**BINDURA UNIVERSITY OF SCIENCE EDUCATION**

**FACULTY OF SCIENCE AND ENGINEERING**


**DEPARTMENT OF STATISTICS AND MATHEMATICS**

# IMPACT OF MOBILE PHONE PENETRATION ON ECONOMIC GROWTH IN SADC

**BY**

TAKUNDA CHIMHONDORO

(B202614B)

*A PROJECT SUBMITTED TO THE DEPARTMENT OF STATISTICS AND MATHEMATICS IN PARTIAL FULFILMENT FOR THE REQUIREMENTS OF BACHELOR OF SCIENCE HONORS DEGREE IN STATISTICS AND FINANCIAL MATHEMATICS*

SUPERVISOR: MS P HLUPO

(2024)

**APPROVAL FORM**

This is to clarify, that this research project is the result of my research work and has not been copied or extracted from past sources without acknowledgment. I hereby declare that no part of it has been presented for another degree in this University or elsewhere.

| | | |
|---|---|---|
| | | 10/06/2024 |
| Takunda Chimhondoro | ……. | ……. |
| B202614B | Signature | Date |

| | | |
|---|---|---|
| Certified | | 10/06/2024 |
| Ms. P. Hlupo | …… | ……. |
| Supervisor | Signature | Date |

| | | |
|---|---|---|
| Dr Magodora | …… | ……. |
| Chairperson | Signature | Date |

## DEDICATION

I dedicate this project to my Aunt Alice Chimhondoro, Father Adiyosi Chimhondoro, mother Landen Kuromora, and Aunt Nyadzai Chamutikinya for their love and support throughout the research process.

## ACKNOWLEDGEMENTS

I would like to thank God the Almighty for making it possible to fully complete this project. Without God's guidance, this research could not have been successful at all. I would like also to thank my supervisor Mrs Hlupo for her support and guidance during the period of study. I also want to thank the Chimhondoro family for the sacrifices, patience, and everlasting support they gave me. My gratefulness also goes to Bindura University of Science Education.

**ABSTRACT**

This study examined the impact of mobile phone usage on economic growth in the Southern African Development Community (SADC) region, using data from eight countries between 2000 and 2021. The research used panel data from world bank. The research found that an increase in mobile phone penetration has a positive effect on economic growth, with financial inclusion being a key driver of this growth. The findings suggest that mobile phone penetration plays a crucial role in promoting economic growth. The study recommends that authorities implement policies to promote the use of mobile phones, such as reducing communication costs to stimulate mobile phone diffusion and drive growth. Regulatory authorities and central governments should work together to craft policies that promote financial inclusion in the SADC region. This can be achieved by designing attractive interest rate packages and promoting policy consistency to encourage investment and economic growth. Using the system of Generalised Moment of Moments (GMM) estimator to address endogeneity issues, the results confirm that mobile phone penetration contributes significantly to economic growth in SADC. Part of the positive effect of mobile penetration comes from financial inclusion.

**TABLE OF CONTENTS**

**LIST OF TABLES**

**LIST OF ACRONYMS**

| | |
|---|---|
| MS | Mobile Phone Subscribers |
| GDP | Real Gross Domestic Product |
| INFL | Inflation |
| DPC | Deposits Private Credit |
| PSE | Primary School Enrolment |
| PD | Population density |

# CHAPTER 1: INTRODUCTION

## 1.0 Introduction

The widespread use of mobile phones has profoundly impacted how people live and work, allowing them to access banking services and revolutionising the banking industry with mobile financial services. Increasing access to financial services has the potential to help underserved populations break free from financial exclusion, promoting greater financial inclusion and playing a crucial role in reducing poverty and boosting economic growth. In the Southern African Development Community (SADC) region, where many countries are low-income, having access to basic financial services is seen as essential for alleviating poverty. The growth of the mobile phone market has been instrumental in the region's economy, and the SADC financial inclusion strategy aims to enhance country strategies through integration and support. As more people gain access to formal banking and financial services, the financial industry expands, contributing to economic growth. This study examines whether the widespread use of mobile phones has had a significant positive impact on economic development and growth rates in eight SADC countries from 2000 to 2021, providing a basis for discussing the importance of mobile phone communication in economic growth.

## 1.1 Background of the Study

The use of mobile phones has reached a significant achievement, with 6 billion subscriptions worldwide, covering 85% of the global population (World Bank, 2013). In sub-Saharan Africa, around 60% of the population has access to mobile phone coverage (Aker and Mbiti, 2012). Mobile phones have advanced from simple communication tools to offering a range of applications and services that enhance people's lives (Donner and Marcela, 2010). The widespread acceptance of mobile devices and fast technological advancements have made financial transactions easier, broadening financial access and promoting inclusivity in the financial industry (Rashid and Elder, 2009). Mobile money transfer programmes have filled the void left by traditional banks, with 16% of the population in sub-Saharan Africa utilizing mobile money services (World Bank, 2013). Mobile phones have delivered transformative advantages, providing new avenues for accessing services and supporting livelihoods (Donner and Marcela, 2010). The rapid and widespread integration of mobile phones has sparked great interest in their potential to propel economic growth and development, sparking debate on their contribution to sustainable livelihoods in developing nations (Mushongah and Scoones, 2012).

### 1.1.1 Mobile Phone Penetration in SADC.

**Table 1.1 Mobile Phone Subscribers in SADC countries (2000-2022)**

| Year | Number Of Phones | Year | Number Of Phones |
|---|---|---|---|
| 2000 | 9 451 069 | 2010 | 132 514 600 |
| 2001 | 12 834 817 | 2011 | 171 010 471 |
| 2002 | 17 070 777 | 2012 | 190 262 986 |
| 2003 | 22 608 541 | 2013 | 201 234 896 |
| 2004 | 29 418 161 | 2014 | 234 021 777 |
| 2005 | 47 337 737 | 2015 | 268 451 333 |
| 2006 | 62 070 777 | 2016 | 271 567 342 |
| 2007 | 76 034 485 | 2017 | 281 345 876 |
| 2008 | 95 522 162 | 2018 | 293 401 667 |
| 2009 | 111 379 831 | 2019 | 301 243 689 |
| | | 2020 | 321 208 453 |
| | | 2021 | 340 769 324 |

Table 1 above displays the number of mobile phone subscribers in SADC countries. The figures on the table reveal a steep increase in mobile phone subscribers which is in indication of the mobile phone penetration. The rate at which mobile phone subscriptions has been growing in developing countries tally with the observation by the World Bank (2012) that the developing world is “more mobile” than the developed world. This indicates that in SADC developing countries, more people, each year, have access to a mobile phone. The developing world followed the “mobile first” development approach while mobile communications have added value to legacy communication systems and have supplemented and expanded existing information flows in the developed countries, World Bank (2012). This concept is known as financial inclusion.

### 1.1.2 Economic Growth

Economic growth is typically measured by the annual increase in a country's Gross Domestic Product (GDP), which is a key indicator of a nation's economic performance and the well-being of its citizens (Aghion and Howitt, 2009). The Southern African Development Community (SADC) aims to promote economic development and regional integration through the establishment of a common market, fostering trade and financial freedom, competitive industrial development, increased investment, and poverty

reduction. However, SADC's real GDP growth has been volatile since 2000, experiencing a peak between 2003 and 2006, followed by a decline in 2007, as shown in the table below.

**Table 1.2: Annual Growth Rates of GDP at Market Prices in SADC from 2000 To 2021**

| Year | Annual Growth Rates (%) | Year | Annual Growth Rates (%) |
|---|---|---|---|
| 2000 | 1.1 | 2011 | 4.4 |
| 2001 | 2.7 | 2012 | 4.4 |
| 2002 | 4.0 | 2013 | 4.3 |
| 2003 | 3.4 | 2014 | 3.5 |
| 2004 | 5.3 | 2015 | 2.2 |
| 2005 | 6.6 | 2016 | 1.5 |
| 2006 | 7.3 | 2017 | 2.1 |
| 2007 | 8.0 | 2018 | 1.8 |
| 2008 | 5.7 | 2019 | 2.3 |
| 2009 | 0.6 | 2020 | 1.9 |
| 2010 | 4.0 | 2021 | 3.4 |

Table 1.1 for mobile phone penetration shows that there is an increase of mobile phone subscription in the period 2000 to 2021. However, the figures of GDP are fluctuating as of the period 2004 to 2021. This research will help to fill the gap in literature by investigating the impact of mobile phone penetration on economic growth where the number of mobile phones seem to increase. As the GDP also showed that the figures were not increasing but rather fluctuating as well as the rate of mobile penetration increasing, as such the research seeks to gain clarity on such relationship.

The impressive economic progress seen in SADC countries, with growth rates ranging from 39% to 72% between 2000 and 2021, demands further examination of the role of mobile phones in this growth.

### 1.2 Statement of the problem

In recent years, mobile phone penetration has increased rapidly in many countries, with significantly implications for economic growth. Despite this, there is limited research on the specific impact of mobile phone penetration on economic growth, particularly in developing countries. While mobile phone penetration consistently increased, GDP figures have fluctuated since 2004. This has raised a concern on the relationship between mobile phone penetration and economic growth. Given the fluctuating GDP figures and increasing mobile phone penetration, this research seeks to unpack their relationship.

Moreover, it is essential to assess how mobile phone services can enhance countries' efforts to achieve financial inclusion goals.

### 1.3 Aims of the study

This research aims to investigate the effect of widespread mobile phone use on the overall economic performance of a country, does more mobile phone use lead to economic growth?

### 1.4 Objectives of the study

This study aims to address a gap in existing research by exploring the following objectives:

1. Investigate the impact of Mobile phone penetration on economic growth,
2. Analyse the effect of other factors on economic growth as control variables.

### 1.5 Research Questions

1. How does mobile phone penetration affect a country's economic growth?
2. What are the key channels through which mobile phone penetration influences economic growth?

### 1.6 Scope of the study

This study examined a panel of eight countries in the Southern African Development Community (SADC) over 21 years, from 2000 to 2021. The panel analysis approach offers two key advantages: it acknowledges and controls for the unique characteristics of each country (heterogeneity) and provides a larger sample size, enhancing the reliability of findings. However, to maintain data integrity and avoid skewed results due to limited data availability, the analysis focused on a representative selection of eight countries, excluding potential outliers.

### 1.7 Assumptions of the study

Whilst caring out the study the following assumptions were assumed:

1. The study assumes that mobile phone penetration has a casual effect on economic growth, not vice versa (causality).
2. The study assumes a linear relationship between mobile phone penetration and economic growth (linearity).
3. The study assumes constant variance in the data (Homoscedasticity).
4. The study assumes normal distribution of data (Normality)
5. The study assumes that the sample of countries used is representative of the population of countries (No multicollinearity).
6. The study assumes that the data used is accurate and reliable (Data accuracy)

### 1.8 Justification of the study

This study is timely and relevant because it addresses a pressing issue: financial exclusion, a key driver of poverty. Mobile phone penetration offers a promising solution through mobile banking, which can promote economic growth by reaching the unbanked population. The study's findings provide valuable

insights for policymakers to develop strategies to expand network coverage and enhance financial inclusion. The business community can also use these findings to identify opportunities and challenges in the market. Additionally, the study's results can guide future research in this area, exploring how mobile phone penetration can unlock new markets for financial institutions and promote economic growth by serving the previously unbanked population.

### 1.9 Limitations of the Study

This research investigates the effect of mobile phone penetration on economic growth in the Southern African Development Community (SADC) region, with a specific focus on the financial inclusion initiatives made possible by the widespread adoption of mobile phones. The study concentrates on a representative sample of eight countries, and the findings broadly applied to other countries in the region, excluding those that were not included in the study. By examining the impact of mobile phone penetration on financial access and economic growth in these eight countries, the research aims to provide insights that be generalized to other SADC countries.

### 1.10 Definition of terms

#### 1.10.1 Mobile phone penetration rate

A mobile phone is a portable, wireless device that enables users to send texts and make and receive calls. Mobile phone penetration refers to the total number of mobile phones or SIM cards in use within a particular country or population. The term "penetration rate" is often misused to describe the number of active mobile phone users as a percentage of the total population, but this definition is inaccurate since it does not account for individuals with multiple mobile phones, resulting in rates that can exceed 100%. A more accurate definition of penetration rate would consider the total number of mobile phones or SIM cards in use, rather than the number of unique users.

#### 1.10.2 Economic Growth

Economic growth represents a long-term expansion in the production of goods and services, measured by the increase in real Gross Domestic Product (GDP), adjusted for inflation, indicating a strengthening economy. It represents an expansion of a nation's economy, marked by a rise in key macroeconomic indicators such as GDP per capita, which typically follows an upward trajectory, though not always linear. This growth has a positive impact on the economic and social sectors, leading to improvements in the standard of living. As Amartya (2012) notes, economic development is a broader concept that encompasses not only economic growth but also the social implications of that growth, including enhancements in quality of life, poverty reduction, and overall well-being.

## 1.11 Conclusion

Chapter 1 sets the stage by introducing the topic, giving background information, identifying the issue, and laying out the research goals and inquiries.

# CHAPTER 2: LITERATURE REVIEW

## 2.0 Introduction

This chapter offers a comprehensive introduction to the growth of mobile phone, the development of phone financial services, the expansion of financial inclusion, and their connection to economic growth. The first section introduces theoretical literature, the second section introduces empirical literature and the research gap is clarified.

## 2.1 Theoretical Literature

This section will review the existing theoretical literature that supports the idea that the utilisation of mobile phones boosts financial services, as well as the link between financial progress and economic activity, providing a foundation for evaluating these concepts.

### 2.1.1 Information and Communication Technology (ICT) for Development Theory

Information and Communication Technology (ICT) for Development, commonly known as ICT4D, is the use of ICT to aid in the social and economic advancement of developing nations. This field covers various elements such as necessary infrastructure, key players involved, and ways to address the digital gap. Its main goal is to foster a wide-ranging appreciation of how ICTs can be utilised for both societal and economic growth. This involves providing individuals from various sectors with the requisite knowledge to effectively utilise ICTs in meeting a country's developmental objectives and addressing its requirements (Yingqin Zheng, 2011).

Information Communication Technologies (ICTs) are dynamic tools that facilitate the generation, transmission, and manipulation of data. Mobile phones have become vital components of modern society since their inception in 1946. This section delves into the overall growth of information and communication technologies (ICT) and their influence on the economy, exploring how they contribute to economic growth and expansion (Will Venters, 2011)

The growth of Information and Communication Technologies (ICT) has the potential to boost economic growth by creating a ripple effect, where increased connectivity and user numbers lead to more opportunities and advancements. The value of ICT, such as telephone networks, tends to grow rapidly as more people start using these technologies. However, in order to reap these rewards, a certain level of development is necessary (Tony Connford, 2012)

While wealthy countries have traditionally been the ones to benefit from ICT progress, recent research indicates that developing nations can also experience significant advantages (Andrianaivo and Kpodar,

2014). Telecommunications networks are recognised as crucial public infrastructure, just like education, healthcare, and transportation services, and they bring positive effects to society (Waverman et al., 2019).

The economic advantages of ICT can be divided into direct benefits from providing telecommunications services and indirect benefits from the various ways these services are used (Lewin and Sweet, 2015). ICT growth drives economic activity by improving productivity, expanding markets, increasing access to information, and encouraging innovation.

**Table 2.1: Vehicles through which ICT Affects Economic Growth**

| Direct Effects | Indirect Effects |
|---|---|
| More jobs and higher demand | Efficiency improvements and lower operating expenses |
| Increased tax income for the government | Rural progress and women's empowerment |
| Enhanced international trade stability | Equal access to financial services for all |

The expanded availability of ICT brings about positive outcomes across various economic measures. As the supply of ICT grows, job opportunities emerge in areas such as network construction, system management, and manufacturing, leading to an increase in employment and incomes. This in turn boosts domestic demand. Furthermore, government revenues see an upturn through taxes like VAT, income tax, and corporate tax. Foreign Direct Investment (FDI) also sees a rise as overseas investors take interest in local ICT advancement, benefiting the balance of payments. A well-established ICT system is recognised for attracting more FDI, leading to strong economic growth fuelled by increased investments, job opportunities, and government revenue.

The indirect impacts of ICT advancement are numerous and wide-ranging, including:

1. Encouraging the accumulation of capital
2. Enhancing company productivity
3. Enhancing market efficiency
4. Supporting rural development
5. Empowering women
6. Promoting financial inclusion

These indirect impacts demonstrate how ICT progress can contribute to broader socio-economic advancement and inclusive growth.

Advanced mobile systems have beneficial impacts, such as enhancing communication channels, strengthening farmers' ability to negotiate, cutting out middlemen, and supporting non-agricultural business opportunities. Moreover, the development of ICT can be especially advantageous for women, who frequently encounter obstacles in obtaining formal bank services. Through ICT-enabled financial inclusion, women can gain autonomy by fostering economic independence (GSMA Women, 2013). Nonetheless, existing models may not offer sufficient insights to differentiate the effects of ICT on women and men, underscoring the necessity for additional studies to comprehensively grasp and optimise the advantages for women.

Mobile devices play a crucial role in supporting economic progress by facilitating the provision of mobile financial services. These services open up new opportunities for entrepreneurs and businesses to thrive. A prime example is mobile banking, which improves access to financial services like money, credit, and banking for individuals, especially those in underserved areas. It removes the need for in-person visits to banks, saving time and cutting down on transaction fees from ATMs. Through mobile banking, users can carry out a range of transactions such as payments, money transfers, purchasing prepaid electricity and airtime, checking balances, and making cash deposits and withdrawals (Leff, 1984).

### 2.1.2 Financial Development Theory

According to the World Bank (2013), financial inclusion involves the ability to access financial services without facing obstacles like high costs or other restrictions. Developing countries often lack sufficient financial infrastructure and services compared to developed nations with stronger financial systems. It is essential to promote financial inclusion among marginalized populations to reduce poverty and ensure that formal financial services are affordable and accessible to all (Triki and Faye, 2013). The key focus is on how to effectively encourage financial services and their impact on economic activity. Financial inclusion covers services such as credit, insurance, banking, and formal payment methods. The African Development Bank (2013) highlights that access, usage, and quality are crucial aspects of financial inclusion. By promoting financial inclusion, not only can it improve the lives of those in poverty, but it can also boost global economic activity.

Merely having access to financial services does not directly result in increased economic activity; rather, it enables the development of the financial sector, which in turn stimulates economic activity. When more individuals are able to use formal banking services, it can benefit the economy. Levine (2015) suggests that financial development can have a positive impact on economic growth through various means:

1. Financial intermediaries offer cost-effective information on investment opportunities, leading to more efficient allocation of resources and funding for promising projects.
2. Financial intermediaries supervise investors, reducing conflicts of interest and encouraging savings, ultimately increasing the availability of capital for investments.
3. Financial intermediaries gather savings to support large-scale projects that individual investors could not afford on their own.
4. Through diversifying investment portfolios, financial intermediaries spread risk across different projects, lowering overall risk through diversification.

These mechanisms demonstrate how financial development, supported by financial inclusion, can promote economic growth. Financial intermediaries play a crucial role in directing investments towards high-return ventures and reducing transaction costs, facilitating the exchange of goods and services, and positively impacting savings and investment choices (Levine, 2015).

Additionally, increasing access to financial services through financial inclusion assists less privileged individuals in funding profitable investments, leading to improved resource distribution efficiency (Galor and Zeira, 2019). Financial inclusion also aids in the accumulation of human capital, as well as in poverty reduction and the mitigation of inequality (World Bank, 2014; GSMA Women, 2013).

Furthermore, the development of the financial sector drives economic activity by facilitating the entry of new businesses into the market, emphasising the significance of entrepreneurs being able to utilise financial services to grow and bring their projects to market (Klapper et al., 2017; Rajan and Zingales, 2013).

Many African economies continue to depend greatly on cash, showing a clear preference for physical money. In order to promote the use of mobile financial services and digital payments, it is important to highlight how easy it is to convert physical cash into mobile wallets and digital payment systems (World Bank, 2014). Although attaining universal financial access is a goal for the future, it does not mean giving unlimited access to credit to all. The recent financial crisis serves as a warning about the dangers of uncontrolled credit expansion, which should be prevented (World Bank, 2014).

### 2.1.3 Social Constructivist Theory

This theory suggests that people develop their perspective on the world through their interactions with others and technology. Studies indicate that providing more financial opportunities for disadvantaged communities and individuals benefits not just them but also financial institutions. In nations like India,

achieving financial inclusion is vital for being able to open savings accounts (Shashank, 2014), although this need is widespread. The level of financial inclusion can vary in complexity, depending on how much clients engage with financial products like getting loans (Leeladhar, 2016). Merely having a savings account doesn't automatically mean complete financial inclusion.

Technology can assist banks in reaching underserved populations while still achieving their business goals (Shashank, 2014). Obstacles to using formal financial services, such as high fees, long distances, and bureaucratic processes (World Bank, 2014), deter many individuals from accessing these services, resulting in inefficiencies in the market and policy recommendations for reducing poverty. The introduction of modernisation and ICT, specifically through mobile phones, can help address these market inefficiencies, allowing underserved individuals to access crucial financial services like bank accounts and loans.

Numerous studies have explored the factors that encourage financial inclusion in developing countries, with a particular focus on the impact of modern Information and Communication Technology (ICT) such as mobile phones (Maria and Frida, 2014; Shashank, 2014). It is widely acknowledged that mobile phones play a crucial role in increasing access to financial services such as savings and loans, which in turn promotes economic growth and development.

Utilising modern ICT, frameworks can be put in place to extend financial services to rural communities, thereby reducing costs for banks, expanding customer outreach, and improving risk management capabilities (Shashank, 2014). Mobile phones also allow customers to directly engage with their banks, check account balances, and conduct transactions from any location, providing unmatched immediacy, convenience, and control compared to traditional methods.

### 2.1.4 Digital Financial Inclusion Theory

Digital financial inclusion refers to the provision of formal financial services to those who currently cannot access them at a reasonable cost, using digital tools. Despite the benefits gained from years of experience in digital financial services, there are inherent risks involved. These risks include non-financial companies entering the financial sector with new technologies, financial institutions forming partnerships with third parties, varying regulations for deposit-like products, potential unforeseen costs for inexperienced customers, and new privacy and data security concerns arising from the use of novel data types (David Mhlanga, 2022).

Economic growth and higher income levels make it easier for individuals to access financial services and participate in economic activities. Population density also plays a role in access to financial services, with more densely populated areas typically having better access to banks. The development of infrastructure impacts the accessibility and cost of financial services, as poorly developed infrastructure can lead to higher costs and lower demand. The presence of bank branches is essential for financial inclusion, as more branches can reduce barriers such as costs and distances. The strength and regulation of the banking sector also play a part in financial inclusion and help mitigate the impact of economic shocks (David Mhlanga, 2022).

## 2.2 Empirical Literature

This part of the chapter will examine the existing scientific studies on how mobile phone usage (mobile phone penetration) affects financial inclusion, using the conceptual structure outlined in the previous part of the chapter as a foundation. It will analyse the empirical evidence to understand the connection between mobile phone penetration and financial inclusion. The review will begin with studies on the impact of ICT development on economic growth, followed by research on financial inclusion, and finally, investigations into the factors that determine financial inclusion.

### The Progress of ICT and Economic Expansion

Studies have repeatedly demonstrated a strong and positive correlation between the widespread use of mobile phones (mobile phone penetration) and economic expansion, indicating that increased mobile phone use has a substantial and beneficial effect on the economy, regardless of a country's income level. Early studies, such as Hardy's (2018) cross-country analysis, found that telecommunication penetration had a positive effect on economic growth, unlike radio penetration. However, the issue of reverse causality arises, making it difficult to determine whether better communication systems lead to higher income or vice versa. To address this, Norton (2015) included the initial value of telephone stock in a study of 47 countries, finding results consistent with Hardy's findings. Research indicates that increased mobile phone use (mobile phone penetration) is linked to improved economic performance, suggesting that mobile phones benefit the economy, even when controlling for reverse causality.

Roller and Waverman (2016) developed an extensive model built on previous studies focused on a single equation, laying the groundwork for future research in this area. Their model encompassed telecommunications investments, considering both supply and demand factors, along with an equation for macroeconomic growth. By adopting this integrated approach, they were able to simultaneously assess the connections between these factors and economic growth. Their research emphasised the importance of network externalities, where the value of the telecommunications system increases as the user base

expands. This led to the identification of a nonlinear correlation between telephone penetration and economic growth, with growth rates increasing rapidly after a certain threshold is reached. Subsequently, Sridhar and Sridhar (2014) broadened the analysis to include mobile phones, discovering that mobile penetration had a more significant influence on economic growth compared to fixed telephone lines in a study of 63 low- and middle-income countries from 1990 to 2001.

Waverman et al. (2015) expanded on the work done by Roller and Waverman (2016) and carried out a research project on 92 nations from 1980 to 2003. They revealed that mobile phones are fulfilling a comparable function in today's low- and middle-income countries as fixed telephone lines did in OECD countries in the 1970s and 1980s. Nonetheless, thanks to swift technological progress, low- and middle-income nations can bypass conventional stages of development. The research concluded that mobile phones are taking the place of fixed lines in poorer countries and are having a positive, notable impact on economic progress. To be specific, a 10% rise in mobile usage in developing countries resulted in a 0.6% growth in the growth rate.

Roller and Waverman (2016) discovered that in OECD countries, having fixed-line telecommunications boosted output growth by approximately a third, with a 10% rise in telecommunications penetration corresponding to a 1.5% growth rate increase. On the other hand, mobile phones have transformed how information is shared without expensive physical infrastructure. In low- and middle-income countries, mobile phones are an alternative to fixed lines, while in high-income countries, they work alongside them (Waverman et al., 2015). Notably, the impact of mobile phones on growth in low- and middle-income countries is said to be twice as significant as in high-income countries, highlighting the importance of adaptability and positive external influences during the earlier stages of development. Mobile phones have substantially boosted growth and progress in low- and middle-income countries, narrowing the gap with high-income nations.

Studies have indicated that mobile phones play a significant role in driving economic growth in developing nations. Waverman, Meschi, and Fuss (2015) determined that in poorer countries, mobile phones are replacing fixed lines and every 10% increase in mobile penetration leads to a 0.6% rise in growth rate. In contrast, Roller and Waverman (2019) found that in OECD countries, fixed-line telecommunications contribute significantly to output growth, with a 10% increase in penetration resulting in a 1.5% growth rate increase. The widespread adoption of mobile phones has facilitated the rapid dissemination of information without the need for expensive physical infrastructure, making them a crucial asset for economic progress.

Kathuria et al. (2019) carried out a case study examining the impact of widespread mobile phone usage on the economic growth and progress of Indian states from 2000 to 2008. By utilising a modified Roller and Waverman model, they discovered that higher rates of wireless phone adoption resulted in increased economic activity, with a notable effect seen when the penetration rate reached 25%. In contrast, Lee et al. (2019) explored the growth implications of mobile phones in sub-Saharan Africa, addressing potential endogeneity concerns through a System GMM estimator. Their findings indicated that regions with limited landline infrastructure experienced more benefits from mobile phones, suggesting that mobile phones serve as substitutes rather than complements to fixed lines in low- and middle-income countries. These results align with Waverman et al.'s (2015) research, emphasising the importance of mobile phones in driving economic prosperity in developing areas.

Research conducted in Uganda by Muto and Yamano (2019) discovered that broadening mobile phone network coverage, as opposed to just owning a phone at home, enhances the flow of information and motivates farmers in remote areas to engage in markets. By using data obtained from household and community surveys, the researchers analysed the factors that influence mobile phone network coverage, household mobile phone possession, and market involvement for banana and maize farmers. Their findings indicated that an increase in information flow leads to a decrease in marketing expenses, such as transportation costs, and decreases the amount of wasted produce due to spoilage. This illustrates that the advancement of mobile phone technology not only stimulates economic growth by improving efficiency and increasing output but also underlines the importance of mobile phone coverage in facilitating market participation and enhancing agricultural productivity.

Previous studies examining the relationship between ICT development and economic activity have not taken into account two important factors: the impact of telecommunications prices and the specific ways in which mobile phones influence growth. Andrianaivo and Kpodar (2013) identified these gaps in their research and proposed that expensive telecommunications services can hinder economic development and that financial inclusion plays a crucial role in how the expansion of wireless phone usage enhances economic activity. Despite some limitations and missing variables in their study, it opens up possibilities for improvement, which this current research intends to capitalise on. By addressing these shortcomings, this study aims to offer a more thorough insight into the correlation between ICT advancement and economic prosperity

**Mobile Phone Penetration**

Numerous research studies have explored the influence of mobile phones on economic development and financial inclusivity in African nations. Mihasonirina and Kangni (2017) alongside Maria and Frida (2014) utilised the Generalized Method of Moments (GMM) technique to analyse how mobile phones affect economic growth, concluding that they play a role in promoting financial inclusivity, particularly in terms of borrowing, thereby stimulating economic expansion. Andrianaivo and Kpodar (2013) also employed the GMM estimator method to scrutinise the impact of mobile phone accessibility on economic growth in African countries, discovering that the development of mobile phone technology significantly contributes to economic expansion by improving financial inclusivity. Furthermore, Peter (2015) assessed the influence of government regulations on the expansion of mobile financial services and access to financial services for marginalized populations in Africa. Emphasising the necessity of financial reforms that embrace modern technology to encourage advancement and progress in mobile financial services, as well as cultivating financial sectors that are fair, secure, and operational for all segments of society. These studies indicate that mobile phones have a beneficial effect on economic growth and financial inclusivity in African countries, with regulatory frameworks supporting mobile financial services potentially enhancing these advantages further.

## 2.3 Research gap

This study aims to contribute to the existing body of research by examining how the presence of mobile phones influences financial inclusion and economic growth in the SADC region. Despite the rise in mobile phone usage, financial inclusion, and GDP, the connection between these factors is not well understood. The primary goal of this research is to determine whether financial inclusion acts as a pathway through which mobile phone accessibility impacts the economy. Furthermore, it seeks to clarify the relationship between mobile phone usage and GDP. The study will assess how mobile phone services can improve financial inclusion and economic growth in the SADC region, filling a significant knowledge gap. Ultimately, the findings of this study will offer valuable insights for policymakers and stakeholders on how to utilise mobile phone accessibility to promote sustainable economic growth and financial inclusion.

## 2.4 Conclusion

This part examined previous theories and practical studies on how the spread of mobile phones affects financial inclusivity and economic advancement. Studies from various countries have looked into this connection using different types of models. To expand on this body of research, our current study will also use both static and dynamic models to gain a thorough insight into how mobile phone usage, financial inclusivity, and economic growth are interlinked. By using both types of models, our study

seeks to understand both the immediate and long-term impacts of mobile phone penetration on financial inclusivity and economic growth.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.0 Introduction

This chapter provides an overview of the research methodology utilised in the study, which includes the model specification and variable selection. To explore the effects of mobile phone usage on financial inclusion and economic growth in SADC countries, a thorough approach was deemed essential. The researcher justifies the choice of particular variables and formulates hypotheses regarding the relationships between economic growth and the selected explanatory variables. Additionally, the chapter highlights the proxies employed for each variable. A regression analysis methodology was utilised to examine the relationships between the variables and ascertain the impact of mobile phone penetration on financial inclusion and economic growth.

## 3.1 Research Design

Research design provide a guideline or a plan for the study, helping researchers to come out with relevant results. In this study, the research design provides a framework for analysing the impact of mobile penetration on economic growth. Various quantitative research designs were used to analyse the relationship between mobile phone penetration and economic growth. Regression analysis was employed for analysis. The study accounted for additional factors that could impact economic growth, including inflation rates, population density, access to domestic credit, and primary enrolment rates.

## 3.2 Data sources

This study on the impact of mobile phone penetration on economic growth leverages secondary data from World Bank. Panel data from these World Bank's reports and databases, covering the period from 2000 to 2021 was utilised. The advantages of using secondary data include:

1. Cost-effectiveness: Secondary data collection is less expensive compared to primary data collection.
2. Readily available: Secondary data is easily accessible, especially with the internet and new technologies.
3. Timesaving: Secondary data reduces the time spent on data collection, allowing for faster analysis.
4. Longitudinal and international comparative studies: Secondary data enables researchers to analyse trends over decades and conduct cross-country comparisons, thanks to the regular updates and availability of data.

By utilizing secondary data can effectively examine the relationships between mobile phone penetration and economic growth over an extended period.

### 3.3 Research Instruments

Research instruments refer to the tools used for data collection and storage. In this study, digital tools were employed for data collection and storage. Specifically, the researcher utilized phones and laptops to gather and access secondary data from the internet. Laptops played a crucial role throughout the research analysis, as they enabled the efficient processing of large datasets due to their computational strength. The laptop's capabilities allowed for the seamless handling of vast amounts of data, facilitating the research process.

### 3.4 Description of Variables and Expected Relationships

| **Variable** | **Proxy** | **Variable Definition** | **Expected Sign** |
|---|---|---|---|
| | | **Dependent Variable** | |
| GDP | Real GDP Growth Rate | (Current Year Real GDP/ Previous Year GDP)-1 | Positive |
| | | **Independent Variables** | |
| MS | Mobile phone Subscribers | Absolute Figures on Total subscribers | Positive |
| INFL | Annual Inflation Rate | Annual inflation rates as given world bank | Positive |
| DPC | Domestic Private Credit | Total Deposits | Positive |
| PD | Population density | Number of people per Square kilometre | Positive |
| PSE | Primary School Enrolment | Number of Children Enrolled for primary education | Positive |

#### 3.4.1 Inflation rate (INFL)

The correlation between inflation and economic growth is a highly debated subject in the field of macroeconomics. While some studies indicate a negative association, others argue for a positive influence. Inflation, which refers to a rise in prices, can result in decreased purchasing power, consumption, and investments, ultimately leading to a drop in real GDP. Elevated inflation rates can also lower exports, further contributing to the decrease in real GDP. Nonetheless, certain studies, like the

Philips Curve, propose that high inflation can result in reduced unemployment, implying a beneficial impact on economic growth (Philips Curve, 2021).

Prior research has produced mixed findings. Kormendi and Meguire (2012) detected a significant adverse impact of inflation on growth, while Fischer (2014) and De Gregorio (2015) verified a negative correlation between inflation and growth. Barro (2018) similarly identified a negative association but suggested that it might not be linear. Conversely, Levine and Zervos (2013) and Sala-i-Martin (2015) concluded that inflation does not significantly determine economic growth.

### 3.4.2 Population Density (PD)

Labour is a crucial factor of production in an economy, and an increase in the labour force due to population growth can lead to an increase in total output and subsequently, GDP. However, this may also result in an excess supply of labour, potentially decreasing wages and the cost of production. Nevertheless, this effect may be observed in the long run, as new labour market entrants may not be considered until they reach a certain age. Moreover, a country may struggle to provide sufficient employment opportunities for its growing population, leading to increased unemployment and potentially, a decrease in GDP. Therefore, the researcher anticipates a positive coefficient, suggesting that population growth may improve GDP.

### 3.4.3 Mobile Phone Subscriptions (MS)

Acker and Mbiti (2010) discovered various ways in which mobile phones can be advantageous for consumers and producers in Sub-Saharan Africa. They contended that mobile phones could:

1. Enhance access to information, lowering search costs and improving market efficiency
2. Boost communication, resulting in increased productivity for businesses and better management of supply chains
3. Create job opportunities and avenues for income generation in mobile-related services

Muto and Yamano (2009) revealed that mobile phones have the potential to enhance agricultural markets in Uganda by encouraging farmers to participate more actively. Moreover, mobile phone applications and development projects can aid in the delivery of financial, agricultural, health, and educational services. Rasmussen (2010) highlighted the growing demand for mobile phone financial services, particularly savings options.

The rapid expansion of mobile services is revolutionising global information and communication systems, with increasing recognition of their potential as a developmental tool. Studies have shown that the growth of mobile phones, as indicated by penetration rates, has a beneficial effect on economic growth in Africa,

in line with previous research. As a result, the researcher is convinced that the development of mobile phones plays a positive role in promoting economic growth in SADC countries.

In conclusion, mobile phones can boost economic growth and sustainability in Africa by increasing access to information, improving communication, generating employment opportunities, and enabling essential services to be delivered more efficiently.

### 3.4.4 Primary School Enrolment (PSE)

The relationship between education and economic development has been acknowledged, with educational infrastructure serving as a key indicator of economic progress. Research has consistently shown a strong link between economic variables and school enrolment. Studies have yielded varying findings on the direction of causality between economic growth and primary schooling, with some suggesting that economic growth drives primary schooling (Erdogan and Yildirim, 2019), while others argue that primary schooling fuels economic growth (Yaylalar and Lebe, 2012). Additionally, research in Turkey has revealed positive correlations between economic growth and schooling at both primary and secondary levels (Duman, 2018). Based on these findings, the researcher is confident in asserting a positive significance between primary school enrolment and GDP per capita, highlighting the critical role of education in driving economic development. Countries with higher GDP per capita tend to have greater levels of financial accessibility.

### 3.4.5 Domestic Private Credit Over GDP (DPC)

Funds offered to private businesses by financial institutions, like loans, investments, and trade agreements, are known as financial inclusion. Adeola and Evans (2017) in Nigeria investigated how financial inclusion and financial growth affect economic diversification. They discovered that greater access to financial services and their utilization had a notable impact on economic diversification. The research also indicated that the variety of banking services provided and the accessibility of credit were important factors influencing financial inclusion. This emphasises the significance of financial inclusion in advancing economic diversification and progress.

## 3.5 Diagnostic tests

### 3.5.1 Panel unit root test

According to Granger and Newbold (1974), when working with time series data, it is possible to detect a statistically significant correlation between variables even if there is no real economic link between them. This can happen when both the dependent and independent variables have unit roots, indicating they are non-stationary. This can lead to false regressions, where a significant correlation is found even though there isn't one, particularly when examining variables in their original form. To tackle this issue, unit root

tests are used, which test two null hypotheses: one assuming a random walk with drift and another assuming a trended random walk. These tests helped determine the stationarity of mobile phone subscriptions, inflation rate, primary school enrolment, population density and domestic private credit, ensuring a more dependable regression analysis.

**Levin, Lin, and Chu Test**

The Levin-Lin-Chu (LLC) unit root test was applied to assess the stationarity of the variables. LLC suggests that conventional individual unit root tests may have constraints, especially in small sample sizes, as they might fail to detect sustained deviations from balance. In simpler terms, these tests may lack the ability to detect non-stationarity in small samples, potentially resulting in incorrect conclusions. The LLC test tackles this problem by offering a more reliable testing method.

### 3.5.2 Multicollinearity Test

In his work from 2004, Gujarati explains multicollinearity as the scenario in which two or more independent variables show a strong correlation, resulting in challenges when it comes to determining their impact on the dependent variable. This correlation between variables causes a lack of independence, evident through high inter-correlations. Multicollinearity can greatly compromise the accuracy of model specification and the reliability of parameter estimation in regression analysis. To tackle this problem, variables that display high correlations are typically excluded from the model and identified through different methods used to identify multicollinearity.

**Correlation Matrix**

To detect multicollinearity, the researcher employed a Correlation Matrix, which examines the relationships between variables to identify if they are correlated or not. The hypothesis is stated as:
Null Hypothesis (H0): There is no significant correlation between the independent variables (i.e., no multicollinearity).
Alternative Hypothesis (H1): There is a significant correlation between the independent variables (i.e., multicollinearity exists).
In other words, the Correlation Matrix helps determine if the independent variables are highly correlated, indicating multicollinearity, or if they are unrelated, suggesting no multicollinearity. Mobile phone subscription, inflation rate, population density, primary school enrolment and domestic private credit were tested for their correlation.

**Variance Inflation Factor (VIF)**

The Variance Inflation Factor (VIF) is a statistical tool used to assess the severity of multicollinearity in a regression model. As proposed by Farrar and Glauber (1967), VIF measures the extent to which the

variance of parameter estimates is inflated due to correlations among explanatory variables. The VIF formula is:

$$VIF = \frac{1}{1 - R_j^2}, j = 0, 1, 2, \ldots m$$

Where $R_j^2$ is the coefficient of determination from the regression of a particular explanatory variable on all other explanatory variables.

In simpler terms, VIF helps identify how much the variance of a parameter estimate increased due to multicollinearity, allowing researchers to adjust the model accordingly. A high VIF value indicates significant multicollinearity, while a low value suggests minimal multicollinearity.

The Variance Inflation Factor (VIF) measures how much the variance of an independent variable is affected by its relationship with other independent variables. It is calculated using the coefficient of determination ($R_j^2$) for each explanatory variable. A VIF value of 10 or more indicates a high level of multicollinearity between variables, which can be a problem. On the other hand, a VIF value close to one indicates that the variables are not highly correlated. In general, VIF values can be interpreted as follows:

1. VIF ≥ 10: High correlation and potential multicollinearity issue
2. VIF < 10 but > 1: Moderate correlation
3. VIF ≈ 1: Low or no correlation

Researchers like Farrar and Glauber (1967) have established these guidelines to help identify and address multicollinearity issues in regression analysis.

### 3.5.3 Heteroscedasticity Test

Heteroscedasticity occurs when the error terms for explanatory variables have non-constant variance, violating a key assumption of regression analysis. This leads to inefficient OLS estimators, which no longer have the minimum variance property among unbiased estimates. To detect heteroscedasticity, the Breusch-Pagan-Godfrey test was employed. The test was conducted under the following hypotheses:
Null Hypothesis (H0): The model does not exhibit heteroscedasticity (constant error variance).

Alternative Hypothesis (H1): The model exhibits heteroscedasticity (non-constant error variance).
In other words, the test checks if the error variance remains constant across all levels of the explanatory variables or if it varies, indicating heteroscedasticity.

### 3.5.4 Autocorrelation Test

According to Gujarati (2014), when using secondary data, which often involves estimates, there is a high likelihood of correlation between disturbance terms. Therefore, it is crucial to test for autocorrelation when using secondary data. If autocorrelation is present, the estimators may not be efficient, meaning they may not have minimum variance. However, if no autocorrelation is found, the estimators are consistent, unbiased, and efficient, indicating reliable estimates. The hypothesis is stated as:

Null Hypothesis (H0): There is no autocorrelation between disturbance terms (no serial correlation).

Alternative Hypothesis (H1): There is autocorrelation between disturbance terms (serial correlation exists).

### 3.5.5 Pesaran CD Test for Serial Correlation/Cross-sectional Independence

To check for serial correlation in the fixed effects model, the researcher conducted the Pesaran CD test. If the p-value exceeds 5 per cent, we cannot reject the null hypothesis that there is a correlation, indicating that there is no serial correlation present in the model.

### 3.5.6 The Sargan Test for testing over-identifying restrictions.

To confirm the reliability of the tools and detect any serial correlation, the researcher utilised the Sargan test. If the p-value exceeds 0.05, this indicates that the null hypothesis cannot be dismissed, demonstrating that the over-identifying restrictions are appropriate. Essentially, this means that the instrument is considered reliable and the researcher can trust the outcomes. In essence:

1. When the p-value > 0.05, the null hypothesis is upheld, indicating that the instrument and over-identifying restrictions are reliable.
2. When the p-value ≤ 0.05, the null hypothesis is refuted, hinting at potential issues with the instrument or the over-identifying restrictions.

Put simply, a p-value above 0.05 signifies that the instrument is probably trustworthy, whereas a p-value equal to or below 0.05 implies possible problems with the instrument or over-identifying restrictions.

### 3.5.7 Arellano-Bond test to assess the presence of Serial Correlation for validation of instruments

The Arellano-Bond test is utilised to confirm the validity of instruments by examining for serial correlation in first differences. The test outcomes demonstrate that instruments are deemed valid if:

1. The p-value for AR (1) is below 0.05 (significant), leading to the rejection of the null hypothesis of no serial correlation in the first differences.

2. The p-value for AR (2) is above 0.05 (not significant), indicating the inability to reject the null hypothesis of no serial correlation in second differences.

Essentially, instruments are considered valid when there is a significant serial correlation in first differences (AR (1)) but no significant serial correlation in second differences (AR (2)). This suggests that the instruments are properly specified and can be utilised in the analysis.

### 3.6 Analytical Model

This research follows a regression model used by Andrianaivo, Kpodar (2013) and Waverman et al. (2015) to apply an endogenous growth model in examining how mobile phone penetration impacts economic growth. Specifically, aim to explore the connection between mobile phone penetration and economic growth using a typical endogenous growth model while considering country-specific (i) and time-specific (t) factors. The econometric model can be summarised as follows:

GDPi,t = f(MS i,t, INFLi,t, PDi,t, PSEi,t, DPCi,t)

This means that economic growth for a particular country i in year t is determined by the previous GDP growth rate (GDP (i, t-1)), mobile phone penetration (Mobile Penetration (i, t)), and other factors. By including the lagged GDP growth rate, the research captured the ongoing impact of mobile phone usage on economic activity over time. This gives a generalized equation, which is:

$$GDP_{i,t} = \beta_0 + \beta_1 INFL_{i,t} + \beta_2 MOB_{i,t} + \beta_3 PSE_{i,t} + \beta_4 PD_{i,t} + \beta_5 DPC_{i,t} + \eta_i + \epsilon_{i,t} \ldots\ldots\ldots (3.2)$$

Where,

$GDP$= real gross domestic product (RGDP),

$INF$ = Inflation rate

$MOB$ = Mobile phone development

$PSE$ = Primary school enrollment

$PD$ = Population density

$DPC$ = Private Deposit Credit

#### 3.6.1 Regression Estimators

This section describes the regression models and estimators utilised in the analysis. The research provided a rationale for selecting the System Generalized Method of Moments (GMM) estimator, as it is well-suited for my analysis of panel data. Furthermore, the research clarified the suitability of Fixed Effects (FE) and Random Effects (RE) estimators for research. The GMM estimator is preferred due to its ability to address endogeneity and data dynamics, while the FE and RE estimators account for unobserved variations and individual-specific effects. By employing a combination of these estimators, the research thoroughly investigated the connections between mobile phone penetration and economic growth.

**System GMM**

Regression Model is an adapted panel data model that accounts for both temporal and individual dimensions. However, this type of model raises concerns about endogeneity, where independent variables correlate with error terms. Specifically, the variables may be predetermined (correlated with past error terms) or endogenous (correlated with both past and present error terms). To address these issues, the research applied the System Generalized Method of Moments (GMM) estimator implemented by Blundell and Bond (2013). My model examines the determinants of economic growth, including:

1. Control variable: Population density.
2. Control variable: Primary school enrolment rate (accounting for human capital).
3. Control variables: inflation and domestic private credit.

To instrument for GDP, the research used annual growth rates. By using the System GMM estimator and appropriate instruments, the research mitigated endogeneity concerns and robustly estimate the relationships between these variables and economic growth.

**3.7 Model Validation Test.**

The Hausman test is utilised to determine whether a GMM model is more suitable for analysing panel data. As panel data typically displays characteristics of both fixed and random effects, the Hausman test aids in selecting the most appropriate model. By comparing the estimates of fixed effects and random effects, if the Hausman statistic surpasses its critical value, the null hypothesis is discarded, indicating a preference for the fixed effects model. In simpler terms:

1. If the Hausman statistic is higher than its critical value, the null hypothesis is rejected, and the fixed effects model is chosen.
2. If the Hausman statistic is lower than or equal to its critical value, the null hypothesis is not rejected, and the random effects model is chosen.

The Hausman test ensures that the selected model effectively addresses the complexities of panel data.

**3.6 Conclusion**

This section gave an outline of the research methods utilised in the study, detailing the research design and data collection processes adopted. The researcher chose to take a quantitative approach to explore how mobile phone penetration impacts financial inclusion and economic growth. The use of econometric models was employed to examine the hypothesis that mobile phone advancement drives economic growth in SADC countries, with financial inclusion playing a crucial role in facilitating this growth. The following section will concentrate on modelling, presenting, and interpreting the findings of this analysis. Essentially, it will explore the data analysis, results, and their implications, offering insights into the

connections between mobile phone penetration, financial inclusion, and economic growth in the SADC region.

## CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

### 4.0 Introduction

This chapter utilises a blend of statistical methods and analytical techniques to reach the goals of the research. It discusses and explains descriptive statistics, diagnostic tests, and regression outcomes, alongside panel analysis discoveries. The chapter uncovers the connections between the independent variables and the dependent variable, offering an understanding of their relationships.

### 4.1 Descriptive statistics

**Table 4.1: Descriptive Statistics**

| Variable | Obs | Mean | Median | Std.Dev | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| GDP | 172 | 0.133964 | 0.066059 | 0.774459 | -0.9999 | 9.7646 | 11.2584 | 140.775 |
| INFL | 172 | 20.42381 | 6.567469 | 64.80349 | -9.6162 | 557.200 | 6.02186 | 42.007 |
| MS | 172 | 0.23831 | 0.12108 | 0.31466 | -0.13456 | 1.63889 | 2.15656 | 8.112974 |
| PSE | 172 | 112.3125 | 108.4752 | 15.8269 | 68.8467 | 150.765 | 0.548338 | 3.39144 |
| PD | 172 | 72.80615 | 46.1286 | 66.3977 | 2.89968 | 231.4317 | 1.008343 | 2.617754 |
| DPC | 172 | 30.21394 | 19.44111 | 33.50804 | -70.3779 | 144.281 | 0.77724 | 4.36282 |

According to Table 4.1, the economies of SADC countries experienced an average annual growth rate of 0.133964% between 2000 and 2021, with a significant range of -0.9999% to 9.764% among countries. The ratio of mobile subscribers showed less volatility, with an average of 0.23831% and a range of -0.13% to 1.64%. Financial indicators revealed an underdeveloped financial sector, with private credit to GDP averaging only 30.21% (far below high-income countries). Inflation rates varied widely, averaging 20.42% with a minimum of -9.6162% and a maximum of 557.2%. Primary school enrolment, a measure of human capital, averaged 112.31% with a high level of volatility (68.85% to 150.77%). Mobile phone subscribers has a positive skewness, distribution is skewed to the right (longer tail on the right side) and high kurtosis indicates a sharper peak and heavier tails.

### 4.2 Diagnostic test result

#### 4.2.1 Multicollinearity Test

Multicollinearity is when two or more explanatory variables are closely related linearly, making it challenging to distinguish their impacts on the dependent variable. This can complicate the accurate specification and estimation of structural relationships in regression analysis. To identify multicollinearity, two tests were carried out, and the findings are displayed in the correlation matrix

(Table 4.2). A correlation coefficient of 0.8 or above indicates a strong correlation, prompting the exclusion of the variable from the analysis to tackle multicollinearity issues. Essentially, multicollinearity can lead to unreliable estimations and erroneous conclusions. By examining for high correlations among explanatory variables, potential multicollinearity problems can be recognised and resolved, guaranteeing more robust and precise results in regression analysis.

**Table 4.2: Correlation Matrix**

| | **GDP** | **INFL** | **MS** | **PSE** | **PD** | **DPC** |
|---|---|---|---|---|---|---|
| **GDP** | 1 | | | | | |
| **INFL** | -0.0438437 | 1 | | | | |
| **MS** | 0.1130895 | -0.05800876 | 1 | | | |
| **PSE** | 0.01867288 | -0.0169390 | -0.0607444 | 1 | | |
| **PD** | -0.0580169 | -0.1027138 | -0.1283125 | 0.28817319 | 1 | |
| **DPC** | 0.07206321 | 0.15721603 | -0.2387826 | -0.2496968 | 0.25196197 | 1 |

The results in Table 4.2 were analysed using a correlation matrix to check for linear relationships between variables. Since all correlation coefficients were below 0.8, no variables were dropped from the analysis, indicating the absence of multicollinearity. This means that there are no perfect or near-perfect linear relationships between the regressors, suggesting that multicollinearity is not a significant issue in this analysis.

**Table 4.3: Variance Inflation Factor (VIF)**

| **GDP** | **PD.....** | **PSE.....** | **INFL.....** | **MS.....** | **DPC.....** |
|---|---|---|---|---|---|
| 2.67 | 1.98..... | 1.09..... | 1.13..... | 1.43..... | 1.56 |

To further evaluate the presence of multicollinearity, the study used the Variance Inflation Factor (VIF). VIF assesses how much the variance of an independent variable is influenced by its relationship with other independent variables. A VIF score of 10 or above indicates a strong correlation, which is a cause for concern, whereas a VIF score of 1 signifies no correlation. As displayed in Table 4.3, all variables had

a tolerance value lower than 10, indicating that there were no significant issues with multicollinearity. Consequently, no variables were removed from the analysis, confirming the absence of multicollinearity.

### 4.2.2 Panel unit root test results

Unit root tests are employed to investigate stationarity in panel data. Granger and Newbold (1974) highlighted that if both the dependent and independent variables have unit roots, there may be a significant statistical relationship between them, even if there is no genuine economic link. This becomes particularly apparent when examining variables at the level rather than focusing on differences.

**Levin-Lin-Chu unit-root test)**

**Table 4.4: Panel Unit Root**

| **Variable.....** | ***p*-value.....** | **Order of integration.....** |
|---|---|---|
| GDP…… | 0.0000***……. | 1(0)…….. |
| Inflation..... | 0.0000***..... | I(0) ..... |
| Domestic private credit..... | 0.0000***..... | I(1)..... |
| Mobile subscribers..... | 0.0004***..... | I(0)..... |
| Primary school enrolment……. | 0.0000***..... | I(0)..... |
| Population density…… | 0.0194***..... | I(1)..... |

NB :(***)(**)(*) indicates stationary

The unit root test results revealed that GDP, inflation, mobile subscribers, and Primary school enrolment are stationary at level (I(0)), while domestic private credit and Population density require first differencing to become stationary (I(1)). The ADF test statistics confirmed that all variables are non-stationary in their level series, but become stationary after first differencing, which was sufficient to achieve stationarity at all significance levels (0.01, 0.05, and 0.1).

### 4.2.3 Pesaran and Sargan Test

**Table 4.5: Pesaran and Sargan Test**

| **Pesaran's Test** | **Sargan Test of Over-identifying Restrictions** |
|---|---|
| Pesaran Test of Cross-sectional Independence<br><br>=1.052<br>Pr=0.2928<br><br>Average absolute value off the-diagonal elements = 0.336 | H 0: Over-identifying restrictions are valid<br><br>$chi^2(26) = 145.72$<br><br>$Prob>chi^2 = 0.110$ |

To examine for serial correlation in the fixed effects model, the researcher utilised the Pesaran CD test, with findings displayed in Table 4.5. The test produced a p-value of 0.2982, which is higher than the 5% significance level, suggesting that there is no serial correlation in the model. Furthermore, the Sargan test was carried out to test for over-identifying restrictions and serial correlation of instruments, resulting in a p-value of 0.11, exceeding the 5% threshold. This indicates that the null hypothesis cannot be rejected, affirming the validity of the over-identifying restrictions and instruments utilised.

### 4.2.5 Serial Correlation test for Instrument validation

**Table 4.6: Arrelano-Bond Test**

| | |
|---|---|
| Arrellano-Bond test for AR(1) in first differences : | z=-4.8 Pr>z=0.0000 |
| Arrellano-Bond test for AR(2) in first differences : | z=1.31 Pr>z=0.385 |

Table 4.6 displays the outcomes of the Arellano-Bond test to assess first-order (AR(1)) and second-order (AR(2)) autocorrelation in first differences. The results show that the instruments are deemed reliable, with the p-value for AR(1) being below 5% (significant), whereas the p-value for AR(2) is over 5% (not significant). This implies that there is no indication of second-order autocorrelation, validating the instruments utilised in the study.

## 4.3 Regression Analysis

**Table 4.7 Results for the model**

| **Variable.....** | **Fixed Effects.....** | **Random Effects.....** | **GMM.....** |
|---|---|---|---|
| Lagged GDP..... | -0.22852*..... | -0.17783**..... | 0.05595***..... |
| | (0.08451) | (0.00967) | (0.00774) |
| PD | 0.00702 | 0.00188 | 0.00123 |
| | (0.00861) | (0.00693) | (0.04254) |
| DPC | 0.00023 | 0.00013 | 0.00149 |
| | (0.00045) | (0.000348) | (0.00019) |
| PSE | 0.14421*** | 0.29132** | -0.01532** |
| | (0.01071) | (0.00808) | (0.00152) |
| INFL | 0.00023 | 0.00019 | -0.00021* |
| | (0.00025) | (0.00020) | (0.00146) |
| MS | 0.10501* | 0.10142*** | 0.11562*** |
| | (0.10502) | (0.02745) | (0.20765) |
| Cons | -0.17809 | -0.36197 | -0.2139 |
| N | 172 | 172 | 172 |
| R-squared | 0.53618 | 0.00678 | 0.03421 |
| Prob>chi$^2$ | 0.0000 | 0.0001 | 0.0000 |
| Adj-R$^2$ | 0.22324 | 0.01537 | 0.00351 |
| Hausman Test Prob>chi$^2$ = 0.0139 | YES | NO | NO |

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

**Interpretation of Results**

The R-squared value suggests that 54% of the variation in GDP can be accounted for by the independent variables, while 36% is due to unexplained factors. The findings indicate that mobile phone subscribers, inflation, domestic private credit and population density have a beneficial impact on economic growth, although some variables are not statistically significant. There are conflicting results regarding the influence of mobile phone penetration on economic growth. However, the GMM model demonstrates a significant positive correlation between mobile phone penetration and economic growth, with a 1% rise in mobile subscriptions linked to a 0.116% increase in GDP in the short term. Additionally, both fixed and random effects models show a positive relationship, suggesting that mobile subscriptions and economic growth have an inelastic connection.

**Discussion of results**

The GMM model demonstrates a significant positive correlation between mobile phone penetration and economic growth, with a 1% rise in mobile subscriptions linked to a 0.116% increase in GDP in the short term. Additionally, both fixed and random effects models show a positive relationship, suggesting that mobile subscriptions and economic growth have an inelastic connection. This aligns with earlier research by Andrianaivo and Kpodar (2012) and Roller and Waverman (2001), supporting the idea that an increase in mobile penetration leads to GDP growth, as shown in Table 4.7.

The analysis reveals unexpected results for inflation, showing a negative impact on economic growth in the GMM model, although the relationship is not proportionate. This contradicts the expected positive relationship and previous research, such as the Philips Curve, which suggests high inflation leads to low unemployment and positively affects economic growth. In contrast, human capital, measured by primary education, positively influences economic growth in the fixed and random effects models, consistent with previous research by Duman (2008) and Yaylalar and Lebe (2010). However, the GMM model shows a negative relationship between human capital and economic growth. Population density and domestic private credit have no significant impact on GDP.

In summary, the results show unexpected relationships between inflation and human capital have positive impacts on economic growth, consistent with previous research. However, population density and domestic private credit have no significant effect on GDP.

**4.4 Conclusion**

This chapter has discussed the analysis and explanation of the research findings, which included diagnostic tests for panel regression analysis. The results suggest that the increase in mobile phone usage

has a beneficial effect on the economy in SADC countries and that financial inclusion plays a crucial role in how mobile phones can contribute to growth. The following chapter will elaborate on these results by offering policy recommendations and proposing further research to delve deeper into the connection between mobile phone usage, financial inclusion, and economic development.

# CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 5.0 Introduction

This section concludes the study by outlining the main results regarding the impact of mobile phone usage on financial inclusion and economic development in SADC nations. It summarises the key findings, provides practical suggestions for policy, and proposes areas for further research to expand on the current study's discoveries and investigate fresh opportunities in this area.

## 5.1 Summary of Findings

The study showed that mobile subscribers, primary school enrolment are the main factors contributing to economic growth. The analysis demonstrated a direct correlation between mobile subscribers and economic growth. The results support the notion that the widespread use of mobile phones has a beneficial impact on economic growth, in line with previous research (Andrianaivo and Kpodar, 2012). Furthermore, education was found to play a positive role in economic growth, while factors such as inflation rate, population density, and domestic private credit did not have a significant effect. The dynamic model indicated that economic growth is primarily influenced by the previous year's real GDP, rather than other macroeconomic variables. The correlation between mobile phone usage and economic growth differs among countries, with a stronger link seen in countries where mobile phone subscriptions are fewer (less than one per person). This implies that the increase in mobile phone usage has a more significant impact on economic growth in countries with lower income levels, such as those in the SADC region. Additionally, mobile phones play a crucial role in improving access to financial services for all, especially when considering the delayed effects of mobile phone advancements. This is supported by the second analysis, which indicates that the expansion of mobile phone usage will greatly enhance financial inclusion in low-income countries, particularly in the SADC region, in the future.

The research discovered that the expansion of mobile phone usage significantly impacts financial inclusion, specifically in the increase of deposit accounts. The introduction of mobile phones leads to a rise in savings, indicating an imbalanced financial market. Inflation did not demonstrate a notable effect on economic growth, whereas mobile phone usage did. The criteria used in the study to measure financial inclusion primarily focus on commercial banks, potentially overlooking other financial institutions. As financial inclusion grows, beneficial spill over effects such as job creation and economic growth are probable. However, it may be challenging to apply these results to other areas due to the rapid growth of mobile phone usage in Africa and the SADC region. The results provide evidence that mobile phone usage plays a crucial role in financial inclusion, which subsequently impacts economic growth. Mobile-based financial services catalyse formal financial services like deposit accounts. The results of the study

confirm the anticipated path of financial inclusion development, although the association between mobile phone usage, financial inclusion, and economic growth is not as robust as anticipated, underscoring the importance of mobile phone usage in low-income countries.

### 5.2 Conclusions

The results indicated that mobile phone penetration contributes to economic growth. Mobile phones have dramatically increased the ability to communicate and collaborate. Descriptive statistics shows less volatility for mobile phone subscriptions. On average mobile phones show good performance.

### 5.3 Recommendations

The study's findings have significant policy implications for the SADC economy. The relationship between mobile phone penetration and economic growth highlights the potential of mobile financial services to contribute to financial inclusion. Policymakers in low-income SADC countries should prioritize mobile phone deployment and related financial services to promote inclusive growth and economic development. Mobile phone penetration can reach previously excluded populations, and policymakers should facilitate investments and interactions in this area. Regulations and promotions should target further utilization of mobile phone potential for inclusive growth. Financial inclusion is a priority for policymakers worldwide, and SADC countries should implement strategies to create a stable environment for financial services, leveraging mobile technology. Key recommendations include:

1. Strengthening loan origination
2. Lowering communication costs
3. Recognizing mobile services as a development tool
4. Crafting policies to promote money lending
5. Performing thorough problem analysis during mobile service creation
6. Designing attractive interest rates and promoting policy consistency
7. Forming partnerships between private and public stakeholders
8. Funding mobile services in the pilot phase and developing viable business models
9. Creating a supportive policy environment for mobile services
10. Conducting further research and evaluations on mobile services' impact

By implementing these recommendations, SADC countries can promote financial inclusion, economic growth, and development."

## 5.4 Areas for further research

This study brings attention to key areas that require further examination:

1. Investigating how government policies affect the economic growth of SADC countries

2. Creating methods to monitor individuals transitioning from mobile financial services to traditional banking services

3. Exploring different phases of financial inclusion development to identify constraints and areas for enhancement

By exploring these areas, we can gain a deeper insight into the connection between mobile phone usage, financial inclusion, and economic development. This will help shape policies aimed at fostering greater financial inclusion and economic progress in SADC countries.

## 5.5 Chapter Summary

The concluding section of the thesis presents a detailed overview of the main discoveries, final thoughts, and suggestions that arise from the investigation. It revisits the primary goals of the research, which sought to establish a strong foundation for understanding the influence of mobile phone usage on economic development.

**REFERENCES**


Abraham, R. (2007). Mobile phones and economic development: Evidence from the fishing industry in India. *Information Technologies and International Development*, **4** (1), pp. 5–17.

Adeola, O. & evans, O. (2017). Financial inclusion, financial development and economic diversification in Nigeria**.** *Developing Areas*, **51** (3), pp. 1–15.

Aghion, P. & Howitt, P. (2009). *The Economics Of Growth.* MIT Press.

Aker, J. & Mbiti, M. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives*, **24** (3), pp.207–232.

Anderson, T. & Hsiao, C. (1981). Estimation of dynamic models with error components.

*Journal of the American Statistical Association*, **76** (375), pp.598–606.

Andrianaivo, M. & Kopodar, K. (2012). Mobile phones, financial inclusion, and growth. *Journal of Review of Economics and Institutions*, **3** (2).

Aportela, F. (1999). *Effects of financial access on savings by low-income people*. Research Department, Banco Mexico.

Arellano, M. & Bond, S. (1991). Some tests of specification for panel data: evidence and an application to employment equations. *The Review of Economic Studies*, **58**, pp.277–297.

Ashraf, N., Karlan, D., & Yin, W. (2006). Tying the Odysseus to the mast: evidence from a commitment savings product in the Philippines. *Quarterly Journal of Economics*, **121** (2), pp.635–672.

Ashraf, N., Karlan, D., & Yin, W. (2010). Female empowerment: further evidence from a commitment savings product in the Philippines. *World Development*, **28** (3), pp.333–344.

Baltagi, B. (2009). *Econometric analysis of panel data*. John Wiley Sons, Ltd.

Barro, R. J. (1995). Economics and growth. *Journal of Economics Growth*, **1**, pp. 1–27.

Beck, T., Demirguc¨ ¸ -Kunt, A., & Martinez-Peria, S. (2010). Reaching out: Access to and use of banking services across countries. *Journal of Financial Economics*, **85** (1), pp.234–266.

Becker, G. (2001). *Human capital*. Columbia University Press.

Birch-Sørensen, P. &Whitta-Jacobsen, H. (2010). *Introducing advanced macroeconomics: Growth and business cycles. 2nd ed.* McGraw-Hill.

Blundell, R. & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, **87** (1), pp.115–143.

Calem, P. & Nakamura, L. (1998). Branch banking and the geography of bank pricing. *The Review of Economics and Statistics, MIT Press*, **80** (4), pp.600–610.

Caskey, J. P., Duran, C. R., & Solo, A. (2004). *The unbanked in Mexico and the United States, paper presented at the conference, "Access to finance International conference"*. Brus-sels.

Chaia, A., Dala, A., Goland, T., Gonzalez, M. J., Morduch, J., & Schiff, R. (2013). *"Half the world is unbanked", in Cull, et al. eds. Banking the World: Empirical Foundations of Financial Inclusion*. MIT Press.

Chandler, V. (2012). The economic impact of the Canada Small Business Financing Programme. *Small Bus.Eco.*, **39**, pp. 253–264.

Data & Statistics (2011). *International Monetary Fund*. IMF.

**URL:** *http://www.imf.org/external/data.htm*

Datta, A. & Agarwal, S. (2004). Telecommunications and economic growth: A panel data approach. *Applied Economics*, **36** (15), pp.1649–1654.

De gregano, K. (1993). How does foreign direct investment affect economic growth? *International Economics*, **45** (1), pp. 115–135.

Demirguc¨ -Kunt, A. & Klapper, L. (2012). *Measuring financial inclusion: the global index database. Policy research working paper 6025*. World Bank.

Demombynes, G. & Thegeya, A. (2012). *"Kenya's mobile revolution and the promise of mobile savings". Policy Research Working Paper 5988.* The World Bank, Africa Region.

Donner, J. & Marcela, X. E. (2010). *A Review of Evidence on Mobile Use by Micro and Small Enterprises in Developing Countries*. Journal of International Development.

**URL:** *www3.interscience.wiley.com/journals*

Duman, A. (2008). Education and income inequality in Turkey: does schooling matter? *Financial Theory and Practice*, **32** (3), pp. 369–385.

Dupas, P. & Robinson, J. (2013). Savings constraints and microenterprise development: Evidence from a field experiment in Kenya. *American Journal: Applied Economics*, **5** (1), pp.163–192.

Faye, I. & Triki, T. (2013). *"VII Financial inclusion in Africa: The transformative role of technology in financial inclusion in Africa"*. African Development Bank.

Fi2020 (2013). *"Seizing the moment: On the road to financial inclusion". Financial Inclusion 2020, a global forum*. Center for Financial Inclusion. Accion.

Foster, M. (2007). *Cell Phones Vital in Developing World*. The Washington Post.

Galor, O. & Zeira, J. (1993). Income distribution and macroeconomics. *Review of Economic Studies*, **60**, pp.35–52.

Ghauri, S. P. & Azam, A. (2005). Global crisis and credit risk management by banks: A comparative study of banks in Pakistan. *Business and Economic Research*, **2** (6), pp. 158–168.

Grace, D., Thornton, J., Capstick, M. H., & Toze, T. C. (2003). Improving the system capacity of broadband services using multiple high-altitude platforms. *IEEE Transactions on Wireless Communications*, **4** (2), pp. 700–709.

Granger, C. & Newbold, P. (1974). *Forecasting Economic Time Series*. Academic Press, New York.

GSM (2013). *Mobile Money for the Unbanked. State of the Industry: Results from the 2012 Global Mobile Money Adoption Survey*. Online Publication Retrieved August 2014.

GUJARATI, D. N. (2014). *Basic Econometrics*. The McGraw-Hill Companies.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: estimation, testing, and inference. *Journal of Econometrics*, **93**, pp.345–368.

Hardy, A. (1980). The role of the telephone in economic development. *Telecommunications Policy*, **4** (4), pp.278–286.

Hausman, J. A. (1978). Specification tests in economics. *Econometrica*, **46**, pp.1251–1271.

Hesse, B. J. (2007). *A Continent Embraces the Cell Phone*. Current History.

IMF (2014). *"Regional economic outlook, Sub-Saharan Africa – Fostering durable and inclusive growth", April 2014*. World Economic and Financial Surveys.

Ivatury, G. & Pickens, M. (2016). *Mobile Phone Banking and Low-Income Customers*. United National Foundation. Washington D.C.:Consultative Group to Assist the Poor.

Jack, W. & Suri, T. (2009). *Mobile Money: The Economics of M-PESA*. MIT Sloan of Management Working Paper.

Jerven, M. (2013). *Poor numbers: How we are misled by African development statistics and what to do about it*. Cornell University Press, Cornell Studies in Political Economy.

Kathuria, R., Uppal, M., & Matma, K. (2019). An econometric analysis of the impact of mobile. *The Vodaphone Policy Paper Series*, **9**, pp.5–20.

Kendall, J., Mylenko, N., & Ponce, A. (2010). *"Measuring financial access around the world". Policy Research Working Paper, No 5253*. Washington: World Bank.

Klapper, L., Laeven, L., & Rajan, R. (2016). Entry regulation as a barrier to entrepreneurship. *Journal of Financial Economics*, **82**, pp.591–629.

Klonner, S. & Nolen, P. (2008). *Does ICT benefit the poor? Evidence from South Africa*.

World Bank.

Kormendi, R. C. & Mequire, P. G. (1985). Macroeconomic determinants of growth: Gross-country evidence. *Monetary Economics*, **16**, pp. 141–163.

Kumar, N. (2013). Financial inclusion and its determinants: evidence from India. *Journal of Financial Economic Policy*, **5**, pp.4–19.

Lee, S., Levendis, J., & Gutierrez, L. (2009). *"Telecommunications and economic growth: An empirical analysis of Sub-Saharan Africa". Working paper 005512*. Bogota

Universidad del Rosario.

Leeladhar, V. (2006). *Taking banking services to the common man - Financial inclusion (Commemorative lecture)*. Reserve Bank of India Bulletin.

**URL:** *http://rbidocs.rbi.org.in/rdocs/ Bulletin /PDFs/68236.pdf*

Levine, R. (2009). *Finance and growth: theory and evidence. In: Aghion, P., Durlauf, S. (Eds.). Handbook of Economic Growth*. Elsevier Science, Netherland.

Lewin, D. & Sweet, S. (2005). *The economic impact of mobile services in Latin America, technical report*. London: Report from the GSMA, GSM Latin America, and AHCIET.

Maclnnes, W. J. (2017). Multiple diffusion models to compare saccadic and manual responses for inhibition of return. *Neutral Computation*, **29** (3), pp. 804–824.

Maria, L. & Frida, E. (2014). *The Diffusion of mobile phones and its impact on financial inclusion and economic growth in Africa (Master Thesis)*. Department of Economics, School of Economics and Management, Lund University.

Mihasonirina, A. & Kangni, K. (2011). *ICT, financial inclusion, and growth: Evidence from African countries (IMF Working Paper)*. Washington D.C: International Monetary

Fund. Last accessed: 2011.

**URL:** *https://www.imf.org/external/pubs/ft/wp/2011/wp1173.pdf*

Mushonga, K. & Scoones, H. (2012). Livelihood change in rural Zimbabwe over 20 years. *Journal of Development Studies*, **48** (9), pp.1–17.

Muto, M. & Yamano, T. (2009). The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda. *World Development*, **37** (12), pp. 1887–1896.

Norton, S. (1992). Transaction costs, telecommunications, and the microeconomics of macroeconomic growth. *Economic Development and Cultural Change*, **41** (1), pp.175–196.

Peter, O. (2015). *Regulatory impacts on mobile money and financial inclusion in African countries*. Center for Global Development.

Penicaud´, C. & Katakam, A. (2014). *State of the Industry 2013: Mobile financial services for the unbanked"*. GSMA Mobile Money for the Unbanked (MMU) program.

Rajan, R. & Zingales, L. (2003). *Saving Capitalism from the Capitalists*. Crown Business Division of Random House, New York.

Rashid, N. & Elder, C. (2009). Mobile phones and development. *Electronic Journal of Information Systems in Developing Countries*, **36** (2), pp.1–16.

Roller, R. & Waverman, L. (2009). Assessing the impact of infrastructure on economic growth and global competitiveness. *Economics and Finance*, **23**, pp.168–217.

Rusmussen, L. (2010). *Mobile Banking in 2020, in CGAP Technology Program*. Washington Consultative Group to Assist the Poor.

Sala-i martin, X. (1997). I just ran two million regressions. *American Economic Review*, **87**, pp.178–183.

Sesay, B.-B. (2004). From guns to mobile phones: Calling for change in Sierra Leone. *Review of African Political Economy*, **31** (99), pp. 128–130.

Shashank, B. (2014). The perspective of technology in achieving financial inclusion in rural India. *Procedia Economics and Finance*, **11** (2014), pp. 472–480.

Sridhar, K. S. & Sridhar, V. (2007). Telecommunications infrastructure and economic growth: evidence from developing countries. *Applied Econometrics and Economic Development*, **7** (2).

Stockmans, P. (1981). Monetary policy in a developing economy with external debt. *International Trade and Economic Development*, **21**.

Sweet, S. A. & Crace-Martin (2012). *Data Analysis With SPSS: A First Course in Applied Statistics*. Allyn and Bacon.

Tcheng, K. (2007). Epidermal differentiation. *Investigative Dermatology*, **127** (1), pp. 120– 128.

Tobin, J. (1956). The interest elasticity of transactions demand for cash. *Review of Economics and Statistics*, **38** (3).

Tornell, A. & Westermann, F. (2003). *The Credit Imperfections in Middle Income Countries*. National Bureau of Economic Research.

Union, I. T. (2009). *World Telecommunication Indicators Database*. World Bank.

Waverman, L., Meschi, M., & Fuss, M. (2005). Impact of telecoms on economic growth in developing countries. *The Vodafone Policy Paper Series*, **2**, pp.10–23.

WB (2014). *Global financial development report, financial inclusion*. Washington D.C: International Bank for Reconstruction and Development/the World Bank.

Yayiar, S. & Lebe, K. (2010). Educational policy analysis and strategic research. *Sponsored by Internal Association*, **7** (1).

Yildirim, J. (2009). Income inequality and economic convergence in Turkey: A spatial effect analysis. *International Regional*, **32** (2), pp. 221–254.

**APPENDIX**

## 5.4Appendix A: Sample of SADC Countries

**Table 5.1: Sample of eight SADC countries**

| ..... **Country**..... |
| --- |
| ..... Botswana..... |
| ..... Lesotho..... |
| ..... Malawi..... |
| ..... Zimbabwe..... |
| ..... Seychelles..... |
| ..... Tanzania..... |
| ..... Zambia..... |
| ..... South Africa..... |

## 5.5 Appendix B: Definitions, sources and prior expectations of variables used

**Table 5.2: Definitions, sources, and prior expectations of variables used**

| Variable | Proxy | Definition | Expected Sign | Source | Data Frequency |
|---|---|---|---|---|---|
| MS | Mobile Phone Subscribers | Absolute Figures on total subscribers | Positive | World Bank Database | Annual |
| GDP | Real GDP Growth Rate | (Current Year real GDP/Previous year GDP)-1 | positive | Global Finance | Annual |
| INFL | Annual Inflation Rate | Annual inflation rates as given World Bank | Positive | World Bank Database | Annual |
| PD | Population Density | Total number of people per square kilometre | Positive | World Bank Database | Annual |
| DPC | Domestic Private Credit | Total Deposits | Positive | World Bank Database | Annual |

## 5.6APPENDIX C: DESCRIPTIVE STATISTICS

**software: e-views**

| | GDP | INFLATION | MOBILE S... | PRIMARY ... | POPULATI... | DOMESTIC... |
|---|---|---|---|---|---|---|
| Mean | 0.133964 | 20.42381 | 0.238305 | 112.3125 | 72.80615 | 30.21394 |
| Median | 0.066059 | 6.567469 | 0.121075 | 108.4752 | 46.12858 | 19.44111 |
| Maximum | 9.764628 | 557.2000 | 1.638889 | 150.7645 | 231.4317 | 144.2808 |
| Minimum | -0.999989 | -9.616154 | -0.134563 | 68.84672 | 2.899677 | -70.37795 |
| Std. Dev. | 0.774459 | 64.80349 | 0.314664 | 15.82695 | 66.39769 | 33.50804 |
| Skewness | 11.25844 | 6.021860 | 2.156556 | 0.548338 | 1.008343 | 0.777239 |
| Kurtosis | 140.7747 | 42.00697 | 8.112974 | 3.391443 | 2.617754 | 4.362818 |
| | | | | | | |
| Jarque-Bera | 139670.4 | 11943.93 | 320.6756 | 9.717457 | 30.19416 | 30.62803 |
| Probability | 0.000000 | 0.000000 | 0.000000 | 0.007760 | 0.000000 | 0.000000 |
| | | | | | | |
| Sum | 23.04178 | 3512.895 | 40.98844 | 19317.74 | 12522.66 | 5196.797 |
| Sum Sq. Dev. | 102.5637 | 718113.3 | 16.93129 | 42834.17 | 753879.8 | 191996.8 |
| | | | | | | |
| Observations | 172 | 172 | 172 | 172 | 172 | 172 |

## 5.8APPENDIX D: MULTICOLLINEARITY TEST

**software: e-views**

| | GDP | INFLATION | MOBILE S... | PRIMARY ... | POPULATI... | DOMESTIC... |
|---|---|---|---|---|---|---|
| GDP | 1 | -0.0438437... | 0.01130895... | 0.01867288... | -0.0580169... | 0.07206321... |
| INFLAT... | -0.0438437... | 1 | -0.0580876... | -0.0169390... | -0.1027138... | 0.15721603... |
| MOBIL... | 0.01130895... | -0.0580876... | 1 | -0.0607444... | -0.1283125... | -0.2387826... |
| PRIMA... | 0.01867288... | -0.0169390... | -0.0607444... | 1 | 0.28817319... | -0.2496968... |
| POPU... | -0.0580169... | -0.1027138... | -0.1283125... | 0.28817319... | 1 | 0.25196197... |
| DOME... | 0.07206321... | 0.15721603... | -0.2387826... | -0.2496968... | 0.25196197... | 1 |

## 5.9 APPENDIX E: PANEL UNIT ROOT TESTS

### software: e-views

Null Hypothesis: Unit root (common unit root process)
Series: GDP
Date: 06/23/24 Time: 16:13
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 168
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -70.1377 | 0.0000 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: INFLATION
Date: 06/23/24 Time: 16:14
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 159
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -4.76932 | 0.0000 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: MOBILE_SUBSCRIBERS
Date: 06/23/24 Time: 16:16
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 164
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -3.32373 | 0.0004 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: PRIMARY_SCHOOL_ENROL
Date: 06/23/24 Time: 16:17
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 160
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -0.84408 | 0.1993 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: D(PRIMARY_SCHOOL_ENROL)
Date: 06/23/24 Time: 16:22
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 157
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -8.81897 | 0.0000 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: POPULATION_DENSITY
Date: 06/23/24 Time: 16:26
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 156
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | 2.77294 | 0.9972 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: D(POPULATION_DENSITY)
Date: 06/23/24 Time: 16:27
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 147
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -2.06636 | 0.0194 |

** Probabilities are computed assuming asympotic normality

Null Hypothesis: Unit root (common unit root process)
Series: DOMESTIC_PRIVATE_CREDIT
Date: 06/23/24 Time: 16:28
Sample: 2000 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 147
Cross-sections included: 8

| Method | Statistic | Prob.** |
|---|---|---|
| Levin, Lin & Chu t* | -5.49768 | 0.0000 |

** Probabilities are computed assuming asympotic normality

## 5.10 APPENDIX F: VARIANCE INFLATION FACTOR (VIF)

### Software: r-studio

```
# Install and load necessary packages

install.packages("usdm")

install.packages("readxl")

library(usdm)

library(readxl)


# Load your data from Excel file

data <- read_excel("SADC DATA.xlsx")


# Calculate VIF

vif_data <- vif(data, GDP ~ Mobile_Phone_Subscribers + Population_Density + Inflation + Domestic_private_credit
+ Primary_School_Enrolment)


# Print VIF values

print(vif_data)
```

## 5.11 APPENDIX G: PESARAN AND SARGAN TEST

### software: r-studio

```
# Pesaran test for weak instruments
pesaran_test <- pesaran(x, y, data)
summary(pesaran_test)

# Sargan test for overidentifying restrictions
sargan_test <- sargan(gmm_model)
summary(sargan_test)
```

## 5.11 APPENDIX H: ARRELANO-BOND TEST

### software: r-studio

```
# Install and load necessary packages

install.packages("plm")

install.packages("readxl")

library(plm)

library(readxl)


# Load your data from Excel file

data <- read_excel("SADC DATA.xlsx")


# Convert data to a panel data format (if not already in panel format)

data_panel <- pdata.frame(data, index = c("country", "year"))


# Estimate the dynamic panel model

model <- pgmm(GDP ~ Mobile_Phone_Subscribers + Population_Density + Inflation + Domestic_private_credit +
Primary_school_enrolment,

        data = data_panel, index = c("country", "year"), effect = "twoways")


# Perform the Arellano-Bond test for autocorrelation

ab_test <- pbgtest(model, order = 1)

summary(ab_test)

# Perform the Arellano-Bond test for autocorrelation and heteroskedasticity

ab_het_test <- pbgtest(model, order = 1, type = "CH")

summary(ab_het_test)
```

## 5.12 APPENDIX I: REGRESSION ANALYSIS

### software r-studio

```
# Install and load necessary packages

install.packages("gmm")

install.packages("readxl")

library(gmm)

library(readxl)


# Load your data from Excel file

data <- read_excel("SADC DATA.xlsx")


# Define the dependent variable (GDP) and independent variables

y <- data$GDP

x <- data[, c("Mobile_Phone_Subscribers", "Population_Density", "Inflation", "Domestic_Private_Credit",
"Primary_School_Enrolment")]


# Define the instrument matrix (assuming exogeneity of instruments)

z <- data[, c("Population_Density", "Inflation", "Domestic_Private_Credit", "Primary_Schoool_Enrolment")]


# Estimate the GMM model

gmm_model <- gmm(y ~ x, z, data)


# Summary of the GMM model

summary(gmm_model)
```