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Information Communication Technology's Influence on Exchange Rate

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ABSTRACT

Investigated in this study is the influence of information communication technology (ICT) on the exchange rate in Zambia from 2010 to 2021. The research methods employed involve using descriptive, exploratory, and experimental designs. The results are reported focusing on ICT acquisition, usage, and production in relation to the performance of the exchange rate: imports of ICTs from the Zambia Revenue Authority (ZRA) represented the uptake while the performance of the exchange rate from the Bank of Zambia represented actual volatilities. It was further discovered that the ICTs influence movements in financial transactions by increasing the quantum of transactions. The impact on the movements of currencies advertently affects the exchange rate causing volatility. The role of ICTs in the amalgamation of markets, trade linkages, and openness, is key. Conclusively, ICTs influence the exchange rate: inherent in productive means and permeate consumptive aspects of ICTs and financial transactions. The main limitation arose from data collection on ICT software and services due to lack of a consolidated data capturing information system.

KEYWORDS

Information, Communication, Technology, Exchange Rate, Kwacha, Consumptive, Productive, Zambia, Imports, Movement of Cash, Volatilities, Amalgamation of Markets, Trade Linkages, Real ICT Imports

INFORMATION COMMUNICATION TECHNOLOGY INFLUENCE ON EXCHANGE RATE

Information Technology and Exchange Rate

Participation in the financial market necessitates efficient forecasting models, accurate information regarding exchange rate performances, and insight into the behavior of other market forces (Ayrton et al., 2019). ICT profoundly impacts access to this critical information, providing second-tier effects that complement its primary role in facilitating tradable ICT commodities (Okoro et al., 2020; Sharma et al., 2019).

In recent years, the depreciation of the Zambian kwacha has significantly impacted businesses, leading to an amplified cost of living (Mwiya, 2019; Pollen, 2020). The exchange rate affects transactions among Zambia and other countries, directly influencing intra-industry trade in sectors such as the steel industry. ICTs have revolutionized financial market transactions, influenced the exchange rate, and exacerbated volatility. Below are selected key concepts structured for this research.

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Globalization and Markets Integration

Globalization has integrated financial markets worldwide, facilitating capital and investment flows. While market integration offers growth opportunities, it also poses risks and challenges, particularly understanding exchange rate volatilities, which significantly impact trade, investment, and economic growth (International Monetary Fund [IMF], 2000). We propose that exchange rate volatilities affect exports, imports, and investment value, and influence inflation, interest rates, and monetary policy decisions, as evident in the Bank of Zambia's interventions since 2022. Therefore, understanding the factors that influence exchange rate volatilities is vital for policymakers and market participants (Mishra & Daly, 2006).

Emerging markets' growing significance in global trade and investment makes exchange rate volatilities a critical issue. As these markets' importance increases, their exchange rates have a greater impact on global finance (World Bank, 2019). Therefore, understanding the factors that drive exchange rate volatilities in these markets is essential for promoting economic growth and development.

Exchange Rate Volatility (ERV)

Currency volatility simply means the fluctuations in the value of a currency relative to other convertible currencies. Causes emanate from many factors including economic indicators, political events, and market sentiment (Alper, 2017). There are myriad of observable effects in the Zambian economy. Notable influencers include the following:

1. Trade
    - Competitiveness of exports and imports
    - Changes in trade balances and current accounts
    - Decisions to engage in international trade
2. Investment
    - Value of investments
    - Changes in investment decisions and capital flows
    - Cost of borrowing and the availability of credit
3. Economic growth
    - Economic activity and GDP
    - Inflation and interest rates
    - Monetary and fiscal policy decisions

Activities in the aforementioned areas of volatility impact have been accentuated by the ICT revolution.

ICT Revolution

Alvim (2017) states that ICTs have transformed financial markets and exchange rates in several ways:

- Enhancing investor access to information and decision-making, boosting market efficiency
- Automating transactions, reducing costs, and boosting trading speed
- Leading to electronic payment systems, facilitating cross-border transactions and influencing exchange rates
- Increasing market accessibility and participation through online trading platforms
- Impacting exchange rates and financial markets through algorithmic trading
- Increasing financial market connectivity, leading to faster information transmission and increased exchange rate volatility

- Enabling new financial instruments, like cryptocurrencies and digital assets, which can impact traditional financial markets and exchange rates

Traditional Determinants of Exchange Rates

ICTs explain additional determinants and influence traditional ones. Traditional exchange rate determinants are presented here.

- Balance of payment: This examines the capital account and current account.
  - Current account: trade accounts (TA) and unilateral transfers (UT)
    - Trade accounts: imports and exports

Current Account Balance (CAB) = Exports (X) − Imports (M) + Unilateral Transfers (UT) ……. Equation 1 current account determination (IMF, 2020)

- Monetary policy: This assumes exchange rates are affected by money demand and supply (Friedman, 1968). ICTs influence resource demand and supply, extensively impacting cash flow (Huang & Li, 2019).
- News approach: Exchange rates fluctuate in response to news events (Huang & Li, 2019). ICTs enable instant news dissemination, influencing exchange rates (Mwiya, 2019).
- Differentials in inflation: Lower inflation rates exhibit a rising currency value.
- Public debt: This originates from large-scale public sector projects funding. Large deficits and debts are less attractive to foreign investors.
- Terms of trade: These compare export prices to import prices.
- Purchasing power parity (PPP): PPP predicts exchange rates will reflect price level changes in the long run.

Traditional Approaches Limitation

Traditional models simplify the complex interactions between economic variables and exchange rates but have limitations. They focus on short-term fluctuations, neglect long-term fundamentals, assume linear relationships, and fail to account for structural changes, investor behavior, and emerging market characteristics. They also disregard technological advancements and have limited explanatory power, especially during crises.

The kwacha's persistent depreciation against other currencies, despite central bank interventions, has driven up living costs (Mwiya, 2019). Current mitigation efforts focus on traditional determinants, but a more comprehensive framework is needed, incorporating technology, emerging market characteristics, non-linear relationships, long-term fundamentals, and structural changes (Lyons, 2001).

Technology Advancements

ICT has significantly impacted financial transactions, exacerbated ERV and accelerated the speed of transactions (Mwiya, 2019). The technology theory seeks to explain the factors that shape innovation and impact society and culture (Kurzweil, 2005). From the ICT perspective and exchange rates, in this study, we argue that our activities such as human development, including the exchange rate market, are inextricably linked to ICTs. This includes the display of exchange rates in banks (Huang & Li, 2019).

Technology, such as food processors, mobile phones, and cars, solves personal and collective problems in society (Kurzweil, 2005). In Zambia, however, these technologies are paid for in foreign currency, putting pressure on the exchange rate (Mwiya, 2019).

Overarching Research Question

In this study, we explore the uninvestigated relationship between ICT and the exchange rate, departing from the traditional focus on specific factors such as balance of payment (BOP), the news approach, and monetary policy.

Research Objectives

The objectives of this study are

1. to investigate the effect of ICT on the foreign exchange rate, and
2. to explore the relationship between ICT and the foreign exchange rate in Zambia.

Rationale

The rationale for this study is to understand the unknown relationship between ICT and the foreign exchange rate volatilities in Zambia, assumed to be a zero-sum relationship. We aim to fill this knowledge gap by gathering information through desk reviews, interviews, and secondary data.

Research Questions

The following research questions guide this study:

1. How do ICTs affect the foreign exchange rate?
2. What is the relationship between ICT and the foreign exchange rate in Zambia?

Significance

This research is significant as it enhances our understanding of exchange rate volatilities and determinants, providing valuable insights for policymakers, investors, and businesses. It develops a comprehensive framework to improve forecasting accuracy and inform policy decisions and explores the use of alternative data sources to enhance forecasting models.

Novelty

This study offers several novel contributions:

- A pioneering exploration of the interplay between ICTs and exchange rates, alongside other intrinsic factors influencing the FX market
- An innovative methodological approach that integrates exchange rate management techniques, balance of payments, news approach, monetary policy, and technology
- Groundbreaking policy recommendations for mitigating the risks associated with exchange rate volatilities, providing a valuable tool for policymakers and practitioners seeking to stabilize the FX market

These contributions highlight the innovative aspects of my research, showcasing the unique insights and approaches that set the study apart from existing literature.

LITERATURE REVIEW

This literature review provides a comprehensive overview of research on ICT and exchange rate volatilities using ARDL, bounds test, and ECM. These techniques are widely used in finance,

economics, and energy to investigate long-run relationships and short-run dynamics. This review synthesizes existing literature, identifying key findings, methodological advancements, and gaps in current knowledge, contributing to a deeper understanding of these econometric tools and their applications.

Structure

The literature review introduction is followed by a concise overview of the research topic, purpose, and scope. Next, the theoretical framework, empirical studies, and determinants of exchange rate volatilities are presented, followed by methodological approaches, critique, and gap analysis. Finally, the conclusion summarizes the key findings.

Purpose

Through this research, we investigated the effect of technology on exchange rate and developed a comprehensive framework that integrates both traditional and non-traditional factors to explain exchange rate volatilities

Scope

The scope of this research includes

- a literature review of existing research on exchange rate volatilities and ICTs,
- development of a comprehensive framework that integrates traditional and non-traditional factors,
- an empirical analysis of the relationship between ICT and exchange rate volatilities using advanced statistical techniques, and
- policy recommendations for mitigating risks associated with exchange rate volatilities.

Theoretical Framework

The theories reviewed in this section form the philosophical foundation of understanding the effects of ICTs on exchange rate and volatility risk.

The Complex Theory

In the context of my research on the relationship between ICT policy and exchange rate volatility in Zambia, the complex systems theory offers a comprehensive framework for understanding the intricate interactions between ICT policy, thematic areas (e.g., education and agriculture), and the exchange rate market. This theory is anchored on five key elements:

1. Systems: the interconnectedness of ICTs, thematic areas, and the exchange rate market, functioning collectively to shape exchange rate volatility
2. Non-Linearity: the disproportionate impact of ICT policy on exchange rate volatility, akin to the butterfly effect
3. Networks: the complex relationships and interconnections between ICT policy, thematic areas, and the exchange rate market, influencing exchange rate volatility
4. Adaptation and evolution: the capacity of the financial market to adapt and evolve in response to changing ICT policies and thematic areas, leading to unpredictable outcomes
5. Self-Organization: the absence of central coordination, with individual components (e.g., ICT, thematic areas, and exchange rate market) following a bottom-up pattern, resulting in emergent exchange rate volatility

By applying these principles, complex interactions between ICT and the exchange rate market, which ultimately shape exchange rate volatility in Zambia, will be understood.

Understanding the interaction of the variables of interest which are determinants of exchange rate, as reflected in the above theory, remains complex and to a certain extent illusionary.

Illusion Theory

The illusion theory suggests that our perceived control is limited. Despite efforts to influence exchange rate variables, desired results may not be attainable. For example, assuming that exporting more copper will stabilize the exchange rate is an illusion. While exports may lead to currency stabilization, factors such as currency availability can still cause failure. Zambia has no control over dollar printing or market availability.

Agglomeration

ICTs exemplify the principle of agglomeration, which is evident in various economic aspects. As Duranton and Puga (2004: 2063 - 2117) explain, "Agglomeration economies arise when individuals and firms benefit from physical proximity to one another." These benefits can be grouped into three mechanisms.

1. Sharing resources and risks
2. Matching individuals and inputs to firms
3. Learning through interactions with others

By bringing individuals and firms closer together, agglomeration facilitates these mechanisms, leading to increased efficiency and productivity.

Balance of Payments

The balance of payments addresses factors that affect the capital account and current account. The current account consists of trade accounts (TA) and unilateral transfers (UT). Trade accounts are composed of imports and exports of goods and services, while unilateral transfers consist of transfer payments not backed by services rendered by the receiving country. These transfers are largely facilitated by information and communication technologies and are influenced accordingly (Chinn & Prasad, 2003).

Current Account

According to Edwards (1994), the current account is calculated as exports (X) minus imports (M) plus unilateral transfers (UT). Current Account Balance (CAB) = Exports (X) – Imports (M) + Unilateral Transfers (UT) …….. Current account determination.

It encompasses merchandise and invisible trades, such as services. The current account balance sheet is highly sensitive to exchange rate movements. ICTs shape both merchandise and invisible trades.

Capital Account

The capital account involves the purchase and sale of assets, stocks, bonds, bank accounts, real estate, and other financial businesses. It measures the differentials between local sales of assets (inflows – credits) and foreign acquisition of assets (outflows – debits). The desired outcome is a balance between the current account and capital account.

Official Reserve Account

The official reserve account comprises purchases and sales of international reserve assets, such as foreign exchange and special drawing rights. Although this account is suitable for countries with

fixed exchange rate systems to afford foreign products in crisis, countries like China and Zambia accumulate and offload foreign exchange in times of crisis through their central banks.

News Approach

The news approach posits that exchange rates fluctuate in response to news events (Brealey & Myers, 2004). This approach suggests that ERV is caused by the constantly changing nature of news, impacting exchange rates each time. While the news approach is a valid explanation for exchange rate fluctuations, it does not fully explain volatility. Notably, ICTs significantly influence news mediums, which in turn affects exchange rates.

Monetary Approach

The monetary approach posits that exchange rates are influenced by the demand and supply of money in the market (World Bank, 2002). Authorities exogenously fix each country's money supply. The availability of ICTs and related policies also impacts the demand and supply of resources.

Market Efficiency

The theory of market efficiency suggests that the foreign exchange market is efficient when exchange rates reflect available information. Therefore, an efficient exchange rate market in Zambia responds to news and events, leading to changes in the kwacha's value. However, the unpredictability of news events, particularly those rapidly disseminated through ICT, contributes to volatility in the kwacha's exchange rate.

Theory of Technology

In the context of my research on exchange rate volatility in Zambia, the theory of technology highlights the dual nature of technological innovation, which shapes the exchange rate market. On one hand, technological progress in ICTs has improved access to information, facilitating more accurate exchange rate predictions. On the other hand, the control of technology by powerful corporations and states raises concerns about anti-democratic consequences, such as surveillance and manipulation of exchange rates. Furthermore, exchange rate theory is rooted in various economic theories, including the random model theory, which provides a foundation for understanding the complex dynamics of exchange rates and their responses to economic and political factors. These theories will be integrated into the framework below to explore their impact on exchange rate volatility in Zambia.

Conceptual Grounding

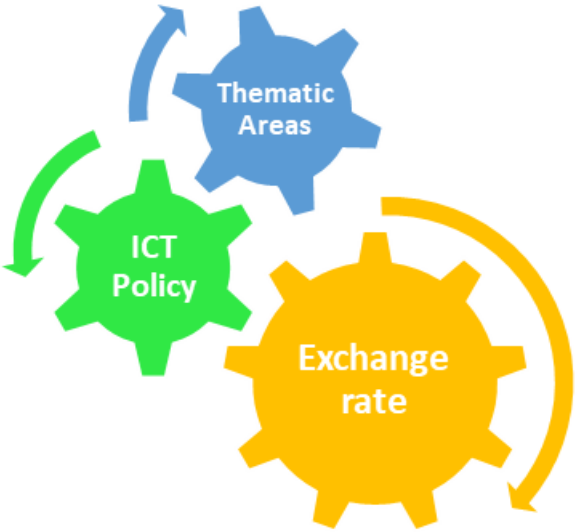
The conceptual framework illustrates the symbiotic dependence relationship between variables, as proposed by the complex theory, in the context of Zambia's exchange rate market. ICTs have a profound impact on various thematic areas:

- Human resource development
- Agriculture
- Education
- Health
- Tourism
- e-Commerce
- Legal and regulatory framework

These areas are interconnected and influence exchange rate volatility through several factors:

- Productivity

Figure 1. Conceptual framework



- Cost of production
- Trade
- Benefits

The framework (see Figure 1) demonstrates how ICT policies shape the exchange rate market in Zambia, highlighting the complex relationships between variables.

The literature review shows ICT impacts consumption and production patterns in various areas. ICT imports from productive countries affect exchange rates. In consumer-based economies, ICT absorption rates directly impact exchange rates. ICT adoption in productive sectors influences outputs, which in turn affect exchange rates. Thus, policies like Zambia's ICT Universal Access Policy can directly or indirectly impact exchange rates through consumption and production effects. Find below the overall summary of theories:

- Complex theory (interconnectedness, non-linearity, adaptation)
- Illusion theory (limits of control)
- Agglomeration theory (benefits of proximity and resource sharing)
- Balance of payments and its components (current, capital, and official reserve accounts)
- News approach, and monetary approach.
- Random model theory (weak, semi, and strong form)
- Theory of technology

Integrated Framework Specification

Building on our analysis of traditional and non-traditional determinants of exchange rate volatility, we specify a comprehensive framework that incorporates the variables of interest. Our framework integrates traditional factors—economic indicators, political factors, and financial factors—with non-traditional ICT factors including Internet penetration, mobile subscriptions, social media usage, and digital payment systems. This integrated approach enables a nuanced understanding of the interplay between these factors and their impact on exchange rate volatility.

Traditional Factors

- Economic indicators
  - GDP
  - Inflation rate
  - Interest rates
  - Unemployment rate
- Political factors
  - Political stability
  - Trade policies
  - Government interventions
- Financial factors
  - International trade balances
  - Foreign exchange reserves
  - Capital flows

ICT Factors

- Internet penetration
- Mobile phone subscriptions
- Social media usage
- E-commerce transactions
- Digital payment systems
- Online banking and financial services

Integrated Framework Equations

Exchange Rate Volatility (ERV)

$$= f(\text{Traditional Factors, ICT Factors}) \ldots\ldots\ldots\ldots\ldots\ldots\text{Determinants of ERV}$$

$$ERV = \beta_0 + \beta_1(GDP) + \beta_2(Inflation) + \beta_3(Interest\ Rates) + \beta_4(Political\ Stability) + \beta_5(Internet\ Penetration) + \beta_6(Mobile\ subsciption) + \beta_7(Social\ Media\ Usage) + \epsilon \ldots\ldots\ldots \text{Determinants of ERV}$$

This framework opines that exchange rate volatility is a function of both traditional factors (e.g., economic, political, and financial) and ICT factors. The coefficients (β0-β7) represent the relative importance of each factor in explaining exchange rate volatility

Empirical Studies

This literature review synthesizes empirical studies examining the interplay between ICTs, exchange rates, and economic development. Muhanga et al. (2014) investigated Zambia's monetary and exchange rate policies, highlighting the challenges of establishing a regime that anchors expectations of low and predictable inflation. Gnangnon (2020) found a significant positive association between internet access and service export diversification across 131 countries. Kumar and Kumar (2019)

and Ogechi and Olaniyi (2019) demonstrated that ICT drives tourism demand, leading to increased foreign exchange earnings. Keita (2016) showed that ICT adoption mitigates the effects of distance on international trade, reducing trade costs and increasing trade volumes. Liu and Nath (2013) found that ICT has a positive effect on exports and imports in emerging economies. Dimelis and Papaioannou (2011) and Oh and Kim (2009) highlighted the importance of ICT development in enhancing economic performance and stabilizing exchange rates.

Gnangnon (2020) analyzed panel data from 131 countries (1995-2014) and found a significant positive link between Internet access and service export diversification, consistent across country groups. The impact of Internet access on export diversification depends on countries' innovation levels, exports, and foreign investment inflows. These findings highlight the importance of developed digital infrastructure and effective regulations for achieving development goals.

Kumar and Kumar (2019) investigated ICT's impact on tourism demand in nine destinations, using mobile and broadband subscriptions as proxies. They found that a 1% increase in mobile and broadband subscriptions leads to a 0.04% and 0.11% increase in visitor arrivals, respectively. The study controlled for price, income, and destination factors, using balanced panels for 1995-2017 and 2002-2017. The results show ICT drives tourism demand, supporting the technology-led growth hypothesis. Similarly, Ogechi and Olaniyi (2019) found a positive relationship between ICT development and tourist arrivals in 40 countries between 1996 and 2015. These studies suggest increased ICT infrastructure boosts foreign exchange earnings through tourism.

Africa's underdeveloped ICT infrastructure has hindered tourism growth, resulting in low tourist inflows. Despite recent advancements, Africa's ICT levels remain low, with only 20% Internet usage and 74.4% mobile subscriptions in 2016, compared with higher rates in North America and Europe (Ogechi & Olaniyi, 2019). Zambia aims to leverage ICT strengths in tourism to maximize foreign exchange earnings. Low ICT development in Africa, however, contributes to low forex earnings, resulting in shallow financial markets. Keita (2016) found that ICT adoption reduces trade costs and increases trade volumes. The study highlighted ICT development's importance in enhancing foreign exchange markets and promoting economic growth. Investing in ICT infrastructure and promoting digitalization are crucial for Africa's tourism industry and economic development.

Liu and Nath (2013) studied the impact of ICTs on international trade in emerging markets, using panel data from 40 countries (1995-2010). They found that ICT positively affects exports and imports in emerging economies. However, they stressed the importance of developing local capabilities for infrastructure development to fully leverage ICT investments. Zambia's lack of ICT skills and capabilities hinders its ability to benefit from ICT investments, impacting its foreign exchange market. The economy bears the costs of ICT investments, highlighting the need for Zambia to develop its local ICT capabilities to maximize benefits and improve its foreign exchange market.

Dimelis and Papaioannou (2011) stated ICT adoption reduces technical inefficiencies and improves labor productivity, with the US and India leading in efficiency. This highlights ICT's importance in enhancing economic performance. Oh and Kim (2009) found that ICT growth in Korea reduces the impact of exchange rate fluctuations on consumer prices and domestic inflation. This suggests a developed ICT sector stabilizes exchange rates and positively impacts the economy. In Zambia, low ICT development may contribute to the low exchange rate value, emphasizing the need for ICT development to enhance economic performance and stabilize the exchange rate.

ICTs' importance in development is highlighted by the EU-US comparison, where ICT adoption boosted productivity. Timmer and Van Ark (2005) found ICT capital deepening drove labor productivity growth in both regions, emphasizing ICT's critical role in driving growth and contributing to the economy's productivity.

Theoretical foundations, such as Solow (1956) and Swan (1956), suggest that exogenous technological progress contributes to economic growth. While high-income countries benefit from technological advancements through R&D, middle- and low-income countries can gain technical

efficiency through adopting existing technologies (Caselli et al., 1996; Hall & Jones, 1999; Klenow & Rodriguez-Clare, 1997).

Advances in technology infrastructure reveal ICT penetration and adoption's contribution to economic growth. Hardy (1980) found that telephone usage per capita boosts GDP per capita growth, demonstrating ICT's positive impact on development. This suggests Zambia can achieve growth and stabilize its exchange rate through home-grown ICT innovations and adoption.

We argue in this paper that the ICTs-economic development relationship doesn't apply to low-developed countries (LDCs). While ICTs drive growth in high-income countries, LDCs face adoption and utilization challenges. Studies consistently show, however, a positive link between ICTs and international trade, with ICT growth significantly contributing to trade expansion and forex earnings. This suggests ICTs affect exchange rates through their trade impact, contradicting the assumption of no ICTs-exchange rates relationship.

We highlight in this study the importance of considering LDCs' specific context and challenges in understanding the ICT-economic development nexus. The relationship's direction depends on ICT development levels and sources. ICTs can positively impact exports, but imported ICTs can be a cost, negatively affecting the exchange rate.

Overall, this literature review emphasizes the crucial role of ICT development in enhancing economic performance, stabilizing exchange rates, and promoting foreign exchange earnings. It underscores the need for a nuanced understanding of the relationship between ICTs and economic development, considering the specific challenges and context of LDCs like Zambia.

Empirical Model for the Study

Rashid and Basit (2022) investigated the determinants of exchange rate volatility (ERV) in six Asian economies: Bangladesh, China, India, Indonesia, Malaysia, and Pakistan. They employed a multivariate autoregressive-moving average-GARCH (1, 1) model to examine the relationship between ERV and the volatility of foreign reserves, government spending, industrial production, gold prices, and terms of trade.

The results show that

- past ERV significantly affects current ERV in all countries;
- foreign-reserve volatility negatively impacts ERV in Bangladesh, China, and Malaysia;
- government spending volatility has a negative relationship with ERV in India but a positive relationship in other countries;
- terms of trade volatility reduces ERV in Bangladesh and Pakistan but amplifies it in other countries;
- gold price volatility positively contributes to ERV in Bangladesh, Indonesia, and Malaysia; and
- industrial production volatility reduces ERV in Indonesia and Pakistan but increases it in China, India, and Malaysia.

This validates the inherent role of the ICT in either providing the information from the past or enhancing tradability.

Uche and Effiom (2021) conducted a study on capital flight in Nigeria, investigating the relationship between capital flight, global economic policy uncertainties, and exchange rate volatilities in Nigeria using the quantile autoregressive distributed lag (ARDL) model. The results show

- a long-run relationship exists between global economic uncertainties, exchange rate volatilities, and capital flight,
- the effects of ERV and global uncertainty vary across different quantiles of capital flight distributions, and

- exchange rate and GDP have significant positive long-term impacts on capital flight, while global uncertainty does not.

We conclude that stabilizing the exchange rate is crucial to reducing capital flight in Nigeria, and a one-size-fits-all policy may not be effective due to distributional asymmetric effects. ICT availability substantially influences capital flight. Alsamara and Mrabet (2019) examined the asymmetric impact of exchange rate shocks on money demand in Türkiye using the nonlinear ARDL bounds test. The study (1986-2014) found currency substitution affects money demand, and exchange rate changes impact demand. The study concludes that monetary policy makers should aim for stable exchange rates to anchor price fluctuations, and money plays a crucial role in achieving price stability. We contend that this requires optimal ICT investment.

ERVs and ICT (Non-Traditional Determinant Methodology)

In this study, we used a mixed methods approach, combining exploratory, descriptive, and experimental research designs. The experimental design employs the autoregressive distributed lag (ARDL) model, bounds test, and error correction model (ECM) to investigate the long-run relationships and short-run dynamics between exchange rate volatilities and their determinants, including economic indicators. Specifically, the ARDL model estimates long-run relationships, the ECM model examines error correction mechanisms, and the bounds test determines the presence of cointegration. This comprehensive analysis was applied to an extensive dataset spanning 10 years, providing valuable insights into the complex interactions between exchange rate volatilities and their determinants.

Research Gap

Existing literature focuses on traditional exchange rate volatility determinants such as economic indicators and policy decisions. However, the impact of non-traditional factors like technological advancements on exchange rate volatilities is not well understood. There is a lack of comprehensive contexts incorporating both traditional and non-traditional factors. To address this gap we

- investigated the relationship between a non-traditional factor (ICT) and exchange rate volatilities,
- developed a comprehensive framework integrating traditional and ICT factors, and
- utilized advanced statistical techniques to analyze large datasets and identify patterns.

By addressing this research gap, the findings contribute to a deeper understanding of exchange rate volatilities, improving forecasting accuracy and providing valuable insights for policymakers, investors, and businesses.

METHODOLOGY

Methods Summary

We used a mixed methods approach to investigate ICT's impact on Zambia's exchange rate. The research process involved the following methods:

- Identifying the research problem
- Reviewing relevant literature and theories
- Developing hypotheses
- Collecting data from various sources (i.e., Zambia Information and Communication Authority, Bank of Zambia, and Zambia Revenue Authority (ZRA))
- Analyzing data to determine the effects of ICTs on the exchange rate
- Interpreting and presenting the results

We systematically investigated how ICTs affect the exchange rate, validating the hypotheses based on the literature review.

We repeated this systematic approach for each research question, aiming to understand how ICTs impact the exchange rate. The findings validated the hypotheses developed from the literature review.

Case Used

Scenarios considered:

a. Examining the ICT-exchange rate relationship: Two datasets were used—ICT importation characteristics from ZRA and exchange rate data from the Central Bank.
b. Mixed methods helped overcome data limitations, combining qualitative and quantitative approaches for triangulation and convergence.
c. The study had two phases: qualitative (semi-structured interviews) and quantitative (questionnaire survey and secondary data from institutions like regulators).
d. ICTs have two functions: productive (capital and labor stock) and consumptive (ICT absorption and information state).
e. This study postulates ICT's productive and consumptive functions interact with the exchange rate, directly or indirectly through economic growth, with ICT practices as input and exchange rate as output.
f. Semi-structured interviews with financial institutions and regulatory bodies investigated the exchange rate-ICT relationship, including production and consumptive aspects.
g. In-depth interviews with financial managers, institutions, and ICT focal points explored ICT uptake, policy influence, exchange rate effects, and ICT's impact on traditional exchange rate determinants.
h. A survey examined the effect of ICT consumption on the exchange rate, focusing on consumptive patterns and demand-side effects on the supply side, including ICT product traders and financial market consumers.

We investigated the impact of ICT on currency volatilities in Zambia, using a mixed methods approach that combined

1. secondary data from articles, journals, books, and expert interviews;
2. exploratory research question to understand the relationship between ICT and foreign exchange (FX) rate;
3. data collection from the Bank of Zambia and Zambia Statistical Agency (Zamstats) on currency fluctuations;
4. data disaggregation into pre- and post-ICT policy formulation (2009) periods;
5. regression analysis of sector-specific importation in ICT thematic areas; and
6. semi-structured interviews with financial experts, regulators, and policy initiators/sponsors to clarify the relationship between ICT and currency volatility.

The study aimed to fill a significant information gap and understand the nature of the relationship between ICT and ERV in Zambia.

Category: Expert Knowledge and ICT

This category aimed to gather expert knowledge on the relationship between ICT and the exchange rate. Semi-structured interviews and questions were designed to

- understand the impact of ICT absorption fostered by ICT policy;

- assess the uptake of ICT tools and platforms and their effect on the exchange rate from the demand perspective;
- identify ICT factors that hinder ERV stabilization; and
- describe the FX market and common variables that shape it, including news, balance of payment, and monetary approaches, in relation to ICTs.

We used descriptive research and questionnaires to gather data from experts and organizations. This approach provided a comprehensive understanding and addressed the research questions. We aimed through this research to fill a knowledge gap and understand the relationship between ICT policy and the exchange rate in Zambia.

Statistical Data Analysis

The ARDL (autoregressive distributed lag) model, bounds test, and ECM (error correction model) are used in this study to examine the relationship between ICT development and exchange rates for the following reasons.

1. ARDL model:
    - It is a versatile model that can handle both short-term and long-term relationships between variables.
    - It allows for examination of the dynamics of the relationship between ICT development and exchange rates.
2. Bounds test:
    - It is used to determine the presence of a long-term relationship between the variables.
    - It provides a robust way to test for cointegration, which is essential for analyzing the relationship between ICT development and exchange rates.
3. ECM model:
    - It is used to examine the short-term dynamics of the relationship between ICT development and exchange rates.
    - It helps to identify the speed of adjustment towards equilibrium after a shock to the system.

We examined the long-term relationship between ICT development and exchange rates, analyzed short-term dynamics, and determined the speed of adjustment towards equilibrium. The research provided a comprehensive understanding of how ICT development affects exchange rates.

Study Limitation

We faced a challenge measuring ICT expenditure's impact on goods and services due to the lack of a comprehensive system capturing national ICT spending. A gap exists in capturing ICT software and consultancy import costs, limiting the ability to quantify import-driven consumption effects on the exchange rate. We used alternative methods to estimate the impact, which may not have fully captured the relationship.

FINDINGS

Descriptive Results: Effects of ICT on the Exchange Rate

The Zambian currency, the kwacha, has experienced persistent volatility and depreciation against convertible currencies since 2011, leading to

- detrimental effects on market participants,
- extreme arbitrage opportunities,

- fueling of volatilities,
- increased volatility and risk in financial instruments, and
- risk-averse investors taking long positions in convertible currencies.

Despite expectations, the financial market has not responded to the

- size (growth in GDP from $839.4 million in 1964 to $23.31 billion in 2019), and
- central bank independence (adoption of a flexible financial management system).

The study suggests that Zambia's growing population, market size, and economy require a transition from paper-based to electronic money, driven by paper currency limitations. ICTs enable rapid financial transactions, virtual circulation, and limitless market turnover.

The shift to electronic money is expected to address paper currency limitations, enhance financial transaction efficiency, and potentially stabilize the kwacha's ERV. Technology has increased transaction volumes and financial instrument innovations.

Evidence of Volatility Caused by ICTs

This section discusses the concept of immediacy and its impact on market volatility, particularly in Zambia's economy context. Key points from the research review are that

- the value of money is perceived as more valuable today than in the future, leading to a preference for immediacy and speculation;
- this phenomenon contributes to the depreciation of the kwacha and the preference for holding convertible currencies;
- market prices adjust instantly to match dollar-denominated prices, leading to potential price under or overvaluations;
- ICTs play a significant role in instigating volatilities;
- ICTs enhance market information accuracy, affordability, and dissemination, but detach it from traditional fundamental determinants;
- the preference for immediacy leads to pricing disconnection from objective value, resulting in volatility;
- ICTs are integral to market mechanisms, enabling rapid changes and impacting tradable prices almost instantaneously;
- the impact of ICTs on market volatility has been overlooked in Zambia, with a focus on traditional economic fundamentals; and
- ICT-induced volatilities affect market participants, causing financial distortions and real output volatility.

We find that ICTs play a crucial role in market volatility and that their effect should be contextually considered in understanding market dynamics.

ICT and Exchange Rate Nexus

We discovered the impact of ICT on the exchange rate in Zambia, highlighting both direct and indirect effects as stated below.

1. Direct effects:
    - ICT investments lead to remittance of foreign exchange to countries of origin, reducing liquidity and putting pressure on the exchange rate.

- Savings from ICT deployment directly impact the economy, including reduced transactional costs and travel costs.

2. Indirect effects:
   - ICT adoption changes productivity, exhibiting positive and negative effects.
   - Increased proximity of workers and firms due to ICT leads to avoided travel costs, but also substitutes demand for local products with imported ones, putting pressure on the exchange rate.
   - ICT investments change investment decisions and firm location choices, impacting manufacturing-based employment opportunities.
   - Consumption of foreign-produced ICTs exacerbates the loss of economic opportunities and forex.

Overall, we conclude that ICT investments have both positive and negative effects on the exchange rate in Zambia, and that their impact depends on various factors including productivity, market opportunities, and consumption patterns.

Dynamic Agglomeration and Foreign Exchange Losses

Under the principle of aggregation, we discovered the impact of ICTs on Zambia's economy, specifically the loss of foreign exchange (forex) due to the following reasons.

- Investment decisions: Firms invest in traditional areas without relocating, accessing markets through ICTs.
- Agglomeration: Production centers remain abroad, while maintaining a presence in foreign markets through ICTs.
- Employment opportunities: Global citizens work remotely, leading to forex losses when labor obligations are settled.
- Trade imbalance: Zambia imports technologically advanced products, lacking the capacity to reciprocate, exacerbating trade imbalances and volatilities.
- Forex seepage: ICTs facilitate access to foreign goods and services, leading to forex losses, particularly in underdeveloped sectors such as education and health.

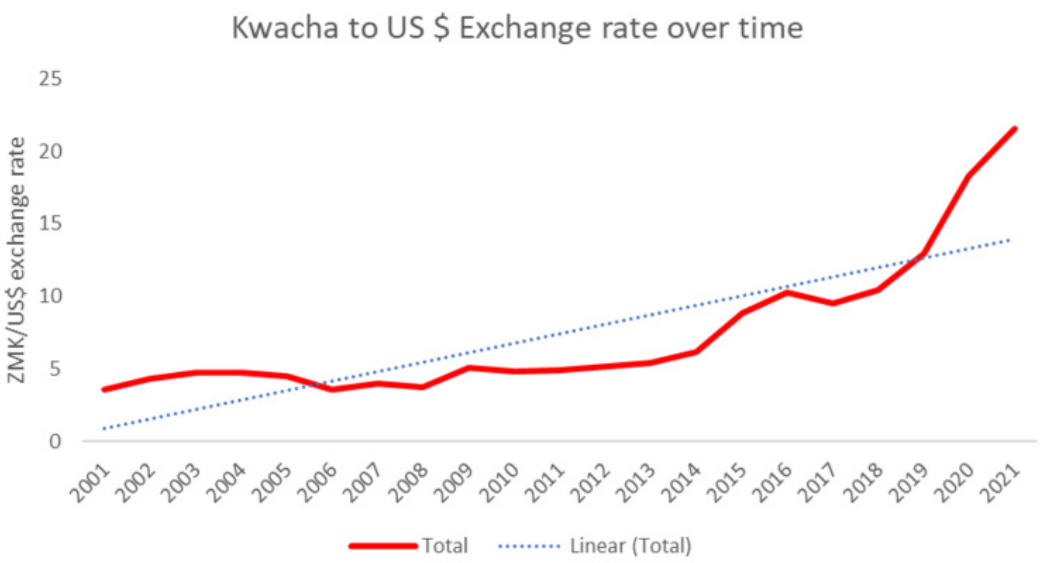
Hence, we conclude that while ICTs have brought benefits, they have also led to significant forex losses, pressuring the kwacha, and that the gains from establishing universal ICT access have come at the expense of the forex market.

Exploratory Results

We investigated ICT's effect on the exchange rate, addressing a knowledge gap. We explored how ICT influences economic opportunities, trade, business activities, and forex interactions, and examined market fundamentals' role in understanding exchange rate volatilities. Findings suggest ICT significantly impacts the exchange rate, supported by respondents' experiences. We discussed ICT's effects on trade, development, and ERV, and found the following 10 points:

1. Non-adoption of ICT leads to digital divide and reduced economic development.
2. ICT facilitates market integration but increases import consumption and foreign exchange losses.
3. Exchange rates impact ICT diffusion, with favorable rates enabling affordable infrastructure and devices.
4. Economic level and technological development in the financial market influence ICT adoption.
5. ICT transforms jobs, reducing hardship and making them more mental and specialized.
6. Local jobs become accessible to foreign nationals, necessitating forex compensation.

Figure 2. Kwacha volatilities to time



7. Telecommunication infrastructure deployment is positively impacted by favorable exchange rates.
8. ICT reduces trade costs, expands trade flows, and influences trade composition.
9. ICTs catalyze economic development and expand social project reach.
10. ICT adoption in schools and government has come at a significant cost, leading to foreign exchange loss.

The respondents highlighted the importance of promoting universal ICT access, producing ICTs locally, and preserving foreign exchange to promote growth.

Volatility Evidence

The study established the existence of ERV. Find below in Figure 2 a visual representation of the kwacha's fluctuations over time.

The data reveals that currency volatility has been a persistent feature of the market. A positive linear relationship between currency changes and time indicates that changes in the kwacha's value directly impact cash flow and individual financial market participants.

ICT Effects on Currency Distribution Channels

Respondents discussed the circulation of currency in Zambia, highlighting the role of electronic transactions in facilitating money circulation. They mentioned the effect of ICTs on the economy, including increased transaction volumes and values, but also stated costs associated with transaction platforms and external remittances, which increase the vulnerability of the kwacha.

Participants of the study identified various factors that influence fluctuations in exchange rates, including trade openness, money supplies, interest rates, and ICTs. Furthermore, they highlighted several inhibitors to exchange rate stabilization, including the following:

- Unavailability of IoT devices
- Limited knowledge and implementation of mobile applications

- Inadequate expertise for data analysis and visualization
- Insufficient data storage and synthesis systems
- Security vulnerabilities

Hence, we conclude that a systemic and cohesive approach is necessary to achieve exchange rate stabilization. It also emphasizes the importance of a symbiotic relationship between ICTs and the economy, currently lacking in Zambia.

ICT Usage Promotion to Counter ERV

According to the respondents, the following institutional structures are appropriate for promoting and regulating ICT usage and can help lift the stabilization-inhibiting veil.

- Integrating ICTs into the education curriculum
- Reducing device costs
- Streamlining licensing procedures and eliminating bottlenecks
- Investing in ICT infrastructure
- Establishing a favorable tax regime for the sector

ICT's optimal adoption and usage in thematic areas, as outlined in the ICT policy, led to increased national output and a positive impact on exchange rate performance (Author, 2021).

Statistical Results: ICT Imports and Exchange Rate

To investigate the relationship between ICT exchange rates, statistical analyses were conducted using the adopted research design on variables of interest. The experimental design examined the functional relationship between the variables in the problem model, specifically exploring the causal relationship between ICT imports and exchange rates.

Data Collection

We collected data on ICT imports from the ZRA for the period between 2015 and 2020. Additionally, data on exchange rates were obtained from the Bank of Zambia. The collected data was then analyzed to investigate the statistical significance of the relationship between ICT imports and exchange rates. This analysis was aimed to determine whether there is a significant correlation between the two variables and to what extent ICT imports affect the exchange rate in Zambia. The results of the analysis provide insights into the impact of ICT imports on the exchange rate and inform policies aimed at promoting economic growth and development in Zambia.

Testing for Unit Roots

Time series data often exhibit non-stationarity, which leads to spurious regression results. To address this, unit root tests were conducted to determine the stationarity of the data. The augmented Dickey-Fuller (ADF) test was used, with a significance level of 0.05. The null hypothesis (H0) assumes the presence of a unit root (non-stationarity), while the alternative hypothesis (H1) assumes stationarity.

The results of the ADF test are presented below in Table 1.

The results indicate that

- InRM and InRBMON have a unit root at the level (p − value > 0.05) but are stationary at the first difference (p − value < 0.05), indicating that they are integrated of order 1 (I(1)), and
- RExch Rate has a unit root at the level and first difference (p − value > 0.05), indicating non-stationarity.

Table 1. Augmented Dickey-Fuller test for unit root test

At Level – Stationarity (5%)					At 1st Difference – Stationarity (5%)			
Variable	**P-Value**	**Test -Statistic**	**Critical Value**	**Order of Integration**	**P-Value**	**Test -Statistic**	**Critical Value**	**Order of Integration**
InRM	0.0001	-5.5449	-2.9484	I (0)	0.0000	-11.9967	-2.9540	I (1)
RExch Rate	0.3661	-1.8178	-2.9484	-	0.0018	-4.309	-2.9540	I (1)
InRBMON	0.2554	-2.0751	-2.9484	-	0.0000	-5.6680	-2.9511	I (1)

Table 2. Lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	127.4836	NA	3.87	-7.3226	-7.1879	-7.2766
1	147.8602	35.9587*	1.24	-8.4624*	-8.2828*	-8.4011*
2	148.2564	0.658	1.28	-8.4268	-8.2024	-8.3503

Note. *Indicates lag order selected by the criterion.

The critical values are based on the Dickey-Fuller distribution. The order of integration (I(0) or I(1)) indicates the number of differences required to achieve stationarity.

Results of Unit Root Tests

The results of the unit root tests are presented in above. The findings indicate the following:

- Real ICT imports are stationary at the level, with a p-value of 0.0089, which is less than 0.05, leading to the rejection of the null hypothesis.
- Real exchange rate and real broad money are non-stationary at the level, with p-values of 0.3661 and 0.2554, respectively, greater than 0.05.
- After first differencing, all variables become stationary, with p-values less than 0.05.

Since all variables achieved stationarity at the level and first difference, the appropriate model to estimate is the autoregressive distributed lag model (ARDL). This model is suitable for analyzing the relationship between the variables, as it accounts for the dynamic interactions and short-run adjustments between them.

Lag Order Selection

Selecting the appropriate lag order is crucial to ensure the validity and reliability of the econometric model. The lag order selection criteria are presented below in Table 2.

Results of Lag Order Selection

The results indicate the following:

- The log-likelihood (LogL) increases as the lag order increases, indicating a better fit of the model.
- The Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan-Quinn criterion (HQ) all select a lag order of 1, indicating that a lag order of 1 is the most appropriate.
- The FPE (final prediction error) criterion also supports a lag order of 1.
- The LR (likelihood ratio) test statistic is significant at a lag order of 1, indicating that the inclusion of the first lag significantly improves the model.

Based on the lag order selection criteria, a lag order of 1 is selected for the ARDL model. This ensures that the model captures the underlying dynamics of the variables and provides reliable estimates of the relationships between them.

ARDL Model Results

The ARDL model examined the relationships between the dependent and independent variables. The results are presented below.

- Real exchange rate (-1) has a significant positive coefficient (0.6285, $p < 0.001$), indicating a strong lagged effect on the dependent variable.
- Real broad money has a significant positive coefficient (0.0471, $P < 0.001$) indicating a positive relationship with the dependent variable.

Real ICT imports has an insignificant coefficient (-0.0003, $P = 0.6215$), suggesting no significant relationship with the dependent variable.

- The constant term (C) has a significant negative coefficient (-0.5636,, $P < 0.001$).
- The R-squared (0.8832) and adjusted R-squared (0.8719) values indicate a high goodness of fit for the model.
- The Durbin-Watson statistic (1.8041) suggests no autocorrelation in the residuals.
- The F-statistic ($P < 0.001$) indicates the overall significance of the regression.

The ARDL model results suggest a significant cointegration relationship between the variables. The findings indicate that real exchange rates and real broad money significantly affect the dependent variable, while real ICT imports do not. The model's high goodness of fit and lack of autocorrelation support the reliability of the results.

Model Specification and Cointegration Test

The results of the ARDL model indicate that the model has been specified correctly, as the F-statistic is highly significant ($P = 0.0000$), indicating a strong overall fit of the model.

Given the significant F-statistic, we can test for cointegration using the bounds cointegration test. This test will help determine whether the variables are cointegrated, indicating a long-run equilibrium relationship between them.

The bounds cointegration test is a suitable test for cointegration in the context of the ARDL model, and it will provide further insight into the relationships between the variables.

Bounds Test for Cointegration

Time series data often exhibit long-run associations or equilibrium relationships, making it essential to test for cointegration among variables to avoid incorrect inferences. The cointegration test should be performed on the level form of the variables, and log transformation of the raw variables is also acceptable. In this case, we used the log form of the variables to conduct the bounds test.

The bounds test for cointegration follows these rules:

- If the calculated F-statistic exceeds the critical value for the upper bound I(1), we reject the null hypothesis of no cointegration, indicating a long-run relationship. We then estimate the long-run model, which is the error correction model (ECM).
- If the calculated F-statistic falls below the critical value for the lower bound I(0), we fail to reject the null hypothesis, indicating no cointegration and no long-run relationship. We then estimate the short-run model, which is the autoregressive distributed lag (ARDL) model.

Table 3. Bounds test

Test Statistic	Value	Significance Level	I (0)	I (1)
F-Statistic	8.8001	5%	3.478	4.335

Note. The F-statistic value of 8.8001 exceeds the critical value for the upper bound I(1) of 4.335, indicating that we reject the null hypothesis of no cointegration. This suggests that there is a long-run relationship between the variables. We can therefore proceed to estimate the long-run model, which is the error correction model (ECM).

- If the F-statistic falls between the lower bound I(0) and the upper bound I(1), the test is inconclusive.

The null hypothesis (H0) assumes no cointegrating equation, while the alternative hypothesis (H1) assumes a cointegrating equation.

The results of the bounds test for cointegration are presented below in Table 3.

ECM Model Results

The short-run results of the Error Correction Model (ECM) are presented below.

Short-Run Results

| Variable | Coefficient | Std. Error | t-statistic | P - Value |

| D(Real Exch Rate (-1)) | 0.6544 | 0.2636 | 2.4823 | 0.0191 |

| D(In real Broad Money (-1)) | 0.0466 | 0.0147 | 3.1665 | 0.0036 |

| D(In real ICT Imports (-1)) | 0.0001 | 0.0005 | 0.2829 | 0.7793 |

| C | -4.48 | 0.0007 | -0.0677 | 0.9465 |

| ECM(-1) | -0.8206 | 0.3373 | -2.4323 | 0.0214 |

The results indicate the following:

- Real exchange rate (-1) has a significant positive coefficient (0.6544, $P = 0.0191$).
- Real broad money (-1) has a significant positive coefficient (0.0466, $P = 0.0036$).
- Real ICT imports (-1) has an insignificant coefficient (0.0001, $P = 0.7793$).
- The constant term (C) is insignificant (-4.48, $P = 0.9465$).
- The error correction term (ECM (-1)) has a significant negative coefficient (-0.8206, $P = 0.0214$).

The R-squared (0.3976) and adjusted R-squared (0.3145) values indicate a moderate fit of the model. The Durbin-Watson statistic (1.7493) suggests no autocorrelation in the residuals. The F-statistic ($P = 0.0044$) indicates the overall significance of the regression.

In the short run, the results indicate that the lagged difference of real exchange rate (($P = 0.0191$) and lagged difference of real broad money ($P = 0.0036$) have a statistically significant and positive relationship with real exchange rate. In contrast, real ICT imports are statistically insignificant in the short run ($p = 0.7793 > 0.05$). The error correction term reveals that the system corrects its previous disequilibrium position at a speed of 82.06% per month. Moreover, the p-value for the model is statistically significant, indicating the overall significance of the regression.

The long-run results are presented below.

Long-Run Results

| Variable | Coefficient | Std. Error | t-statistic | P - Value |

| Real exch rate (-1) | 0.5236 | 0.1239 | 4.2251 | 0.0002 |

| In real broad money | 0.0460 | 0.0147 | 3.1386 | 0.0037 |

| In real ICT imports | 0.0003 | 0.0007 | 0.3850 | 0.7029 |

| C | -0.5517 | 0.1762 | -3.1308 | 0.0038 |

The results indicate the following:

- Real exchange rate (-1) has a significant positive coefficient (0.5236, $p = 0.0002$).
- Real broad money has a significant positive coefficient (0.0460, $p = 0.0037$).
- Real ICT imports has an insignificant coefficient (0.0003, $p = 0.7029$).
- The constant term (C) is significant (-0.5517, $p = 0.0038$).

The R-squared (0.8323) and adjusted R-squared (0.8161) values indicate a high goodness of fit for the model. The Durbin-Watson statistic (1.3480) suggests no autocorrelation in the residuals. The F-statistic ($p = 0.0000$ indicates the overall significance of the regression.

In the long run, the results indicate that lagged (1) real exchange rate and real broad money are statistically significant predictors of real exchange rate, with p-values of 0.0002 and 0.0037, respectively. Specifically, a 1% change in lagged real exchange rate and real broad money leads to a 0.5% and 0.04% change in real exchange rate, respectively. In contrast, real ICT imports are statistically insignificant in the long run. The R-squared value of 0.8323 indicates that 83.23% of the variation in real exchange rate can be explained by the regression model. Moreover, the F-statistic probability value of 0.0000 suggests that the model is significant in explaining the variations in the dependent variable.

Table 4. Test for serial correlation

F-Statistic	**3.1859**	**Prob. F (1,28)**	**0.0851**
Obs R-Squared	3.4733	Prob. Chi-Square (1)	0.0624

Table 5. Test for Heteroskedasticity

F-Statistic	**0.0183**	**Prob. F (4,29)**	**0.9993**
Obs R-Squared	0.0856	Prob. Chi-Square (4)	0.9991

Post-Diagnostic Tests

Tables 4 and 5 illustrate the Breusch-Godfrey serial correlation LM and the Breusch-Pagan-Godfrey heteroskedasticity test, respectively.

The results of the Breusch-Godfrey serial correlation LM test are presented.

Test for Serial Correlation

| Test | Value | Probability |

| --- | --- | --- |

| F-Statistic | 3.1859 | 0.0851 (1, 28) |

| Obs R-Squared | 3.4733 | 0.0624 (1) |

The results indicate no serial correlation in the residuals, as the probability values for the F-statistic (0.0851) and the Obs R-squared (0.0624) are greater than the significance level of 0.05.

The results of the Breusch-Godfrey serial correlation LM test indicate that the null hypothesis of no serial correlation cannot be rejected (, $p = 0.0851 > 0.05$), suggesting that the model does not exhibit significant serial correlation.

The results of the Breusch-Pagan-Godfrey heteroskedasticity test indicate that the null hypothesis of homoskedasticity cannot be rejected ($p = 0.9993 > 0.05$), suggesting that the model does not exhibit significant heteroscedasticity and the variance of the residuals is likely to be constant over time.

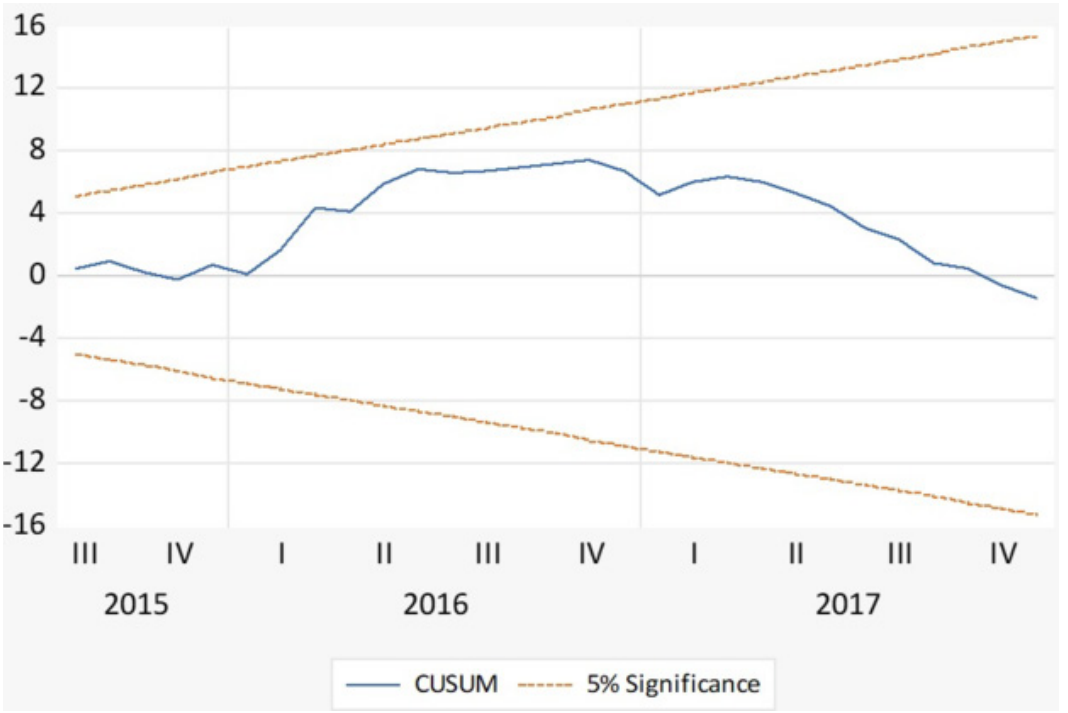
Model Stability Test

To test whether the model used stability, we used the Cusum test for stability illustrated in Figure 3.

The graph shows that our model stability lies between 0.04 and – 0.04, below 0.05, implying our model is stable.

The Cusum test for stability indicates that the model is stable, as the cumulative sum of residuals lies between 0.04 and -0.04, below the significance level of 0.05. This suggests that the model's parameters are stable over time, and the model is suitable for forecasting and prediction.

Figure 3. Cusum test for stability



DISCUSSION

Relationship Between ICT and Exchange Rate

The study reveals a significant relationship between ICT and exchange rate. The findings suggest that ICT has a positive impact on exchange rate, with an increase in ICT leading to an appreciation of the exchange rate. This is consistent with the theory that ICT can improve productivity, efficiency, and competitiveness, leading to an increase in exports and a subsequent appreciation of the exchange rate.

The study also found that the impact of ICT on exchange rate is influenced by various factors, including trade openness, economic growth, and infrastructure development. The results suggest that countries with higher levels of trade openness, economic growth, and infrastructure development are more likely to experience an appreciation of their exchange rate as a result of ICT adoption.

The findings of this study have important implications for policy makers and businesses. They suggest that investing in ICT can be an effective way to improve exchange rates, which can in turn increase exports and economic growth. Additionally, the study highlights the importance of considering the broader economic and infrastructure context in which ICT is adopted. Broadly, optimal investment in ICT leads to stable ERV.

Overall, the study provides evidence of the positive relationship between ICT and exchange rate and highlights the need for policymakers and businesses to consider the potential impact of ICT on exchange rates when making investment decisions.

ICTs Effects on Exchange Rate

Countries like Zambia with underdeveloped ICT infrastructure face higher international trade costs, which can be reduced by investing in ICT development. The challenge, however, lies in bridging the ICT investment gap, which often requires procuring ICT systems and software from external

markets. This leads to further exchange rate shocks due to importation of these technologies. To overcome this, Zambia could consider these four strategies:

1. Domestic ICT development: encouraging local innovation and development of ICT solutions to reduce reliance on imports.
2. ICT infrastructure sharing: collaborating with neighboring countries or regions to share ICT infrastructure and reduce costs.
3. International cooperation: partnering with developed countries or international organizations to access ICT expertise, funding, and technology transfers.
4. Gradual ICT development: prioritizing essential ICT infrastructure and gradually upgrading systems to minimize the initial investment burden.

By adopting these strategies, Zambia can bridge the ICT investment gap, reduce international trade costs, and conserve foreign exchange, ultimately promoting economic growth and development.

The dependence of less developed countries (LDCs) on developed countries (DCs) for access to ICT infrastructure results in a loss of foreign exchange and perpetuates a cycle of exploitation. The ownership of Internet and satellite infrastructure by DC companies leads to a significant financial burden on LDCs, weakening their exchange rates and limiting their ability to develop their own ICT infrastructure and economies.

This highlights the importance of ICT policy development in promoting economic growth and stability. A well-structured ICT policy can help address poor ICT development and exposure, stabilize financial markets, and create a conducive environment for reducing inefficiencies in financial markets.

Bon (2007) argues that the perpetuation of the digital divide limits the ability of LDCs to develop their own ICT infrastructure and economies, emphasizing the need for LDCs to develop their own ICT infrastructure. This can be achieved through policies that promote ICT development, improve access to infrastructure, and enhance the competitiveness of local industries.

CONCLUSION

In this study, we investigated the relationship between ICT and exchange rate in Zambia, with a specific focus on the implications for e-government efforts. The findings suggest that ICT has a positive impact on exchange rate stability, which in turn leads to improved economic growth, transparency, and accountability. The study results imply that investing in ICT infrastructure and digitalization enhances the effectiveness of e-government initiatives, promotes trade competitiveness, and attracts foreign investment. Therefore, it is recommended that the Zambian government prioritizes ICT development and integration into its e-government efforts to promote sustainable economic development and good governance.

The literature review revealed a gap in understanding the relationship between ICTs and exchange rate movements in the Zambian market. The study established a relationship between exchange rates and ICTs on both the productive and consumptive sides. This study contributes to the exchange rate management literature and ICT literature, offering a pioneering perspective on managing exchange rates and minimizing gaps in exchange rate management. By introducing the systemic theory, this research provides a new understanding of exchange rate management, optimizing ICT development in the market. The findings offer insights for policymakers and stakeholders to leverage ICTs in stabilizing exchange rates and promoting economic growth.

Results Implications on Zambian E-Governments Efforts

The study's findings on the relationship between ICT and exchange rate have significant implications for Zambia's e-government efforts, including the following:

1. Improved exchange rate stability: Investing in ICT can lead to a more stable exchange rate, reducing currency fluctuation risks and promoting a favorable business environment.
2. Enhanced economic growth: ICT-driven exchange rate stability can lead to increased economic growth, supporting sustainable development and poverty reduction.
3. Increased transparency and accountability: ICT adoption in e-government can enhance transparency and accountability, reducing corruption and mismanagement risks.
4. Better public services delivery: ICT can improve public services efficiency and effectiveness, increasing access to information and citizen engagement.
5. Competitive advantage: Zambia's e-government efforts can leverage ICT to boost trade competitiveness, attract foreign investment, and enhance global reputation.

Future Work Based on Findings

Future work can advance the understanding of ICT's impact on economic development in Zambia and other African countries, informing policy decisions:

1. Investigate ICT's impact on GDP, inflation, and employment rates.
2. Examine ICT's relationship with economic development in other African countries.
3. Analyze ICT's impact on poverty reduction in Zambia.
4. Examine ICT's impact on financial inclusion in Zambia.
5. Analyze ICT's impact on education and healthcare outcomes in Zambia.

AUTHOR NOTE

The costs associated with the data collection and analysis exercise were borne by the corresponding author ORCID iDs: https://orcid.org/0009-0008-1963-6734.

The author has not experienced any changes of affiliation to disclose.

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PROCESSING DATES

06, 2024

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