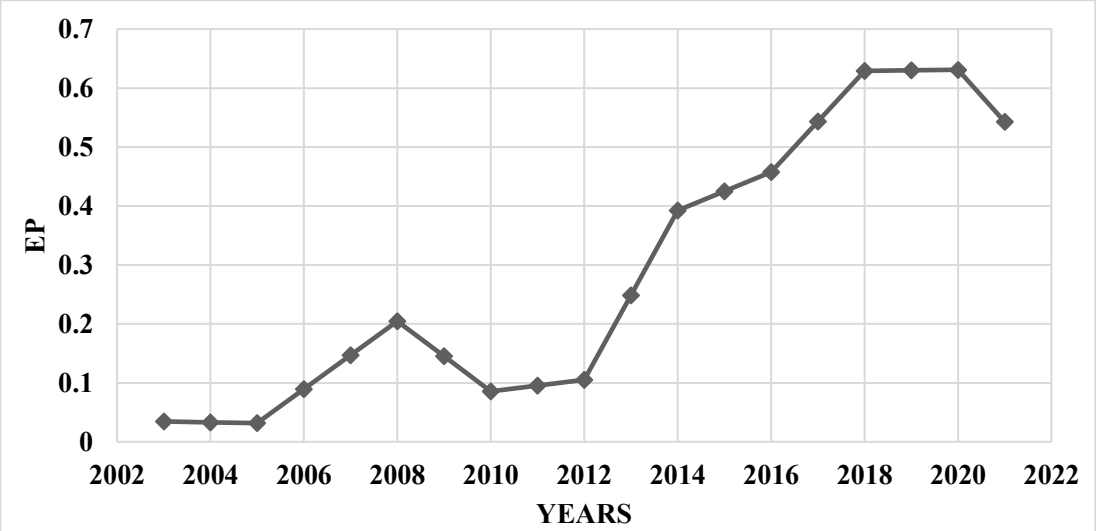

Fig. 2. 7 The trend of Ghana's E-participation from 2003 to 2021

Source: ***Author's own construction from data obtained from the United Nations E-government Survey***

Figure 2.3 above also indicates a generally upward trend of Ghana's E-participation, though there are a few up and down trends. This again means there is an increase in E-participation in Ghana.

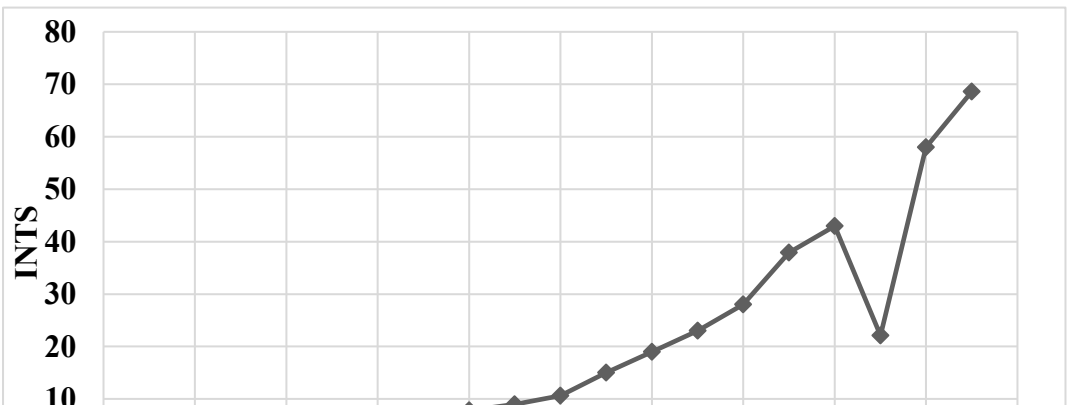

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Fig. 2. 10 the trend of Ghana's Internet availability from the year 2003 to 2021

Source: ***Author's own construction from data obtained from the World Development Indicators of the World Bank.***

Figure 2.4 above indicates an upward trend of Ghana's Internet availability though, there was a sharp fall in the year 2019. It can be seen that there was also a sharp rise in internet availability in the years 2020 and 2021. This generally indicates an increase in Internet availability in Ghana.

2.3. Theoretical Review

2.3.1. Introduction

There are several economic theories related to technology and fiscal deficit, as discussed below.

2.3.2. Schumpeter's Theory

Understanding capitalism, innovation, and long-term economic change is greatly aided by Joseph Alois Schumpeter's theory of economic development in 1942. By highlighting the dynamic, evolutionary character of capitalist economies propelled by innovation and entrepreneurship, Schumpeter's framework, which was developed in the early 20th century, challenged static equilibrium models. His theory of "creative destruction" has grown to be essential to contemporary comprehension of market dynamics, technological advancement, and economic development processes. Through a number of significant works, such as "The Theory of Economic Development," which established the fundamental ideas of entrepreneurship, innovation, and economic development as a process of internal

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transformation rather than external growth, Schumpeter's theoretical framework developed. He presented Schumpeter's mature theoretical framework, added the idea of "creative destruction," and examined the long-term evolutionary dynamics of capitalist systems. He also extended the framework to explain macroeconomic fluctuations through innovation waves and their clustering effects.

By making a distinction between "development" and "growth," which emphasize quantitative expansion within preexisting economic structures and qualitative transformation through innovation, Schumpeter's theory sets itself apart from neoclassical economic analysis. With five categories—the introduction of new goods or attributes, the introduction of new production techniques, the opening of new markets, the acquisition of new supply sources, and the development of new industrial organization structures—innovation holds a central place in Schumpeter's framework. The human agent of innovation, entrepreneurship, is defined by resistance to change, a willingness to deviate from routine, and an awareness of new opportunities.

The term "creative destruction" refers to the ongoing internal revolution of economic structures brought about by innovations, which both create new industries, jobs, and lifestyles and destroy old ones. The relationship between macroeconomic fluctuations and microeconomic innovation processes is the main focus of Schumpeter's business cycle analysis. He distinguished between three different kinds of cycles: long-term Kondratieff cycles, medium-term Juglar cycles, and short-term Kitchin cycles. As new industries develop and grow, these cycles lead to increases in output, investment, and employment, which in turn create economic booms. However, economic activity slows down as innovations mature and markets become saturated, resulting in periods of depression and recession that eliminate outdated structures and prepare the way for the next wave of innovation.

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By highlighting monopolistic aspects for economic growth and innovation, Schumpeter's study of market structure questioned conventional models of perfect competition. He maintained that larger companies with market dominance are in a better position than perfectly competitive businesses with narrow profit margins to make significant investments in significant innovations. According to Schumpeter's theory, the innovation function of entrepreneurship sets it apart from both management and capitalist functions. According to Schumpeter's theory of institutional evolution, effective economic systems must constantly modify their institutional frameworks to take into account societal and technological advancements. The forces of creative destruction will ultimately overpower static institutions that are resistant to adaptation, but adaptable institutions that change with the times can preserve their core purposes while changing their particular forms.

Economic development, entrepreneurship, and innovation have all made extensive use of Schumpeter's theoretical framework. It has been discovered that during times of rapid technological change, innovation clustering plays a crucial role in the concentration of significant innovations. Nevertheless, it has proven challenging to empirically validate Schumpeter's precise cycle lengths and mechanisms. In recent decades, Schumpeter's theories have attracted renewed attention as economists attempt to comprehend industrial transformation, economic growth, and technological change. Schumpeter's ideas have been further developed in recent years by advances in endogenous growth theory, evolutionary economics, innovation systems research, and digital economy analysis.

The theoretical underpinnings and empirical applicability of Schumpeter's theory of entrepreneurship, innovation, and creative destruction have drawn criticism. Because it is difficult to quantify ideas like entrepreneurship, innovation, and creative destruction, the measurement problem is difficult. The theory's focus on individual business owners undervalues the institutional and collective aspects of innovation processes, indicating the

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need for more comprehensive analytical frameworks. Schumpeter's optimistic theory of creative destruction is criticized for underestimating social costs and for having cyclical features that are hard to empirically confirm. There may be other explanations for economic fluctuations that better fit the patterns that have been noticed.

2.3.3. Information Economics Theory on Technology

This theory is mainly attributed to George Stigler (1961) & Kenneth Arrow (1962). A key framework for comprehending how knowledge attributes, uncertainty, and information asymmetries affect technological innovation, diffusion, and economic results is information economics theory. It resulted from the realization that information has special economic qualities that present both opportunities and difficulties for the technology markets. The theory sheds light on how information issues impact technology transfer, innovation incentives, R&D choices, and the structure of technology-intensive industries. Since technological knowledge is informational by nature, it necessitates specific institutional arrangements and produces market failures due to its non-rivalry, partial excludability, and uncertainty. Analyzing technology policy, intellectual property systems, innovation financing, and the rise of technology platforms and ecosystems all depend on an understanding of these information-theoretic underpinnings.

A number of intellectual advancements in the middle to late 20th century gave rise to the theoretical underpinnings of information economics. The theoretical framework for analyzing information asymmetries was further developed by Kenneth Arrow's work, George Akerlof's (1970) analysis of the "market for lemons," Michael Spence's (1973) signaling theory, and Joseph Stiglitz's contributions. These ideas have been expanded upon in technology economics by scholars such as Paul David and Nathan Rosenberg. Particularly pertinent to comprehending technology markets, information characteristics give rise to distinct economic challenges.

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Although non-rivalry erodes traditional property rights and market mechanisms, it permits enormous social returns from the production of information. Although information producers can take precautions to stop unauthorized use, information leaks through a variety of channels, which leads to partial excludability. Another essential quality that is especially pertinent to technological innovation is uncertainty. Due to experience goods characteristics, the value of many information-based technologies cannot be determined until after purchase and use. This limits the effectiveness of price mechanisms in signaling quality and increases the risk of market failures due to adverse selection. Information Economics Theory sheds light on how technology diffusion and innovation incentives are impacted by intellectual property systems. With patent length and breadth dictating the extent of protection, the ideal patent system must strike a balance between these conflicting factors. According to absorptive capacity theory, an organization's current knowledge base and research capabilities determine its capacity to identify, absorb, and apply external knowledge.

The main ways that innovation from one party benefits others are through technological knowledge transfer and knowledge spillovers; however, the type and degree of these spillovers rely on institutional arrangements and information characteristics. Venture capital markets use a variety of strategies, including staged financing, close monitoring and due diligence, networks and experience, and portfolio diversification, to mitigate information asymmetries between investors and entrepreneurs. After funding, moral hazard concerns surface, and problems with adverse selection occur in innovation finance. Market failures in innovation finance are addressed by public funding mechanisms such as government venture funds and research grants, especially for basic research and early-stage technologies with high levels of uncertainty and spillover potential.

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Understanding digital platforms and information technology markets requires an understanding of information economics theory. It focuses on how businesses add value by enabling interactions between various user groups, with network effects and information flows being key components. While network effects occur when a technology's value rises with the number of users, two-sided market theory explains how platforms must balance the interests of various user groups. While privacy economics studies how information asymmetries between businesses and consumers impact data collection and use practices, data economics studies how information characteristics directly impact market outcomes. The theory also sheds light on how businesses plan their R&D projects and choose which technologies to invest in research consortia and collaborative arrangements to address information market failures by facilitating knowledge sharing and minimizing duplication of effort, while open innovation models aid in striking a balance between internal and external R&D decisions. Frameworks for valuing R&D investments in the face of uncertainty are provided by real options theory.

In addition to discussing strategic and welfare issues, the standards and compatibility of technology are examined, along with the difficulties presented by digital platforms, big data, and artificial intelligence. While algorithmic decision-making raises concerns about information accountability and transparency, machine learning systems produce unique information assets. Blockchain and distributed ledger technologies use cryptographic techniques to solve issues with information and trust.

2.3.4. Network Effect Theory on Technology

A key paradigm for comprehending how technology markets diverge from conventional economic models by establishing positive feedback loops in which network size increases utility is the network effects theory. When examining software ecosystems, digital platforms, telecommunications systems, and emerging technologies where user adoption

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patterns determine the value proposition, this framework is crucial. The unique competitive dynamics created by network technologies, which show rising returns to adoption, defy conventional economic analysis. The theory's importance goes beyond market analysis to include understanding innovation dynamics in interconnected systems, developing regulatory policies, and strategic considerations for technology companies.

The formal theoretical development of Network Effects Theory emerged through convergent research streams in industrial organization, technology adoption, and platform economics. The theory's historical development dates back to early observations about the value of telecommunications. Broader theoretical background on network effects, market efficiency, and technological advancement is provided by the theoretical works of Theodore Vail in the early 1900s, Jeffrey Rohlfs (1974), Michael Katz and Carl Shapiro (1985), and Brian Arthur (1989). According to Network Effects Theory, other users' adoption of a technology affects its value, producing positive externalities that conventional market analysis is unable to account for. This theory identifies a number of mechanisms, such as direct network effects, indirect network effects, data network effects, and two-sided market network effects, that function across various technology categories.

By increasing returns to scale in adoption rather than production, network effects change the dynamics of competition and produce market structures that differ greatly from conventional models. A key idea in network competition is critical mass, which refers to the bare minimum of users needed for networks to become self-sufficient and appealing to new users. Because marginal users favour larger networks, winner-take-all situations frequently occur in network markets. However, variables like switching costs, multi-homing costs, opportunities for differentiation, and network compatibility choices all affect market outcomes. Because platforms must draw in numerous interdependent user groups

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while handling intricate feedback effects, platform competition is qualitatively different from traditional product competition.

The theory of network effects also sheds light on standards competition, in which incompatible technologies use network-building tactics to vie for market supremacy. In extreme cases of network competition, such as standards wars, early advantages can become self-reinforcing and result in winner-take-all situations. Decisions about compatibility, which involve trade-offs between short-term market access and long-term value appropriation through proprietary control, are fundamental strategic choices in network markets.

Understanding platform economics in digital markets, where platforms serve as middlemen for interactions between various participant groups, requires an understanding of network effects theory. In order to draw users and achieve critical mass across a variety of market segments, successful platforms employ complex pricing and incentive schemes. By generating switching costs and barriers to competition, platform ecosystem strategies take advantage of network effects to gain a competitive edge. In digital markets, data-driven competitive advantages are becoming more and more significant. Ecosystem governance entails difficult choices regarding control, transparency, and value allocation. Both incentives and obstacles to technological advancement are created by network effects theory, which has implications for innovation in technology markets. In network markets, disruptive innovation must create new network categories, reduce the significance of current network effects, or create technologies with better value propositions. In network markets, open versus closed innovation strategies are crucial.

New forms of network value and competitive dynamics have been created by recent theoretical advancements that have extended the analysis of network effects to new market structures and emerging technologies. Through protocol governance, token economics, and

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decentralized validation, blockchain and cryptocurrency networks exhibit distinctive network effects. Data-driven network effects produced by AI and machine learning improve algorithmic performance with use, generating cumulative benefits that get stronger over time. Global markets prompt inquiries into the ways in which network formation and competitive outcomes are impacted by geographic borders, cultural distinctions, regulatory fragmentation, and infrastructure variances. An active area of study is platform ecosystem evolution, which looks at how network effects function in intricate networks of linked platforms and services.

Nevertheless, network effects theory has a number of drawbacks, such as exaggerating how long network advantages last, ignoring quality and user experience issues, and failing to identify alternative sources of growing returns. Network effects can benefit consumers through increased connectivity and ecosystem benefits, but they can also hinder long-term competition and innovation by posing barriers to entry or causing excessive market concentration. As a result, the welfare implications of network effects are multifaceted and context-dependent.

2.3.5. Keynesian Theory

The traditional belief that markets automatically clear at full employment equilibrium is contested by the Keynesian theoretical framework, which has its roots in John Maynard Keynes' "The General Theory of Employment, Interest and Money." Keynes challenged Say's Law and conventional economic theory by arguing that economies can endure prolonged periods of underemployment equilibrium as a result of inadequate aggregate demand. The Effective Demand Principle, Liquidity Preference Theory, and Multiplier Mechanism are some of his central theoretical claims.

According to Keynes' principle of effective demand, the aggregate demand function determines the amount of employment in equilibrium, and fiscal deficits are necessary

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when private sector demand is insufficient to sustain full employment. His use of liquidity preference theory to determine interest rates shows that supply and demand for money, not just flows from savings and investments, affect interest rates. John's employment multiplier concept, which illustrates how initial government spending creates subsequent rounds of income and expenditure, forms the theoretical basis of the multiplier mechanism. The framework theoretically supports the stabilizing characteristics of fiscal systems by incorporating built-in stabilizers in the form of progressive taxation and unemployment benefits.

The standard framework for examining the effects of fiscal policy is the IS-LM model, which was created by Hicks in 1937. By taking into account the portfolio effects of government debt, Tobin's Portfolio Balance Theory expands on Keynesian insights. Among the theoretical issues with the original Keynesian framework were its lack of supply-side considerations, its minimal attention to long-term sustainability constraints, and its limited treatment of expectations formation.

2.3.6. Neoclassical Theory of Fiscal Deficits

Walrasian general equilibrium theory, which emphasizes market efficiency, rational optimization, and the long-term neutrality of fiscal interventions, is the foundation of the neoclassical theory of fiscal deficits. The framework is predicated on flexible prices, rational expectations, and perfect capital mobility. The intertemporal budget constraint, the crowding-out hypothesis, and the Ricardian Equivalence Theorem are important theoretical claims.

According to Solow's growth framework, sustained fiscal deficits lower national savings, which in turn lowers capital accumulation and slows long-term growth. The idea that government debt equates to net wealth is contested by overlapping generations models,

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which offer theoretical underpinnings for examining the intergenerational impacts of fiscal deficits.

In his critique of Keynesian policy analysis, Lucas contended that the way policy changes impact the formation of expectations determines how effective the policy is.

The policy ineffectiveness argument put forth by Sargent and Wallace (1975) showed that in models with flexible prices and rational expectations, expected changes in fiscal policy have no practical impact. Fiscal deficits have been analyzed using the Real Business Cycle Theory (RBC) and optimal taxation theory. Because of Ricardian equivalency and effective private sector responses, RBC models, which incorporate fiscal variables into dynamic stochastic general equilibrium frameworks, find that fiscal interventions are not very effective. According to the theory of optimal taxation, tax rates ought to be gradually reduced, which implies that short-term deficits might be ideal in times of war or recession.

2.3.7. New Keynesian Theory of Fiscal Deficits

The 1980s and 1990s saw the emergence of the New Keynesian Theory of Fiscal Deficits, a synthesis approach that preserved Keynesian insights regarding market imperfections while integrating microeconomic underpinnings. By carefully simulating market frictions, this framework responds to critiques of conventional Keynesian and neoclassical methodologies. Nominal and real rigidities, wage rigidities, credit market imperfections, and heterogeneous agent models are examples of fundamental theoretical mechanisms. A number of market imperfections are included in the Dynamic Stochastic General Equilibrium (DSGE) framework, including agent heterogeneity, nominal price rigidities, wage rigidities, and credit market imperfections. State-dependent fiscal multipliers are produced by the theory and are influenced by a number of variables, including economic slack, monetary policy stance, the type of fiscal intervention, and the duration of fiscal shocks.

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Liquidity trap models, fiscal theory of price level (FTPL), and zero lower bound (ZLB) economics are examples of advanced theoretical extensions. These models highlight the fact that the effectiveness of fiscal deficits varies by state and that fiscal interventions are more successful during recessions. Whether monetary policy supports or restrains fiscal expansion determines fiscal effectiveness, and during financial crises, credit market flaws intensify fiscal effects. Taking into account the timing of fiscal interventions, the makeup of fiscal packages, their interaction with monetary policy, automatic stabilizers versus discretionary policy, and the sustainability of debt, new Keynesian models offer rich implications for the design of optimal fiscal policy. While retaining fundamental understandings of market imperfections and the efficacy of fiscal policy, the transition from Keynesian to New Keynesian theory signifies a rise in theoretical complexity.

2.3.8. Public Choice Theory

A ground-breaking method for comprehending political and governmental processes via economic analysis is public choice theory. This theoretical framework, which was created in the middle of the 20th century, challenges conventional beliefs about government as a kind social welfare maximizer by applying the instruments of microeconomic analysis to political decision-making. The theory essentially asserts that political actors, including voters, politicians, and bureaucrats, are self-interested, rational people who react naturally to incentives, much like participants in economic markets. Although Duncan Black's 1948 work and his examination of committee decision-making provide the theoretical underpinnings of public choice theory, the field really took off with James Buchanan and Gordon Tullock's groundbreaking work in "The Calculus of Consent" (1962).

Another important basis was established by Anthony Downs in 1957 with "An Economic Theory of Democracy," which applied economic logic to party rivalry and voting behavior.

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Mancur Olson (1965) examined the logic of collective action and free-rider issues in "The Logic of Collective Action," while Kenneth Arrow's impossibility theorem illustrated basic issues with combining individual preferences into collective choices. The foundational tenets of public choice theory are taken from neoclassical economics. First, methodological individualism makes the assumption that individual decisions lead to collective outcomes and that individual decision-makers, not abstract collective entities, should be the subject of analysis. Second, according to rational choice theory, people make choices to maximize their utility while taking constraints into account and have consistent preferences.

Third, the theory makes the assumption that competitive processes and exchange relationships define political markets, just as they do economic markets. An important development of public choice theory is William Niskanen's (1971) theory of bureaucracy, which is modelled as budget-maximizing agents with informational advantages over lawmakers that result in an overabundance of government services and bureaucratic inefficiencies. This theory offers a framework for comprehending market failure as it relates to government failure. Legislative behaviour, bureaucratic behaviour, electoral studies, regulatory capture, and cross-national studies are just a few of the areas where Public Choice Theory has produced a significant amount of empirical research. Nonetheless, it is subject to a number of significant critiques, such as the presumption of exogenous preferences, the role of institutions, norms, and culture in influencing political behavior, and the assumption of pure self-interest.

2.3.9. Transaction Cost Theory

A key theoretical framework in contemporary economics, transaction cost theory offers a thorough explanation of why businesses exist, how they set up their production, and when market exchanges are better than hierarchical coordination. The theory, which was first formulated by Ronald Coase and then further developed by Oliver Williamson, centers on

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the relative costs of conducting business under various forms of government. The fundamental presumptions of the theory include opportunism, which holds that certain economic actors will act dishonestly when it benefits them, and bounded rationality, which acknowledges that decision-makers aim to be rational but are constrained by cognitive limitations and insufficient information. These behavioral presumptions, along with environmental elements like complexity and uncertainty, result in transaction costs that need to be minimized through suitable governance procedures.

According to the theory, asset specificity, uncertainty, and frequency are the three key aspects of transactions that affect governance costs. Bilateral dependency brought on by high asset specificity leaves parties open to opportunistic behavior and calls for protections. To reduce overall costs, including production and transaction costs, governance structures will be in line with transaction characteristics. Markets, hierarchies (firms), and hybrid forms (like long-term contracts, joint ventures, and networks) are the three main modes of governance identified by the theory. It has sparked a great deal of empirical research in a wide range of fields, including the petrochemical, automotive, aerospace, and vertical integration industries; the decision made by multinational corporations between licensing and foreign direct investment; supply chain structure; and the arrangement of professional services. Transaction cost reasoning has been used in financial economics to explain capital structure choices, corporate governance practices,

and financial market structure.

Numerous extensions and related theoretical developments, including Property Rights Theory, Resource-Based Theory of the Firm, and Relational Contracting Theory, have been born out of Transaction Cost Theory. The Resource-Based Theory of the Firm looks at how businesses generate and seize value using their own resources and capabilities, while Property Rights Theory concentrates on the distribution of control rights in cases where

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contracts are not fully completed. The theory of relational contracting investigates how trust and enduring relationships can govern transactions in place of formal contracts. Nonetheless, there are a number of significant objections to Transaction Cost Theory. Since transaction costs are frequently hard to see and measure directly, empirical testing presents a special challenge to the measurement problem.

Critics assert that the theory occasionally seems tautological, using unquantified transaction costs to explain observed organizational arrangements. It has been argued that the theory's focus on cost reduction ignores innovation, value creation, and strategic organizational design considerations. Behavioural criticisms raise concerns about how well the theory explains the entire spectrum of human motivations and cognitive processes given its presumptions about opportunism and bounded rationality. According to research on social preferences, reciprocity, and trust, purely mathematical methods might overlook crucial facets of economic structure.

2.3.10. Deliberative Democracy Theory

A fundamental rethinking of democratic legitimacy and political decision-making, Deliberative Democracy Theory places more emphasis on the quality of democratic discourse than just the sum of individual preferences. According to this theoretical framework, legitimate democratic decisions are the result of sincere deliberation in which citizens engage in rational public discussion about shared issues rather than simple majority rule or bargaining among conflicting interests. The theory contends that genuine communication between citizens and their representatives is necessary for democratic legitimacy in order to arrive at mutually agreeable solutions to societal issues, challenging both interest-group pluralism and traditional majoritarian democracy.

One of the most significant normative theories in modern political philosophy and

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democratic theory, Deliberative Democracy Theory first gained prominence in the late 20th century.

It provides a critical analysis of current democratic practices as well as a suggested reform of democratic institutions and procedures to better achieve democratic goals. Classical democratic theorists, especially John Stuart Mill's focus on the educational value of political engagement and John Dewey's pragmatic view of democracy as a way of life involving cooperative problem-solving, are the philosophical forerunners of Deliberative Democracy Theory. Nonetheless, a number of intellectual advancements from the late 20th century came together to form the modern theory. Political equality, the need for rational justification, openness, and provisional decision-making are among the fundamental theoretical tenets of deliberative democracy theory.

By mandating that all citizens have equal opportunities to engage in democratic deliberation—rather than just equal votes—these principles set it apart from other democratic theories.

To put deliberative democratic principles into practice, a number of institutional models have been created, including the parliamentary model, the participatory model, empowered participatory governance, and digital deliberation models. Compared to other democratic approaches, Deliberative Democracy Theory asserts both legitimacy and epistemic advantages. In terms of epistemology, the theory contends that deliberation enhances the quality of decisions by introducing decision-makers to a range of viewpoints, fostering critical analysis of presumptions, and fostering learning via organized discussion. Deliberative democracy provides a compromise between purely substantive and purely procedural ideas of democratic legitimacy. Decisions are valid not only because they adhere to proper protocols (like majority rule) or because they produce accurate results

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based on an impartial criterion, but also because they are the result of sincere discussions among equal and free citizens.

Significant empirical evidence has been produced by research on the theory of deliberative democracy, looking at both the factors that encourage high-quality deliberation and the consequences of deliberative processes for participants and results. Deliberative polling studies have consistently shown that participation increases civic engagement, reduces polarization on certain issues, and produces more thoughtful and informed opinions. Studies on mini-publics have shown that they are capable of handling intricate technical matters and coming to logical conclusions on contentious subjects. Significant obstacles are also revealed by empirical research, such as polarization rather than convergence, strategic behavior rather than truth-seeking, and dominance by the most outspoken participants rather than inclusive discourse.

The viability and desirability of the democratic decision-making process known as Deliberative Democracy Theory have been questioned. Critics contend that because citizens have limited time, attention, and cognitive capacity, the theory's demands for informed deliberation are unrealistic. Public choice theorists contend that in large-scale democracies, rational ignorance precludes thorough deliberation. Deliberative democracy's emphasis on reasoned argument, according to the exclusion critique, favours dominant social groups while marginalizing alternative forms of expression. According to the power critique, elite dominance could result from deliberative reforms that fail to address underlying disparities in power and resources. According to Chantal Mouffe's agonistic democracy theory, deliberative democracy's emphasis on rational consensus ignores the importance of passion and conflict in democratic politics, and some critics contend that consensus-oriented deliberation may not always be desirable.

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2.3.11. Endogenous Growth Theory

A paradigm shifts in economic growth theory, endogenous growth theory departs from the neoclassical presumption that exogenous technological advancement determines long-term growth. In order to overcome the shortcomings of the Solow-Swan model, this theoretical framework, which first appeared in the 1980s and 1990s, explains the origins of technological advancement and shows how government regulations, the gathering of human capital, investments in R&D, and knowledge spillovers can all have a lasting impact on growth rates. The main finding of endogenous growth theory is that increasing returns to scale in the production of human capital, knowledge, or other factors that do not show diminishing marginal returns can lead to sustained economic growth. This discovery settled the theoretical conflict between neoclassical models, which predicted convergence to steady-state growth rates based only on population growth and exogenous technological change, and the empirical observation of sustained growth. Economists who challenged the exogeneity of technological advancement in neoclassical models laid the theoretical groundwork for Endogenous Growth Theory.

The groundbreaking study "Increasing Returns and Long-Run Growth" by Paul Romer (1986) showed that knowledge creation spillovers could produce long-term growth without the need for exogenous technological advancement. A different basis was offered by Robert Lucas's (1988) seminal work "On the Mechanics of Economic Development," which modeled the accumulation of human capital as the growth engine. A number of unique but connected modeling techniques are included in endogenous growth theory, each of which focuses on a different mechanism for long-term growth. The most basic endogenous growth framework, the AK model, eliminates diminishing returns to capital accumulation by assuming a production function in which output is proportionate to the capital stock ($Y = AK$). The Lucas (1988) human capital model views the accumulation of human capital as

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the main driver of growth, whereas the Romer (1986) model concentrates on knowledge spillovers and learning-by-doing. The most thorough discussion of innovation can be found in the R&D-based model proposed by Romer (1990).

Economic policy is significantly impacted by endogenous growth theory, which fundamentally changes the accepted wisdom regarding the role of government in fostering economic growth. Through complementarities and spillovers of human capital, public investments in education, training, and lifelong learning can result in long-term increases in growth rates. With government funding for basic research, patent protection, research subsidies, and technology transfer, research and development policies are essential to innovation-based growth models. Investments in information, communication, and transportation infrastructure can have a positive impact on the economy by creating network effects and spillovers.

The relationship between growth rates and different variables has been the subject of much empirical research on endogenous growth theory. Research and development expenditures, infrastructure quality, institutional variables, and educational attainment have all been found to positively correlate. The magnitudes and causal interpretation of these effects are still up for debate, though. Additional evidence is provided by studies of returns to education conducted at the micro level. R&D spending and productivity growth are positively correlated, according to research on innovation and growth. However, the inability to quantify knowledge spillovers makes it difficult to measure the social returns to innovation.

Countries with similar institutional and human capital characteristics may converge to similar growth rates, according to empirical research on convergence, which has found conflicting evidence for the unconditional convergence predicted by neoclassical models. However, the theory faces criticisms, such as the need for precise parameter values and the

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weak empirical evidence for scale effects. Furthermore, there are issues with identification, cross-country regressions, and the overestimation of the role of policy in determining growth rates that undermine the empirical support of the theory.

2.3.12. Systems Theory

Systems Theory is an interdisciplinary framework that has significantly influenced economics by providing conceptual tools for understanding complex, interconnected phenomena that cannot be adequately analyzed through traditional reductionist approaches. Systems Theory, which has its roots in biology and cybernetics, places more emphasis on the connections, structures, and emergent qualities that result from the interaction of system elements than it does on the elements alone. The Santa Fe Institute's work on complexity science, Norbert Wiener's Cybernetics, Jay Forrester's System Dynamics, and Ludwig von Bertalanffy's General Systems Theory were among the intellectual traditions that came together to form Systems Theory in the middle of the 20th century. The theory differs from reductionist and mechanistic approaches to analysis because it is based on a number of core ideas.

In systems theory, feedback loops are key mechanisms that explain how a system's outputs are fed back as inputs to create circular cause-and-effect chains. Analyzing economic phenomena like business cycles, financial bubbles, and development processes requires an understanding of these feedback mechanisms. Another important idea is hierarchy and levels of analysis, which acknowledge that systems exist at several levels, each with unique dynamics and properties. Two essential systemic characteristics that describe how systems alter their structure and behavior in response to changes in their environment are adaptation and learning. Price adjustments, institutional evolution, technological innovation, and behavioral shifts that allow for survival and growth in shifting circumstances are examples of how economic systems exhibit their capacity for adaptation.

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Many branches of economic analysis have been impacted by systems theory, which offers frameworks for comprehending phenomena that are difficult for conventional models to explain. In order to gain insight into business cycle dynamics, financial stability, and the efficacy of policies, macroeconomic systems analysis looks at how aggregate economic variables interact through intricate feedback mechanisms. Systems thinking has helped industrial organizations by analyzing supply chains, network effects, and business ecosystems. Ideas like poverty traps as stable low-level equilibria, development as a complex adaptive system, and the function of institutional systems in fostering or impeding economic development have all had a significant impact on development economics.

Because they are complex adaptive systems with many levels, feedback loops, and emergent properties that affect economic performance and innovation, financial systems and stability are especially suited for systems analysis. Since Peter Senge's work on learning organizations highlights the significance of mental models, shared vision, and systems thinking skills in organizational effectiveness, systems theory also benefits management and organizational systems. Systems thinking, which looks at how formal and informal institutions interact to determine economic outcomes, has had a big impact on institutional economics.

Complex adaptive features such as path dependence, feedback effects, and emergent characteristics are displayed by these systems. In order to comprehend why development strategies work or fail, development economists are increasingly using systems approaches, which look at how social, political, and economic systems interact to influence development outcomes. The study of social capital looks at how networks of reciprocity, trust, and relationships form social systems that affect economic performance by lowering transaction costs, fostering greater collaboration, and improving information flows.

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However, there are a number of objections to systems theory when it comes to economics. According to the complexity critique, systems approaches can become unfalsifiable because of their intricacy and lack of policy or prediction guidance. Another challenge is the boundary problem, which makes it difficult to determine which components to include in the analysis and where to draw system boundaries. Systems thinking is criticized for lacking the formal theoretical underpinnings and mathematical rigor of contemporary economic theory.

2.4. Empirical Literature Review

At a conceptual level, digitalization enhances revenue mobilization through automated taxpayer identification, e-filing, and real-time data analytics, which curb evasion and broaden the tax base. It also improves expenditure efficiency by tracking public outlays and reducing duplication. Moreover, digital platforms foster greater transparency and accountability**,** thus strengthening citizens' trust and compliance incentives. Conversely, initial implementation costs or transitional disruptions can temporarily widen deficits. Understanding these dual dynamics underpins empirical analyses of short-run versus long-run effects.

2.4. 1 Fiscal Deficit and E-Governance

Andersen and Henriksen (2006) empirically validated the stage model of e-governance evolution put out by Layne and Lee (2001), which demonstrated progressive cost reductions as governments progressed through integration phases. Their analysis of 196 Danish towns revealed that, on average, online services were 15–25% less expensive than traditional delivery methods. According to a thorough analysis of state governments in the United those by Welch et al. (2005), those with more sophisticated e-governance systems had lower administrative expenditures per capita. According to their regression study,

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administrative costs and e-governance maturity were negatively correlated ($r = -0.34$, $p < 0.01$).

According to Kaylor et al. (2001), who looked at the effectiveness of tax collection, online tax filing systems lowered processing costs by up to 40% and raised compliance rates by 12–18%. In their research on electronic benefit systems, Carter and Belanger (2005) found similar results. Heeks (2006) examined 40 e-governance initiatives in poor nations and discovered that, on average, each project cost between $2.5 and $15 million to construct, with 35% of those expenses going over budget. These expenses frequently led to short-term increases in the deficit, especially in settings with limited resources. According to a 2007 study by Gil-García and Martinez-Moyano, federal e-governance programs in the United States saw investments totaling more than $65 billion between 2000 and 2010. According to their investigation, budget deficits due to IT had brief spikes before showing favorable returns, typically after 4-6 years.

According to Tolbert and Mossberger (2006), continuous e-governance expenses usually account for 60–80% of overall lifecycle costs, putting constant strain on the budget that, if not carefully managed, might lead to structural deficits. In a thorough analysis of 30 member nations, the OECD (2014) discovered that more developed e-governance systems were linked to reduced government spending as a proportion of GDP. Over a ten-year period, nations with sophisticated digital government capabilities demonstrated average deficit reductions of 0.5–1.2% of GDP. The World Bank (2016) found mixed results from its analysis of e-governance projects in 50 developing nations. Within five years, 60% of initiatives demonstrated favorable fiscal outcomes; however, 40% either failed to produce the anticipated advantages or were shelved because of cost overruns.

Bannister and Connolly (2014) investigated the fiscal effects of e-governance projects in EU member states. Their study of panel data from 2000 to 2012 revealed that consistent

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investment in e-governance was linked to better budgetary sustainability; however, there was a notable difference between nations in terms of institutional capability and governance quality.

2.4. 2 Fiscal Deficit and E-Participation

In their 2008 study of 500 American communities, Coursey and Norris discovered that, in comparison to financially sound cities, municipalities with budget deficits were 23% less likely to provide online participation options. Their regression analysis revealed a significant negative correlation between the breadth of e-participation services and the extent of the deficit ($\beta = -0.31$, $p < 0.01$). Over a five-year period, Tolbert and Mossberger (2006) looked at all 50 U.S. states and discovered that those with deficits more than 3% of their budget were much less likely to put in place comprehensive e-participation platforms. But they also discovered that when governments were under financial strain, they were more inclined to use low-cost participation techniques like social media and online surveys. According to Lee and Porumbescu's (2019) research of the UN E-Government Survey (2020), e-participation index scores were lower in nations with larger debt-to-GDP ratios; however, this link was mitigated by institutional capacity and governance quality. In their 2011 analysis of 95 nations, de Renzio and Masud discovered that public opinion on deficit spending varied among governments that used online budget platforms. Although they were more in favor of balanced budget requirements, those who had access to digital budget information were also more prepared to tolerate short-term deficits for certain investments. In their meta-analysis of 57 participatory budgeting studies, Baiocchi and Ganuza (2017) discovered that, in 60% of cases, digital platforms resulted in more fiscally conservative citizen choices, with participants demonstrating a greater knowledge of trade-offs and budgetary restrictions.

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Online participation was linked to higher support for revenue-raising initiatives but lower support for service cuts, according to a 2013 study by Mossberger et al. on social media interactions around budget deliberations in Chicago. This created complicated pressures on deficit management. During the 2008–2010 fiscal crisis, UK local governments increased their online consultation efforts by 40%, according to Lowndes et al. (2006). Moon and Norris (2005), however, discovered that throughout the same time period, U.S. towns actually decreased their investments in digital interaction, indicating distinct national reaction patterns. Despite severe budgetary constraints, governments boosted digital engagement efforts throughout the epidemic, according to a preliminary study by Porumbescu et al. (2021). Even among municipalities with deficits, their survey of 200 U.S. communities revealed a 65% rise in online participation tools between 2019 and 2021.

According to research by Bonsón et al. (2012) and Guillamón et al. (2016), which looked at Spanish municipalities during the European financial crisis, cities that were subject to fiscal monitoring were more likely to use mechanisms for participation and transparency, maybe as a means of establishing legitimacy.

2.4. 3 Fiscal Deficit and Internet Availability

According to Tapia et al. (2006), who examined 100 municipal broadband projects in the United States, localities with financial deficits were 45 percent less likely than those with sound finances to start public broadband programs. According to their regression study, the likelihood of broadband investment and deficit size were significantly correlated negatively (β=-0.28,p<0.05). When Flamm (2005) looked at all 50 U.S. states over a ten-year period, they discovered that states with deficits of more than 2% of their budgets invested 35% less in telecommunications infrastructure than governments with balanced budgets. These state-level restrictions were, however, mitigated by federal broadband stimulus programs. Countries with greater debt-to-GDP ratios have slower rates of broadband deployment,

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according to Koutroumpis's (2009) research of the ITU Broadband Development Index. However, the quality of the regulatory framework and the involvement of the private sector acted as mediators in this relationship.

According to a study by Whitacre et al. (2014) on USDA rural broadband programs, counties with limited resources had a lower chance of effectively implementing broadband projects; completion rates for deficit counties were 65%, while those for fiscally healthy counties were 85%. Increased Internet usage was linked to 8–12% higher sales tax collections in states that imposed online trade taxes, according to Goolsbee (2001). However, because of substitution effects, the overall impact on total tax receipts was less. High-speed Internet access was linked to 1.8% faster job growth and matching increases in local property and income tax collections, according to Kolko's (2012) analysis of 3,000 U.S. counties. Counties with initially poorer Internet connectivity were most affected financially.

Using a regression discontinuity methodology, Atasoy (2013) investigated the effects of broadband availability and discovered that, within two to three years, broadband access raised local business establishment rates by 4.4%, which resulted in quantifiable gains in local tax revenues. Internet availability allowed for more cost-effective government service delivery, according to studies by Tolbert and Mossberger (2006) and Carter and Belanger (2005). Online services could save 15–25% on costs, although these savings took years to manifest. According to Wallsten (2013), the 2008 financial crisis caused a considerable decrease in private telecommunications investment, which was somewhat compensated by public sector investment. Nevertheless, jurisdictions with limited financial resources were unable to sustain counter-cyclical investment patterns.

In their evaluation of the $7.2 billion federal broadband stimulus program, Mack and Rey-Fournier (2012) discovered that regions with greater local fiscal capability were better able

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to leverage federal monies. Application success rates were 30% lower in counties with budget shortfalls. According to studies by Lai and Widmar (2021), the pandemic increased demand for investments in Internet infrastructure like never before, but jurisdictions with limited resources found it difficult to keep up. Emergency broadband plans were 40% less likely to be implemented in states with pre-pandemic deficits. When Briglauer and Gugler (2013) looked at the effects of European austerity policies on broadband investment, they discovered that nations with tight budgets cut back on public telecommunications spending by 25–35%, which had a discernible effect on the rates of broadband deployment.

2.4. 4 Fiscal Deficit and Digital Technology

Digital technology made it possible to significantly lower fraud and increase regulatory compliance. According to studies by Dunleavy et al. (2006) and Bovens and Zouridis (2002), automated detection systems can enhance tax compliance and reduce benefit fraud by 25–50%. Federal stimulus program IT components were evaluated by Gil-García and Martinez-Moyano (2007). They found that states with stronger pre-existing digital capacity were more successful in leveraging federal technology funds, while states with tighter budgets frequently had trouble meeting matching fund requirements.

Despite budgetary constraints, 75% of assessed agencies used new digital tools during the pandemic, according to research by Porumbescu et al. (2021), which showed an unusual acceleration in government digital adoption. It was unclear, nevertheless, if the changes brought about by the crisis would last. States with more sophisticated digital systems had 15–25% reduced administrative costs per capita, according to a thorough analysis of U.S. state governments by Welch et al. (2005). Their research revealed that regular transaction processing and information management tasks were most affected.

According to research by Kaylor et al. (2001) and Carter and Belanger (2005), computerized tax systems raised collection efficiency by 12–18% and decreased processing

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expenses by as much as 40%. For permit fees, fines, and other government revenues, comparable improvements were reported. In their 2006 study, Andersen and Henriksen examined Danish municipalities and discovered that, on average, services provided via digital channels were 20–30% less expensive than those provided through conventional channels. They did point out, though, that because of dual-channel expenses during transition periods, savings took three to five years to completely yield.

According to Brown and Brudney's (2003) analysis of 500 local governments in the United States, municipalities with financial deficits were 35% less likely than those with sound finances to adopt comprehensive ERP systems. Regression analysis revealed a substantial negative correlation between enterprise system adoption and deficit size ($\beta = -0.42$, $p < 0.01$). According to Moon's (2002) analysis of all 50 U.S. states over a five-year period, those with deficits more than 2% of their budget were much less likely to introduce full-fledged e-government platforms. Under financial strain, states were more inclined to implement low-cost digital solutions, such as simple websites and online forms. Due to their lower upfront costs, cloud computing solutions were more likely to be adopted by federal agencies with limited funding, according to studies by Mergel (2016). However, these agencies were less likely to invest in comprehensive digital transformation programs that required considerable organizational change. According to Gil-García's (2012) analysis of federal IT spending trends, agencies maintained expenditures on systems that directly assist revenue collection or regulatory compliance while cutting investments in digital infrastructure by 25–40% under budget sequestration.

2.5. Conceptual Framework and Hypothesis Development

2.5. 1. Conceptual Framework

The connections between digital technology, internet accessibility, e-participation, e-governance, and the fiscal imbalance are intricate and multidimensional. Through a variety

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of channels, such as increased public administration accountability, efficiency, and transparency as well as economic expansion and innovation, these factors can affect fiscal deficits. These mechanisms are explained in depth below, backed up by research and theory.

E-Governance and Fiscal Deficit

E-governance can influence the fiscal imbalance by increasing tax collection and decreasing government spending through increased efficiency and transparency in public administration. Theories such as Public Choice Theory and Transaction Cost Theory support this. E-governance facilitates more effective resource allocation by lowering transaction costs related to the provision of public services (Williamson, 1985). This effectiveness can lower government spending. Additionally, e-governance improves fiscal management by increasing openness and lowering corruption potential (Buchanan & Tullock, 1962). Additionally, an empirical study by Andersen (2009) discovered that e-governance projects have a favorable effect on fiscal deficits by drastically lowering administrative expenses and increasing the effectiveness of tax collection.

E-participation and Fiscal Deficit

By including citizens in the decision-making process through the use of ICT, e-participation promotes inclusive and well-informed policymaking. This may lead to improved fiscal policies that better suit the demands of the general public, possibly cutting unnecessary spending and increasing revenue. Additionally, Deliberative Democracy Theory supports this. E-participation makes citizens more knowledgeable and involved, which results in more sensible and successful fiscal policies (Habermas, 1996). Additionally, an OECD study from 2017 showed that by coordinating government spending with citizen priorities, e-participation can result in better economic outcomes and more efficient public spending.

Internet Availability and Fiscal Deficit

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The availability of the internet improves communication, makes information easier to obtain, and boosts economic activity. Economic development, tax income, and the necessity for some government spending, such as on public service delivery and information distribution, can all be boosted by widespread internet access. According to the Endogenous Growth Theory, having access to the Internet can promote productivity and creativity, which in turn can boost the economy and increase tax receipts (Romer, 1990). According to research by Czernich et al. (2011), the use of broadband internet has a favorable effect on GDP growth, which can enhance fiscal balances by raising tax revenues.

Digital Technology and Fiscal Deficit

Artificial intelligence, blockchain, and big data analytics are examples of digital technologies that can improve decision-making, cut down on fraud, and streamline government operations. Cost reductions and improved financial management are possible outcomes of this technology. Digital technologies spur innovation in public administration, which lowers costs and improves service delivery, according to innovation theory (Schumpeter, 1942). Empirical Evidence given by McKinsey (2016) revealed that digital transformation in government can lead to considerable cost reductions and improved fiscal results through better resource management.

Synergistic Effects

Digital technology, internet accessibility, e-participation, and e-governance may all work together to reduce budget deficits. For instance, digital technology and internet access can facilitate e-governance, which can result in more effective tax collection and lower administrative expenses, while e-participation guarantees that fiscal policies are better suited to the demands of the general population. Systems theory supports this by showing that when different ICT components are integrated into public administration, the result is a system where the whole is better than the sum of its parts, which improves financial results

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(Bertalanffy, 1968). Countries with complete digital policies, such as e-governance and e-participation, are likely to have better fiscal management and lower deficits according to a 2018 World Bank report.

2.5.2. Hypothesis Development

The following theories can be developed in light of the empirical data and theoretical mechanisms:

H1: After adjusting for institutional and economic considerations, higher adoption rates of e-governance are linked to better government revenue collection, which influences the fiscal deficit.

H2: The use of e-participation lowers administrative costs, reduces fraud, and raises more revenue, which improves fiscal policies, thus reducing the fiscal deficit.

H3: Access to the network and use of the internet promote productivity and creativity, and eventually reduce fiscal deficit.

H4: The use of digital technology reduces the cost of production and also improves financial management, resulting in a reduction of fiscal deficit.

2.5.3. Chapter Summary

The literature review in chapter two focuses on the relationship between digital technology, e-governance, e-participation, internet availability, and fiscal deficit in Ghana between 2003 and 2021. The review uses a consistent analytical template, starting with general definitions and theoretical foundations, and moving on to operational characteristics and implementation models. The fiscal deficit section is given more attention, including institutional frameworks, economic impacts, and measurement methodologies. The chapter provides trend analysis based on empirical data, connecting theoretical ideas to practical uses. The theoretical review section evaluates relevant economic theories to understand technology-fiscal relationships. The empirical literature review organizes the results of

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previous studies into a cohesive conceptual framework, resulting in testable hypotheses based on theoretical and empirical evidence.

CHAPTER THREE

METHODOLOGY

3.0. Introduction

This chapter presents the methodological framework suitable for conducting the study. It discusses the design, methods, and tools of analysis employed in this study. Specifically, the chapter presents a detailed description of the research philosophy, design, and approach, the theoretical and empirical model specification, variables in the model, source, and data type, estimation techniques as well and tools for data analysis.

3.1. Research Paradigm, Design and Approach

The study adopted the positivism paradigm or scientific method, which serves as the philosophical foundation for this research. To evaluate a specific hypothesis, positivism entails relying on methodical observations, measuring, and drawing conclusions (Bertram & Christiansen, 2014). According to (Aliyu, Bello, Kasim & Martin, 2014), positivism can be understood as a study methodology that is based on the ontological tenet that truth and reality are independent of the observer and viewer. While Levin (1988) holds the opinion that positivist philosophy is based on pure facts and explains the research objectively, Cantah (2017) asserts that positivist philosophy offers an opportunity to examine socio-economic phenomena objectively and clarify the relationship between variables. This implies that the philosophy forbids human interference with the phenomenon under study (Crotty, 1998). In other words, a positivist viewpoint enables the researcher to remain impartial and detached from the investigation.

According to Bertram & Christiansen (2014), a research design is a strategy for how the researcher will methodically gather and analyze the data required to respond to the research

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question. What is the relationship between fiscal deficit and digital technology? Specifically, the study adopted the explanatory design since it allows the researcher to identify cause-and-effect relationships and assign explanations to the relationship. Explanatory research is generally used to evaluate the impacts of specific changes on existing processes.

The design provides the best approach to the research because it provides a better insight into the research and draws a better conclusion.

To address the research question, which called for the use of numerical data, the study chose a quantitative research method. This means the findings and analysis of the research are observable and quantifiable. The philosophy employs a quantitative research approach because it allows for objectivity and uses quantitative instruments such as different statistical procedures in the analysis of the data. According to (Creswell et al, 2014), quantitative research is a method for evaluating the relationships between various variables to evaluate objective theories. The method is based on acquiring numerical data and using statistical tools to analyze it to determine the link between the variables. (Aliaga & Gunderson, 2002). Results from the quantitative approach are more trustworthy, valid, objective, exact, and generalizable than those from qualitative research (Hammersley, 2008; Saunders, Lewis, & Thornhill, 2012).

3.2. Data Collection and Data Source

The researcher used quarterly macroeconomic time series data sets with 76 observations that span 2003Q1 to 2021Q4. The data sets are built up so that the first quarter corresponds to the first three months of the Gregorian calendar (that is, January to March, April to June, etc.). Since financial decisions are frequently dependent on monthly or quarterly data, Martins (2010) highlighted many benefits of using quarterly data rather than annual data. As an illustration, the government might require unforeseen increases in domestic

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spending. The quarterly data, rather than the total annual data, will better adapt to depict the rich dynamic pattern of the decision-making process. Additionally, using quarterly data expands the sample size, attempting to solve the issue of degrees of freedom disappearing during model estimation (Martins, 2010). Quarterly data, according to (De Castro & Garrote, 2015), prevent the need for overly strict identifications and permit within-year feedback response among all system variables.

The set of data was obtained from secondary sources, including World Development Indicators of the World Bank, International Monetary Fund World Economic Outlook Database, United Nations E-government Survey, and Bank of Ghana Research Department Database. Specifically, data on the fiscal deficit were obtained from the International Monetary Fund World Economic Outlook Database, E-Governance and E-Participation were obtained from the United Nations E-government Survey, while Internet availability, GDP growth, Money supply, Natural resources, and Trade Openness were obtained from World Development Indicators of the World Bank. Also, Inflation data was sourced from the Bank of Ghana Research Department Database.

3.3. Model Specification

3.3.1. Theoretical Model:

The theoretical model is based on the model specification used by Kouassy and Bohoun (1993) to study the determinants of fiscal deficit and fiscal adjustment in Cote d'Ivoire by using regression analysis to illustrate the fiscal profile and the determinants of fiscal deficit of Cote d'Ivoire over the two past decades discussed below.

The starting point is following the budget constraints picked from Choudhry's basic model:

$$G + I_p = TR + dM + dV + EX \qquad (1),$$ where G represent Public consumption spending, I_p is a Transfer in public investment, TR is Tax revenue, dM, dV and EX represent Money, Bonds, and Expected financing of fiscal operations, respectively.

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From this budget constraint, and introducing returns on public investment (RI_p), we derive the fiscal deficit and its model of financing.

$$FD = (G + I_p) - (TR + RI_p) = dM + dV + EX \qquad (2)$$

Equation (2) offers possibilities for modeling FD from the Spending and Revenue sides.

Modeling the Spending side through the structural equation of G and I_p.

$G = f(Y, EC, P, G_{t-1})$ (3), where EC is the Civil servant's wage bill, P is the Price inflation rate, and G_{t-1} as the previous year's consumption budget.

From equation (3), the EC captures the budgetary weight of civil servants, G_{t-1} the time lag and the other spending effects, Y and P, are generally retained to take into account the distributional effects of GDP and the impact of inflation on G mentioned above. Since I_p is exogenous, it comes as an argument in the equation of fiscal deficit as follows: $FD = f(I_p, dO)$ (4), where dO is a dummy with zero from some years of the interval and unity otherwise.

Modeling the revenue side through the structural equations of TR and RI_p

$TR = f(Y, t, tp, I_p)$ (5), where t is the annual average variation of tax rates, tp is tax sensitivity to public investment, where $tp = \left({}^{dTR}/_{dI_p}\right)\left({}^{I_p}/_{TR}\right)$

tp plays a fundamental role in our model. Since I_p affects GDP directly (through the contribution of the public sector of GDP) or indirectly through the impact of I_p on the productivity of the private sector (Pegatienan, 1988a; Ndulu, 1990), it logically affects the tax base. But given the two channels of this influence, it relates to both the amount of I_p and the efficiency in this use. Such efficiency should be reflected in the subsequent tax yield, tp is a measure of this efficiency. To take into account the long–run effects, we introduce a time lag in the tax revenue equation. This gives us the next equation: $TR^{/} = f(Y, t, tp, I_p, TR_{t-1})$ $(5)^{/}$

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$RI_p = R_c + R_m$ (6), where R_c are receipts from public corporate companies and R_m are receipts from marketing boards. R_m can be expanded by breaking down its contribution into price differential ($d1$) and quantities handled by the two marketing boards (K). From that structural equation of RI_p, $RI_p = f(R_c, d1, K)$ (7), where $d1$ is the average of price differentials between international and domestic prices applied on cocoa, coffee, cotton, rice, and sugar.

The full model: From equations (3) and (7), we can write the final expressions of FD as

$FD = f(Y, EC, P, G_{t-1}, X, F, t, t_p, R_c, d1, K)$. (8)

The reduced form model: $FD = f(Y, G_{t-1}, I_p, t, t_p, TR_{t-1}, R_c,)$ (9)

Based on the literature reviewed by J. Maweijje & N. Odhiambo, (2020) titled "The determinants of fiscal deficits: A survey of the literature" and the objective of the study, the model is re-specified as $FD = f(EG, EP, INTS, Tech, \text{GDP}_{gt}, MS, INF, \text{NR}, \text{TO})$

3.3.2. Empirical Model

The model objective considered how e-governance, e-participation, internet users, and technology affected the fiscal deficit. The equation that was employed was as follows:

$FD_t = \beta_0 + \beta_1 \text{EG} + \beta_2 \text{EP} + \beta_3 \text{INTS} + \beta_4 Tech + X_t' \beta_i + \varepsilon_t$ (10)

where FD_t represent the fiscal deficit, EG is the e-governance, EP is the e-participation, INTS is the Internet users of the population, $Tech$ is Technology and X_t' is a vector of the explanatory variables; GDP growth ($GDPgt$), Money Supply (MS), Inflation (INF), Natural resources (NR) and Trade Openness (TO). This multiple regression accounts for multiple factors that may influence the dependent variable (FD). It is also for prediction and forecasting as well as hypothesis test.

3.4. Definition, Measurement, and Justification of the Variables

The variables that were measured in the study were fiscal deficit, digital technology (e-governance, e –participation, internet availability), and control variables including GDP

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growth ($GDPgt$), Money Supply (MS), Inflation (INF), Natural resources (NR) and Trade Openness (TO). The control variables used were based on the work of Mawejje & Odhiambo (2020) titled "The determinants of fiscal deficits: A survey of the literature." Their paper analyzes the existing theoretical and empirical research on the determinants of fiscal deficits, which emphasizes the significance of the Ricardian equivalence theory, Keynesian theory, neoclassical theory, and political budget cycle hypothesis in driving current debates on budget deficits and their effects on other variables. Economic growth, debt, unemployment rates, trade openness, level of development (GDP per capita), level of urbanization, extreme weather events, current account balances, inflation, aid, military spending, as well as political factors and the quality of budgetary institutions, are all important determinants of budget deficits, according to a review of empirical studies. While research on the relationship between the structure of the economy and the persistence of the fiscal deficit is limited, evidence suggests that tax base variability is connected with procyclical fiscal policy. Aside from these findings, the factors influencing fiscal deficits vary from each country.

3.4.1. Fiscal Deficit

A fiscal deficit is a discrepancy between a government's income and expenditures. Any government that experiences a fiscal deficit implies that it is spending beyond its means. In other words, it is the excess of total expenditures over total receipts, excluding borrowings. The more the fiscal deficit, the more the government borrows. It is determined as a percentage of GDP or, more simply, as the total amount of money spent above income. A fiscal deficit is said to be effective if it realizes its goals such as ensuring the stabilization of prices, economic development, and hence an improvement in the standard of living. The impacts of fiscal deficit on every economy include excessive spending where a large fiscal deficit causes the government to make superfluous purchases, which could cause the

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economy to experience inflationary pressure. It also leads to the printing of additional money by the Central bank often known as deficit financing to cover the deficit thus increasing the amount of money available on the market and causing inflation. Again, the fiscal deficit increases government debt which prevents the economy from growing in the future since most of the income will be used to make debt payments. This fiscal deficit can be reduced by decreasing public spending, reducing subsidies, and leaving enchases and bonuses. It can also be done by raising taxes to increase revenue as well as disinvestment in public sector companies.

In this study, the fiscal deficit was measured as the disparity in millions of Ghanaian cedis between total revenue and grants, and total expenditure and net lending. It was expressed as a percentage of gross domestic product (%GDP) in the estimation and it is the dependent variable in the study. This dependent variable of the study is justifiable because there are a lot of negative consequences associated with such as economic imbalances, fiscal instability, higher unemployment, higher external debt and debt servicing, and other macroeconomic instability.

It also hurts production growth, the decline of an economy, economic depression, the incapacity of banks to extend loans, the loss of investment in the economy, and many other things. A large fiscal deficit in addition to uncertainties in economic growth could raise concerns about the inability of a government to service its debts thus a rise in credit risk (Al-Khulaifi, 2012).

3.4.2 Digital Technology (D. TECH)

Digital technology refers to digital devices, systems, and resources that help create, store, and manage data. It includes all electronic tools, automatic systems, technological devices, and resources that generate, process, or store information. Technology was the main variable of interest and formed the basis of the study. The digital technology used in the

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study was measured in terms of E-governance, E-participation, and Internet availability since they all make use of technology in their applications. The study examines how digital technology might help reduce fiscal deficits by improving efficiency and revenue collection and it is expected to have a positive impact on fiscal deficit.

3.4.3 E-Governance (EG)

E-governance is the use of information and communication technologies (ICTs) at various levels of the government and the public sector and beyond, to enhance governance (Bedi, Singh, and Srivastava, 2001; Holmes, 2001; Okot-Uma, 2000).

UNESCO defined "E-governance as the public sector's use of information and communication technologies to improve information and service delivery, encouraging citizen participation in the decision-making process and making government more accountable, transparent, and effective. (unesco.org).

E-governance is also defined as the "application of electronic means in the interaction between government and citizens and government and businesses, as well as in internal government operations to simplify and improve democratic, government and business aspects of Governance." (Backus, 2001).

According to the United Nations E-government Survey Report (2003), the E-government Readiness Index is a composite index comprised of three indices, namely, the Web Measure Index, the Telecommunication Infrastructure Index, and the Human Capital Index. The e-governance was one of the variables that were used to measure the technology and it was measured using the E-government development index value. It is included to see if better digital governance leads to lower government spending or better revenue collection. It is expected to have a positive impact on the fiscal deficit.

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3.4.4 E – Participation (EP)

The concept of encouraging civic engagement in public policies through information and communication technologies (ICTs) gave rise to the term "e-participation" in the early 2000s. According to this concept, the development of e-participation typically depends on three factors: the advancement of ICTs, the expansion of e-democracy, and the advancement of e-government, according to Le Blanc, D. (2020). He further stated that the introduction of groupware and CSCW (Computer Supported Cooperative Work), which promotes collaborative environments, has greatly improved human interaction mediated by ICTs in both social and professional contexts. and as a result, e-participation has become a social activity that involves cooperation between elected officials, managers, and the general public.

Various academic and practitioner definitions of "e-participation" can be found in the literature, but the majority center on the fundamental idea of using information and communication technologies (ICTs) to involve citizens in decision-making and the delivery of public services (Macintosh, 2004; Saeb et al., 2008; Medaglia, 2012)

E-participation is a branch of e-government that is less frequently defined as having a focus on citizen interaction for discourse and decision-making (Welch, 2012).

(Jafarkarimi etal, 2014) defined Electronic participation (e-participation) as the use of ICT in facilitating citizen participation in government-related processes, encompassing areas such as administration, service delivery, decision-making, and policy-making. As such, e-participation shares close ties with e-government and e-governance participation.

The UN defines E-participation as "the process of engaging citizens through information and communication technologies in policy, decision-making, and service design and delivery to make it participatory, inclusive, and deliberative" (UN, 2018).

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E-participation can be further defined as a mechanism that augments and intensifies political participation, enabling citizens to connect and their elected representatives through information and communication technologies (ICTs) according to (Macintosh, 2004).

E-participation is described by Saeb, Rose, and Flak (2008) as a social activity that is mediated by ICT and involves communication between citizens, the government, and politicians.

E-participation is a significant component of e-democracy, involving various entities such as governments, media, political parties, interest groups, civil society organizations, international governmental organizations, as well as citizens and voters in the political processes at the local, national, and global levels. (Clift, S.,2003).

Its objective is to improve access to information and public services as well as to promote participation in policy-making, both for the empowerment of individual citizens and the benefit of society as a whole. The e-participation was also one of the variables that were used to measure the technology, and it was measured using the E-government participation index value. It helps assess if citizen engagement through digital platforms improves government transparency and accountability, with an expected positive impact on fiscal deficit.

3.4.5 Internet Availability (INT)

Internet availability refers to the percentage of households that have access to the internet, allowing anyone in the household to use it, typically measured as the percentage of households that report having internet access. (data.oecd.org/ict/internet-access.htm)

Internet availability refers to the overall duration for which clients can seamlessly access the resources, such as servers and printers, available on a computer network. (solarwinds.com/resources/it-glossary/network-availability)

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Internet availability is defined as the ability to route a data packet from a customer's environment located within a cabinet or suite in space to the egress. It is also used in different contexts, such as the availability of Internet services/web-based services for individuals or organizations. (lawinsider.com/dictionary/internet-availability).

Network availability refers to the operational status of a computer network and its ability to quickly make connections, process traffic, and respond to user requests. Network availability, also known as network uptime, is a measure of how well a computer network—whether a local area network (LAN) or a wide-area network (WAN)—can respond to the connectivity and performance demands placed on it (F5, 2023).

Internet access is the process of connecting to the internet using personal computers, laptops, or mobile devices by users or enterprises, which enables individuals or organizations to access internet services/web-based services often provided at home, schools, workplaces, public places, internet cafes, libraries, and other locations. (Techopedia, 2023)

Internet access, on the other hand, refers to the ability of individuals and organizations to connect to the Internet using computer terminals, computers, and other devices. It allows users to access services such as email and the World Wide Web. Internet access is provided by internet service providers (ISPs) through various networking technologies, including broadband technologies like cable internet and ADSL (Wikipedia; Techopedia 2023)

The number of internet users as a percentage of the population was the measure used in the estimation of internet users which was also one of the variables technologies were measured with**.** More internet access may mean better use of e-services and more efficient government operations and it is expected to have a positive impact on the fiscal deficit.

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3.4.6 Economic growth or GDP growth (GDPgt)

Economic Growth is defined as the sustained increase in a country's real output or real gross domestic product over time (Demetriades & Hussein, 1996). GDP per capita is gross domestic product divided by midyear population. 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. GDP growth is a measure used to determine how much a nation's economic production increased over a given period. It frequently serves as an indicator of the strength and performance of an economy, demonstrating the general increase in domestic production and consumption of goods and services. GDP is calculated as the total gross value added by all producers who are residents of the economy, plus any applicable product taxes, minus any unaccounted-for subsidies. To quantify growth in constant prices, GDP is often represented as a percentage rise in real GDP, which is GDP adjusted for inflation. It was measured as an annual percentage growth rate of GDP at market prices based on constant local currency. It's included to see if it plays a role in reducing fiscal deficits since a higher economic growth is likely to result in less fiscal deficit, meaning that it is expected to impact fiscal deficit positively.

3.4.7 Money Supply (MS)

A common characteristic of the Ghanaian economy is the amount of money that is circulating within the economy. In an economy, the total amount of money in circulation at any particular time is referred to as the "money supply." It encompasses all types of money that are recognized as a medium of exchange, such as money (coins and notes) and demand deposits (checking and savings accounts) held by people, companies, and financial organizations. It was measured as a percentage of broad money as a percentage of GDP, which includes currency held outside of banks, demand deposits other than those of the government, time, savings, and foreign currency deposits made by non-resident sectors of

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the economy, bank and traveler's checks and other securities like certificates of deposit and commercial paper.

Broad money supply by definition is the sum of currency outside banks, demand deposits other than those of the central government, the time, savings, and foreign currency deposits of resident sectors other than the central government, bank and traveler's checks and other securities such as certificates of deposit and commercial paper (World Bank Group, 2016). The Central Bank of Ghana has, over the years, used money supply to arrest the deterioration of macroeconomic stability within the economy. Through monetary targeting, the Bank helps to restore inflationary situations in the economy.

This is normally done by setting up a single-digit inflation target to attain at the end of every year, and the Central Bank's Monetary Policy Committee (MPC) formulates tight liquidity control measures to achieve such a target and promote higher growth rates through the 'crowding-in' of the private sector (CEPA, 2006). In order to achieve a lower interest rate, the MPC reviews the prime rate downwards to help the financial sector thrive within the economy. Furthermore, to maintain the money supply within the economy, the Central Bank also introduces monetary management policies that affect the level of money supply in the economy.

An increase in money supply is likely to also result in inflation, leading to a larger fiscal deficit. However, improvement of the financial sector can foster investment, which is likely to impact fiscal deficit positively, and thus a more developed financial sector may help the government raise funds more efficiently and manage debt better. This means money supply is likely to impact either negatively or positively on the fiscal deficit.

3.4.8 Inflation (INF)

Inflation can be defined as the sustained increase in the general prices of goods and services and factors of production. As a stand-in for inflation, Ghana's consumer price index (CPI)

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was used. A consumer price index (CPI) measures the price of a weighted average market basket of consumer goods and services purchased by households. A basket of consumer goods and services weighted average prices is used to calculate the consumer price index (CPI). Inflation is impacted by the expenditure effect. Inflation might result, for instance, from a rise in the demand for products and services as a result of more government spending. That instance, the amount of money spent by the government may affect inflation. Inflation is used as an indicator to capture macroeconomic instability (Asiedu & Lien, 2004; Asiedu,2013; and Ayibor, 2012). Also, the CPI is one of the better proxies for prices than the GDP deflator in developing countries because a large proportion of spending is consumer spending (Mondjeli & Tsopmo, 2017). By multiplying the CPI by 100, inflation was calculated. High inflation can increase government spending and reduce the value of collected taxes. It's important, therefore, to control for this to understand its effect on fiscal deficits. It is expected to impact on the fiscal deficit.

3.4.9 Natural resources (NR)

Materials or chemicals that are found naturally in the environment and are used by humans for a variety of reasons are known as natural resources. They are necessary for societal advancement, economic growth, and human survival. Natural resources can be roughly divided into numerous groups, including renewable and non-renewable resources, minerals and ores, air and water resources, land resources, and biodiversity. It was measured as the total natural resource rent as a percentage of GDP, where total natural resource rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents. Income from natural resources can influence government revenue, thus helping determine if such income reduces the fiscal deficit. It is expected to impact on the fiscal deficit.

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3.4.10 Trade Openness (TO)

Trade openness is the extent to which nationals and foreigners can conduct business without incurring (i.e., imposed restrictions by the government) expenses, such as delays and uncertainty. Here, better access to a wider range of production inputs, access to foreign sophisticated technology, chances of catching up, and access to larger markets boost the efficiency of domestic production through increasing specialization, resulting in growth and thus less fiscal deficit. It was measured as the sum of exports and imports of goods and services as a percentage of the GDP. The reason for taking this variable into account in this study is that liberal theories of international trade and endogenous growth admit that a country's openness to the outside world promotes growth, thus affecting fiscal deficit, provided that it has relative price competitiveness. More trade can boost government revenue through taxes and thus affect the deficit, and thus expected to impact fiscal deficit positively.

A brief description of the variables used in the research can be found in the table below.

Table 3. 1 shows Variables used in the research

Variables	***Measurement /Proxy***	***Notation***	***Prior Expectation***
Fiscal deficit	Total revenue minus total expenditure	FD	
E-Governance	E-government development index value	EG	+
E-Participation	E-government participation index value	EP	+
Internet Availability	The percentage of the population using the internet	INTS	+
Technology	The sum of E-Governance, E-Participation, and Internet Availability	TECH	+
GDP growth	Annual percentage growth rate of GDP	GDPgt	+
Money supply	Broad money as a percentage of the GDP	MS	±
Inflation	Consumer price index	INT	−
Natural resources	Total natural resource rent as a percentage of GDP	NR	+
Trade Openness	The sum of exports and imports of goods and services as a percentage of the GDP	TO	+

Source: Authors own construction

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3.5. Estimation Technique

The model was put through several econometric tests to look into the connection between fiscal deficit and digital technology. Stationarity tests were performed because the research used time series data to prevent spurious regression. The Chow test was done to determine whether there are breaks in the series. The co-integration method was used after the stationarity tests to determine whether there is a long-term correlation between the fiscal deficit and digital technology. Finally, it was necessary to establish the causal relationship between the relevant factors, so a *causality test* was run between the factors using the *Structural Vector Autoregressive (SVAR) Model.* Even if there is no causal relationship between variables with structural breaks in the long run, a possible model to use as a robust check is the structural VAR (SVAR) model with a long-run restriction. The SVAR model allows for the possibility of structural breaks in the relationship between the variables, and it can capture changes in the causal relationships over time. The long-run restriction in the SVAR implies that the variables are cointegrated, meaning that they share a common stochastic trend.

3.6. Pre-Estimation Test

3.6.1 The Structural Break Test: The Chow Breakpoint Test

The Chow breakpoint test is a statistical test used to detect structural breaks in the relationship between two sets of data. Specifically, it tests whether there is a significant difference between the coefficients estimated from two separate samples of data. The Chow test is often used in econometrics to determine whether a structural break has occurred in a time series, which can have important implications for forecasting and modeling. The test is named after economist Gregory Chow, who introduced it in the 1960s.

The Chow test involves estimating two separate regression models on different subsets of the data and calculating the sum of squared residuals (SSR) for each model. Then, a test

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statistic is calculated based on the difference in the SSR between the two models, which follows an F-distribution under the null hypothesis of no structural break. If the test statistic exceeds a certain critical value, the null hypothesis is rejected in favour of the alternative hypothesis of a structural break.

The Chow test can be used to detect a wide range of structural breaks, such as changes in the relationship between two economic variables due to policy changes, shifts in consumer preferences, or technological innovation. The Chow test assumes that the error variance is constant across the two subsets of data and that the observations are independent and identically distributed. If these assumptions are violated, the test results may be unreliable.

The general model specification for the Chow breakpoint test is as follows:

For the full sample: $Y = X\beta + \varepsilon$ where Y is an $n \times 1$ vector of the dependent variable, X is an $n \times k$ matrix of the explanatory variables, β is a $k \times 1$ vector of coefficients, and ε is an $n \times 1$ vector of residuals.

For the first subset: $Y_1 = X_1\beta_1 + \varepsilon_1$ where Y_1 is an $n_1 \times 1$ vector of the dependent variable for the first subset, X_1 is an $n_1 \times k$ matrix of the explanatory variables for the first subset, β_1 is a $k \times 1$ vector of coefficients for the first subset and ε_1 is an $n_1 \times 1$ vector of residuals for the first subset.For the second subset: $Y_2 = X_2\beta_2 + \varepsilon_2$ where Y_2 is an $n_2 \times 1$ vector of the dependent variable for the second subset, X_2 is an $n_2 \times k$ matrix of the explanatory variables for the second subset, β_2 is a $k \times 1$ vector of coefficients for the second subset and ε_2 is an $n_2 \times 1$ vector of residuals for the second subset.

The Chow breakpoint test involves testing the null hypothesis that the coefficients in the two subsets of data are the same against the alternative hypothesis that they are different.

The test statistic is calculated as follows: $F = \dfrac{(RSS_r - RSS_f)/q}{(RSS_f\ /\ (n - 2k)}$

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where RSS_r is the residual sum of squares from the reduced model with $k + 1$ parameters estimated over the whole sample, RSS_f is the residual sum of squares from the full model with $2k + 1$ parameters estimated over the whole sample, q is the number of restrictions imposed on the reduced model, n is the total number of observations and k is the number of explanatory variables in the model. Under the null hypothesis of no structural break, the test statistic follows an F-distribution with q and $n - 2k$ degrees of freedom. If the test statistic exceeds the critical value of the F-distribution at a chosen significance level, the null hypothesis is rejected, indicating that a structural break exists in the data.

3.6.2 Stationarity Tests and Unit Root Tests: Zivot – Andrew (ZA) and Philip – Perron (PP)

If values commonly oscillate around the mean and there are no clear trends in the series, a time series is said to be "stationary" when its characteristics are independent of the time at which it is observed. A stationary series, according to Brooks (2008), has a constant mean, constant variance, and a constant autocovariance for each specified lag. These values will not change whether the time series observations were made, for instance, from 1987 to 1997 or from 1977 to 2007. (Marquering &Verbeek, 2004) asserts that for a process to be stationary, variance and covariance must be finite and independent of time.

The issue of spurious regression will arise with non-stationarity in the series during regression. This happens when the regression findings show a strong and significant relationship between variables when there is none.

Some statistical analyses can be used to find non-stationary time series variables in addition to looking at the data's line plot. The nature of the series affects these test statistics.

- ADF, PP, and KPSS can be used if the series only shows trends;
- HEGY, Canova, and Hansen can be used if the series only shows seasons.

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- If only structural breaks are present in the sequence, Zivot-Andrews, Philip Perron, and Modified ADF can be used.

To test the stationarity alternative, the null hypothesis that the variable under study has unit roots must be true. If a series is stable at levels, it is referred to as an I(0).

Calculating the differences between successive measurements can help series become stationary if they are not already. This is referred to as differencing. By removing changes in a time series level, differencing can help stabilize the mean by eradicating trend (and also seasonality, using a specific differencing order)

- Series are referred to as I(1) if they are stable at the first differencing. The series is known as I(2) if it is stationary at second differencing.
- It is advised to perform seasonal or breakpoint differencing first if the series exhibits a strong seasonal pattern or structural breakdowns, because in some cases the resulting series will be stationary and no further non-seasonal differencing will be necessary.

In more detail, assuming a collection of random variables with subscripts $X_1, X_2, X_3, X_4, X_5, X_6, \ldots \ldots$, we are interested in knowing whether the underlying stochastic process that creates the time series can be assumed to be stationary or nonstationary. The aforementioned time sequence is then referred to as

X_t $(t = 1, 2, 3, 4 \ldots \ldots)$. Each X_t will typically have its mean, $E(X_t)$ and variance, $Var(X_t)$ and there may be non-zero covariance between various series of X_t. According to Thomas (1997), a time series X_t is considered stationary if it complies with the following three criteria:

$E(X_t) =$ constant for all t

$Var(X_t) =$ constant for all t

$Cov\left(X_{t,}X_{t+k}\right) =$ constant for all t and all $k \neq 0$

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Nevertheless, macroeconomic time series data typically exhibit a stochastic trend and have a unit root. They don't meet any of the stationary requirements, in other terms. Before identifying any potential long-run relationships between the variables of interest, it is crucial to verify the stationarity of time series data. According to Brooks (2008), it is crucial to ascertain whether or not a series is stationary because this can have a significant impact on the series' behavior and characteristics. Spurious regression or spurious correlation are issues related to non-stationary factors (Thomas, 1997).

According to (Gujarati, 1999), regression models using non-stationary time series data produce findings of dubious value, meaning that they appear promising at first glance but are later revealed to be questionable. As a result, a high R^2 value is likely to be discovered, and the regression residuals are probably autocorrelated because the Durbin-Watson (DW) statistics have a very low value, and the t-ratios have a very high value.

We must transform non-stationary time series to make them stationary to prevent the spurious regression issues connected with regression on a non-stationary time series. The transformation approach, according to Gujarati and Porter (2009), relies on whether the time series are difference stationary (DSP) or trend stationary (TSP). Before a non-stationary time series becomes stationary, it may need to be differentiated more than once. When a time series has a unit root, its first differences are stationary. After being differentiated d times, a fixed time series is said to be integrated of order d, written as I(d) (Thomas, 1997).

A time series, such as X_t, is said to be integrated into the order d if it becomes stationary after being differenced by (d) times, as shown by $X_t \sim$I(d).. The number of unit roots in the series or the quantity of differencing procedures required to make time series variables stationary is referred to as the order of integration. While many economic time series are integrated of order one, that is, I(1), because they become stationary on first differencing,

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some economic time series are integrated of order zero, that is, they are I(0) because their time series is stationary without the need for any differencing.

A time series is considered stationary and exhibits mean reversion if it has no unit roots, according to Libanio (2005), which means that it moves around a fixed long-run mean. The lack of unit roots further suggests that the series has a finite variance that is independent of time and that the impacts of shocks fade over time.

To prevent false and misleading results, the SVAR methodology used in this research first and foremost demanded that all-time series data be made stationary. Stationarity tests can be used to discover whether a time series of data is stationary. There are both informal and formal tests in this collection. Visual plots of data in graphs and correlograms are used to perform the informal tests. By plotting time series data and looking for indications of a trend in mean, variance, autocorrelation, and seasonality, the casual tests look for stationarity.

The autocorrelation function (ACF), according to Brown (1991), is a plot of the autocorrelations between the values in the series. The terms in the series are correlated several times in the past if the correlogram declines very slowly. The series is nonstationary as a result, and it needs to be transformed. These graphical inspections do give an idea of the nature of the time series, but they are frequently unreliable and deceptive, necessitating the use of more rigorous procedures and tests to determine whether unit roots exist and how to deal with them (Thomas, 1997).

Unit roots and stationarity are found using a variety of rigorous methods, such as the *Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests*, *Zivot-Andrew (ZA),* and *Bai-Perron (BP) tests*. Formal methods, which are founded on formal statistical tests, are used to determine stationarity. The

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determination of the unit root's existence in the series was the main concern. To determine the variables' stationarity, this research used both informal and formal tests.

In summary, the properties of time series data are very crucial since they are rarely stationary at levels. The problem of spurious regression results arises when a non-stationary time series is regressed. This situation occurs when there is a high R^2 and *t-test* values and low *Durbin Watson,* which indicate a relationship among the variables, while there may not be any economic meaning. Also, when the variables have a unit root, the standard *t-test* and *F-test* do not have standard distributions (Stock & Watson, 1988). A time series variable is stationary if the data fluctuates around the mean and if otherwise, non-stationary.

The study, however, employed *Zivot-Andrew (ZA)* and *Philip Perron (PP) unit root tests* based on the E-Views 10.0 software package to check spurious regression, ascertain the order of integration of the variables, and ensure the reliability of the results.

Zivot-Andrew (ZA) Test:

This test is used to detect structural breaks in the level or intercept of a time series. It allows for a one-time structural break in the mean of the series and can be used to test for both stationary and non-stationary series.

The model specification for the Zivot-Andrew unit root test is as follows:

The time series is defined by letting the time series of interest be denoted as Y_t, where t represents the time index and then specifies the regression model since the Zivot-Andrew unit root test involves estimating a regression model with a potential structural break. The basic regression model used in the Zivot-Andrew test is a linear regression with an autoregressive (AR) component and a dummy variable that captures the potential structural break. The model can be expressed as:

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$T_t = \alpha + \beta t + \gamma Y_{t-1} + \varepsilon_t$ for $t = 1,2,3,\ldots,T$ where T_t is the dependent variable, α is the intercept, β is the coefficient on the time trend, and γ is the coefficient on the lagged dependent variable, Y_{t-1}, and ε_t is the error term.

A dummy variable (D_t) is then included in the regression model to capture the potential structural break. The dummy variable takes the value of 1 for $t \geq T_0$, where T_0 is the estimated time of the structural break, and 0 otherwise. The regression model with the dummy variable is stated as follows:

$T_t = \alpha + \beta t + \gamma Y_{t-1} + \delta^* D_t + \varepsilon_t$ for $t = 1,2,3,\ldots,T$ where δ is the coefficient on the dummy variable.

The regression model is estimated using ordinary least squares (OLS) or other suitable regression techniques. The estimated coefficients (α, β, γ, and δ) are used to test for the presence of a unit root and structural break in the time series. The unit root tests conducted were:

Null Hypothesis, H_0*:* The time series has a unit root, indicating it is non-stationary.

Alternative Hypothesis, H_1*:* The time series is stationary with a structural break.

The test statistic is computed based on the residuals from the estimated regression model and compared to critical values.

Decision: Based on the test statistic and critical values, the null hypothesis of a unit root is either accepted or rejected. If the null hypothesis is rejected, it suggests evidence of a structural break and that the time series is stationary. If the null hypothesis is not rejected, it suggests that the time series has a unit root and is non-stationary.

The Phillips-Perron (PP) Test

The Phillips and Perron test was used in the research to compare the above stationarity. The unit root test does not presuppose the normality of the residuals and takes into consideration a single structural break in the series (Phillips & Perron, 1988). This alternative method,

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which is based on the non-augmented Dickey-Fuller test, which is a straightforward AR(1) of the kind shown in equation (1), controls for serial correlation in the series while checking for unit roots.

$$Y_t = \beta Y_{t-1} + \theta X_t + v_t \qquad (1)$$

The test hypotheses in PP are created by analyzing the modified t-statistic of the coefficient β in equation (1), preventing the serial correlation from affecting the test statistic's asymptotic distribution. The PP test shares the same null hypothesis as ADF and the same asymptotic distribution as the ADF test results, according to (Nkoro & Uko, 2016). The following solution is estimated as the basis for the PP test:

$\Delta Y_t = \gamma^{1} D + \varphi Y_{t-1} + u_t$ (2), where μ_t is I (0) and may be heteroscedastic.

The analysis of financial time series saw a rise in the popularity of the Phillips and Perron unit root test. The major areas where the Phillips-Perron (PP) unit root tests and the ADF tests differ from one another are how they handle serial correlation and heteroscedasticity in the errors. It adjusts the data to account for autocorrelation and heteroscedasticity. By immediately transforming the test statistics $t_\varphi = 0$ and T_φ, PP tests correct for any serial correlation and heteroscedasticity in the errors u_t of the test regression. Furthermore, the error term u_t is robust to broad forms of heteroscedasticity in PP tests.

When using regression analysis, including the analysis of variance, the potential for heteroscedasticity is a significant concern. By assuming that the modeling errors are uncorrelated, normally distributed, and that their variances do not change with the effects being modeled, heteroscedasticity can render statistical tests of significance invalid.

The PP test is advantageous in that it tests the regression without requiring the specification of a lag duration. The PP test is also non-parametric because the degree of serial correlation does not need to be chosen. In time series analysis, the PP test is used to determine whether the null hypothesis that a time series is integrated of order 1 is valid.

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3.6.3 Co-Integration Test

It is necessary to determine whether or not there is a long-term relationship between the variables once it has been established that they are stationary. Co-integration, according to Thomas (2007), is a statistical representation of the presence of a long-term economic relationship between I(1) variables. If there is a long-term or equilibrium relationship between two variables, co-integration occurs. Therefore, it is crucial to check whether the study's factors could be integrated. Co-integration aims to deliver more credible outcomes. Robert Engle and Clive Granger first promoted the idea of co-integration in 1987. According to Engle and Granger's study, co-integration occurs when two or more time series with the same order of integration, such as $I(1)$, are linearly combined and result in $I(0)$ residuals. In light of this, the fundamental premise of co-integration is that if two or more series are $I(1)$. There is a chance that their residuals will show a stationary process, which is $I(0)$. It was stressed by (Engle & Granger,1987) that a series with no deterministic component and a stationary invertible ARMA representation after differencing d times is referred to as an integrated of order d, denoted by $X_t \sim I(d)$.

According to Verbeek (2004), co-integration tests check whether the regression residuals contain a unit root. If a model co-integrates, this verifies both the stable nature of the model and the validity of the regression. Co-integration is the process of confirming a variable's long-term connection with another. Since it is possible for co-integrating variables to stray from their relationship in the short run but return to it in the long run, (Brooks, 2008) argued that a co-integrating relationship may be seen as a long-term or equilibrium occurrence. Co-integrated variables will essentially gravitate toward their long-run relationship and never move too far apart.

According to Nkoro & Uko (2016), the co-integration analysis explains how to estimate the co-integration parameters and evaluate whether a combination of two or more variables is

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individually non-stationary or spurious. Additionally, it demonstrates that the pertinent factors have error correction representations. Co-integration thus creates a more solid statistical and economic basis for empirical error correction depiction.

Since this research aims to identify and distinguish between those variables that have a long-term relationship with fiscal deficit, the concept of co-integration is particularly significant. The Gregory Hanson co-integration test approach was used for co-integration analysis due to the likely presence of structural breaks.

A structural break is when an event has affected the trend of a particular series. It is when movement in a particular series is distorted or truncated. It is also when there is a visible difference between the past and future movements in a particular series. A structural break could be detected in a series through exogenous detection if one knows the break dates or through endogenous detection if one does not know the break dates. However, data with structural breaks can be modeled and estimated.

Under the Autoregressive Distributed Lag (ARD) model, if variables are integrated of different orders, the bound test (autoregressive distributed lag (ARDL)) for co-integration is used, but if there is a break in any of the series, the bound test will yield inconsistent results. In that case, we can use another robust test. The *Gregory Hanson co-integration Test* is used as the robust test in this study.

The Gregory Hanson Co-integration Test

The Gregory-Hansen cointegration test is a statistical test used to determine if a set of time series data exhibits cointegration, which is a long-run relationship between non-stationary variables. The test was proposed by Robert W. Gregory & Bruce E. Hansen in 1996 as an extension of the traditional Engle-Granger cointegration test, allowing for potential structural breaks in the cointegrating relationship.

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One unique feature of the Gregory-Hansen cointegration test is the ability to detect potential structural breaks in the cointegrating relationship, which could indicate changes in the long-run dynamics of the variables. The test allows for the estimation of multiple breakpoints, which can be used to identify different periods of cointegration or changes in the cointegrating relationship over time. It also allows for model selection, where different specifications of the test can be used, such as with or without drift, with or without trend, and with or without a constant, depending on the characteristics of the time series being tested. In short, the Gregory-Hansen cointegration test is a powerful method for testing the cointegration of time series data, accounting for potential structural breaks and autocorrelation in the data, and providing critical values for hypothesis testing. It is widely used to analyze the long-run relationship between variables in time series data and make inferences about their cointegration behaviour.

The specification of the Gregory-Hansen cointegration test includes the following:

Null Hypothesis, H_0*:* There is no cointegration relationship among the variables in the time series data or at the breakpoint.

Alternative Hypothesis, H_1*:* There is a cointegration relationship among the variables in the time series data or at the breakpoint

Test Statistic: This is based on the generalized least squares (GLS) estimator, which accounts for potential autocorrelation and heteroscedasticity in the data. The test statistic is calculated by estimating the GLS regression model and then computing a test statistic, which is compared to critical values to determine statistical significance.

Decision: Based on the test statistic (ADF) and critical values, the null hypothesis of a unit root is either accepted or rejected. Reject the null hypothesis if the absolute value of the calculated t statistic is higher than the 5% critical value; otherwise, do not reject. If the null hypothesis is rejected, it suggests evidence of cointegration in the time series data or at the

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breakpoint. In other words, it implies that the linear combination of the variables exhibits stable properties in the long run, but with structural breaks. If the null hypothesis is not rejected, it suggests that there is no co-integration in the time series data or at the break point and thus nonstationary.

3.7 Principal Component Analysis (PCA)

This objective used Principal Components Analysis. It is a common statistical method for analyzing any dimensionality-reducing datasets while preserving their key information. It is a dimensionality reduction strategy that reduces a big set of variables into a smaller set of primary components, which are uncorrelated variables. When working with large datasets with many variables, PCA is especially helpful because it can help identify the most crucial variables and lessen the complexity of the data. It is used to identify and understand the underlying patterns, relationships, and structures within a dataset that may not be immediately apparent. Its main goals are to reduce multicollinearity (i.e., high correlation among variables), identify pertinent variables, and simplify and summarize complex data to enhance model estimation and interpretation.

PCA is a popular statistical technique for evaluating and dimensionality-reducing datasets while maintaining the essential data. It is a dimensionality reduction approach that breaks down a large set of core components, which are uncorrelated variables, into a smaller set. PCA is particularly useful when working with huge datasets with several variables since it can help identify the most important factors and reduce the complexity of the data. It is used to find and comprehend hidden patterns, connections, and structures in datasets that might not be immediately obvious. Its primary objectives are to reduce multicollinearity—that is, strong correlation between variables—find relevant factors, summarize and simplify complex data, and identify pertinent variables to improve model estimation and interpretation. In this research, PCA is used to create a Ghana ICT Index named Digital

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Technology from E-governance, E-participation, and Internet availability, yielding a robust principal component.

3.8 Structural Vector Autoregressive (SVAR) Model

A time series econometric model called a Structural Vector Autoregression (SVAR) model is used to examine the dynamic interactions between numerous variables. Based on each variable's own lagged values as well as the lagged values of the other variables in the system, a set of equations is used to describe how each variable has changed through time. To create a structural VAR model that produces results that are intelligible and understandable, you must first define the endogenous variables, choose the right lag order, specify the structural shocks, estimate the structural parameters, and impose identifying assumptions. The following elements are commonly used to specify the SVAR model:

Endogenous Variables: These are the variables whose dynamics are being modeled and are of interest. They are represented by the symbol $\boldsymbol{Y_t}$, where $\boldsymbol{t}$ denotes the period. The size of the system is determined by the number of endogenous variables in the SVAR model.

Lag Order: The number of lags that the endogenous variables have in the model is indicated by the lag order. The number $\boldsymbol{p}$ indicates how many previous values of the variables have been utilized to model their dynamics. Economic theory or statistical methods, such as information criteria like AIC and BIC, can be used to determine the appropriate lag order.

Structural Shocks: These are the exogenous shocks or disturbances that affect the dynamics of the endogenous variables. They are typically assumed to be unobservable and are denoted as epsilon t. $(\boldsymbol{\varepsilon_t})$ The number of structural shocks in the SVAR model is equal to the number of endogenous variables.

Structural Parameters: The effect of the structural shocks on the endogenous variables is determined by these coefficients. They are often expressed as *beta* and calculated using econometric methods like maximum likelihood estimation or Bayesian approaches.

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Equations: The SVAR model consists of a system of linear equations that connect the endogenous variables to their own lagged values, as well as the lagged values of other variables in the system. The equations can be represented in matrix form as:

$Y_t = A_0 + A_1{*}Y_{t-1} + A_2{*}Y_{t-2} + \ldots + A_q{*}Y_{t-p} + \varepsilon_t$ (1), where A_0, A_1, A_2, ..., A_q are coefficient matrices representing the contemporaneous impact of the lagged variables, and ε_t is the vector of structural shocks.

Identifying Assumptions: Additional identifying assumptions are required to estimate the structural parameters in the SVAR model. The limits on the contemporaneous or lag coefficients in the equations or the restrictions on the covariance matrix of the structural shocks are examples of these assumptions, which are often based on economic theory.

This study therefore employed the *Structural Vector Autoregressive* (SVAR) which hinges on the maximum likelihood estimation (MLE) technique. The MLE method provides a means to estimate a set of parameters characterizing a distribution that is assumed to be known. The technique assumes that the errors are normal and identically distributed. The maximum likelihood estimator is consistent and asymptotically efficient. The SVAR approach is used to analyze the dynamics of a model subjected to an unexpected shock and test and evaluate the effectiveness of economic policies (Gottschalk, 2001; McCoy, 1997). The SVAR model was preferred to the Dynamic Stochastic General Equilibrium (DSGE) model **(***DSGE model is a type of macroeconomic model used to study the interactions among different sectors of an economy over time based on economic theory and incorporates dynamic behavior, stochastic shocks, and general equilibrium interactions among various agents in the economy*) because the SVAR model avoids incredible and strict restrictions and provides economic transmission mechanism which the DSGE model fails to provide (Gottschalk, 2001; Kamati, 2014; Tovar, 2009). Besides, the DSGE model has numerous assumptions and is suited for policy simulation. Moreover, the imposition of

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identification restrictions on the VAR model is based on the Choleski decomposition, which has been criticized (Cooley & LeRoy, 1985). The estimated shocks in the VAR model are not pure shocks but linear combinations of structured disturbances, which makes it difficult to assess the dynamic effects of the variables (McCoy, 1997).

The SVAR model can determine the dynamic effects on variables because the dynamic effect depends on all the structural disturbances but not a linear combination of the disturbances, and the restrictions imposed are based on economic theory (McCoy, 1997). Besides, the theoretical approach to the VAR model does not provide an economic interpretation for the impulse response function (IRF) and variance decomposition (VD). The SAR model used in the study was presented:

$$A_0 Y_t = \alpha + \sum_{p=1}^{q} A_p Y_{t-p} + \delta W_t + B\varepsilon_t \quad (2)$$

$$A_0 Y_t = \alpha + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_q Y_{t-q} + \delta W_t + B\varepsilon_t \quad (3)$$

The matrix A_0 is a 9×9 dimension of contemporaneous coefficient relations on Y_t , and Y_t is a column vector with 9×1 endogenous variables. α is a column vector with 9×1 constant variables of the endogenous variables. A_p is matrices of structural coefficients on the lagged endogenous variables in the model. Using the endogenous variables fiscal deficit, e-governance, e-participation, Internet availability, GDP growth, Money supply, Inflation, Natural resources, and Trade Openness, W_t is an exogenous variable. Matrix B was set as a diagonal matrix because of the orthogonal assumption of structural innovations. ε_t is a 9×1 column vector of structural shocks. It is normally distributed with mean zero and its variance-covariance matrix $\sum\varepsilon$, where $\sum\varepsilon$ is a diagonal (identity) matrix. The Ordinary Least Squares (OLS) method cannot be applied to equation (2) because Y_t breaks the assumption of no correlation between independent variables in matrix A and structural shocks (Kamati, 2014). The reduced form of Equation (2) was given as:

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$$Y_t = A_0^{-1}\alpha + A_0^{-1}A_1Y_{t-1} + \ldots + A_0^{-1}A_qY_{t-q} + A_0^{-1}\delta\mathrm{Wt} + A_0^{-1}B\varepsilon_t \quad (4)$$

$$Y_t = D + C_1Y_{t-1} + \ldots + C_qY_{t-q} + B\mathrm{Wt} + \mu_t \quad (5)$$

From equation (5), the reduced form of the residuals is obtained as μ_t . The lagged values of the endogenous variable are on the right-hand side; hence OLS can be applied directly to equation (5) because the estimates are consistent and efficient.

3.8.1 Identification Conditions: Short – Run and Long – Run SVARs

The structural residuals were obtained from the reduced form residuals by linear transformation: $\mu_t = A_0^{-1}B\varepsilon_t \; or \; A_0u_t = B\varepsilon_t$ (6)

The restriction was imposed on the matrix A_0 and B where the B the restriction is the diagonal restrictions placed on the error term. The matrix A_0 contains the instantaneous effect of the structural shocks on the observed variables. There is a need to impose restrictions on the structural model to be able to identify the structural model from an estimated VAR. The minimum number of restrictions that can be imposed on matrix A_0 is $(n^2 - n)\,/2$. A block-recursive structure was imposed on the matrix A_0^{-1} (equation (6)). From matrix A_0^{-1}, the number of restrictions required was 36 based on economic theory and intuition.

Structural VAR Estimate for the Short–run pattern.

$$\begin{pmatrix}\text{Variables}\\ \text{FD}\\ \text{EG}\\ \text{EP}\\ \text{INTS}\\ \text{GDPgt}\\ \text{MS}\\ \text{INF}\\ \text{NR}\\ \text{TO}\end{pmatrix} \begin{pmatrix}\varepsilon_t^{FD} & \varepsilon_t^{EG} & \varepsilon_t^{EP} & \varepsilon_t^{INTS} & \varepsilon_t^{GDPgt} & \varepsilon_t^{MS} & \varepsilon_t^{INF} & \varepsilon_t^{NR} & \varepsilon_t^{TO}\\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 & 0 & 0\\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 & 0 & 0\\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 & 0 & 0\\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 & 0 & 0\\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 & 0 & 0\\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & 1 & 0\\ a_{91} & a_{92} & a_{93} & a_{94} & a_{95} & a_{96} & a_{97} & a_{98} & 1\end{pmatrix} \quad (7)$$

Structural VAR Estimate for the Long–run pattern.

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$$\begin{pmatrix} \text{Variables} \\ \text{FD} \\ \text{EG} \\ \text{EP} \\ \text{INTS} \\ \text{GDPgt} \\ \text{MS} \\ \text{INF} \\ \text{NR} \\ \text{TO} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{FD} & \varepsilon_t^{EG} & \varepsilon_t^{EP} & \varepsilon_t^{INTS} & \varepsilon_t^{GDPgt} & \varepsilon_t^{MS} & \varepsilon_t^{INF} & \varepsilon_t^{NR} & \varepsilon_t^{TO} \\ C_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & C_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & C_3 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & C_4 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & C_5 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & C_6 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & C_7 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & C_8 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & C_{19} \end{pmatrix} \quad (8)$$

The above equations for both short run and long SVAR estimates pattern matrix assume that the Fiscal deficit (FD) is the most endogenous variable in the model, but does not affect by the shocks to all other variables in the model.

The *first* row of the matrix (equation (7)) represents the equation for FD. It was assumed that at least in the short run, the other variables do not have an immediate impact on fiscal deficit. The activities in the economy and the changes in the macroeconomic variables do not determine fiscal deficit, at least in the short run.

The *second* row represents the E-governance equation. This was based on the assumption that structural shocks from the other variables do not have an immediate effect on the E-governance, except for the fiscal deficit.

Despite the interconnectedness between the variables, changes in the other variables may not affect E-governance at least within the shortest time. For instance, changes in inflation will not have an immediate impact on E-governance because price changes at a particular period and may not influence the variable. Also, changes in the money supply may not influence E-governance since money supplied is for a particular fixed period and thus cannot be changed within the shortest time. The *third* row represents the E-participation equation. The equation was based on the assumption that structural shocks from the other variables do not have an immediate effect on E-participation except Fiscal deficit and E-governance.

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The *fourth* row represents the Internet availability equation. The equation was based on the assumption that structural shocks from the other variables do not have an immediate effect on internet availability except for the Fiscal deficit, E-governance, and E-participation. Changes in E-governance may have immediate effects on Internet availability through the provision of Internet equipment and human capital. Even though interdependency is observed between the variables, it takes a long time for E-governance changes to affect the Internet availability, at least in the short run, because it requires time to adjust to these changes.

The *fifth* row represents the GDP growth equation. The equation was based on the assumption that structural shocks from the other variables do not have an immediate effect on GDP growth except for the Fiscal deficit, E-governance, E–participation, and Internet availability.

The Money supply equation is represented by the *sixth* row based on the assumption that structural shocks from the other variables do not have an immediate effect on Money supply except fiscal deficit, E-governance, E – participation, Internet availability, and GDP growth.

Again, the *seventh* row represents the Inflation equation. The equation was based on the assumption that structural shocks from the other variables have a contemporaneous effect on Inflation, except for Natural resources and Trade openness.

Again, the *eighth* row represents the Natural resources equation based on the assumption that structural shocks from all the other variables have a contemporaneous effect on Natural resources except Trade openness. Again, the *ninth* row represents the Trade Openness equation. This is based on the assumption that structural shocks from all the other variables have a contemporaneous effect on Trade Openness.

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3.9 SVAR – Impulse Response Functions and Forecast Error Variance Decompositions

Individual coefficients in an estimated VAR or SVAR are difficult to interpret (Enders, 2010). In light of this, the study considered the *structural forecast error variance decompositions* (SFEVD) and the *structural impulse response functions* (SIRF), which are the main outputs of SVAR. The SIRF shows the dynamic response of the current and future values of each variable to a unit change in the current value of one structural shock (Kamati, 2014). From equation (2), the impulse response functions were derived as: $A_0 Y_t = \alpha + A(L)Y_t + \delta W_t + B\varepsilon_t$ (9) where L is the lag operator and $A(L) = \sum_{p=1}^{q} A_p$

$$A_0 Y_t - A(L)Y_t = \alpha + \delta W_t + B\varepsilon_t \quad (10)$$

$$[A_0 - A(L)]Y_t = \alpha + \delta W_t + B\varepsilon_t \quad (11)$$

$$RY_t = [A_0 - A(L)]^{-1}\alpha + [A_0 - A(L)]^{-1}\delta W_t + [A_0 - A(L)]^{-1}B\varepsilon_t \quad (12)$$

Now let $\boldsymbol{D} = [A_0 - A(L)]^{-1}\alpha$

$\boldsymbol{C} = [A_0 - A(L)]^{-1}\delta$ and $E = [A_0 - A(L)]^{-1}B$

$$Y_t = D + CW_t + E\varepsilon_t \quad (13)$$

$$Y_t = D + CW_t + E_0\varepsilon_t + E_1\varepsilon_{t-1} + E_2\varepsilon_{t-2} + E_s\varepsilon_{t-s} \quad (14)$$

$$Y_t = D + CW_t + \sum_{s=0}^{\infty} E_s\varepsilon_{t-s} \quad (15)$$

Equation (15) represents the *structural moving average* (SMA). SMA traces out the time path of various shocks on the variables in SVAR and is useful in examining the interaction between the variables in $\boldsymbol{Y_t}$ (Enders, 2015). The $\boldsymbol{E_s}$ stands for the *structural dynamic multipliers* which constitute the marginal effect of the innovations in the system $\boldsymbol{Y_{t+s}}$. This is expressed as follows: $E_s = {}^{\partial Y_{t+s}}/_{\partial \varepsilon_t}$. The *forecast error variance decomposition* (FEVD) shows the proportion of movements in a sequence owing to its shocks against

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shocks of other variables (Enders, 2015). The SFEVD provides information about the relative importance of each random innovation to the variables in the SVAR.

3.10 Diagnostic Tests

A diagnostic test was conducted before the estimation of the SVAR model. The diagnostic tests conducted were lag selection criteria, vector autoregression model and stability test. The lag length selection criteria were employed to determine the optimal lag required to be included in the model. The degrees of freedom are affected if the number of lags required in the model exceeds the optimal. To avoid this, the log-likelihood (LL), sequentially modified likelihood ratio (LR), Akaike information criterion (AIC), final prediction error (FPE), Hannan-Quinn information criterion (HQIC), and Schwarz information criterion (SIC) tests were employed.

The vector autoregression model provides estimates for the coefficients of the variables which can be used to interpret the relationships between the variables. The significance of the coefficients is determined by the t-statistics, which compares the magnitude of the estimate to its standard error. A coefficient is considered statistically significant if its t-statistic is greater than 1.96 or less than -1.96, which corresponds to a 5% level of significance in a two-tailed test. Finally, the plots of eigenvalues were used to test for the stability of the model.

3.11. Data Analysis

The quarterly time series of fiscal deficit, e-governance, e – e-participation, internet availability, GDP growth, Money supply (Money supply), Natural resources, and Trade Openness were generated by the (Chow & Lin, 1971) extrapolation technique with E-Views 10 statistical package. The match sum was used to ensure that the quarterly data sums up to the yearly data available. However, Inflation data was already in the quarterly series. Descriptive statistics was conducted to describe the variables that were used for the

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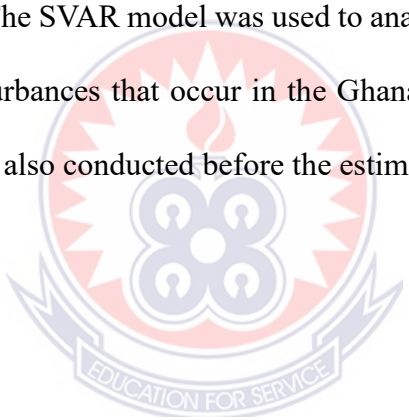
estimation. This was done to determine the nature of the variables. The mean and median were used to measure the central tendencies while standard deviation, skewness, and kurtosis were employed as a measure of dispersion. The Jarque-Bera test for normality was done at a 5% level of significance. All estimations were done in E-views version 10 and STATA 14 statistical packages (IHS Markit, 2017; Stata Corp, 2015).

3.12. Chapter Summary

The positivist philosophy, quantitative approach, and explanatory research design were adopted for the study. Quarterly time series data on the fiscal deficit, e-governance, e–participation, internet availability, GDP growth, Money supply (Money supply), Inflation, Natural resources, and Trade Openness from January 2003Q1 to December 2021Q4 were employed for the study. The SVAR model was used to analyze the dynamic response of the variables to various disturbances that occur in the Ghanaian economy. The unit root test and diagnostic tests were also conducted before the estimation of the SVAR.



CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0. Introduction

This chapter presents the results and discussions of the study which focuses on the descriptive statistics, stationarity test, diagnostic test, structural impulse response function (SIRF), and structural forecast error variance decomposition (SFEVD) on the effects of digital technology on fiscal deficit in Ghana.

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4. 1. Descriptive Statistics

The descriptive statistics on fiscal deficit, e-governance, e-participation, availability of Internet, technology, Money supply, economic growth, inflation, natural resources, and trade openness are presented in *Table 1*.

Fiscal deficit (FD) had a mean of -6.26 percent of GDP. This implies that an average of 6.26 percent of the GDP deficit is experienced in Ghana every quarter. The maximum amount of fiscal deficit of -2.01 percent of GDP was about one-third of the average fiscal deficit within the study period. The minimum amount of fiscal deficit was -15-29 percent of GDP.

A comparison of the mean deficit with the maximum and minimum amounts indicates that there is progress in sustaining Ghana's fiscal deficit quarterly. The variation from the mean fiscal deficit every quarter was 3.31. This indicates a relatively *high* variation in the amount of fiscal deficit that occurs quarterly.

The skewness and kurtosis values were -0.93 and 3.88. This implies that the fiscal deficit is not normally distributed since the values of skewness and kurtosis deviate from 0 and 3, respectively. The observation conformed to the Jarque-Bera test for normality (p-value = 0.00) at a 5% level of significance, indicating the fact that fiscal deficit is not normally distributed.

The mean value of E-governance is 0.38, which indicates the average E-governance every quarter. The extent to which the observations on" E-governance deviated from the mean value was low (0.12). A comparison of the mean E-governance (0.38) with a maximum of 0.60 and a minimum of 0.24 indicates that Ghana has progressed in E-governance, even though the minimum value indicates a low value for the country. The skewness (0.76) and kurtosis (2.12) indicate that the E-governance value is not normally distributed. Similarly,

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the Jarque-Bera test for normality was significant (P-value = 0.01) at a 5% level of significance, which indicates that E-governance is not normally distributed.

The E-participation recorded a mean value of 0.29, suggesting that, on average, the value of E-participation is 0.29. A low value of 0.22 deviated from the mean value of 0.29. A minimum value of 0.03 and a maximum value of 0.63 were recorded for the E-participation. This observation indicates that the E-participation is not progressing when compared with the mean value of 0.22. The skewness value of 0.37 recorded for the E-participation indicated that most of the observations were above the mean (not normally distributed). The Jarque-Bera test gave a p-value of 0.01, which was significant at a 5% level of significance, suggesting that the E-participation is not normally distributed.

The availability of the internet as a percentage of the population has a mean value of 19.10. The extent to which the value of internet availability deviates from the mean was 19.51, indicating a very low variation among the observations. The minimum and maximum values were 1.19 and 68.6, respectively. This means there is no progress in internet availability based on the mean minimum and the maximum values obtained in the study. The skewness value of 1.21 and the Kurtosis value of 3.46 indicate that internet availability is not normally distributed since they deviate from 0 and 3, respectively.

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The observation also conformed to the Jacque Bera test for normality (p-value = 0.00) which is significant at a 5% level of significance suggesting that internet availability is not normally distributed.

Table 4. 1 Summary statistics of Fiscal deficit and other variables

	FD	*EG*	*EP*	*INTS*	*TECH*	*GDPGT*	*MS*	*INF*	*NR*	*TO*
Mean	-6.2561	0.3751	0.2880	19.1043	-5.79E-08	6.0553	27.5816	12.2474	11.2745	73.8751
Med	-5.9060	0.3159	0.2045	10.6000	-1.0122	5.9000	26.9266	10.8000	10.6682	70.5484
Max	-2.0090	0.5960	0.6310	68.6000	3.1589	14.0471	32.7226	29.9000	16.2914	99.6703
Min	-15.2900	0.2370	0.0317	1.1931	-1.8494	0.5139	21.9528	0.6900	7.6087	38.5169
St Dv.	3.3080	0.1187	0.2232	19.5112	1.6796	2.9485	3.1581	5.6203	2.4303	15.2350
Ske	-0.9292	0.7588	0.3693	1.2149	0.6711	0.6292	-0.0012	0.8635	0.9012	0.0099
Kur	3.8758	2.1204	1.5265	3.4579	1.9986	4.0502	1.8409	4.4887	2.8765	2.9354
J-B	13.3663	9.7425	8.6032	19.3595	8.8796	8.5070	4.0309	16.4641	9.7912	0.0144
Prob	0.0013	0.0077	0.0135	0.0001	0.0118	0.0142	0.1333	0.0003	0.0075	0.9928
Sum	-475.4600	28.5088	21.8854	1451.9260	-4.40E-06	460.2032	1985.8760	930.8000	811.7651	5614.5110
S Sq. Dv.	820.7129	1.0559	3.7372	28551.5100	211.5842	652.0120	708.1409	2369.0640	419.3396	17407.8400
Obs	76	76	76	76	76	76	76	76	76	76

Source: ***Author's compilation***
Med=Median; Max=Maximum; Min=Minimum; St. Dv=Standard deviation; Ske=Skewness; Kur=Kurtosis; J-B=Jarque-Bera; Prob=Probability; S Sq Dv=Sum of Squares Deviation; Obs= Observations

The value of the technology (sum of E-governance, E-participation, and internet availability) was 5.79-E08 (0.00) and the deviation from the mean value was 1.68. The comparison of the mean value with the minimum (-1.85) and maximum (3.16) reveals that there is some level of progress in the technology.

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The skewness value for the technology was 0.67. This indicates that most of the observations in the technology were above the mean. The kurtosis also gave a value of 2.0. The skewness (0.67) and kurtosis (2.0) values observed simply imply that the technology level is not normally distributed. This observation was in line with the result obtained from the Jarque-Bera test of normality (p-value=0.01), which was significant at a 5% level of significance.

The Economic growth as a percentage growth rate of GDP has a mean value of 6.1. The variation of the Economic growth from the mean was 2.95 percent of GDP. This indicates a high variation among the observations in the Economic growth. The maximum observation for Economic growth was 14.05, whilst the minimum observation was 0.51. This indicates the level of progression in Economic growth, comparing the mean value (6.1) with the minimum (0.51) and maximum (14.05) percent of GDP. The skewness value of 0.63 and the Kurtosis value of 4.05 indicate that Economic growth is not normally distributed. This was consistent with the Jarque-Bera test for normality, which was significant (p-value = 0.01) at a 5% level of significance, suggesting that Economic growth is indeed not normally distributed.

Money Supply recorded a mean value of 27.58, and the variation from the mean value was 3.16. The comparison of the mean value of the MS with the minimum value of 21.95 and the maximum value of 32.72 reveals that there is a progression in the Financial Sector. The skewness value of –0.001 indicates that MS is normally distributed since it does not deviate from 0. It is also consistent with the Jarque-Bera test for normality, which was not significant (p-value = 0.13) at a 5% level of significance, suggesting that MS is normally distributed. However, this was in contrast with the Kurtosis value of 1.84, indicating that MS is not normally distributed since its value deviates from 3.

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The mean value of Inflation (Consumer Price Index) as a weighted average price of a basket of consumer goods and services was 12.25, and the variation from the mean value was 5.62. The comparison of the mean value (12:25) with the minimum value of 0.69 and maximum value of 29.90 reveals that there is a progression in the Inflation level performance within the period of study. The skewness value for the Inflation was 0.86, whilst the Kurtosis was 4.49. This indicates that the inflation value is not normally distributed. This is also in line with the Jarque Bera test of normality with a p-value of 0.00, which is significant at a 5% level of significance. This means that inflation is truly not normally distributed.

The mean Natural resources as a percentage of GDP were 11.27. The variation of the Natural resources from the mean was 2.43 percent of GDP. This indicates a low variation among the observations in the Natural resources. The maximum observation for Natural resources was 16.29 percent of GDP, whilst the minimum value was 7.6 percent of GDP. This indicates progression in Natural resources in comparison with the mean (1127 percent of GDP) and the minimum value (7.6 percent of GDP), with the maximum value (16.29 percent of GDP). The skewness value of 0.90 and the Kurtosis value of 2.88 indicate that Natural resources are not normally distributed, though close to it. This therefore conforms with the Jarque Bera test for normality, which was significant (p-value = 0.00) at a 5% level of significance, suggesting that Natural resources are not normally distributed.

Trade Openness as a percentage of GDP has a mean of 73.86. The extent of deviation from the mean was relatively low (15.23). The maximum value and the minimum value of Trade openness were 99.67 and 38.52, both as percentages of GDP, suggesting that there is a progression in Trade openness when the mean, minimum, and maximum values are compared. The skewness value (0.01) implies that most of the observations were around the mean, and thus, Trade openness is normally distributed. In the case of the Kurtosis, which has a value of 2.9, thus close to the value of 3, it also indicates that Trade Openness

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is indeed normally distributed. Also, the Jacque-Bera test was in line with the skewness and the Kurtosis. The p-value (0.99) for the Jarque-Bera test for normality was not significant at a 5% level of significance. This suggests that Trade openness is normally distributed.

4. 2. Pre – estimation tests

4. 2. 1. Structural break test: Chow breakpoint test

The estimation of the Chow breakpoint test was done for all the Empirical Estimates (1 to 5), and plotting of the stability diagnostics, CUSUM of squares test for all the Estimates. The summary of the Chow breakpoint is indicated in Table 4.2, showing the result of the stability diagnostics Chow Breakpoint Test of all the Estimates. It can be seen that there is a digression out of the 5% significance level boundary. This, therefore, indicates that there is a breakpoint in the model.

Table 4. 2 Result of the Stability Diagnostics Chow Breakpoint Test of all the Estimates

	Empirical Estimate Main Variables	*F-statistic*		*Probability*
1	FD & EG	5.698906	Prob. F (6,60)	0.0001
2	FD & EP	6.682088	Prob. F (6,60)	0.0000
3	FD & INTS	17.09111	Prob. F (6,60)	0.0000
4	FD, EG, EP & INTS	19.63703	Prob. F (8,56)	0.0000
5	FD & TECH	8.320085	Prob. F (6,60)	0.0000

Source: ***Author's compilation***
Note: The Control Variables for each estimate are *G*DPgt, FSD, INF, NR and TO

From Table 4.2, it can be seen that all the F-statistics are significant at 1%, 5% and 10%. This means that the null hypothesis of no structural break in the series is rejected. This implies that there is a structural break in the series.

4. 2. 2. Stationarity Test

The stationarity level of the variables used in the study was determined using the Zivot–Andrew and Phillip–Perron (PP) unit root test. This was done to avoid spurious regression in the results. The variables were first examined by inspecting their trends graphically. (*Appendix 1 and 2*)

Table 4.2 Result of the Zivot - Andrew (ZA) Unit Root Test

Level	*1st Difference*

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Variable	*Intercept*	*Trend*	*Trend & Intercept*	*Intercept*	*Trend*	*Trend & Intercept*
	t-Statistic	*t-Statistic*	*t-Statistic*	*t-Statistic*	*t-Statistic*	*t-Statistic*
FD	-2.8680**	-2.5221***	-4.0352***	-7.2667**	-6.8695*	-7.2655**
EG	-3.9973***	-3.5976**	-3.4688	-3.0870***	-3.1656***	-4.3941***
EP	-3.4233***	-2.7022	-3.1750	-3.4538***	-2.9312**	-4.3224***
INTS	-2.7201	-3.8489***	-4.8179***	-8.8292	-8.9129	-8.9988
GDPgt	-3.6327**	-3.0582	-3.6232**	-6.2396**	-5.6552	-6.1921**
MS	-3.0514	-2.7568	-3.8359	-8.4464*	-8.3346	-9.1254**
INF	-4.0828***	-3.6393*	-4.3992***	-7.1181**		-7.6432***
NR	-3.9771***	-2.8287***	-3.9771***	-8.8489**	-8.5059	-9.1274***
TO	-3.7137	-3.3900		-6.0690	-5.8315	-6.2391*
TECH	-3.4631***	-4.4511***	-4.7108**	-9.7469*	-9.5015	-9.7311*

Source: ***Author's compilation***
Note: ***(***), (**),*** *and* ***(*)*** *denote Significance level at 1%, 5% and 10% respectively.*

The Zivot-Andrew test for unit root was conducted (*Table 4.3*). All the variables were stationary at either 1%, 5%, or 10% levels of significance at either level or first difference. Thus, the null hypothesis of the presence of unit root (non-stationary) was therefore rejected since the p-values of the Zivot-Andrew statistic were statistically significant at either 1%, 5%, or 10% at either level or first difference.

Table 4. 3 Result of the Philip Perron (PP) Unit Root Test

Level				*1st Difference*		
Variable	*None*	*Intercept*	*Trend and Intercept*	*None*	*Intercept*	*Trend and Intercept*
	t- statistic	*t- statistic*	*t- statistic*	*t- statistic*	*t- statistic*	*t- statistic*
FD	0.0617	-1.7070	-2.6925	-8.6375***	-8.67947***	-8.6127***
EG	3.3629	0.6784	-1.4886	-8.7004***	-9.5471***	-9.7291***
EP	0.8316	-0.6768	-1.9028	-8.6513***	-8.8841***	-8.8281***
INTS	1.1804	0.1401	-2.2004	-8.5440***	-8.7509***	-8.8783***
GDPgt	-1.1217	-2.7342*	-2.8318	-8.5440***	-8.4853***	-8.4300***
MS	-0.2679	-2.3515	-2.1887	-8.3066***	-8.2462***	-8.2728***
INF	-2.0559**	-3.7893***	-3.6043**	-7.9315***	-7.9136***	-7.9945***
NR	-1.0860	-2.5292	-2.4777	-8.3066***	-8.2877***	-8.2498***
TO	-1.0408	-2.4767	-3.0675	-8.5440***	-8.5234***	-8.4704
TECH	0.3917	0.5550	-1.9032	-8.5440***	-9.3035***	-9.4346***

Source: ***Author's compilation***
Note: ***(***), (**)*** *and* ***(*)*** *denote Significance level at 1%, 5% and 10% respectively*

In the case of Phillip Perron (PP), all the variables were non-stationary at levels except Economic growth (GDPgt) and Inflation (INF). However, the plots of all the variables in their first differences indicated that the variables were stationary.

The PP test for unit root is presented in *Table 4*.4. The p-values of the PP statistic for all the variables except Economic growth (GDPgt) and Inflation (INF) were not statistically

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significant at 1%, 5%, and 10% levels of significance at levels. This means that Fiscal deficit (FD), E-Governance (EG); E-participation (EP), Internet availability (INTS), Money Supply (MS), Natural resources (NR), Trade openness (TO), and Technology (TECH) were all non-stationary at levels. The presence of statistical significance in the p-values of PP statistics of Economic growth (GDPgt) and inflation (INF) at all the conventional levels of significance suggests that GDPgt and INF are stationary of the intercept (intercept and trend) and integrated of order zero I(0). However, all the variables were stationary at 1%, 5%, and 10% levels of significance at the first difference.

The null hypothesis of the presence of unit root (non-stationary) was rejected since the p-values of the PP statistic were statistically significant at 1%, 5%, and 10% levels of significance for all first difference estimates.

According to Bernanke (1986) and Blanchard and Watson (1986), the shocks of I(0) variables have a temporal effect. However, the shocks of the I(1) variable have a permanent effect (Blanchard & Quah, 1986; Shapiro & Watson, 1988). Therefore, the study used the first difference I(1) variables to ensure uniformity in the impacts of the shocks.

4. 2. 3. Co – integration test

Table 4. 4 Results of Gregory – Hansen Co-integration test for the fiscal deficit models.

Model	*Breakpoint date*	*ADF-statistic*	*t-Critical @ 5%*	*Rejection of Null hypothesis*
Estimation 1	2019q1	-5.14(2) **	-4.99	Yes
Estimation 2	2015q1	-5.83(3) **	-5.50	Yes
Estimation 3	2016q3	-5.78(3) **	-5.50	Yes
Estimation 4	2019q1	-5.14(2) **	-4.99	Yes

Source: ***Author's compilation***

Note: 1. ** denotes the level of significance at 5%
2. The numbers in parentheses are the lags.
3. Chosen for an optimal length based on the Akaike Information Criteria (AIC) and t-test statistics.

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The empirical results of the Gregory and Hansen cointegration test are presented in *Table 4.5*. The results show that the t-statistics of ADF (Augmented Dicky Fuller) are significant at the 5% level in all four Empirical estimates, indicating that the null hypothesis of no cointegration in all models is rejected. This implies that the fiscal deficit in all the models has a long-run relationship with its explanatory variables.

4.3. Diagnostics test

Some diagnostic test on the structural vector autoregression model (SVAR) was done. This includes VAR Lag order selection, Vector Auto regression model, and Stability test.

4.3. 1. VAR lag Order Selection

The lag length criteria were conducted before estimating the VAR model to ensure that the appropriate lag was used in estimating the SVAR.

Table 4. 5 Result of lag length of all the variables

Var.	*Lag*	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
FD	1	-123.7460	104.1670	2.2411	3.6448	3.7096*	3.6705
	5	-117.8925	10.0926*	2.1247*	3.5911*	3.7854	3.6682*
EG	5	214.6594	26.9748*	0.0001*	-6.0481*	-5.8538*	-5.9710*
EP	5	148.4359	22.3644*	0.0009*	-4.1286*	-3.9343*	-4.0515*
INTS	1	-213.8816	172.5581*	30.5565*	6.2574*	6.3222*	6.2831*
GDPgt	1	-135.9171	76.2620*	3.1891*	3.9976*	4.0624*	4.0233*
MS	1	-123.9375	75.0674*	2.8211*	3.8750*	3.9419*	3.9014*
INFS	1	-167.5277	64.6106*	7.9724*	4.9138*	4.9786*	4.9395*
NR	1	-102.3689	83.8259*	1.4528*	3.2114*	3.2783*	3.2377*
TO	1	-237.8977	78.0558*	61.2949*	6.9536*	7.0183*	6.9792*
TECH	1	3.3116	262.7702*	0.0564*	-0.0380*	0.0267*	-0.0123*

Source: ***Author's compilation***
Note: * Indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

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As shown in Table 4.6, optimum lag order selection was done to determine the number of lag(s) to be included in the model before the structural test. The maximum lag for the model was chosen based on the five different information criteria. The study adopted five lags as the maximum for the model.

4.3. 2. Vector Autoregression Model

The summary of the Vector Autoregression estimated is shown in Table 4.7 below.

Table 4. 6 Vector Autoregression Model for Fiscal deficit

	Estimate 1	*Estimate 2*	*Estimate 3*	*Estimate 4*
D(FD(-1))	-0.0154	-0.0459	-0.0410	-0.0669
	(-0.1966)	(-0.2068)	(-0.1727)	(-0.2012)
	[-0.07819]	[-0.2222]	[-0.2377]	[-0.3322]
D(EG(-1))	5.4311			
	(-13.2352)			
	[0.4103]			
D(EP(-1))		3.0312		
		(-6.5371)		
		[0.4637]		
D(INT(-1))			0.0143	
			(-0.0488)	
			[0.2932]	
D(TECH(-1))				0.7717

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				(-1.0101)
				[0.7640]
D(GDPgt(-1))	0.01161	0.02650	0.0207	0.0267
	(-0.1290)	(-0.1350)	(-0.1093)	(-0.1290)
	[0.0900]	[0.1963]	[0.1894]	[0.2066]
D(MS(-1))	0.0011	0.0138	-0.0263	-0.0397
	(-0.1648)	(-0.1716)	(-0.1778)	(-0.1724)
	[0.0067]	[0.0804]	[-0.1477]	[-0.2301]
D(INF(-1))	-0.0084	-0.0088	-0.0026	-0.0115
	(-0.0630)	(-0.0686)	(-0.0535)	(-0.0632)
	[-0.1338]	[-0.1283]	[-0.0488]	[-0.1824]
D(NR(-1))	-0.01394	-0.01903	-0.0245	-0.0310
	-0.2060	(-0.2130)	(-0.1760)	(-0.2070)
	[-0.0677]	[-0.0893]	[-0.1390]	[-0.1496]
D(TO(-1))	0.001308	0.0033	0.0096	0.0200
	-0.04196	(-0.0440)	(-0.0525)	(-0.0508)
	[0.03118]	[0.0759]	[0.1831]	[0.3934]
C	-0.21266	-0.3330	-0.3161	-0.4542
	(-0.25551)	(-0.2315)	(-0.1602)	(-0.2341)
	[-0.83230]	[-1.4381]	[-1.9728]	[-1.9403]

The ( ) represents t-statistics whilst [ ] represents the Standard errors
Source: Author's Own Compilation

Table 4.7 provides the estimates for the coefficients, which can be used to interpret the relationships between the variables. The significance of the coefficients is determined by the t-statistics, which compares the magnitude of the estimate to its standard error. A coefficient is considered statistically significant if its t-statistic is greater than 1.96 or less than -1.96, which corresponds to a 5% level of significance in a two-tailed test.

For example, the coefficient for D(FD(-1)) in the equation is -0.0154, and its t-statistic is -0.1966. The negative coefficient suggests that an increase in the first lag of the first difference of the fiscal deficit leads to a decrease in the first difference of the fiscal deficit in the current period. However, the t-statistic is not significant at the 10% level, indicating that the coefficient might not be different from zero.

STRUCTURAL VAR ESTIMATES

After the investigation of the properties of the variables and the diagnostic tests after estimating the vector autoregression (VAR) model, the restrictions were imposed to estimate the SVAR model for both the short and long run. Since the coefficients of the

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SVAR are difficult to interpret, the *Accumulated Impulse Response Functions* and *Forecast Error Variance Decomposition* were estimated to find the effects of digital technology on fiscal deficit in Ghana in both the short and long run.

4.4. Empirical Estimate 1: FD, EG, GDPgt, MS, INF, NR and TO

4.4.1. Structural VAR Estimates

Table 4. 7 Result of Structural VAR Estimates on Short Run and Long Run Pattern

Var.	***Short Run***				***Long Run***			
	Coeff.	*SE*	*z- stat.*	*Prob.*	*Coeff.*	*SE*	*z- stat.*	*Prob.*
FD					0.9639	0.0833	11.5758	0.0000***
EG	0.0006	0.0015	0.4078	0.6834	0.0066	0.0035	1.9110	0.0560**
GDPgt	0.2404	0.1932	1.2448	0.2132	-0.5851	0.1583	-3.6954	0.0002***
MS	-0.82831	0.2341	-3.5387	0.0004***	0.2854	0.2791	1.0225	0.3065
INF	0.5428	0.3865	1.4043	0.1602	1.4087	0.3807	3.7002	0.0002***
NR	0.0429	0.1235	0.3475	0.7283	-0.6013	0.1784	-3.3700	0.0008***
TO	3.8814	0.8491	4.5713	0.0000***	0.0512	0.7737	0.0662	0.9472
	Log-likelihood			-529.16	Log-likelihood			-529.1600

Source: Author's Computation using E-views – 10
Note: 1. *The *** indicates significance at 1%, ** indicates significance at 5% and * indicates significance at 10%*
2. *Fiscal Deficit (FD), E-governance (EG), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), Trade openness (TO)*
3. *Variable (Var.), Coefficient (*Coeff.**)** Standard error (SE), z-statistic (z–stat.), Probability (Prob.)

Short Run: The FD shock consists of E-governance (EG), Economic growth (GDPgt), Money Supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO). This shows that in the short run, FD is positively related to EG, GDPgt, INF, NR, and TO but only negatively related to MS.

Evidence from the above result makes it inconclusive to reject our assumptions of FD as the most endogenous variable in the model which cannot be affected by the other shocks of all other variables in the model because the FD has been affected by shocks to variables like MS and TO both at 1% significance level but not affected by shocks to variables such as EG, GDPgt, INF and NR.

Long Run: From the table above, the Fiscal deficit (FD) shock has recently affected E-governance (EG), Economic growth (GDPgt), Money supply (MS), Inflation (INF),

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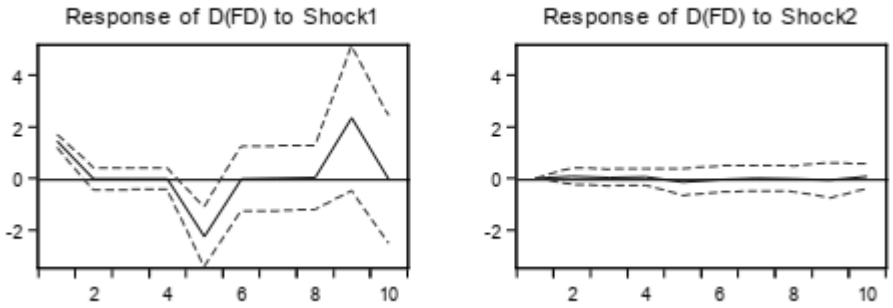
Natural resources (NR), and Trade openness (TO) given FD as statistical significance at 1% level of significance given its p-value of 0.0000. The FD is positively related to EG, MS, INF, and TO whilst it is negatively related to GDPgt and Natural resources.

Evidence from the above results shows that E-governance (EG), Economic growth (GDPgt), Inflation (INF), and Natural resources (NR) have a long-term effect on Fiscal Deficit (FD) at 1% significance level except for EG which is at 5% significance level. On the other hand, it can also be observed that MS and TO have no significant long-run effect on FD.

4.4.2. Structural Impulse Response Function

The figures below show the short-run and long-run impulse response functions of the first difference in the Fiscal deficit

Short Run



Source: Author's Construct using E-views – 10

Fig. 4.1: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *E-governance (EG)*

The impulse response function (IRF) result helps to trace the responsiveness of endogenous variables to shocks. **Shock 1** represents *Fiscal Deficit (FD) whilst* **Shock 2** *indicates E-governance (EG).* It is a response to the structural decomposition of one standard deviation

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innovation. The ***zero line,*** which is the original, separates both the upper bound and the lower bound. The reaction functions indicate a positive relationship when above the zero line, while below the line shows a negative relationship. The figures on the horizontal axis also represent the timing into the future, and this study utilizes 10 quarter periods into the future. That is, the x-axis represents years from 2003 – 2021.

The Impulse Response Function (IRF) is a tool to analyse the dynamic response of a variable to a shock in a model, which shows how a variable responds to a one–time shock in the short and long run. The IRF is useful in understanding the transmission mechanism of shocks in an economy and policy analysis. The Y-axis: D(FD) = The first difference of the Fiscal Deficit. This represents the change in the fiscal deficit from one period to the next. D(FD) > 0: The deficit is increasing (fiscal policy is becoming more expansionary). D(FD) < 0: The deficit is decreasing (fiscal policy is becoming more contractionary or consolidating). D(FD) = 0: The deficit is stable; it's neither growing nor shrinking.

The left panel shows the response to Shock 1 (the fiscal deficit shock). The pattern has a lot of ups and downs and very wide confidence intervals, which means it is very unstable. There is an initial positive response of about +1.5 from Period 1 to Period 2, but then it goes down to zero. In period 4, there is a sharp drop to about -3, which means a very strong contractionary response. From Periods 5 to 7, there is a big rise with a steep recovery. The peak positive response in Period 8 is around +2.5, which could mean that the government is spending more money or changing its policies. From Periods 9 to 10, the response slowly goes down but stays high. This extreme volatility indicates that fiscal policy engenders considerable short-term instability, characterized by initial adjustments succeeded by possible overcorrections or political economy pressures.

The right panel shows how people reacted to Shock 2 (E-Governance Shock). The pattern shows that the response is very stable and doesn't change much over time. In all periods,

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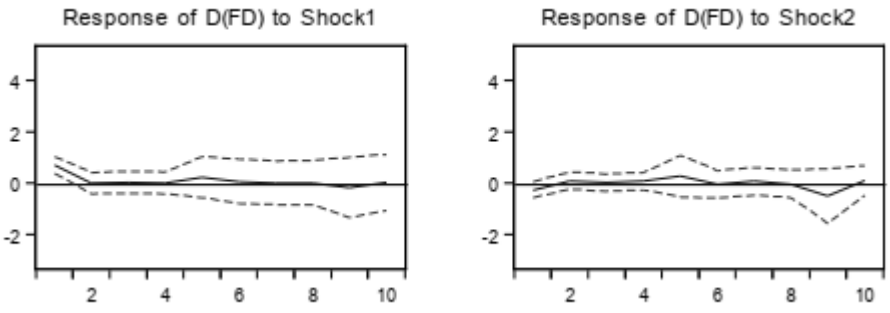
the response stays close to zero (within ±0.5 range). There is a small trend that shows a very slow drop toward a small negative value. The tight confidence bands show that the effects are very predictable because they are stable. There is virtually no measurable short-run fiscal impact in terms of magnitude.

There is a stark difference in how volatile things are, which shows that there is a very different mechanism at work. Fiscal shocks cause immediate but chaotic responses, while E-governance shocks have very little effect in the short term. E-governance also has little short-term effect because it takes time to set up and improve administrative systems, and the benefits of digital government services come slowly because of institutional inertia in government operations. The very wide confidence bands for fiscal shocks (±5) and the very narrow bands for e-governance (±1) show that fiscal policy outcomes are very hard to predict, while e-governance effects are more reliable and measurable, even if they are small. Fiscal policies have direct, immediate, and unstable transmission mechanisms, whereas e-governance has indirect, delayed, and stable transmission through increased administrative efficiency. The divergent trends imply that these instruments function on distinct time horizons: e-governance for slow structural improvements, and fiscal policy for quick (but erratic) responses. According to the scant e-governance response, digital government reforms take longer to produce quantifiable fiscal benefits, which makes them inadequate instruments for short-term fiscal management but possibly useful for long-term efficiency gains.

Long run



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Source: Author's Construct using E-views – 10

Fig. 4.2: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *E-governance (EG)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. After a slow decline, the pattern eventually converges toward negative territory. Initial responses from periods 1-3 are almost zero with a small positive bias. There is a consistent downward trend from Periods 4–8 that reaches about -1. Stabilization occurs between -1 and -1.5 levels during Periods 9–10. Convergence to a new, lower equilibrium is observed overall. This implies that fiscal deficit shocks eventually result in better fiscal positions over time, perhaps as a result of structural reforms brought on by fiscal stress, institutional learning and enhanced fiscal discipline, and the gradual improvement of automatic stabilizers.

Response to Shock 2 (E-governance Shock) is displayed in the Right Panel. The pattern shows a very similar slow decline with similar timing and magnitude. The general trend is almost the same as the fiscal deficit response. There is a comparable final equilibrium in terms of convergence level between -1 and -1.5. The same gradual adjustment pathway is used for timing over ten periods. Comparable statistical significance and confidence intervals are present in the case of stability. It is evident that the long-term effects of fiscal deficit and e-governance shocks are strikingly similar, indicating that they function through interconnected pathways. The long term shows long-term fiscal improvements or benefits from digital government reforms through administrative efficiency gains compound over time, digital systems lowering long-term operational costs, and improved service delivery, which increases government effectiveness, in contrast to the short-term analysis where e-governance showed minimal effects. The comparable -1 to -1.5 final responses show that e-governance reforms can be just as successful in reducing the long-term deficit as direct fiscal measures.

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Similar to system integration and optimization phases, staff training and adaptation periods, and cultural shifts in government operations, the gradual 10-period adjustment indicates that the benefits of e-governance take a long time to fully manifest. This suggests that fiscal policy and e-governance seem to be stand-in instruments for long-term fiscal consolidation. Additionally, the significant long-term advantages outweigh the initial e-governance expenditures. Once more, e-governance must be utilized for structural long-term improvements, while fiscal policy must be utilized for short-term adjustments. Additionally, the permanent negative shift implies that both shocks produce long-term gains in fiscal management capability as opposed to short-term fixes. E-governance reforms produce significant and long-lasting fiscal benefits that are comparable to direct fiscal interventions, despite their negligible short-term effects, as demonstrated by the convergence toward similar negative responses.

4.4.3. Structural Forecast Error Variance Decomposition

Table 4. 8 Short-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*EG*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4347	100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.4370	99.6983	0.2291	0.0479	0.0018	0.0203	0.0017	0.0008
3	1.4435	98.8276	0.2961	0.2166	0.0036	0.6225	0.0321	0.0014
4	1.4451	98.6086	0.4253	0.2309	0.0036	0.6973	0.0328	0.0014
5	3.1319	72.9037	0.3040	11.0794	1.3655	2.9680	0.7393	10.6402
6	3.1359	72.7206	0.3180	11.1393	1.3692	3.0988	0.7381	10.6161
7	3.1452	72.2935	0.3178	11.1306	1.4057	3.5564	0.7422	10.5538
8	3.1468	72.2294	0.3243	11.1227	1.4095	3.6249	0.7453	10.5439
9	4.3260	67.2445	0.2074	9.2720	2.8897	4.3448	1.9465	14.0951
10	4.3282	67.1823	0.2369	9.2624	2.8965	4.3957	1.9453	14.0809

Source: ***From E-views, version 10***

Table 4. 9 Long Run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*EG*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4347	22.7598	3.6651	30.9127	9.2553	3.4467	17.6998	12.2606
2	1.4370	22.7070	3.9364	30.8152	9.2361	3.4382	17.6439	12.2232
3	1.4435	22.5152	3.9108	30.5817	9.4076	3.9746	17.4918	12.1183
4	1.4451	22.4642	4.0820	30.5189	9.3959	3.9958	17.4519	12.0914
5	3.1319	5.2670	1.5292	53.4912	7.1327	2.5722	14.2573	15.7504
6	3.1360	5.2716	1.5688	53.3550	7.1900	2.6828	14.2216	15.7103
7	3.1452	5.2413	1.5964	53.1579	7.1821	3.0613	14.1427	15.6183
8	3.1468	5.2361	1.6169	53.1341	7.1769	3.1020	14.1287	15.6053
9	4.3260	2.9526	2.2739	61.3388	5.74796	2.2700	9.7332	15.6836

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10	4.3282	2.9504	2.3228	61.2912	5.7431	2.2997	9.7250	15.6678

Source: ***From E-views version 10***

Short Run: Table 4.9 shows the result of variance decomposition which indicates the proportion of the forecast error variance in the Fiscal deficit explained by its own innovations as well as innovations in E-governance, Economic growth, Money supply, inflation, Natural resources, and Trade openness. The table shows that Fiscal deficit dominates its own innovation with 67.1823% to 100 percent of the variance of its forecast and contributed variability mainly to Trade openness for about 0.0008% to 14.0809% and Economic growth with 0.0479% to 9.2624% but less to inflation of 0.0203% to 4.3957%, money supply for about 0.0018% to 2.8965%, natural resources for 0.0017% to 1.9453% and E-governance for about 0.2291% to 0.2369% from 2003Q1 to 2021Q4.

Long Run: Table 4.10 represents the long-run variance decomposition of the Fiscal Deficit (FD) across multiple periods, which shows the contributions of various factors, including E-governance (EG), Economic Growth (GDPgt), Money Supply (MS), Inflation (INF), Natural Resources (NR), and Trade Openness (TO).

The period represents different time periods (10 periods) for which the variance decomposition is calculated. FD (Fiscal Deficit) column indicates the percentage of the total variance in Fiscal Deficit (FD) that can be explained by FD itself indicating how much of the fiscal deficit's variation is due to its own past values. EG (E-governance), column indicates the percentage of the variance in Fiscal Deficit that is explained by E-governance. GDPgt (Economic Growth) also indicates the proportion of the variance in Fiscal Deficit explained by Economic Growth. MS (Money supply) and INF (Inflation) columns indicate the percentage of the variance in Fiscal Deficit explained by MS (Money supply) and INF (Inflation) respectively whilst NR (Natural Resources) and TO (Trade Openness) columns

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imply the proportions of the variance in Fiscal Deficit attributed to Natural Resources and TO (Trade Openness) respectively.

During the initial periods (1 to 4), the Fiscal Deficit (FD) itself explains 22-23% of the variance in fiscal deficit values, indicating that past fiscal deficit values play a significant role in determining the fiscal deficit in the early periods. In periods 5 to 8, the contribution of FD (Fiscal Deficit) to its own variance declines sharply to 5.2-5.7% implying that as time progresses, FD is less influenced by its own past and more influenced by other factors. In the final periods (9 and 10), FD (Fiscal Deficit) explains only 2.95-2.95%, marking a significant drop further showing that in the long run, fiscal deficit behavior is almost entirely determined by external factors rather than its own past values.

In the case of Economic Growth (GDPgt), at the initial periods (1–4), it consistently explains around 30-31% of the variance in FD across these periods suggesting that changes in the economy, especially growth in GDP, are a key determinant of fiscal deficits in the early years. In period 5 to 8, it continues to be the dominant contributor, explaining between 53-53.5% of the variance in FD highlighting that, as the economy grows, fiscal deficits are more dependent on broader economic conditions rather than just fiscal policies or past deficits. In the final periods (9 and 10), Economic Growth (GDPgt) becomes the dominant force, explaining over 61% of the variance in FD in both periods suggesting that, in the long run, the fiscal deficit is largely influenced by economic performance, potentially reflecting how fiscal policy is tied to economic performance.

Natural Resources (NR) also explains a significant portion (around 17%) of the variance in FD, which could imply that in these early periods, revenue from natural resources, such as oil, minerals, or other resources, had a strong impact on the fiscal deficit in the early period of 1 to 4. It maintains a notable contribution, explaining about 14-15% of the variance from the period of 5 to 8 which might indicate that natural resource revenues (e.g., from exports)

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continue to influence fiscal decisions. However, in the period of 9 and 10, it sees a decline in influence, explaining around 9-10%, possibly indicating that the importance of resource revenues diminishes as other factors, like trade and growth, become more dominant.

From the period of 1 to 4, other variables like Money Supply (MS), Inflation (INF), and E-governance (EG) contribute much smaller portions of the variance, ranging from 3-10%. From the period of 5 to 8, Money Supply (MS), and Inflation (INF) still contribute less, with MS explaining about 7-7.2%, and INF around 2.5-3%. From period 9 to 10, Inflation (INF) remains a relatively small factor, explaining around 2-2.3%, while Money Supply (MS) also remains a minor contributor, explaining 5.7-5.7%.

Trade Openness (TO) starts to play a larger role, accounting for 12-15% variance in FD from period 1 to 8 suggesting that during this period, international trade and external economic conditions have a significant impact on fiscal deficits. It still explains around 15-15.7% from the 9 to 10 periods highlighting that global trade continues to influence the fiscal deficit, especially in the later periods.

The impulse response and variance decomposition result provide information on the relationship between E-governance and fiscal deficits indicating that good governance is essential for attracting foreign investment and influencing fiscal deficits which is consistent with the conclusion made by (Bertot et al 2010) who investigates the idea that e-governance platforms facilitate real time monitoring of government activities, thus strengthening accountability mechanisms and reducing corruption thus reducing fiscal deficit.

Also, the explanation power of Economic growth (GDPgt) could be attributed to the fact that an increase in government expenditure through the money supply resulting in economic growth could impact fiscal deficit in the long run.as well as information on the importance of inflation in macroeconomic stability such that high inflation thus impacting fiscal deficit in the long run which could be as a result of government spending more on digital

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infrastructure. This can be likened to the clear evidence that in the long run of over ten years, nations with sophisticated digital government capabilities reduce fiscal deficit (OECD, 2014) and also consistent investment in e-governance is linked to better fiscal deficit (Tolbert &Massberger, 2006; Bannister & Connolly, 2014). Again, this is also consistent with the work of Welch et al (2005) who argues that economies who spends more on sophisticated e-governance systems have lower administrative expenditure; and Schedler & Summermatter (2007) that digital government services can reduce processing time and administrative cost to cause reduction in fiscal deficit. Moreover, both public choice theory and that of transaction cost theory support that e-governance can influence fiscal deficit by increasing tax collections and decreasing government spending through increased efficiency and transparency in public administration. However, this is inconsistent with the work of Heeks (2006) that e-governance initiative in the short run increases expenses causing fiscal deficit to rise. Also, e-governance programs spike fiscal deficit in the short run however favourable in the long run (Gil-Garcia & Martinex-Moyano, 2007).

4.5. Empirical Estimate 2: FD, EP, GDPgt, MS, INF, NR and TO

4.5.1. Structural VAR Estimates on Short Run and Long Run Pattern

Table 4. 10 Structural VAR Estimates on Short Run and Long Run Pattern

Var.	Short Run				Long Run			
	Coeff.	*SE*	*z- stat.*	*Prob.*	*Coeff.*	*SE*	*z- stat.*	*Prob.*
FD					0.9745	0.0842	11.5759	0.0000***
EP	0.0013	0.0038	0.3327	0.7394	0.0407	0.0069	5.9204	0.0000***
GDPgt	0.3490	0.1729	2.0187	0.0435**	-1.1813	0.2005	-5.8927	0.0000***
MS	-0.7370	0.2408	-3.0610	0.0022***	-1.0218	0.2404	-4.2507	0.0000***
INF	0.5190	0.3401	1.5262	0.1270	1.4754	0.3192	4.6228	0.0000***
NR	0.1663	0.1356	1.2257	0.2203	-1.1428	0.2016	-5.6688	0.0000***
TO	4.3116	0.8845	4.8744	0.0000***	-2.5527	0.6875	-3.7128	0.0002***
	Log-likelihood		-551.162		Log-likelihood		-551.162	

Source: Author's Computation using E-views – 10

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

2. *Fiscal Deficit (FD), E – participation (EP), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), Trade openness (TO)*

*3. Variable (Var.), Coefficient (*Coeff.**)** Standard error (SE), z-statistic (z–stat.), Probability (Prob.)

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Short run: From Table *4.13*, the FD shock consists of E – participation (EP), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO). It shows that in the short run, FD is positively related to EP, GDPgt, INF, NR, and TO whilst negatively related to MS.

The evidence from the above result makes it inconclusive to reject the assumption of FD as the most endogenous variable in the model which cannot be affected by the other shocks of all other variables in the model because the FD has been affected by shocks to variables by GDPgt (at 5% significance level), MS and Trade openness (both at 1% significance level) in the short run whilst it is not affected by shocks to variables by EP, INF and NR in the short run.

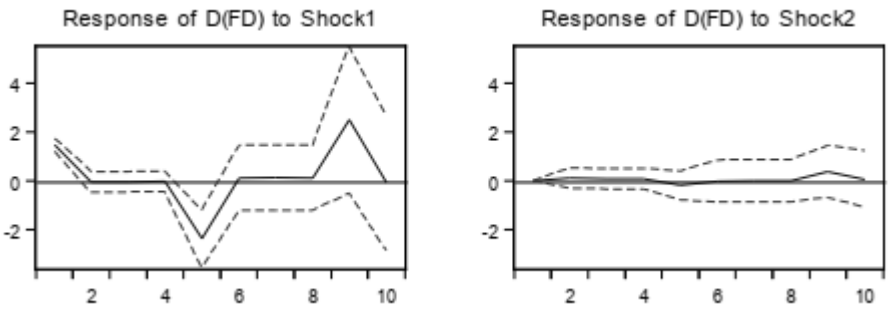
Long run: From the table above, the Fiscal deficit (FD) shock has recently affected E – participation (EP), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO) given C (1) as statistical significance at 1% level of significance given its p-value of 0.0000. In the long run, the FD is positively related to EP and INF whilst it is negatively related to GDPgt, MS, NR, and TO.

Evidence from the above results shows that all the variables; that is E – participation (EP), Economic growth (GDPgt), Money supply (MS), Inflation (INF), and Natural resources (NR) and trade openness have a long run effect on Fiscal Deficit (FD) in Ghana at 1% significance level.

4.5.2. Structural Impulse Response Function

The figures below show the short-run and long-run Impulse response functions of the first difference in the Fiscal deficit

Short Run



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Source: Author's Construct using E-views – 10

Fig. 4.3: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *E-participation (EP)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. Wide confidence intervals and sharp swings characterize this extremely erratic pattern. An immediate fiscal adjustment is indicated by the initial decline to about -1 from Periods 1-3. Peak contractionary response is represented by a sharp negative spike in Period 4 that reaches about -3. There is a sharp upward trajectory and a dramatic reversal from Periods 5–6. While there is a slow but steady decline from Periods 8–10, there is a huge positive spike in Period 7 that reaches +2.5, indicating significant fiscal expansion or overshooting. Because of initial corrections followed by possible policy reversals or political economy effects, fiscal policy adjustments are inherently unstable in the short term, as evidenced by the extreme volatility.

The reaction to Shock 2 (E-participation Shock) is shown in the right panel. The pattern exhibits a muted response and remarkable stability across all time periods. Response stays near zero with only slight variation (±0.5 range) throughout the entire period. While there is a slight, gradual decline toward small negative values in terms of trend, the confidence bands are much tighter in the case of stability, indicating more predictable effects. Limited short-term fiscal impact is also suggested by the Persistence or Consistent near-zero response. The sharp contrast between stable e-participation responses and extremely erratic fiscal deficit responses demonstrates essentially distinct transmission mechanisms. E-participation has little immediate impact, which is in line with the notion that institutional

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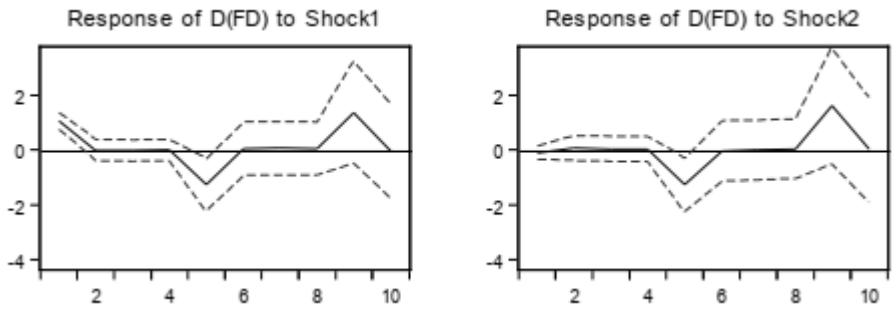
reactions to greater participation are slow, behavioural shifts in citizen engagement occur gradually, and digital platform adoption takes time.

When it comes to the timing of policy effectiveness, fiscal shocks have immediate but unstable effects that could overshoot, whereas e-participation shocks have gradual, delayed effects that are more predictable. While the effectiveness of fiscal policy is highly uncertain, the results of digital engagement initiatives are more predictable, as evidenced by the wide bands or confidence intervals for fiscal shocks compared to the narrow bands for e-participation. The policy implications are that, while e-participation may provide more stable fiscal management than direct fiscal interventions, its short-term fiscal benefits are limited, indicating that it is more of a long-term structural tool than traditional fiscal policy, which causes significant short-term instability. Once more, the divergent trends imply that e-participation and fiscal policy function on different timescales, with e-participation aiming for gradual structural improvements and fiscal policy for quick but erratic adjustments.

Long run



Source: Author's Construct using E-views – 10

Fig. 4.4: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *E-participation (EP)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. A cyclical response with moderate volatility that eventually converges is the pattern. Fiscal adjustment mechanisms are indicated by the initial decline from +1 to roughly -1.5 from Periods 1-3.

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Peak contractionary effects are suggested by the period 4 deepest negative response, which is around -1.8. There is a recovery phase with a slow return to equilibrium from periods 5-7. While Periods 9–10 show a convergence back toward zero with decreasing volatility, Period 8 shows a positive correction reaching +1, suggesting a possible policy reversal or automatic stabilizers. According to the cyclical pattern, fiscal deficit shocks set off adjustment mechanisms that progressively bring the budget back into balance without having any long-term, irreversible effects.

The reaction to Shock 2 (E-participation Shock) is shown in the right panel. The cyclical response pattern to fiscal deficit shocks is quite similar in this instance. Overall, the pattern indicates that it is almost the same as the fiscal deficit response, both in terms of timing and size. Period 8 exhibits a similar positive peak around +2, while Period 4 displays a comparable negative trough around -1.5. By period 10, there is the same slow return to equilibrium for convergence. It is discovered that the two panels' remarkable resemblance points to a long-term relationship between fiscal deficits and e-participation. Digital civic engagement follows similar cycles as fiscal policy, and both variables may respond to common underlying economic factors. These findings suggest that e-participation shocks generate nearly identical fiscal responses to direct fiscal deficit shocks (Symmetric Effects). No Permanent Effects: The system has built-in stabilizing mechanisms that ensure long-term fiscal sustainability, and both shocks exhibit mean reversion or no permanent effects, indicating that neither fiscal deficits nor e-participation have long-term, permanent effects on changes in fiscal deficits.

E-participation is a fiscal tool as one of the policy implications. Additionally, it seems that fiscal policy and e-participation operate through comparable mechanisms. The adjustment periods for both are comparable (4-period trough, 8-period peak). Better governance and transparency brought about by e-participation may have a direct impact on fiscal outcomes,

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and both may react to more general institutional or economic factors. For both kinds of shocks, the comparable confidence bands imply similar degrees of uncertainty and statistical significance.

4.5.3. Structural Forecast Error Variance Decomposition

Table 4. 3 Short-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*EP*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4672	100	0	0	0	0	0	0
2	1.4725	99.4267	0.4311	0.1110	0.0075	0.0174	0.0026	0.0036
3	1.4824	98.2951	0.5846	0.1095	0.0359	0.9103	0.0505	0.0140
4	1.4857	97.9375	0.8083	0.1393	0.0517	0.9978	0.0511	0.0142
5	3.2777	73.3507	0.5532	9.5094	6.8734	2.0647	0.1453	7.5033
6	3.2810	73.2773	0.5674	9.5115	6.8677	2.1425	0.1450	7.4886
7	3.2897	73.0145	0.5656	9.4784	6.8315	2.5051	0.1510	7.4540
8	3.2936	72.9478	0.5659	9.4575	6.8816	2.5540	0.1524	7.4408
9	4.6445	65.1958	0.8974	8.9640	10.8808	2.8548	0.8268	10.3804
10	4.6471	65.1578	0.9102	8.9594	10.8753	2.9025	0.8260	10.3688

Source: ***From E-views – 10***

Table 4. 12 Long-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*EP*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4671	51.9901	0.4583	19.1109	0.2713	2.0098	13.8692	12.2904
2	1.4725	51.6128	0.7516	19.3527	0.3018	1.9952	13.7847	12.2012
3	1.4824	50.9540	0.8304	19.1021	0.5352	2.8770	13.6601	12.0412
4	1.4857	50.7263	0.9169	19.3173	0.5459	2.8935	13.6068	11.9933
5	3.2777	25.2929	14.9794	30.5220	0.1258	1.5602	10.8144	16.7052
6	3.2810	25.2652	14.9563	30.5920	0.1255	1.5938	10.7955	16.6717
7	3.2897	25.1792	14.8767	30.4303	0.14470	1.9990	10.7638	16.6064
8	3.2936	25.1543	14.8542	30.5126	0.15431	2.0118	10.7404	16.5725
9	4.6445	21.4461	19.6897	34.1126	0.1150	1.3406	6.9126	16.3834
10	4.6471	21.4278	19.6709	34.1471	0.1157	1.3636	6.9099	16.3652

Source: ***From E-views – 10***

Short run: The result of variance decomposition shown in ***Table 4.12*** indicates the proportion of the forecast error variance in the Fiscal deficit explained by its own innovations in addition to innovations in E-participation, Economic growth, Money supply, inflation, Natural resources, and Trade openness. The table shows that fiscal deficit dominates its own innovation with 65.16% to 100 percent of the variance of its forecast. However, the explanation power of the variability of the fiscal deficit is mainly due to

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Money supply (0% to 10.88%), Trade openness 0% to 10.37%), and Economic growth (0% to 8.96%) with less predicted power by Inflation (0% to 2.90%) and natural resources (0% to 0.83%) from 2003Q1 to 2021Q4.

Long run: Table 4.13 represents the structural forecast error variance decomposition for fiscal deficit. The Fiscal deficit (FD)column indicates the percentage of the total variance in Fiscal deficit that can be explained by itself indicating how much of the FD variation is due to its own past values. E-participation (EP), Economic Growth (GDPgt), Money supply (MS), Inflation (INF), Natural Resources (NR), and Trade Openness (TO) columns show the percentage or proportion of the variance in fiscal deficit (FD) that is explained by E-participation (EP), Economic Growth (GDPgt), Money supply (MS), Inflation (INF), Natural Resources (NR), and Trade Openness (TO) respectively.

A shock from a fiscal deficit of 52% contributed to the variation of the fiscal deficit itself in the first quarter indicating that past Fiscal deficit values play a significant role in determining itself in the early period with the remaining share of the variation in the FD mostly accounted by Economic growth (19.11%), Natural resources (13.87%), and Trade openness (12.29%). Inflation, E-participation, and Money supply contributed least to the variation of the fiscal deficit by 2.01%, 0.46%, and 0.27% respectively in that same first quarter. However, in the tenth quarter, the variation of the fiscal deficit by itself reduced by more than half from 52% to 21.43% indicating that as time progresses, FD is less influenced by its own past and more influence thus that of the variation of the same fiscal deficit by E-participation and Economic growth increased up to approximately 20% and 34% respectively. This means that in the tenth quarter, economic growth contributed the largest to the variation of the fiscal deficit. Again, from 9 and 1 periods, FD explained 21.4% implying that in the long run, FD behaviour is almost 80% determined by external factors rather than its own past values.

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The results from both the impulse response and variance decomposition provide information on the impact of E-participation and fiscal deficits, which could be that the increase in government expenditure through E-participation infrastructure leads to economic growth and in the long run, impacts fiscal deficit. Again, economic growth could influence fiscal deficits by increasing tax revenues and reducing government expenditure on social welfare programs. Natural resources also impact the fiscal deficit. Again, it provides information on the importance of trade openness in promoting economic growth and influencing fiscal deficits such that trade openness can increase competition, reduce prices, and increase productivity, leading to higher economic growth and influencing fiscal deficits. This is consistent with the works of Guillamon et al (2016), Mossberger (2013), and Bonson et al (2012), all asserting that online participation leads to higher government revenue generation necessary to reduce fiscal deficit. Also, e-participation improves accountability and transparency since it facilitates real-time monitoring of government operations and offering forums for citizens concerns thus reduce fiscal deficit (Bertot et al, 2010); through online petition systems, budget transparency platforms and real -time policy monitoring systems, digital technology makes it possible for government accountability thus affecting fiscal deficit positively (Noveck, 2009) both being consistent with the result. Deliberate democracy theory also supports that e-participation can influence fiscal deficit. However, this is not consistent with the work of Coursey & Noms (2008), arguing that e-participation services and fiscal deficit are significantly negatively related.

4.6. Empirical Estimate 3: FD, INTS, GDPgt, MS, INF, NR and TO

4.6.1. Structural VAR Estimates on Short Run and Long Run Pattern

Table 4. 13 Structural VAR Estimates on Short Run and Long Run Pattern

Var.	Short Run				Long Run			
	Coeff.	*SE*	*z- stat.*	*Prob.*	*Coeff.*	*SE*	*z- stat.*	*Prob.*
FD					0.9023	0.0780	11.5758	0.0000***
INT	-1.0145	0.5984	-1.6954	0.0900*	0.9598	0.2696	3.5597	0.0004***
GDPgt	-0.1728	0.1729	-0.9995	0.3175	-0.8884	0.1251	-7.1026	0.0000***

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MS	-0.2702	0.2245	-1.2040	0.2286	-0.2179	0.2109	-1.0333	0.3015
INF	0.5105	0.3855	1.3244	0.1854	1.5462	0.3544	4.3627	0.0000***
NR	0.2066	0.1382	1.4954	0.1348	-0.6860	0.1422	-4.8235	0.0000***
TO	2.5568	0.8041	3.1798	0.0015***	-0.1878	0.7117	-0.2638	0.7919
	Log-likelihood	-848.142			Log-likelihood	-848.142		

Source: Author's Computation using E-views – 10

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

2. *Fiscal Deficit (FD), Internet availability (INT), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), Trade openness (TO)*

*3. Variable (Var.), Coefficient (*Coeff.**)** Standard error (SE), z-statistic (z–stat.), Probability (Prob.)

Short run: From table 4.18, the FD shock comprises Internet availability (INTS), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO). This indicates that FD is positively related to INF, NR, and TO but negatively related to INTS, GDPgt, and MS in the short run. The evidence from the above result makes it inconclusive to reject our assumptions of FD as the most endogenous variable in the model which cannot be affected by the other shocks of all other variables in the model in the short run with the reason being that the FD has been affected by shocks to variables including INTS and TO at 1% and 10% significance level respectively whilst the same FD is not affected by shocks to variables like GDPgt, MS, INF and NR in the short run.

Long run: As indicated in the table, the Fiscal deficit (FD) shock has recently affected Internet availability (INTS), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO) given C (1) as statistical significance at 1% level of significance given its p-value of 0.0000. The FD is positively related to INTS and INF in the long run whilst it is negatively related to GDPgt, MS, NR, and TO. From the above results, the evidence indicates that Internet availability (INTS), Economic growth (GDPgt), Inflation (INF), and Natural resources (NR) have a long-run effect on Fiscal Deficit (FD) all at a 1% level of significance. On the other hand, it can also be seen that, based on the p values, the Money supply (MS) and Trade openness (TO) have no significant long-run effect on FD.

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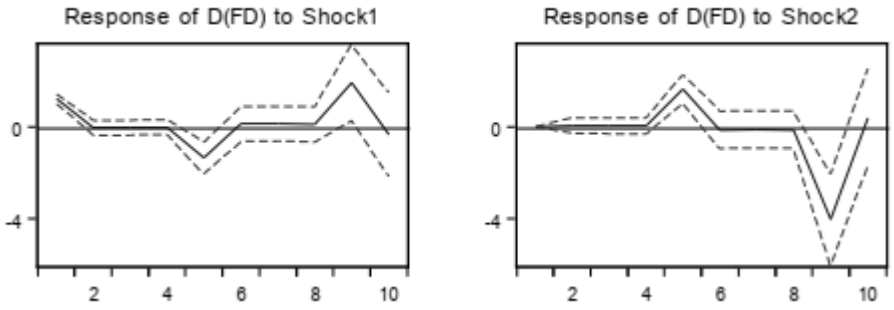
4.6.2. Structural Impulse Response Function

The figures below show the short and long-run Impulse response functions of the first difference of Fiscal deficit

Short run



Source: Author's Construct using E-views – 10

Fig. 4.5: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *Internet availability (INT)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. The pattern shows moderate volatility with a contained response range. In periods 1–5, the initial negative response reached about -1, indicating immediate fiscal adjustment measures; in periods 4–5, the deepest negative response was around -1.5, suggesting peak contractionary effects; in periods 5–7, there was a gradual recovery toward equilibrium with a slight positive correction; in periods 8–10, there was a positive spike to about +1.5, suggesting possible fiscal expansion or automatic stabilizer effects; finally, from periods 9–10, there was a decline back toward zero, indicating convergence. This is a typical fiscal adjustment cycle:

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initial tightening followed by moderate expansion, suggesting balanced fiscal policy responses.

The reaction to Shock 2 (Internet Availability Shock) is displayed in the right panel. The response is dramatic, especially in later periods, but the pattern is delayed. The minimal response from periods 1-4 is close to zero, indicating adoption and implementation lags that are common for internet infrastructure. In period 5 there is a slight positive response around +1, possibly reflecting initial government investment in digital infrastructure. Early efficiency gains are indicated by the start of a negative trend from Periods 6-7. Significant fiscal deficit reduction is demonstrated by the sharp decline that reaches -5 from Periods 8–9. Although there is a partial recovery in period 10, the results are still very negative.

Improved internet access has significant short-term fiscal benefits, as evidenced by the sharply negative response to shocks to internet availability. These benefits are probably due to increased economic activity and tax base, better tax collection and compliance, lower administrative costs, and more efficient government service delivery. Realistic timelines for the conversion of internet infrastructure into financial gains are reflected in the delayed response (periods 6–9). Once more, shocks to internet availability result in significantly greater fiscal improvements (-5) than direct fiscal policy interventions (±1.5), indicating that internet infrastructure might be a more effective tool for fiscal consolidation. The availability of the internet seems to be a potent fiscal policy tool in terms of policy implications. Once more, the high number of negative responses points to a substantial opportunity to reduce the deficit by investing in digital infrastructure. Additionally, the short-term volatility suggests that internet infrastructure policies should be carefully timed. Both responses exhibit statistical significance, according to the confidence intervals, but the internet availability shock exhibits significantly wider confidence bands during the peak

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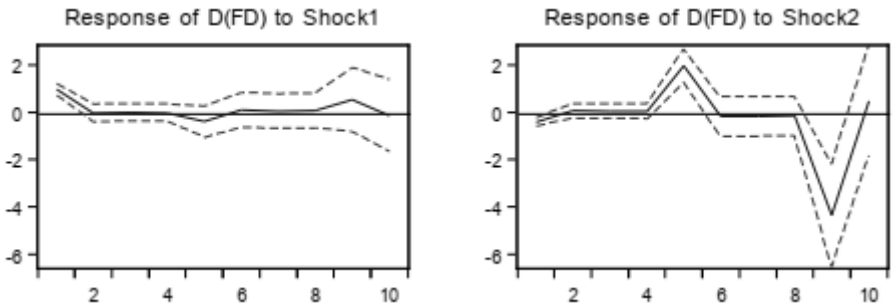
negative response, suggesting greater uncertainty regarding the effect's magnitude but a clear direction.

Long run



Source: Author's Construct using E-views – 10

Fig. 4.6: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *Internet availability (INT)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. Over the long-term horizon, the response pattern is comparatively stable and stays near zero. Overall, the response indicates that fiscal deficit shocks have no lasting effects, with mild fluctuations between roughly -1 and +0.5 and a gradual convergence toward zero. While the low persistence suggests that fiscal deficits are eventually mean-reverting, the stability suggests that fiscal policy has built-in stabilizing mechanisms. This suggests that shocks to the fiscal deficit are transient and eventually self-correct, in line with automatic stabilizers and the concepts of fiscal sustainability.

The reaction to Shock 2 (Internet Availability Shock) is displayed in the right panel. There is a strong and enduring negative reaction, which is especially noticeable later on. There is little initial impact from periods 1-4, which is indicative of lags in infrastructure development and adoption. The initial government investment costs in internet infrastructure are probably represented by the positive spike to +2 in period 5. As benefits start to appear, periods 6-7 see a shift into negative territory. While Period 10 shows a partial recovery but still maintains high negative levels, Periods 8–9 again show a massive negative response, reaching -4 to -5, indicating significant long-run fiscal improvements.

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According to this, the availability of the Internet leads to long-term structural improvements in fiscal positions, implying that improved tax collection systems are integrated, digital government services lower long-term operating costs, and increased economic productivity permanently raises the tax base. The classic investment-return profile—upfront expenses followed by significant long-term savings—is illustrated by the initial positive spike that was followed by a significant number of negative responses. Once more, the -4 to -5 response indicates a significant fiscal dividend from internet infrastructure that is significantly greater than the effects of normal fiscal policy. Additionally, the effects of internet availability are extremely persistent, indicating long-lasting structural benefits, in contrast to the transient nature of fiscal deficit shocks.

Some implications for development policy include the following: digital infrastructure may be more effective than traditional fiscal austerity measures; the long-term benefits of internet infrastructure justify large initial investments; and internet infrastructure seems to be one of the most effective long-term fiscal consolidation tools. The persistently negative response implies that internet accessibility promotes long-term gains in economic productivity and governmental efficiency, generating a positive feedback loop for financial stability.

4.6.3. Structural Forecast Error Variance Decomposition

Table 4. 14 Short-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*INTS*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.2146	100	0	0	0	0	0	0
2	1.2169	99.7528	0.1391	0.0645	0.0276	0.0034	0.0017	0.0110
3	1.2233	98.8590	0.2260	0.3044	0.0294	0.5336	0.0279	0.0196
4	1.2250	98.6269	0.3333	0.3641	0.0450	0.5789	0.0281	0.0238
5	2.5424	51.3333	41.6280	1.9097	2.9934	0.2551	0.1308	1.7496
6	2.5523	51.1554	41.6475	1.9724	3.0462	0.2952	0.1310	1.7523
7	2.5650	50.9117	41.4800	2.0235	3.1034	0.5967	0.1423	1.7424
8	2.5718	50.7960	41.5345	2.0567	3.0905	0.6440	0.1417	1.7367
9	5.2290	25.8688	69.8137	0.5661	3.0044	0.1581	0.1113	0.4777
10	5.2547	26.0091	69.6853	0.5629	2.9876	0.1566	0.1196	0.4788

Source: ***From E-views – 10***

Table 4. 4 Long Variance Decomposition of Fiscal Deficit

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Period	*S.E.*	*FD*	*INTS*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.2146	63.8238	11.0748	0.0678	11.0137	0.5789	10.7377	2.7032
2	1.2169	63.6977	11.2511	0.0676	11.0049	0.5805	10.6985	2.6995
3	1.2233	63.0319	11.3278	0.2123	11.1049	1.0450	10.5979	2.6803
4	1.2250	62.9048	11.4355	0.2181	11.1107	1.0890	10.5681	2.6738
5	2.5424	17.0788	62.6369	3.0348	11.6440	0.3554	3.6291	1.6211
6	2.5523	17.0987	62.6564	3.0114	11.6188	0.3937	3.6089	1.6121
7	2.5650	16.9634	62.5035	3.1690	11.5168	0.6543	3.5969	1.5962
8	2.5718	16.9597	62.5461	3.1670	11.4630	0.6976	3.5783	1.5885
9	5.2290	5.1592	84.0896	3.3465	4.9877	0.1857	1.8334	0.3980
10	5.2547	5.1961	84.1147	3.3160	4.9475	0.1840	1.8464	0.3953

Source: ***From E-views - 10***

Short run: The result above shows the variance decomposition as seen in Table 4.15, which indicates the proportion of the forecast error variance in the Fiscal deficit explained by its own innovations in addition to innovations in Internet availability, Economic growth, Money supply, inflation, Natural resources, and Trade openness. The table indicates that fiscal deficit dominates its own innovation with 50.80% to 100 percent of the variance of its forecast from the first quarter to the eighth quarter period, until it reduced to approximately 26% in the ninth and tenth quarter periods. The explanatory power of the variability of the fiscal deficit by internet availability kept on increasing from 0% to as high as 69.69% with the remaining contributing less to the variability in terms of the predicted power of the Fiscal deficit from 2003Q1 to 2021Q4.

Long run: Table 4.16 represents the structural forecast error variance decomposition for fiscal deficit, where 63.82% variation of the fiscal deficit was attributed by itself in the first quarter and even reduced to 5.20% by the tenth quarter. In the first quarter, internet availability, Money supply, natural resources, trade openness, inflation, and economic growth were 11.07%, 11.01%, 10.74%, 2.70%, 0.58%, and 0.07% respectively. By the end of the tenth quarter, variation in the same fiscal deficit caused by internet availability increased to 84.11%, Money supply reduced to 4.95% whilst that of economic growth increased to 3.32%, trade openness and inflation reduced to 0.40% and 0.18% respectively, whilst natural resources also reduced to 1.85%. What it all means is that in the initial period,

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past FD values play a significant role in determining their own variations; however, in the long run, the FD behaviour is explained by external factors, mainly by internet availability, which accounted for 84%.

The results from both the impulse response and variance decomposition provide information on the impact of internet availability and fiscal deficits. The explanatory power of Internet availability on the variation of the fiscal deficit could be due to the use of the increased Internet assess thus influencing the fiscal deficit which is consistent with the works of Goolsbee (2001) who argued that increased internet usage leads to higher sales tax revenue necessary to reduce fiscal deficit and that of Kolko's (2012) stating that countries with high-speed internet access leads to increase in local property and income tax collections thus affecting fiscal deficit positively. It is also in congruence with the works of Atasoy (2013), stating that broadband access raises local business establishment, which leads to gains in local tax revenue. Again, internet availability allows for more cost-effective government service delivery, leading to less expenditure to cause fiscal deficit to reduce. Likewise, the endogenous growth theory supports that internet availability can promote productivity, which also influences fiscal deficit. However, the result is in conflict with the work of Goolsbee (2001) arguing that the increased internet usage which result in higher sales tax results in less tax revenue due to substitution effects.

4.7. PCA: Empirical Estimate 4: FD, TECH, GDPgt, MS, INF, NR and TO

4.7.1. Structural VAR Estimates on Short Run and Long Run Pattern

Table 4. 19 Structural VAR Estimates on Short Run and Long Run Pattern

Var.	Short Run				Long Run			
	Coeff.	*SE*	*z- stat.*	*Prob.*	*Coeff.*	*SE*	*z- stat.*	*Prob.*
FD					0.9974	0.0862	11.5758	0.0000***
TECH	-0.1166	0.0336	-3.4667	0.0005***	0.1235	0.0310	3.9884	0.0001***
GDPgt	0.3196	0.1962	1.6285	0.1034	-0.7442	0.1417	-5.2531	0.0000***
MS	-0.6199	0.2349	-2.6392	0.0083***	0.0766	0.2800	0.2737	0.7843
INF	0.4500	0.3812	1.1806	0.2378	1.7139	0.3538	4.8448	0.0000***
NR	0.2269	0.1330	1.7064	0.0879*	-0.6259	0.1662	-3.7663	0.0002***
TO	4.1671	0.8800	4.7351	0.0000***	0.0513	0.7943	0.0645	0.9485

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Log-likelihood	-705.466	Log-likelihood	-705.466

Source: Author's Computation using E-views – 10

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

2. *Fiscal Deficit (FD), Technology (TECH), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), Trade openness (TO)*

*3. Variable (Var.), Coefficient (*Coeff**.)** Standard error (SE), z-statistic (z–stat.), Probability (Prob.)

Short run: From table 4.32, the FD shock consists of Technology (TECH), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO). This shows that in the short run, FD is positively related to GDPgt, INF, NR, and TO but negatively related to TECH and MS.

Evidence from the above result makes it inconclusive to reject our assumptions of FD as the most endogenous variable in the model which cannot be affected by the other shocks of all other variables in the model because the FD has been affected by shocks to variables by TECH, MS and TO (all at 1% significance level) and NR (at 10% level of significance) whilst the FD is not affected by shocks to variables including GDPgt and INF.

Long run: The Fiscal deficit (FD) shock has recently affected Technology (TECH), Economic growth (GDPgt), Money supply (MS), Inflation (INF), Natural resources (NR), and Trade openness (TO) given C (1) value of 0.9974 as statistical significance at 1% level of significance given its p-value of 0.0000. The FD is positively related to TECH, MS, INF, and TO, whilst it is negatively related to GDPgt and Natural resources.

The evidence from the above results shows that Technology (TECH), Economic growth (GDPgt), Inflation (INF), and Natural resources (NR) have a long-run effect on Fiscal Deficit (FD), all at a 1% significance level. However, the MS and TO have no significant long-run effect on FD based on the p-values.

4.7.2. Structural Impulse Response Function

The figures below show the short and long run Impulse response functions of the first difference in Fiscal deficit.

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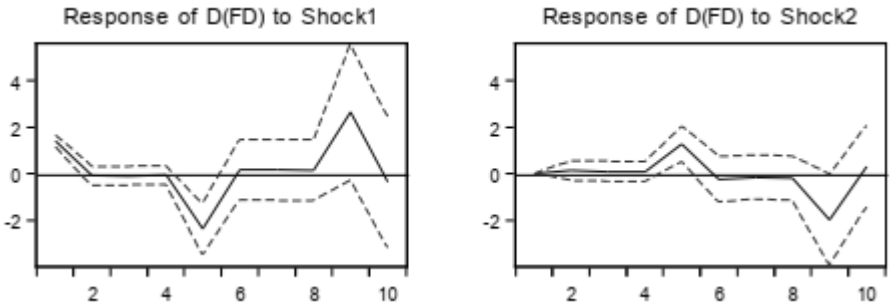
Short run



Source: Author's Construct using E-views – 10

Fig. 4.7: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *Digital Technology (TECH)*

Response to Shock 1 (Fiscal Deficit Shock) is shown in the left panel. Over short periods, the pattern exhibits dramatic swings and is extremely volatile. Following a deficit shock, there is an initial negative response from Periods 1-3, indicating fiscal tightening measures. The sharp drop to roughly -3 in Period 4 indicates a strong contractionary fiscal response. A significant positive spike that reaches +4 indicates either fiscal expansion or overshooting during the dramatic reversal that occurs between periods 5-8. It returns to equilibrium during Periods 9–10, although it remains high. This erratic trend is indicative of common short-term fiscal policy changes, such as initial corrections followed by possible policy reversals or the activation of automatic stabilizers.

Response to Shock 2 (Digital Technology Shock) is shown in the right panel. Compared to fiscal shocks, the response is more stable and fluctuates only slightly. There is little initial impact from periods 1-4, which is indicative of digital technology implementation lags. The

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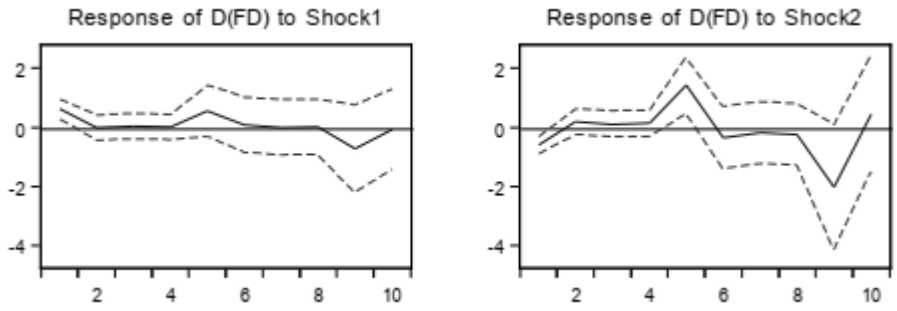
modestly positive response in Period 5 may be a result of the government's early investment in digital infrastructure. It shows a slow decline toward negative territory from periods 6–8, indicating early efficiency gains. Emerging fiscal benefits are indicated by the moderately negative response from Periods 9–10, which is around -1.5.

Given the intrinsic instability of discretionary fiscal policy adjustments, it can be inferred that fiscal deficit shocks produce far more erratic short-term reactions than technology shocks. In line with actual implementation timelines for technological adoption in government operations, digital technology also exhibits delayed effects. Additionally, the wide confidence bands or interval (dashed lines) indicate significant uncertainty in short-run responses, which is typical for fiscal policy effectiveness, while the large positive spike in fiscal deficit response (period 7-8) suggests possible policy overshooting in the event that initial fiscal tightening is followed by excessive expansion. Additionally, compared to direct fiscal interventions, digital technology shocks yield more stable and predictable fiscal outcomes, indicating that technology-based fiscal improvements could be a more dependable policy instrument.

Long run



Source: Author's Construct using E-views – 10

Fig. 4.8: Structural Response to FD

Shock 1= *Fiscal Deficit (FD),* **Shock 2**= *Digital Technology (TECH)*

The response to Shock 1 (Fiscal Deficit Shock) is displayed in the left panel. Over the course of the 10-period horizon, the response exhibits initial volatility that progressively

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converges toward zero. The fiscal deficit itself first fluctuates in response to a one-unit shock. Over time, the response dampens after oscillating, indicating that the fiscal system has self-correcting mechanisms. By period 10, the effect is almost zero, suggesting that the shock's long-term effects fade. This implies that the effects of fiscal deficit shocks on changes in the fiscal deficit are transient rather than long-lasting.

Response to Shock 2 (Digital Technology Shock) is shown in the left panel. Pattern-wise, the effects are more noticeable and long-lasting, with noticeable adverse effects in later times. This indicates that the initial impact of digital technology shocks on changes in the fiscal deficit is not entirely consistent. Once more, there is a positive spike around periods 4-5, which might be related to the first government investment in digital infrastructure. Additionally, while the sharp decline to about -4 units indicates strong fiscal benefits from adopting digital technology, the significant negative response in periods 7-9 suggests that digital technology eventually reduces fiscal deficits in the long run.

The significant negative reaction to digital technology shocks implies that digitalization strengthens government fiscal positions, most likely by increasing the effectiveness of tax collection, cutting administrative expenses, and promoting economic growth that raises revenues. While the delayed negative response (periods 7-9) indicates that the benefits of digital technology take time to manifest but become significant once put into practice, digital technology also seems to be a potent tool for long-term fiscal consolidation. These effects, especially the strong negative response to digital technology shocks, are statistically significant, as indicated by the confidence bands (dashed lines).

4.7.3. Structural Forecast Error Variance Decomposition

Table 4. 20 Short-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*TECH*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4265	100	0	0	0	0	0	0
2	1.4391	98.5758	0.9303	0.3875	0.0022	0.0154	0.0057	0.0830
3	1.4536	96.9885	1.4169	0.4413	0.0141	0.9217	0.0605	0.1570
4	1.4605	96.2087	1.9428	0.5960	0.0140	0.9936	0.0599	0.1849

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5	3.3253	68.8266	15.3886	7.4468	3.4008	0.6886	0.0135	4.2350
6	3.3476	68.1781	15.6664	7.7525	3.3603	0.7900	0.0143	4.2389
7	3.3676	67.6032	15.6576	7.6790	3.3474	1.4448	0.0412	4.2268
8	3.3803	67.3129	15.8645	7.7110	3.3327	1.5284	0.0409	4.2096
9	4.9595	59.7802	23.0092	5.1699	6.5364	0.8189	0.2451	4.4401
10	4.9865	59.6328	23.1671	5.2122	6.4748	0.8357	0.2491	4.4283

Source: ***From E-views – 10***

Table 4. 21 Long-run Variance Decomposition of Fiscal Deficit

Period	*S.E.*	*FD*	*TECH*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	1.4265	18.4820	17.8370	18.7815	22.6225	2.0061	14.1033	6.1677
2	1.4391	18.1711	19.1337	18.4958	22.2286	1.9868	13.8667	6.1172
3	1.4536	17.8667	19.2900	18.1354	22.3333	2.7273	13.5931	6.0542
4	1.4605	17.6983	19.9187	18.0087	22.1230	2.7732	13.4687	6.0093
5	3.3253	6.2111	21.9879	32.7614	21.8044	1.7155	8.7175	6.8022
6	3.3476	6.1853	22.7775	32.3848	21.5214	1.7897	8.6034	6.7379
7	3.3676	6.1126	22.8113	32.0452	21.4852	2.3692	8.5136	6.6630
8	3.3803	6.0685	23.1897	31.9198	21.3332	2.4206	8.4501	6.6183
9	4.9595	4.9656	27.3825	36.2537	19.9435	1.8245	4.3674	5.2627
10	4.9865	4.9288	27.9198	36.0000	19.7888	1.8158	4.3271	5.2197

Source: ***From E-views – 10***

Short run*:* Table 4.21 shows the result of variance decomposition, which indicates the proportion of the forecast error variance in the Fiscal deficit explained by its own innovations as well as innovations in Technology, Economic growth, Money supply, inflation, Natural resources, and Trade openness. The table shows that Fiscal deficit dominates its own innovation with 67.60% to 100 percent of the variance of its forecast and contributed variability to Technology for about 0.93% to 23.17%, Money supply with 0.00% to 6.47%, economic growth of 0.00% to 5.21%, trade openness for about 0.00% to 4.43%, inflation for 0.00% to 0.84% and natural resources for about 0.00% to 0.25% from 2003Q1 to 2021Q4.

Long run: Table 4.22 represents the structural forecast error variance decomposition for the fiscal deficit. The Fiscal deficit (FD) column indicates the percentage of the total variance in Fiscal deficit that can be explained by itself, indicating how much of the FD variation is due to its own past values. Digital Technology (TECH), Economic Growth (GDPgt), Money supply (MS), Inflation (INF), Natural Resources (NR), and Trade

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Openness (TO) columns show the percentage or proportion of the variance in fiscal deficit (FD) that is explained by Digital Technology (TECH), Economic Growth (GDPgt), Money supply (MS), Inflation (INF), Natural Resources (NR), and Trade Openness (TO) respectively.

In the first quarter, the predicted power of fiscal deficit was 18.48%. In other words, the variation in fiscal deficit explained by itself was 18.48% while the remaining share of variation was accounted for by technology (17.84%), Economic growth (18.78%), Money supply (22.62%), Inflation (2.01%), Natural resources (14.10%) and Trade Openness (6.17%). However, the predicted power of fiscal deficit declined to 4.93% after the tenth quarter indicating that the FD is less influenced by its own past values with the remaining share of variation accounted by Economic growth (36.00%), technology (27.92%), Money supply (19.79%), Trade Openness (5.22%), Natural resources (4.32%) and Inflation (1.82%). In other words, in the long run, FD behaviour is 95% determined by external factors rather than its own past values.

The impulse response and variance decomposition result provide information that Digital Technology (TECH), Economic growth (GDPgt), Inflation (INF), and Natural resources (NR) have a long-run effect on Fiscal Deficit (FD). This result is coherent with the works of Dunleavy et al (2006) and Bovens & Zouridis (2002), stating that automated detection systems can enhance tax compliance and reduce fraud to cause revenue to increase and expenditure to fall necessary to influence fiscal deficit positively. Also, it is again consistent with the works of Carter & Belanger (2005) and

Kaylor et al (2001) stated that computerized tax systems raise revenue collection efficiency and decrease expenditure, thus reducing fiscal deficit. Andersen & Henriksen (2006) asserted that services provided via digital channels are less expensive than through conventional channels, thus influencing fiscal deficit positively, which is also in congruous

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with this work. However, this result is not coherent with the work of Porumbescu et al (2021), who didn't see government digital adoption positively influencing budgetary constraint or fiscal deficit, and that of Brown & Brudney's (2003), stating that enterprise system adoption and fiscal deficit are negatively correlated.

4.8 Chapter Summary

Chapter Four presents the empirical analysis of the relationship between digital technology adoption and fiscal deficit in Ghana. It outlines key variables such as internet penetration, e-government initiatives, government spending, revenue generation, and fiscal deficit metrics. The analysis uses regression analysis, correlation coefficients, impulse response, and variance decomposition to assess the relationship between the variables. The chapter also discusses the implications of the findings for understanding Ghana's fiscal deficit drivers and the potential role of digital technology in addressing these challenges. It suggests that digital governance initiatives could improve government efficiency, transparency, and revenue generation.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0. Introduction

This study concludes the study by summarizing the main findings and suggesting pathways forward based on the research conducted. The chapter begins by providing an overview of the key insights uncovered regarding the relationship between digital technology adoption and Ghana's fiscal deficit. It looks at the implications of these findings for understanding the dynamics of fiscal management within the context of technological advancement.

5.1. Summary

The study investigated the relationship between digital technology adoption and fiscal deficit in Ghana. It began with a global perspective, focusing on ICT's transformative role in economic development over the past 30 years. Attention then shifted to Africa's unique position of high growth rates but low ICT penetration, offering comparative international statistics and a conceptual definition of fiscal deficit. Ghana has the worst fiscal deficit in Africa and Sub-Saharan Africa (-12.1% of GDP in 2021). It presents Ghana's digital governance efforts as a possible remedy, listing important digital policies and implementations from 2005 to 2017. The main research question was whether digital technology is assisting or impeding the reduction of the fiscal deficit. The research hypotheses were formulated to test the significance of various factors related to digital technology and fiscal deficit. The scope of the research was delimited to the years 2003 to 2021, utilizing secondary quarterly data from reputable sources like World Bank and IMF. A literature review was done by starts with conceptual reviews before moving on to theoretical frameworks and empirical data. The chapter provides trend analysis based on empirical data to determine the present status of every variable in Ghana between 2003 and

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2021, accompanied by visual aids that illustrate changing trends and connections. Furthermore, detailed explanation of the methodology employed in the study to investigate the relationship between digital technology adoption and fiscal deficit in Ghana was done. It discussed the research design, data sources, variables, and analytical techniques used in the empirical analysis. It also elaborated on the analytical techniques employed to examine the relationship between digital technology adoption and fiscal deficit, including correlation and regression analysis, impulse response and variance decomposition The results of the empirical analysis conducted to investigate the relationship between digital technology adoption and fiscal deficit in Ghana was also done. It presents descriptive statistics and graphical representations of the key variables related to digital technology adoption and fiscal deficit in Ghana. It also discussed the results of the statistical analysis conducted to examine the relationship between digital technology adoption and fiscal deficit, as well as the implications for understanding the drivers of the fiscal deficit in Ghana and the potential role of digital technology in addressing these challenges.

The study found that in the short run, e-governance has no significant effect on fiscal deficit but rather only Money supply and Trade Openness have effects on Fiscal deficit. However, in the long run, E-governance, Economic growth, Inflation, and Natural resources have significant effects on Fiscal deficit.

Also, in the short run, Fiscal deficit is affected by shocks to Economic growth, Money supply, and Trade Openness whilst in the long run, E – participation, Economic growth, Money supply, Inflation, Natural resources, and Trade openness had a significant impact on Fiscal deficit.

Again, in the short run, Internet availability and Trade openness impacted Fiscal deficit more whilst in the long run, Internet availability, Economic growth, Inflation, and Natural

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resources had more effect on FD. Furthermore, in both the short run and long run, Economic growth and Digital Technology impacted more on the Fiscal deficit.

In all the estimations, all the independent variables had both negative and positive effects on FD depending on different periods of time.

Economic growth contributed more variability to the Fiscal deficit, whilst E-governance contributed less variability to the Fiscal deficit in the long run. In the long run, the variability of the Fiscal deficit is more attributed to E-participation and Economic growth. Also, in the long run (and even short run), Internet availability contributed more variability to the Fiscal deficit as well as Economic growth, Digital Technology, and Money supply contributed more variability to Fiscal deficit in the long run.

5.2. Conclusions

The short-run estimates reveal that digital technology indicators—e-governance, e-participation, and internet availability—do not exert a consistent or statistically significant impact on Ghana's fiscal deficit. Digital variables either remain insignificant or show inconsistent signs. In other words, in the immediate term, fluctuations in digital technology adoption have yet to translate into measurable improvements in fiscal balance.

In contrast, the long-run results demonstrate that digital technology adoption is significantly associated with fiscal deficit reduction over time. E-governance emerges as not much significant determinant of the deficit; however, e-participation shows a significant long-run effect, and internet availability shows that greater internet penetration significantly contributes to lower deficits.

Overall, digital technology emerges as one of the two most influential drivers of fiscal deficit dynamics in both the short and long run. Specifically, the PCA-derived technology component accounts for roughly 27.9% of the long-run variance in the fiscal deficit—

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second only to economic growth—underscoring the cumulative importance of digital adoption for fiscal outcomes.

This confirms that, although individual digital variables may be muted in the short run, their collective impact is substantial over time. These findings suggest that sustained investments in digital governance and connectivity can materially strengthen fiscal management.

5.3. Policy Recommendations

The Ministry of Communication should make an expansion of broadband infrastructure to improve internet penetration and harness its long-run deficit-reducing effects. Secondly, the government, through the Ministry of communication, should fully integrate e-government platforms (e-tax filing, e-procurement, digital payments) into revenue agencies to cut leakages and boost compliance.

Again, there should be an enhancement of e-participation tools (online budget feedback, open-data portals) to increase transparency and citizen oversight of public spending.

Furthermore, there should be investment in digital capacity-building for civil servants in revenue and expenditure agencies to improve the short-run impact of technology reforms.

Last but not least is the establishment of a monitoring unit using SVAR-based dashboards to track digital-fiscal indicators and guide policy adjustments in real time.

5.4. Limitations of the Study

One of the primary limitations is the availability and quality of data. Data on digital technology adoption and fiscal deficit in Ghana may be limited, incomplete, or subject to measurement errors. This could affect the accuracy and reliability of the empirical analysis and the robustness of the findings. Again, establishing causality between digital technology adoption and fiscal deficit is challenging due to potential endogeneity issues. Factors such as government policies, economic conditions, and other external variables may influence

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both technology adoption and fiscal outcomes, leading to biased estimates and spurious correlations. Furthermore, the study's findings may be influenced by technological advancements occurring during the study period. Changes in technology adoption rates, innovation, and infrastructure development could affect the relationship between digital technology and fiscal deficit over time, impacting the study's validity. Moreover, the study's findings may be context-specific and influenced by unique political, social, and economic factors in Ghana. Extrapolating the results to other countries or regions with different contexts should be done cautiously, considering the specific circumstances of each setting. Finally, the study's focus on Ghana may limit its generalizability to other countries or regions with different institutional frameworks, governance structures, and technological landscapes. Caution should be exercised when applying the findings to contexts outside of Ghana.

5.5 Directions for Future Research

1. Investigate Sector-Specific Impacts. Future research should explore how digitalization in specific sectors (e.g., health, education, transport) uniquely contributes to fiscal outcomes. This sector-specific analysis could highlight areas where technology interventions have the greatest potential to improve fiscal management and service delivery.

2. Assess Cost-Benefit Dynamics by examining the fiscal trade-offs of digital technology—especially the upfront costs versus long-term deficit reduction.

3. Explore Behavioral Factors by analyzing how citizens' and civil servants' digital engagement levels mediate the effectiveness of technology in reducing fiscal deficits.

4. Expand Geographic Scope by comparing the effects of digital technology adoption in addressing fiscal deficit across different countries or regions. This comparative analysis could identify best practices and lessons learned that can inform policy decisions in Ghana

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and other developing countries. Also, a comparative study between Ghana and other Sub-Saharan African countries can yield broader policy insights.

5. Conducting longitudinal studies to track the effects of digital technology adoption on fiscal deficit over time. This would provide insights into the sustainability and long-term effectiveness of technology-based interventions in addressing fiscal challenges.

6. Evaluating the effectiveness of existing digital governance policies and initiatives in Ghana in addressing fiscal deficit. This policy evaluation could assess the outcomes and impacts of specific technology interventions and inform future policy decisions and investments in digital infrastructure.

7. Investigating the socioeconomic impacts of digital technology adoption on fiscal deficit, including its effects on employment, income distribution, and poverty alleviation. Understanding the broader social and economic implications of technology-driven fiscal reforms is essential for ensuring inclusive and sustainable development.

8. Exploring emerging technologies, such as blockchain, artificial intelligence, or big data analytics, and their potential applications in fiscal management. Future research could examine how these advanced technologies can enhance transparency, accountability, and efficiency in government operations and revenue mobilization.

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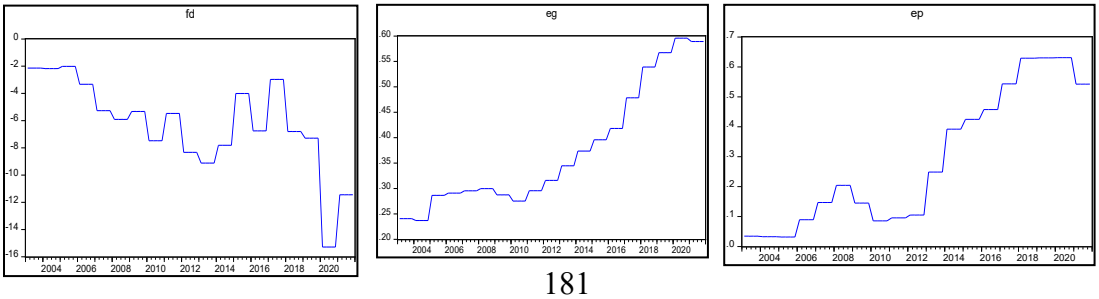
APPENDICES

APPENDIX 1: Plot of variables in levels



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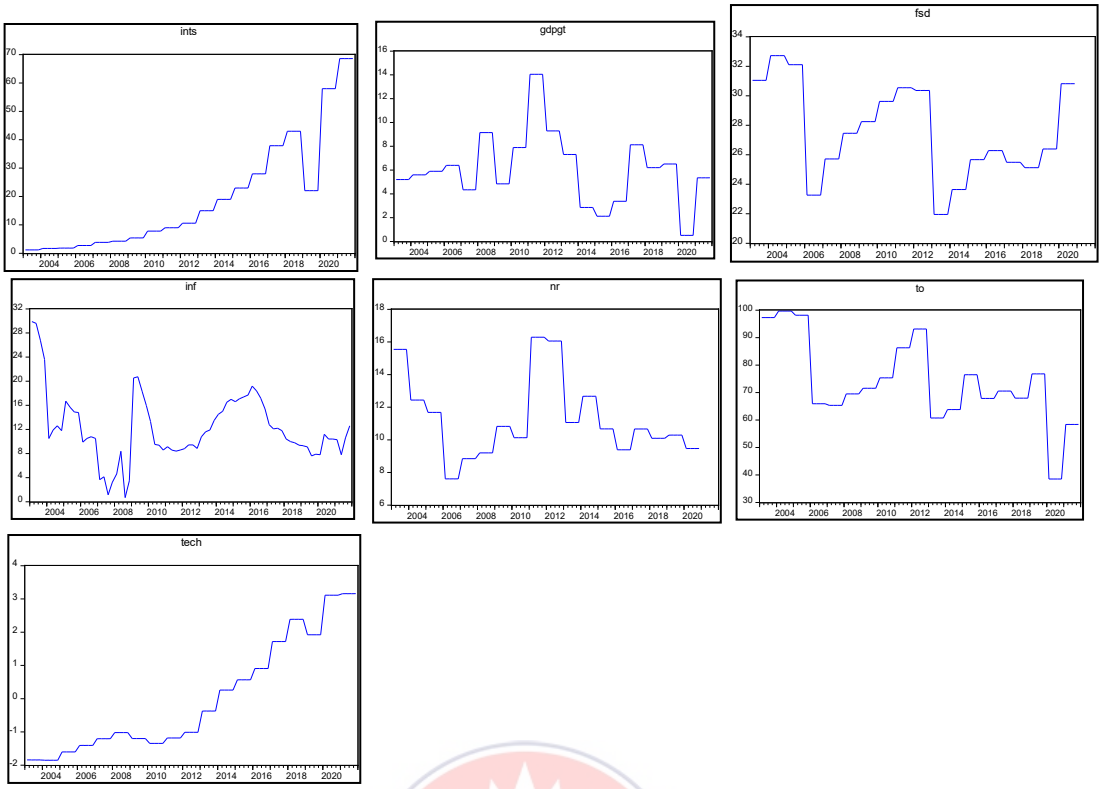
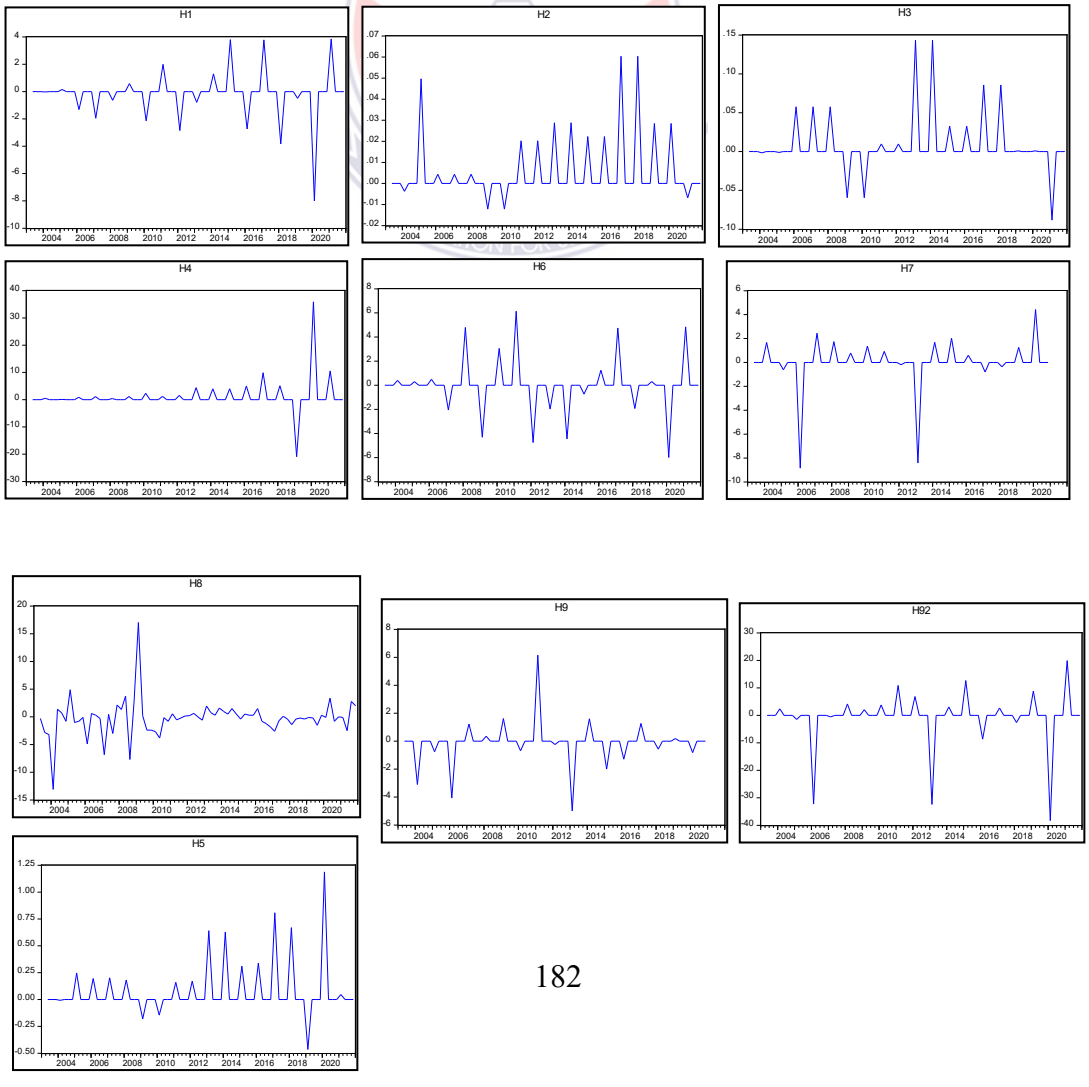


APPENDIX 2: Plot of variables in first difference



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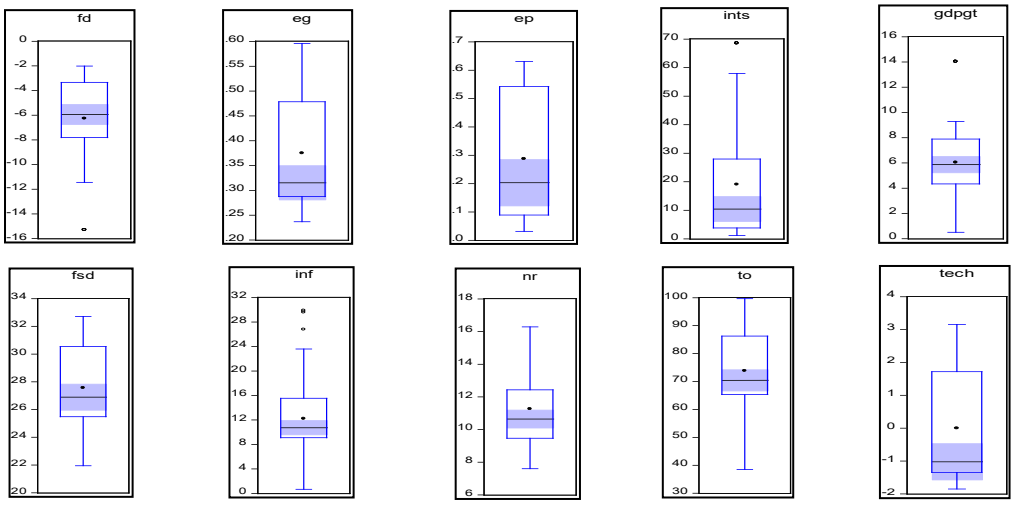
APPENDIX 3: Outlier Detection of Variables using Box Plot



APPENDIX 4: PRE-ESTIMATION TEST

Diagnostics test - VAR lag Order Selection Criteria

4A: Estimate 1

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-604.4590	NA	0.3496	18.8141	19.0483*	18.9065*
1	-602.1780	4.0001	1.4848	20.2516	22.1250	20.9908
2	-596.0270	9.4631	5.8368	21.5701	25.0825	22.9560
3	-592.4280	4.7619	27.0146	22.9670	28.1187	24.9997
4	-389.6320	224.6357*	0.3141*	18.2348*	25.0256	20.9142
5	-380.9500	7.7472	1.8061	19.4754	27.9053	22.8015
6	-363.4320	11.8582	11.6465	20.4441	30.5132	24.4170

4B: Estimate 2

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-649.8610	NA	1.4134	20.2111	20.4453*	20.3035*
1	-647.9610	3.3331	6.0737	21.6603	23.5337	22.3995
2	-640.5440	11.4103	22.9641	22.9398	26.4523	24.32571
3	-637.2320	4.3819	107.2281	24.3456	29.4972	26.3783
4	-410.9830	250.6148*	0.6059*	18.8917*	25.6826	21.5712
5	-400.9330	8.9671	3.3402	20.0903	28.5202	23.4164
6	-387.9950	8.7581	24.7988	21.1999	31.2689	25.1728

4C: Estimate 3

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Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-954.9400	NA	16865.3700	29.5981	29.8323*	29.6905*
1	-953.5120	2.5035	73537.5700	31.0619	32.9352	31.8011
2	-948.4680	7.7608	299091.3000	32.4144	35.9269	33.8003
3	-946.6740	2.3730	1463364.0000	33.8669	39.0185	35.8995
4	-699.0380	274.3045*	4281.9100*	27.7550*	34.5458	30.4344
5	-686.4950	11.1921	21863.2600	28.8768	37.3067	32.2029
6	-669.1990	11.7082	141948.400	29.8523	39.9214	33.8252

4D: Estimate 4

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-770.0650	NA	57.0873*	23.9097	24.1439*	24.0021*
1	-768.0780	3.4859	244.6626	25.3562	27.2296	26.0954
2	-762.1220	9.1621	967.5887	26.6807	30.1932	28.0666
3	-759.1420	3.9439	4564.2910	28.0967	33.2483	30.1293
4	-560.4040	220.1400*	60.1291	23.4894*	30.2801	26.1688
5	-550.3960	8.9301	331.9230	24.6891	33.1191	28.0153
6	-534.5350	10.7369	2252.3090	25.7088	35.7779	29.6817

APPENDIX 5: SVAR VARIANCE DECOMPOSITION

5A: Empirical Estimate 1

Short-run Variance Decomposition of E-governance

Period	*S.E.*	*FD*	*EG*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.0119	0.2479	99.7521	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0120	0.3362	99.1661	0.0082	0.0034	0.4740	0.0119	0.0002
3	0.0120	0.4288	98.6441	0.0733	0.0056	0.8242	0.0196	0.0045
4	0.0120	0.4685	98.5321	0.0831	0.0080	0.8566	0.0445	0.0072
5	0.0159	7.4081	87.4391	0.0986	0.3039	3.8276	0.2515	0.6714
6	0.0160	7.5935	86.9841	0.1875	0.4817	3.8171	0.2635	0.6727
7	0.0161	7.6302	86.6209	0.2158	0.5957	4.0039	0.2654	0.6680
8	0.0161	7.6729	86.5512	0.2162	0.6350	3.9835	0.2755	0.6657
9	0.0179	6.8064	84.2171	1.9272	0.7117	5.2384	0.2749	0.8242
10	0.0180	6.9550	83.8758	2.0051	0.7759	5.2399	0.2725	0.8758

Source: ***From E-views – 10***

Long-run Variance Decomposition of E-governance

Period	*S.E.*	*FD*	*EG*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.0119	2.7200	89.4235	3.1670	0.0757	1.8058	2.4674	0.3406
2	0.0120	2.7107	88.8195	3.1500	0.2231	2.3088	2.4460	0.3418
3	0.0120	2.6982	88.6119	3.2369	0.2525	2.4238	2.4249	0.3517
4	0.0120	2.7091	88.5399	3.2291	0.2585	2.4876	2.4170	0.3587
5	0.0159	1.5546	89.1529	5.5408	0.2254	1.4264	1.8627	0.2372
6	0.0160	1.5505	88.6805	5.6178	0.5344	1.5306	1.8459	0.2403
7	0.0161	1.5612	88.3374	5.6446	0.7473	1.6313	1.8336	0.2445
8	0.0161	1.5517	88.318	5.6486	0.7839	1.6270	1.8212	0.2494

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9	0.0179	4.0318	86.5699	5.0772	1.0088	1.3544	1.7124	0.2454
10	0.0180	4.0646	86.2895	5.2567	1.0739	1.3492	1.7105	0.2556

Source: ***From E-views – 10***

5B: Empirical Estimate 2

Short-run Variance Decomposition of E-participation

Period	*S.E.*	*FD*	*EP*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.0309	0.1651	99.8349	0	0	0	0	0
2	0.0310	0.3283	99.2466	0.0018	0.0334	0.3750	0.0129	0.0020
3	0.0311	0.4041	98.8838	0.0480	0.0391	0.6075	0.0153	0.0022
4	0.0312	0.4919	98.3985	0.0524	0.0445	0.9603	0.0434	0.0089
5	0.0454	12.2876	68.3892	1.4467	12.7606	0.8069	0.2960	4.0131
6	0.0454	12.3057	68.2935	1.4441	12.7382	0.8850	0.3043	4.0291
7	0.0455	12.3161	68.0598	1.4388	12.7527	1.1065	0.3148	4.0114
8	0.0456	12.2866	67.9755	1.4557	12.7370	1.1852	0.3322	4.0278
9	0.0497	18.2270	61.2779	2.0579	12.6605	1.1075	0.3699	4.2993
10	0.0497	18.2143	61.2658	2.0817	12.6559	1.1153	0.3697	4.2973

Source: ***From E-views - 10***

Long run Variance Decomposition of E-participation

Period	*S.E.*	*FD*	*EP*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.0309	34.5061	33.7412	21.6738	3.3490	2.0245	2.0178	2.6877
2	0.0310	34.2946	33.5543	21.5573	3.4630	2.4306	2.0272	2.6730
3	0.0311	34.1127	33.4537	21.7724	3.4447	2.5328	2.0208	2.6628
4	0.0312	33.9205	33.3363	21.6502	3.5172	2.8908	2.0380	2.6469
5	0.0452	33.5893	47.4991	13.0295	1.8074	1.3762	1.1159	1.5827
6	0.0454	33.5674	47.4362	13.0332	1.8418	1.4142	1.1140	1.5932
7	0.0455	33.5327	47.2842	12.9814	1.9003	1.5999	1.1100	1.5914
8	0.0456	33.4577	47.2352	12.9524	1.9775	1.6577	1.1092	1.6103
9	0.0497	34.7678	46.2271	12.4420	1.6621	1.4928	1.7163	1.6919
10	0.0497	34.7684	46.1951	12.4371	1.6688	1.5083	1.7197	1.7026

Source: ***From E-views - 10***

5C: Empirical Estimate 3

Short-run Variance Decomposition of Internet Availability

Period	*S.E.*	*FD*	*INTS*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	4.9503	4.200159	95.7998	0	0	0	0	0
2	4.9572	4.2751	95.6810	0.0138	0.0096	0.0058	0.0073	0.0074
3	4.9636	4.3503	95.5444	0.0164	0.0233	0.0363	0.0127	0.0167
4	4.9678	4.3887	95.4989	0.0164	0.0265	0.0365	0.0126	0.0203
5	7.7081	10.5732	88.5667	0.2582	0.2437	0.1019	0.1677	0.0885
6	7.7423	10.8529	88.2550	0.2627	0.2619	0.1029	0.1752	0.0894
7	7.7615	10.9151	88.0835	0.2655	0.3501	0.1141	0.1775	0.0943

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8	7.7792	11.0273	87.9707	0.2647	0.3497	0.1170	0.1767	0.0939
9	11.5617	16.5381	81.3265	0.3895	1.4340	0.1701	0.0954	0.0463
10	11.6947	16.9581	80.9240	0.3892	1.4138	0.1729	0.0965	0.0455

Source: ***From E-views – 10***

Long-run Variance Decomposition of Internet Availability

Period	*S.E.*	*FD*	*INTS*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	4.9503	0.7127	96.9323	0.5900	0.01340	0.0908	1.4175	0.2433
2	4.9572	0.7192	96.8888	0.6038	0.0184	0.0958	1.4282	0.2458
3	4.9636	0.7382	96.8193	0.6244	0.0194	0.1198	1.4290	0.2499
4	4.9678	0.7469	96.8116	0.6257	0.0195	0.1196	1.4267	0.2501
5	7.7081	1.1376	95.5946	0.9445	0.2839	0.3825	1.4725	0.1843
6	7.7423	1.2047	95.4996	0.9429	0.2895	0.3842	1.4963	0.1828
7	7.7615	1.2167	95.4223	0.9876	0.2962	0.3907	1.5047	0.1819
8	7.7792	1.2497	95.3950	0.9844	0.2975	0.3912	1.5007	0.1815
9	11.5617	1.1492	93.3313	1.4198	2.9793	0.3097	0.7282	0.0824
10	11.6947	1.3280	93.2490	1.3951	2.9149	0.3049	0.7273	0.0809

Source: ***From E-views -10***

5D: Empirical Estimate 4:
Short-run Variance Decomposition of Technology

Period	*S.E.*	*FD*	*TECH*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.2874	16.4610	83.5390	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.2894	16.5835	83.2132	0.0798	0.0012	0.0381	0.0116	0.0726
3	0.2909	16.6681	82.9928	0.1178	0.0021	0.0718	0.0215	0.1260
4	0.2920	16.7148	82.8536	0.1547	0.0024	0.0822	0.0268	0.1654
5	0.3126	19.9339	72.4548	1.8971	3.2111	0.1156	0.4118	1.9755
6	0.3129	20.0189	72.2956	1.9449	3.2161	0.1417	0.4109	1.9719
7	0.3134	20.0635	72.0757	1.9750	3.2068	0.2977	0.4158	1.9655
8	0.3136	20.0805	72.0357	1.9736	3.2055	0.3217	0.4166	1.9664
9	0.3540	21.8098	67.8091	2.9454	4.7961	0.2999	0.4224	1.9174
10	0.3562	22.1823	67.5092	2.9123	4.7563	0.3277	0.4180	1.8942

Variance Decomposition of Technology

Period	*S.E.*	*FD*	*TECH*	*GDPgt*	*MS*	*INF*	*NR*	*TO*
1	0.2874	13.9374	78.0904	4.4890	2.9449	0.4182	0.0025	0.1176
2	0.2894	13.7462	78.2073	4.448	2.9875	0.4442	0.0051	0.1612
3	0.2909	13.6137	78.2722	4.4169	3.0311	0.4684	0.0059	0.1919
4	0.2920	13.5173	78.3458	4.3946	3.0485	0.4734	0.0070	0.2134
5	0.3126	11.8077	68.5819	11.0644	6.1251	0.57445	0.1130	1.7334
6	0.3129	11.8888	68.4852	11.0606	6.1116	0.5834	0.1345	1.7359
7	0.3134	11.8688	68.2565	11.0237	6.1938	0.7557	0.1670	1.7345
8	0.3136	11.8843	68.2005	11.0296	6.18891	0.7649	0.1834	1.7485
9	0.354	13.3089	61.1853	14.2217	8.7966	0.6656	0.1444	1.6774
10	0.3562	13.1521	61.2260	14.3364	8.7966	0.6584	0.1684	1.6621

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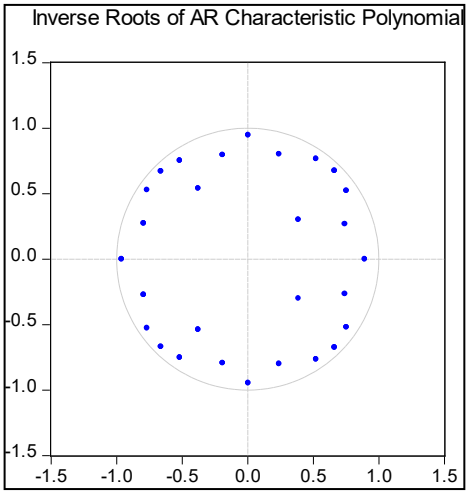
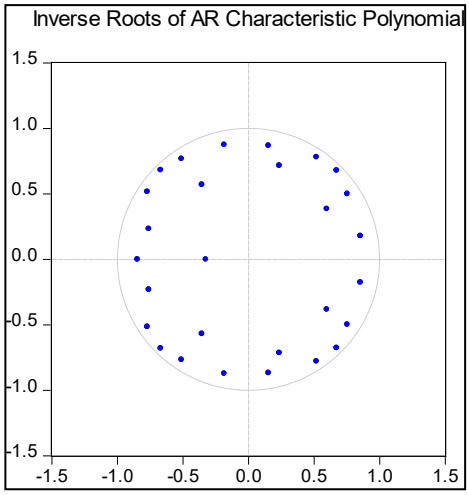
APPENDIX 5: STABILITY TEST-The graph of stability test showing eigenvalues located within the unit circle, implying that the system is stationary and stable.

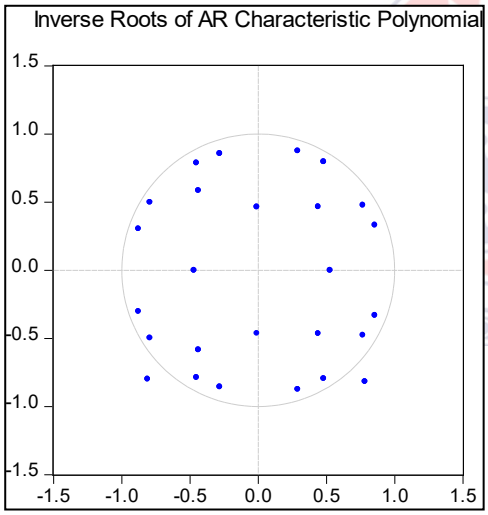
Estimate 1



Estimate 2



Estimate 3



Estimate 4