THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION ON STOCK MARKET DEVELOPMENT IN AFRICA

by

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ABSTRACT

The information communication technology (ICT) sector has, arguably, grown in leaps and bounds over the years to assume a key role in every facet of economic activity. In the wake of the fourth industrial revolution, the major policy preoccupation of governments is how to harness ICT to spur economic growth. As such, the principal objective of this study was to examine the impact of adopting ICT on the development of African stock exchanges, determine whether ICT adoption and stock market development are co-integrated, and establish any causal links between ICT adoption and stock market development. The study examined a panel of 11 African stock exchanges for the period 2008-2017 and employed various econometric techniques to test its objectives. The dependent variable for this study was stock market development, while the independent variable was ICT adoption. The control variables employed were financial freedom and economic growth proxied by gross domestic product. In its findings, the study established that the adoption of ICT has a positive and statistically significant effect on the number of listed companies, stock market capitalisation and the total value of shares traded at the selected African stock exchanges. Hence, as an economy turns out to be progressively ICT-situated, expanded access to and utilisation of ICT advances, thus improving a nation's financial economy. Secondly, it established that ICT adoption and the stock market are cointegrated and positively related in the long run. The results further indicated a bi-directional causal relationship (complementarity) between ICT adoption and stock market development. In essence, ICT adoption and stock market development reinforce each other. This study contributes to the body of knowledge in a number of ways. This is the first study to examine the phenomenon of ICT-stock market nexus employing a panel study. Moreover, the study employed a robust methodology underpinned by using indices to proxy ICT and stock market development. Thirdly, unlike other studies on this topic, this study did not just end with the first inquiry of a deterministic relationship, but also probed for co-integration of the series tested for causality and proffers policy advice. The findings of the research imply that policymakers should be more resolute when formulating ICT policies that can drive stock market development for better economic growth and for better integration with other African stock exchanges.

Keywords: stock exchange, ICT, adoption, integration, impact, policy, economic growth, Africa, co-integration

NGOKURHUNYEZIWEKO

Umkhakha wezethekinoloji yelwazi kanye nokuthintana (ICT) ngaphandle kokuphikiswa, ukhule wandlondlobala eminyakeni edlulileko ukobana uthome ukudlala indima eqakathekileko kiyo yoke imisebenzi yezomnotho. Ekuthomeni kwamatjhuguluko wesine wezamabubulo, into ekulu yokuthoma ngomthethomgomo karhulumende kuqala ukobana ihlelo le-ICT lingasetshenziswa bunjani ukobana lihlumise umnotho. Ngakho-ke, umnqopho omkhulu werhubhululo leli bekukuhlola umthintela wokutjhugulukela ku-ICT mayelana nokuthuthukiswa kwemaraga ye-Afrika yezokutjhentjhiselana ngamatjhezi, ukuqinisekisa ukuthi mhlambe ukutjhugulukela ku-ICT kanye nokuthuthukiswa kwemaraga yamatjhezi kungahlanganiswa na, begodu nokuhloma nginanyana ngiliphi itjhebiswano phakathi kokutjhugulukela kwi-ICT kanye nokuthuthukiswa kwemaraga yamatjhezi. . Irhubhululo belihlola iphanele yeemaraga ezili-11 zokutjhentjhiselwana mwamatjhezi esikhathini esiphakathi kuka 2008-2017 begodu lisebenzise iindlela ezahlukeneko zokumeda umnotho ukobana ihlole iminqopho yayo. Ivarebuli engakazijameli yerhubhululweli bekukuthuthukiswa kweemaraga zamatjhezi, kanti ivarebuli ezijameleko yona bekukutjhugulukela ku-ICT. Amavarebuli asetjenziswe ngeemedo kube kukhululeka ngokweemali nangokuhlumisa umnotho lokhu okukhambisana nomkhiqizo woke wangekhaya wenarha. Kilokho okutholwe lirhubhululo, irhubhululo lithole ukuthi ukutjhugulukela kwi-ICT kunomthelela omuhle khulu nokuqakatheka ngokwamanani phezu kwembalo yeenkhamphani ezitloliswe ngaphasi kwemaraga yokutjhentjhisana ngamatjhezi, phezu kokuqiniswa ngeemali kwemaraga yamatjhezi kanye nenani loke lamatjhezi athengiswa eemaraga ezikethiweko zamatjhezi ze-Afrika. Yeke-ke, njengombana ituthuko yomnotho ibonakala idzimelele phezu kwe-ICT, njengombana ukutholakala kanye nokusetjenziswa kwetuthuko ye-ICT, kanti lokho kuthuthukisa umnotho wezeemali wenarha. . Kwesibili, irhubhululo likghonile ukubona ukuthi ukutjhugulukela ku-ICT kanye neemarageni zamatjhezi kuzizinto ezihlangeneko nezihlobene ngendlela ehle esikhathini eside. Imiphumela iragele phambili nokuveza itjhebiswano elinikela indlela (*complementarity*) phakathi kokutjhugulukela ku-ICT kanye nekuthuthukisweni kweemaraga zamatjhezi. . Eqinisweni, ngokutjhugulukela ku-ICT neemarageni zamatjhezi kuyaziqinisa lezi zinto. Leli rhubhululo lifaka isandla kuziko

lelwazi ngeendlela ezinengi. Leli kulirhubhululo lokuthoma elihlola indaba yethintano lemaraga yamatjhezi elisebenzisa irhubhululo lephaneli. Ngaphezu kwalokho, irhubhululo lisebenzisa indlela ekhutheleko esekelwa kusebenzisa amatshwayo ku-ICT esekelako kanye nokuthuthukiswa kwemaraga yamatjhezi. Kwesithathu, lokhu kuhlukile kamanye amarhubhululo amalungana nalesi sihloko, leli rhubhululo akhange aphelele nje ngokuthoma ukubuza itjhebiswano elivezako, kanti begodu leli rhubhululo belihlola ukuhlanganiswa ndawonye komlandelande ehlolwe ukudala ubujamo begodu nokunikela isiyeleliso somthethomgomo. Okutholwe lirhubhululo kutjho bona abenzi bomthethomgomo kufanele baqalisise khulu lokha nabatlama imithethomgomo ye-ICT leyo engakhozelela ituthuko yeemaraga zamatjhezi ukobana kuhlume umnotho begodu nokuhlanganiswa ncono neemaraga ze-Afrika zokutjhentjhana ngamatjhezi.

Amagama aqakathekileko: ukutjhentjhiselana ngamatjhezi, i-ICT, ukutjhugulukela, ukuhlanganisa, umthelela, umthethomgomo, ukuhluma komnotho, i-Afrika, ukuhlanganiswa ndawonye

ISISHWANKATHELO

Icandelo leTheknoloji yoNxibelelwano loLwazi(i-ICT) nelinokuphikiswa, likhule kakhulu ngokukhawuleza eminyakeni egqithileyo ekudlaleni indima ephambili kwiinkalo zonke zemisebenzi yezoqoqosho. Ukuvela kwenguqu yesine yezoshishino, owona mgaqo-nkqubo uphambili koorhulumente ngowokufumana iindlela zokudibanisa ezobuchwepheshe ukukhuthaza uhlumo kwezoqoqosho. Kunjalo, injongo ephambili kolu phononongo ibikukuhlola impembelelo yokusebenzisa/ yokwamkela i-ICT kuphuhliso lotshintshiselwano lweempahla zase-Afrika, ukuhlola ukuba ukwamkelwa kwe-ICT kunye nophuhliso lweemarike zidityanisiwe, kunye nokumisa naliphi na ikhonco lonxibelelwano lonobangela phakathi kokwamkelwa kwe-ICT kunye nophuhliso lwemarike yotshintshiselwano lwempahla

Uphononongo lwahlola iphaneli ezili-11 zotshintshiselwano lwempahla eAfrika kwisithuba sowama-2008 kuya ku-2017 kwaye kwasetyenziswa uthotho lweendlela zobugcisa kwezoqoqosho ukuvavanya iinjongo zalo. Into eguqukayo yoxhomekeko kolu phando yayikuphuhlisa imarike yesitokhwe, ngelixa okwakuyinto ezimeleyo yayikukwamkela i-ICT. Izinto eziguquguqukayo ezilawulwayo ezazisetyenziswa yayiyinkululeko yezemali nokukhula koqoqosho okwakucaciswa ngemveliso yasekhaya ngokubanzi. Kwiziphumo zalo zophando, lufumanise ukuba ukusetyenziswa kwe-ICT kunefuthe elilungileyo elibonakalayo ngokwamanani kwiinkampani ezidwelisiweyo, ukurhweba kwimarike yesitokhwe kunye nexabiso elipheleleyo lezabelo ezithengiswa kwiimarike zesitokhwe zotshintshiselwano ezikhethiweyo zase- Afrika..

Ngenxa yoko, njengoko uqoqosho luguquka ngokuqhubekekayo luba kwimeko ye ICT lwandise ukufikeleleka kunye nokusetyenziswa kwenkqubela phambili ye-ICT, ngaloo ndlela iphucula uqoqosho lwezimali lukazwelonke. Okwesibini, yafumanisa ukuba ukwamkelwa kwe-ICT kunye nemarike yesitokhwe kudityanisiwe kwaye ziya kusebenzisana kakuhle ekuhambeni kwexesha. Iziphumo zaye zaphinda zabonisa ubudlelwane bozalwano macala (ukuphelelisa) phakathi kokwamkelwa kwe-ICT kunye nophuhliso lwemarike yotshintshiselwano/yesitokhwe. Ngokubalulekileyo, ukwamkelwa

kwe-ICT kunye nophuhliso lweemarike kwenza zomelezane. Olu phando lunegalelo kulwazi oluninzi olukhoyo ngeendlela ezininzi.

Olu luphando lokuqala ukuvavanya uthotho lwamakhonco emarike yesitokwe ye-ICT-isebenzisa iiphaneli zophando. Ngaphaya koko, uphononongo lusebenzise indlela engqongqo exhaswa kukusebenzisa izalathiso (indices) zomelwano kwi-ICT kunye nophuhliso lwemarike. Okwesithathu, ngokungafaniyo nolunye uphando olwenziweyo kwesi sihloko, olu phononongo aluphelanga nje kuphando lwangaphambili olwalungobudlelwane lwezigqibo (zokuzimisela), kodwa lwaphinda lwaphandela ukuhlanganiswa kothotho oluvavanyiweyo lonobangela kunye nokuphakamisa ingcebiso yomgaqo-nkqubo. Iziphumo zophando zithetha ukuba abaqulunqi bemigaqo-nkqubo kufuneka bazimisele ngakumbi xa besenza imigaqo-nkqubo ye-ICT enokuqhubela phambili ukuphuculwa kwemakethi yesitokhwe ukwenzela ukukhulisa uqoqosho olungcono kunye nokusebenzisana kakuhle nezinye iimarike zotshintshiselwano zaseAfrika.

Amagama aphambili: ukutshintshiselana ngesitokhwe, i-ICT, ukwamkelwa/ ukuvunywa ngokusemthethweni, ukudibanisa, impembelelo, umgaqo-nkqubo**,** ukukhula koqoqosho, i-Afrika, ukusebenzisana/ukubambisana

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DECLARATION

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The Impact of Information and Communication Technology Adoption on Stock Market Development in Africa

I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

Jerry Igwilo 31 January 2020

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SIGNATURE DATE

Table of Contents

ABSTRACT II

NGOKURHUNYEZIWEKO IV

ISISHWANKATHELO VI

ACKNOWLEDGEMENTS VIII

DECLARATION IX

LIST OF TABLES XV

LIST OF FIGURES XVII

LIST OF ACRONYMS XVIII

CHAPTER 1 1

INTRODUCTION AND BACKGROUND 1

1.0 Introduction 1
1.1 Background 6
1.2 Problem Statement 11
1.3 Aim of the Study 14
1.4 Research Questions 14
1.4.1 Research Question One 14
1.4.2 Research Question Two 15
1.4.3 Research Question Three 15
1.5 Significance of the study 16
1.5.1 Contribution to Knowledge 16
1.5.2 Contribution to Policy 17
1.5.3 Contribution to Practice 18
1.6 Delimitation of the Study 18
1.7 Outline of the Study 18

CHAPTER 2 21

STOCK MARKET DEVELOPMENT AND ECONOMIC GROWTH NEXUS 21

2.0 Introduction 21
2.1 An Overview of Financial Markets 21
2.2 Types of Financial Market 22
2.2.1 Capital Market 22
2.2.2 Money Market 22
2.2.3 Foreign Exchange Market 23
2.2.4 Commodity Market 23
2.2.5 Derivatives Market 23
2.2.6 Insurance Market 23
2.2.7 Bond Market 24
2.2.8 Stock Exchange 25
2.3 Stock Market Development 25
2.4 Finance and Economic Growth nexus 30
2.5 Empirical Evidence on the Stock Market Development - Economic Growth Linkage 40
2.6 Chapter Summary 45

CHAPTER 3 50

INFORMATION AND COMMUNICATIONS TECHNOLOGY AND STOCK MARKET DEVELOPMENT: THEORETICAL AND EMPIRICAL EVIDENCE 50

3.0 Introduction 50
3.1 Information and Communications Technology 50
3.2 ICT Adoption Theories 52
3.2.1 Technology Acceptance Model 52
3.2.2 Diffusion of Innovations 53
3.2.2.1 The Innovation-Decision Process 55
3.2.2.2 The Knowledge Stage 55
3.2.2.3 The Persuasion Stage 56
3.2.2.4 The Decision Stage 57
3.2.3 Unified Theory of Acceptance and Use of Technology 58
3.2.4 Model of the IT Implementation Process 59
3.2.5 Information Systems Success Model 59
3.3 Information Communication Technology and Stock Markets 60
3.4 ICT Adoption and Stock Markets : A Review of Empirical Studies 62
3.5 Conceptual Framework 72
3.6 Chapter Summary 74

CHAPTER 4 75

RESEARCH METHODOLOGY 75

4.0 Introduction 75

4.1 RESEARCH DESIGNS AND PARADIGMS 76
4.2 POPULATION AND SAMPLING 80
4.3 PANEL DATA TECHNIQUES 80
4.3.1 PANEL DATA REGRESSION MODEL 81
4.3.2 POOLED REGRESSION MODEL 83
4.3.3 FIXED EFFECT MODEL 84
4.3.4 RANDOM EFFECT MODEL 86
4.3.5 GENERALISED METHOD OF MOMENTS 87
4.4 DATA AND DEFINITION OF VARIABLES 89
4.4.1 DEPENDENT VARIABLES 92
4.4.1.1 STOCK MARKET CAPITALISATION TO GDP 93
4.4.1.2 STOCK MARKET TOTAL VALUE TRADED 93
4.4.1.3 STOCK MARKET TURNOVER RATIO 94
4.4.1.4 NUMBER OF LISTED COMPANIES 94
4.4.1.5 STOCK MARKET DEVELOPMENT INDEX 95
4.4.2 INDEPENDENT VARIABLES 95
4.4.2.1 NUMBER OF MOBILE PHONES SUBSCRIPTIONS 96
4.4.2.2 NUMBER OF INTERNET USERS 96
4.4.2.3 NUMBER OF BROADBAND USERS 96
4.4.2.4 NUMBER OF FIXED TELEPHONE SUBSCRIPTION 96
4.4.2.5 ICT INDEX 97
4.4.3 CONTROL VARIABLES 98
4.4.3.1 FINANCIAL FREEDOM INDEX 98
4.4.3.2 GROSS DOMESTIC PRODUCT 98
4.5 ESTIMATION TECHNIQUES 101
4.5.1 MODEL SPECIFICATIONS 102
4.5.2 PRINCIPAL COMPONENTS ANALYSIS 103
4.5.3 COINTEGRATION 105
4.5.4 GRANGER CAUSALITY 108
4.6 DIAGNOSTICS TESTS 109
4.7 ETHICAL CONSIDERATION 111
4.8 CHAPTER SUMMARY 111

CHAPTER 5 112

EMPIRICAL RESULTS OF THE IMPACT OF ICT ADOPTION ON STOCK MARKET DEVELOPMENT 112

5.0 INTRODUCTION 112
5.1 EMPIRICAL RESULTS AND DATA ANALYSIS 112
5.1.1 DATA 112
5.1.2 SUMMARY STATISTICS 113
5.2 CORRELATION ANALYSIS 116
5.3 DIAGNOSTIC TESTS AND PANEL REGRESSION RESULTS 118

5.3.1 PRINCIPAL COMPONENTS ANALYSIS 118
5.3.2 STOCK MARKET DEVELOPMENT INDEX 120
5.4 PANEL COINTEGRATION RESULTS 122
5.5 PANEL UNIT ROOT TEST 122
5.5.1 COINTEGRATION AND THE ERROR CORRECTION MODEL 123
5.5.1.1 POOLED MEAN GROUP, MEAN GROUP OR DYNAMIC FIXED EFFECTS 124
5.5.2 PANEL COINTEGRATION AND THE ERROR CORRECTION MODEL: POOLED MEAN GROUP APPROACH 125
5.5.2.1 COINTEGRATION AND THE ERROR CORRECTION MODEL FOR STOCK MARKET INDEX, *ICT INDEX AND FFI.* 125
5.5.2.2 COINTEGRATION AND THE ERROR CORRECTION MODEL FOR STOCK MARKET *DEVELOPMENT INDEX, ICT ADOPTION INDEX AND GDP* 127
5.6.1 EMPIRICAL FINDINGS ON THE IMPACT OF ICT ADOPTION ON STOCK MARKET DEVELOPMENT IN AFRICA 134
5.6.2 EMPIRICAL FINDINGS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF FIRMS LISTED ON THE AFRICAN STOCK EXCHANGES 137
5.6.3 EMPIRICAL FINDINGS ON THE IMPACT OF ICT ADOPTION ON THE MARKET CAPITALISATION OF THE AFRICAN STOCK EXCHANGES 141
5.6.4 EMPIRICAL FINDINGS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF SHARES TRADED ON THE AFRICAN STOCK EXCHANGES 144
5.6.5 EMPIRICAL FINDINGS ON THE EFFECT OF ICT ADOPTION ON THE TURNOVER RATIOS OF THE AFRICAN STOCK MARKETS 147
5.7 CHAPTER SUMMARY 149

CHAPTER 6 152

SUMMARY OF RESULTS, CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH 152

6.0 INTRODUCTION 152

6.1 THEORETICAL INSIGHTS ON ICT ADOPTION AND STOCK MARKET DEVELOPMENT 155

6.2 EMPIRICAL INSIGHTS ON ICT ADOPTION AND STOCK MARKET DEVELOPMENT 156

6.3 SUMMARY OF RESULTS 159

6.3.1 SUMMARY OF METHODOLOGICAL APPROACHES 159
6.3.2 SUMMARY OF EMPIRICAL FINDINGS 161
6.3.2.1 RESEARCH FINDINGS ON THE IMPACT OF ICT ADOPTION ON STOCK MARKET DEVELOPMENT 162
- *THE IMPACT OF ICT ADOPTION ON A NUMBER OF FIRMS LISTED ON THE AFRICAN STOCK EXCHANGES* 162
- *THE IMPACT OF ICT ADOPTION ON THE MARKET CAPITALISATION OF THE AFRICAN STOCK EXCHANGES* 163
- *THE IMPACT OF ICT ADOPTION ON THE NUMBER OF SHARES TRADED ON THE AFRICAN STOCK EXCHANGES* 163
- *THE IMPACT OF ICT ADOPTION ON THE TURNOVER RATIOS OF THE AFRICAN STOCK MARKETS* 164

6.3.2.2 RESEARCH FINDINGS ON WHETHER ICT ADOPTION AND STOCK MARKET DEVELOPMENT INDEX WERE COINTEGRATED 164

6.3.2.3 RESEARCH FINDINGS ON THE CAUSAL RELATIONSHIP BETWEEN ICT ADOPTION AND STOCK MARKET DEVELOPMENT INDEX 165
6.4 CONTRIBUTION OF THE STUDY 166
6.5 CONTRIBUTION TO POLICY 167
6.6 DIRECTIONS FOR FUTURE RESEARCH 168

REFERENCES 170

APPENDICES 203

LIST OF TABLES

TABLE 1. 1: SELECTED AFRICAN STOCK EXCHANGES 5

TABLE 3. 1 : SUMMARY OF THE REVIEWED EMPIRICAL STUDIES 68

TABLE 4. 1 : DATA AND SOURCES 91
TABLE 4. 2 : SUMMARY OF VARIABLES 99

TABLE 5. 1 : SUMMARY STATISTICS OF THE VARIABLES 114
TABLE 5. 2 : CORRELATION MATRIX FOR THE MAIN VARIABLES USED FOR THIS STUDY 117
TABLE 5. 3 : PRINCIPAL COMPONENT ANALYSIS : EIGEN VALUES 120
TABLE 5. 4PRINCIPAL COMPONENT ANALYSIS : EIGEN VECTORS (LOADINGS) 121
TABLE 5. 5 : PANEL UNIT ROOT TEST USING LEVIN LIN AND CHU TEST 122
TABLE 5. 6 : SUMMARY OF THE PMG, MG AND DFE ON THE COINTEGRATING AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET INDEX, ICT INDEX AND FFI. 126
TABLE 5. 7 : SUMMARY OF THE PMG, MG AND DFE ON THE COINTEGRATING AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET DEVELOPMENT INDEX AND ICT INDEX AND GDP 128
TABLE 5. 8 : SUMMARY OF THE POOLED MEAN GROUP ON THE COINTEGRATING AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET INDEX, ICT INDEX AND FINANCIAL FREEDOM INDEX 130
TABLE 5. 9 : SUMMARY OF THE POOLED MEAN GROUP ON THE COINTEGRATION AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET INDEX, ICT INDEX AND GDP 131
TABLE 5. 10 : SUMMARY OF THE POOLED MEAN GROUP ON THE COINTEGRATING AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET INDEX, ICT INDEX AND FINANCIAL FREEDOM INDEX 132
TABLE 5. 11 : SUMMARY OF THE POOLED MEAN GROUP ON THE COINTEGRATING AND CAUSALITY RELATIONSHIP BETWEEN STOCK MARKET INDEX, ICT INDEX AND GDP. 133
TABLE 5. 12 : DIAGNOSTIC STATISTICS OF THE DATA ESTIMATIONS ON THE DETERMINANTS OF STOCK MARKET DEVELOPMENT (FINDEX) 135
TABLE 5. 13 : DETERMINANTS OF STOCK MARKET DEVELOPMENT (FINDEX) 136
TABLE 5. 14 : DIAGNOSTIC TESTS OF THE DATA ESTIMATIONS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF LISTED FIRMS 138
TABLE 5. 15 : PANEL REGRESSION RESULTS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF LISTED FIRMS 140
TABLE 5. 16 : DIAGNOSTIC TEST OF THE DATA ESTIMATIONS ON THE IMPACT OF ICT ADOPTION ON STOCK MARKET CAPITALISATION 141
TABLE 5. 17 : PANEL REGRESSION RESULTS ON ESTIMATIONS ON THE IMPACT OF ICT ADOPTION ON STOCK MARKET CAPITALISATION 143
TABLE 5. 18 : DIAGNOSTIC STATISTICS OF THE DATA ESTIMATIONS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF SHARES TRADED 144

TABLE 5. 19 : PANEL REGRESSION RESULTS ON ESTIMATIONS ON THE IMPACT OF ICT ADOPTION ON THE NUMBER OF SHARES TRADED 146
TABLE 5. 20 : DIAGNOSTIC STATISTICS OF THE DATA ESTIMATIONS ON EFFECT OF ICT ADOPTION ON THE TURNOVER RATIOS OF AFRICAN STOCK MARKETS..... 147
TABLE 5. 21 : PANEL REGRESSION RESULTS ON EFFECT OF ICT ADOPTION ON THE TURNOVER RATIOS OF THE AFRICAN STOCK MARKETS 148

LIST OF FIGURES

FIGURE 3. 1 : CONCEPTUAL FRAMEWORK 72

FIGURE 4. 1 : EXEMPLIFIES THE DEDUCTIVE APPROACH IN A RESEARCH PROCESS. 79

LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
AfCFTA	African Continental Free Trade Area
ARDL	Autoregressive-Distributed Lag
ASEA	African Securities Exchanges Association
ASEAN	Association of South East Asian Nations
BRIC	Brazil, Russia, India and China
BRVM	The Bourse Regionale des Valeurs Mobilieres
BSE	Botswana Stock Exchange
BVMT	Bourse de Tunis
CAPM	Capital Asset Pricing Model
Casa SE	Casablanca Stock Exchange
CC	Constant Coefficient
CSCS	Central Securities Clearing System
DEL	Direct Exchange Line
DFE	Dynamic Fixed Effects
DOI	Diffusion of Innovations
FDI	Foreign Direct Investment
FEM	Fixed-effect-model
FFi	Financial Freedom index
FINDEX	Stock Market Development Index
FM	Financial Market
GDP	Gross Domestic Product
GEX	Egyptian Exchange
GSE	Ghana Stock Exchange
ICT	Information Communication Technology
ICTDEX	ICT adoption index
IPO	Initial Public Offering
IPS	Im, Pesaran and Shin

IS	Information Society
ITU	International Telecommunication Union
IU	Number of Internet Users
JET	Johannesburg Equities Trading
JSE	Johannesburg Stock Exchange
KIBS	Knowledge-intensive business services
LSE	London Stock Exchange
MG	Mean Group
MM	Motivational Model
MPU	Model of PC utilisation
MSCI	Morgan Stanley Capital International
NBU	Number of broadband Users
NFTU	Number of Fixed Telephone Users
NLC	Number of Listed Companies
NMU	Number of Mobile Phone Users
NSE	Nigerian Stock Exchange
NSE	Nairobi Securities Exchange
NSX	Namibia Stock Exchange
OECD	Organisation for Economic Cooperation and Development
PCA	Principal component analysis
PDR	Panel Data Regression
PMG	Pooled Mean Group
PRM	Pooled Regression Model
PSTN	Public switched telephone network
REM	Random effect Model
SADC	Southern African Development Community
SCT	Social Cognitive Theory
SEM	Stock Exchange of Mauritius
SETS	Stock Exchange Electronic Trading System
SMC	Stock Market Capitalization to GDP
SMTR	Stock Market Turnover Ratio

SMTV	Stock Market Value Traded to GDP
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
USD	United States Dollar
UTAUT	Unified Theory of Acceptance and Use of Technology
VECM	Vector error correction model

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.0 Introduction

Africa is perceived to be a continent with significant prospects in terms of resources and hope as a new developmental frontier. In the light of this perception, some African countries have commenced economic and structural reforms in the financial sectors to revive the so far subdued systems and, more essentially, to strengthen and develop their stock markets (Ngare, Nyamongo & Misati, 2014). The major reason that necessitated these reforms has been the need to strengthen financial markets through stock markets development, in order to induce improved economic growth. Therefore, the development of stock markets in an emerging economy is seen as one of the major panaceas for achieving economic growth and lifting the standard of living. Arguably, a sound regulatory environment that supports the development of the stock markets is key to driving market confidence for both listed companies and investors.

The growth and development of stock markets in emerging economies has been on a rapid increase in recent times, most particularly in Africa. This is in line with Okwu's (2016) assertion that Africa's equity markets have grown within a short period of time. Stock market development is assessed and appraised by liquidity, stock market size, volatility, concentration, synergy with other global capital markets, and also through the supervision and regulation by a body which sets the legal rules in the market. A stock market can be seen as a place, either virtual or physical, where issuing and trading of shares occur. This is either via exchanges or over-the-counter (OTC) markets, which can also be regarded as the equity market in particular, and part of financial markets in general.

Solarin, Shahbaz, Khan and Razali (2019) assert that stock markets are considered as one of the most crucial aspects of a market economy, in the sense that on the one hand they make it possible for firms to gain access to capital. On the other hand, stock markets enable investors to have a share of ownership in the listed firm, based on the firm's expected performance in the future. According to Aud, Marbuah and Mensah

(2013), the stock market is considered as one of the most crucial aspects of a financial system. This is in light of the fact that, through the stock market, listed firms can elicit capital by issuing their shares and at the same time bring about an environment through which the same issued shares can be freely traded by market participants. Hence, more recently, a growing strand of literature has focused on stock market development as the main factor for economic growth (see for instance; Tsaurai, 2018; Bundoo, 2017 & Okwu, 2016). One of such determinants of stock market development has been argued by researchers to include the adoption of information and communication technology (ICT) (see for instance; Tsaurai, 2018; Bundoo, 2017 & Okwu, 2016).

Developments in ICT have affected livelihoods and various other aspects of human activities and interactions in the last few decades. Among the aspects of human activities and interactions that have been tremendously affected by ICT is the development of African stock markets in particular, and the world in general. This was reflected in a study of stock markets development and integration in South African Development Community (SADC) member countries, carried out by Bundoo in 2017, that highlights the importance of ICT in stock market development (Bundoo, 2017). Furthermore, Bundoo (2017), concluded in the study that the SADC member states' stock exchanges must work towards a greater integration so that they can attract more capital portfolio flows (capital finance flows) rather than relying on more volatile portfolio flows. The Bundoo (2017) study also concluded that greater foreign direct investment (FDI) flows which are much needed for the financial and economic development of the SADC countries in particular, and Africa in general, will be attracted through greater stock market integration. Therefore, by implication, the Bundoo (2017) study emphasised the importance of ICT adoption for the development of African stock markets.

Dorodnykh (2014), argued that among other factors, the removal of regulatory impediments, globalisation, technological developments and adoption are among the main reasons for the development of stock markets in general. The importance of ICT adoption in the development of stock markets, therefore, necessitated the study of the impact of ICT adoption on stock market development in Africa, which is the major objective of this research.

Furthermore, ICT enablers can be regarded as any device that store, manipulate, transmit, retrieve, or accept information via electronic means and also in a digital format. With respect to Kayisire and Wei, (2016), they asserted that the advent of ICT in the last decades has resulted in a striking turnaround of business globally, thereby turning our environment into a society with adequate information. This is as a result of ICT infrastructure such as internet, computers, mobile phones, people and organisations. These ICT infrastructures has also help governmental institutions collect, store and manage data effectively and in a more efficient way to access information. This also helps government with knowledge and understanding of largescale information and at a very high speed, now more than ever before. Furthermore, the integration of ICT has to a larger extent enhanced the efficiency of allocation of resources. This, as in the case of stock markets, had significantly improved market activities (Bahrini & Qaffas, 2012).

In addition, the recent years have seen the growth and development of ICT in a remarkable manner, mostly in different countries, sectors and industries of the world, as a result of transformational power of technology which favours efficiency and productivity. Dzidonu (2010) asserted that ICT can be termed as a collection of technologies which may consist of a microprocessor, computer, multimedia, broadcasting network telecommunication, and internet technology. Further, he concluded that there has been a boost of service and operation as a result of these technologies at both individual and organisation levels. Emamnuel Baro (2011), highlighted that the impact of ICT in the development of the global economy and life in general cannot be over stated. He further implied that the increase in the implementation of ICT projects and its usage over the last few decades in Africa has been phenomenal in nature (Emmanuel Baro, 2011). This can be attributed to the outstanding and efficient role ICT plays in both public and private sectors.

Moreover, in Africa, the development of ICT has been geared up and motivated by mobile communication technology. For instance, Yonazi, Kelly and Blackman (2012) posited that the subscription of mobile phones in Africa in 2012, almost peaked at 650 million users, while North America and the European Union had fewer mobile phone subscribers in the same year. Hence, they concluded that using the subscription figure, it can be ascertained that the fastest growing part in the world in terms of mobile

communication technology is Africa. The affordability and availability of mobile phones are increasing every day and they are being used as a base for accessing internets, e-government services and financial services, among others.

Developments in ICT have not only affected lives, but also various other areas of human activities in the last few years. Among the areas of social skills and activities that have been tremendously affected by ICT are developments in the global and, most especially, African stock markets. With respect to Bundoo's 2017 study of development of stock markets as well as its integration in the SADC, he concluded that SADC share issuing and trading should of necessity attain towards a greater integration in order to bring in more capital investment instead of relying on more volatile investment.

The study by Bundoo (2017) also concluded that greater FDI flows which are greatly required for economic development of African communities' development will be attracted through greater stock market integration. Therefore, by implication, Bundoo (2017), emphasised the importance of ICT adoption for the development of African stock markets. Furthermore, Dorodnykh (2014), argued that among other factors like deregulation and globalisation, technological developments and adoption are one of the crucial grounds for the development of stock markets in general. Therefore, given the importance of ICT adoption by the players in the economy, in the development of stock markets, this necessitates the study of the influence of ICT adoption on the development of the stock markets in Africa.

The following eleven African stock exchanges will be the base of this study, namely; Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) and Stock Exchange of Mauritius (SEM). These eleven selected stock exchanges were mostly selected based on the availability of data required for the analysis; which are secondary data from 2008 to 2017.

Table 1. 1: SELECTED AFRICAN STOCK EXCHANGES

NUMBER	COUNTRY	NAME	ABBREVIATION	NUMBER OF LISTED COMPANIES	MARKET CAPITALISATION
1	Botswana	Botswana Stock Exchange	BSE	33	$37,505,515,000
2	Cote D'voire	BRVM Stock Exchange	BRVM	45	$6,960,322,592
3	Egypt	Egypt Exchange	EGX	223	$45,628,544,290
4	Ghana	Ghana Stock Exchange	GSE	42	$9,951,00,000
5	Kenya	Nairobi Securities Exchange	NSE	63	$22,007,506,496
6	Mauritius	Stock Exchange of Mauritius	SEM	97	$8,980,000,000
7	Morocco	Casablanca Stock Exchange	Casa SE	75	$60,576,297,847
8	Namibia	Namibia Stock Exchange	NSX	40	$141,128,581,560
9	Nigeria	Nigeria Stock Exchange	NSE	147	$35,925,467,734
10	South Africa	Johannesburg Stock Exchange	JSE	353	$898,990,000,000
11	Tunisia	Bourse de Tunis	BVMT	88	$8,922,590,000

Source: Author's construction based on the information obtained from World Bank Global Financial Development database

1.1 Background

The JSE was formed in 1887. It is Sub-Saharan Africa's oldest stock exchange. Also, South Africa's stock markets are the most highly developed in sub-Saharan Africa. The JSE was formed during the gold rush of the late 1800s. This is notable as Johannesburg is also called gold city and the gold capital of South Africa, during the gold rush era. Furthermore, in the early 1990s, the JSE upgraded its trading platform to electronic trading system. Then in 2005 the JSE demutualised and also listed on its own exchange (Johannesburg Stock Exchange, 2019).

The notable ICT-driven improvement toward stock market development, regional cooperation and integration among the 14 South African Development Community (SADC) member states initiated by the JSE is highlighted as Irving (2005) explained. The initiatives include the harmonised stock exchange listing requirements. In the year 2000, based on the 13 principles of the JSE's listing requirements, the JSE's electronic trading system, known as the Johannesburg Equities Trading (JET) System was installed. In 2002, the JSE adopted the London Stock Exchange's trading system technology, which is known as Stock Exchange Electronic Trading System (SETS). In addition, the London Stock Exchange (LSE) provided technical support and trading system upgrades and enhancements that enabled brokers in both South Africa and the United Kingdom to access one another's stock markets.

Furthermore, ICT-driven progress towards the development of exchanges has enhanced activities on the JSE since 1998 and offered the use of its trading system and technical assistance to the other SADC exchanges. Subsequently, SADC exchanges have considered how to adopt the JSE's trading system as the trading platform of the sub-region, as well as other technology options for an integrated network of exchanges (Irving, 2005).

The Namibia Stock Exchange (NSX) was founded in 1904 during the diamond rush at that time. However, within 6 years, the diamond rush ended, and the stock exchange was closed. In 1992, NSX was relaunched with funds contributed by 36 leading businesses in Namibia. The companies contributed $10,000 (Ten Thousand USD) each, as startup capital for the exchange. Also, the Namibia Stock Exchange (NSX) in 1998, via a telecommunications link to the JSE and, in 2002, joined the JSE in adopting

the LSE's trading system technology, which is known as Stock Exchange Electronic Trading System (SETS). In addition, the London Stock Exchange (LSE) provided technical support and trading system upgrades and enhancements that enabled brokers in both South Africa and the United Kingdom to access one another's stock markets (Namibia Stock Exchange, 2019).

The Nigerian Stock Exchange (NSE) was founded in 1960 and like most African stock exchanges, it went through several reforms from inception. NSE is the largest stock exchange in West Africa and serves the largest African economy (Nigerian Stock Exchange, 2019). Among the several ICT related developments and reforms in the Nigerian Stock Exchange (NSE) are the introduction in 1997, of automated clearing, settlement and delivery system – Central Securities Clearing System (CSCS), to ease transactions and foster investors' confidence in the stock exchange. Also, performance information on the NSE was linked to Reuters International System for timely dissemination of relevant market information to subscriber investors (Obiakor & Okwu, 2011). The CSCS enables shares to exist in electronic form in a central depository and thus, helps eliminate risks of loss, mutilation, and theft of certificates as well as reduce errors and delivery delays. Other ICT adoptions include the CSCS trade alert, phone-in-service, e-bonus and e-dividend payments (Ezirim et al., 2009).

The NSE adopted twenty-first century technologies strategies that led to the development of a new website in 2011 and achievement of X-Net VPN, X-Gen development and market data in 2012. This was to facilitate the delivery of new trading platform and the automation of transaction lifecycle from 2013 (Onyema, 2013). Therefore, ICT will ensure that the enhancement of formidable pillars of economic development is reinforced and this will further enhance trading capacities and relevance of stock market in the financial infrastructure of African economies.

For instance, in the Nigeria context, prior to the 1980s, trading in the Nigerian Stock Exchange was weak, attributable mainly to the low level of information dissemination and awareness. However, most market indicators show that the market has demonstrated remarkable growth and efficiency since the 1980s with an increased level of computerisation and availability of corporate information (Adenuga, 2010). As such, stockbrokers, dealers and investors are placed on level grounds of access to

information for the trading of securities and can also implement deals via the internet of connected computers which can be from places that are remote during transaction hours (Ezirim, Adebajo, Elike & Muoghalu, 2009).

The Johannesburg Stock Exchange (JSE) and the Nigerian Stock Exchange (NSE) share similarities in terms of the timing of reforms and ICT transformations. For instance, these exchanges went through significant reforms in the 1990s, which culminated in unrestricted foreign interests in locally quoted companies and the introduction of fully automated trading systems to replace the open outcry trading system that existed before. In recent times, both exchanges have undergone further restructuring and reformation, including the moves to electronic system, amendments of their listing requirements and existing laws relating to capital market (Irving, 2005; Ezirim et al., 2009; Obiakor & Okwu, 2011). At one time or the other, inflows of foreign investment to the exchanges increased substantially.

According to Egypt Exchange (2019), the rebranding of what is known today as Egypt Exchange (EGX) took place in 2009. This was as a result of the merger of Alexandria and Cairo stock exchanges. Alexandria Stock Exchange which was the oldest Stock Exchange in the Middle East, was established in 1883, dealing in cotton futures, while Cairo Stock Exchange was established in 1904 and limited to cotton brokers who were dealing in cotton futures. The two exchanges went through several reforms and in 1994 shifted from an outcry system to an automated order-driven system, using ICT infrastructure as the core of its trading systems.

The Nairobi Securities Exchange (NSE) was established in 1954, after an approval was received by London Stock exchange, to create NSE as an overseas stock exchange a year earlier. The reason for such approval was because Kenya at that time was an English colony. The NSE went through several reforms, which culminated in the introduction of Electronic Trading System (ETS) in 2006 and a year later the creation of a Wide Area Network (WAN), that allowed stock brokers to connect to the Stock exchange and able to trade from different jurisdictions, instead of physically being on the floor of the Stock Exchange, which was usually the case. The NSE was demutualised and was listed on the stock exchange in 2014; this allowed the stock exchange’s shares to be traded on the stock exchange. NSE is said to be playing a

very important role in the economic growth being experienced by Kenya today (Nairobi Securities Exchange, 2019).

The Stock Exchange of Mauritius Limited (SEM) was initially incorporated as a limited liability company in 1989 and it became a public company in 2008 when its shares were listed. At inception the stock exchange traded once a week, under the box method which was based on a theory developed my Nicolas Darvas in the late 1950s. SEM has also gone through several reforms and developments over time. In 1991, it adopted the open cry trading system, which is a single price auction system. In 1997, SEM launched its first website. This development helped the stock exchange to share trading information like online tracking of shares, trading prices, volume traded and listing rules. In 2001, SEM moved away from open cry trading system to a fully automated online trading system (Stock Exchange of Mauritius, 2019).

The Casablanca Stock Exchange (Casa SE) was founded in 1929. Like most African Stock Exchanges, Casa SE also went through different stages of reforms. In 1967, the stock exchange was reorganised to a well-organised legal and technical framework. All through the years, the stock exchange has continued to undertake reforms to strengthen and modernise the exchange. In 1997, Casa SE launched an electronic trading system, to allow for online trading and in 2001, a further improvement was made to allow stockbrokers to trade from their office. This was a significant development because trading was made possible through the use of ICT infrastructure, which further supports the objective of the research (The Casablanca Stock Exchange, 2019)

Botswana Stock Exchange (BSE), like all other African stock exchanges had undergone several developmental stages. However, the most pertinent was the initial idea to establish a stock exchange in Botswana which was contemplated and actualised in 1989. BSE has actively pursued the use of ICT improvements to meet stakeholders' requirements, integrity, capacity and cost efficiency as well as to meet international standards. (Botswana Stock Exchange, 2019). BSE is also the third largest stock exchange in SADC, and one of the best performing stock exchanges in the last decade. (Botswana Stock Exchange, 2019)

In February 1969, the Tunis Stock Exchange, which is also known as Bourse de Tunis (BVMT) was established as a public institution and also as is the case with other African Stock Exchanges, BVMT underwent several reforms which culminated in BVMT becoming a limited liability company in 1995. In 1996, the stock exchange set up the electronic trading system (NSC) which, as in the case of the other stock exchanges, enabled the trading and settlement of trading activities electronically. This development shows that stock exchanges can enhance their operations through the use of Information and Communication Technology (Bourse de Tunis, Presentation Bourse de Tunis, 2019).

Ghana Stock Exchange (GSE) was established in 1989. Even though Ghana had enacted a stock exchange act in 1971, it was only in 1989 that an actual stock exchange was established. The GSE was organised and registered as a private company limited by guarantee. The stock exchange commenced trading in November of 1990, after the receiving recognition as an authorised stock exchange, under the stock exchange act of 1971. Then, in 1994, the stock exchange became a public company by guarantee. (Ghana Stock Exchange, 2019).

The GSE also went through different processes of structuring and restructuring before becoming a reality. Since the formation of the stock exchange it has adopted ICT as a backbone of its operation. This manifested in the stock exchange winning the most innovative stock exchange award in 2018, awarded by Africa investor (Ai) awards.

The Bourse Regionale des Valeurs Mobilieres (BRVM) is a regional stock market for members of the West African Economic and Monetary Union (WAEMU) which comprises 8 member states and includes the following countries: Côte d'Ivoire, Niger, Senegal, Togo Benin, Burkina Faso, Guinea-Bissau and Mali. It is said to be the only stock market in the world that is shared by multiple countries and it is totally run as a digital platform, supported by information and communications technology, with a perfect integration.

In 1993, the member states of WAEMU decided to establish a joint stock market, solely for the member states. After several engagements between the member states, BRVM was established and began operations in 1998. This was a result of the member states

giving a mandate to West African Central bank to establish the stock exchange a year before. BRVM went through several rapid developments from inception; however, the most pertinent of all was the creation in 2014 of a stand-alone index by Morgan Stanley Capital International (MSCI) for WAEMU financial market. Then, in 2014, the BRVM was integrated into the MSCI and S&P Dow Jones indices (Bourse Regionale des Valeurs Mobilieres.org, 2019).

All the stock exchanges discussed above have undergone several reforms at different times. However, they all have made ICT adoption one of the major developmental factors of the reforms they experienced over the period of their existence. This highlights the importance of ICT in the life of a stock exchange, which further enforces the need for this research, which is to study the impact of ICT adoption on stock market development in Africa.

1.2 Problem Statement

Notwithstanding the gains enjoyed by African stock markets in the last decade, African stock exchanges still face the challenge of integration, especially in the wake of the newly signed African free trade agreement. Moreover, there is need for building the technical requirements and developing institutional capacity to resolve the problem of low liquidity faced by most African stock exchanges (Yartey & Adjasi, 2007). Investors, policymakers and market participants require adequate studies on the subject matter. A study conducted by the World Economic Forum (WEF) indicates that an increase in the digitization of a country by 10 percent would lead to a 0.75 percent increase in GDP per capita, and a 1.02 percent drop in the unemployment rate (World Economic Forum, 2013). This also highlights the need to explore the impact of ICT on stock market development, given that its impact on economic development is pertinent.

Furthermore, Schwab (2019) in the WEF global competitiveness report (2019), listed the following as some of the major pillars of the report; ICT adoption, macroeconomic stability and financial system. The report shows that Sub-Sahara Africa had an increase of 15.8% in ICT adoption, while Europe and North America had an increase of 3.7% in ICT adoption. However, the corresponding increase in macroeconomic stability was 3.7% for Sub-Sahara Africa while Europe and North America had an increase of 0.9%. This shows that there is need to explore the impact of ICT on stock

market development in particular and economic development in general. Furthermore, the ICT adoption in Europe and North America was at 70.4% and the financial system performance at 70.9%, while Sub-Sahara Africa ICT adoption was at 34.3% and the financial system performance was 50.8%. This indicates that there is room for improvement in ICT adoption and consequently financial system performance. Therefore, ICT adoption could have a positive effect on stock market development. However, the ICT adoption rate in Africa is rather too low for ICT adoption to have a highly positive effect on stock market development. This reinforces the need to investigate the impact of ICT adoption on stock market development.

With adequate understanding of these issues, policymakers can make appropriate laws to support stock market development in Africa, thereby helping investors and other market participants to make optimal investment and financing decisions that will also aid stock market development.

Okwu (2016) and Adeleye and Eboagu (2019) studied the relationship between economic growth and development of the stock market, and the determinants of stock market development in Africa. Their studies show mixed results on the impact of economic development on the development of the stock market in the economy. However, in view of the rising significance of ICT and the way it is changing the human perspective and the world in general, there needs to be more empirical research conducted on the adoption of ICT on the development of stock market in Africa (see for example, Okwu, 2016 and Bhunia, 2011).

Most studies which are empirical in nature have documented that the stock market in Africa is still emerging and not volatile which has affected the development of the stock market itself (for example, Yartey & Adjasi, 2007, Owusu, 2016, Adeleye & Eboagu, 2019). Furthermore, most studies on ICT have significantly focused on economic growth, (refer to: Adeleye & Eboagu, 2015; Vincenzo, 2013 & Shahram, 2014 among others). There appear to be limited empirical studies on the impact of ICT adoption on African stock market development in general, even though the stock market can be considered as one of the main parts of financial markets used in driving the engines of economic development, through its ability to increase financial participation by a wider range of participants. Possibly, the limited studies in the area of African stock

market development can also be part of the reasons why there has been a dearth in literature on the impact of ICT adoption on the development of African stock markets.

Moreover, while relevant studies focused only on Nigerian and South African stock markets (Okwu, 2015, 2016), there is none, yet, which comparatively studied African stock markets employing a sample of a much wider panel study of stock markets in Africa. This underscores the peculiarity of this study which examines the impact of ICT adoption on the development of stock markets in Africa, focusing on at least eleven stock exchanges in the continent.

Therefore, this study seeks to address the lack of or inadequate ICT policies, which are focused on the development of African stock markets by the policymakers. The focus on ICT-driven initiatives has been majorly on the Fintech space; however, policymakers need to focus on ICT policies which can support stock market development, given the impact of stock market development on the economy. One of the major policy syndromes that this study seeks to address is that with the speed of African market integration, especially with the ratification of African Continental Free Trade Area (AfCFTA) agreement by most African countries, there is a need for a major ICT policy to drive also the integration of African stock markets and in the process help their development. The lack of a cohesive or uniform ICT policy can be a major impediment to adequate integration of African stock markets, in this era of AfCTA. Thus, a major opportunity is lost to further develop the African stock market, through the use of ICT-driven initiatives.

Furthermore, the study seeks to highlight the potential problems that both the policymakers and market participants might face if adequate ICT policies are not implemented to drive African stock market development. The issues are three-pronged in nature: The first one is economic growth: It is an indisputable fact that stock market development leads to economic growth and vice versa. The second part is African stock market development which is the specific issue at hand. Therefore, this study seeks to examine whether ICT adoption can foster African stock market development. If the link is established, this can be of help to government policymakers who are currently crafting ICT policies in Africa.

1.3 Aim of the Study

The major aim of this research is to evaluate the impact of ICT adoption on the development of stock markets in Africa.

1.4 Research Questions

The research is relevant to the African continent; therefore, in order to achieve the aim of the study, effort would be made to proffer answers to the following research questions:

1.4.1 Research Question One

What is the impact of ICT adoption on Stock Market Development in Africa?

Deriving from this question, the main hypothesis of this study is that ICT adoption has no significant effect on African stock market development. The following hypotheses were formulated in order to address this research question:

Hypothesis One

H_o : ICT adoption has no significant effects on the number of firms listed to 10,000 people on the African stock exchanges.

H_A : ICT adoption has a significant effect on the number of firms listed to 10,000 people on the African stock exchanges.

Hypothesis Two

H_o : ICT adoption has no significant impact on the market capitalisation to GDP of the African stock exchanges.

H_A : ICT adoption has significant impact on the market capitalisation to GDP of the African stock exchanges.

Hypothesis Three

H_o : ICT adoption has no significant impact on the value of shares traded to GDP on the African stock exchanges.

H_A : ICT adoption has significant impact on the value of shares traded to GDP on the African stock exchanges.

Hypothesis Four

H_o : ICT adoption has no significant impact on the turnover ratios of the African stock exchanges.

H_A : ICT adoption has significant impact on the turnover ratios of the African stock exchanges

1.4.2 Research Question Two

What cointegrating relationships exist between ICT adoption and stock market development in Africa?

In order to answer this research question, the following hypothesis was developed:

Hypothesis Five

H_o : Cointegrating relationships do not exist between ICT adoption and stock market development in Africa

H_A : Cointegrating relationships exist between ICT adoption and stock market development in Africa

1.4.3 Research Question Three

What is the direction of causality between ICT adoption and stock market development in Africa?

The following hypothesis was developed in order to address this research question:

Hypothesis Six

H_o : There is no causality between ICT adoption and stock market development in Africa

H_A : There is causality between ICT adoption and stock market development in Africa

1.5 Significance of the study

1.5.1 Contribution to Knowledge

Several studies on the general level have attempted to examine the relevance of capital market and the stock market with respect to economic growth and development in most developed economies (refer to Adeleye and Eboagu, 2015; Vincenzo, 2013 and Shahram, 2014 among others). Since emerging and developing economies are lagging behind in this area, this study seeks to add to the body of knowledge to further enhance the existing empirical studies. Most of the studies concentrated on the relationship between stock market development and economic growth (see for example; Shahram, 2014; Vincenzo, 2013; Kumar and Vu, 2014; Saeed, 2013; Okunola, 2012; Osisanwo and Atanda, 2012; Obiakor and Okwu, 2011; Donwa and Odia, 2010; Zagorchev et al., 2011; Francesco, 2011).

Another strand of studies focused on ICT as a tool in cross-border buying and selling of tangible goods, integration of exchanges and regional cooperation as well as operations in banks and financial performance (Farid, 2013; Adesola, Moradeyo & Oyeniyi, 2013; Benkraiem & Miloudi, 2012; Onwe, 2013;; Adejola, 2011; Bankole et al., 2010; Mihasonirina & Kangni, 2011).

Yet others analysed ICT with respect to financial, information and communication, corporate governance, investor new valuation, internalisation flows, as well as socio-economic development (Fernandez et al., 2011; Oyelere & Kuruppu, 2012; Donwa & Odia, 2010). It is noteworthy that these studies did not consider how ICT significantly influences or impacts stock exchange development, which constitutes the foundation of the stock market effect on the various indices in the areas of interest of their research. This current study contributes to closing the gap observed in the literature.

Furthermore, available studies on the effects of ICT on the development of the stock markets, more particularly in the last few years, have tended to focus on the developed economies, the world's leading markets and emerging and high-income economies, with only a few on developing economies like Nigeria (Hossein et al., 2013; and Ezirim et al., 2009). Interestingly, the studies on Nigeria, for instance, did not place particular emphasis on the development of the Nigerian Stock Exchange, let alone the leading stock exchanges in the African continent. Moreover, a survey of the literature indicated the likelihood that such studies are not yet available for African markets. This current study also intends to bridge this gap in knowledge and literature.

It is also evident from the review of literature that research efforts at ICT relative to macroeconomic indicators have been focused on economic activities and growth with diminutive attention on the stock markets, which is the pivotal part of the capital market in influencing the process of economic development and growth (Okwu, 2015). There exists a relationship dearth in the literature on the impact of ICT adoption on African stock exchange development. As earlier indicated, the available studies on the stock market on Africa are tilted toward the banking industry, with just a few on Nigerian stock market and South Africa. Throughout the course of this research, the researcher found no panel study which used more than ten African countries to examine the impact of ICT adoption on African stock markets.

1.5.2 Contribution to Policy

This further provoked the curiosity and interest to undertake research and examine the impact of ICT adoption on the development of African stock markets. It is especially significant in this transformational regime when regional cooperation, like the AfCFTA and integration of stock exchanges have become a motivating influence towards global integration and international competitiveness of financial markets in general. Hence, the overarching objective of this study is to examine the impact of ICT adoption on the development of African stock markets, to help drive policy direction and formulation by policy makers. It is instructive to note that African governments are still grappling with the crafting of ICT policies, with new ministries being created in some countries to focus on ICT related issues. This study could help focus policymakers on formulating specific ICT policies that can engender stock market development and help with regional stock market integration.

1.5.3 Contribution to Practice

One of the major prospective contributions to practice of this research is to show if the impact of ICT adoption has significant relevance to African stock market development. By extension, this will help determine the impact of ICT policies and investment by key stakeholders in African stock markets. These stakeholders include the management of the stock exchanges, the regulators and also fund managers. Furthermore, the study seeks to show how adoption and investment in ICT can improve accessibility and regional integration of the stock markets across Africa, especially in this era of AfCFTA. This research further seeks to shows how stock market accessibility with the use of ICT, impacts the development of stock markets in general.

1.6 Delimitation of the Study

This study is concentrated on Information Communications Technology (ICT) adoption and stock market development in Africa, for the period from 2008 to 2017 being a 10 (ten)-year period. As a result, the findings and conclusions drawn from the study can only be deemed to be thoughtful and realistic through an extensive analysis of available data. The ICT adoption variables are general in nature due to the limitation on availability of data for specific variables like number of stockbrokers with active/nonactive websites, number of stockbrokers using electronic trading systems. The scope of this study is limited to the Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) as well as Stock Exchange of Mauritius (SEM). Consequently, this study has endeavoured to stimulate further research into the impact of ICT adoption and financial market dynamics in general, and stock exchange in the African context. The study relied more on quantitative information (secondary data) for its analysis.

1.7 Outline of the Study

The rest of this thesis is structured as follows:

Chapter 2 : This chapter discusses stock market development and economic growth nexus. It provides an overview of financial markets, with emphasis on types of financial

markets and their functions. Stock market development is further explored, as well as the linkage between finance and economic growth. Thereafter, the empirical evidence on the stock market development-growth linkage is discussed. The chapter ends with a conclusion, which shows that there is no uniformity in the way economic growth reacts to stock market development. However, it does show that stock market development impacts economic development in different forms.

Chapter 3 : This chapter examines information and communications technology and stock market development from theory and empirical perspectives. The chapter begins by discussing information and communications technology in general, then goes on to explain information and communications technology adoption theories. Then the chapter discusses information and communications technology in relation to stock markets, with a review of empirical studies on information and communications technology and the stock market. The chapter ends with a conclusion on the main findings in the reviewed theories and empirical studies.

Chapter 4: This chapter describes the research methodology and research design employed in the study. The chapter evolves through the definition of data and the different variables used for the study. The process of collecting the data to ensure reliability and validity is considered, and the method of analysis is also treated. Then the model of the study, ethical consideration and model specifications are discussed.

Chapter 5: This chapter deals with the process of data analyses and the outcome. The chapter also lays out the empirical outcomes of hypotheses developed in this thesis concerning the impact of ICT adoption on stock market development in Africa. Majorly, there are four hypotheses that are being tested for this study. First, whether ICT adoption has a significant effect on the number of firms listed on the African stock exchanges. Second, whether ICT adoption has no significant impact on the market capitalisation of the African stock exchanges. Third, whether ICT adoption has a significant impact on the number of shares traded on the African stock exchanges. The fourth hypothesis tests whether ICT adoption has a significant impact on the turnover ratios of the African stock markets. The chapter also looks at the issues of variables cointegration and the direction of causality effect on the variables. The outcomes of the various analyses and results are fully discussed.

The remainder of this chapter is composed as follows: Section 5.2 lays out the descriptive statistics as well as the trend analysis thereof. Section 5.3 displays and discusses the after-effects of testing the impact of ICT adoption on stock market development in Africa. Section 5.4 then gives a synthesis of the results, while section 5.5 links the results to the empirical analysis and section 5.6 concludes the chapter.

Chapter 6: This chapter concludes the study and gives recommendations for future reference. Section 6.1 introduces the chapter by setting the stage for the final conclusion of the research. This section further highlights the importance of ICT in the general life of business and other human endeavours. Section 6.2 discusses empirical insights on ICT adoption and stock market development and goes further to show the empirical evidence on stock markets by providing insights into how ICT adoption significantly influences stock market development in Africa. Section 6.3 presents the summary of results beginning with a summary of methodological approaches, which shows that panel data techniques are adequately employed in this study. This section also recaps the empirical findings. Section 6.4 discusses contribution of the study, then goes on to present the outcome of investigations meant to give experimental proof of a positive relationship between the implementation of information communication technologies and the development of African stock markets. Section 6.5 concludes the chapter by giving direction for future research opportunities in this area of study.

CHAPTER 2

STOCK MARKET DEVELOPMENT AND ECONOMIC GROWTH NEXUS

2.0 Introduction

The chapter discusses theories and intricacies of Information and Communications Technology (ICT) in the context of stock markets. The rest of the chapter is structured as follows: Section 2.2 provides an overview of financial markets, while section 2.3 discusses types of financial markets. Section 2.4 looks at stock market development and ICT-economic growth nexus. Section 2.5 analyses the finance and economic growth nexus, while section 2.6 considers the empirical evidence on the stock market development and growth linkage. Section 3.7 concludes the chapter.

2.1 An Overview of Financial Markets

Valdone (2010) considers the financial market (FM) as the market place where monetary instruments are exchanged or traded. He gives details that the FM allows for a body with excess money to assign such money through proper monetary possessions to individuals that have potentially additional creative means to put in the resources. A financial market can also be considered to be a market where new issues of securities are sold to initial buyers for the first time; commonly referred to as Initial Public Offerings (IPOs) (Ibrahim, Adam & Sare, 2019).

The financial market can be said to be any market place where buyers and sellers participate in the trade of assets such as equities, bonds, currencies and derivatives (Solarin & Dahalan, 2014; Solarin, Shahbaz, Khan & Razali, 2019). In keeping with Kabila (2018), the notion of financial sector development builds on concepts of formalisation, semi-formalisation, informalisation and non-formalisation (Asongu & Nwachukwu, 2017). Amalendu (2011) found that financial structure was not an important indicator for ICT but at the same time financial development was found to be an important determinant of ICT development.

2.2 Types of Financial Market

The financial market can be said to be any market place where buyers and sellers participate in the trade of assets such as equities, bonds, currencies and derivatives (Solarin & Dahalan, 2014; Solarin, Shahbaz, Khan & Razali, 2019). There are different types of financial market as follows:

i. Capital Market
ii. Money Market
iii. Foreign Exchange Market
iv. Commodity Market
v. Derivative Market
vi. Insurance Market
vii. Bond Market
viii. Stock Market

2.2.1 Capital Market

Gurusamy (2010), in his book entitled *Essentials of Fin Services 2E*, defined capital market as a market for borrowing and lending long-term capital funds required by business enterprises. Gurusamy (2010) went further to note that capital market is the market for financial assets that have long or indefinite maturity. The development of the capital market, and also the stock market, provides opportunities for greater funds mobilisation, improved efficiency in resource allocation and provision of relevant information for appraisal (Inanga & Emenuga, 1997). The capital market is a network of specialized financial institutions, series of mechanisms, processes, and infrastructure (Al-Fark, 2006).

2.2.2 Money Market

Money market is defined as the market for short-term funds. These are funds or market instruments with less than twelve months maturity (Choudhry, 2011). The money market enables market participants to manage their surplus liquidity positions through lending and borrowing short-term loans, generally with duration of under one year. It facilitates the interface between individuals and institutions with short-term surpluses of funds or other forms of liquid assets and their counterparts who are experiencing a temporary shortage of funds or a particular liquid asset. The money market is part of

the financial market where highly liquid securities with short-term maturities are traded (Jhingan, 1994; Bhunia, 2011).

2.2.3 Foreign Exchange Market

Foreign Exchange Market, also fondly called “forex market” in short, is the segment of the financial market where currencies are traded. It is the most liquid market in the world because the items of trade are currencies. The spot or cash market is an aspect of the financial marketplace for immediate settlement of transactions involving commodities and securities (Adar, 2018). Foreign exchange market abets foreign exchange trading. It is the largest, most liquid market in the world with an average traded value of more than $5 trillion per day. It includes all of the currencies in the world and any individual, company or country can participate in it (Binary Tribune, 2019).

2.2.4 Commodity Market

Commodity markets are markets where primary or raw products are traded. This is a market where a wide range of primary products are traded, including agricultural produce, raw mineral, energy and different types of precious metals (Kulkarni, 2011). The commodity market is a medium for trading a wide range of products that are usually in their raw or natural form. The market for commodities can be formal and in some cases they are informal.

2.2.5 Derivatives Market

A derivative market, is a market where derivatives as traded. A derivative instrument is an instrument whose performance and value is based on or derived from the behavior of the price of an underlying asset (often simply known as the underlying). The underlying asset does not need to be bought or sold and the majority of the transactions are cash-settled. A premium may be due at the settlement date. Derivatives are financial tools used to manage or take financial risk, sometimes used as an insurance against a future obligation (Taylor, 2012).

2.2.6 Insurance Market

Insurance market is the platform where insurance contracts are traded. Insurance contract means a contract in which a party, in this case the insurer, will promise

another market participant, who in this case is the policyholder, to protect the policyholder against a specified risk or event in exchange for a payment, which is called a premium. The important component of an insurance contract is that there is the transfer of economic consequences of a risk to a third party, typically the insurer and the obligation of the insured to pay premium for the transfer of the unwanted risk or event. The risk or event is usually an unwanted occurrence such as death, accident, fire or burglary. Where the event does occur, the person who will benefit from the insurance contract must have an interest in the contract.

However, there are other types of insurance contract, where the risk or event might also be considered a desired event. In that case this will be like being alive at a certain date, getting married or the birth of a child. Such desired events may raise similar economic concerns for the policyholder who has to deal with the event (Basedow et al., 2009). Also, there are different types of insurance contracts and each type deals with a specific type of risk or event and is classified as such. For example, there are life insurance, health insurance, accident insurance, business insurance and many others.

2.2.7 Bond Market

The bond markets are a vital part of the world economy, according to Choudhry (2010). He went on to define bond market as a platform where bonds are traded, and bond is defined as a debt instrument that represents cash flows payable during a specific time period. The cash flows that are represented in this definition are like the interest rate payable on a normal loan. However, bond is different from bank loan because bonds are traded on a secondary market. Bonds are usually called fixed-income instruments, because bonds normally pay out annual coupons (interest) to the bondholders (Choudhry, 2010).

Therefore, the bond market creates an enabling environment for the raising of funds through the issuance of bonds and subsequently the bond market facilitates the trading of the bonds in a secondary market. Bonds can be issued by private or listed companies and this type of bond is called corporate bond. Government and government agencies and parastatals can also issue bonds and these are called public bonds.

2.2.8 Stock Exchange

Norman (2006) defined stock exchange as the secondary capital market where large and small investors can buy and sell securities (share, bond). Benchivenga (2007) defined a stock exchange as a market in which securities are traded by members of the exchange who may act as both agent (brokers) and as principal (dealers). Armstrong (1994) defined stock exchange market as the citadel of capital; the temple of value. A stock market or equity market is a public exchange market for the company stock (shares) trading and derivatives at an agreed price (Abadi, Faghani & Tabatabaee, 2013).

A stock exchange is an organised marketplace, licensed by a relevant regulatory body, where ownership stakes (shares) in companies are listed and traded. Listing happens in the so-called 'primary market', where a portion of a company's shares is made available to the public. The company often uses the listing to raise funds through issuing new equity shares (an initial public offering or IPO). Investors can then buy and sell these listed shares in the so-called 'secondary market'. While listing in the primary market may result in a flow of funds from investors to the firm, the trading between investors in the secondary market does not result in new funding for the company. However, investors can make or lose money while actively engaging in the trade of shares. Sometimes, investors engage the services of stock brokers who arrange the trade in stock to help facilitate, buy or sell interest among willing market participants for a fee. (Siobhan, Stefano, Richard, Miller & Somerville, 2017).

2.3 Stock Market Development

This section is focused on the variables used to measure development of stock market which can be the determinant of economic growth. The stock market development variables considered for this study are; Number of listed companies, stock market capitalisation, number of shares traded and stock market turnover ratio. These variables indicate the transaction capacity of a stock exchange, for example, number of listed companies, number of shares traded and market capitalisation, while the liquidity of a stock exchange can be measured through the turnover ratio of the stock exchange. The number of listed companies on the following stock exchanges was considered for this study: Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange

(Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) as well as Stock Exchange of Mauritius (SEM).

Market capitalisation, usually termed as market-cap, is the market estimation of an open market traded organisation's extraordinary offers. Also, organisation size matters in investing. Typical thinking holds that small-cap stocks beat large-cap stocks over broadened timeframes. However, the market favours distinctive firm size at various occasions, bringing about a revolution of market-cap in/out of favour. More so, Barberis and Shleifer (2003) argued that the outperformance of small-cap stocks in the seventies (70s) and mid-eighties (80s) triggered stakeholders and assets to small-cap stocks, moving their profits higher. However, in 1983 these profits were turned around.

Jensen, Johnson and Mercer (1998) discovered that the small-cap premium is very huge during extensive approach periods and practically non-existent in prohibitive periods. In addition, Gompers and Metrick (2001) reported that in the 1990s, institutional holding of huge capital stocks expanded quickly. This huge capitalisation favour caused the underperformance of small stocks in certain periods. As a rule, the changes in profits on small-caps and large capitalisation contribute to more investment opportunities: purchasing out-performing market capitalisations as well as short-selling failing to meet expectations market capitalisations.

Of the total number of shares that are mostly transacted via stock-exchanges globally, the study is examining the traded shares in African continent and it is affirmed that there are numerous exchanges in Africa. Moreover, shares as a phenomenon are often traded on different share markets as well as indices to some degree, permitting shareholders that enter into what is acknowledged as less-mainstream securities business. The number of shares traded at a particular period also indicates the transaction capacity of a stock exchange.

Stock market turnover ratio is an indication of how easy or difficult it is to sell a specific share on a stock exchange (Okwu, 2015). This compares the total number of shares

sold and exchanged in a period with the total number of listed shares. It is also an indication of how liquid a particular share is, in the stock market. A higher ratio is an indication that the share can be bought or sold easily and a lower the ratio indicates that the share is illiquid, which also means that the share is less likely to be traded. It is also an indication of how concentrated a particular share is; if a share is highly concentrated in the hands of few shareholders, the share is more likely to be illiquid and if widely held by many shareholders, a share is more likely to be widely traded.

Nwokoye and Out (2018) stated that stock market development is the effectiveness of marketplace to mobilise allocated resources to the achievement of greater level of growth and development of the economy. The stock market is supposed to guarantee through the takeover mechanism that past investments are also most efficiently used (Petros, 2007; Bhunia, 2011; Pradhan, 2014). The development of the Nigerian stock market has been phenomenal since 1960 when it was established with an amount of traded market instrument (Araoye, Ajayi & Aruwaji, 2018).

Regarding relationship between capital markets and ICT development in an economy, King and Levine (1993) assert that capital markets unimpede the diversification of ICT risks and for that reason positive growth of stock markets augment modernisations in ICT. Nevertheless, Singh et al. (2000), in their study explored the relationship between ICT and the capital market, using multivariate regression analysis in the case of both emerging and developed economies and confirmed that stock markets are neither necessary nor sufficient conditions for promoting the development of ICT.

ICT is relevant in enabling financial institutions to increase the availability of credit to corporations and households (Binuyo & Aregbeshola, 2014). Therefore, ICT, through information sharing, contributes to reducing information asymmetry and therefore enhances the capacity of financial institutions to assess the risk profiles of borrowers (Asongu & Nwachukwu, 2017).

Porteba and Summers (1988) argued that capital markets had become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks. Fama and French (1988), on the other hand, argued that information technology has made capital markets more efficient as

attendant stock prices now reflect important information and investors' perception of stocks more swiftly. Porteba and Summers (1988) argued that ICT has made the capital market more efficient by providing all participants with faster and more effective means of exchanging information. They maintained that new products and instruments have been made readily available as a result of the advent of sophisticated ICT. Evidently, capital markets can be more resilient, possess greater depth and breadth with the intervention of ICT (Pradhan, 2014).

Financial development has largely been documented as the key driver of economic development of nations (Solarin & Dahalan, 2014). Financial development has long-run impacts on economic growth (Mun, Lin & Man, 2008), and a well-developed financial system contributes to the technological spill over process and economic performance of an economy (Hermes & Lensink, 2003). Energy consumption, economic growth and financial development are significantly and positively related and this relation plays an important role in the development and economic prosperity of a country (Shahbaz, Khan & Tahir, 2013).

Financial development, however, was found to be an important determinant of ICT development and the paper therefore emphasised the need to develop financial markets in emerging economies (Solarin, et al. 2019). Previous researchers attempted to establish relationships between ICT diffusion in an economy as facilitated by capital markets (see for instance: Amalendu, 2011; Binuyo and Aregbeshola, 2014). The examined literature suggests that automation of stock exchanges reduces the costs and inefficiencies associated with share trading, and increase trading activity and liquidity (Solarin, et al. 2019; Pradhan, 2014). Furthermore, adoption of ICT speeds up operations and activities of the exchange and reduces costs associated with manual systems. ICT enables the exchanges extend trading days and hours as cumbersome processes are eliminated, thereby increasing the transaction capacity of the stock exchange.

Information communication technology and the growth of stock market, particularly for a particular period, have been determined to have an impact on the industrialised economy of foremost and developing markets and also high-income economies of the world. Information communication technology in relation to the development of stock

market, especially in the past 5 years, has focused on the economic development, of foremost and rising markets, including the world economies with high interest rate (Okwu, 2015). According to Petros (2007), stock markets are proficient to control the growth of economies through supporting investments between persons and providing means for organisations to raise capital.

Mwalya (2010) concluded in his study on the influence of ICT, the returns on stock, and volume of trade in Nairobi stock exchange that the adoption of information and communication technology increased the mean of daily trade volume and return. It also eliminates the need for intermediation (stockbrokers) as investors can monitor markets and trade online (Amalendu, 2011). Thomas and Marianne (2011) in their study *titled information and communication technology productivity and non-information and communication technology capital - roles of rate of return and prices of capital in Europe*, found that there is contribution by information and communication technology to productivity of labour and also outcomes of growth from capital investment and development.

The costs of acquiring information, enforcing contracts, and making transactions create incentives for the emergence of particular types of financial contracts, markets and intermediaries. Different types and combinations of information, enforcement, and transaction costs in conjunction with different legal, regulatory, and tax systems have motivated distinct financial contracts, markets, and intermediaries across countries and throughout history (Levine, 2005).

Financial development can be defined as the ability of a financial sector to acquire information, enforce contracts, facilitate transactions and create incentives for the emergence of particular types of financial contracts, markets and intermediaries, and all this at a low cost (Rajan & Zingales, 2003:9; Levine, 1999:4). Financial development occurs when financial instruments, markets and intermediaries ameliorate – though not necessarily eliminate – the effects of information, enforcement and transaction costs, and therefore better provide financial services (Solarin, & Dahalan, 2014).

An active stock market may be relied upon to measure changes in the general economic activities using the stock market index (Obadan, 1995). Stock market contributes to economic growth through the specific services it performs either directly or indirectly. Notable among the functions of the stock market are mobilisation of savings, creation of liquidity, risk diversification, improved dissemination and acquisition of information, and enhanced incentive for corporate control (Ohiomu & Enabulu, (2011). The stock market enables governments and industry to raise long-term capital for financing new projects, expanding and modernising industrial or commercial concerns (Ohiomu & Enabulu, 2011).

2.4 Finance and Economic Growth nexus

The nexus between financial development and economic growth has been the focus of significant discussion in the literature of development and growth among researchers. While empirical studies often provide a direct relationship between financial development proxies and growth, considerable arguments remain about how these results should be understood. Empirical studies by researchers have shown that there is majorly a positive causal relationship between finance and economic growth. This means that growth or improved financial activities in an economy, leads to economic growth. However, based on other empirical reviewed literature, it is predicted that causal relationships between finance and economic growth is unidirectional (positive) in some cases and bi-directional or complementary in others.

Also, some researchers argue that the causal relationship between finance and growth nexus is negative, which means economic growth causes financial improvement or increase in financial wellbeing of the populace, though others also argue that in some cases the casual relationship is neutral in nature. This is where there are no causal relationships between finance and economic growth. The differences in outcomes by different researchers could be explained by the technique, variables and data size used for the econometric analysis. However, it is clear that the finance to economic growth nexus has more cases and empirical evidence to support the hypothesis that financial development has a positive causal relationship with economic growth (Chee-Koeng & Chan, 2011, Khan, 2008, Gelb, 1989, Khan & Senhadji, 2000, King & Levine, 1993, Levine et al., 2000).

Kedibonye (2018) examines the interrelationships between financial development, economic growth, capital accumulation and productivity growth in Botswana over the period 1980-2014. Using the Autoregressive Distributed Lag (ARDL) bound test technique, his finding shows that financial development, measured by private credit, has a negative and significant impact on economic growth both in the long and short run. Contrary to this, Kediboye (2018) observed that financial development, measured by liquid liabilities, has a positive and significant impact on economic growth in the short run. This shows a positive causal relationship between finance and economic growth.

The costs of acquiring information, enforcing contracts, and executing transactions create incentives for the emergence of particular types of financial contracts, markets and intermediaries. Different types and combinations of information, enforcement, and transaction costs in conjunction with different legal, regulatory, and tax systems have motivated distinct financial contracts, markets, and intermediaries across countries and throughout history (Levine, 2005). In the study by Levine and Zervos (1998), on stock markets, banks and economic growth, they concluded that both banks development and stock markets liquidity positively predicted growth, accumulation of capital and productivity improvement. The causal relationship between finance and economic growth in these studies by Levine, Levine and Zervos also support that a positive relationship does exist.

Choong and Chan (2011), found the positive relationship between financial development and economic growth, where they discussed four main sources of controversy, namely: the selection and measurement of financial development indicators, the causality direction of the financial development and economic growth, the use of empirical approaches to the finance-growth hypothesis, and the debate concerning the channels by which financial development promotes economic growth. Choong and Chan (2011), raised pertinent questions in their work, on the challenges that affect this line of study. Their work shows that depending on the financial development variables used, and also depending on the economic growth variable applied in a study, these can lead to different outcomes on the causal direction of the finance economic growth nexus.

Levine (2002), in her study, stated that nations with improved developed monetary structure have a propensity to mature more rapidly, particularly monetary mediators and market issue for development. The dimension of the bank structure and the stock market's liquidity are all absolutely connected with growth of the economy. Beck and Levine (2004), in their study, used stock market turnover ratio as stock market variable and bank credit as banking variable. Beck and Levine (2004) concluded that there is a positive relationship between stock markets, banks and growth; that stock markets and banks positively influence growth of the economy. Bittencourt (2011) empirically looked into financial development and economic growth and whether Schumpeter is right or wrong in Latin America. Bittencourt (2011) confirmed the Schumpeterian prediction that proposes that investment authorises capitalists to put in their money in activities that are productive in nature and as a result encourage growth of the economy. These studies also show the existence of positive causal relationship between finance and economic growth.

Afonso and Blanco-arana (2018) used random effects and conducted a study on the relationship among economic growth and monetary development in OECD nations from 1990-2016 The study focused on the current economic catastrophe. They found that the rise in domestic credit made available through the monetary-sector, within capitalisation of the market and in the turnover proportion of domestic share, entails an important optimistic effect on per capita GDP. Afonso and Blanco-arana (2018) also found different effects during the period of the crisis on domestic credit provided by the financial-sector and on market capitalisation. Among other socioeconomic determinants related to economic growth, expenditure in education, inflation and unemployment rates appear highly significant for economic growth of the analysed countries, therefore, showing a positive causal relationship between finance and economic growth.

Karagiannis and Kvedaras (2016) studied the relationship between financial development and economic growth from the perspective of high-income countries focusing on European Union (EU), European Monetary Union (EMU) and Organisation for Economic Co-operation and Development (OECD). The empirical finding of the study shows that changes in the monetary policy affects the improvement of economic growth. This argument goes to show that the impact is contingent on both the

dimension and arrangement of finance in an exact time and the real distance from the stage of credit producing the largest impact on growth, thereby showing that a positive causal relationship does exist between finance and economic activities.

Ibrahim and Alagidede (2018) examined the effect of financial development on the growth of Sub-Saharan African countries' economies. They studied the general growth of economic effect in the business and real-sector and found that it is disproportionate depending on panel information for 29 Sub-Saharan African countries for the period of 1980 to 2014. The outcome from the technique Generalized Method of Moments (GMM) revealed that, as monetary development supports growth of economy, the degree to which money assists growth depends significantly on the concurrent growth of authentic and financial industry. They also showed that fast and unrestrained credit development can add an enormous cost to growth of the economy with penalty stemming from monetary uncertainty and indefensible investments, in addition to phony utilisation, and causing economic growth. Though, it does exist through positive economic growth with effect on the means of assets which leads to a stronger economy. This shows that a positive causal nexus does exist between finance and economic growth in sub-Sahara Africa.

Levine (1996) argues that the prevalence of hypothetical way of thinking and experimental data proposed an optimistic, first-order association between monetary development and the growth of the economy. There is still confirmation that the stage of monetary development is a high-quality forecaster of prospect rates of growth in an economy, accumulation of resources, and technical changes. Furthermore, cross-country, case-study, industry-level, in addition to firm-level analyses document extensive duration at what time monetary development significantly influences the pace and model of economic growth. Levine (1996, p. 9), explained what the monetary system does, in addition to the way it has an effect on and is affected through, growth of the economy. This study goes to show that there is a complementary causal relationship between finance and economic growth.

Levine (1996), also proposed that monetary mechanism, marketplace, and establishment happen to alleviate the special effects of information and operation costs. This showed that there are dissimilarities in how a healthy monetary system,

can decrease information, in addition to how business costs effect reserves charge, investment choice, technical improvement, as well as long-run rates of growth. Therefore, for less developed economies, hypothetical literatures showed the means by which transformed economic actions can control monetary systems. Levine (1996) follows a practical approach to consider the role of monetary systems in relation to growth of the economy and show that economic growth has a causal effect on financial decision, which goes to support the notion that there is also a negative causal relationship between finance and economic growth.

Iheanacho (2016) applied ADRL and co-integration analysis to the influence of financial development on growth of the economy in Nigeria. Empirically, the study examines the association among monetary agent development plus economic expansion in Nigeria from 1981 to 2011. According to the findings, there exists association among financial development as well as growth of the economy in Nigeria. This is not dissimilar to the general experience in an economy that does not depend on oil. There is no significant negative association between financial agent development and growth of the economy in Nigeria in the long-run, but there is a significantly negative relationship in the short-run.

Alrabadi and Kharabsheh (2016) examined the dynamic association between financial deepening and growth of the economy in Jordan for the period between 1992 and 2014. Using periodical information, the outcome pointed to no statistically important effect of financial deepening upon growth of the economy in the short run. On the other hand, test for cointegration demonstrated a statistically important long run symmetric association between the two variables in spite of the substitute used for monetary deepening. Furthermore, test for Granger causality confirmed a bi-directional causality between growth and deepening while the second is calculated through the quantity of credit established in private region. Though, a clear connecting association from the growth of the economy to monetary deepening is established while the quantity of savings as well as supply of money (M2) are applied as substitutes of monetary deepening. This study shows that both finance and economic growth have a complementary causal relationship.

Akbas (2015) looked into the financial development and economic growth in emerging markets, using bootstrap panel causality analysis. The study tested if there is causality association amongst financial development and the growth of the economy in developing nations and using data from 1988 to 2013 with the use of panel causality test, put cross-section dependence and heterogeneity into consideration. The finding from the outcomes shows that weak causal association exists between finance and growth of the economy. It also found that financial development aids the neutrality of the hypothesis in developing nations, except for Turkey. Positive growth, privatisation, practice speed-up to liberalising of the market, leads to the expansion of the monetary industry. Also, development and political steadiness contribute significantly to the expansion of economic markets in Turkey. The existence of positive causal relationship between finance and economic growth was established in this study. However, it was noted to be weak in nature.

Ngongang (2015) made use of dynamic panel data analysis to examine financial development and growth of the economy in Sub-Sahara Africa, with an effort to explore and authenticate empirically the argument on the association among the monetary area and real area from 21 countries in Sub-Sahara Africa. Applying dynamic panel GMM method, the study showed that there is an existence of encouraging connection between monetary growth and economic enlargement. This connection is influential for the problem of the monetary structure in Sub-Sahara Africa. On the other hand, the result stresses that an ultimate connection between foreign direct investment and the growth of the economy is timely.

Le Roux and Moyo (2015) examined the relationship between financial liberalisation and economic growth in Southern African Development Community (SADC) countries. They used Annual data for the 15 SADC countries for the period 1985-2011 to develop a fixed effect model, Generalised Method of Moments (GMM) and the Fully-Modified Ordinary Least Squares (OLS) (FMOLS) cointegration test. They concluded that the relationship between financial liberalisation and economic growth is a short-run phenomenon; however, it does exist.

Adu, Marbuah and Tei (2013), examined financial development along with economic growth in Ghana. The research question was if the measure of financial development

matters. The study focused on the long run growth effects of financial development in Ghana. They discovered that growth of financial development is sensitive to the choice of substitute to the ratio of GDP and total domestic credits is favourable for economic growth while broad cash stock to GDP ratio is not instrumental to growth. They also discovered that whether monetary development is good or not good for growth depends on the indicator used to alternate for monetary development.

Yıldırım, Özdemir and Doğan (2013) conducted a study on monetary development in addition to economic development nexus in rising European economies. The study examined the relation among monetary development as well as economic growth from the unevenness viewpoint in the rising European economies. The outcomes showed the route of causality relied upon the pointers which are opting to stand for the monetary development. In addition, the relation among monetary development and growth of the economy displayed dissimilarity between rising European nations in spite of these economies having related structural features.

Baliamoune-Lutz (2013) explored the long-run relationship between financial development and income using 18 African countries. Annual data from 1960 to 2001 was used and the findings indicated mixed results on the link between financial development and income using VAR models. On the other hand, Rousseau and D'Onofrio (2013) found positive relationships between financial development (measured by M1 and M2 money stocks and by their difference M2-M1) and growth for the majority of their sample of 22 Sub Saharan African countries over the period from 1960 to 2009 using time series (VECM/VAR) models. An extensive literature has been written on financial liberalisation and economic growth. However, there is no consensus as to how financial liberalisation affects economic growth, as suggested by Stiglitz (2000) or Eichengreen and Leblang (2003) and reviewed by Henry (2007).

Bangake and Eggoh (2011), conclude that there is strong evidence of bidirectional long-run causality between financial development and economic growth in 71 developed and developing countries over the period from 1960 to 2004. However, their results indicated a marked difference based on the country's income level in the short-run. For low and middle income countries, there is no evidence of a short-run effect, while in high income countries economic growth significantly affects finance. In the

work of Choong (2012), a positive link exists between financial openness (particularly, FDI) and economic growth using a panel of 95 developed and developing countries from 1983 to 2006. However, he also found that the domestic financial system is a significant prerequisite for the financial openness to having a positive impact on economic growth.

However, on the contrary, Demetriades and James (2011) found no relationship between financial development and economic growth in Sub-Saharan African countries. Using panel co-integration for 18 Sub-Sub-Saharan countries over the period of 1975 to 2006 they found no significant long-run link between financial development and growth. Gries et al. (2009), also found similar results using cointegration for sixteen Sub-Saharan African countries. They find no significant long-run relationship among finance, growth and openness in Sub-Saharan Africa.

Ahmad and Malik (2009), did an empirical study of financial sector development and economic growth in developing nations. They used panel data from 35 developing nations for the duration 1970 to 2003 and analyses of the role of monetary sector development in the growth of the economy, and domestic with foreign capital accumulation, The main finding of the study is that financial sector development affects per capita gross domestic product, majorly through its contribution in the allocation of resources efficiently, instead of its effects on accumulation of capital. Domestic capital accumulation is the instrument in the increment of per worker output and hence promoting growth of the economy on the long run.

Caporale, Rault, Sova, and Sova (2009) reviewed the major features of the financial institution as well as monetary regime in 10 fresh European Union associates. They afterward observed the connection between monetary development in addition to growth of economy among these nations through estimation of the dynamic panel model from 1994 to 2007. Their findings proposed that the stock markets along with credit markets are still immature in these economies. Also, the contribution of economic growth is incomplete due to lack of financial depth. As a result of difference, the more proficient the banking industry is, the more it will help to speed up growth. In addition, test for Granger causality pointed that causality runs from monetary development to growth of the economy, but not in the contrary direction.

Perera and Paudel (2009) carried out a study on the relationship between financial development and the growth of the economy in Sri-Lanka from 1955 to 2005, with the use of ECM to examine the relationship between financial development and growth of the economy. The result does not strongly support the view that financial development boosts economic growth. Also, broad money causes the growth of the economy and there exist two means of causality between money and economic growth. Private organisation has contributed positively to the growth of the economy as a single way causality.

Kargbo and Adamu (2008) conducted a study in Sierra Leone on financial development and growth of the economy. The study examined an association between monetary development and economic development from 1970 to 2008. Principal components method was employed to variables of monetary sector growth indicator applied to alternative development within the sector. Using approach of ARDL, there is unique co-integrating connection between real gross domestic product, monetary development, and investment in addition to rate of real deposit. Also, the outcomes propose that monetary development put forth an optimistic and statistically important consequence on growth of the economy. Also, they found that investment is a significant means by which monetary development sustains the growth of the economy.

Also, Christopoulos and Tsionas (2004), examined the most efficient long-run relationship through panel unit root tests and panel cointegration analyses in addition to threshold cointegration tests, and dynamic panel data estimation for a panel-data based vector error correction model. The long-run relationship is estimated using fully modified OLS, for ten developing countries. The empirical results give clear support for the hypothesis that there is a single equilibrium relation between financial depth, growth, and ancillary variables and that the only cointegrating relation implies unidirectional causality from financial depth growth. Ndikumana (2001) reviewed theory and evidence on the links between financial development and economic activity in the context of African countries and found that financial market development correlates positively to the growth rate of real income.

Yartey and Adjasi, (2007) examined the importance and development of stock markets in Africa. Their analysis of unbalanced panel data from 14 African countries using the Generalized Method of Moments (GMM) indicates that stock markets have indeed contributed to the financing and growth of large corporations in certain African countries. However, they do not find conclusive empirical evidence on the impact of stock markets on economic growth in these 14 African countries.

Succinctly, Gregorio and Guidotti (1995) among others, documented that financial openness increases the capital accumulation of the country, which in turn increases economic growth. However, this positive relationship between openness and economic growth may be conditional, which depends on the strength of a country's financial institutions as pointed out by Klein and Olivei (2008). On the other hand, Rodrik (1998) and Prasad et al. (2003), among others, suggest that financial liberalisation causes crisis (capital flight) or that it has no significant impact on growth. The other possible channel could be the reduced cost of capital due to liberalisation. Several papers address the links between the cost of capital and financial liberalisation for emerging markets. Among them are Edison and Warnock (2003), Bekaert and Harvey (2003) and Henry (2007), with all concluding that financial liberalisation is negatively related to the cost of capital. Due to the reduction in the cost of capital, projects having negative net present value, turn into positive net present values, which increase economic growth.

Furthermore, to buttress this, the empirical results also show that the interrelationship between financial development (private credit) and economic growth support the supply leading hypothesis while the interrelationships between financial development (liquid liabilities) and economic growth support the demand-following hypothesis. On a positive note, the empirical evidence also suggests that financial development (private credit) leads to a higher output level in Botswana through promoting the accumulation of assets. Thus, for financial development to promote economic growth through both the accumulation of capital and productivity growth, it is useful to further develop Botswana's financial market in particular and the African financial markets in general.

The empirical studies reviewed above, showed various means and ways both finance and economic growth nexus interact with each other. This is made possible through the use of different variables for the studies. This also highlights that there are no universally accepted variables to explain the hypothesis of the linkage of finance and economic growth. Also, depending on the data analysis technic adopted, will result in a different outcome. However, most empirical studies reviewed have shown that there is a positive causal relationship between finance and economic growth, though it is pertinent to mention that differences in channels and methods will influence the outcome of the study.

2.5 Empirical Evidence on the Stock Market Development - Economic Growth Linkage

Empirical studies on stock market developments and the linkage to economic growth provides insights into the causal relationship between economic development and stock market development. From empirical perspectives, the discussion on the determinants of economic growth and stock market development in this section has been structured into three categories, namely, developing countries, developed countries, and emerging economies. Furthermore, this section, describes the expectations in terms of the causal relationships between stock market and economic development. In each of the empirical evidence analysed, the relationship will show whether it is positive, negative or neutral as the case might be. At the end of this section, the predominant causal relationship will be highlighted.

Nazir, Nawaz and Gilani (2010), explored the relationship between economic growth and stock market development in Pakistan. They considered the relationship between the stock market development and economic growth in Pakistan for the period of 1986 to 2008. They looked into stock market development and economic growth relationship by using the two major measures of stock market development, namely: size of the market and liquidity prevalent in the market in terms of market capitalization. The results revealed that economic growth can be attained by increasing the size of the stock market of a country as well as the market capitalisation in an emerging market like Pakistan. The study, therefore, shows that there is bi-directional positive causal relationship between economic growth and stock market development.

Ngare, Morekwa and Misati (2014), examined stock market development and economic growth in Africa. The objectives of the investigation are to establish the role of stock market development on economic growth in Africa. Findings show that:

(i) The countries with stock markets tend to grow faster compared to countries without stock markets,
(ii) Countries which are relatively developed and have stock markets tend to grow less fast compared to small countries with stock markets,
(iii) Stock market development has a positive effect on economic growth,
(iv) Investment, human capital formation and openness positively influence economic growth in the Africa region,
(v) Macroeconomic instability (inflation) and government consumption impact economic growth negatively, and,
(vi) Countries that are politically stable and less corrupt tend to grow faster,

Ngare, Morekwa and Misati (2014), from the outcome of their study, showed that there is a positive relationship between economic growth and stock market development, which is also bi-directional.

Osinubi (2002) examines whether stock market promotes economic growth in Nigeria. To achieve this objective, OLS was employed using the data from 1980 to 2000. The results indicated that there is a positive relationship between growth and all the stock market development variables used. The results of the study established positive links between the stock market and economic growth, and also suggests the pursuit of policies geared towards the rapid development of the stock market. This linkage also showed that stock market development leads to positive economic growth, therefore, it can be concluded that to grow an economy, having a strong stock market will give a positive boost to the process.

Oke and Adeusi (2012) examined the impact of capital market reforms on economic growth in Nigeria. OLS method of regression and the Johansen cointegration analysis were employed to analyse the secondary data sourced. Results show that capital reforms positively impact economic growth.

Ohiomu and Godfrey (2011) observed the effect of the stock market on economic growth in Nigeria. OLS was employed using the data from 1989 to 2008. The results indicated that there is a positive relationship between economic growth and all the stock market development variables used. The study affirmed positive links between the stock market and economic growth; and suggests the pursuit of policies geared towards rapid development of the stock market can also lead to positive economic growth. Therefore, this study showed that the causal relationship is unidirectional in nature.

Furthermore, Katuma (2012) identify the role of Stock Exchange market in economic growth in Tanzania. The study determined the factors which hinder the swift growth of Dar es Salaam Stock Exchange (DSE) Market and the suggested measures to be taken by DSE to promote economic development in Tanzania. Findings revealed that both market capitalisation and value of share traded contribute a small amount to the growth of the economy of Tanzania. Furthermore, the findings have revealed the challenges which hinder the growth of DSE, like lack of liquidity, low market capitalisation, poor macro-economic high transaction costs, lack of adequate track-openness, lack of skilfully human resources, and lack of public awareness of DSE.

Msangi (2015) used secondary data for the period of 1998 to 2012 and employed multiple regression analysis models whose parameters were estimated via Ordinary Least Squares (OLS) techniques to examine the determinants of capital market development in Tanzania. The study found no relationship between capital market development and stock market liquidity. Therefore, this study shows a neutral relationship between stock market development and economic growth.

Petros (2007) did an empirical analysis of the relationship between economic growth and its determinants with special focus on the stock market development in Zimbabwe. Findings of this study suggest a positive relationship between an efficient stock market and economic growth both in short and long runs. Also, financial instability and inflation have a negative effect, and human capital and foreign direct investment have a positive effect on growth. The results are consistent with theoretical predictions, which show that there exists a positive relationship between economic growth and stock market development.

Quaidoo (2011), examined the relationship between stock market capitalisation and economic growth in Ghana using quarterly time-series data from 1991 to 2006. The study discovered that real economic growth, real stock market liquidity and real gross domestic investment have a significant positive impact on the development of the Ghana Stock Exchange. In contrast, the results showed that the banking sector development has a significant negative relationship with the stock market development and suggested that they are substituted in financing corporate investments in Ghana. The results of the Granger-causality test indicated that economic growth leads to stock market capitalisation (stock market development) without any feedback supporting "demand following" hypothesis. The relationship that exists between stock market development and economic growth in this study, indicates a positive relationship and a unidirectional causality, which shows that economic growth positively affects stock development.

Acquah-Sam (2016) examined the macroeconomic factors that influence capital market development in Ghana. However, inflation and Foreign Direct Investments (FDI) did not prove significant in the estimated equation. The study posited that the growth of real income or output, and physical infrastructural development would enhance capital market development in Ghana. This study showed that there is a positive relationship between stock market development and economic growth. However, only economic growth has a causal effect on stock market development.

Njimanted, Ngwengeh and Mobit (2016) employed Ordinary Least Squares (OLS) techniques to study the impacts of domestic credit on the private sector, commercial bank deposits, asset concentration ratio of commercial banks, inflation rate, total value of shares traded, interest rate spreads and stock market capitalisation on financial market development in Cameroon. The study found that the variables, except interest rate, spreads and stock market capitalisation, were significant determinants of financial market development in Cameroon.

In the methodological context, Calderon-Rossell's (1991) specification was the first behavioural model that established economic growth and stock market liquidity as the main determinants of stock or capital market development. Over time, the model has been modified to examine capital market determinants in some related aspects of

research (Yartey, 2008; Quaidoo, 2011; Kemboi & Tarus, 2012). The model considered economic growth and stock market liquidity as the main determinants of stock market development, using market capitalisation as a proxy for stock market development. The study showed that stock market liquidity and economic growth are important determinants of stock market growth (Yartey, 2008). Garcia and Liu (1999), reported on the determinants of capital market development. They also used market capitalisation as a proxy for capital market development and concluded that real income level, saving rate; financial intermediaries' development; and stock market liquidity are important stimulants of stock market development, while macroeconomic stability does not prove significant. Obviously, however, financial intermediaries and stock markets are complements rather than substitutes.

The work of Kemboi and Tarus (2012), which considered macroeconomic determinants of stock market development in Kenya during 2000 to 2009 periods based on quarterly secondary data, showed that macroeconomic factors such as income level, banking sector development, and stock market liquidity were important determinants of the development of the Nairobi Stock market. The results also established that macroeconomic stability was not a significant predictor of the development of the securities market. Claessens, Klingebiel and Schmukler's (2002) analysis of the determinants of the increasing movement of stock market activity to international financial centres showed that FDI correlated positively with stock market capitalisation and value traded.

Quartey and Gaddah (2007), looked at the long-run determinants of stock market development in Ghana and found that gross domestic savings, real income, domestic credit to the private sector, and exchange rate predicted the long-run development of the Ghana Stock Exchange (GSE). However, Treasury bill rates had a negative impact on the long-run development of the GSE. Also, inflation did not prove to be a significant factor in predicting the long-run development of the stock market. Fama (1981), argued that expected inflation is negatively correlated with anticipated real activity, which also positively related to returns on the capital market. Therefore, capital market returns should correlate negatively with the expected interest rate.

Kemboi and Tarus (2012), Nacuer et al. (2007), Garcia and Liu (1999) and Yartey (2008) found support for a positive relationship between banking sector development and stock market development. Both the capital market and the banking sector intermediate savings towards investment projects, and they can be both complements and substitutes for capital mobilisation for economic growth (Demirguc-Kunt & Levine, 1996). Capital Market Liquidity (CML) is proxied by stock turnover ratio, and value traded ratio.

Yartey (2008) argued that liquid capital markets afford investors access to their savings, and thus boost their confidence in stock market investment. One other area of attention is that most studies in the developing economies have used Johansen's co-integration techniques, but the strict unit-root assumption that these methodologies rely upon is often not easy to justify on economic or theoretical grounds (Hjalmarsson & Osterholm, 2007). Whether stock market development contributed to economic growth or not varies from country to country, and economy to economy. From the review, the development of the stock market has influence and relationship with economic growth.

Popoola, Ejemeyovwi, Alege, Adu and Onabote (2018), examined the short-run effect, long-run effect and causal relationship between the stock market and economic growth in Nigeria. The OLS result showed that the all-share index had a significant but negative relationship with economic growth. The Johansen cointegration test showed that a long-run relationship exists between the stock market performance and economic growth in Nigeria in the long run while the Granger causality test results showed that stock market performance does not cause economic growth but economic growth causes stock market performance at 5 percent significance level. This study showed that a one directional casual positive relationship, between stock market development and economic growth, has causal effect on stock market development. This relationship between stock market and economic growth in this study is shown to be negative.

2.6 Chapter Summary

It is evident from this chapter that stock markets have heterogeneous effects on the economic growth of the developed, developing and emerging economies. Moreover,

countries differ in the levels of development, of their stock markets. Many studies have been carried out on the stock market, financial development and economic growth from different countries of the world from developed to developing nations but there is no mutual result on the relationship between the variables (stock market and economic growth along with financial development and economic growth).

From the reviewed literatures we can conclude, according to Beck and Levine (2004) that stock markets and banks positively influence the growth of the economy and Bittencourt (2011) confirmed the Schumpeterian prediction that proposes that investment authorises the capitalist to put in their money in activities that are productive in nature, and as a result encourage growth of economic. Levine (1996) still confirmed that the stage of monetary development is a high-quality forecaster of prospect rates of growth in an economy, accumulation of resources, and technical changes.

Yartey and Adjasi (2007) indicated that stock markets have indeed contributed to the financing and growth of large corporations in certain African countries. Nazir et al. (2010) revealed that economic growth can be attained by increasing the size of the stock markets of a country as well as the market capitalisation in an emerging market like Pakistan. These are in line with Ohiomu and Godfrey (2011) that positive relationship exists between economic growth and all the stock market development variables used. They also affirmed positive links between the stock market and economic growth and suggests the pursuit of policies geared towards rapid development of the stock market. Claessens et al. (2002), showed that FDI positively correlated with stock market capitalisation and value traded. Quartey and Gaddah (2007) found that gross domestic savings, real income, domestic credit to the private sector, and exchange rate predicted the long-run development of the Ghana Stock Exchange (GSE).

Katuma (2012) revealed that both market capitalisation and value of share traded contribute a small amount to the growth of the economy of Tanzania. Petros (2007) established a positive relationship between an efficient stock market and economic growth both in short-run and long run. Also, financial instability and inflation have a negative effect, and human capital and foreign direct investment have a positive effect

on growth. Quaidoo (2011) showed that the banking sector development having a significant negative relationship with stock market development suggested that they are substituted in financing corporate investments in Ghana. Also, the growth of the economy leads to stock market development without any feedback supporting "demand following" hypothesis. The results are consistent with theoretical predictions.

Afonso and Blanco-arana (2018), found that the rise in domestic credit made available through the monetary sector, within capitalisation of market and in the turnover proportion of domestic share, entail an important optimistic effect on per capita GDP. However, it has a different effect during the period of crisis on domestic credit provided by the financial-sector and on market capitalisation. This result is related to the work of Adu, et al. (2013) that discovered that the growth of financial development is sensitive to the choice of substitutes, the ratio of GDP and total domestic credits are favourable for growth, while broad cash stock to GDP ratio is not instrumental to growth. They discovered that whether monetary development is good or not good for growth depends on the indicator used as the alternative for monetary development.

For Ibrahim and Alagidede (2018), quick and unrestrained credit development causes enormous cost to the growth of the economy with consequence stemming from monetary uncertainty and indefensible investments combined with bogus utilisation of fund, which fuels increase in prices of goods and services. In the work of Karagiannis and Kvedaras (2016), they showed that corporate credit has a positive impact on economic growth. However, credit to individuals had a negative impact on the economy. Ngongang (2015) showed that there is an existence of encouraging connection among monetary growth and economic enlargement. Le et al. (2015) showed that the relationship between financial liberalisation and economic growth is a short-run phenomenon that does exist.

Baliamoune-Lutz (2013) explores the long-run relationship between financial development and income, using 18 African countries annual data from 1960 to 2001 and found mixed results on the link between financial development and income using VAR models. On the other hand, Rousseau and D'Onofrio (2013), showed that positive relationships exist between financial development and growth. Choong and Chan (2011) found that there is positive relationship between financial development

and economic growth. In the work of Choong (2012), positive link was shown to exist between financial openness (particularly, FDI) and economic growth and domestic financial system is a significant prerequisite for the financial openness to having a positive impact on economic growth. It is not different in the case of Kargbo and Adamu (2008), who found that there is a connection between real GDP, monetary development, investment and rate of real deposit. They also showed that there was a positive and statistically important influence on the growth of the economy with investment as a significant means by which monetary development promotes economic growth. Also, Christopoulos and Tsiona's (2004) results give clear support for the hypothesis that there is a single equilibrium relation between financial depth, growth, and ancillary variables. Oke and Adeusi, (2012) showed that capital reforms positively impact economic growth.

For Popoola et al. (2018), they showed that a long-run relationship exists between stock market performance and economic growth in Nigeria. Acquah-Sam (2016) posited that the growth of real income or output, and physical infrastructural development would enhance capital market development in Ghana. Njimanted et al. (2016) found that the variables, except interest rate spreads and stock market capitalisation, were significant determinants of financial market development in Cameroon.

In contrast, the work of Kemboi and Tarus (2012) established that macroeconomic stability was not a significant predictor of the development of the securities market. Iheanacho (2016) showed that there was association among financial development as well as growth of the economy in Nigeria. This is not divergent from the general empirical view in an economy that does not depend on oil. There is no significant negative association among financial agents, development and growth of the economy in Nigeria on the long-run but had significant negative impact on the short-run. Alrabadi and Kharabsheh (2016) stated that there is no statistical important effect of financial deepening upon growth of the economy in the short run and confirmed a bi-directional causality between growth and financial deepening. The second is calculated through the quantity of credit established to private region. Also, Akbas (2015) showed that weak causal association exists between growth of the economy and financial development. This also aids the neutrality of the hypothesis in developing nations,

except for Turkey. However, on the contrary, Demetriades and James (2011) found no relationship between financial development and economic growth in Sub Saharan African countries. There is no significant long-run link between financial development and growth. Also, for Gries et al. (2009), there is no significant long-run relationship among finance, growth and openness in the Sub-Saharan African.

Perera and Paudel's (2009) result does not strongly support the view that financial development boosts economic growth. Msangi (2015) discovered that there is no relationship between capital market development and stock market liquidity. These indicated that the relationship between stock market and economic growth and financial development and economic growth depend on a particular economy, and it varies from country to country and economy to economy. However, most of the studies showed a positive relationship between stock market development and economic growth, although the causality effect between stock market development and economic growth is not generally heterogeneous in nature.

The next chapter explores the theoretical and empirical literatures for the relationship between ICT adoption and stock market development. The insight from the literature should bring to the fore the deficiencies and knowledge gaps in the existing literature and serves as the launchpad to explaining the new knowledge to be added by the current study.

CHAPTER 3

INFORMATION AND COMMUNICATIONS TECHNOLOGY AND STOCK MARKET DEVELOPMENT: THEORETICAL AND EMPIRICAL EVIDENCE

3.0 Introduction

The major purpose of this chapter is to explore the theoretical and empirical literature for the relationship between ICT adoption and stock market development. The insight from the literature brings to the fore the deficiencies and knowledge gaps in the existing literature and serves as the launchpad to explaining the new knowledge to be added by the current study. The rest of the chapter is structured as follows: Section 3.2 discusses Information and Communications Techno. Section 3.3 considers theories of ICT adoption with an emphasis on the theories that are germane to the current study. Section 3.4 makes a review of empirical studies and points out literature gaps to further substantiate the need for the current study in the context of the empirical literature while Section 3.5 discusses the conceptual framework on which analysis in the current study is anchored. Section 3.6 is the conclusion to the chapter.

3.1 Information and Communications Technology

Over the past few decades, the world has transformed into what could aptly be described as Information Society (IS) in virtually all human activities, with Information and Communications Technology (ICT) as the main driver of the transformation process (Esteban, & Jose-Luis, 2010). The transformation force has permeated all strata of human settings such as households, firms and governments at the local, regional, national and international levels (Esteban & Jose-Luis, 2010). This assertion by Esteban and Jose-Luis, clearly indicates that ICT plays a very vital role in every sphere of our daily lives. The role that the internet and mobile phones currently play in every human interaction can never be over emphasised.

Most of the available studies on the diffusion of ICT have focused on its impact on economic growth thereby neglecting its impact on development of stock exchanges, which actually determines the capacity of the exchanges to engender economic

growth. The perceived mechanisms through which ICT innovations and adoption transmit to impact on the development of the African stock exchanges are as illustrated in the conceptual framework below.

Information and Communications Technology (ICT) is an umbrella term that includes any communication device or application such as radio, television, cellular phones, computer, satellite systems, network hardware and software as well as the various devices and applications associated with them such as videoconferencing and distance learning (Rouse, 2014). ICT is centred on computer applications, telecommunications equipment and infrastructure to generate, process, store, retrieve, transmit and manipulate data or information in the context of businesses or other transactions. ICT is often conceptualised within the framework of computer wares, networks and other information dissemination channels such as television, radios and telephones.

Chandler and Munday (2012) noted that several industries such as computer hardware, software, electronics, semiconductors, internet service providers, telecommunications equipment, e-commerce and computer services are associated with the ICT concept. The business value of ICT is to automate a business process, provide information for decision making, connect businesses with their customers or clients, and render service flows to increase efficiency and productivity (Hossein, Fatemeh & Seyed, 2013). Measuring the relevance of ICT adoption to stock market development has become important not only for industrial and marketing purposes but also for policymakers who should formulate effective measures to overcome the existing and even growing digital inequalities.

Furthermore, Parida et al. (2009) contend that ICT is an effective tool that can be used for improving external communications and delivering quality service to customers. It improves a firm's ability to plan better for the future by providing the management with easy access to relevant information about different activities and or operations within and outside the firm. For Fulantelli and Algra (2003), ICT offers a wide range of possibilities for improving their competitiveness and provides mechanisms for getting access to new market opportunities and specialised information services in organisations.

Menzie and Fairlie (2010) used panel data analysis technique to explore the determinants of cross-country disparities in personal computer and Internet penetration in developed and developing countries. The results showed evidence that income, human capital, youth dependency ratio, telephone density, legal quality and banking sector development are associated with technology penetration rates. They found the main factors responsible for low rates of technology penetration in developing countries to include disparities in income, telephone density, legal quality, and human capital. The study also established fairly rapid reversion to long-run equilibrium for Internet use and somewhat lower reversion for computer use.

3.2 ICT Adoption Theories

With the development and spread of ICT, and its application to various fields and activities, several studies have been carried out in order to test existing theories and ensure better understanding about its diffusion, adoption, acceptance and usage (Yi, Jakson, Park & Probst, 2006; Venkatesh, Morris, Davis & Davis, 2003, Rogers, 2003). A theoretical review of the study was built upon the most cited theories of information and communication technology (ICT) in popular publications including books and journal articles. These include:

ix. Technology Acceptance Model (TAM),
x. Diffusion of Innovations (DOI),
xi. Unified Theory of Acceptance and Use of Technology (UTAUT),
xii. Model of the IT Implementation Process; and,
xiii. Information Systems Success Model,

The explanation and summary of each of the theories are provided as follows:

3.2.1 Technology Acceptance Model

In keeping with Korpelainen (2011), this is the most cited theory with David (1989) being the foremost contributor to the Technology Acceptance Model (TAM). Davis (1989) presented a theoretical model aiming to predict and explain ICT usage behaviour; that is, what causes potential adopters to accept or reject the use of information technology. Theoretically, TAM is predominantly centred on two

theoretical constructs, perceived usefulness and perceived ease of use, which are the fundamental determinants of system use, and predict attitudes toward the use of the system. This means that the user's willingness to use the system - perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort", according to Davis (1989).

Meanwhile, Venkatesh and Davis (2000) developed and tested a theoretical extension of TAM, referred to as TAM2 later on. They both used TAM2 to explain perceived usefulness and usage intentions with the help of social influence and cognitive instrumental processes, and Adams et al. (1992) tried to replicate Davis' 1989 study confirming the efficacy of the model.

3.2.2 Diffusion of Innovations

Diffusion of Innovations (DOI) is a general theory of how new ideas are spread and adopted in a community, and it seeks to explain how communication channels and opinion leaders shape adoption (Korpelainen, 2011). In addition, Korpelainen (2011), while citing Rogers (1983), proposed the first process model, a five-stage model of the implementation and adoption of innovation in organisations (for example. DOI). On the other hand, Moore and Benbasat (1991) used DOI to develop "an instrument designed to measure the various perceptions that an individual may have of adopting an Information Technology (IT) innovation". According to Korpelainen (2011), the instrument was intended to be a tool for the study of the initial adoption and subsequent diffusion of IT innovations within organisations.

Innovation is described as any good, service or idea that is perceived by someone as new, according to Rogers (1995). Innovation takes time to spread through the social system and innovation diffusion process is of a new idea becoming widespread from its source of invention or creation to its ultimate users or adopters. Diffusion of Innovation (DOI) Theory, advanced by Everett Mitchell Rogers in 1962, is one of the oldest social science theories. It originated in communication to explain how, over time, an idea or product gains momentum and diffuses (or spreads) through a specific population or social system. The end result of this diffusion is that people, as part of a

social system, adopt a new idea, behaviour, or product. Adoption means that a person does something different than what they had previously (i.e., purchase or use a new product, acquire and perform a new behaviour, etc.). The key to adoption is that the person must perceive the idea, behaviour, or product as new or innovative.

Ilo, et al. (2014) explained an innovation as an idea, practice, or object that is perceived to be new by a person or adopting entity. When an innovation emerges, diffusion unfolds which entails communicating or spreading of the news of the innovation to the group for which it is intended (Rogers, 1995). Adoption, however, is the sense of duty regarding the utilisation of the innovation. The diffusion of innovation theory gives clarifications to when and how another thought, rehearsed or recently presented data and communication medium is embraced or dismissed after some time in a given society. Adoption of a new idea, behaviour, or product (i.e., "innovation") does not happen simultaneously in a social system; rather it is a process whereby some people are more apt to adopt the innovation than others.

Researchers have found that people who adopt an innovation early have different characteristics than people who adopt an innovation later (see for instance; Massetti and Zmud, 1996; Tornatzky and Klein, 1982; Zmud and Apple, 1992). When promoting innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder the adoption of the innovation. There are five established adopter categories, and while the majority of the general population tends to fall in the middle categories, it is still necessary to understand the characteristics of the target population. When promoting innovation, there are different strategies used to appeal to the different adopter categories (Wayne, 2016).

Baker (2002), posits that the primary drivers of innovation include, financial pressures to decrease costs and increase efficiency, increased competition, shorter product life cycles, value migration, stricter regulations, industry and community needs for sustainable development, increased demand for accountability, community and social expectations and pressures, demographic, social and market changes, rising customer expectations regarding service and quality, greater availability of potentially useful new technologies coupled with the need to keep up or exceed the competition

in applying these new technologies, and the changing economy It is through this that diffusion is possible.

Roger's (1962), model of innovation theory has been applied in many disciplines, and researchers who study the adoption of innovations often use it to explain the technology innovation process (refer to among others: Oliver and Goerke 2008; Tabata and Johnsrud 2008; Kilmon and Fagan 2007). Meyer (2004) noted that the model has effectively been used in various studies in such areas as sociology, communications, economics, marketing and technology. Jayson (2009) undertook a critical perspective on the diffusion of innovations theory and its application in developing nations.

3.2.2.1 The Innovation-Decision Process

Rogers (2003) conducted a research on the choice for innovation procedure, when searching for information as well as the processing of actions. The research concluded that the process has 5 stages like, Awareness, persuading, choice, application, and validation. The stages characteristically complement each other in the following order.

3.2.2.2 The Knowledge Stage

The decision process of innovation begins through an awareness phase where a particular person e explores the existence of the invention as well as search for information on the new invention. The questions What? How? and Why? are instituted within this phase (Rogers 2003). Throughout this stage, a particular person tries to decide which invention is available, in addition to how it is used and as well as why it works (Rogers 2003). Awareness to knowledge, how-to knowledge as well as principles to knowledge are the forms of three questions on types of knowledge. This stage denotes the awareness of the being of inventions. Individuals can learn more about innovation through motivation by this kind of awareness and later make use of it. Likewise, this might inspire a person towards learning about another kind of knowledge. How-knowledge comprises information on the way to practise an invention properly. Hence, equipment is not applied on the expected degree, as aid is needed on the way to use the technology correctly within the training surrounding (Spotts, 1999). As seen by Rogers (2003), awareness is a vital factor in the decision process in adoption of invention. People ought to have an adequate degree of the knowledge

prior to the experimentation of invention for it to grow the probability of invention implementation. Consequently, this understanding turns out to be an additional serious process for fairly multifaceted innovations.

3.2.2.3 The Persuasion Stage

The persuading stage happens immediately a person has an undesirable or desirable approach to the innovation. However, the development of an advantageous or disapproving disposition towards an invention does not consistently result immediately or otherwise in acceptance or refusal (Rogers, 2003). It is possible for an individual to form an approach when identifying an invention. This is because in this phase, it is important to keep an eye on the awareness phase within the process of decision making on an invention. Furthermore, Rogers (2003) explained that though the awareness phase is extra intellectual, the persuading phase is centred more on feelings. So, at this phase people are involved sensitively more with the invention.

Also, the uncertainty level whether an invention will work as well as the strengthening of social status, starting from contemporaries, can have a serious influence on the opinion of people as well as their beliefs concerning the invention. The evaluations of innovation by the close friends which reduce the risk of the invention results are commonly relied upon by people. However, some important information about new invention are usually obtained from experts through a systematic process. Instructors commonly pursue this from reliable contacts and co-workers whose biased feelings of a new invention are more convincing.

Furthermore, Rogers (2003), argued that well-matched is the level to which an innovation is observed as reliable by others, previous understandings, as well as desires of prospective acceptance. Nonexistence of well-matched within information technology with the needs of an individual might adversely influence individual's adoption of information technology (McKenzie, 2001). In line with Rogers (2003), the difficulty of usage of an invention is observed as reasonably problematic towards the apprehension and in addition to the usage, differing to other qualities, the complication is adversely connected to acceptable rate. Thus, the extreme difficulty of an invention is a significant problem in acceptance of it.

3.2.2.4 The Decision Stage

In this stage of decision on innovation, people accept an adoption or rejection of innovation. Acceptance denotes the complete application of innovation as the greatest option of achievement that exists, while the meaning of refusal is not adopting an invention (Rogers, 2003). In a condition that innovation has an incomplete test foundation, it is accepted commonly more swiftly, as many people like to attempt the innovation within their circumstances. Though, refusal is likely in all phases of the decision process of innovation. There are two types of rejection according to Roger (2003), active and passive refusal. In an active refusal, people attempt an invention as well as thinking on how to adopt it, then in future he or she chooses not to accept it. A dis-endurance choice, which is towards rejecting an innovation after accepting innovation previously, might be measured as active kind of refusal. But in a passive refusal situation, people do not reason about implementing the invention at all. This kind of denial has not been separated and examined in previous work of research. In some circumstances, the direction from awareness to decision phases can be awareness of persuasion. Particularly in beliefs of collectivity like in eastern nations, which takes place and assembly impact upon the acceptance of invention, this has the ability to convert the individual invention choice into a group decision of invention (Rogers, 2003).

On the other hand, the application phase is in the direction of the choice phase. According to Rogers (2003), degree of acceptance is the relative speed that innovation is accepted by associates of a social arrangement. Example of this is the number of people who make use of the innovation meant for some time that can be measured as the implementation degree of the innovation. Most important, the analysts of the implementation rate, observed the qualities of innovation. Rogers, (2003) declared that an adoption degree as the comparative speed by which invention is accepted by followers of a social organisation. An instance of this is the number of people that accepted the invention for a particular time, this can be used as a measure for the level of acceptance of the invention. The observed qualities of the innovation are important catalysts of acceptance degree.

Rogers (2003) specified that well-matched is the rate towards which innovation is observed as stable by the present principles, previous experiences, as well as

requirements for prospective adopters. Absence of well-matched in information technology by individual requirements might adversely impact the person's information technology adoption (McKenzie, 2001). The definition of complexity according to Rogers (2003) is the rate towards which innovation is observed as comparatively problematic to comprehend as well as usage. Rogers specified, contradiction towards other qualities, the difficulty is adversely associated with the degree of acceptance. Therefore, the higher complication of innovation is a significant hindrance in the adoption of innovation.

In keeping with Rogers (2003), sample capability is the grade towards which innovation might be tried with, on an incomplete foundation. Correspondingly, the experimental ability is definitely associated with the acceptance degree. Succinctly, this theory is relevant to this study because it observed and embraced customer relationship management as a means of innovation. The theory might be built towards explaining the purpose of accepting customer relationship management. The more an organisations increase in the area of innovation, the better and more relevant they are in their business environment.

3.2.3 Unified Theory of Acceptance and Use of Technology

Unified Theory of Acceptance and Use of Technology (UTAUT) is the fifth most cited theory. Venkatesh et al. (2012) stated that the unified model came into existence having reviewed eight models which explain ICT usage, namely Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), the Motivational Model (MM), Theory of Planned Behaviour (TPB), a model combining TAM and TPB, the model of PC utilisation (MPU), Diffusion of Innovation (DOI), and the Social Cognitive Theory (SCT). According to Korpelainen (2011), the purpose of UTAUT is to explain a user's intentions to use ICT and the subsequent user's behaviour.

Moreover, the model considers four constructs as direct determinants of user acceptance and usage behaviour, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. There are four key moderating variables: gender, age, experience, and voluntariness of use. Also, it was stated that UTAUT provides a tool for managers to assess the likelihood of success of technology introductions and to understand the drivers of acceptance in order to design

interventions, which include, e.g., training or marketing. UTAUT focuses on users who may be less willing to adopt and use new systems (Korpelainen, 2011).

3.2.4 Model of the IT Implementation Process

The eighth most cited theory was the Model of the IT Implementation Process, according to Korpelainen (2011). He cited Cooper and Zmud (1990), also Kwon and Zmud (1978), as major contributors to this model. It was noted that Cooper and Zmud (1990) took Kwon and Zmud's (1978) model of the IT Implementation Process and developed it further (Korpelainen, 2011). The model is based on organisational change, innovation, and technological diffusion literature. The purpose of the model is to offer a directing and organising framework for ICT implementation research. This stage model comprises six stages, namely initiation, organisational adoption, adaptation, acceptance and adoption routinisation, and infusion. Thus, the model covers an implementation process from the scanning of organisational needs to full and effective use of technology in daily practice (Korpelainen, 2011).

Moreover, the model also identifies five contextual factors ranging from the characteristics of the user community, the organization, the technology being adopted, the task, and to the organizational environment, which impacts on processes and products in each implementation stage, consistent with Korpelainen (2011).

3.2.5 Information Systems Success Model

On the word of Korpelainen (2011), the last most cited theory was the Information Systems Success Model. DeLone and McLean (1992) reviewed prior research and introduced a comprehensive taxonomy of factors contributing to the success of information systems. They also examined the literature on IS success and categorised success measures into six major categories: system quality, information quality, user satisfaction, individual impact, and organisational impact. These categories are interrelated and interdependent and provide a comprehensive view of IS success. The target of the model is to guide future research efforts.

In relation to the current study, the Technology Acceptance Model (TAM) is much relevant in the areas of the adoption of IT. It also has varied applications to accounting processes and the profession has been greatly influenced by the perceived usefulness

and perceived ease of usage to accounting in providing quality accounting information to various end-users of accounting statement, in the most efficient and effective manner. Regarding the relevance of DOI to this study, IT has become a tool for the initial adoption in all facets of life and subsequent diffusion of IT innovations has positively influenced business processes within organisations and accounting process is no exception.

Lastly, the relevance of Information Systems Success Model can be observed in the rate of adoption and use of Accounting Information System such as Enterprise Resource Planning (ERP), which is a multi-module application software system that helps organisations to streamline their business processes and Management Information System (MIS) today in business organization, most especially in their accounting unit. This theory is useful to this study as it has been used successfully in many fields including communication, agriculture, public health, criminal justice, social work, and marketing. For example, an intervention to address a public health problem is developed, and the innovation is promoted to people in a social system with the goal of adoption (based on Diffusion of Innovation Theory) (Wayne, 2016).

3.3 Information Communication Technology and Stock Markets

Mahonney (1997) confirmed that information technology innovations frequently result in changes in the way securities transactions are negotiated, executed, cleared and settled. The stock market is supposed to ensure through the takeover mechanism that past investments are also most efficiently used (Petros (2007); Bhunia (2011); Pradhan (2014)). Levine (1991); Gourène, Mendy and Diomande (2019), argued that ICT assumes a main responsibility in economic development in terms of stock market liquidity with trading of shares. Clemons and Weber (1990) examined the support of ICT in the London Stock Exchange and argued that the ICT has the tactical role for exchange's new screen-based market and recommends that computerisation of stock exchanges reduce the costs and inefficiencies associated with share trading, increase trading activity and liquidity.

Regarding relationship between capital markets and ICT development in an economy, King and Levine (1993) asserted that stock markets unimpeded the diversification of ICT risks and for that reason positive growth of stock markets augment modernisations

in ICT. Nevertheless, Singh et al. (2000), in his study, explored the relationship between ICT and the capital market using multivariate regression analysis in the case of both emerging and developed economies and confirmed that stock markets are neither necessary nor sufficient conditions for promoting the development of ICT.

ICT is relevant in enabling financial institutions to increase the availability of credit to corporations and households (Binuyo & Aregbeshola 2014). Therefore, ICT, through information sharing, contributes to reducing information asymmetry and therefore enhances the capacity of financial institutions to assess the risk profiles of borrowers (Asongu & Nwachukwu, 2017). Financial development has long run impacts on economic growth (Mun, Lin and Man 2008), and a well-developed financial system contributes to the technological spill over process and economic performance of an economy (Hermes and Lensink, 2003). Energy consumption, economic growth and financial development are significantly and positively related and this relation plays an important role in the development and economic prosperity of a country (Shahbaz, Khan & Tahir, 2013).

Porteba and Summers (1988) argued that stock markets had become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks. Fama and French (1988), on the other hand, argued that ICT has made stock markets more efficient as attendant stock prices now reflect important information and investors' perception of stocks are swifter. Fama and French (1988) further argued that ICT has made the stock market more efficient by providing all participants with faster and more effective means of exchanging information. They maintained that new products and instruments have been made readily available as a result of the advent of sophistication in ICT (Fama and French, 1988). Evidently, stock markets can be more resilient, and have greater depth and breadth with the intervention of ICT (Pradhan, 2014).

Financial development however was found to be an important determinant of ICT development and the paper therefore emphasised the need to develop financial markets in emerging economies (Solarin, et al. 2019). Previous researchers attempted to establish relationships between ICT diffusion in an economy as facilitated by stock markets (see for instance: Amalendu, 2011; Binuyo and Aregbeshola, 2014). The

available literature examined suggests that automation of stock exchanges reduce the costs and inefficiencies associated with share trading, and increase trading activity and liquidity (Solarin, et al. 2019; Pradhan, 2014). Furthermore, adoption of ICT speeds up operations and activities of the exchange and reduces costs associated with manual systems. ICT enables the exchanges to extend trading days and hours as cumbersome processes are eliminated. It also eliminates the need for intermediation (stockbrokers) as investors can monitor markets and trade online (Amalendu, 2011). Therefore, astute investors can benefit from reductions of transaction cost, which is provided by ICT enabled trading platforms. Also, they are able to buy or sell shares faster, in order to take advantage of new market information.

The costs of acquiring information, enforcing contracts, and making transactions create incentives for the emergence of particular types of financial contracts, markets and intermediaries. Different types and combinations of information, enforcement, and transaction costs in conjunction with different legal, regulatory, and tax systems have motivated distinct financial contracts, markets, and intermediaries across countries and throughout history (Levine, 2005).

Financial development can be defined as the ability of a financial sector to acquire information, enforce contracts, facilitate transactions and create incentives for the emergence of particular types of financial contracts, markets and intermediaries, and all this at a low cost (Rajan & Zingales, 2003:9; Levine, 1999:4). Financial development occurs when financial instruments, markets and intermediaries ameliorate – though not necessarily eliminate – the effects of information, enforcement and transaction costs, and therefore better provide financial services (Solarin & Dahalan, 2014).

3.4 ICT Adoption and Stock Markets : A Review of Empirical Studies

It is evident from literature that some researchers have considered Information and communication technology (ICT) in relation to stock market development and performance, especially in the developed and emerging countries. It is evident that, significantly, studies had examined ICT relative to economic growth and some other features of finance and banking development. Therefore, it will be pertinent to note that ICT has been studied relative to various aspects of human activity. An

examination of the literature implies that the effects of ICT on stock market development in Africa is not yet well researched and documented.

Ngassam and Gani (2003) explored the links between ICT and stock market development in emerging markets and high-income economies. They used number of telephone per 1,000 (one thousand) people, number of mobile phone users per one thousand people and number of internet users per one thousand people as the ICT variables. While the following variables were used as stock market variables; total stock traded as a percentage of Gross Domestic Product (GDP), market capitalisation as a percentage of GDP and credit to private sector as a percentage of GDP. The study used least-squares multiple regression model, and relevant proxies for ICT adoption and stock market development. The study found that personal computers and Internet hosts have strong effects on stock market development. Credit to the private sector and market capitalisation were also found to exert significant positive effects on stock market development.

Motivated by the curiosity to provide an approach for investigating whether the process of communication and interaction between investors and boards of companies has an impact on stock market return, Lattemann (2005) examined the actual penetration of ICT into 'external' corporate governance of Germany's publicly listed companies. The study employed descriptive statistics and the Capital Asset Pricing Model (CAPM)-based regression analysis. The findings suggest that stock market returns are negatively related to ICT usage.

Yartey (2006) used panel data for 76 advanced and emerging countries to examine the role of financial development structure in explaining cross-country diffusion of ICT during the 1990-2003 periods. The study found that credit and stock market development tend to foster ICT development, but that financial structure does not appear to have any significant relationship with ICT development. The study submitted that financial development is an important determinant of ICT development.

In a study of the external effects of ICT on economic growth, Farhadi and Famah (2011), used endogenous production growth model on panel data for newly industrialised countries for the period 1990-2008. The study considered GDP per

capita as a proxy for growth, and ICT investment, physical capital, human capital or labour, FDI and trade openness as proxies for ICT adoption and relevant control variables. ICT was found to statistically enhance GDP growth in the countries as a whole. The effect was also positive signs in each subgroup such as Brazil, Russia, India and China (BRIC), Organisation for Economic Cooperation and Development (OECD), and Association of Southeast Asian Nations (ASEAN).

In a relatively more broad-based study, Zagorchev, Vasconcellos and Bae (2011) employed a panel cointegration methodology to examine the dynamic relationship among financial development, ICT and GDP per capita in 86 sample countries. Variables in their analysis were a number of personal computers, Internet users and mobile phone subscribers (as proxies for ICT adoption), and GDP per capita (a proxy for economic growth). They found that personal computers and GDP per capita increase the liquidity, size and activity of financial systems. Also, Internet and GDP per capita improve the liquidity, size, stock trading and activity of the financial markets. Mobile phones and GDP per capita stimulate financial market liquidity, size and credit expansion.

Bhunia (2011) studied the impact of ICT on the growth of the Indian Stock Exchange, against the proposition that capital markets have become excessively volatile since the adoption of computer-assisted trading strategies. Employing data on relevant indicators of ICT adoption and capital market growth, the study showed that, though the market is still relatively thin compared to more developed markets, most of the stock market development indicators are significantly affected by ICT adoption, especially the number of stockbrokers.

Hossein, Fatemeh and Seyed (2013) employed correlational and regression analysis techniques to study the impact of Information Technology development on stock market development in the world's leading capital markets. Their analysis showed that market capitalisation, turnover ratio and values of shares traded have a direct relationship with the ICT adoption components in the study. But they found no relationship between ease of access to local markets and ICT development. However, in the aggregate, the ICT adoption indices in their analysis collectively exerted a significant impact on stock market development.

Concerned by impediments of stock exchanges' development in Eastern and Southern Africa, Irving (2005) explored a historical and descriptive approach, as well as progress and prospects perspectives, to assess the possibility of remedying the situation via regional cooperation and integration of stock exchanges in Eastern and Southern African regions. Identifying ICT-induced diversified risks, efficiency and competition, higher returns, liquidity and cross-border capital flow as potential benefits of such networking, the study adduced that the exchanges stand to benefit more from closer cooperation by encouraging more cross-border and information/technology sharing.

Farid (2013), attempted to ascertain whether African stock markets can improve their informational efficiency by formally harmonising and integrating their operations on a common platform. Using the method of Generalised Method of Moments (GMM) approach for panel data analysis, and relevant capital macroeconomic indicators, the study showed that institutional deficiencies and openness to trade have a negative impact on economic growth. Further, African economies that were more open to international capital flows do not seem to grow faster than the rest, thereby leading to a number of empirical questions. More generally, the financial market integration so far executed is still insufficient to reflect in the data sets owing probably to the short-term maturity concentration of the financial instruments.

Ezirim, Adebajo Elike and Muoghalu (2009), examined the effects of Information Technology on the growth and development of the capital market in Nigeria for the period 1998-2007. They found that the level of ICT-facilitated interaction between stockbrokers and investors significantly affect the growth of market capitalisation, and volume and value of shares traded. However, Information Technology does not significantly affect a number of listings and government bonds. Their analysis was anchored on a modified version of Gompertz technology diffusion model introduced by Chow (1983), which examined the relationship between ICT as the independent variable and the factors that cause a change in the level of ICT, as the dependent variables.

Okwu (2015) studied ICT adoption and financial markets: a study of the leading stock exchange markets in Africa. The study examined the effects of ICT adoption on

Nigerian and Johannesburg Stock Exchange markets. The analysis was anchored on panel data metrics of ICT adoption, control and transaction capacities measures of the exchanges. Findings show that ICT adoption had heterogeneous effects during the study periods. Use of the Internet had negative effects on the market indices, except capitalisation. Some of the regressors had no significant effects on individual merits, but aggregate effects were significant.

Okwu (2016) looked into the ICT and stock market nexus in Africa: focusing on evidence from Nigeria and South Africa. Pooled data were used in this paper to spur further studies on stock markets in Africa. This paper employed data on functional models adapted from the Gompertz curve model for technology diffusion to examine the effects of ICT on market outcomes of two leading stock exchange markets in Africa during the 1995-2015 periods. Results showed mixed effects of most ICT metrics and moderating variables in the study. Specifically, the effect of a mobile telephone on all market indicators was positive and significant. Furthermore, the aggregate effect of the ICT proxies and moderating variables on all market indices was statistically significant. The ICT proxies accounted for positive dynamics in market outcomes, market operations and, thus, sine quo non to growth and development of the markets and financial sectors in the Continent.

Bhunia (2011) examines the impact of ICT on the growth of the Indian Stock Exchange using a modified version of the Gompertz technology diffusion model introduced by Chow (1983) and consequently reshuffles the model with ICT development turn into the independent variable while stock market growth indicators are the dependent variables. Capital markets have become excessively volatile since the adoption of computer-assisted trading strategies as the latter increase short-term price volatility and risks. The data in the present study is obtained from BSE and NSE stock exchanges database, MCX India database, Securities and Exchange Commission and websites of World Development Indicators. In the course of analysis, descriptive statistics and regression model has been designed. The results disclose that selected variables are significantly affected by information and communications technology, especially regarding the increase in the number of stockbrokers, investors and access to ICT.

In a somewhat broader dimension to the study of ICT in relation to business and economic outcomes, Donwa and Odia (2010) employed ordinary least squares (OLS) multiple regression analysis to determine the impact of the Nigerian capital [stock] market on socio-economic development for the 1981-2008 period. Considering gross domestic product (GDP), market capitalisation, total new issues, transactions volume, total listings and government stock, they found that the market indicators significantly enhanced economic growth, and moderately explained growth dimensions during the period. In isolation, the market indicators had mixed effects on the socio-economic development of the country. Benkraiem and Miloudi (2012) used descriptive analysis and OLS pooled multiple regression models to study ICT small businesses' access to banking finance in France. Employing relevant variables, the study found that ICT businesses encountered difficulties in accessing bank debt to finance further ICT investment assets.

Table 3.1 provides a summary of other empirical studies that have been conducted to examine the ICT adoption and stock market development nexus. On the basis of this evidence, there is a demonstrable relationship between ICT adoption and stock market development. By and large, it would seem as if ICT adoption positively influences stock market activity. What remains unknown is whether ICT has a positive or negative impact on stock market development in Africa.

Table 3. 1 : Summary of the Reviewed Empirical Studies

Author(s) and Year.	Objective/Purpose/Study Focus	Findings/Conclusion
Ezirim et al. (2009)	Examined the effects of information and technology on the growth and development of the capital market in Nigeria (1998 – 2007).	A number of securities listed and government bonds are not significantly affected by ICT adoption. Corporate bonds are significantly affected by ICT. ICT has contributed to the growth of the Nigerian capital market.
Hossein et al. (2013)	Examined the impact of Information Technology development on capital market development in the world's leading markets.	Information Technology development indicators collectively exerted a significant effect on capital market development.
Bhunia, A. (2011)	Examined the impact of ICT on the growth of the Indian Stock Exchange, against the proposition that capital markets have become excessively volatile since the adoption of computer-assisted trading strategies.	Most of the market development indicators are significantly affected by ICT, especially the number of stockbrokers. ICT has contributed to the growth of the Indian capital market, with the most effect on information available to investors, and improved trading patterns of the Exchange. However, the market is still relatively thin compared to more developed markets.

Ngassam, C. and Gani, A. (2003)	Examined the links between ICT and stock market development in emerging markets and high-income economies.	Personal computers and Internet hosts have strong positive effects on stock market development. Market capitalisation and credit to the private sector (as non-ICT variables) exerted strong positive effects on stock market development.
Ayartey (2006)	Examined the role of financial development in explaining cross-country diffusion of ICT in 76 advanced and emerging countries during 1990-2003 periods.	Credit and stock market development tend to foster ICT development. The financial structure does not appear to have any significant relationship with ICT development. Financial development is an important determinant of ICT development
Irving, J. (2005)	Assessed whether regional co-operation and integration of stock exchanges in Eastern and Southern Africa could offer a way of overcoming impediments to the exchanges' development.	The exchanges could benefit more from closer cooperation by encouraging more cross-border listings and information/technology sharing.

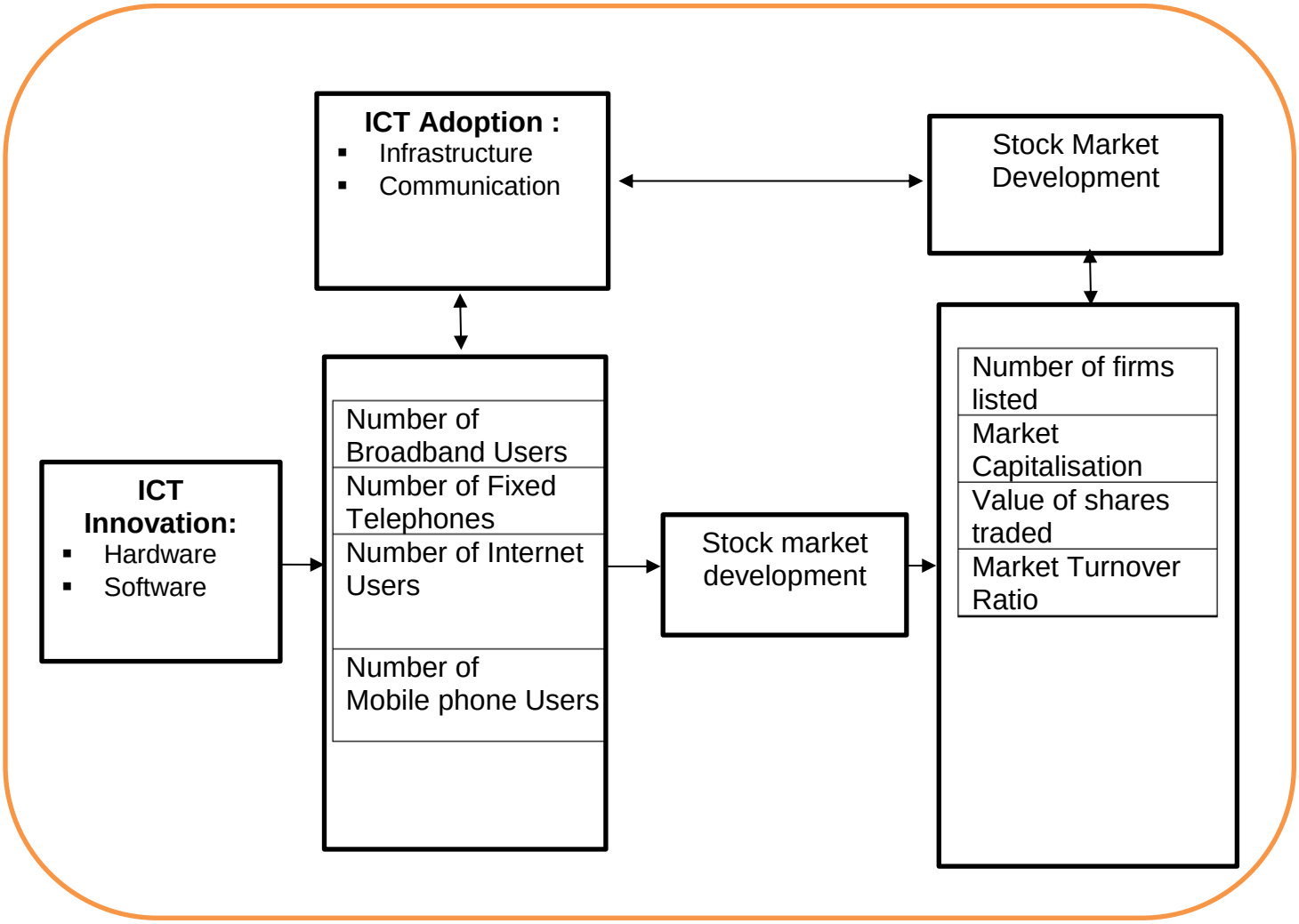
Farid, S. (2013)	Attempted to ascertain whether African Stock markets can improve their informational efficiency by formally harmonising and integrating their operations.	African economies that were more open to international capital flows during the period do not seem to grow faster than the rest, thereby leading to a number of empirical questions. Possibly, openness promotes growth through indirect channels via financial development. The growth effect could also be conditional to other factors such as institutional characteristics, macroeconomic environment or other economic conditions.
Zagorchev, et al. (2011)	Sought to establish the dynamic relationship among financial development, ICT and GDP per capita in 86 sample countries.	Personal computers and GDP per capita increase the liquidity, size and activity of financial systems. The Internet and GDP per capita improve the liquidity, size, stock trading and activity of financial markets. Mobile phones and GDP per capita stimulate financial market liquidity, size and credit expansion. There is an equilibrium relationship between financial development, ICT and GDP per capita.
Sofianos, G. and Werner, I. M. (2000)	Studied the contributions of NYSE floor brokers to the exchange's agency auction market by analysing how the cross-sectional distribution of floor	NYSE floor brokers bring two-sided liquidity to the NYSE floor. On the average, floor brokers represent 91.0% of the total volume of buys and sells in upstairs-facilitated block trades. There is no evidence of a direct effect of floor

	broker trading depends on liquidity, block volume, on- and off-exchange competition, volatility, and order flow internalisation.	broker trading on specialist trading or vice versa. Floor brokers are extremely important components of the NYSE auction market.
Fernandez, C. B., Callen, F. Y. and Gadea, L. A. J. (2011)	Examined investors' valuation of non-financial corporate news items issued by European companies in the ICT industry, and analysed stock market reaction to the publication of press releases on a sample of 145 firms (2003-2005).	While investors react positively to information concerning a firm's capacity to consolidate its position, diversify and grow, they react negatively to information about new product launches and upgrades. Also while Investors in companies with a strong market position and growth prospects highly-valued information on takeovers and internalisation, those in low-performing companies value news of disposals and distribution alliances.
Kehbuma, L. (2005)	Examined the role of ICT in the economic development of South Africa	Positive as well as negative contributions of the Internet in bringing about developmental changes in South Africa. Aggravated African connectivity problems. High dependency on ICT products from the West. However, the Internet has played a great role in changing lives and moving South African communities forward.

3.5 Conceptual Framework

The speed and extent of stock market development in the developing countries have not only been unprecedented but have also led to a paradigm shift in both the financial structures of developing countries and in the capital flows from developed nations. Stock markets are expected to leverage on these to accelerate economic activities by providing a boost to domestic savings and, thus, increase the quantity and quality of investment (Hossein et al., 2013). This has implications for the transactions capacity of the stock exchanges.

Figure 3. 1 : Conceptual Framework



Source: Researcher's Conceptual Model (2019)

The framework conceptualises that ICT innovation (hard and software development and other infrastructure) transmits through adoption (indicated by number of internet

users, number of fixed phone users, number of broadband users and number of mobile phone users) to stock market development (number of listed companies, market capitalisation, values of shares traded and market turnover ratio). Based on the conceptual framework and literature, an analytical model was developed, discussed and employed for analysis in the relevant chapters of the study. Most of the previous studies have not specifically examined ICT adoption in relation to African Stock market development (Oyelere & Kuruppu, 2012; Mihasonirina & Kangni, 2011; Bankole et al., 2010; Ezirim et al., 2009). The current study explores this framework to establish the impact of ICT adoption on African stock market development.

The conceptual framework shows the directional flow of ICT adoption theories which are discussed above. However, Korpelainen (2011) and David (1989) confirmed that Technology Acceptance Model (TAM) is the most cited theory, which makes TAM the foremost contributor to the ICT adoption in academic literature that made TAM an appropriate theory to explain the ICT adoption in the context of this research. TAM presented a theoretical model aiming to predict and explain ICT usage behaviour, that is, what causes potential adopters to accept or reject the use of information technology. The usage of the ICT variables selected for this research is likely to be used due to the benefit it can bring to the user. In this case, a stock market participant is more likely to use the internet or mobile phone to conduct their stock market activities.

Theoretically, TAM is predominantly centred on two theoretical constructs, perceived usefulness and perceived ease of use, which are the fundamental determinants of system use, and predict attitudes toward the use of the system. This means that the user's willingness to use the system - perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" according to Davis (1989). Therefore, the adoption of broadband, fixed telephone, the Internet and the use of mobile phone, which are the ICT adoption independent variables selected for this research, which are ICT innovation introduced through the use ICT hardware and software, can lead stock market development when used by market participants. The adoption of these ICT variables can then lead to increase in the number of listed

companies, market capitalisation, value of shares traded and turnover ratio in a stock exchange.

3.6 Chapter Summary

The major focus of this chapter was to do a review of conceptual, theoretical and empirical literature on the link between ICT adoption and development of African stock markets. It is evident from the review that most of the available studies assumed a linear relationship between ICT adoption and stock market development, thereby neglecting the peculiarities of stock markets in Africa and other developing countries.

Moreover, most of the existing empirical studies that analysed stock markets in relation to ICT adoption did not consider African stock market development. Most of the available studies are on financial or stock markets outside Africa. The current study is intended to contribute to bridging this observed knowledge gap in the literature. Consequently, this chapter provided a springboard upon which a research gap and new contribution to knowledge are fostered.

The next chapter lays the foundation for hypotheses testing and resolves the methodological issues relating to the current study and develop the research design and specification of econometric analytical models employed in testing the hypotheses formulated in chapter one of the current study. The chapter will explore the methods and procedures adopted for this thesis and also discuss the research paradigms that informed the research design. The chapter will proceed to discuss the concept of population and sampling for of data and also define the variables employed. Furthermore, the next chapter will discuss method of data analysis employed and the ethical consideration that is pertinent to this study. The chapter will end with a discussion and presentation of the model specification adopted for this study and a summary of the chapter.

CHAPTER 4

RESEARCH METHODOLOGY

4.0 Introduction

The previous chapters elaborated on the research aims, hypotheses as well as reviewed extant studies on the finance-growth nexus, stock market development and ICT adoption. This chapter presents the research methodology used to execute the study. The primary research question that this study seeks to answer is 'What is the impact of ICT adoption on Stock Market Development in Africa?' While answering this primary question and in order to understand that cointegration relationship does exist between ICT adoption and stock market development in Africa, this secondary question was also raised to be addressed by this study: 'What cointergrating relationships exist between ICT adoption and stock market development in Africa?' Furthermore, the following question was further raised to understand the causal direction of the relationship between ICT adoption and stock market development in Africa: 'What is the direction of causality between ICT adoption and stock market development in Africa?

It was observed in the reviewed literature that diverse techniques affirmed different outcomes on the subject of ICT adoption and stock market development. With respect to the methods previously adopted in investigating the nexus between ICT adoption and stock market development, the most matched methodology employed was considered and explained in Section 4.5 underneath.

In this chapter, the methods and procedures adopted for this thesis are explored. The rest of the chapter is structured as follows: Section 4.1 discusses the research designs and paradigms, Section 4.2 presents the concept of population and sampling adopted for this study. 4.3 discuses the concept of panel data techniques adopted for this study. Section 4.4 describes the data and also defines the variables employed in the study. Section 4.5 describes the estimation techniques employed. Section 4.6 discusses the diagnostics tests performed in the Section 4.7 outlines the ethical

consideration that is pertinent to this study. Section. Section 4.8 then concludes the chapter with a brief summary.

4.1 Research Designs and Paradigms

Creswell (2013) acknowledged research design as the model/standard which was developed to find solutions to questions postulated in research. In addition, it is seen as the sum strategy that benefits and helps to combine different components of the study in a clear and logical way. Therefore, the research design also helps to ascertain the merit in confronting the research problem. In this thesis, the descriptive and ex post facto research design was adopted. The descriptive research design is basically utilised to follow up the crucial elements of the determinants of interests in research, while ex post facto research design basically pertains to the causal relationship that exists among determinant variables.

In this case, ICT adoption variables which are; Number of Broadband Users (NBU), Number of Fixed Telephone Users (NFTU), Internet Users (IU) and Number of Mobilephone Users (NMU) serves as the independent variables, while stock market total value traded to GDP (%) (SMTV), Stock market capitalisation to GDP (%) (SMC), Stock Market Turnover ratio (value traded/capitalisation) (%) (SMTR) and Number of Listed Companies per 10,000 (NLC) of the African stock markets serve as the dependent variables. Furthermore, the thesis adopted ex post facto research design since the research embraced data that are time-bound in order to comprehend phenomenon over a period of time. Ex post facto is also adopted since the thesis is quantitative in nature and uses statistical techniques in addressing the problems stated in the thesis. Similarly, the ex post facto design is utilised due to the fact that data for this thesis is already available in their secondary state, hence it is devoid of manipulation by the researcher (Creswell, 2013).

The study adopted a quantitative method of research by means of analysing prevailing archival data on ICT adoption and stock market development in African stock markets, and accomplishing the study objectives as this corroborates the standpoints of Saunders, Lewis and Thornhill (2012). More so, a quantitative approach was embraced in order to determine and authenticate nexuses leading to appropriate generalisation in addition to expansion of knowledge in the study area (Leedy &

Ormrod, 2001). Moreover, descriptive statistics and then panel data methodologies are considered in this study to determine the nexus between ICT implementation and stock market development encompassing the control study variables.

Additionally, the cointegration and causal links are observed via the vector error correction model (VECM) and ARDL. These methods VECM and ARDL are employed in order to determine the long run effect among the variables and also to analyse if any variations in stock market development explains the level of ICT adoption and vice visa. For the nature of this research which is quantitative-inclined, deductive in addition to positivist research models are utilised.

The research design employed is in accordance with the objectives and problem analysis applied in the first chapter to the extant and applicable empirical components of this thesis. In line with Yin (2002), the scholar argues that research design is considered as a rational and reasonable classification connecting the empirical data to a research's key objectives as well as its decisive assumption and conclusion. The approaches in addition to procedures for data collection and analysing the nexus of ICT adoption and stock market development are drawn in this section. On the other hand, the articulation of research design is centred on the category of data required and essentially, the approaches or methods employed in analysing the data gathered. Also, the research design outlines the approach and the methods employed to answer the problems identified (Saunders et al., 2012).

The research paradigm, which is also discussed in this chapter, outlined data collection process as well as the method of analysis that seeks to answer the research questions described in the first section of this chapter. Furthermore, the ethical consideration/issues in relation to the restrictions (limitations) of this research were discussed in the research process (Saunders et al., 2012). Accordingly, Creswell (2014) considered research paradigm as a positive construal or insight that encompasses the ethics, beliefs, principles as well as methodological expectations of a researcher. Mackenzie and Knipe (2006) argued that research paradigm is acknowledged as a logical thinking and/or common ethics that edify the data analysis.

Positivism is considered as the position of epistemology that promotes the research strategy applications which this study employed. Moreover, positivism encompasses a deductive (rational) method according to Crotty (1998) and supported by means of objectivist ontology. Research strategy as a phenomenon is considered germane to any research for hypotheses identification and essential to the development of research (Crowther and Lancaster, 2012; Bryman and Bell, 2007; Marczyk, DeMatteo and Festinger, 2005; Miller, 1983). On the other hand, research approaches (i.e. primary and secondary) identified by Yin (2002), encompass experiments and surveys recognized as (primary research), then case studies in addition to archival analysis known as (secondary research). These research approaches are acknowledged as interviews, field work, observation, library research, evaluation, surveys as well as analysis. Accordingly, archival analysis (secondary data) was considered in this thesis. The data gathered were analysed with the application of Stata version 15 software package to ascertain the nexus between ICT adoption as well as the explanatory study variables employed in this study.

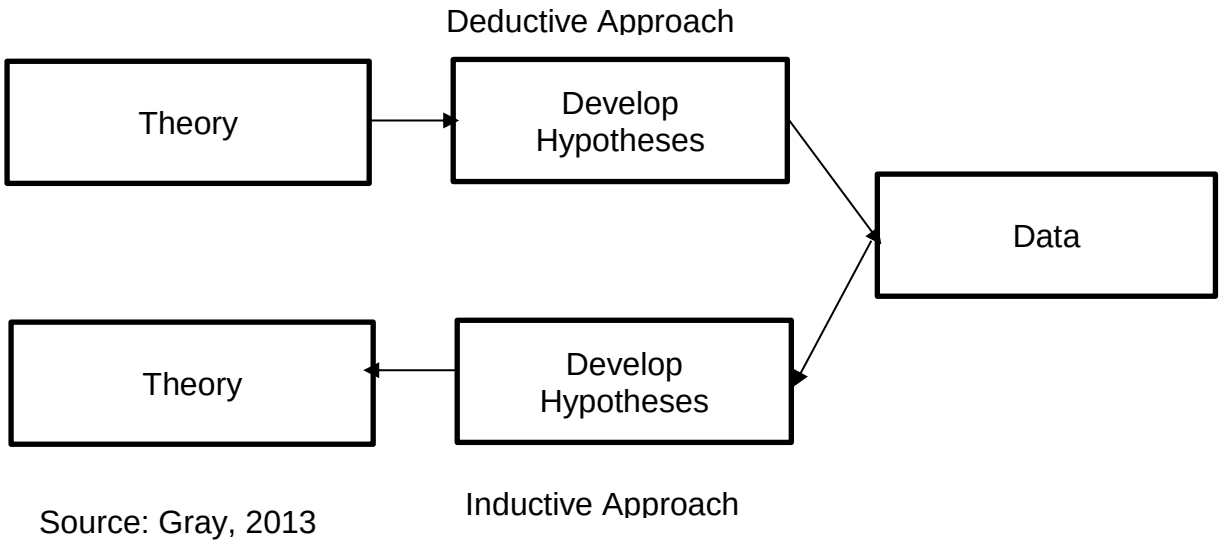
The secondary data gathered was analysed for ICT adoption features employing literature as the foundation in answering the research question through positivist paradigm. Moreover, the nexus between ICT adoption and stock market development is made in anticipation and the need of making predictions based on employing quantifiable results as promoted by positivism (Kaboub, 2008). It is suggested by Cohen, Manion and Morrison (2000), that some initial expectations employed in the case of positivism can be seen as empiricism, parsimony, determinism, as well as generalisation.

By employing empiricism, Creswell (2014), emphasised that the problem of a research is considered by means of gathering supportable research data to back up the preferred theoretical framework which aids the test of derived hypotheses. Conversely, parsimony argued that phenomena must be explained in the best economical technique possible (Cohen, et al., 2000). In the case of determinism, undertakes that observed actions are instigated by means of added features (characteristics) of which these causal relationships are revealed and achieved (Cohen et al., 2000). Integrating the determinism, the research pursues to determine a nexus between ICT adoption and the explanatory variables (stock market development).

For the enlightened positivism paradigm expectations, the study employs secondary data because it's financially economical. Moreover, using dependable source of data gathering implies that this form of research can be simulated to a different destination**.** As enlightened in the research procedures employed, integrating the determinism, the exploration strive for determination of a nexus between ICT adoption and the explanatory variables (stock market development).

Moreover, with the positivist model, the study integrated a deductive paradigm. Krauss (2005) affirmed that a deductive method is adopted when data is utilised or employed to test theory, whereas Saunders et al. (2012), were of the opinion that data is only employed to assess the established conceptual context in a deductive method**.** More so, Wilson (2014) contended that deductive approach hypothesis is mechanised through the prevailing theory. Also, a research strategy was developed in this section for the hypotheses testing. Two renowned scholars Robson and McCartan (2016) established that a deductive approach is incorporated wherever pre-existing theoretical perspectives were tested.

Figure 4 1 : **Exemplifies the deductive approach in a research process.**



Source: Gray, 2013

Figure 4.1 is a summary of the deductive research process which this thesis adopted. This study started by reviewing the existing literature. The researcher established hypotheses as the propositions, based on measuring of ICT adoption, stock market development and the study control variables**.** Bhattacherjee (2012) and Wilson (2014),

opine that these propositions are empirically formulated hypotheses indicating the cause-effect relationships between variables of the study. Data is then collected and analysed where the data can either validate or refute the hypotheses developed in this chapter. The performed data analysis provides the implications of the hypothesis supported with statistical inferences as illustrated in Figure 4.1. The inferences either confirm or reject the theories and concepts which were discussed in Chapter Two and Chapter Three.

4.2 Population and Sampling

Neuman (2000), stated that the population is the sum total of all units of analysis from which the sample is drawn. While Cooper and Schindler (2008), described the target population as the whole group of individuals from which generalisation of findings will be based, hence in this study, the target population includes all the Twenty-one (21) stock exchanges that are currently members of the ASEA. Without doubt, Africa as a region is said to have vast potential in terms of economic activities, which include activities from its stock market, there are twenty-nine exchanges (29) in Africa, which have capital markets from thirty-eight (38) nations. Also, twenty-one (21) of these stock exchanges are currently associated with the African Securities Exchanges Association (ASEA).

On the other hand, the sample for this study was limited to 11 stock exchanges in the ASEA, and these include the Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) and Stock Exchange of Mauritius (SEM). These eleven stock exchanges were selected mostly due to the availability of data and the value of their market capitalisation being among the highest in Africa.

4.3 Panel Data Techniques

Since there exist different methods of analysis of panel data set, the issues of which of the methods is the most suitable arises. For this reason, in selecting, the most appropriate method of PDR, particularly between the REM and FEM is needed. Tian

and Zeitun, (2007) posited that a simple test, in choosing the most appropriate test is the Hausman (1978) Chi-square specification Test. The matter arising here is whether there is a significant association between the regressors and the observation of specific random effects of the unobserved unit. If the results say no correlation, then REM will be more suitable. However, if the results say yes then FEM will be more suitable and in this case, renders REM model an inconsistently estimated model. The Generalised Methods of Movement (GMM) is also considered. In order to mitigate the problems of specification and endogeneity errors, the GMM estimators is adopted in place of Pooled OLS, FE and RE.

4.3.1 Panel Data Regression Model

Panel data regression (PDR) model was utilised by the researcher in this study to disentangle cross-country dependencies, where it exists and to explore the influence of ICT adoption on the stock market development in Africa. Pesaran, Shin and Smith (2000) and Wooldridge (2003) considered PDR model, as a regression analysis that pertains to the collection of time series alongside cross-sectional data. They are also said to have a single cross-section data but with recurring observations. Panel data is a crucial means of analysis of data which are longitudinal in nature as it provides a series of regression analysis which are in units (spatial/three-dimensional) and time (temporal/historical) proportions and measurements. The unit type of data means that a series of cross-sectional spatial observation, for example states, organisations, or countries as is the case of this thesis. On the other hand, the time aspect indicates that there is a consistent recurring observation of variables set over the same period of time.

Baltagi (2008:309) highlighted various benefits that come with using PDR and these are as follows:

i. It allows for more data that are informative, few colinearity among variables, less variability, less degree of freedom increase in efficiency due to the fact that it combines both time series observation and cross section data,

ii. The detection and measurement of effects which are not frequently observed when engaging with either time series or cross sectional data as a stand-alone observation,

iii. It also ensures that biasness that could come up as a result of sum total of individual units into overall sum is reduced. This is based on the fact that data exist in a panel data setting,

iv. It facilitates more advanced dealing of behavioural models; for instance, change in technology, which tends to be difficult when acting as a stand-alone in either time series data or cross-sectional observation,

v. Heterogeneity is eliminated when it comes to the process of estimation, because it gives room for particular individual variables,

vi. Furthermore, PDR model is more effectively used when a research is pertains to the volatility of change. For instance, variables that pertain to the repeated cross section of observations, e.g. turnover,

The foregoing indicates the benefits of utilising PDR. However, there are some limitations that come with this type of estimation. Since PDR pertains to the use of time series and cross-section dimensions, the limitation associated with it includes the concerns of autocorrelation and heteroscedasticity. Other concerns that usually arise when handling PDR is the concern of specific units of cross-correlation at the same point in time.

On the other hand, a balanced panel data model implies that there are no missing data points and this is basically put together in a specific pattern. As such, a linear model for panel data allows for the intercept as well as its tangent to differ over both individual unit and over time, which is presented as follows:

$$y_{it} = \alpha_{it} + \beta_{it} x_{it} + \mu_{it} \quad \text{.....4.1}$$

Where:

y_{it} = dependent variable (in vector)

α_{it} = Intercept (in vector)

β_{it} = coefficients (in vector)

x_{it} = independent variables (in the form of K x 1 vector)

μ_{it} = error term (Scalar), which is the addition of time specific error and cross sectional specific error. i.e. $u_{it} = \mu_{it} + V_{it}$.

i = Specific unit in cross section observations

t = time observations

The above equation 4.5, seems to be in a basic form as the observation is less than the number of parameters, and as such this makes the equation not sufficient or an under equation. Hence, the constraints basically are noted on how α_{it} and β_{it} differs with respect to the cross section time observations as well as the error term behaviour. Notwithstanding, there are three types of PDR model estimation and as such the task of estimating and specifying a model that is restrictive in nature makes it necessary to bring up which method of estimation to adopt. This includes the random effect Model, (REM), the fixed-effect-model (FEM) as well as the Pooled Regression Model, (PRM). These estimation models are frequently utilised in studies that are empirical in nature (Tian and Zeitun, 2007; Pesaran, et al., 2000; Greene, 2003; Chen, 2004).

4.3.2 Pooled Regression Model

The PR model can also be called the Constant Coefficient (CC) model. Of the three models it the CC appears to be the most barest, in PDR model. Nevertheless, CC does not put into account the time dimension as well as the space dimension of the data pooled.

For instance, in a scenario where a particular cross section (e.g. a country) is insignificant and also where the time observation is insignificant, pooling all the data and performing OLS analysis is considered effective. Hence, due to the fact that there can be scenarios where country and time observations are insignificant statistically, Equation 4.5 reduces to the following form:

$$y_{it} = \alpha + \beta_{it} x_{it} + \mu_{it} \quad \text{.....4.2}$$

Thus, out of the three models, the PR model seems to be the most constrained in PDR when specified correctly while the variables are not correlated with the error term, then using Ordinary least square that is pooled is the most effective.

4.3.3 Fixed Effect Model

There is room for variability of the constant terms across cross-sections (i.e. individual country) in the fixed effect model, due to the fact that each country may possess distinct characteristics. The Fixed Effect Model (FEM) is particularly desirable in a scenario where individual constant terms tend to correlate with one or more of the independent variables. Hence, in taking into consideration the varying constants, the difference mean or dummy variable are usually utilised based on the most desirable.

In addition, in a scenario where dummy variables are utilised, the model employed in this situation is called least square dummy variable. This is usually employed when the total number of observations is particularly small. A major limitation of least square dummy variable is that it evidently minimises the degree of freedom, when cross-sections numbers (N), is much. However, the amount of dummies put into the estimation will assist to minimise the common constant term. Hence, equation 4.7 is now dependent on the outcome of the assumptions on α, β_{it} and as well as the error term.

In this technique, few certainties abound where individual cases come up with advanced estimation PDR models. In this thesis, only 2 are taken to be essential and they are given below. Two of them are considered relevant for this study, which are as stated below:

The coefficients tangents, β_{it} are constant but the constant α differs across the cross sections. Hence, Equation 4.6 is rewritten as follows:

$$y_{it} = \alpha + \beta x_{it} + \mu_{it} \quad \text{.....4.3}$$

or

$$y_{it} = \Sigma \alpha_j \, d_{jit} + \beta x_{it} \quad \text{.....4.4}$$

Where $j = 1$

The $u_{it} = \mu_{it} + V_{it}$., where u_{it} indicates the specific individual effect of the variables and V_{it} indicates the invariant-time effect; that is when the variables are independent

from one another and are noted to be identically and independently distributed d_{ijt} over t and i that is the time dimension and the cross-sectional units respectively.

The constant term, α_j are random that assist to note the heterogeneity of the unobserved. Also, the basis of strict exogeneity is often allowed under this method. Hence, the mean of the stochastics disturbance also known as the error term is given as:

$E[\mu it \mid \alpha i, xi1, \ldots, xiT] = 0 \; where \; t = 1, \ldots, T$ …. 4.5

The error term, μ_{it} is taken to possess mean zero with respect to the values of the variables which can be in the form of future, current and past. This basis of strict exogeneity is not often usable to models that tend to lag dependent constraint as regressors. As such, the presence of fixed effects with its correlation with the regressors, x_{it}, hence, pooled OLS among most estimators is seen as discrepancy. In this scenario, the technique that put away the intercepts terms α_j is sometimes utilised as another method, in order to see to it that there is lack of discrepancy in the estimation of the coefficients, β in a short panel.

The coefficient tangents, β_{it} are constant but the constants, α differs across the cross sections as well as time. Hence, Equation 4,9 is rewritten as follows:

$$y_{it} = \alpha_i + y_t + \beta_{it} + \mu_{it} \text{.....4.6}$$

Or

$$y_{kit} = \Sigma \alpha_j \, d_{jit} + \Sigma \, y_s \, d_{s.it} + \beta x_{it} + \mu_{it} \text{.....4.7}$$

Where

j=1 s=*2*

The amount N of standalone dummies d_{jit} = 1 if and ony if $i = j$ and = 0 vice versa, while the dummies times (*T - 1*), $d_{s.it}$ =1 if and only if $t = s$ and = 0 zero vice versa. In addition, it is also noted that x_{it} does not contain a constant term. In that sense, when a constant term is introduced, there seems to be a reduction in the degree of

freedom by 1, due to the fact that one of the standalone dummies is needed to be put down. Hence this estimation has $N + (T - 1) + dim[X]$ parameters which can be continuously estimated if at the same time $N\ tends\ to \infty\ and\ T\ also\ tends\ to \infty$.

4.3.4 Random Effect Model

The Random Effect Model (REM) can also be termed as Error Components (EC) model, which is usually utilised in place of the fixed effect model. Here, the standalone constant term is given as a deviation from the mean constant value. One particular benefit of EC model over CC model is that it has parsimonious degrees of freedom. Therefore, one need not bother to analyse N cross-sectional intercepts but only its mean value and its variance. The REM or EC model is desirable in a situation where the constant of each cross-sectional unit is not correlated with the variables. As such EC model is specified as follows:

$$y_{it} = \beta_{1i} + \beta_{2i}x_{2it} + \beta_{3i}x_{3it} + \mu_{it} \quad \text{.....4.8}$$

Instead of noting β_{1i} as fixed, it is assumed that it is a random variable with a mean value of β_1.The constant value for the standalone cross-section unit (in these case countries) is given as:

$$\beta_{1i} = \beta_1 + \varepsilon_i \quad \text{.....4.9}$$

Where

$$i = 1, 2, \ldots, N$$

The ε*i* is an error random term which has a mean value of 0 and variance = $\sigma 2\varepsilon$. Hence eqn 4.9 by merging Equation 4.10, would result in Equation 4.11 stated as follows:

$$y_{it} = \beta_1 + \beta_{2i}x_{2it} + \beta_{3i}x_{3it} + \pi_{it} \quad \text{.....4.10}$$

where

$$\pi_{it} = \varepsilon_i + \mu_{it} \quad \text{.....4,11}$$

The π_{it} now called the error composite timer consists of two parts that is ε_i, also called the standalone-specific error component, and μ_{it} = the combination of error component in time series observation and cross-sectional units.

4.3.5 Generalised Method of Moments

In order to mitigate the problems of specification and endogeneity errors, the generalised method of moments (GMM) estimators is adopted in place of Pooled OLS, FE and RE. The GMM was introduced by Holtz-Eakin, Newey, and Rosen (1988), and Arellano and Bond (1991) to sort out the issues of specification and endogeneity errors in panel data which lack capacity to be addressed by the OLS process. Hence, according to Blundell and Bond (1998), Arellano and Bover (1995) and Arellano and Bond (1991), the study utilises and adopts the dynamic panel GMM estimator, which develops a matrix of internal instruments to succeed in representing the endogeneity of the dependent variable that is being lagged as well as the independent variables of this thesis. The GMM method is adopted in place of OLS and the generic model estimated is specified in equation 4.31

$$Y_{it} = \alpha Y_{it-1} + \beta X_{i\,t-1} + \mu_i + \varepsilon_{it} \quad \text{.....4.12}$$

Where:

Y = stock market development proxies {proxied by, number of listed firms (NLC); stock market capitalisation (SMC); Stock market value of shares traded (SMTV); Stock market turnover ratio (SMTR) and stock market development index (FINDEX)}.

X = a vector of explanatory variables (other than lagged stock market development)

μ = an unobserved country-specific effect,

ε = the error term,

and the subscripts i and t represent country and time period, respectively.

Taking the first difference of equation 4.31 can be parameterised as follows:

$$\Delta Y_{it} = (\alpha\text{-}1)\,\Delta Y_{it-1} + \beta \Delta X_{i\,t-1} + \Delta\varepsilon_{it} \quad \text{.....4.13}$$

Bond, Hoeffler and Temple (2001) argued that the difference estimator GMM eliminates unobserved time-invariant country-specific properties. Notwithstanding, the difference GMM estimator has potential problems of a possibility of individual specific heteroscedasticity, autocorrelation and omitted variable biasness in the model. The differenced error term in equation 4.32 ($\Delta\varepsilon_{it}$) becomes correlated to ΔY_{it} since the error

term (ε_{it}) is now included in both variables. As explained earlier, the estimates of equation 4.32 using either OLS or FE will be inconsistent and biased as the model is dynamic.

In keeping with Seven and Coskun (2016) and Levine, Loayza and Beck, (2000), the model has its foundation on first differencing of the data of which the model still held back the issue of correlation between the error term and the dependent variable lagged. Also, as α nears unit the estimates are meaningless. This corroborates the view of Batuo, Mlambo and Asongu (2018), Jeanneney and Kpodar (2011) and Levine et al. (2000). As such, to sort out the issues, a dynamic panel data model is utilised for this thesis. In order to develop a consistent and efficient estimate on the effect of ICT adoption on stock market performance, the GMM model is utilised (Blundell and Bond, 1998; Arellano and Bover, 1995).

Hence, the basic model specification under the umbrella of GMM is specified in equation 4.32.

$Y_{it} = \alpha Y_{it-1} + \beta X_{i\,t-1} + \mu_i + \varepsilon_{it}$ 4.14

Where Y_{it} is the dependent variable (i.e. stock market development indices) of country i for time t. Y_{it-1} is the lag of the dependent variable, X is a vector of the explanatory variables whilst μ_i captures the invariant country specific effect.

The general system GMM equation in 4.14 is therefore parameterised as follows

$SMTV_{i\,t} = \alpha \text{SMTV}_{it-1} + \alpha_1 NBU_{i\,t} + \alpha_2 NMU_{i\,t} + \alpha_3 IU_{i\,t} + \alpha_4 NFTU_{i\,t} + \alpha_5 FFI_{i\,t} + \alpha_6 GDP_{i\,t} + \mu_i + \varepsilon_{it}$ 4.15

$SMC_{i\,t} = \theta_0 SMC_{\text{it}-1} + \theta_1 NBU_{i\,t} + \theta_2 NMU_{i\,t} + \theta_3 IU_{i\,t} + \theta_4 NFTU_{i\,t} + \theta_5 FFI_{i\,t} + \theta_6 GDP_{i\,t} + \mu_i + \varepsilon_{it}$.....4.16

$SMTR_{i\,t} = \gamma_0 \text{SMTR}_{\text{it}-1} + \gamma_1 NBU_{i\,t} + \gamma_2 NMU_{i\,t} + \gamma_3 IUs_{i\,t} + \gamma_4 NFTU_{i\,t} + + \gamma_5 FFI_{i\,t} + \gamma_6 GDP_{i\,t} + \mu_i + \varepsilon_{it}$.. .....4.17

$$NLC_{i\,t} = \beta_0 \mathrm{NLC}_{\mathrm{it}-1} + \beta_1 NBUs_{i\,t} + \beta_2 NMU_{i\,t} + \beta_3 IU_{i\,t} + U + \beta_5 FFI_{i\,t} + \beta_6 GDP_{i\,t} + \mu_i + \varepsilon_{it} \quad \text{.....4.18}$$

$$FINDEX_{i\,t} = \varphi_0 + \varphi_1 NBU_{i\,t} + \varphi_2 NMU_{i\,t} + \varphi_3 IU_{i\,t} + \varphi_4 NFTU_{i\,t} + \varphi_5 FFI_{i\,t} + \varphi_6 GDP_{i\,t} + \mu_{i\,t} \quad \text{.....4.19}$$

Where

NBU = Number of Broadband Users

NMPU = Number of Mobile phones Users

IU = Number of Internet Users

NFTU = Number of Fixed Telephone Users

SMTV = Stock market total value traded as a % of GDP, that is $\frac{Total\ Value\ Traded}{GDP}$ %

SMC = Stock Market Capitalisation to % of GDP, that is $\frac{Market\ Capitalisation}{GDP}$ %

SMTR = Stock Market Turnover Ratio in (%),

NLC = Number of listed companies per 10,000 people

FFI = Financal Freedom Index

FINDEX = Stock Market Development Index

GDP = Gross Domestic Product

α_0, θ_0,γ_0, φ_0 and β_0 = Each model Models intercepts respectively

α_i, θ_i, γ_i, φ_i and β_i where i= 1, 2, 3 4 and 5 represent the coefficient of the model exlantory variables, while the time invariant country specific effects are captured by μ_i whilst ε_{it} the error term.

4.4 Data and definition of variables

This study focused on the impact of ICT adoption and stock market development in Africa. As such, the area of study is on the continent of Africa. Andrews, Higgins, Andrews and Lalor (2012) considered secondary data as archival data (namely, existing information) and this formed the basis for this thesis. The justification for the secondary data was as a result of the financial restrictions as the data is affirmed economical as well as inexpensive (Saunders et al., 2012). Annual panel data was adopted for analysis of this thesis. The stock market data utilised for this study were secondary data extracted from World Bank Global Financial Development database

for the selected African stock exchanges which are the Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) and Stock Exchange of Mauritius (SEM). While the ICT adoption variables data was sourced from the International Telecommunication Union database, the control variables data, which are Financial Freedom index (FFi), was sourced from Heritage Foundation database and Gross Domestic Product (GDP) was extracted from World Bank Global Financial Development database.

Table 4. 1 : Data and Sources

Table showing Data and Sources		
ICT Adoption Variables	**Abbreviation**	**Data Source**
Number of Broadband Users	NBU	International Telecommunication Union database
Number of Fix Telephone Users	NFTU	International Telecommunication Union database
Internet Users	IU	International Telecommunication Union database
Number of Mobilephone Users	NMU	International Telecommunication Union database
Stock Market development Variables		
Stock Market Total Value Traded to GDP (%)	SMTV	World Bank Global Financial Development database
Stock Market Capitalisation to GDP (%)	SMC	World Bank Global Financial Development database
Stock Market Turnover Ratio (%)	SMTR	World Bank Global Financial Development database
Number of Listed Companies per 10,000 persons	NLC	World Bank Global Financial Development database
Control Variables		
Financial Freedom Index	FFI	Heritage Foundation database
Gross Domestic Product	GDP	World Bank Global Financial Development database

The study centres on certain emerging economies in Africa and predominantly on data availability for the preferred nations. With regard to Im, Pesaran and Shin (2003), panel study encompassed time (T) and the cross-section measurement (N). It is documented that a variable y_{it} is recognised for cross-section units i = 1… N and the time i.e. t = 1…T. The panel data employed ranged from 2008 to 2017. The T was unambiguously preferred as a result of the data availability on stock market development. In accordance with the issues documented in the extant review of literature, African stock markets are at different stages of development despite the rising importance of ICT and the way it is changing the human perspective and the world in general. Theorem are limited empirical works on the impact of ICT adoption on the development of stock market in Africa (see: Okwu, 2015; 2016 and Bhunia, 2011).

The variables employed in this study are described in this section. These are the dependent variables, the independent variables as well as the control variables. These are described in turn, ICT adoption variables which are; Number of Broadband Users (NBU), Number of Fixed Telephone Users (NFTU), Internet Users (IU) and Number of Mobilephone Users (NMU) serve as the independent variables. While Stock market total value traded to GDP (%) (SMTV), Stock market capitalisation to GDP (%) (SMC), Stock Market Turnover ratio (value traded/capitalisation) (%) (SMTR) and Number of Listed Companies per 10,000 persons (NLC) of the African stock markets serve as the dependent variables. Then the control variables data, which are Financial Freedom index (FFI), and Gross Domestic Product (GDP).

4.4.1 Dependent variables

The following proxies of stock market development constitute the dependent variables employed in this study namely; Stock Market Total Value Traded to GDP (%) (SMTV), Stock market capitalisation to GDP (%) (SMC), Stock Market Turnover ratio (value traded/capitalisation) (%) (SMTR) and Number of Listed Companies per 10,000 (NLC). A composite Stock Market Development Index (FINDEX) and ICT adoption index (ICTDEX) were created comprising all of these proxies in weights as dictated by the principal component analysis. These variables are now discussed below.

4.4.1.1 Stock Market Capitalisation to GDP

Stock Market capitalisation to GDP, usually termed as market-cap, is the market estimation of an open market traded organisation's extraordinary offers as percentage of GDP. Also, organisation size matters in investing. Typical way of thinking holds that small-cap stocks beat large-cap stocks over broadened time frames. However, the market favours distinctive firm size at various occasions, bringing about a revolution of market-cap in/out of favour. More so, Barberis and Shleifer (2003) argued that the outperformance of small-cap stocks in the seventies (70s) and mid-eighties (80s) triggered stakeholders and assets to small-cap stocks, moving their profits higher. However, in 1983 these profits were turned around.

Jensen, Johnson, and Mercer (1998) discovered that the small-cap premium is very huge during extensive approach periods and practically non-existent in prohibitive periods. In addition, Gompers and Metrick (2001) reported that in the 1990s, institutional holding of huge capital stocks expanded quickly. This huge capitalisation favour caused the underperformance of small stocks in certain periods. As a rule, the changes in profits on small-caps and large capitalisation contribute to more investment opportunities: purchasing out-performing market capitalisations as well as short-selling failing to meet expectations of market capitalisations.

Stock Market Capitalisation to GDP as a percentage can be calculated as follows:

$$SMC = \frac{SMC}{GDP} \times 100 \quad \text{.....4.20}$$

Where:

SMC = stock market capitalisation

GDP = Gross Domestic Product

4.4.1.2 Stock Market Total Value Traded

The stock market total value traded to GDP is the total monetary value of shares traded on the stock exchange at a particular period, as a percentage of gross domestic product of the country where the stock exchange is domiciled, that is the value of shares that are mostly transacted via stock-exchanges globally. However, the thesis is examining the traded shares in Africa and it is affirmed that there are numerous exchanges in Africa. Moreover, shares as a phenomenon are often traded on different

share markets as well as indices to some degree, permitting shareholders that enter into what is acknowledged as less-mainstream securities business.

Stock Market Total Value Traded to GDP as a percentage can be calculated as follows:

$$SMTV = \frac{SMTV}{GDP} \times 100 \quad \text{.....4.21}$$

Where:

SMTV = stock market total value traded

GDP = gross domestic product

4.4.1.3 Stock Market Turnover Ratio

Share turnover ratio is an indication of how easy or difficult it is to sell a specific share on a stock exchange (Okwu, 2015). This compares the total number of shares sold and exchanged in a period with the total number of listed shares. It is also an indication of how liquid a particular share is, in the stock market. A higher ratio is an indication that the share can be bought or sold easily and a lower ratio indicates that the share is illiquid, which also means that the share is less likely traded. It is also an indication of how concentrated a particular share is; if a share is highly concentrated in the hands of few shareholders, the share is more likely to be illiquid and if widely held by many shareholders, a share is more likely to be widely traded.

Stock Market Turnover Ratio (SMTR) as a percentage can be calculated as follows:

$$SMTR = \frac{TVST}{MCT} \times 100 \quad \text{.....4.22}$$

Where:

TVST = total value of shares sold at a period

MCT = market capitalisation at a period

4.4.1.4 Number of Listed companies

This is quoted companies under the following countries' stock exchange: Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi

Securities Exchange (NSE), Namibia Stock Exchange (NSX), Nigerian Stock Exchange (NSE) and Stock Exchange of Mauritius (SEM).

4.4.1.5 Stock Market Development Index

The Stock Market Development Index (FINDEX) was created using Principal component analysis (PCA). PCA is done by computing the Eigen values of the variance matrix of the variable. Adnan (2011) suggested that PCA transforms data into new variables which are not correlated; while the highest variation of the original variables is contained in the first few principal components (Jolliffe, 2002). Variables of interest are summarised by a number of mutually independent principal components, of which each principal is the weighted average of the underlying variables (Adnan, 2011). The advantage of applying PCA to construct the composite indices was that the index weights were based on the correlation of the individual measures of stock market development (smtv, smc, smtr and nlc,). As such, the first principal component for a set of variables is the unit length linear combination of those variables and always contains the maximum variance for any combination. If more than one principal component is generated for the variables, then they are uncorrelated.

According to Johnson and Wichtern (1992) and Huang (2005), after the first principal variable, all subsequent principal variables maximise the variance between the unit length linear combination and are statically independent to the prior variables and captures different aspects of the data under consideration. Therefore, in line with the literature and for the purposes of this study, the first principal components are adopted as an aggregate measure of stock market development.

4.4.2 Independent Variables

The following variables constituted the independent variables employed in this study, namely; number of broadband user (NBU), number of mobile phones subscriptions (NMPS), number of internet users (NIUs), number of fixed telephone subscription (NFTS) and the composite ICT index (ICTDEX). We consider these in turn.

4.4.2.1 Number of Mobile Phones Subscriptions

A NMPS is the public mobile telecommunication systems usage (often termed mobiles or cellphones) by means of cellular technology which offers the public-switched telephone network access via cellular technology. Moreover, cellular technology encompasses subscriptions of prepaid and post-paid in addition to digital as well as analogue cellular systems, which are connected to a telecommunication network. When conducting telecom survey on telecommunications services, active pre-paid cards are treated as an individual who possibly has more than one subscription to the network.

4.4.2.2 Number of Internet Users

The continued development of the personal computer has given people the opportunity to conduct financial transactions from their homes, or indeed from any location where they can connect their portable computers to telephone networks. In keeping with Lipis, Marschall, and Linker (1985), through the use of special software and a modem, people can connect to the system used by their bank to examine accounts, issue orders to transfer funds among customer account, issue order to transfer to the accounts of other parties (e.g. to pay bills) and apply for loans.

4.4.2.3 Number of Broadband Users

LTE subscriptions rate improved by 200,000,000 (mil.) in the Q3 to reach (3.3 billion). It was remarkable that the net-addition for WCDMA/HSPA subscriptions was roughly 60,000,000 (mil.). Also, GSM/EDGE-only subscriptions dropped by 110,000,000 (mil.) in 2018 and other technologies (know-hows) deteriorated by roughly 30,000,000 (mil.). Smartphones subscriptions are currently above 60% of the entire mobile-phone subscribers. Roughly, 360,000,000 (mil.) smartphones were reported to have been traded in the third quarter, totalling 86% of the entire mobile phones purchase.

4.4.2.4 Number of Fixed Telephone Subscription

A fixed telephone line can also be termed as the main telephone line in operation, which is an active line that links the users to the to the public switched telephone

network (PSTN) with their terminal equipment. Fixed telephone subscription is also known as Direct Exchange Line (DEL) which is generally utilised in telecommunication. Hence fixed telephone subscription includes ISDN channels, active number of analogue fixed telephone lines, fixed wireless, VoIP subscriptions and public payphones.

Furthermore, active lines means that users have used their lines to have documented an activity in the past three months. Additionally, the derivation of data on fixed telephone lines includes the administrative data that the regulators of telecommunications in a nation regularly gather for instance, on an annual basis, from operators in the telecoms sector of the country.

4.4.2.5 ICT Index

ICT Index ICTDEX was created using Principal Component Analysis (PCA). PCA is done by computing the Eigen values of the variance matrix of the variable. Adnan (2011) suggested that PCA transforms data into new variables which are not correlated; while the highest variation of the original variables is contained in the first few principal components (Jolliffe, 2002). Variables of interest are summarised by a number of mutually independent principal components, of which each principal is the weighted average of the underlying variables (Adnan, 2011).

The advantage of applying PCA to construct the composite indices was that the index weights were based on the correlation of the individual measures of ICT adoption (nbu, nftu, iu and mnu). As such, the first principal component for a set of variables is the unit length linear combination of those variables and always contains the maximum variance for any combination. If more than one principal component is generated for the variables, then they are uncorrelated.

According to Johnson and Wichtern (1992) and Huang (2005), after the first principal variable, all subsequent principal variables maximise the variance between the unit length linear combination and are statically independent to the prior variables and capture different aspects of the data under consideration. Therefore, in line with the

literature and for the purposes of this study, the first principal components are adopted as an aggregate measure of ICT adoption.

4.4.3 Control variables

This study employed two control variables, namely the Financial Freedom Index (FFI) and Gross Domestic Product (GDP). These variables are described below.

4.4.3.1 Financial Freedom Index

Financial freedom index otherwise known as index of economic freedom looks at the proportion of boundaries against each other in terms of tax burden, trade freedom, judicial effectiveness, government spending, business freedom, labour freedom etc. in which they are weighted in line with their corresponding impact on economic freedom and are put together into a standalone score which makes ranking possible.

4.4.3.2 Gross Domestic Product

Gross Domestic Product (GDP) is the measure to compare how well or badly a country is doing economically; it is also a measure of the size of a country's economy. GDP is said to be the aggregate monetary value of all the goods and services produced in a country on an annual basis (Coyle, 2015). Therefore, GDP is used to show if an economy is growing or declining on a year on year basis. This economic measure is also an indication of the economic health of the country at a specific period.

Table 4.2 summarises the variables that are employed in this study. It also lists examples of studies that employed these variables as proxies.

Table 4. 2 : Summary of Variables

Variable Name	Empirical Studies	Apriori Expectation
NFTS = Number of Fixed Telephone Subscription per	Forenacher et al., (2019); Okwu (2015); Ezirim, e tel., (2009);	Increase in number of Fixed telephone Subscription leads to Increase in ICT development
NBU = Number of Broadband Users	Czernich, et al., (2011)	Broadband users increments leads to ICT development
IU = Number of Internet Users	Ejemeyovwi et al. (2019); Okwu (2015); Ezirim, et al., (2009); Baliamoune (2002); Zagorchev, et al. (2011)	The apriori expectations of study from theory state that Internet usage (with technical knowledge) should have a significant positive impact on human development in West Africa
NMU = Number of Mobile Phones Users	Ejemeyovwi, (2017); Okwu (2015); Ezirim, e tel., (2009); Baliamoune (2002); Zagorchev, et al. (2011)	apriori expectation here states that its coefficient has a positive sign. Meaning that, an increase in number of mobile cell phone users should bring about an increase in human development, hence, 2 > 0.
SMTR = Stock Market Turnover Ratio in percentage	Adiqwe et al., (2015); Allen, Otchere and Senbet (2011); Mahonye and Ojah (2014); Makoni (2016); Soumaré and Tchana (2015)	An increase in SMTR should bring about increase in GDP
SMC = Stock Market Capitalisation as a percentage of GDP	Adiqwe et al., (2015); Makoni (2016); Ojah and Kodongo (2014); Soumaré and Tchana (2015),	An increase in MCap should bring about increase in GDP
NLC = Number of Listed Companies	Ombugu (2016); Ezirim, et al. (2009)	An increase in Listed companies significantly influences

per 10,000 people		economic development.
SMTV = Stock Market Total Value Traded as a percentage of GDP	Adiqwe et al. (2015); Ezirim, et al. (2009)	An increase in Number of shares traded should bring about increase in GDP
Control Variable: FFI = Financial Freedom Index	Gorlach and Roux (2013)	apriori expectations stated in the literature review that freer and more open economies experience higher growth rates
GDP = Gross Domestic Product	Adu et al., (2013); Zagorchev, et al. (2011)	Personal computers and GDP per capita increase the liquidity, size and activity of financial systems. The Internet and GDP per capita improve the liquidity, size, stock trading and activity of financial markets.
FINDEX = Stock Market Development Index	Makoni (2016);	The composite FMD index has a positive and highly significant effect on both FDI and FPI inflows to the selected African countries.
ICTDEX = ICT Adoption Index		

4.5 Estimation Techniques

To analyse the data collected, Stock market performance variables such as the number of firms, the market capitalisation, and the number of shares traded as well as the turnover ratios of the African stock markets have to be considered.

For the descriptive statistics, the thesis utilises descriptive analysis which centres on descriptive statistics to explain the variables characteristics using measures of central tendency, namely; maximum, minimum, median, mean and standard deviation, as well as tests for normality namely; kurtosis, skewness, and Jarque-Bera. The mean, median, maximum and minimum value give hints on how the variables are significantly spread. The standard deviation indicates the scattering of variables with respect to their corresponding mean value. In addition, skewness indicates if the variables are symmetrical or otherwise. On the other hand, the probability and statistics of Jarque-Bera indicate if the variables are normally distributed or not.

Furthermore, the correlation matrix indicates the strength of association between the variables. Majorly, the correlation matrix helps detect the existence of multi-collinearity among the variables and more specifically the nature and kind of the multi-collinearity. The existence of multi-collinearity among variables understudy is confirmed when the r-value is 0.800 and above, while it is not confirmed when the r-value is less than 0.800 Marczyk DeMatteo, and Festinger, (2005) pointed out that the correlation analysis reveals only the extent of association among study constraints. As such, it does not allow for research to give causal draw point pertaining to the type of the association between the constraints. Hence, and due to the nature of data for the study, Panel Data Regression (PDR) analysis was used to test the hypothesis and as well as elucidate the association between ICT adoption and the development of Africa stock market performance by controlling the influence of dependent variables. The PDR model was adopted due to the fact that it allows for or gives room for more comprehensive data, improve variability, limit the existence of collinearity among the determinants, and also gives room for the improvement of the efficiency of the determinants.

4.5.1 Model Specifications

This study adopted and modified the model of Okwu (2015), on ICT adoption and stock markets, that is the independent variables, which is the subset (division) of ICT network as acknowledged by Perin and Poullot (2013). The following general empirical research model was developed in the form of Panel data regression equation:

$$\text{SMTV}_{it} = \alpha_0 + \alpha_1 NBU_{it} + \alpha_2 NMU_{it} + \alpha_3 IUs_{it} + \alpha_4 NFTU_{it} + \alpha_5 FFI_{it} + \alpha_6 GDP_{it} + \mu_{it} \quad \text{.....4.23}$$

$$SMC_{it} = \theta_0 + \theta_1 NBU_{it} + \theta_2 NMU_{it} + \theta_3 IU_{it} + \theta_4 NFTU_{it} + \theta_5 FFI_{it} + \theta_6 GDP_{it} + \mu_{it} \quad \text{.....4.24}$$

$$SMTR_{it} = \gamma_0 + \gamma_1 NBU_{it} + \gamma_2 NMU_{it} + \gamma_3 IU_{it} + \gamma_4 NFTU_{it} + \gamma_5 FFI_{it} + \gamma_6 GDP_{it} + \mu_{it} \quad \text{.....4.25}$$

$$NLC_{it} = \beta_0 + \beta_1 NBU_{it} + \beta_2 NMU_{it} + \beta_3 IU_{it} + \beta_4 NFTU_{it} + \beta_5 FFI_{it} + \beta_6 GDP_{it} + \mu_{it} \quad \text{.....4.26}$$

$$FINDEX_{it} = \varphi_0 + \varphi_1 NBU_{it} + \varphi_2 NMU_{it} + \varphi_3 IU_{it} + \varphi_4 NFTU_{it} + \varphi_5 FFI_{it} + \varphi_6 GDP_{it} + \mu_{it} \quad \text{.....4.27}$$

Where :

NBU = Number of Broadband user

NMU = Number of Mobile phones Users

IU = Number of Internet Users

NFTU = Number of Fixed Telephone Users

SMTV = Stock market total value traded as a % of GDP, that is $\frac{Total\ Value\ Traded}{GDP}\%$

SMC = Stock Market Capitalisation as a % of GDP, that is $\frac{Market\ Capitalisation}{GDP}\%$

SMTR = Stock Market Turnover Ratio in (%),

NLC = Number of Listed Companies per 10,000 people

FFI = Financial Freedom Index

FINDEX = Stock Market Development Index

GDP = Gross Domestic Product

α_0, θ_0, γ_0, φ_0 and β_0 = Each model Models intercepts respectively

α_i, θ_i, γ_i , φ_0 and β_i where i= 1, 2, 3 4. 5 represent the coefficient of the model explanatory variables.

The equation 4.13 – 4.16 specified above lays an issue when adopting the ordinary least squares (OLS) method. Notwithstanding, according Gujarati and Porter, (2009) and Judson and Owen (1999), adopting the static panel estimation method such as the pooled OLS, fixed effects and random effects models in estimating the equation 4.13 – 4.16 also has the tendency of incurring biased estimates. The error term and the lagged dependent variable tend to have correlation issues, thereby obtaining spurios results as a result of the presence of autocorrelation. Thus, the problems of measurement errors, endogeneity, and specification bias remain in equation 4.13 – 4.16 of it is estimated using (Pooled OLS, FE and RE) estimation techniques. To mitigate these problems the system GMM was adopted.

4.5.2 Principal Components Analysis

Principal component analysis (PCA) is a commonly applied method to reduce the attributes of a data set, where variables have different meanings when applied in a certain way. PCA absolutely reduces a squared loss function, which may be inappropriate for data that is not real-valued, such as binary-valued data (Collins, Dasgupta & Schapire, 2001). This method was applied to help generate a single composite index of stock market development, as well as ICT adoption for the selected eleven African stock exchanges.

This was essential because there has been no unanimity in literature on a single most appropriate variable to measure stock market development or ICT adoption. The objective of using principal component analysis (PCA) in this study was to develop uni-dimensional measures of stock market development, based on the identified stock market variables, as well as for ICT adoption variables. It is also necessary because using the individual variables independently may not have captured and revealed the status of stock market development or ICT adoption precisely and sufficiently for the African countries selected for this study (see Sahoo, Dash and Nataraj, 2010; Love and Zicchino, 2006; Demirguc-Kunt and Levine, 1996). The PCA indices for stock market development (FINDEX) and ICT adoption (ICTDEX) were applied in the

regressions for FINDEX and ICTDEX from determining variables, precisely across to Granger-causality tests.

The FINDEX and ICTDEX were created using Principal component analysis (PCA). PCA is done by computing the Eigen values of the variance matrix of the variable. Adnan (2011) suggested that PCA transforms data into new variables which are not correlated; while the highest variation of the original variables is contained in the first few principal components (Jolliffe, 2002). Variables of interest are summarised by a number of mutually independent principal components, of which each principal is the weighted average of the underlying variables (Adnan, 2011). The advantage of applying PCA to construct the composite indices was that the index weights were based on the correlation of the individual measures of stock market development (smtv, smc, smtr and nlc,), as well as ICT adoption (nbu, nftu, iu and mnu). As such, the first principal component for a set of variables is the unit length linear combination of those variables and always contains the maximum variance for any combination. If more than one principal component is generated for the variables, then they are uncorrelated.

According to Johnson and Wichtern (1992) and Huang (2005), after the first principal variable, all subsequent principal variables maximise the variance between the unit length linear combination and are statically independent to the prior variables and capture different aspects of the data under consideration. Therefore, in line with the literature and for the purposes of this study, the first principal components are adopted as an aggregate measure of stock market development and ICT adoption.

This study used PCA to determine appropriate composite indices for stock market development and ICT adoption in selected African countries using the following equation:

$$\beta\varrho = \varpi\varrho 1 \times 1 + \varpi\varrho 2 \times 2 + \varpi\varrho 3 \times 3 + \cdots + \varpi\varrho\gamma \times \gamma \quad \text{.....4.28}$$

Where,

$\beta\varrho$ = estimate of the jth factor

$\varpi\varrho$ = weight on factor score coefficient

ϱ = variable of interest

γ = number of variables.

The specific equations and index values for stock market development and ICT adoption are defined and discussed in Chapter 5.

4.5.3 Cointegration

The Cointegration is ascertained between variables if a long run equilibrium relationship between the variables exists (Awe, 2012). The study as such noted that there exists cointegration between the variables and proceeded to perform the vector error correction between stock market index, ICT index, financial freedom index and GDP.

In examining the cointegration relationship between stock market index, ICT index, financial freedom index and GDP, the pooled mean group estimator in a panel ARDL procedure was most suitable. The ARDL technique has an advantage, because it does not necessarily need the construct to be in the same order of integration. However, for harmonious uniformity of the estimates, the constructs are not to be of higher order than the first order of integration I (1). Additionally, the Error Correction Term (ECT) is drawn out from the panel ARDL estimation to examine the short run characteristics of the relationship between stock market index, ICT index, financial freedom index and GDP.

Furthermore, the insignificance/significance of the short run, long run and the error correction coefficients of panel ARDL explain the causal effects between stock market index, ICT index, financial freedom index and GDP. As per the view of Attiaoui, Toumi, Ammouri, and Gargouri, (2017), the panel ARDL can be categorised as the error correction model as it can identify the short run and long run relationships.

In order to check for cointegration, various tests such as the residual-based Dickey-Fuller and augmented Dickey-Fuller tests (Kao tests) [also known as the Engle-Granger (EG) and augmented Engle-Granger (AEG) tests], residual-based LM test, Pedroni tests and Likelihood-based (LR) panel test of cointegrating rank in

heterogeneous panel models can be used (Baltagi, 2008). However, according to Pesaran, Shin and Smith (2001), all these methods are applied in cases where the underlying variables are integrated of order one [I(1)]; thereby involving pre-testing, and hence introduces a further degree of uncertainty into the analysis of levels relationships.

For the purposes of this study, we decided to apply the autoregressive distributed lag (ARDL) bounds testing approach to cointegration, a method developed by Pesaran, Shin and Smith (2001). This was because the sample size was only approximately 10 years, and therefore not long enough to apply other techniques such as Engle-Granger (1987) residual-based cointegration test and the maximum likelihood test based on Johansen and Juselius (1990) methods (Alhassan & Biekpe, 2016: Frimpong & Oteng-Abayie, 2006; Mah, 2000).

The nominated ARDL methodology, which is based on the estimation of an unrestricted error correction model (ECM), has several advantages over other cointegration tests. The ECM is simple and straightforward in its application compared to the more complex vector error correction model (VECM). The ECM uses both lagged (to estimate the long run model) and differenced (used to estimate the short run model) variables. On the other hand, the VECM assumes that all variables in the model are endogenous, uses vector auto regression (VAR), and is applicable in situations where there is more than one cointegrating relationship in the model.

In an ECM, any type of cointegration relationship is accommodated and the nature of cointegration relationship determines the restrictions that one needs to place in the model. According to Odhiambo (2014), the ECM Bounds Test using autoregressive distributed lags (ARDL), assumes only one cointegration relationship in the model, and is only applied when regressors are either integrated in the I(0) or I(1). However, an important condition is that none of the variables is integrated I(2). Pattichis (1999) argued that the ARDL model has better statistical properties since it does not push short-run dynamics into the residual term as in the Engle-Granger (1987) technique. According to Persan and Shin (1999), the ARDL method employs a single reduced-form equation set-up, making it easy to implement and interpret. Finally, the ARDL Bounds Testing method has the added advantage of an estimation being possible even when the explanatory variables are endogenous (through simultaneity bias or bi-

directional causality) and is sufficient to simultaneously correct for residual serial correlation (Ziramba, 2008).

The study as such noted that there exists cointegration between the variables and proceeded to perform the vector error correction between stock market index, ICT index, financial freedom index and GDP. In order to investigate the relationships between stock market index, ICT index, financial freedom index and GDP, the models below were specified and estimated using the ARDL Bounds testing approach, consisting of estimating an unrestricted error correction model (ECM) as follows:

$$\Delta \mathrm{F}INDEX_{\mathrm{it}} = a_0 + a_1 FINDEX_{\mathrm{it\_1}} + a_2 ICTDEX_{\mathrm{it\_1}} + a_3 FFI_{\mathrm{it\_1}} + a_4 GDP_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{1i} \Delta \mathrm{F}INDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{2i} \Delta \mathrm{I}CTDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{3i} \Delta \mathrm{F}FI_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{4i} \Delta \mathrm{G}DP_{\mathrm{it\_1}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.29$$

$$\Delta \mathrm{I}CTDEX_{\mathrm{it}} = a_0 + a_1 ICTDEX_{\mathrm{it\_1}} + a_2 FINDEX_{\mathrm{it\_1}} + a_3 FFI_{\mathrm{it\_1}} + a_4 GDP_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{1i} \Delta \mathrm{I}CTDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{2i} \Delta \mathrm{F}INDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{3i} \Delta \mathrm{F}FI_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{4i} \Delta \mathrm{G}DP_{\mathrm{it\_1}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.30$$

$$\Delta \mathrm{F}FI_{\mathrm{it}} = a_0 + a_1 FFI_{\mathrm{it\_1}} + a_2 FINDEX_{\mathrm{it\_1}} + a_3 ICTDEX_{\mathrm{it\_1}} + a_4 GDP_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{1i} \Delta \mathrm{F}FI_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{2i} \Delta \mathrm{F}INDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{3i} \Delta \mathrm{I}CTDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{4i} \Delta \mathrm{G}DP_{\mathrm{it\_1}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.31$$

$$\Delta \mathrm{G}DP_{\mathrm{it}} = a_0 + a_1 GDP_{\mathrm{it\_1}} + a_2 FINDEX_{\mathrm{it\_1}} + a_3 ICTDEX_{\mathrm{it\_1}} + a_4 FFI_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{1i} \Delta \mathrm{G}DP_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{2i} \Delta \mathrm{F}INDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{3i} \Delta \mathrm{I}CTDEX_{\mathrm{it\_1}} + \sum_{i=0}^{\infty} a_{4i} \Delta \mathrm{F}FI_{\mathrm{it\_1}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.32$$

Where, Δ represents the first difference operator and other variables are consistent as described above. Although it has already been noted that it was not important to test for stationarity in the ARDL framework, the study used the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP) and Im, Pesaran and Shin (IPS) unit root tests to check for stationarity and whether the variables were not integrated of order two [I(2)].

4.5.4 Granger causality

Causality means the ability of a variable to be able to predict or forecast the other. Granger causality in the case of two time series variables say P and Q, variable P is said to granger-cause variable Q, if P can be better predicted using the histories of both P and Q than it can, using the histories of Q alone. To show the direction of causality in the presence of cointegrated vectors, Granger causality for a panel data mode is modelled by fitting a Vector Autoregressive (VAR) model as:

$$\Delta FINDEX_{it} = \alpha_o + \delta_{1it} + \lambda_1 e_{it-j} + \Phi_1 \Delta FINDEX_{it-j} + \beta_1 \Delta ICTDEX_{it-j} + \Delta FFI_{it-j} + \xi_{it} \quad \text{.....4.33}$$

$$\Delta ICTDEX_{it} = \alpha_o + \delta_{2it} + \lambda_2 e_{it-j} + \Phi_2 \Delta ICTDEX_{it-j} + \beta_2 \Delta FINDEX_{it-j} + \Delta FFI_{it-j} + \xi_{it} \quad \text{.....4.34}$$

Where ΔY_{it} and ΔX_{it} are the non-stationary series, e_{it-i} is the error correction term, it and it-j show current and lagged values. The error correction terms are included in the model since they are cointegrated.

To now examine if the independent variable Granger-cause the dependent variable, thus, P Granger-cause Q, we test the following hypotheses with the null hypothesis stating that, the independent variable (P) does not Granger-cause the dependent variable (Q). Also, to find if the independent variable (Q) in the second equation Granger-cause the dependent variable (P), we test the hypothesis with the null hypothesis stating that the independent variable (Q) does not Granger-cause the dependent variable (P).

4.6 Diagnostics Tests

Dickey and Fuller (1981) posited that the primary issue with time series data is the issue of non-stationarity. According to, Box, Jenkins, Reinsel, and Ljung, (2016), time series data have to attain stationarity and as well the data meeting the statistical property of time independent. In as much as the properties and the variables of the time series are of concern to the researcher, the statistical properties of time-series estimators are crucially dependent on the nonstationary or stationary form of the data (Hsiao, 2014; Banerjee, 1999). Thus, prior to analysis using cointegration techniques, it is germane to assess the order of integration of the variables.

The test of unit root assesses the integration order of the variables. In the sense that one can encounter a spurious regression, in which the statistical evidence indicates a relationship between variables but not causally related, like in a situation where the F-statistics cannot be strictly make sense of if the variables are of a higher order of integration (Pesaran et al., 2001). This study utilises the panel test of unit root which emanates from the time series test of unit root. In line with Im, Pesarah and Shin (2003), the panel test of unit root does not have the same traits with the single time series unit roots test. This is due to the fact that panel unit root takes into consideration the dimension of the time series asymptotic behaviour (T) and as well as the dimension of the cross-section (N), in contrast to the single time series roots test which only takes into consideration the time dimension only. To satisfy the rule of the presence of cointegrating relationship, Rousseau and Wachtel (1998) posited that the data series must exist in non-stationary form. As such, the panel test of unit roots are carried out in order to check for the stationarity of the series.

In addition, Baltagi (2008) and Hsiao (2014), asserted that the single test of unit root lack capacity in panel data sets and this is complicated when the panel data set appear to be in small samples. In line with most studies (examples: Moon and Perron, 2004; Bai and Ng, 2004, Pesaran, 2007; Hadri, 2000; Breitung and Das, 2005; Choi, 2001; Levin, Lin and Chu, 2002; Im, Pesaran and Shin, 2003), it is suggested that there is no particular panel unit root test method that appears to be most superior among other types. Since majority of the test originated on the panel unit root test were based on the enhancement to the hypothesis on cross section independence, for this study,

Levin, Lin and Chu (2000), that is LLC test and Im, Pesaran and Shin (IPS) test panel unit root tests were adopted.

Levine, Loayza and Beck (2000) asserted that there is confined capacity in single unit root test in contrast to the alternative hypothesis and they power in individual unit root tests against the alternative hypotheses and they are inclined to possess unrelenting difference from the equilibrium which is even more complicated in smaller samples. In Levine, Lin, Chu (LLC) test it is hypothesised that every single series possesses a unit root against an alternative of that each time series is stationary as follows:

H_a = each time series is stationary

H_0 = each time series contains a unit root

Levin, Lin and Chu (2000) reasoned that the the Augmented Dickey Fuller (ADF) unit root test as the initial point of the unit root testing procedure (Barnejee, 1999; Levine et al., 2000) be ujtilised. It hypothesised that the following model;

$$\Delta y_{it} = \rho y_{i,\, t-1} + \sum_{L=i}^{p_i} \theta_{i\,L}\, \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.35$$

Where m =1, 2, 3

with d_{mt} implying the vector of deterministic variables whilst α_{mi} are the corresponding vector of coefficients for model m = 1, 2, 3.

According to Baltagi (2008) and Levin et al. (2002), the order of the lag order permitted to vary across individual auxiliary regressions are run on equation 4.2 in order to have the error terms which are then standardised. Notwithstanding, Barnejee (2009) and Baltagi (2008) posited that the test has limited capacity in smaller samples and it assumes cross section independence, thus the Im, Pesaran and Shin that is IPS test is also utilised in this study for robustness.

The extended LLC test was carried out by Im et al. (2003) and it permitted for heterogeneity of the roots across the units. The null hypothesis is that the individual unit root follows a unit root process against the alternative that allows for some but not

all to have a unit root process. The IPS is considered to be an improvement of LLC in the cases where smaller sample sizes are involved.

4.7 Ethical Consideration

In line with the essence of ethics in carrying out research as well as the issues pertaining to the research process itself, Silverman (2009) posited that institutions tend to go the major distance in protecting the quality of being worthy of esteem of the research participant and ensuring their safety. In this thesis, the researcher guaranteed conservative steps in seeing to it that this thesis abides by ethical research standards. Before the process of collection of data, the researcher applied for ethical clearance from the Departmental Ethics Review committee. An ethical clearance certificate which can be found in the appendices was subsequently issued. The researcher also saw to it that he registered online on African exchanges securities, and this process granted him access to relevant materials and data through downloads.

4.8 Chapter Summary

This chapter is distinct from the others, as it carefully laid out a detailed description of the research design and paradigms, based on the objectives of the thesis. In addition, it carefully outlined the following in sections: data analysis and definition of variables, population and sampling, data collection source, data reliability and validity, variable descriptions, method of data analysis, framework/model of the study, ethical consideration, expectations, and model specifications of the methodology.

The next chapter will discuss the empirical findings to the econometric analysis done for this research. This commences with an introduction, where the key hypothesis and questions are outlined and discussed. The next sections depict the outcomes of all the data analyses performed in order to answer the key question of this research, which is if ICT adoption has an impact on stock market development in Africa.

CHAPTER 5
EMPIRICAL RESULTS OF THE IMPACT OF ICT ADOPTION ON STOCK MARKET DEVELOPMENT

5.0 INTRODUCTION

This chapter laid out the empirical outcomes of hypotheses developed in this thesis concerning the impact of ICT adoption on stock market development in Africa. Primarily, there were three main research questions being tested in this research effort. First, to establish what is the impact of ICT adoption on stock market development in Africa. Secondly, to ascertain what cointergrating relationships exist between ICT adoption and stock market development in Africa. Thirdly, to establish if there was any causuality between ICT adoption and stock market development in Africa.

In conducting the analysis for this thesis, the econometric technique employed was the Panel data method prior to the use of either a static model or dynamic model to estimate the impact of ICT adoption on the different stock market indicators using a study of selected African countries. On each occasion, an attempt is made to choose the most robust estimation method by applying a battery of initial diagnostic tests.

The remainder of this chapter is composed as follows: Section 5.1 presents the empirical results and data analysis; it also discusses the descriptive statistics as well as the trend analysis thereof. Section 5.2 presents the correlation results and analysis. Section 5.3 presents diagnostic tests and the panel regression results of testing the Impact of ICT adoption on stock market development in Africa. Section 5.4 presents the cointegration results. Section 5.5 reports on the causality results, while Section 5.6 concludes the chapter.

5.1 Empirical results and data analysis

5.1.1 Data

This study focused on the impact of ICT adoption and stock market development in Africa. As such, the area of study for this thesis is on the continent of Africa. Andrews, Higgins, Andrews and Lalor (2012), considered secondary data as archival data

(namely, existing information) and this formed the basis for this thesis. The justification for the secondary data was as a result of the financial restrictions as the data is affirmed economical as well as inexpensive (Saunders et al., 2012). Annual panel data was adopted for analysis of this thesis. The stock market data utilised for this study were secondary data extracted from World Bank Global Financial Development database for the selected African stock exchanges which are the Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NEX), Nigerian Stock Exchange (NSE) and Stock Exchange of Mauritius (SEM). While the ICT adoption variables data was sourced from the International Telecommunication Union database, the control variables data, which are Financial Freedom index (FFI), was sourced from Heritage Foundation database and Gross Domestic Product (GDP) was extracted from World Bank Global Financial Development database.

There were some cases where few values were missing from the original collected data. In those few cases simple moving average was applied to fill the gap. This was done by using three year moving average of the preceding figures and the following figures, in conformity with Ruedin (2013), who stated that each previously missing data point will become the average of all available data points within the moving average window, including the new point itself.

5.1.2 Summary Statistics

This section presents the descriptive statistics of all the variables employed for this study. Also, the section describes and analysea the trends of the variables over time.

Table 5.1 presents the descriptive statistics of the variables employed for this thesis. These include the mean, maximum, minimum, well as the standard deviation, for the sample of determinants of ICT adoption indicators and stock markets development indicators in the selected African countries under consideration.

Table 5. 1 : Summary statistics of the variables

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
COUNTRY	110	6	3.18	1	11
YEAR	110	2,012.50	2.89	2,008.00	2,017.00
NLC	109	8.28	14.56	0.87	59.36
SMC	110	49.12	65.15	7.24	328.36
SMTV	110	9.98	22.74	0.14	123.25
SMTR	110	12.36	14.71	1.08	82.88
FFI	110	0.52	0.12	0.3	0.7
NBU	110	507,576	895,321	320	5,223,311
NFTU	110	1,448,491	2,524,060	35,000	11,900,000
IU	110	27.66	16.96	1.9	61.76
NMU	110	36,400,000	38,100,000	1,033,300	154,000,000
GDP	110	121,000,000,000	146,000,000,000	8,490,000,000	568,000,000,000
FINDEX	109	0	1	-0.43	4.96
ICTDEX	110	0	1	-0.56	4.12

First, considering the variables of stock market development, the number of listed companies (NLC) has a mean of 8.28; this means that there are 8 listed companies for every ten thousand persons on average among all the countries adopted for this study. The minimum is .87 while the maximum number of listed companies per ten thousand people was 59 companies. The standard deviation for number of listed companies per ten thousand people was 14.56. Stock market capitalisation to GDP on the other hand has a mean of 49.12, which indicates that on average the stock market capitalisation to GDP of the selected countries is 49.12, when compared to that of USA which is 148, it becomes clear that there is growth potential in African stock markets. The minimum is 7.24, while the maximum was 328.36 and the standard deviation was 65.15. The stock market total value traded to GDP, had a mean of 9.98, which indicates that on average the total value of shares traded as a percentage of GDP was 9.98%, while the minimum was 0.14% and the maximum was 123.25% for the African stock exchanges selected for the period of the study. Stock market turnover ratio as a percentage had a mean of 12.36%, which means that on average African stock exchanges' value of shares traded in relation to the stock market capitalisation was 12.36% at a particular period. The minimum SMTR was 1.08%, while the maximum was 82.88%, and the standard deviation was 14.71%.

Furthermore, the ICT adoption variables has the following; Number of Broadband Users (NBU) has a mean of 507,576; this indicates that on average the number of broadband users in the countries selected for this study was 507,576, with a minimum number of 320 and a maximum number of 5,223,311, while the standard deviation was 895,321, which means that spread around the mean was wide. Number of Fixed Telephone Users (NTFU), had a mean of 1,448,491, which showed that on average the number of fixed telephone users in the African countries selected for this study was 1,448,491, the minimum number of users among the selected countries was 35,000 and the maximum number of users that any of the selected countries had was 11,900,000, while the standard deviation was 2,524,060 users. Internet users as a percentage of population (UI) had a mean of 27.66%, indicating that on average the African countries selected for the study had an internet penetration level of 27.66%, while the minimum internet users was 1.9% and the maximum users in the countries of interest was 61%, the standard deviation was 16.96%. Number of Mobile Phone Users (NMU) had a mean of 36,400,000, which indicates that on average there are

36,400,000 mobilephone users in the selected countries for this study. The minimum mobilephone users was 1,033,300 and the maximum number of mobilephone users was 154,000,000, while the standard deviation was 38,100,000.

The control variables had the financial freedom index mean of 0.52 which indicates that the African countries selected for this study had a level of financial freedom the index average, which is ranked from one to hundred. The minimum or lowest financial freedom index ranking for the selected countries was 0.3 and the highest ranked country on the financial freedom index had 0.7, the standard deviation was 0.12. The GDP had a mean of $121,000,000,000 (One hundred and twenty-one billion United States dollars); this is the average GDP of the selected countries. The lowest GDP among the countries was $8,490,000,000 (eight billion four hundred and ninety thousand United States dollars) and this is the lowest GDP of the African countries selected for this study. The highest GDP value was $568,000,000,000 (Five hundred and sixty-eight billion United States dollars) and a standard deviation of $146,000,000,000 (One hundred and forty-six billion United States dollars).

5.2 Correlation Analysis

The correlations of the main variables used in this study are reported in Table 5.2. It is noteworthy to highlight that the predictions were in line with the predictions of the other works on this topic. Financial freedom index is positively correlated with stock market development index at 11% significant level, which clearly indicates significant positive correlation and goes to show that the more finance is freely available in a country, the more likely that stock market will be more developed. Also, financial freedom index is significantly negatively correlated with ICTDEX at 22% significant level, which further indicates that increase in ICT adoption does not lead to more financial freedom.

Furthermore, ICTDEX is significantly positively correlated with all the stock market development variables and with GDP, indicating that with an increase in ICT adoption, there will be significant increase in stock market development and GDP growth.

Table 5 2 : Correlation matrix for the main variables used for this study

	FFI	FINDEX	ICTDEX	IU	NBU	NFTU	NLC	NMU	SMC	SMTR	SMTV	GDP
FFI	1.0000											
FINDEX	0.1084	1.0000										
ICTDEX	-0.2241**	0.54487***	1.0000									
IU	0.0765	0.249911***	0.4325***	1.0000								
NBU	-0.19581**	0.348211***	0.9027***	0.397885***	1.0000							
NFTU	-0.146969	0.650513***	0.81866***	0.0877	0.676802***	1.0000						
NLC	0.497439***	-0.0217	-0.16427*	0.242739**	-0.1293	-0.1183	1.0000					
NMU	-0.31522***	0.325608***	0.710722***	0.1089	0.473155***	0.443348***	-0.350968***	1.0000				
SMC	0.302301***	0.913163***	0.343162***	0.313926***	0.1905**	0.372365***	0.1350	0.189241**	1.0000			
SMTR	-0.174286*	0.77069***	0.69923***	0.1456	0.532488***	0.852811***	-0.1425	0.395011***	0.461828***	1.0000		
SMTV	0.1305	0.980175***	0.454925***	0.207545**	0.249699***	0.565469***	-0.0444	0.298979***	0.933933***	0.658771***	1.0000	
GDP	-0.25491***	0.4762***	0.4852***	0.0849*	0.4097***	0.4852***	-0.2670***	0.9233***	0.3905***	0.4642***	0.4767***	1

(*) / (**) and (***) indicate the (10%), (5%) and (1%) level of significance respectively. The variables are defined as follows: FFI = Financial Freedom Index; FINDEX = Stock Market Development Index; ICTDEX = ICT Adoption Index; IU = Internet Users; NBU = Number of Broadband Users; NFTU = Number of Fixed Telephone Users; NLC = Number of Listed Companides; NMU; Number of Mobilephone Users; SMC = Stock Market Capitalisation; SMTR = Stock Market Turnover Ratio; SMTV = Stock Market Total Value Traded; GDP = Gross Domestic Product

Furthermore, FFI was negatively related to ICTDEX and positively related to FINDEX. To the contrary, FINDEX was positively correlated with ICTDEX. Therefore, increased ICT adoption leads to an increase in the stock market. ICTDEX is positively correlated to all the financial development variables, except NLC, which indicates that an increase in ICT adoption will lead to stock market development.

On examining the correlation matrix, certain trends emerged. First, the correlations involving FINDEX are of the same sign as those of all the other variables except NLC, including ICT adoption variables and stock market development variables. This demonstrates that they are highly correlated. Secondly, the correlations involving ICTDEX were positively correlated with all the other variables except NLC. Wherever the correlations were significant, they were of the same sign.

5.3 Diagnostic Tests and Panel Regression Results

In reporting the findings on the impact of ICT adoption on stock market development in Africa, we start by reporting the diagnostic tests which were conducted to choose the most fitting estimator to run each model. The diagnostic tests that were conducted include principal components analysis, done to determine the impact of variables on each other. Also tests for panel heterogeneity (presence of fixed effects), random effects and fixed effects-versus random effects specification were done. In order to determine the most suitable estimator between the fixed effects and random effects model, the data set were subjected to Hausman specification test. This helps to determine whether there is a significant association between the regressors and the observation of specific random effects of the unobserved unit (Tian & Zeitun, 2007) Secondly, the panel regression results are presented.

5.3.1 Principal Components Analysis

Principal component analysis (PCA) is a commonly applied method to reduce the attributes of a data set, where variables have different meaning when applied in a certain way. PCA absolutely reduces a squared loss function, which may be inappropriate for data that is not real-valued, such as binary-valued data (Collins, Dasgupta & Schapire, 2001). This method was applied to help generate a single composite index of stock market development, as well as ICT adoption for the selected eleven African stock exchanges. This was essential because there has been no

unanimity in literature on a single most appropriate variable to measure stock market development or ICT adoption. The objective of using principal component analysis (PCA) in this study was to develop uni-dimensional measures of stock market development, based on the identified stock market variables, as well as for ICT adoption variables. It is also necessary because using the individual variables independently may not have captured and revealed the status of stock market development or ICT adoption precisely and sufficiently for the African countries selected for this study (see Sahoo, Dash & Nataraj, 2010; Love & Zicchino, 2006; Demirguc-Kunt & Levine, 1996). The PCA indices for stock market development (FINDEX) and ICT adoption (ICTDEX) were applied in the regressions for FINDEX and ICTDEX from determining variables, precisely across to Granger-causality tests.

The FINDEX and ICTDEX were created using Principal Component Analysis (PCA). PCA is done by computing the Eigen values of the variance matrix of the variable. Adnan (2011) suggested that PCA transforms data into new variables which are not correlated; while the highest variation of the original variables is contained in the first few principal components (Jolliffe, 2002). Variables of interest are summarised by a number of mutually independent principal components, of which each principal is the weighted average of the underlying variables (Adnan, 2011). The advantage of applying PCA to construct the composite indices was that the index weights were based on the correlation of the individual measures of stock market development (SMTV, SMC, SMTR and NLC,), as well as ICT adoption (NBU, NFTU, IU and NMU). As such, the first principal component for a set of variables is the unit length linear combination of those variables and always contains the maximum variance for any combination. If more than one principal component is generated for the variables, then they are uncorrelated.

According to Johnson and Wichtern (1992) and Huang (2005), after the first principal variable, all subsequent principal variables maximise the variance between the unit length linear combination and are statically independent of the prior variables and captures different aspects of the data under consideration. Therefore, in line with the literature and for the purposes of this study, the first principal components are adopted as an aggregate measure of stock market development and ICT adoption.

This study used PCA to determine appropriate composite indices for stock market development and ICT adoption in selected African countries using the following equation:

$$\beta\varrho = \varpi\varrho 1 \times 1 + \varpi\varrho 2 \times 2 + \varpi\varrho 3 \times 3 + \cdots + \varpi\varrho\gamma \times \gamma \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5.1$$

Where,

$\beta\varrho$ = estimate of the jth factor

$\varpi\varrho$ = weight on factor score coefficient

ϱ = variable of interest

γ = number of variables.

5.3.2 Stock Market development index

Table 5.3 presents the eigen values of the correlation matrix of the four different indicators that constitute stock market development index (FINDEX). The sum of the eigen values is equal to the number of individual indicators.

Table 5. 3 : Principal component analysis : Eigen values

Principal component	Eigenvalue	% of Variance	Cumulative %
1	2.38904	132	60
2	1.07253	56	87
3	0.511295	48	99
4	0.0271344	0	100

The first principal component explains the maximum variance (60%) in all the individual indicators (eigenvalue of 2.39). The second principal component explains the maximum amount of the remaining variance (27%), with an (eigenvalue of 1.07). The third principal component explains 13% of the variance with an (eigenvalue of

0.51), while the fourth principal component explains the remaining (1%) of the indicators at (eigenvalue of 0.027) of the variance. Therefore, the first two principal components are more relevant measures of FINDEX as they explain over 87% of the variance.

Table 5. 4 Principal component analysis: Eigen vectors (loadings)

Principal component	PC 1	PC 2	PC 3	PC 4
NLC	-0.0140	0.9370	0.3360	0.0950
SMC	0.5908	0.2305	-0.4381	0.6371
SMTV	0.6341	0.0122	-0.2174	0.7419
SMTR	0.4986	0.2623	0.8050	0.1860

As noted in Table 5.4, the positive coefficients for the first principal component (PC2) imply that it represents the overall measure for stock market development. The maximum weights in PC1 and PC4 are for stock market transaction value of the stock exchanges (SMTV) suggesting that there is a strong influence of this variable in these components. Stock market turnover ratio has the strongest influence in PC3, while stock market capitalisation shows the largest positive weight in PC5.

This study used PCA to determine an appropriate composite index for stock market development in selected African stock exchanges using the following specific PCA equation:

$$\boldsymbol{FINDEX} = 0.5908 * \mathbf{SMC} - 0.014 * \mathbf{NLC} + 0.6341 * \boldsymbol{SM}\mathbf{VT} + 0.4986 * \mathbf{SMTR} \quad \ldots\ldots\ldots\ldots\ldots 5.2$$

Where,
FINDEX = The first principal component for stock market development
SMC = Stock Market Capitalisation as a percentage of GDP.
NLC = Number of Listed Companies per 10,000

SMTV= Stock Market Total Value Traded as a percentage of GDP.
SMTR = Stock Market Turnover ratio

The dynamic GMM model regression results for FINDEX using PCA are shown in Table 5.12

5.4 Panel Cointegration Results

This research effort also sought to establish whether there existed any cointegrating relationship between ICT adoption and stock market development by applying the panel autoregressive distributive lag procedure and to estimate the long run and short run dynamics if in the affirmative. However, before cointegration analysis could be conducted, diagnostics tests in the form of panel unit root tests needed to be implemented. We discuss these in turn.

5.5 Panel Unit Root Test

In determining whether the variables used in this study are stationary or otherwise, Panel unit root tests using Levin Lin & Chu, ADF - Fisher Chi-square and PP - Fisher Chi-square tests, were conducted for robustness check. However, Levin Lin & Chu test results are presented, where; if P-value is greater than 0.05 then it is non-stationary at levels, we then go ahead to determine the order of integration.

Table 5. 5 : Panel Unit root test using Levin Lin and Chu Test

Variables	Level		1st Difference	
	Statistics	Prob.	Statistics	Prob.
FINDEX	-11.7403	0.0000**		
ICTDEX	-0.17606	0.4301	-4.31602	0.0000**
FFI	-7.00584	0.0000**		
GDP	-2.01000	0.0222**		

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.5 above shows the Panel Unit root test for Stock Market Index (FINDEX), ICT Index (ICTDEX), Financial Freedom Index (FFI) and Gross Domestic Product (GDP),

using Levin Lin and Chu Test method, If, p-value > 0.05, accept null hypothesis, i.e., unit root exists. That is, mean data is non stationary also If p-value < 0.05, reject null hypothesis, i.e., unit root does not exist. That is, the mean data is stationary. Considering the Levin Lin and Chu Test method it is observed that Stock Market Index (FINDEX), Financial Freedom Index (FFI) and Gross domestic Product (GDP) were all at stationary levels, with their p-values less than 0.05, while ICT Index was stationary at first level of difference. Thus, since unit root exists among one of the variables which is ICT Index, then there is need to conduct cointegration test to ascertain the long run relationship among the variables. The following section discusses the panel cointegration results.

5.5.1 Cointegration and the Error Correction Model

This section outlines the analysis that covers the cointegrating relationship between variables – that is, the cointegration between stock market index, ICT index, and financial freedom index to ascertain if there are causality effects between proxies of stock market index and ICT index. The stock market index utilised in this study for the cointegration relationship and causality are Number of Listed Companies (NLC), ratio of Stock Market Capitalisation to GDP (SMC), Stock Market Turnover (SMTR), and Stock Market Traded Value (SMTV). Cointegration is ascertained between variables if a long run equilibrium relationship between the variables exists (Awe, 2012). The study as such noted that there exists cointegration between the variables and proceeded to perform the vector error correction between stock market index, ICT index, financial freedom index and GDP.

In examining the cointegration relationship between stock market index, ICT index, financial freedom index and GDP, the pooled mean group estimator in a panel ARDL procedure was most suitable. The ARDL technique has an advantage, because it does not necessarily need the construct to be in the same order of integration. However, for harmonious uniformity of the estimates, the constructs are not to be of higher order than the first order of integration I (1). Additionally, the Error Correction Term (ECT) is drawn out from the panel ARDL estimation to examine the short run characteristics of the relationship between stock market index, ICT index, financial freedom index and GDP.

Furthermore, the insignificance/significance of the short run, long run and the error correction coefficients of panel ARDL explain the causal effects between stock market index, ICT index, financial freedom index and GDP. As per the view of Attiaoui, Toumi, Ammouri, and Gargouri, (2017), the panel ARDL can be categorised as the error correction model as it can identify the short run and long run relationships.

5.5.1.1 Pooled Mean Group, Mean Group or Dynamic Fixed Effects

In this section, it is pertinent to decide if Pooled Mean Group (PMG), Mean Group (MG) or the Dynamic Fixed Effects (DFE) is the most suitable estimator for the board ARDL. The Hausman test was conducted to select the most suitable estimator for the ARDL model and the p-value of the Hausman test is statistically insignificant, rendering the PMG estimator more appropriate. If there is a probability that there is homogeneity of the slope, the PMG is the most suitable estimator and the null hypothesis of slope homogeneity over the long run cannot be dismissed. If the likelihood or probability value is in excess of 5 percent, the PMG is the best estimator to use to analyse panel data. The PMG expects that the long run coefficients are the equivalent or are over the group that makes up the sample.

Therefore, as PMG is the expected estimation procedure, the discourse of the outcomes will be basically from the yield of the PMG estimator (Hausman test results are accounted for in the appendix). According to Pesaran et al. (1999), the PMG has some advantages over the MG and the DFE. This is because the PMG estimator permits heterogeneity in the intercept, the short run parameters and the error variance between the groups while restricting homogeneity of the long run coefficients among the groups. At the point when the homogeneity of the parameters holds, the error term are sequentially uncorrelated and the long run parameters are homogenous crosswise over for every one of the countries in the panel (Loayza & Rancière, 2006). Therefore, in order to examine the cointegration between the variables, the study utilised the panel ARDL.

The panel ARDL helps to analyse the long run and short run elements of the variables of interest. The panel ARDL is ideal as it additionally enables the examination of the heterogeneity of the factors of interest crosswise over country in the short run. The study contrasts these outcomes and those reached by utilising increasingly restrictive

Dynamic Fixed Effects (DFE) techniques. The Mean Group (MG) approach and the output of these results of all the three panel error corrections estimators that is PMG, MG and DFE are displayed. This segment gives accentuation on the outcomes acquired by utilising the PMG estimator, as the Hausman test neglected to dismiss the null hypothesis. Moreover, it will be a favoured estimator because of its advantages in consistency and proficiency over the other panel estimators (Loayza & Rancière, 2006). The results that were acquired from mean group and the dynamic fixed effects are additionally displayed for comparison purposes. This segment just introduced and examined the outcomes from the PMG estimator.

5.5.2 Panel cointegration and the Error Correction Model: Pooled Mean Group approach

In this section, the study discusses the results of the cointegration and the vector error correction between the stock market index, ICT index, financial freedom index and GDP. The results presented here used the pooled mean group which assumes that a long run relationship between stock market index, economic growth and ICT index are identical across countries whilst allowing the short run relationship to be country specific. The coefficients have been verified for the long run homogeneity using the Hausman test as explained in section 5.5.2.1. Tables 5.3 - 5.4 report the results of PMG estimation of the long-run and short-run coefficients.

5.5.2.1 Cointegration and the Error Correction Model for stock market index, *ICT index and FFI.*

Table 5.6 summarises the pooled mean group estimates of the cointegrating relationship between the stock market index, ICT index and financial freedom index for the African countries selected for this study.

The results from Table 5.6 document that there is long run relationship between stock market index, ICT index and financial freedom index. The long-run relationship between stock market index (FINDEX) (which proxies stock market development) and ICTDEX (which proxies ICT adoption) is positive and significant at 1 percent level. A one percent increase in the adoption of ICT in the long run increases the stock market indices by 0.7 percent.

Table 5. 6 : Summary of the PMG, MG and DFE on the cointegrating and causality relationship between stock market index, ICT index and FFI.

	PMG	MG	DFE
	D.FINDEX	D.FINDEX	D.FINDEX
Long Run			
ICTDEX	0.707***	-0.936	2.700***
	(12.60)	(-0.50)	(3.67)
FFI	0.0440***	-4.550	-2.129
	(4.10)	(-0.97)	(-0.67)
ECT	-0.541**	-0.722***	0.244*
	(-2.86)	(-4.19)	(2.35)
Short Run			
D.ICTDEX	-0.782	-0.0466	0.200
	(-1.54)	(-0.11)	(0.98)
D.FFI	-0.187	0.908	-1.452*
	(-0.27)	(1.12)	(-2.11)
_cons	-0.130	-0.307	-0.281
	(-1.35)	(-0.42)	(-0.66)
N	98	98	98

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's computation

Furthermore, there is a significant positive long run relationship between stock market index, and financial freedom index. This implies that an improved financial efficiency will lead to development stock markets in Africa.

However, in the short run, the study observed an insignificant negative relationship between ICT index and stock market index. Similarly, the study also observed an insignificant negative relationship between financial freedom index and stock market index. Hence, the insignificance of the p-values for all the proxies in the short run also implies that there is no short run cointegration.

The error correction term is negative and significant under the preferred PMG estimator. Further, the results document that stock markets in Africa adjust to changes in ICT index and financial freedom index to its long run equilibrium at a speed of adjustment of 54.1 percent.

5.5.2.2 Cointegration and the Error Correction Model for stock market *development index, ICT adoption index and GDP*

This section discusses results presented in Table 5.7. These are results of the cointegration relationship between stock market development index and ICT index and GDP.

The results from Table 5.7 show that there is long run relationship between stock market index, ICT index and gross domestic product. Also, the long run relationship between stock market index as measured by Number of Listed companies (NLC), ratio of Stock Market Capitalisation to GDP (SMC), Stock Market Turnover (SMTR) and Stock Market Traded Value (SMTV) and ICT index is positive and significant at 1 percent level. This indicates that an increase in the adoption of ICT index in the long run increases the stock market indices, which implies improvement in stock market development. Furthermore, there is a significant positive long run relationship between stock market index, and gross domestic product which is significant at 10%. This implies that an improved economic growth will lead to an improved stock market development.

Table 5 7 : Summary of the PMG, MG and DFE on the cointegrating and causality relationship between stock market development index and ICT index and GDP

	PMG	MG	DFE
	D.FINDEX	D.FINDEX	D.FINDEX
Long Run			
ICTDEX	0.163***	-2.301	3.698**
	(4.68)	(-0.85)	(2.67)
GDP	1.31e-13**	4.19e-13	9.97e-12**
	(3.11)	(0.25)	(2.58)
ECT	-0.416**	-0.833***	0.207*
	(-3.06)	(-4.06)	(2.10)
Short Run			
D.ICTDEX	-0.968	-1.633	0.185
	(-1.02)	(-1.27)	(0.89)
D.GDP	-1.00e-12	-1.32e-12	8.58e-13
	(-0.90)	(-1.61)	(0.91)
_cons	-0.291**	-0.681	0.240*
	(-2.68)	(-0.93)	(2.43)
N	98	98	98

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's computation

However, in the short run, the study observed an insignificant negative relationship between ICT index and stock market index. Similarly, the study also observed an insignificant negative relationship between gross domestic product and stock market index. Hence, the insignificance of the p-values for all the proxies in the short run also implies that there is no short run cointegration.

The error correction term is negative and significant under the preferred PMG estimator. Stock market index as measured with the Number of Listed companies (NLC), ratio of Stock Market Capitalisation to GDP (SMC), Stock Market Turnover Ratio (SMTR), and Stock Market Traded Value (SMTV) adjusts to changes in ICT index and GDP to its long run equilibrium at a speed of adjustment of 41.6 percent.

5.5.3 Panel Causality Test

The tri-variate ECM within the ARDL framework was utilised to examine the causal relationships between each of the stock market indices; ICT index and Financial Freedom index. The study did not perform the Granger causality test, rather the study used the ECM to examine the causality between the variable of interest in this study. The causality links that this study inferred are in three categories, namely; long run causality, short run causality and strong causality/joint causality and the results are summarised in Tables 5.8 - 5.11 for each of the poverty proxies. Literature references on the causal relationships between the financial dimension and poverty that we have analysed in this study is negligible. For this study, the causality between the variables is determined by the statistical significance of the coefficients while the statistical significance of the respective error terms shows joint causality of the variables for the panel. The causal links that are presented in Table 5.9, show that the causal links are mainly in the long run and there is joint causality for the selected variables as the ECT coefficients are statistically significant. The causal analysis for the panel of the selected countries in this study is unique in that it did not only allow us to examine the relationship between ICT index and stock market index but also among the financial freedom index and stock market index.

Table 5: 8 : Summary of the Pooled Mean group on the cointegrating and causality relationship between stock market index, ICT index and financial freedom index

Dependent variable	Source of Causation (independent variables)						
	Long run coefficients			Short run coefficients			
	FINDEX	**ICTDEX**	**FFI**	**∆FINDEX**	**∆ICTDEX**	**∆FFI**	**ECT**
∆FINDEX		0.707***	0.0440***		-0.782	-0.187	-0.541**
		(12.60)	(4.10)		(-1.54)	(-0.27)	(-2.86)
∆ICTDEX	0.673***		-0.340	22.90		0.000538	-0.402*
	(9.41)		(-1.50)	(0.71)		(0.00)	(-2.44)
∆FFI	-1.397**	1.401		33.50	-33.33		-0.733***
	(-1.13)	(0.44)		(1.02)	(-0.79)		(-6.89)

Notes: *t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: 9 : Summary of the Pooled Mean group on the cointegration and causality relationship between stock market index, ICT index and GDP

Dependent variable	Source of Causation (independent variables)						
	Long run coefficients			Short run coefficients			
	FINDEX	**ICTDEX**	**GDP**	**∆FINDEX**	**∆ICTDEX**	**∆GDP**	**ECT**
∆FINDEX		0.163***	1.31e-13**		-0.968	-1.0e-12	-0.416**
		(4.68)	(3.11)		(-1.02)	(-0.90)	(-3.06)
∆ICTDEX	0.417**		-9.96e-14	-0.223		-2.5e-13	-0.293*
	(3.15)		(-0.46)	(-1.23)		(-0.74)	(-2.37)
∆GDP	0.237***	0.315***		-0.717	-0.0123		-0.304*
	(3.54)	(3.72)		(-1.21)	(-0.10)		(-2.51)

Notes: *t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: 10 : Summary of the Pooled Mean group on the cointegrating and causality relationship between stock market index, ICT index and financial freedom index

Dependent variable	**Source of Causation (independent variables)**						
	Long run coefficients			**Short run coefficients**			
	FINDEX	**ICTDEX**	**FFI**	**∆FINDEX**	**∆ICTDEX**	**∆FFI**	**ECT**
∆FINDEX		Causality*** (12.60)	Causality*** (4.10)		No causality (-1.54)	No causality (-0.27)	Cointergrating** (-2.86)
∆ICTDEX	Causality*** (9.41)		No causality (-1.50)	No causality (0.71)		No causality (0.00)	Cointegrating* (-2.44)
∆FFI	Causality** (-1.13)	No causality (0.44)		No causality (1.02)	No causality (-0.79)		Cointergrating*** (-6.89)

Notes: *t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. 11 : Summary of the Pooled Mean group on the cointegrating and causality relationship between stock market index, ICT index and GDP.

Dependent variable	Source of Causation (independent variables)						
	Long run coefficients			Short run coefficients			
	FINDEX	**ICTDEX**	**GDP**	**∆FINDEX**	**∆ICTDEX**	**∆GDP**	**ECT**
∆FINDEX		Causality*** (4.68)	Causality** (3.11)		No causality (-1.02)	No causality (-0.90)	Cointegrating** (-3.06)
∆ICTDEX	Causality** (3.15)		No causality (-0.46)	No causality (-1.23)		No causality (-0.74)	Cointegrating* (-2.37)
∆GDP	Causality*** (3.54)	Causality*** (3.72)		No causality (-1.21)	No causality (-0.10)		Cointegrating* (-2.51)

Notes: *t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The study found bidirectional causality between stock market index and ICT index in the long run. The causal links are in both directions where stock market index causes ICT adoption and ICT index causes stock market development. The findings are in line with the view of Okwu (2015). Also, there is bidirectional long run relationship between stock market index and stock freedom index, in the sense that the causal links are in both directions where stock market development causes financial freedom and financial freedom causes stock market development.

5.6 Estimation Framework and Empirical Results

In this part, we start by subjecting the data set into diagnostics methods which are conducted so as to choose the most fitting estimation technique. In this way, the regression is evaluated. Along these lines, the estimation of the model was done and the outcomes and deductions thereof talked about. The primary dependent variable in this model is number of listed companies, stock market capitalisation, stock market traded shares, and turnover ratio.

5.6.1 Empirical findings on the impact of ICT adoption on stock market development in Africa

Lastly, a battery of tests was conducted on the pooled OLS, fixed effects and random effects models. These also included the tests for panel heterogeneity (presence of fixed effects), significance of time effects, random effects and fixed effects-versus random effects specification, while the Hausman Specification test, was conducted to ascertain the most suitable test. Hence, based on the results in Table 5.12, the Hausman test follows chi-square test and the value of chi-square tests is $T_{Hausman}$ = 25.94 which is significant (p (0.000) < 0.05) as such the null hypothesis was rejected hence, there is a significant relationship between time invariant variables with time variant explanatory variables.

Table 5.12 : **Diagnostic statistics of the data estimations on the Determinants of stock market development (FINDEX)**

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
Observations	98	98	98	87	98
Groups	11	11	11	11	11
F-stats/Wald chi2				4411.34	1755.75
Prob>F/Prob>Wald chi2				0.0000	0.0000
Hausman (Chi2)		25.94			
Prob>chi2		0.0000			
R-SQUARED					
Within	0.6843	0.7421	0.6843		
Between	0.9982	0.4596	0.9982		
Overall	0.9389	0.4910	0.9389		
Number of instruments				16	

The regression output is presented in Table 5.13. In a similar manner, we have reported the pooled OLS, fixed effects (FE), random effect (RE) and GLS estimation results just for comparison. Also, this suffices to highlight that the estimated coefficients and signs of the RE and FE estimation outputs are comparable for most of the variables. However, in making inference on the effects of ICT adoption index on the Stock Market Development (FINDEX) in the selected African countries, the System GMM estimation results was also adopted. Furthermore, as reported in Table 5.13 the result of the system-GMM also shows a consistent significant result i.e. the p-value (0.000) of the Sargan/Harsen tests of the estimations is significant. This invariably means that there is a significant effect of ICT adoption on the Stock Market Development (FINDEX) in the selected African countries. These findings conform to the view of Bahrami (2008), who investigated the cumulative effect of ICT on securities. She made findings that all indicators of ICT development have significant effect on Securities Exchange development indexes. In addition, in two group's countries, effect of ICT on economic growth is positive

Table 5 13 : Determinants of stock market development (FINDEX)

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
	FINDEX	FINDEX	FINDEX	FINDEX	FINDEX
L.FINDEX	1.133***	1.212**	1.133***	1.188***	1.133***
	(0.0606)	(0.266)	(0.0606)	(0.0675)	(0.0317)
ICTDEX	-0.122***	-0.723	-0.122***	-0.624***	-0.122***
	(0.0232)	(0.421)	(0.0232)	(0.107)	(0.0291)
FFI	-0.182	-0.431	-0.182	-1.034*	-0.182
	(0.138)	(0.866)	(0.138)	(0.476)	(0.185)
GDP	5.27e-15	-1.78e-12	5.27e-15	-1.92e-12***	5.27e-15
	(2.06e-13)	(1.53e-12)	(2.06e-13)	(3.43e-13)	(1.73e-13)
_cons	0.0834	0.429	0.0834	0.589	0.0834
	(0.0922)	(0.518)	(0.0922)	(0.369)	(0.108)
N	98	98	98	87	98
R^2		0.742			

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In order to determine the impact of ICT adoption on stock market, a series of tests were conducted on the pooled OLS, fixed effects and random effects models. These included the tests for panel heterogeneity (presence of fixed effects), random effects and fixed effects-versus random effects specification. In order to determine the most suitable estimator between the fixed effects and random effects model, the data set was subjected to Hausman specification test. This helps to determine whether there is a significant association between the regressors and the observation of specific random effects of the unobserved unit (Tian & Zeitun, 2007). If the P- value less than 0.05, we reject the null hypothesis that indicates that the two models are different and we have to run the fixed effect model.

5.6.2 Empirical findings on the impact of ICT adoption on the number of firms listed on the African stock exchanges

In order to determine the impact of ICT adoption on the number of firms listed on the African stock exchanges, a series of tests were conducted on the pooled OLS, fixed effects and random effects models. These included the tests for panel heterogeneity (presence of fixed effects), random effects and fixed effects-versus random effects specification. In order to determine the most suitable estimator between the fixed effects and random effects model, the data set was subjected to Hausman specification test. This helps to determine whether there is a significant association between the regressors and the observation of specific random effects of the unobserved unit (Tian & Zeitun, 2007). If the P- value is less than 0.05, we reject the null hypothesis that indicates that the two models are different, and we have to run the fixed effect model.

Based on the results in Table 5.14, the Hausman test follows chi-square test and the value of chi-square tests is $T_{Hausman}$= 3.18 which is insignificant (p (0.3633) > 0.05). As such, the null hypothesis failed to be rejected thus it stands that there is no significant relationship between time invariant variables with time variant explanatory variables, which indicates the random effects model was preferred for this model

Table 5. 14 : **Diagnostic tests of the data estimations on the impact of ICT adoption on the number of listed firms**

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
Observations	98	98	98	87	98
Groups	11	11	11	11	11
F-stats/Wald chi2				4309.79	39592.05
Prob>F/Prob>Wald chi2				0.0000	0.0000
Hausman (Chi2)		3.18			
Prob>chi2		0.3633			
R-SQUARED					
Within	0.7001	0.7068	0.7001		
Between	1.0000	0.9979	1.0000		
Overall	0.9977	0.9957	0.9977		
Number of instruments				22	

The results output are presented in Table 5.9 and 5.10. We have reported the pooled OLS, fixed effects (FE), random effects (RE), and GLS estimation results just for comparison. Also, this suffices to highlight that the estimated coefficients and signs of the RE and FE estimation outputs are comparable for most of the variables. However, in making inference, the System GMM estimation results was adopted, in the sense that the estimations in first difference and in system allow taking into account the problem of endogeniety of variables. The GMM System estimator treats combination of both difference and level equations. Instruments used for the difference equation are the delayed values of variables in levels.

As reported in Table 5.14, the result of the system-GMM-Difference shows a consistent significant result, for example the p-value of the Sargan tests of the estimations show that the model is significant as such. This invariably means that ICT adoption has a significant effect on a number of firms listed on the African stock exchanges. This finding conforms to the view of Bharadwaj, Keil and Mähring (2007), who analysed two hundred and thirteen newspaper reports of information technology failures by publicly traded firms, which were recorded over a 10-year period. They opined that information technology failures notably decreased the number of public traded firms in the stock exchange. This finding also conforms to the view of Porteba and summers (1988) who argued that capital markets had become excessively volatile since the adoption of computer-assisted trading strategies as the latter increase short-term price volatility and risks.

Table 5. 15 : Panel regression results on the impact of ICT adoption on the number of listed firms

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
	NLC	NLC	NLC	NLC	NLC
L.NLC	1.015***	0.913***	1.015***	0.927	1.015***
	(0.00261)	(0.0170)	(0.00261)	(0.474)	(0.00620)
NBU	5.68e-08	-8.86e-08	5.68e-08	-1.88e-08	5.68e-08
	(7.83e-08)	(0.000000161)	(7.83e-08)	(0.000000168)	(0.000000133)
NFTU	-6.26e-08**	-0.000000203	-6.26e-08**	-0.000000160	-6.26e-08
	(1.92e-08)	(0.000000112)	(1.92e-08)	(0.000000135)	(4.89e-08)
IU	0.00420	0.0162	0.00420	0.00476	0.00420
	(0.00682)	(0.0209)	(0.00682)	(0.0214)	(0.00502)
NMU	-7.70e-10	-1.12e-08	-7.70e-10	-6.28e-09	-7.70e-10
	(7.21e-10)	(1.24e-08)	(7.21e-10)	(1.49e-08)	(5.35e-09)
FFI	-0.802***	-0.588	-0.802***	-2.050	-0.802
	(0.182)	(0.501)	(0.182)	(4.106)	(0.683)
GDP	-1.09e-13	9.04e-13	-1.09e-13	3.71e-13	-1.09e-13
	(1.89e-13)	(8.47e-13)	(1.89e-13)	(6.13e-13)	(1.37e-12)
_CONS	0.317	1.235**	0.317	1.186	0.317
	(0.164)	(0.290)	(0.164)	(1.128)	(0.384)
N	98	98	98	87	98
R^2		0.707			

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.6.3 Empirical findings on the impact of ICT adoption on the market capitalisation of the African stock exchanges.

Similarly, to estimate the model on the impact of ICT adoption on the market capitalisation of the African stock exchanges, a series of diagnostic tests were conducted on the pooled OLS, fixed effects and random effects models. These also included the tests for panel heterogeneity (presence of fixed effects), significance of time effects, random effects and fixed effects-versus random effects specification. Likewise, Hausman Specification test was conducted to ascertain the most suitable test. In essence, a dynamic model was specified to test the relationship between ICT adoption and Stock Market development. The Pooled OLS, FE and RE estimators were employed for comparison purposes (base models). The GMM estimators were used for inference as they mitigate the problem of inherent endogeneity and heteroscedasticity which were established to be present in this study.

Table 5. 16 : **Diagnostic test of the data estimations on the impact of ICT adoption on stock market capitalisation**

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
Observations	99	99	99	88	99
Groups	11	11	11	11	11
F-stats/Wald chi2				129.84	3866.41
Prob>F/Prob>Wald chi2				0.0000	0.0000
Hausman (Chi2)		11.59			
Prob>chi2		0.0089			
R-SQUARED					
Within	0.4481	0.4927	0.4481		
Between	0.9985	0.9763	0.9985		
Overall	0.9787	0.9545	0.9787		
Number of instruments				22	

Likewise, the Hausman specification test was conducted to ascertain the most suitable test. As such, based on the results in Table 5.16, the Hausman test follows chi-square test and the value of chi-square tests for $T_{Hausman}$ is 11.59 which is significant (p (0.0089) < 0.05). As such, the null hypothesis was rejected, while the alternative was accepted, that there is a significant relationship between time invariant variables with time variant explanatory variables.

Also, the regression output is presented in Table 5.17, where we have reported the pooled OLS, fixed effect (FE), random effects (RE), and GLS estimation results just for comparison. However, in making inference on the effect of ICT adoption on the market capitalisation, the System GMM estimation results was also adopted. Furthermore, as reported in Table 5.17 the result of the system-GMM also shows a consistent significant result, for example, the p-value of the Sargan/Harsen tests of the estimations is significant. This invariably means that ICT adoption has a significant impact on the market capitalisation of the African stock exchanges.

The findings in the above foregoing are consistent with the view of Leff (1984) as well as that of Aker and Mbiti (2010) who, in their study, looked into the mediating relationship between the spreading of ICT and economic development by investigating specifically how the spreading of ICT such as broadband internet services and mobile telephony have influenced a country's market capitalisation. Their results indicated that the number of internet users, mobile cell subscriptions, and fixed broadband subscriptions per 100 individual each have a statistically strong and positive effect on market capitalisation.

Further, the findings of this study do not conform to the view of Lee, Alford, Cresson and Gardner (2017), who studied the effects of information communication technology on stock market capitalisation, using panel data analysis. Their finding shows that the spread of ICT is positively associated with SMC. On the other hand, this finding supports the view that SMC are neither sufficient nor a prerequisite for advancing the increase and spreading of ICT (Hobjin & Jovabonic, 2000).

Table 5. 17 : Panel regression results on estimations on the impact of ICT adoption on stock market capitalisation

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
	SMC	SMC	SMC	SMC	SMC
L.SMC	1.094***	0.746***	1.094***	0.708*	1.094***
	(0.0299)	(0.0539)	(0.0299)	(0.310)	(0.0258)
NBU	0.00000199	-0.00000139	0.00000199	0.00000405	0.00000199
	(0.00000111)	(0.00000259)	(0.00000111)	(0.00000898)	(0.00000187)
NFTU	-0.00000179**	-0.00000105	-0.00000179**	0.00000268*	-0.00000179*
	(0.000000618)	(0.00000177)	(0.000000618)	(0.00000717)	(0.000000724)
IU	-0.00285	0.140	-0.00285	0.273	-0.00285
	(0.0490)	(0.0828)	(0.0490)	(0.226)	(0.0734)
NMU	5.31e-08	0.000000144	5.31e-08	1.85e-08	5.31e-08
	(8.77e-08)	(0.000000145)	(8.77e-08)	(0.000000223)	(8.12e-08)
FFI	-17.04*	-69.48	-17.04*	-80.47*	-17.04
	(7.761)	(66.44)	(7.761)	(34.98)	(9.540)
GDP	-1.56e-11	-6.12e-11	-1.56e-11	-4.28e-11	-1.56e-11
	(2.48e-11)	(7.06e-11)	(2.48e-11)	(9.09e-11)	(2.28e-11)
_CONS	5.893	49.00	5.893	40.50	5.893
	(3.181)	(35.73)	(3.181)	(29.90)	(5.506)
N	99	99	99	88	99
R^2		0.493			

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.6.4 Empirical findings on the impact of ICT adoption on the number of shares traded on the African stock exchanges.

Furthermore, a battery of tests was also conducted on the pooled OLS, fixed effects and random effects models. These also included the tests for panel heterogeneity (presence of fixed effects), significance of time effects, random effects and fixed effects-versus random effects specification. More so, Hausman Specification test was conducted to ascertain the most suitable test. Based on the results in Table 5.18 below, the Hausman test follows chi-square test and the value of chi-square tests is $T_{Hausman}$= 2.37, which is insignificant (p (0.4993) > 0.05). As such, the null hypothesis thus stands; that there is no significant relationship between time invariant variables with time variant explanatory variables.

Table 5. 18 : Diagnostic statistics of the data estimations on the impact of ICT adoption on the number of shares traded

	Pooled OLS	Fixed Effects	Random Effects	System GMM	GLS
Observations	99	99	99	88	99
Groups	11	11	11	11	11
F-stats/Wald chi2				333.86	2121.52
Prob>F/Prob>Wald chi2				0.0000	0.0000
Hausman (Chi2)		2.37			
Prob>chi2		0.4993			
R-SQUARED					
Within	0.7547	0.7748	0.7547		
Between	0.9938	0.9364	0.9938		
Overall	0.9634	0.9152	0.9654		
Number of instruments				22	

The regression output is presented in Table 5.19. We have reported the pooled OLS, fixed effects (FE), random effect (RE), and GLS estimation results just for comparison. Also, this suffices to highlight that the estimated coefficients and signs of the RE and FE estimation outputs are comparable for most of the variables. However, in making inference on the impact of ICT adoption on the number of shares traded on the African stock exchanges, the System GMM estimation results was also adopted.

Furthermore, as reported in Table 5.19 the result of the system-GMM also shows a consistent significant result, for example, the p-value (0.000) of the Sargan/Harsen tests of the estimations is significant. This invariably means that ICT adoption has a significant impact on the number of value of shares traded on the African stock exchanges.

These findings conform to the view of Hobjin and Jovabonic (2000), who empirically looked into the information technology revolution in the capital market. Their findings show that the increase in the utilisation of ICT resulted in more decrease of value, but IT destroyed the old firm and will enter new firms into the market. Furthermore, the findings also support the view of Ashraf and Joarder (2009), who investigated the effect of IT on stock market trade volume and volatility, using a case of Dhaka stock exchange in Bangladesh. Their results showed that the “Net” has a significant impact on these two parameters of volume and volatility of Dhaka stock market.

In addition, the findings conform to the view of Mwalya (2010) in the study on the influence of ICT on the returns on stock and volume of trade in Nairobi stock exchange that adoption of information and communication technology increased the mean of daily trade volume and return.

Table 5. 19 : Panel regression results on estimations on the impact of ICT adoption on the number of shares traded

	Pooled Effects	Fixed Effects	Random Effects	System GMM	GLS
	SMTV	SMTV	SMTV	SMTV	SMTV
L.SMTV	1.208***	1.185***	1.208***	1.441***	1.208***
	(0.0861)	(0.194)	(0.0861)	(0.314)	(0.0367)
NBU	0.00000229*	0.00000177	0.00000229*	0.00000198***	0.00000229**
	(0.000000907)	(0.00000251)	(0.000000907)	(0.000000527)	(0.000000864)
NFTU	-0.00000205***	-0.00000347	-0.00000205***	-0.00000480	-0.00000205***
	(0.000000564)	(0.00000245)	(0.000000564)	(0.00000398)	(0.000000379)
IU	-0.00562	0.0472	-0.00562	0.142	-0.00562
	(0.0360)	(0.0529)	(0.0360)	(0.112)	(0.0312)
NMU	8.32e-08	0.000000113	8.32e-08	7.59e-08	8.32e-08*
	(0.000000102)	(0.000000113)	(0.000000102)	(0.000000134)	(3.43e-08)
FFI	-4.231	-11.64	-4.231	-1.465	-4.231
	(3.597)	(16.84)	(3.597)	(19.40)	(3.875)
GDP	-2.36e-11	-4.85e-11	-2.36e-11	-5.98e-11***	-2.36e-11*
	(2.93e-11)	(4.48e-11)	(2.93e-11)	(1.29e-11)	(9.59e-12)
_CONS	1.502	8.270	1.502	0.440	1.502
	(1.588)	(13.41)	(1.588)	(10.76)	(2.333)
N	99	99	99	88	99
R^2		0.775			

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

5.6.5 Empirical findings on the effect of ICT adoption on the turnover ratios of the African stock markets

More so, a battery of tests was conducted on the pooled OLS, fixed effects and random effects models. These also included the tests for panel heterogeneity (presence of fixed effects), significance of time effects, random effects and fixed effects-versus random effects specification. The Hausman Specification test was conducted to ascertain the most suitable test. Hence, based on the results in Table 5.20 below, the Hausman test follows chi-square test and the value of chi-square tests is $T_{Hausman}$ = 7.33 which is insignificant (p (0.0620) > 0.05). As such, the null hypothesis thus stands; that there is no significant relationship between time invariant variables with time variant explanatory variables.

Table 5. 20 : Diagnostic statistics of the data estimations on effect of ICT adoption on the turnover ratios of African stock markets

	Pooled	Fixed effects	Random effects	System GMM	GLS
Observations	99	99	99	88	99
Groups	11	11	11	11	11
F-stats/Wald chi2				287.23	244.02
Prob>F/Prob>Wald chi2				0.0000	0.0000
Hausman (Chi2)		7.33			
Prob>chi2		0.0620			
R-SQUARED					
Within	0.2791	0.3497	0.2791		
Between	0.9849	0.6967	0.9849		
Overall	0.7817	0.5883	0.7817		
Number of instruments					

Table 5. 21 : **Panel regression results on effect of ICT adoption on the turnover ratios of the African stock markets**

	Pooled Effects	Fixed Effects	Random Effects	System GMM	GLS
	SMTR	SMTR	SMTR	SMTR	SMTR
L.SMTR	0.397***	0.283***	0.397***	0.228**	0.397***
	(0.0516)	(0.0444)	(0.0516)	(0.0874)	(0.0874)
NBU	0.000000161	0.00000120	0.000000161	0.00000218	0.000000161
	(0.000000736)	(0.00000330)	(0.000000736)	(0.000001420)	(0.00000129)
NFTU	0.00000243***	0.00000429	0.00000243***	0.00000447*	0.00000243***
	(0.000000496)	(0.00000284)	(0.000000496)	(0.000003110)	(0.000000708)
IU	0.0571	0.0140	0.0571	-0.00598	0.0571
	(0.0341)	(0.0345)	(0.0341)	(0.0215)	(0.0458)
NMU	-2.23e-08	3.77e-09	-2.23e-08	-1.55e-08	-2.23e-08
	(2.80e-08)	(6.72e-08)	(2.80e-08)	(2.76e-08)	(4.70e-08)
FFI	-1.420	-44.91	-1.420	-76.00	-1.420
	(3.386)	(42.94)	(3.386)	(2.381)	(5.641)
GDP	1.04e-11	-3.78e-11	1.04e-11	-4.68e-11	1.04e-11
	(5.65e-12)	(4.33e-11)	(5.65e-12)	(4.65e-12)	(1.23e-11)
_CONS	1.730	29.00	1.730	47.95	1.730
	(2.654)	(26.52)	(2.654)	(.)	(3.337)
N	99	99	99	88	99
R^2		0.350			

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The regression output is presented in Table 5.21 In a similar manner, we have reported the pooled OLS, fixed effects (FE), random effect (RE) and GLS estimation results just for comparison. Also, this suffice to highlight that the estimated coefficients and signs of the RE and FE estimation outputs are comparable for most of the variables. However, in making inference on the effects of ICT adoption on the turnover ratios of the African stock markets the System GMM estimation results was also adopted. Furthermore, as reported in Table 5.21 the result of the system-GMM also shows a consistent significant result, for example the p-value (0.000) of the Sargan/Harsen tests of the estimations is significant. This invariably means that ICT adoption has a significant impact on the turnover ratios of the African stock markets. This finding is in agreement with the view of Afonso (2018) who found that the rise in ICT adoptions indices significantly influences the turnover proportion in the stock exchanges of the selected OECD Countries

5.7 Chapter Summary

The world is quickly turning into an information-driven society with the development of ICT in all parts of human life. Internet access and utilisation of different types of devices to access information from the world wide web, has made impact in every human culture today. This development has an undeniably developmental effect on various networks utilized to spur innovation in the sector. The improvement in ICT infrastructure is considered as a process with multi-steps. Establishment of communication, lawful and instruction infrastructure and workforce training are instances of the endeavours made in such manner. In information-based networks, issues like instructive improvement and social advancement must be put into consideration. Today, it is important that scholarly and social fields of ICT are adequately ready, in light of the fact that there are immediate connections between the economic wellbeing and the degree of their abilities, particularly in the stock market sector. In this sense, legitimate usage and advancement of ICT can have advantageous impacts on the development of stock markets.

Hence, the purpose of this study was to examine the impact of information and communication technology adoption on stock market development of the leading stock exchanges in Africa. It documents the empirical results of testing the four central hypotheses relating to how the determinants of ICT adoption significantly influence

selected indicators of stock market development in the leading stock exchanges in Africa.

Five indicators were considered for measurement of ICT adoption, and these are: Number of broadband Users (NBU), Number of Fixed Telephone User (NFTU), Number of Internet Users, (IU) and Number of Mobile Phone Users, (NMU) including ICTDEX, on the other hand, Stock Market Turnover Ratio (SMTR), Stock Market Capitalisation to GDP (SMC), Stock Market Value Traded to GDP (SMTV) and Number of Listed Companies (NLC) were considered as stock market development indexes.

The first central hypothesis was to investigate whether ICT adoption has a significant effect on a number of firms listed on the African stock exchanges. Based on the system GMM results, the estimation was significant. This invariably means that ICT adoption has a significant effect on a number of firms listed on the African stock exchanges. This finding conforms to the view of Bharadwaj (2013), who analysed two hundred and thirteen newspaper reports of IT failures by publicly traded firms, which occurred during a 10-year period. He noted that IT failures significantly decreased the number of public traded firms in the stock exchange. This finding also conforms to the view of Porteba and Summers (1988) who argued that capital markets had become excessively volatile since the adoption of computer-assisted trading strategies, as the latter increase short-term price volatility and risks.

The second central hypothesis that was being investigated was whether ICT adoption has a significant impact on the market capitalisation of the African stock exchanges. Likewise, based on the system GMM results show that the estimation was significant. This invariably means that ICT adoption has a significant impact on the market capitalisation of the African stock exchanges The findings above conform to the view of Leff (1984) and Aker and Mbiti (2010) who examined the mediating relationship between ICT expansions and economic development by investigating specifically how expansions of ICT such as broadband internet services and mobile telephony have affected a country's market capitalisation. Their results indicated that the number of mobile cell subscriptions, internet users, and fixed broadband subscriptions per 100 people each have a positive and statistically strong effect on market capitalisation.

Also the findings of this study do not conform to the view of Lee, Alford, Cresson and Gardner (2017), where they studied the effects of information communication technology on stock market capitalisation, using panel data analysis., their findings shows that ICT expansion are positively associated with stock market capitalisation. However, this finding supports the view in another study that stock markets are neither a necessary nor sufficient condition for promoting the development of ICT (Hobjin & Jovabonic, 2000).

Thirdly, the null proposition that ICT adoption has no significant impact on the number of shares traded on the African stock exchanges was also subjected to the system GMM results, which shows that the estimation was significant. This invariably means that ICT adoption has a significant impact on the number of value of shares traded on the African stock exchanges. These findings conform to the view of Hobjin and Jovabonic (2000), whose empirical study on the Information Technology Revolution and the Stock Market, found that more application of IT resulted in decrease of value, but IT destroyed the old firms entered new firms into the market. Furthermore, the findings also support the view of Ashraf and Joarder (2009), in their investigation of the effect of IT on stock market trade volume and volatility, using a case of Dhaka stock exchange in Bangladesh. Their results showed that the “Net” has a significant impact on these two parameters of volume and volatility of Dhaka stock market. In addition, the findings conform to the view of Mwalya (2010), in the study of the influence of ICT on the returns on stock and volume of trade in Nairobi stock exchange, that adoption of information and communication technology increased the mean of daily trade volume and return.

Lastly, this research effort probed if ICT adoption has no significant impact on the turnover ratios of the African stock markets. In line with the system GMM results, which reported that the estimation was significant, this invariably means that ICT adoption has no significant impact on the turnover ratios of the African stock markets. This finding is in conflict with the view of Afonso and Blanco-arana (2018) who found that the rise in ICT adoption indexes significantly influences the turnover proportion in the stock exchanges of selected *OECD Countries.*

CHAPTER 6

SUMMARY OF RESULTS, CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

6.0 Introduction

This study sought to establish the relationship between ICT adoption and stock market development in Africa. This was underpinned by the resolution of three research questions, namely; (1) What is the impact of ICT adoption on stock market development in Africa, (2) *What cointegrating relationships exist between ICT adoption and stock market development in Africa?* and (3) *What is the direction of causality between ICT adoption and stock market development in Africa?.* With the ICT development in every facet of human life, the world is considered a universal village as a result of the information society. The following comments by Noah Samara, founder of World Space undoubtedly attributes the success and/or failure of nations to availability of information or lack of it, Samara held; ..."*Look beyond the wealth of nations and you find information, look beyond the poverty of nations and you find lack of information*". An information-rich world objective, therefore, is increasingly being realised as adequate investment in information technology has become paramount in competing in today's world of work. In other words, the multi-destination, distance-insensitive communication satellites which are fast turning the world into a global village are components of information technology. For instance, over four billion viewers in over 100 countries of the world watched the recently concluded "Miss World, 2019" pageant won by Miss Jamaica and this was made possible by voting on the internet courtesy of developments in information technology.

In today's business environment, one of the most crucial processes in information technology management is execution, growth and maintenance of information systems. ICT is relevant in enabling financial institutions to increase the availability of credit to corporations and households (Binuyo & Aregbeshola, 2014). Therefore, ICT, through information sharing, contributes to reducing information asymmetry and enhances the capacity of financial institutions to assess the risk profiles of borrowers (Asongu & Nwachukwu, 2017). In the course of recent decades, the world stock

markets have flooded, and developing markets have represented a lot of this blast. The speed and degree of stock market development in emerging economies have been uncommon and have prompted principal moves both in the financial structures of less developed economies and in the capital flows from developed economies.

Stock markets are relied upon to quicken economic development by giving a lift to household reserve funds and expanding the amount and the nature of investment. Specifically, stock markets can empower economic development by making way for developing organisations to raise capital at lower cost. Likewise, organisations in nations with developed stock markets are less reliant on bank financing, which can decrease the danger of a credit crunch. ICT through the use of the world wide web and the internet can be used to access market records, by making minimal effort, this helps to balance stock market information asymmetry. It also help create multiple avenues for market participants to engage in stock market activities from anywhere in the world. ICT gives chances to reduce constraints of economic and social disparities and supports consistent wealth distribution. Nevertheless, economic changes are decimated with more businesses being created and some businesses are made obsolete, yet new businesses have made different types of jobs available through the use of ICT. ICT is a factor that strongly affects the development of stock markets.

Furthermore, available studies on the effects of ICT on the development of the stock markets, more particularly in the last few years, have tended to focus on the developed economies, the world's leading markets and emerging and high-income economies, with only a few on developing economies like Nigeria (Hossein et al., 2013; and Ezirim et al., 2009). Interestingly, the studies on Nigeria, for instance, did not place particular emphasis on the development of the Nigerian Stock Exchange, let alone the leading stock exchanges in the African continent. Moreover, a survey of the literature indicated the likelihood that such studies are not yet available for African markets. This current study also intends to bridge this gap in knowledge and literature.

It is also evident from the review of literature that research efforts on ICT relative to macroeconomic indicators have been focused on economic activities and growth with diminutive attention for the stock markets, which is the pivotal part of capital market in

influencing the process of economic development and growth (Okwu, 2015). There exists a relationship dearth in the literature on the impact of ICT adoption on African stock exchange development. As earlier indicated, the available studies on the stock market in Africa is tilted toward the banking industry, with just a few on Nigerian stock market and South Africa (Johannesburg stock exchange). Throughout the course of this research, the researcher has found no panel study which used more than ten African countries to undertake a study on the impact of ICT adoption on development of African stock markets.

Regarding relationship between capital markets and ICT development in an economy, Levine (1993), asserts that capital markets unimpeded the diversification of ICT risks and for that reason positive growth of stock markets augments modernisations in ICT. Nevertheless, Singh et al. (2000), in their study explored the relationship between ICT and the capital market using multivariate regression analysis in the case of both emerging and developed economies and confirmed that stock markets are neither necessary nor sufficient conditions for promoting the development of ICT.

Information communication technology and the growth of stock market, particularly for some time, have been determined on the industrial economy, foremost, and rising market and high-income economy of the world. Information communication technology in relation to the development of stock markets, especially in the past 5 years, has focused on the economies of developed countries, foremost, and developing markets, including the economies of countries with high interest rate (Okwu, 2015). According to Petros (2007), stock markets are proficient to control the growth of economies via supporting investments between individuals who save and this provides means for organisations to finance their investment. Okwu (2015) stated that the market for stock is seen as the driver of information technology, through controlled device, which provides user of fresh long-term finances with an edge and existing monetary securities are traded at marketplace-driven price.

The rest of the chapter is organised as follows: Section 6.1 presents theoretical insights on ICT adoption and stock market development. Section 6.2 presents empirical insights on ICT adoption and stock market development. Section6.3 presents a summary of results of the study. Section 6.4 presents the contribution of

the study, 6.5 is on the contribution of the study to policy and section 6.6 suggests direction for future studies.

6.1 Theoretical Insights on ICT adoption and Stock Market Development

An extant literature review of ICT adoption theory was conducted in this study which offered insights on how to interpret ICT adoption and stock market development. This in turn assists in the formulation of the hypotheses for this study. Further, the main theories in ICT were looked into. These are theory of technology acceptance, Diffusion of Innovation and the Unified Theory of Acceptance and Use of Technology.

The theory of technology acceptance was first propounded by Davis (1989) who presented a theoretical model aiming to predict and explain ICT usage behaviour, that is, what causes potential adopters to accept or reject the use of information technology. Theoretically, TAM is predominantly centred on two theoretical constructs, perceived usefulness and perceived ease of use, which are the fundamental determinants of system use, and predict attitudes toward the use of the system. The user's willingness to use the system - perceived usefulness, refers to "the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" according to Davis (1989).

Roger (1983) propounded the theory of Diffusion of Innovation (DOI) in describing the kind of change being brought to the global business world via the use of information and Communication Technology. Rogers (1983) proposed the first process model, a five-stage model of the adoption of innovation in organisations (i.e. DOI). On the other hand, Moore and Benbasat (1991) used DOI to develop "an instrument designed to measure the various perceptions that an individual may have of adopting an information technology (IT) innovation". Roger's model of innovation theory has been applied in many disciplines, and researchers who study the adoption of innovations often use it to explain the technology innovation process (Oliver & Goerke, 2008; Tabata & Johnsrud, 2008; Kilmon & Fagan, 2007). Meyer (2004) noted that the model has effectively been used in various studies in such areas as sociology, communications, economics, marketing and technology. Jayson (2009) undertook a

critical perspective on the diffusion of innovations theory and its application in developing nations. According to Korpelainen (2011), the instrument was intended to be a tool for the study of the initial adoption and subsequent diffusion of IT innovations within organisations.

In line with the view of Rogers (1995), the end result of this diffusion is that people, as part of a social system, adopt a new idea, behaviour, or product. Adoption means that a person does something different from what they had previously (i.e., purchase or use a new product, acquire and perform a new behaviour, etc.). The key to adoption is that the person must perceive the idea, behaviour, or product as new or innovative.

Lastly, pertaining to the Unified Theory of Acceptance and Use of Technology (UTAUT), Korpelainen (2011), while citing Venkatesh et al. (2003), stated that the unified model came into existence having reviewed eight models which explain ICT usage, namely TRA, TAM, the motivational model, TPB, a model combining TAM and TPB, the model of PC utilisation, DOI, and the social cognitive theory. According to Korpelainen (2011), the purpose of UTAUT is to explain a user's intentions to use ICT and the subsequent user's behaviour.

6.2 Empirical Insights on ICT adoption and Stock Market Development

Empirical insights on how ICT adoption significantly influenced stock market development in Africa are outlined below.

Nazir, Nawaz & Gilani, (2010) examined the relationship between economic growth and stock market development in Pakistan. They explored the relationship between stock market development and economic growth in Pakistan for the period of 1986 to 2008 by using the two major measures of stock market development, namely; size of the market and liquidity prevalent in the market in terms of market capitalisation. Their results revealed that economic growth can be attained by increasing the size of the stock markets of a country as well as the market capitalisation in an emerging market like Pakistan.

Bahrami (2008), investigating the cumulative effect of ICT on securities, adopted the use of consumer spending overall indicator securities. These indicators include the

telephone and mobile penetration, the number of internet users and the number of PC as ICT adoption indexes. The study made findings that all indicators of ICT development have had significant effect on securities exchange development indexes. In addition, in two groups' countries, the effect of ICT on economic growth is positive.

Bharadwaj *et al* (2007) critically analysed two hundred and thirteen newspaper reports of IT failures by publicly traded firms, which occurred during a 10-year period. He noted that the reduction of publicly traded firms in Bangladesh is as a result of IT failures. Hobjin and Jovabonic (2000), in their study, recommended that stock markets are neither sufficient nor a prerequisite for promoting the development of ICT.

Furthermore, Hobjin and Jovabonic (2000), in their research which focused on the information technology revolution and the Stock Market found that more application of ICT leads to more decrease of value, but ICT destroyed the old firms and will support the entry of new firms into the market.

Lucas *et al*. (2002) critically looked into ICT and the New York stock exchange's strategic resources from 1982-1999. The results provide insights for firms that invest in IT to create a system of traditional and IT resources to obtain a sustainable competitive advantage. Ngassam and Gani (2003) examined the effect of information and communications technology on stock market development, in a sample comparing emerging markets and high-income economies. Their model confirms that personal computers and internet hosts are the two ICT variables which have strong positive effects on stock market development.

Furthermore, Hovav and D'Arcy (2005) worked on capital market reaction to defective IT products using the case of computer viruses. Their results show that the market reacts negatively to the production of flawed IT in approximately 50% of the cases. However, this negative market reaction is not statistically significant over extended periods and is limited to announcements involving certain types of defects (i.e., IT products that contain computer viruses). There was no statistically significant negative market reaction for announcements involving IT products that are susceptible to computer viruses. Toivonen *et al*., (2007) examined the impacts of information technology on the stocks and flow of a firm's intellectual capital. Based on their

analysis, the main part of IT applications serves dissemination, storing and acquisition of explicit knowledge. They present two ways: the use of IT for the development of social capital in a firm, and the use of external experts—knowledge-intensive business services (KIBS)—as supporters in firms' knowledge functions linked to IT.

Lo and Lie (2008) conducted a study on the selection of communication technologies, from the angle which is focused on information richness theory and trust. As per the results, communicators will choose a tool with high information richness when faced with a long-distance communication situation involving a highly equivocal task and a low degree of trust for the other party. However, media selection decisions for communication over short distances are not affected by either task equivocality or trust. Ashraf and Joarder 2009 examined the effect of IT on stock market trade volume and volatility: A case for Dhaka stock exchange in Bangladesh. Their results showed that the "Net" has a significant impact on these two parameters of volume and volatility of Dhaka stock market. Narcys and Heniz's (2009) stock market reaction to information and communication technology investments, from the angle of exploratory model, proposed a conceptual model describing the factors that are influenced by IT investments based on findings of studies on market reaction to major event on IT implementation announcements.

Osinubi (2002) examines whether stock market promotes economic growth in Nigeria. To achieve this objective, OLS was employed using the data from 1980 to 2000. The results indicated that there is a positive relationship between growth and all the stock market development variables used. The results of the study which established positive links between the stock market and economic growth, also suggest the pursuit of policies geared towards the rapid development of the stock market. Oke and Adeusi (2012) examined the impact of capital market reforms on economic growth in Nigeria. OLS method of regression and the Johansen cointegration analysis were employed to analyse the secondary data sourced. Results show that capital reforms positively impact economic growth.

Ohiomu and Godfrey (2011) observed the effect of the stock market on economic growth in Nigeria. OLS was employed using the data from 1989 to 2008. The results indicated that there is a positive relationship between economic growth and all the

stock market development variables used. The study affirmed positive links between the stock market and economic growth; and suggests the pursuit of policies geared towards rapid development of the stock market.

Katuma (2012, identifies the role of the stock market in economic growth in Tanzania. The study determined the factors which hinder the swift growth of Dar es Salaam Stock Exchange (DSE) and the suggested measures to be taken by DSE to promote economic development in Tanzania. Findings revealed that both market capitalisation and value of share traded contribute a small amount to the growth of the economy of Tanzania. Furthermore, the findings revealed the challenges which hinder the growth of DSE, such as lack of liquidity, low market capitalisation, poor macro-economic high transaction costs, lack of adequate track-openness, lack of skilfully human resources, and lack of public awareness of DSE.

Msangi (2015) used secondary data for the period of 1998 to 2012 and employed multiple regression analysis models whose parameters were estimated via Ordinary Least Squares (OLS) techniques to examine the determinants of capital market development in Tanzania. The study found no relationship between capital market development and stock market liquidity. Petros (2007) undertook an empirical analysis of the relationship between economic growth and its determinants with special focus on stock market development in Zimbabwe. Findings of this study suggest a positive relationship between an efficient stock market and economic growth both in the short-run and long run. Also, financial instability and inflation have a negative effect, and human capital and foreign direct investment have a positive effect on growth. The results are consistent with theoretical predictions.

6.3 SUMMARY OF RESULTS

6.3.1 Summary of Methodological Approaches

The panel data techniques were employed in this study. The primary advantages that accrue from utilising panel data techniques are that it consolidates both time series and cross-sectional investigation and the degrees of freedom increase in tandem. Panel data additionally controls heterogeneity which was basic in our investigation. The essential flight of this investigation from other comparative examinations on stock market development and ICT adoption is that it guarantees that the assessed

outcomes were dependable; a series of diagnostic tests were undertaken in order to ensure that the estimated model was well specified.

In the quest to answer the research questions, a dynamic model was specified to test the relationship between ICT adoption and Stock Market development. This model was tested using the panel data Generalised Method of Moments (GMM), a methodology that was propounded by Arellano and Bond (1991). The GMM System estimator treats combination of both difference and level equations. Instruments used for the difference equation are the delayed values of variables in levels. Before the panel data GMM was estimated, a number of econometric tests were conducted to ascertain whether the characteristics of the variables entering the tests were satisfactory. The Pooled OLS, FE and RE estimators were employed for comparison purposes (base models). Hence, the GMM estimators were used for inference as they mitigate the inherent problem of endogeneity and heteroscedasticity which were established to be present in this study.

As the data were panel data, which included a time-series component, panel unit root tests were used to examine whether the series were stationary. That is, the panel test of unit roots were first carried out in order to check for the establishment of the stationarity of the series. The test includes Levin Lin & Chu, ADF - Fisher Chi-square and PP - Fisher Chi-square tests, the Levin Lin & Chu test (panel unit root tests), was adopted, further lending credence to the notion that our indicators and data gotten from different countries were heterogeneous in their respective panels. In addition, the panel cointegration analysis in the form of Pooled Mean group was adopted to estimate the long run estimation between the variables, after ascertaining the long run relationship. As such, the pooled OLS model becomes inconsistent in estimation.

Secondly, the study tested for time (period) effects. In the event that these were detected, time dummies were added on the model. This related to instances when the time effects were detected to be present. These time effects include FFI and changes in GDP all of which have an impact on the leverage decision. Thirdly, the Breusch Pagan (1980) LM test was conducted to establish whether random effects were present. If random effects were detected, the Hausman (1978) specification test was employed to discern which estimator to use between the RE and FE estimators. In

addition, the modified Wald Test was utilised to test for group-wise heteroskedasticity. It was found to be present in most cases, if not corrected, this could lead to standard errors being biased.

All the variables besides the construct of ICT were found to be integrated of order one I(1). Since the variables were found to be I(1), panel cointegration tests could be performed on the equations with regard to testing for Cointegration. The Hausman test was conducted to select the most suitable estimator for the ARDL model and the p-value of the Hausman test is statistically insignificant rendering the PMG estimator as the most appropriate. The PMG expected that a long run coefficient is the equivalent of the group that makes up the sample. More so, we then tested for long-run and short-run causality using vector error-correction models and found bidirectional causality between stock market development and ICT development in the long run. The causal links are in both directions where stock market development causes ICT development and ICT development causes stock market development.

6.3.2 Summary of Empirical Findings

It is evident from literature that some researchers had considered Information and Communication Technology (ICT) in relation to stock market development and performance, especially in the developed and emerging countries. It is evident that significantly, studies had examined ICT relative to economic growth and some other features of finance and banking development. Therefore, it will be pertinent to note that ICT has been studied relative to various aspects of human activity. An examination of the literature implies that the effects of ICT on stock market development in Africa is not yet well researched and documented. This was underpinned by the resolution of three research questions, namely; (1) What is the impact of ICT adoption on stock market development in Africa, (2) What cointegrating relationships exist between ICT adoption and stock market development in Africa? And (3) What is the direction of causality between ICT adoption and stock market development in Africa?

6.3.2.1 Research Findings on the Impact of ICT adoption on Stock Market Development

This research effort sought to establish whether ICT adoption had an impact on stock market development in Africa. A number of proxies were employed for stock market development and ICT adoption. Further, the study utilised composite indices for stock market development and ICT adoption. By and large, the empirical results documented that ICT adoption is positively related to stock market development. ICT adoption and stock market development were cointegrated and positively related in the long run. Thus, ICT advancement also led to stock market development in Africa in the long run. The study documented a bi-directional causal relationship (complementarity) between ICT adoption and stock market development in Africa. In essence, the causal relationship indicate that ICT adoption led to stock market development and vice-versa. The channel that ICT adoption leads to stock market development, is that technology (for example mobile phones and internet) enables investors to transact with ease and buy shares on the stock exchanges. This drives upwards the stock market capitalisation and value of shares traded on the stock exchanges. Yet on the other hand, the channel by which stock market development leads to enhanced ICT adoption, is that the stock market provides capital to ICT companies which results in improved telecommunication infrastructure and mobile phone penetration. The results are discussed in turn:

- *The Impact of ICT adoption on a number of firms listed on the African stock exchanges*

The null proposition that ICT adoption has no significant effects on a number of firms listed on the African stock exchanges was rejected while its alternative was accepted, and this states that ICT adoption has a significant effect on the number of firms listed on the African stock exchanges. This finding conforms to the view of Bharadwaj (2013), who analysed two hundred and thirteen newspaper reports of IT failures by publicly traded firms, which occurred during a 10-year period. He noted that IT failures significantly decreased the number of public traded firms in the stock exchange. This finding also conforms to the view of Porteba & Summers (1988), who argued that capital markets had become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks.

- *The Impact of ICT adoption on the market capitalisation of the African stock exchanges*

Also, the null proposition that ICT adoption has no significant impact on the market capitalisation of the African stock exchanges, based on the results, failed to be rejected, and thus stands. However, this finding is in conflict with the view of Leff (1984) and Aker & Mbiti (2010), who examined the mediating relationship between ICT expansions and economic development by investigating specifically how expansions of ICT such as broadband internet services and mobile telephony have affected a country's market capitalisation. Their results indicated that the number of mobile cell subscriptions, internet users, and fixed broadband subscriptions per 100 people each have a positive and statistically strong effect on market capitalisation. Also, the findings of this study do not conform to the view of Lee, Alford, Cresson and Gardner (2017), who studied the effects of information communication technology on stock market capitalisation, using panel data analysis. Their findings show that ICT expansion is positively associated with stock market capitalisation. However, this finding supports the view another study, that stock markets are neither a necessary nor sufficient condition for promoting the development of ICT (Hobjin & Jovabonic, 2000).

- *The Impact of ICT adoption on the number of shares traded on the African stock exchanges*

Thirdly, the null proposition that ICT adoption has no significant impact on the number of shares traded on the African stock exchanges was rejected, based on the results, while its alternative was accepted and this states that ICT adoption has a significant impact on the number of value of shares traded on the African stock exchanges. These findings conform to the view of Hobjin and Jovabonic (2000), whose empirical study of the Information Technology Revolution and the Stock Market shows more application of IT resulted in a decrease of value, but IT destroyed the old firms and entered new firms into the market. Furthermore, the findings also support the view of Ashraf and Joarder (2009), in their investigation ofthe effect of IT on stock market trade volume and volatility, using a case of Dhaka stock exchange in Bangladesh. Their

results showed that the “Net” has a significant impact on these two parameters of volume and volatility of Dhaka stock market. In addition, the findings conform to the view of Mwalya (2010) who concluded in the study of the influence of ICT on returns on stocks and volume of trade in Nairobi stock exchange that adoption of information and communication technology increased the mean of daily trade volume and return.

- *The Impact of ICT adoption on the turnover ratios of the African stock markets*

Lastly, the null proposition that ICT adoption has no significant impact on the turnover ratios of the African stock markets was found to be false based on the results. This proposition is in conflict with the view of Afonso and Blanco-arana (2018), who found that the rise in ICT adoption indexes significantly influences the turnover proportion in the stock exchanges of selected OECD countries.

- *The impact of ICT adoption on stock market development (proxied by indices)*

The research finding on the impact of ICT adoption on stock market development as proxied by indices showed that the system-GMM had a consistent significant result, for example, the p-value (0.000) of the Sargan/Harsen tests of the estimations is significant. This invariably means that there is a significant effect of ICT adoption (ICTDEX) on the stock market development (FINDEX) in the selected African countries. This finding is in conformity with the view of Bahrami (2008), who investigated the cumulative effect of ICT on securities. Her finding was that all indicators of ICT development have significant effect on securities exchange development indexes. In addition, in two groups’ countries, the effect of ICT on economic growth was positive.

6.3.2.2 Research Findings on whether ICT adoption and Stock Market Development index were cointegrated

With respect to the second research question which was, what cointegrating relationships exist between ICT adoption and stock market development in Africa? The results from the analysis performed demonstrate that there is long-run relationship between stock market index, ICT index and gross domestic product which was one of

the control variables. Also, the long-run relationship between stock market index and ICT index is positive and significant at 1 percent level. This indicates that an increase in the adoption of ICT index in the long run increases the stock market indices, which implies improvement in stock market development. Furthermore, there is a significant positive long-run relationship between stock market index and gross domestic product which is significant at 10%. This implies that an improved economic growth will lead to an enhanced stock market development.

However, in the short run, the study observed an insignificant negative relationship between ICT index and stock market index. Similarly, the study also observed an insignificant negative relationship between gross domestic product and stock market index. Hence, the insignificance of the p-values for all the proxies in the short run also implies that there is no short-run cointegration.

The error correction term is negative and significant under the preferred PMG estimator. Stock market index adjusts to changes in ICT index and GDP to its long-run equilibrium at a speed of adjustment of 41.6 percent. A similar result was also noticed when financial freedom index was introduced as the control variable. However, the error correction term is negative and significant under the preferred PMG estimator. Further, the results document that stock markets in Africa adjust to changes in ICT index and financial freedom index to its long-run equilibrium at a speed of adjustment of 54.1 percent.

6.3.2.3 Research Findings on the causal relationship between ICT adoption and Stock Market Development Index

This is the empirical research findings for the causal relationship between ICT adoption and stock market development series using the tri-variate VECM within the ARDL. The results of the causality links that this study inferred are in three categories, namely; long run causality, short run causality and strong causality/joint causality.

First, the causal links are mainly in the long run and there is joint causality for the selected variables as the ECT coefficients are statistically significant. Secondly, the study found bidirectional causality between stock market development and ICT development in the long run. The causal links are in both directions where stock market development causes ICT development and ICT development causes stock market

development. And lastly, there is bidirectional long-run relationship between stock market development and financial freedom index – in the sense that the causal links are in both directions where stock market development causes financial freedom Index and financial freedom index causes stock market development.

6.4 Contribution of the Study

New knowledge: To the best of the researcher's knowledge this is the first study to examine the phenomenon of ICT-Stock market nexus employing a panel study. Moreover, this study employed a robust methodology, underpinned by the use of indices to proxy ICT adoption and stock market development. The main advantage of this approach (indices) is to limit the issue of cointegration which exists among the individual variables used for this study. The study did not just end at the first inquiry of a deterministic relationship, but also probed for cointegration of the series and tested for causality. Several studies on the general level have attempted to investigate the relevance of capital market and the stock market with respect to economic growth and development in most developed economies (refer to Adeleye & Eboagu, 2015; Vincenzo, 2013 and Shahram, 2014 among others). While emerging and developing economies are lagging behind in this area of studies, this study has added to this body of knowledge by further enhancement of the existing empirical studies. Most of the studies concentrated on the relationship that connects stock market development and economic growth (see for example; Shahram, 2014; Vincenzo, 2013; Kumar and Vu, 2014; Saeed, 2013; Okunola, 2012; Osisanwo & Atanda, 2012; Obiakor & Okwu, 2011; Donwa & Odia, 2010; Zagorchev et al., 2011; Francesco, 2011).

Another strand of studies focused on ICT as a tool in cross-border buying and selling of tangible goods, integration of exchanges and regional cooperation as well as operations in banks and financial performance (Farid, 2013; Adesola, Moradeyo & Oyeniyi, 2013; Benkraiem & Miloudi, 2012; Onwe, 2013;; Adejola, 2011; Bankole et al., 2010; Mihasonirina & Kangni, 2011).

Yet, others analysed ICT with respect to financial, information and communication, corporate governance, investor new valuation, internalisation flows, as well as socio-economic development (Fernandez et al., 2011; Oyelere & Kuruppu, 2012; Donwa & Odia, 2010). It is noteworthy that these studies did not consider how ICT significantly

influences or impacts stock exchange development, which constitutes the foundation of the stock market effect on the various indices in the areas of interest of their research. This current study contributes to closing the gap observed in the literature.

Furthermore, available studies on the effects of ICT on the development of the stock market more particularly in the last few years, have tended to focus on the developed economies, the world's leading markets and emerging and high-income economies, with only a few on developing economies like Nigeria (Hossein et al., 2013; and Ezirim et al., 2009). Interestingly, the studies on Nigeria, for instance, did not place particular emphasis on the development of the Nigerian Stock Exchange, let alone the leading stock exchanges in the African continent. Moreover, a survey of the literature indicated the likelihood that such studies are not yet available for African markets. This current study also intends to bridge this gap in knowledge and literature.

It is also evident from the review of literature that research efforts in ICT relative to macroeconomic indicators have been focused on economic activities and growth with diminutive attention for the stock markets which is the pivotal part of capital markets influencing the process of economic development and growth (Okwu, 2015). There exists a relationship dearth in the literature on the impact of ICT adoption on African stock exchange development. As earlier indicated, the available studies on the stock market on Africa are tilted toward the banking industry, with just a few on Nigerian and South African stock markets. Throughout the course of this research, the researcher found no panel study that used more than ten African countries to undertake a study on the impact of ICT adoption on African stock markets; therefore, this study has enhanced the body of knowledge in this area.

6.5 Contribution to Policy

This study further provokes the curiosity and interest to undertake research and investigate the impact of ICT adoption on the development of African stock markets, especially in this transformational regime of regional cooperation, like the signing of Africa Continental Free Trade Agreement by most major African countries which can lead to the integration of stock exchanges. This can also become a motivating influence towards global integration and an increase in the international competitiveness of African stock markets in general. This study has demonstrated the

impact of ICT adoption on stock exchanges and on the economy in general. Therefore, policy makers must continue to create the enabling environment for ICT adoption and investment in order to induce economic growth. This is supported by the positive influence of Financial Freedom on stock market development. Therefore, if African governments promulgate ICT policies that promote investments in the improvement of internet services, broadband and telephone (mobile and fixed) infrastructure, this will spur stock market development. For example, African governments can remove restriction on the repatriation of dividends or profits on ICT related investments by foreign investors and, also, they can give tax holiday for a specific period or they can give tax credit for companies that invest in ICT related infrastructure.

6.6 Directions for Future Research

This study is concentrated on Information Communications Technology (ICT) adoption and stock market development in Africa, for the period from 2008 to 2017 being a 10 (ten) year period. As a result, the findings and conclusions drawn from the study can only be deemed to be thoughtful and realistic through an extensive analysis of available data. The scope of this study is limited to the Botswana Stock Exchange (BSE), Bourse de Tunis (BVMT), The Bourse Regionale des Valeurs Mobilieres (BRVM), Casablanca Stock Exchange (Casa SE), Egyptian Exchange (EGX), Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Namibia Stock Exchange (NEX), Nigerian Stock Exchange (NSE) as well as Stock Exchange of Mauritius (SEM). Consequently, these limitations create the need for the study of a wider number of African stock exchanges and for a more extensive period.

Furthermore, when this study was conceived, the researcher sought to examine how ICT adoption (that is automation by Stock Exchanges and the adoption of technology by brokers, such as the use of internet services) has a bearing on stock market development. However, due to inadequate data and information of stockbrokers' internet usage, this idea was limited in scope. This creates an opportunity for future study to understand how stockbrokers' behaviour influences stock market development. The other research gap will also be to extend the analysis to the whole

financial sector, for example, to establish whether ICT adoption influences Stock Market Development.

Furthermore, the results show that ICT adoption still has a much greater essential function in the development of stock markets in selected African stock exchanges, in contrast to market capitalisation and market turnover ratio. We do not find any significant impact of ICT on them, when accounting for country-specific effects. Interestingly, both market capitalisation and market turnover ratio exhibit significant impacts on ICT adoption index in the OLS model when accounting for just individual countries. It can, however, be noticed that the fixed effect model fails to support the impact of ICT adoption on a number of listed firms and number of shares traded in the selected countries. One could therefore assume that there is some time-invariant heterogeneity aspect that renders ICT negligible when accounting for it. Hence, this study suggests that future research should be carried out using other estimation techniques.

Also, from the literature review, it is clear that ICT adoption leads to stock market development indirectly through some mediators. Specifically ICT adoption leads to stock market development by reducing information asymmetry, transaction costs and making the markets more efficient. Although getting measures for such mediators and inclusion of them in a model is a complex issue. This is a possible limitation to this study and also presents an opportunity for future study.

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APPENDICES

Appendix A: SAMPLE DATA - BOTSWANA AND COTE D'LVORE

COUNTRY	N/A	YEAR	NLC	SMC	SMTV	SMTR	FFI	NBU	NFTU	IU	NMU	GDP
Botswana	1	2008	10.34	41.25	1.11	3.14	0.7	8,900	142,282	6.25	1,485,791	10,945,070,442
Botswana	1	2009	10.25	38.05	1.20	2.68	0.7	10,000	137,422	6.15	1,874,101	10,267,133,178
Botswana	1	2010	10.66	31.56	0.91	3.23	0.7	11,978	137,422	6.00	2,363,411	12,786,654,366
Botswana	1	2011	11.58	26.83	0.94	3.53	0.7	19,125	149,578	9.00	2,900,263	15,351,972,230
Botswana	1	2012	11.98	28.46	0.84	2.74	0.7	22,236	160,488	16.00	3,081,726	16,067,155,187
Botswana	1	2013	10.96	33.23	1.00	3.06	0.7	21,590	174,165	30.00	3,246,787	14,901,750,765
Botswana	1	2014	11.09	31.63	0.98	3.05	0.7	33,290	169,236	36.74	3,410,507	16,250,750,259
Botswana	1	2015	11.25	30.34	0.93	3.12	0.7	36,845	160,490	37.31	3,475,327	14,420,604,206
Botswana	1	2016	11.37	30.10	0.94	3.10	0.7	59,057	142,122	39.36	3,288,986	15,646,323,341
Botswana	1	2017	10.88	30.75	0.94	3.01	0.7	32,434	141,207	41.41	3,240,589	17,406,565,823
Cote d'Ivore	2	2008	1.97	33.95	0.98	3.55	0.6	10,000	356,502	1.90	10,449,036	24,224,905,504
Cote d'Ivore	2	2009	1.93	26.42	1.06	3.75	0.6	10,000	282,070	2.00	13,184,308	24,277,494,337
Cote d'Ivore	2	2010	1.94	25.94	0.91	3.52	0.5	86,818	283,343	2.70	15,599,044	24,884,503,951
Cote d'Ivore	2	2011	1.89	27.48	0.71	1.67	0.5	95,078	276,494	2.90	17,344,242	25,381,615,976
Cote d'Ivore	2	2012	1.75	25.01	0.52	2.41	0.5	46,167	276,135	5.00	18,099,532	26,790,577,891
Cote d'Ivore	2	2013	1.71	37.83	0.88	3.11	0.5	56,281	272,145	12.00	19,390,902	31,264,184,741
Cote d'Ivore	2	2014	1.72	34.43	1.12	3.39	0.5	126,857	242,684	19.27	22,104,575	35,316,494,574
Cote d'Ivore	2	2015	1.72	35.10	1.35	4.68	0.5	109,707	277,248	38.44	25,407,610	33,131,113,901
Cote d'Ivore	2	2016	1.76	32.97	0.91	3.05	0.5	136,380	289,108	41.21	27,451,250	35,296,979,104
Cote d'Ivore	2	2017	1.73	33.07	0.96	3.33	0.5	142,825	305,562	43.84	31,747,233	38,053,610,009

Appendix B: SAMPLE DATA - EGYPT AND GHANA												
COUNTRY	**N/A**	**YEAR**	**NLC**	**SMC**	**SMTV**	**SMTR**	**FFI**	**NBU**	**NFTU**	**IU**	**NMU**	**GDP**
Egypt	3	2008	4.68	76.23	50.83	77.21	0.5	769,744	11,852,539	18.01	41,286,662	162,818,181,818
Egypt	3	2009	3.85	47.48	46.05	82.88	0.5	1,077,489	10,312,559	20.00	55,352,233	188,982,374,701
Egypt	3	2010	2.74	40.48	26.12	42.00	0.5	1,451,628	9,618,123	21.60	70,661,005	218,888,324,505
Egypt	3	2011	2.73	27.83	11.13	24.20	0.5	1,845,249	8,714,286	25.60	83,425,145	236,001,858,960
Egypt	3	2012	2.71	19.18	5.86	31.90	0.4	2,288,773	8,557,497	26.40	96,798,801	279,372,758,362
Egypt	3	2013	2.66	20.59	5.10	21.43	0.4	2,676,263	6,820,892	29.40	99,704,976	288,586,231,502
Egypt	3	2014	2.72	21.00	6.23	41.22	0.4	3,067,878	6,315,915	33.89	95,316,034	305,529,656,458
Egypt	3	2015	2.70	18.62	6.15	23.83	0.4	3,826,410	6,235,133	37.82	94,016,152	332,698,041,031
Egypt	3	2016	2.66	12.61	3.53	24.02	0.4	4,469,164	6,118,250	41.25	97,791,441	332,927,833,278
Egypt	3	2017	2.61	13.79	4.24	44.45	0.4	5,223,311	6,604,849	44.95	102,958,194	235,369,129,338
Ghana	4	2008	1.32	8.81	0.72	11.42	0.5	22,980	143,900	4.27	11,570,430	28,526,891,010
Ghana	4	2009	1.28	9.11	0.56	2.19	0.6	28,401	267,389	5.44	15,108,916	25,977,847,814
Ghana	4	2010	1.25	8.48	0.24	3.73	0.6	52,085	277,897	7.80	17,436,949	32,174,772,956
Ghana	4	2011	1.14	7.63	0.45	8.41	0.6	65,149	284,721	9.00	21,165,843	39,566,292,433
Ghana	4	2012	1.12	7.46	0.33	1.72	0.6	68,132	284,981	10.60	25,618,427	41,939,728,979
Ghana	4	2013	1.09	8.30	0.19	5.49	0.6	68,795	270,422	15.00	28,026,482	63,277,216,921
Ghana	4	2014	1.18	8.20	0.35	4.31	0.6	70,170	260,407	25.52	30,360,771	53,601,126,665
Ghana	4	2015	1.16	8.01	0.31	4.73	0.6	73,132	275,570	31.45	35,008,387	49,181,854,795
Ghana	4	2016	1.14	7.92	0.32	4.94	0.6	86,596	251,490	34.67	38,305,078	55,009,730,589
Ghana	4	2017	1.13	7.98	0.30	4.24	0.6	56,810	301,551	37.88	36,751,761	58,996,776,244

Appendix C: SAMPLE DATA - KENYA AND MAURITIUS												
COUNTRY	**N/A**	**YEAR**	**NLC**	**SMC**	**SMTV**	**SMTR**	**FFI**	**NBU**	**NFTU**	**IU**	**NMU**	**GDP**
Kenya	5	2008	1.38	35.84	2.80	5.77	0.5	3,282	646,356	5.20	16,303,573	35,895,153,328
Kenya	5	2009	1.34	27.95	1.18	1.92	0.5	18,200	664,099	6.10	19,364,559	37,021,512,049
Kenya	5	2010	1.31	31.15	1.21	6.37	0.5	6,866	380,748	7.20	24,968,891	40,000,088,347
Kenya	5	2011	1.34	28.36	1.95	7.71	0.5	54,144	283,546	8.80	28,080,771	41,953,433,591
Kenya	5	2012	1.35	25.35	1.96	7.90	0.5	54,348	251,567	10.50	30,731,754	50,412,754,861
Kenya	5	2013	1.34	29.73	2.53	5.93	0.5	74,144	204,354	13.00	31,830,003	55,096,728,048
Kenya	5	2014	1.39	28.51	2.30	5.97	0.5	101,813	179,990	16.50	33,632,631	61,448,046,802
Kenya	5	2015	1.34	28.62	1.26	6.78	0.5	135,107	85,496	16.60	37,715,944	64,007,750,179
Kenya	5	2016	1.33	28.11	1.06	6.86	0.5	152,992	72,801	16.60	38,982,188	69,188,755,511
Kenya	5	2017		28.06	1.82	6.69	0.5	288,303	69,861	17.83	42,815,109	78,757,391,333
Mauritius	6	2008	52.25	68.95	4.11	5.06	0.6	52,511	363,600	21.81	1,033,300	9,990,370,016
Mauritius	6	2009	51.31	58.92	3.58	6.33	0.7	72,875	375,160	22.51	1,086,748	9,128,843,109
Mauritius	6	2010	49.58	72.49	3.57	5.03	0.7	93,922	387,700	28.33	1,190,900	10,003,670,690
Mauritius	6	2011	50.30	70.60	3.92	6.27	0.7	118,235	374,600	34.95	1,294,100	11,518,393,367
Mauritius	6	2012	47.78	63.15	3.38	4.01	0.7	140,800	349,100	35.42	1,485,800	11,668,685,524
Mauritius	6	2013	50.05	65.89	2.52	4.02	0.7	162,400	363,000	40.12	1,533,600	12,129,642,296
Mauritius	6	2014	52.34	70.16	3.11	5.16	0.7	182,000	372,200	44.80	1,652,000	12,803,445,934
Mauritius	6	2015	56.23	64.89	3.77	6.07	0.7	197,400	380,000	50.14	1,762,300	11,692,287,066
Mauritius	6	2016	59.36	60.75	3.20	4.30	0.7	212,600	389,500	52.19	1,814,000	12,232,463,656
Mauritius	6	2017	58.52	66.99	2.97	5.06	0.7	246,000	413,100	55.56	1,839,500	13,259,351,418

Appendix D: SAMPLE DATA - MOROCCO AND NAMIBIA												
COUNTRY	**N/A**	**YEAR**	**NLC**	**SMC**	**SMTV**	**SMTR**	**FFI**	**NBU**	**NFTU**	**IU**	**NMU**	**GDP**
Morocco	7	2008	2.44	82.54	20.89	29.89	0.4	493,228	35,000	33.10	22,815,694	92,507,257,784
Morocco	7	2009	2.38	69.53	11.39	46.54	0.5	479,503	43,179	41.30	25,310,761	92,897,320,376
Morocco	7	2010	2.26	74.06	7.41	8.83	0.6	504,499	42,910	52.00	31,982,279	93,216,746,662
Morocco	7	2011	2.29	65.34	5.17	6.18	0.6	595,207	44,495	46.11	36,553,943	101,370,474,295
Morocco	7	2012	2.29	55.30	3.73	6.43	0.6	689,541	45,743	55.42	39,016,336	98,266,306,615
Morocco	7	2013	2.22	50.52	3.20	6.00	0.6	843,940	46,850	56.00	42,423,794	106,825,649,872
Morocco	7	2014	2.16	48.25	2.84	5.72	0.6	993,451	50,610	56.80	44,114,534	110,081,248,587
Morocco	7	2015	2.13	45.18	2.74	6.39	0.6	1,147,533	49,085	57.08	43,079,696	101,179,808,076
Morocco	7	2016	2.11	50.19	2.96	6.13	0.6	1,255,428	46,575	58.27	41,513,933	103,345,296,967
Morocco	7	2017	2.05	56.76	3.37	6.79	0.6	1,378,867	47,013	61.76	43,916,066	109,708,728,849
Namibia	8	2008	3.43	7.24	0.19	3.17	0.5	320	145,360	5.33	1,052,000	8,486,721,917
Namibia	8	2009	3.36	8.88	0.22	1.75	0.5	477	148,672	6.50	1,631,576	8,876,191,121
Namibia	8	2010	3.30	10.28	0.22	1.08	0.4	9,435	157,063	11.60	1,950,072	11,282,192,605
Namibia	8	2011	2.78	9.51	0.14	5.14	0.4	17,610	159,059	12.00	2,194,495	12,409,629,836
Namibia	8	2012	3.19	8.95	0.27	2.32	0.4	24,053	171,249	12.94	2,146,833	13,016,272,899
Namibia	8	2013	3.58	11.39	0.34	3.94	0.4	35,740	183,532	13.90	2,727,913	12,717,790,505
Namibia	8	2014	3.52	13.88	0.39	2.84	0.4	41,212	182,593	14.84	2,670,983	12,786,078,008

Namibia	8	2015	3.46	15.21	0.27	3.06	0.4	70,408	182,507	25.69	2,549,817	11,650,656,642
Namibia	8	2016	3.39	17.97	0.28	3.46	0.4	64,343	187,853	31.03	2,659,951	11,286,139,080
Namibia	8	2017	4.16	20.55	0.31	3.13	0.4	65,779	193,045	36.84	2,680,196	13,566,192,143

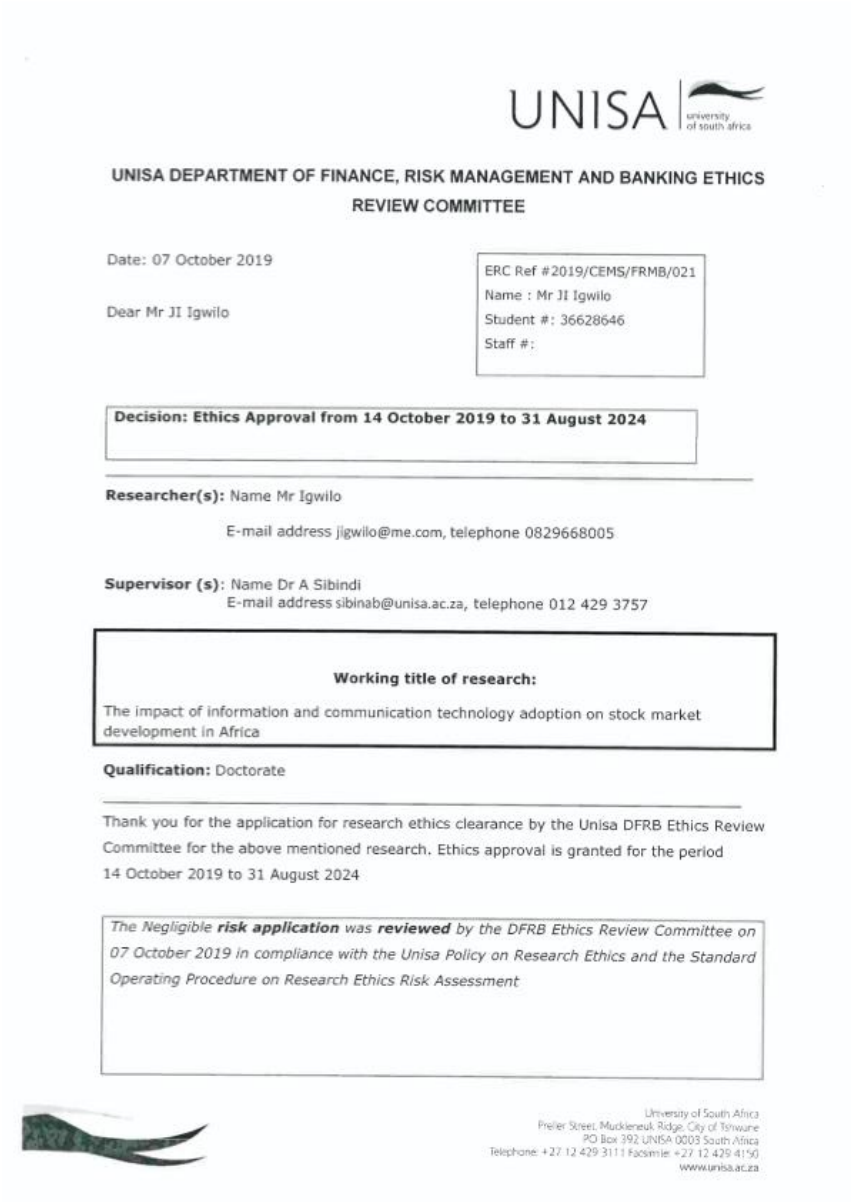
Appendix E: SAMPLE DATA - NIGERIA AND SOUTH AFRICA												
COUNTRY	**N/A**	YEAR	**NLC**	**SMC**	**SMTV**	SMTR	**FFI**	**NBU**	**NFTU**	**IU**	**NMU**	**GDP**
Nigeria	9	2008	1.41	21.36	5.34	23.22	0.4	67,776	1,307,625	8.00	62,988,492	337,035,512,677
Nigeria	9	2009	1.39	12.11	3.13	12.71	0.4	81,958	1,482,000	9.30	74,518,264	291,880,204,327
Nigeria	9	2010	1.36	11.32	1.32	12.42	0.4	99,108	1,050,237	11.50	87,297,789	363,359,886,203
Nigeria	9	2011	1.20	10.92	1.09	8.64	0.4	33,736	719,406	13.80	95,167,308	410,334,579,161
Nigeria	9	2012	1.13	10.34	0.87	8.62	0.4	14,279	418,166	16.10	112,777,785	459,376,049,764
Nigeria	9	2013	1.09	13.24	1.00	9.13	0.4	15,045	360,537	19.10	127,246,092	514,966,287,334
Nigeria	9	2014	1.07	12.67	1.00	7.13	0.4	15,740	183,290	21.00	138,960,320	568,498,937,616
Nigeria	9	2015	1.01	10.36	0.85	7.97	0.4	15,688	187,155	24.50	150,830,089	494,583,180,777
Nigeria	9	2016	0.91	8.66	0.60	4.31	0.4	107,931	154,513	25.67	154,342,168	404,649,527,538
Nigeria	9	2017	0.87	8.28	0.46	7.09	0.4	110,834	139,344	27.68	144,920,170	375,745,486,521
South Africa	10	2008	7.37	212.68	75.07	33.23	0.6	426,000	4,875,000	8.43	45,000,000	286,769,029,768
South Africa	10	2009	6.99	215.51	70.90	34.11	0.6	481,000	4,868,000	10.00	46,436,000	295,937,388,336
South Africa	10	2010	6.87	247.80	70.81	29.81	0.6	743,000	4,861,000	24.00	50,372,000	375,348,316,918
South Africa	10	2011	6.67	208.89	61.35	25.96	0.6	907,000	4,854,000	33.97	64,000,000	416,417,032,179
South Africa	10	2012	6.40	202.73	53.97	28.24	0.6	1,107,200	4,847,000	41.00	68,394,000	396,329,389,720
South Africa	10	2013	6.00	234.83	58.24	26.97	0.6	1,615,210	3,875,582	46.50	76,865,278	366,644,891,407
South Africa	10	2014	5.90	256.20	65.32	27.35	0.6	1,706,313	3,647,770	49.00	79,280,731	350,637,643,679

South Africa	10	2015	5.71	243.06	70.19	30.32	0.6	1,409,347	4,131,055	51.92	87,999,492	317,415,623,434
South Africa	10	2016	5.39	270.28	102.46	50.35	0.6	1,150,770	4,522,850	54.00	82,412,880	296,340,945,653
South Africa	10	2017	5.16	328.36	123.25	35.77	0.5	1,123,189	4,810,074	56.17	88,497,610	349,268,114,387

Appendix F: SAMPLE DATA – TUNISIA

COUNTRY	N/A	YEAR	NLC	SMC	SMTV	SMTR	FFI	NBU	NFTU	IU	NMU	GDP
Tunisia	11	2008	4.80	13.24	2.41	25.04	0.3	227,328	1,239,074	27.53	8,602,164	44,856,586,316
Tunisia	11	2009	4.94	17.24	3.00	16.98	0.3	372,887	1,278,548	34.07	9,797,026	43,454,935,940
Tunisia	11	2010	5.27	21.96	4.09	18.97	0.3	482,204	1,289,585	36.80	11,114,206	44,050,929,160
Tunisia	11	2011	5.31	22.34	3.19	10.27	0.3	559,358	1,217,781	39.10	12,387,656	45,810,626,509
Tunisia	11	2012	5.44	19.54	2.43	14.22	0.3	527,308	1,098,893	41.44	12,843,889	45,044,112,939
Tunisia	11	2013	6.48	18.55	1.82	5.38	0.3	519,984	1,021,979	43.80	12,712,365	46,251,061,734
Tunisia	11	2014	6.96	17.79	1.38	10.47	0.3	567,539	949,395	46.16	14,283,633	47,632,326,088
Tunisia	11	2015	6.98	18.99	2.58	11.86	0.3	573,977	943,642	46.50	14,595,875	43,152,528,548
Tunisia	11	2016	6.99	19.69	2.28	10.44	0.3	640,267	974,129	49.60	14,282,078	41,808,379,888
Tunisia	11	2017	7.08	20.49	2.10	10.48	0.5	801,785	1,113,168	55.50	14,334,080	39,952,095,561

Appendix G: ETHICS CERTIFICATE



UNISA university of south africa

UNISA DEPARTMENT OF FINANCE, RISK MANAGEMENT AND BANKING ETHICS REVIEW COMMITTEE

Date: 07 October 2019

ERC Ref #2019/CEMS/FRMB/021
Name : Mr JI Igwilo
Student #: 36628646
Staff #:

Dear Mr JI Igwilo

Decision: Ethics Approval from 14 October 2019 to 31 August 2024

Researcher(s): Name Mr Igwilo

E-mail address jigwilo@me.com, telephone 0829668005

Supervisor (s): Name Dr A Sibindi
E-mail address sibinab@unisa.ac.za, telephone 012 429 3757

Working title of research:

The impact of information and communication technology adoption on stock market development in Africa

Qualification: Doctorate

Thank you for the application for research ethics clearance by the Unisa DFRB Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 14 October 2019 to 31 August 2024

*The Negligible **risk application** was **reviewed** by the DFRB Ethics Review Committee on 07 October 2019 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment*

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