IMPACT OF DIGITAL BANKING ON BANKS' PROFITABILITY: STUDY ON SRI LANKAN BANKING INDUSTRY

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Degree of Master of Science

Department of Mathematics

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Name of the supervisor: Mr. T. M. J. A. Cooray

Siganture of the supervisor: ……. Date: …….

ABSTRACT

Information Technology is widely used in development and outspreading of banking options. Banking sector is more into digital banking in the current world. A number of studies are carried out on digital banking worldwide. In Sri Lankan context, a quantitative analysis on the bank performance and digital banking aspects was not found. This study attempts to fill this gap by analyzing quarterly data from year 2010 to 2018. Data were obtained from Payment and Settlement Department of Central Bank of Sri Lanka and Central Bank Web site. Bank performance is identified by the return on assets (ROA) before tax. From number of digital banking aspects, the variables used in this study are, number of internet banking transactions, number of point-of-sale (POS) machine transactions and number of mobile banking transactions (MOBT). Time effectiveness and the cost effectiveness of digital banking is discussed in the study. Augmented Dickey Fuller Test was used to check the stationarity of the variables. Since the stationarity test revealed that all the four variables become stationary at the 1^{st} difference, cointegration of the variables were drawn through Johansen Cointegration Test. Trace test indicated four cointegration equations and Max-Eigen Statistic test indicated only one cointegration equation at the 5% level. Hence Vector Error Correction Model (VECM) was fitted to determine the long run equilibrium. Model showed that there exists a very stable long run association that, when the system is deviated from the equilibrium, it is corrected by 63.36% increase in the ROA per quarter. Impulse Response Function was employed to illustrate the importance of each digital banking aspect to banking sector profitability when a shock is imposed to the system. It is observed that the POS transactions affects profitability positively, while internet banking and mobile banking showed a negative impact on profitability. In the short run, internet banking and POS transactions showed an association with profitability. This study recommends that adequate consideration must be given to digital banking in policy implementation with regards to banking sector.

Key words: ROA, INTERNET, ATM, POS, MOBT, VECM

DEDICATION

I dedicate this Thesis to

God Almighty for the gift of life

and my family

for their love, encouragement and understanding.

ACKNOWLEDGEMENT

Apart from my effort, the completion of this report depends on the encouragement and support of many others. I take this opportunity to express my heartfelt gratitude to those who have helped me in completing this study.

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LIST OF ABRIVIATIONS

AIC	- Akaike Information Criterion
ATM	- Automatic Teller Machine
CBSL	- Central bank of Sri Lanka
CCT	- Call Centre Transactions
FATF	- The Financial Action Task Force
IRF	- Impulse Response Function
ICT	- Information and Communication Technology
LB	- Licensed Banks
LCB	- Licensed Commercial Banks
LSB	- Licensed Specialized Banks
MENAFATF	- Middle East & North Africa Financial Action Task Force
MOBT	- Mobile Banking Transactions
PBT	- Profit Before Tax
POS	- Point of Sale
PSD	- Payments and Settlements Department of CBSL
ROA	- Return on Assets
ROE	- Return on Equity
RTGS	- Real Time Gross Settlement System

SLIP - Sri Lanka Interbank Payment

VAR - Vector Auto Regression

VECM - Vector Error Correction Model

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Financial system plays the role of backbone of the country's economy. An established financial system ensures the way for achieving a stabilized economy of a country. The banking system is considered as the most prominent segment that involves with the financial system which facilitates the money flow in an economy and ensures financial resources are allocated efficiently in supporting economic growth and development. Pierre Monnin and Terhi Jokipii (2010) have shown that future output growth of a country becomes uncertain with non-stable banking sector. It is stated that a stabilized banking sector is considered a significant factor of GDP growth of a country. In the means of economic policy implementation of a country, a considerable attention must be given to banking sector.

Information Technology (IT) has influenced almost every sectors. Among them the banking sector was given a considerably important place. Sumra S., Manzoor M., Sumra H. and Abbas M. (2011) showed that involvement of Information Technology has revolutionized the operations of banks. Technology is used as a main support for the success of an organization. Globalization, technological changes and advanced development in different economies' financial system especially in this 21st century have really changed the dynamics of financial transactions globally. Rapid development in ICT Sector, have removed the narrowed digital drive and turned business sphere into an electronic world.

According to the World Payments Report 2018, Global non-cash payments volume has hit 482.6 billion, grown at the percentage of 10.0% in 2016. Emerging Asia, in which Sri Lanka includes has contributed 25.2% on this growth while the contribution of Central Europe, Middle East and Africa is recorded as 17.1%. Growth rates were enhanced in

emerging markets to 16.5% value, under the governments' exertion in increasing financial inclusion, enhancing of mobile based payments etc. Mobile payments growth in India is 33.2%, while the growth of China and South Africa are 25.8% and 15.1%. Global non-cash transactions have achieved a growth rate of 12.7% compounded annually. Emerging Asia is expected to reach a compound annual growth rate of 28.8% by the year 2021, driven mostly by sustainable digital modernization, implementation of mobile based payments and establishment of financial inclusion aspects. Further, globally the volume of e-wallet transactions are estimated to be nearly 41.8 billion in year 2016, including 8.6% of total non-cash transactions. With the concept of e-wallet, large global companies like Google, Amazon, Apple, Alibaba and Facebook have the potential of expanding their respective markets. Such companies are leveraging their user base, giving much attention on the providing of vast user experience, value added services with the use of network features to make an impact on the profit. The report suggests that the small companies must also invest on the technological platforms, in order to compete with them.

The banking sector of Sri Lanka has stepped towards a digital world. Many digital revolutions have taken place in banking sector. Banking industry of Sri Lanka is at a transforming stage, as it walks towards a digital society. In order to upgrade the infrastructure for implementing digital banking of Sri Lanka, many investments have taken place. Banking industry of Sri Lanka has been transformed from physical banking to branchless banking with the speedy increase in the use of internet and other IT inventions. As an agent, it is foremost need of bank to have latest technology and highly developed services which increase trading, exports and improve industry as a gift of globalization.

Being a developing country, Sri Lanka has adopted new trends in electronic banking area. Claessens et al (2001) mentions that the impact caused by e-finance is not restricted to industrial countries and the most developed markets. He states that, an opportunity of leapfrogging has been emerged for the countries with an underdeveloped e-finance

systems. Digital banking concept has been penetrated into Sri Lankan banking sector. Roche I. D, showed in the study done on how the service quality of internet banking and corporate image affects the customer satisfaction, that in the era after the ethnic war, Sri Lankan banking sector grew rapidly, contributing in the country's GDP. By the year 2012, 56% of the total assets were assigned in finance sector. Fast growth of the use of internet banking in the country may have caused this.

There are numerous advantages identified in digital banking. Through automation of the services, staff cost of the banks can be controlled. Through the use of digital banking, physical cash circulation is reduced. The harm happens to the physical cash notes is minimized resulting the cost of printing of the cash notes low. The insecurity of transporting money is minimized with the enhancement of using digital banking. Customer satisfaction is enhanced through providing value added services through digital banking options. This resulted in attracting potential customers to the banks. Enhanced banking products such as transacting through web portal or mobile apps are identified as an ideal method for the current busy world. Another very important advantage in digital banking is since all the transactions happens through digital banking portal, are recorded with the banks, providing a trail of money transferred making scope for investigation on money laundering and terrorist financing. Financial Action Task Force Report provides evidence that physical transportation of cash opens roads for money laundering. Cash is widely used in criminal economy. The report, 'Money Laundering through the Physical Transportation of Cash' issued by FATF and MENAFATF (2015) provided information on this fact.

This study discusses about the disadvantages in digital banking products too, in order to enhance the awareness on this regard. Though digital banking is a highly discussed topic over generations, there are many underlying infrastructure established in order to use the products. Computer illiteracy of the customers is a major drawback when introducing digital banking. Another fact is that, ATMs are not located in rural areas. Hence the residents in such areas do not witness the earlier discussed advantages of digital banking.

Also, when ATMs form system errors, the customers face many difficulties. Further, ATM frauds are common, resulting customers discourage in using ATMs. Network connection must be errorless in order to use digital banking options. Further, large expenses were incurred in establishing digital banking such as transaction web site. The expected profit considered with the cost may not have gained. In that context, digital banking can be ineffective. Such issue can be addressed with having proper advertising, developing user friendly websites etc.

A wide discussion on advantages and disadvantages is presented in the chapter 2, Review of Literature.

1.2 Digital payment platform of Sri Lanka

The concept of digital banking or cashless banking is not a new concept in Sri Lankan banking industry. Sri Lankan banking system is enriched with numerous digital banking portals. As depicted in the annual report of Central Bank of Sri Lanka 2018, Sri Lanka is enriched with a literacy rate of 92.6% by 2017. When the physical, social and financial infrastructure facilities are considered, 100 persons have 11.5 fixed telephone lines. When mobile phone facilities are also counted in, 161.5 units are owned by 100 persons. Internet usage including mobile internet services of 100 persons has hit 33.5. For 100,000 persons, 7,916 credit cards are in use. Banks density is explained as 16 bank branches for 100,000 persons. Automatic Teller Machines (ATMs) situation is assessed to be 21 for 100,000 persons. These statistics gives the picture that the customers have more opportunity to be familiar with and engage in digital banking. With these kind of infrastructure, customers are more tend to use digital banking platform rather than visiting branch banks.

As shown in the Payments Bulletin fourth quarter of 2018 published by PSD of CBSL, when considering the Sri Lankan financial sector, digital banking transactions are performed through both large value payment system and retail payment system in Sri Lanka. Real Time Gross Settlement System (RTGS) is a large value payment system.

Further, cheques transactions, Sri Lanka Interbank Payment (SLIP) system, payment cards credit and debit card transactions done through ATM and point of sale (POS) terminals, mobile phone based transactions, internet based payments, tele banking and postal instruments can be shown as retail payment systems and instruments.

1.3 Scope of the study

Financial sector of Sri Lanka

Banking Sector of Sri Lanka comprised with the Central Bank of Sri Lanka, Licensed Commercial Banks (LCBs) and Licensed Specialized Banks (LSBs). As depicted in the CBSL Annual Report 2018, banking sector of Sri Lanka currently armed with 32 licensed banks where 26 of them are licensed commercial banks and 6 of them are licensed specialized banks. Out of 26 licensed commercial banks, 13 are Sri Lankan incorporated and other 13 are foreign banks. All the licensed specialized banks are local. By the end of year 2018, 6185 licensed commercial banks outlets have been functioning in Sri Lanka. Apart from these the Sri Lankan financial sector consist with 43 licensed financial companies (LFCs) and 6 leasing companies. When considering the financial system of the country, 72.5% is the banking sector, while other deposit taking financial institutions (LFCs, Thrift and Credit Co-operative Societies and Co-operative Rural Banks) owns 8.1%. Contractual savings institutions such as specialized leasing companies (SLCs), primary dealers etc. own 1.4% while contractual savings institutions (Insurance Companies, EPF, ETF etc.) owns 18% of the financial system of the Sri Lanka.

Though other financial sectors also engage in digital banking, this study is carried out considering the digital banking figures of only the Sri Lankan Banking Sector. Data relating to digital banking features of the banking sector is considered and analyzed in this study. Overall banking sector profitability of the country is used as the dependent variable.

Digital banking can be decomposed into various channels. In this study, three channels, namely internet banking transactions, POS machine transactions and mobile banking transactions were included to the model as the independent variables.

1.4 Research problem

According to Gutpa N, Gupta S, (2017), digital banking is described as financial transactions which are not done in the form of physical banknotes or coins, but done as the transmission of digital information among the transacted parties. World today is more in to use digital banking considering the effectiveness and efficiency. There the problem arouse, 'does digital banking influence the profitability of the banking sector?'

Conducting a study to ascertain the possible association between the digital banking aspects and the bank profitability has become more imperative. The determination of this study is to observe how the digital banking aspects associates with the profitability of the banking sector.

1.5 Research question

The research question can be implied as, 'Is there any impact of digital banking on banks' profitability: A study on Sri Lankan banking industry?'

To carry out this study, three proxies for digital banking were selected, considering the popularity and referring to the existing literature. They are namely number of internet transactions, POS machine transactions and mobile banking transactions. The variable, Return on Assets (ROA) was selected as the dependent variable.

1.6 Research objectives

The following objectives to be achieved in this study.

I. Discussion of current situation of digital banking in Sri Lankan context.

II. Explore the structure of the digital banking of Sri Lanka.
III. Examine the impact of digital banking on the profitability of the banking industry.
IV. Suggest the future developments for the digital banking Concept.

1.7 Significance of the study

Upon completion of this study, it will contribute more to the existing literature on the impact of digital banking, which is widely discussed concept worldwide.

Many researches were being carried out on this regard worldwide. It is observed that in Sri Lanka, research on this topic is minimal. No research was found which analyzed time series data in Sri Lankan context. Hence this study contributes in filling that gap.

This study gives the impression to the policy makers that the bank charges imposed on the various digital banking options must be reduced in order to encourage the public to use these options more.

1.8 Collection of data

Data were collected for 9 years from 2010 Quarter 1 to 2018 Quarter 4. All the data were acquired from the Central Bank of Sri Lanka.

1.9 Chapter Outline of the Study

The thesis comprises of five chapters. The second chapter presents a review of literature followed by the third chapter which elaborates the research methodology. The results of the data analysis and discussion is included in the chapter four. The fifth chapter concludes the study.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

The use of internet in banking has opened new paths and scenarios for the banks to stretch out their functions. Retail banking is in to digital banking or electronic banking and it work towards gaining better productivity through digitalizing its functions such as deposits and withdrawals, fund transfers, Account Inquiry and Account creating. Digital banking is also considered as less time consuming and more productive method in delivering services to the customers. Yang S, Li Z, Ma Y and Chen X (2017) shows that in the perspective of the customer, important motivation of consumption of banking products was dragged by convenience and great range of available e-banking products. Sri Lankan Banking Industry is also on the process of digitalization. Most of the banks and financial institutions have executed digitalization projects. A competition is also being created among the banks in order to attract the customers by establishing digital banking options. Maldeni and Jayasena (2009) states that the impact of Information and Communication Technology (ICT) on the organizational performance, is significant and positive. Further, growth and competitiveness of banks are influenced by the way new technologies are used in applications successfully.

According to, Kamboh, K.M and Leghari M.E.J. (2016), digital banking is an innovative way of providing the banking services to its customers without or minimum involvement of cash. Kamboh, K.M states that Pakistani Banking industry is in a transforming age, in order to make the banks more profitable, many investments have been taken place to enhance the development of digital banking infrastructure. Huge investments on developing infrastructure on digital banking platforms are made. The study has shown that the POS transactions and mobile banking transactions show a positive and significant impact on banks' profitability, while ATM Transactions and call center transactions were negatively impacted on the profitability.

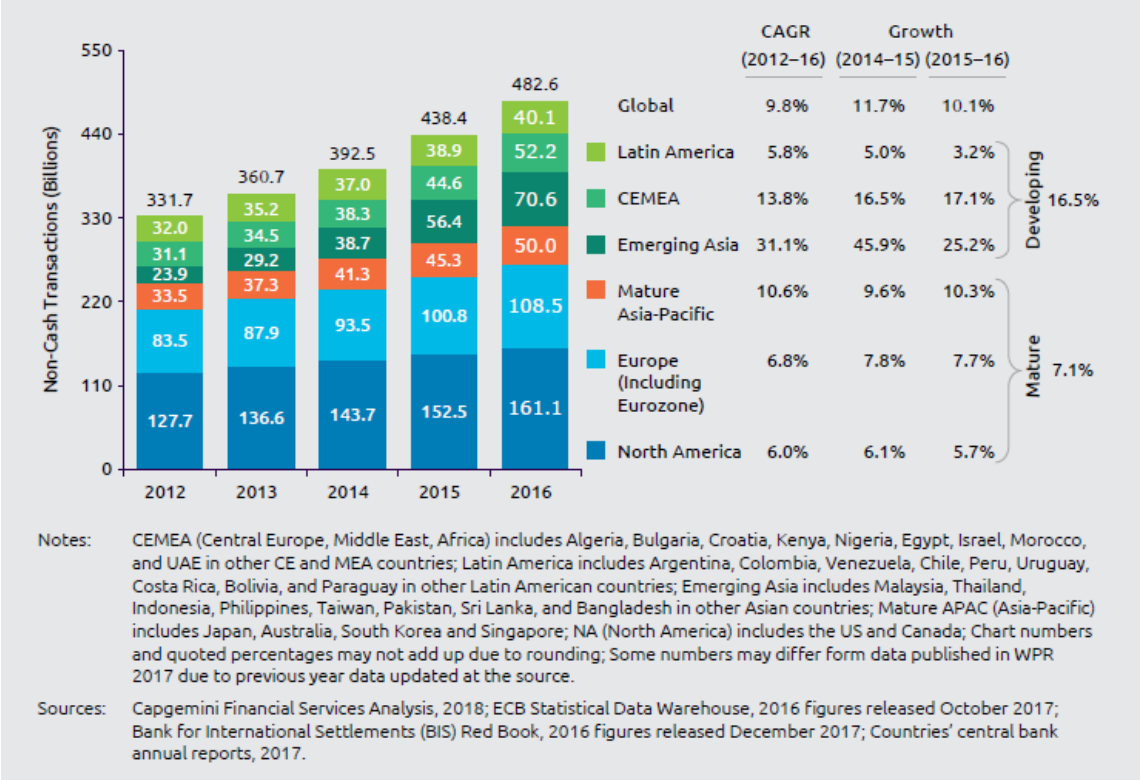
Sumra S.H., Manzoor M. K., Sumra H.H. and Abbas M. (2011) depicts that the electronic banking services provided by the financial institutions includes ATM, credit card, fund transfer, cheque payments, bank drafts, pay orders, deposits, balance inquiry, utility bills payments, issuance of account statements, remittances, mobile banking, phone banking and PC banking. The manual banking scenario is considered as lengthier and time consuming. Due to human errors, accuracy can be reduced when maintaining of the accounts and transfers manually. When the human involvement exits, the labor cost is also must be counted. When the computers are taken place for the employees, the labor cost is decreased and the accuracy of the services is enhanced. Hence, customer satisfaction is aroused on the delivery methods of the banks making efficient performances of banks. The main purpose of the banks to switch to the electronic resources is identified as to escalation of the clientage and enhance customers' loyalty. Financial statements of the banks are also analyzed in this study that had shown that the profitability of the Pakistani banks were increased to a large extent by incorporating electronic banking.

According to Felix U. O., Rebecca U. I., Igbinoba O. K. (2015), with the use of information technology, electronic banking is used to drive business banking towards immediate and future goals in Nigeria. Customers are offered with the easily accessible account operating on-line, without reaching the bank branches. The risk is emerged at the banks that were not adopted with this development to lose their customers. Central bank of Nigeria (CBN) has implemented new cash policy with the aim of gaining economic growth, reducing the cost of banking and improving the effectiveness of the banking through electronic banking. Some of the negative consequences of using cash such as high cost of cash, risk of handling cash, high inefficiency and fraud evolve with cash have been minimized with the new cash policy. Here the author has drawn the research to a different path stating that, though digital banking has helped banking service and value added benefits to the social wellbeing, there can also be drawbacks of internet banking such as misuses and network failures. It is mentioned that Nigeria is a major hub of

electronic frauds. In such a situation, electronic banking can be used for frauds. The study suggests that the adequate plans must be initiated to make the public aware of the advantages of using electronic banking and adequate procedures to check possible disadvantages. It is suggested that the Central Bank of Nigeria must take actions to issue adequate legislations on e-banking and cashless society in a manner of protecting both the service providers and the public.

Cashless Economy or Society doesn't mean that there are no involvement of cash or outright absence of hard cash. Nyoni and Bonga (2017) conveys that the volume of cash based transactions are significantly reduced to the bearable minimum is meant by cashless economy. In a background of cash crisis emerged in Zimbabwe, the paper emphasizes that the need of the development of cashless economy is encouraged by the cash crisis. It is shown, that the increased usage of digital transaction might enhance the effectiveness of the monetary policy of the country, especially in terms of reducing the cash circulation, hence able to maintain a smooth control over inflationary pressure. The author has identified the plus points of digital banking as, faster transactions, reduced costs, improvement of hygiene on site, increased sales, easy cash collection, reduced cash related crimes and availability of credit etc. The study further recommends that since electronic payments are capital intensive, the government must collaborate to finance the infrastructure underlying the electronic payments. Further, government must aware the public adequately.

According to the World Payment Report-2018, development of new payment systems open new prospects in transaction banking and payments. Global non-cash transactions compound annual growth rate is 10.1% and reached 486.2 billion transactions by 2016 (Figure 2.1). The main growing regions are Emerging Asia and Central Europe, Middle East and Africa (CEMEA). The report showed that market of electronic wallet has grown more rapidly with an estimated transaction volume of 41.8 billion.



Notes: CEMEA (Central Europe, Middle East, Africa) includes Algeria, Bulgaria, Croatia, Kenya, Nigeria, Egypt, Israel, Morocco, and UAE in other CE and MEA countries; Latin America includes Argentina, Colombia, Venezuela, Chile, Peru, Uruguay, Costa Rica, Bolivia, and Paraguay in other Latin American countries; Emerging Asia includes Malaysia, Thailand, Indonesia, Philippines, Taiwan, Pakistan, Sri Lanka, and Bangladesh in other Asian countries; Mature APAC (Asia-Pacific) includes Japan, Australia, South Korea and Singapore; NA (North America) includes the US and Canada; Chart numbers and quoted percentages may not add up due to rounding; Some numbers may differ form data published in WPR 2017 due to previous year data updated at the source.

Sources: Capgemini Financial Services Analysis, 2018; ECB Statistical Data Warehouse, 2016 figures released October 2017; Bank for International Settlements (BIS) Red Book, 2016 figures released December 2017; Countries' central bank annual reports, 2017.

Figure 2.1: Region wise number of world-wide non cash transactions, from 2012 to 2016

2.2 Advantages of digital banking

Existing literature revealed the benefits e-banking brings to banking sector. It can be explained in the means of efficiency, cost effectiveness, value added services for customers, enhanced acquiring of clients, and an enhancement of bank's reputation. Felix U. O., Rebecca U. I. and Igbinoba O. K. (2015) emphasize that e-payments offer benefits to customers like, privacy, reliability, compatibility, time efficiency, mobility, acceptability, convenience and low financial risk, which the traditional methods of transactions can never provide. Further, businesses, benefit by e-payments in the means of cost reduction, increasing cash flow, providing attractive customer service, enhancing customer base and improving competitiveness.

Odior E. S. and Fadiya .B. B shows that the growth of e-money could lead to the weakening in currency demand. Cash is expensive. Printing cost of physical cash notes is high and cost of moving cash to different location is expensive. This makes sense that it is important to reduce the usage of physical cash.

Kamboh, K.M and Leghari M.E.J (2016) shows that, commercial banks intentionally provides and encourages the customers to use digital banking options, since carrying cash is very risky. Through digital banking, customer is offered options that time saving, cost effective and less risky. Even the banks benefit on digital Banking since it's cost effective and efficient.

Financial innovation improves the bank performance by increasing banks market share, expand and customize the products range, and reduce bank operating cost. Odior E. S. and Fadiya B. B. states that bank charges are minimized as cost of banking and payments are reduced. Further, Yang S, Li Z, Ma Y, Chen X (2017) stated that banks can save the operational cost by delivering e-banking products.

Providing customer convenience is a key factor in a good establishment of a business, which eventually leads to business's profitability. Felix U. O., Rebecca U. I., Igbinoba O. K. (2015) identify reasons such as, competitiveness of providing better service among banks, convenience by eliminating the need for invoices and other documentation, allowing credit to customers in the form of credit cards, encourage online purchases through small discounts, in the means of improving the perception of value.

Money Laundering is widely done through physical transportation of cash. Money Laundering is defined as, making the illegally generated money seem to be come from a legal source. FATF Report 2015 on 'Money Laundering through Physical Transportation of Cash' compiled by Middle East & North Africa Financial Action Task Force (MENAFATF), provides evidence that physical cash is widely used in the criminal activities. Even when the illegitimate incomes are initially generated in electronic form, convicts later withdraw them from bank account and physically transport the money. The

reason for this ill activity is recognized as in order to break the audit trail. When the transactions are done through digital form, it provides authorities to keep a trail of money transferred, investigate on money laundering crimes. Odior E. S. and Fadiya .B. B denotes that through implementing a cashless policy, it is possible to track down all major movements of money such as terrorism financing, bribery and attempts of money laundering.

Shendge P. A. and Shelar B. G. (2017) claims that in transacting through digital form, it is more difficult for tax evaders to hide their income. Moving to digital banking, makes a record of income hence the taxation could be done systematically. It must be highlighted that when the number of tax payers increases, a lesser tax rate can be imposed benefitting the whole country.

Digital Banking has contributed to country's economy in a vast way. Still the disadvantages must be taken into consideration in order to imply preventive measures. This study provides literature on advantages and disadvantages of digital banking.

2.3 Drawbacks of digital banking

Implementation of digital banking is costly in a considerable amount. The problem arouse here is not getting a significant benefit for the cost incurred. Roche I. D, confirms this situation in the study done on service quality of internet banking in Sri Lanka, that despite the heavy investments done on implementing internet banking by the banks, the customer usage is still at a very low stage. The low usage is caused by the absence of confidence, disappointment, security concerns and unsatisfied service quality.

The study done by Kamboh, K.M and Leghari M.E.J (2016) shows that ATM transactions cause negative impact on Banks profitability, which indicates that 1% rise of ATM transactions leads to 2.75% reduction in banks profitability. The reasons are indicated as ATMs Breakdowns, cash shortage not done at proper time in ATMs, increasing rate of

ATM frauds, ATM theft and waiting in long queue on certain days of the months. These reasons have caused the sense of security and ease which ultimately reduce profitability.

Study carried out in paper, 'Cashless Banking in Nigeria: Challenges, Benefits And Policy Implications', by Odior E. S. and Fadiya B. B, discussed about the challenges faced by the cashless policy when implemented in Nigeria. Electric power must be constantly supplied for the smooth operation of e-banking activities. The risk of cyber hacking has become threatening. The cost of infrastructure development and literacy of the customers are major concerns. High Bank Charges on some electronic channels was considered as a drawback.

These disadvantages can be converted in to profit gaining such as while using internet banking, applications must be developed to have interactivity with customers electronically, by ways such as live chats, and implementing 24 hour e-mail and hotline, to minimize the physical interaction.

2.4 Bitcoin and Blockchain technology

Kirankalyan Kulkarni (2018) explains that**,** Bitcoin and Blockchain are considered to be the next big wave of change after the internet which opens wide roads to digital economy. The blockchain technology is the backbone of cryptocurrency and it uses cryptography to keep the data secure. Cryptocurrency is digital money, while the underlying technology that enables the moving of digital coins or assets between individuals is called blockchain. Bitcoin is an instance of cryptocurrence. It's an international network of payments. Bitcoin is the first decentralized digital currency, and as such it is a revolutionary technology invention. In bitcoin, transactions details are maintained. Further, new bitcoins units are generated by the mathematical problems solved computationally and it is operated independently of a central bank.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Digital banking can be classified into many channels such as ATM transactions, credit card transactions, fund transfers, cheque payments, bank drafts, pay orders, deposits, balance inquiry, on-line utility bills payments, on-line issuance of account statements, remittances, phone banking, mobile banking and PC banking. Yang S, Li Z, Ma Y and Chen X (2017) showed that e-banking platforms can be classified to telephone banking, mobile banking, TV based banking, online banking and internet banking.

In the context of Sri Lankan banking system, these options are very popular among banking customers. The main reasons for this situation are understood as cost effectiveness, time effectiveness, increasing of the breadth and quality of the services and widened access to the financial services.

With the introduction of 'Automation' by private banking corporations in 1980s, the banking sector of Sri Lanka performed with new phase. Previously foreign banks like HSBC Bank and Standard Chartered Bank were having Automated Teller Machines. (ATMs). These facilities were limited to high end customers. A local Bank, Sampath Bank first introduced instant money transfers within cities and ATMs in 1986. Currently, practically all banks in Sri Lanka are facilitated with automated digital banking systems including ATMs. This has opened a door to the customers for access to faster and after-hour services. Further, internet banking and mobile banking facilities have become popular among customers with the introduction of modern telecommunication technology in Sri Lanka.

Sri Lankan banking industry is engaged in wide array of digital banking developments and large investments have taken place on those projects. So it is considerably important to carry out an empirical research to investigate and analyze the relationship between

digital banking and banks profitability. Through many digital Banking channels, internet transactions, POS transactions and Customer Based Mobile Banking were used to carry out this study. Profitability was indicated by return on assets (ROA).

A brief description on the variables, the method of the study carried out and the econometric model used to done the analysis is described in this chapter.

3.2 Selection of data

In Sri Lanka, cashless payments are taken place in large value payments and retail payments. Real time gross settlement system, called as RTGS is instance for a large value payments system. Retail payment system can be classified into many aspects such as cheques transactions, Sri Lanka interbank payment (SLIP) system, credit, debit card transactions done through ATM and POS Terminals, other payment cards, mobile transactions, internet payments, tele-banking and postal instruments. (Payment Bulletin 4th quarter 2018, Payments and Settlements Departments, CBSL)

From these, three channels were considered in this study as the explanatory variables, considering the popularity of the service. Accordingly, number of POS terminal transactions (POS), number of transactions done through mobile banking (MOBT) and number of transactions done through internet banking portal (INTERNET) are considered as the measurement of digital banking in this empirical study. As the indicator of banks' profitably, measures such as return on equity (ROE), return on assets (ROA), profit before tax (PBT) and profit after tax (PAT) are available. The ratio of profit before tax to average assets, also named as return on assets before tax, is used in this study as the indicator of bank's profitability since it is considered the most suitable variable.

Work done by Kamboh K. M. and Leghari M. E. J. (2016) in study done on banking industry of Pakistan', Eze G. P., Egoro S. (2016) on electronic banking and profitability

of Nigerian commercial banks, and Itah A. J. (2014), on impact of cashless banks profitability in Nigeria, are followed in this study.

All the time series data on the mentioned variables were collected from the e-Research data Library of the Central Bank of Sri Lanka and the 'Payments and Settlements Department' of the Central Bank of Sri Lanka. Quarterly data were collected for 9 years from 2010 to 2018. (2010Q1 to 2018Q4)

3.2.1 Return on Assets (ROA)

Return on assets before tax and after tax is calculated. In this study, ROA before tax is considered. In this study the variable is indicated as ROA. Return on assets before tax is also defined as profit before tax to average assets. It is the total profit of the banks before deducting the interest expenses and operating expenses. An average total asset is the average amount of the total assets recorded in the bank's balance sheets at the end of the current year and the preceding year. The ratio of profit before tax to average assets gives out a more static evidence on the banks' profitability. This is even discussed by Dr. Ceylan Onay (2008), in his study that it is more reliable to use the before-tax figures.

3.2.2 Payment Cards

Payment cards is a method of storing value in electronic means, which enables the cardholder to access the funds in making payments, purchases and withdraw funds from ATMs at any desired time. Globally accepted payment cards are credit cards, debit cards, charge cards and stored-value cards. Payment Bulletin 4th quarter 2018, published by PSD, shows that by the end of year 2018, there were 32 service providers for issuing debit cards and 17 service providers for issuing credit cards were registered with CBSL.

Sri Lankan Commercial banks started issuing credit cards in 1989, while debit cards were introduced in 1997. Currently, 14 licensed commercial banks and 3 other financial institutions had been registered to involve in credit card industry and 21 licensed banks, and 11 various other financial companies had been registered in debit cards business by the end of 2018. For foreign transactions, a stamp duty of Rs. 25.00 for every Rs, 1,000.00 or a part of it is charged from January 1, 2016.

Other than the payment cards and mobile payment systems Regulations, mentioned earlier in this section, Payment and Settlement systems Act, No. 28 of 2005 and Credit Card Guideline No. 1/2010 issued by the CBSL, are the underlying regulations issued by the CBSL, in order to secure and efficient operations and safeguard the customers as well as banks, when credit cards are used as a mode of payment. (Interview on Payments and Settlements System and Money Laundering Activities on 2019.05.06 as published in CBSL official website).

Point-Of-Sale (POS) Terminal

Point-of-Sale (POS) terminals were first introduced to Sri Lanka in 1994. By the end of year 2018, 62652 number of POS terminals were in use. This is a 28.3% increase from the previous year.

Customers have the ability of making payments through credit cards, debit cards and stored value cards at the merchant outlets through POS terminals. Currently, nine commercial banks and one finance company have registered as the payment cards acquirers. CBSL has taken strict and adequate measures to regulate such financial acquirers of payment cards in order to protect cardholder's data.

3.2.3. Mobile phone based transactions

Mobile phone based transactions can be classified in to two; customer account related mobile payment system and mobile phone related e-money system. Mobile phone based

e-money systems are understood as value can be stored at such systems when the funds are received electronically, and the funds can be used for the payments in future. Mobile network operators are involved in this business and the first mobile network operator was registered with CBSL in 2012.

Mobile phone based banking services are regulated by the Mobile Payment Guidelines No. 1 of 2011 issued by the CBSL. Customer account based mobile payment systems or mobile phone banking provide the customers the facility to access their bank accounts through the mobile phones.

3.2.4 Internet based payment system

The concept of internet banking was introduced to Sri Lanka in 1999. Convenience and efficiency provided by such facility have attracted customers since then. Some widely used services through internet banking are get account information, pay utility bills, apply or subscribe for financial services and fund transfers through own accounts as well as third party accounts.

Reports prove that the value and volume of financial transactions done through internet banking channel, have increased speedily over time. That reflects the much popularity of internet banking among customers. Customer convenience and time saving benefits are most prominent factors for this. Various promotional schemes, sophisticated banking web sites and awareness programmes hosted by the banks are the other factors that cause the rise of the volume of internet banking transactions. .

3.3 Model specification

This study is carried out to find the impact of the digital banking on the profitability of the banks in Sri Lanka. The most appropriate variables were selected as the dependent and independent variables after an analysis of the all available data. The relationship of

the digital banking variables and the banking sector's profitability was analyzed using relevant econometric model.

The mathematical linear model can be shown as,

$$ROA = f(INTERNET + POS + MOBT)$$

$$ROA = \alpha_0 + \alpha_1 INTERNET_t + \alpha_2 POS_t + \alpha_3 MOBT_t + u_t$$

The dependent variable ROA, is a ratio. The three independent variables are given as no. of units. So, the natural logarithms of the variables INTERNET, POS and MOBT were obtained.

$$ROA = \beta_0 + \beta_1 ln(INTERNET_t) + \beta_2 ln(POS_t) + \beta_3 ln(MOBT_t) + v_t$$

β_0 is the constant. $\beta_1, \beta_2, \beta_3$ are the coefficient of the independent variables. v_t is the white noise error.

3.4 Research methodology

As described earlier in this chapter, four time series data variables are used in this analysis. The dependent variable is the ratio of return on assets. The explanatory variables are number of transactions done through internet banking, POS terminal transactions and number of transactions done through mobile banking portal.

The dependent variable, ROA was given as a ratio and all the independent variables are given in number of units. To include these variables in one time series model, natural logarithm of the independent variables were formed. Accordingly, log (volume of internet transactions), log(volume of POS transactions) and log(volume of mobile banking transactions) were formed.

As the initial step in analyzing data, the stationarity of the variables is checked. It is compulsory to check the variables to be Stationary in order to provide meaningful statistical inference.

To establish a long run relationship, cointegration test was performed. That is it is assumed that there is a long run association in the model though the series are drifting apart of equilibrium upward or downward. Most prominent cointegration tests are Engle and Granger cointegration test and the Johansen cointegration test. This study uses Johansen cointegration test to check whether a long run relationship exists. Cointegrating relationship was found among the variables suggesting the long run relationship among the digital banking and Bank Profitability. The long run association between the variables is detected through estimating the Vector Error Correction Model. (VEC).

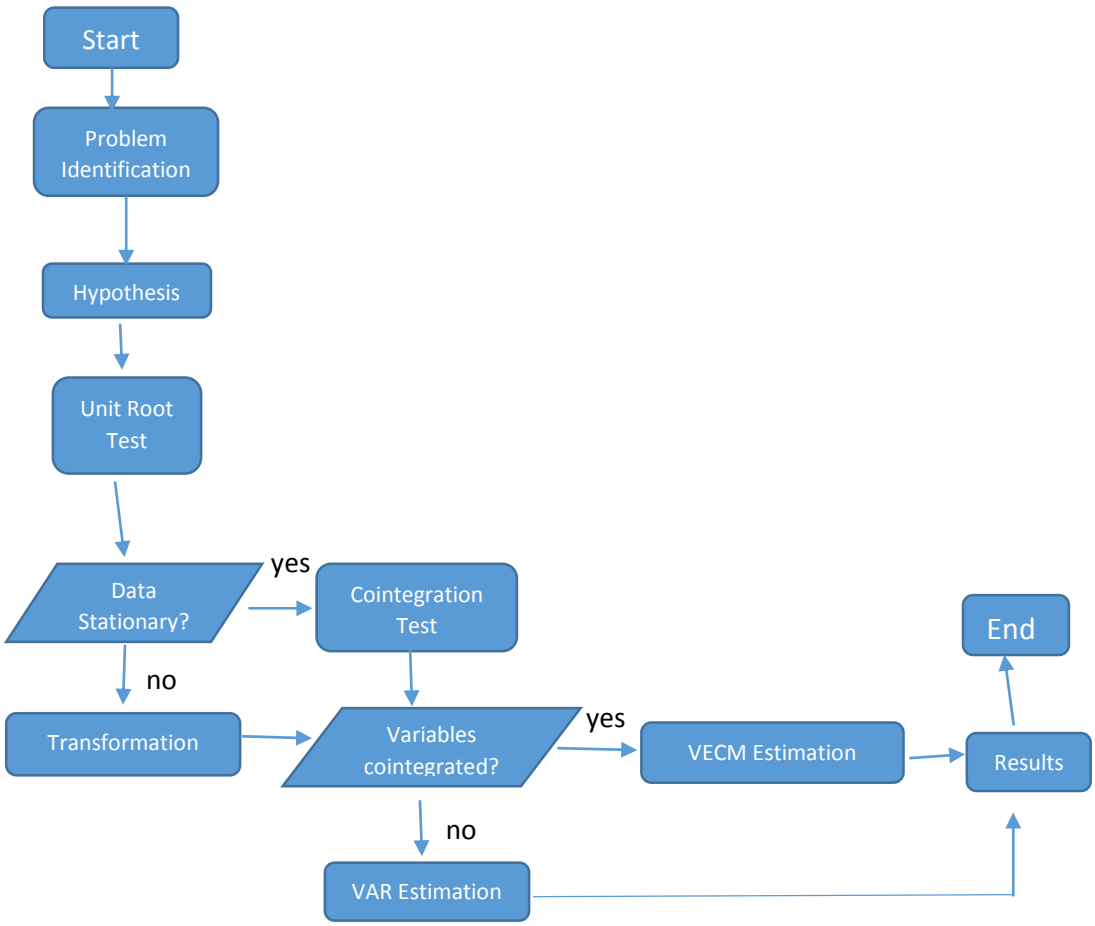


Figure 3.1: Research Framework

When the VEC Model reveals that there exists a long run association, and but the direction the relationship formed cannot be identified through VEC Model, Granger Causality test is carried out to identify the causal relationship among the four variables.

Then a short run dynamic analysis, Impulse Response Function was employed. Each variable is tested for an error shock on its own future dynamics and

That test allows to examine the performance of an error shock to each variable on its own future dynamics as well as on the future dynamics of the rest of the variables under consideration. The Impulse Response Function show response of the i^{th} variable in the VECM system to the time paths of its own error shock against error shocks to the other variables in the system. Moreover IRF is a practical way to envision the response.

Finally some diagnosis tests and stability test were carried out to ensure the accuracy of the fitted model.

The research framework can be shown as Figure 3.1

3.5 Theoretical Background

In carrying out the study, a number of econometric models were used. These includes Unit Root Test, Selection of Lag Length Criteria, Johansen Cointegration Test, Vector Error Correction Model, Granger Causality Test and Impulse Response Function.

Further, to confirm the acceptability of the model a set of diagnostic tests such as Breusch-Godfrey Serial Correlation LM Test, Breusch-Pagan-Godfrey Hetroscedasticity Test, Normality Test, corralogram Q-Statistics of residuals test and CUSUM Test were carried out.

These models are further discussed as follows.

3.5.1 Test for Stationarity (Unit Root Test)

A stationary process has the property that the mean, variance and covariance do not change over time. It is shown in the study done by Emeka N. and Aham K. U, (2016), that the recent developments in Economics have revealed that, time series are not stationary most of the time. It is seen that sometime the series show a deviation from the mean over time, while in some the mean is stable over time. Time series that deviate away from their mean over time are said to be non-stationary.

Before modelling data series in to a regression, time series must be checked for stationarity. If the series show a unit root that depicts that the series is non-stationary which may resulting in providing bogus regression.

In a stochastic process Y_t, if its first difference, $(Y_t - Y_{t-1})$ is stationary, there shows a unit root problem. Random Walk model is given by,

$$Y_t = \rho Y_{t-1} + u_t$$

$$\text{for } -1 \leq \rho \leq 1$$

A data series which shows a unit root cannot be included into a long run form and the variance of the time series is time dependent. Such a series follows random walk, suffering with random shocks. Thus, the data series must be stationary, meaning that the mean and the variance must be constant over time and the covariance of two time periods must only depends on the distance of the two time periods.

To have data series engaged in a statistical estimation, variables must be stationary. It is important to check the integration order of the variables in order to decide which statistical model to be employed.

There are various tests to check the unit root. Among them, Durbin-Watson (DW) test, Dickey-Fuller test (1979) (DF), Augmented Dickey-Fuller(1981) (ADF) test, Philip-

Perron (1988) (PP) test are widely use. Augmented Dickey-Fuller Test is used in this analysis to check the stationarity.

The Dickey-Fuller Test (DF)

The Dickey-Fuller test is one of the most popular methods for checking the integratedness of a series. The hypothesis used are as follows.

H_0: Series has a unit root; hence series is non-stationary

H_1: Series doesn't have a unit root; hence series is stationary

Following regression is used in the Dickey-Fuller unit root tests.

$$Y_t = \alpha + \rho Y_{t-1} + \delta_t + u_t$$

The Augmented Dickey-Fuller Test(ADF)

This is the same as the Dickey-Fuller Test, except the fact that the Dickey-Fuller regression equation is improved to capture any correlation in the error term. ADF test adjusts the possible autocorrelation in the residuals of the DF test through adding the lagged difference term of the dependent variable.

The general augmented Dickey-Fuller regression equation is,

$$Y_t - Y_{t-1} = \alpha + \beta Y_{t-1} + \delta_t + (\text{lagged values of } (Y_t - Y_{t-1}))u_t$$

Emeka N. and Aham K. U, (2016), shows that Augmented Dickey Fuller Test is considered more important among all, because its more popular and widely applied in statistical analyses.

3.5.2. Lag order Selection

When estimating the long run and short run relationship among the variables in a model, the applied lag length is very important. For selection of appropriate lag length, five criteria namely, sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterian (AIC), Schwarz information criterian (SC) and Hannan-Quinn information criterion (HQ) are used. The lag which associated with minimum value of the mentioned criteria is selected as the Lag length.

3.5.3 Cointegration Test

In modeling of time series, Cointegration test is used to explain the long run relationship. Granger (1981) and, Engle and Granger (1987) have first formalized the idea of cointegration. Then have provided tests and estimation techniques to examine the existence of long run association amongst variables.

Non-stationary Time series which drift too much away from the equilibrium, can be paired and examined through cointegration tests, in order to assure that they do not drift extensively away from equilibrium, meaning that cointegration involves with certain set of variables which are individually non-stationary but become stationary at order, I(d). Cointegration shows the existence of long run association among the time series that converge over time. It can be demonstrated that cointegration shows a strong statistical inference for error correction model that brings long run and short run information of modeled variables together.

In this study, the Johansen cointegration test was used. The Johansen Test is more informative in the sense that it finds all possible cointegration relationships. When there are many variables in the system and when there is no clear indication of what would be the dependent variable, Johansen test is more suitable. Further, Johansen test seeks the linear combination which is more stationary.

Johansen cointegration test uses two tests, Maximum Eigenvalue test and the Trace test to define the number of cointegration vectors. The Maximum Eigenvalue statistic tests the null hypothesis of r cointegrating relationships against the alternative of r+1 cointegrating relationships for r =0,1,2,…..,n-1.

Trace and Maximum Eigenvalue tests may yield different results.

3.5.4 Error Correction Model

Granger Representation Theorem implies that a VAR model on differences on I(1) variables will be miss-specified when the variables are cointegrated; an equilibrium specification is missing in the model. But when lagged disequilibrium terms are added as independent variables, the model becomes well defined. Such a model is called an Error Correction Model.

Error Correction Model gives the idea that how much the short run deviations from the long run equilibrium are adjusted. The VEC model for the four variables investigated in this study will be in the form as follows.

$$\Delta X_{nt} = c + \sum_{i=1}^{k} \beta_{1i} \Delta X_{1t-1} + \sum_{i=1}^{k} \beta_{2i} \Delta X_{2t-1} + \sum_{i=1}^{k} \beta_{3i} \Delta X_{3t-1} + \sum_{i=1}^{k} \beta_{4i} \Delta X4_{t-1} + \gamma_n Z_{t-i}$$

Where,

n = 1,2,3,4 (no. of variables)

k = Maximum lag length

Δ = First differenced operator

$Z1 = X_t - \sum_{i=2}^{n} \alpha_i X_{it} + c$, disequilibrium term

Lag lengths and coefficients are determined by testing down OLS regression. The value of the coefficients α_i defines the speed of adjustment to the long run equilibrium.

This Z value is highly stationary and convergence to the long run equilibrium is speedy, when the value of speed of adjustment is large.

3.5.5 Wald Test

When an estimated model showed a long run relationship, it must be evaluated for short run association too. In such instance, Wald Test is used to evaluate the short run association among the variables.

Wald Test determines whether a certain predictor variable is significant or not. It rejects the null hypothesis of the corresponding coefficient being zero.

H_0: variables are not significant jointly.

H_1: at least one variable is jointly significant

3.5.6 Granger Causality test

To determine whether one time series is beneficial in forecasting another, the Granger Causality test is used.

X is said to Granger Cause *Y*, if *Y* can be better predicted using the histories of both *X* and *Y*, than by using the history of *Y* alone.

Considered the following VAR model;

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + ... + \alpha_p Y_{t-p} + b_1 X_{t-1} + ... + b_p X_{t-p} + u_t$$

$$X_t = c_0 + c_1 X_{t-1} + ... + c_p X_{t-p} + d_1 Y_{t-1} + ... + d_p Y_{t-p} + v_t$$

Hypothesis used to test X does not Granger Cause Y,

H_0: X does not granger cause Y

H_1: at least one $b_1 \neq 0$, X granger cause Y

Hypothesis used to test Y does not Granger Cause X,

H_0: Y does not granger cause X

H_1: at least one $b_1 \neq 0$, Y granger cause X

In these cases, rejection of null hypothesis means that there exists Granger Causality.

3.5.7 Impulse Response Function (IRF)

The Impulse Response Function measures the reaction of the variables in a model on a one unit shock to one variable in the model. This function investigates the time horizon of variables and their responses for any sudden shock in any variable in the model with time passes. When plotted, Y axis indicates the impulse responses against periods from the initial shock in X axis.

The IRF is estimated as,

$$X_t = \mu + \sum_{i=0}^{\infty} \varphi_{jk}(i) e_{t-1}$$

Where μ is a 4 X 1 vector of constant, e_{t-1} is a 4 X 1 error vector, $\varphi_{jk}(i)$ are the impct multipliers which examine the interaction among the variables.

3.5.8 Diagnostic tests for the fitted model

The objective of these tests is to check the acceptability of the fitted model. The few tests carried out in this study to check the robustness of the model is discussed here.

It is very important to carry out tests for the correlation and variance of the residuals of the model.

Serial Correlation LM Test

Breusch-Godfrey serial correlation LM test, examines the serial correlation of the residuals in a regression model.

If a linear regression of any form is considered,

$$Y_t = \beta_1 + \beta_2 X_{t,1} + \beta_3 X_{t,2} + u_t$$

Where the errors might follow an AR(p) autoregressive scheme, follows:

$$u_t = p_1 u_{t-1} + p_2 u_{t-2} + \ldots + p_p u_{t-p} + \varepsilon_t$$

first the simple regression model is fitted by ordinary least squares for obtaining a set of sample residuals u_t. Breush and Godfrey showed that, if the following auxiliary regression model is fitted,

$$u_t = \alpha_0 + \alpha_1 X_{t,1} + \alpha_2 X_{t,2} + p_1 u_{t-1} + p_2 u_{t-2} + \ldots + p_p u_{t-p} + \varepsilon_t$$

and if the usual R^2 statistic is calculated for this model, then the following asymptotic approximation can be used for the distribution of the test statistic,

$$nR^2 \sim X_p^2,$$

The null hypothesis is H: $p_i = 0$ for all i holds (that is, there is no serial correlation of any order up to p). Here, n is the number of data points available for the second regression, that for u_t,

$$N = T\text{-}p,$$

Where, T is the number of observations in the basic series. The value of n depends on the number of lags of the error term (p).

Heteroscedasticity Test

When the variance of the residuals increase with the fitted values of the dependent variable, the residuals of the fitted model is said to be heteroscedastic. One of the

important assumptions made in linear regression is, that the residuals are free from hetroscedasticity. If the residuals are hetroscedastic, the patterns of the response variable Y_t, are unpredictable, because model gives spurious results. This is the reason that ineffective and unstable regression models producing unusual estimates.

Hetroscedaticity of the residuals can be detected through graphical form or through statistical tests. There are several methods to test for the presence of heteroscedasticity. Park Test, Goldfeld-Quandt Test, Breusch-Pagan Test and White Test are some of the Statistical Tests.

In this study, Breusch-Pagan Heteroscedasticity Test is used to confirm the non-existence of heteroscedasticity in the residuals. The test checks whether the variance of the errors from a regression is dependent on the values of the independent variables. In that case, heteroscedasticity exists.

If a regression is considered,

$$Y = \beta_0 + \beta_1 x + u_t$$

and obtain values for residuals, u from this fitted model. In ordinary least square method, residuals are constrained so that their mean is 0. Under the assumption that the independent variables does not affect their variances, average of squared values of the residuals gives an estimation of the variance. If the assumption become false, model becomes like that the variance is linearly related to independent variables. Such a model can be observed by regressing the squared residuals of the independent variables, using an auxiliary regression equation of the form,

$$u_2 = \tilde{a}_0 + \tilde{a}_1 x + v$$

Breusch–Pagan test is a chi-squared test. The test statistic is distributed $n\chi^2$ with k degrees of freedom. If the estimated probability value is below the threshold of 0.05 level, the

null hypothesis is rejected and the residuals are assumed to be heteroscedastic. If the probability value is larger than the critical value, residuals are said to be homoscedastic.

Normality Test

The purpose of the Normality Test is to define if a data set is well established by a normal distribution. It computes how likely it is for a random variable underlying the data set to be normally distributed. The test can used for model selection. Histogram of the sample data is compared to a normal distribution curve.

CUSUM Test

The CUSUM Test provides evidence of the stability of the estimated model. This test is based on the cumulative sum of the residuals. The cumulative sum of the recursive residual values are plotted against the upper and lower bounds of the 95% confidence interval at each point. If the cumulative sum of the residuals are marked outside of the two critical confidence lines, the test finds parameter instability of the model.

The statistic of the CUSUM test can be written as,

$$W_t = \frac{\sum_{r=k+1}^{t} u_r}{s} \; ; \; t=k+1,\ldots.T$$

Where u is the recursive residual defined above, and s is the standard error of the regression fitted to all T sample points. Movement of W_t outside the critical lines is suggestive of coefficient instability.

3.6 Information Criteria

Below mentioned criterions are often used in model selection. Smaller values are preferred. Information Criterions are usually needed at the point of appropriate lag selection.

3.6.1 Akaike Information Criteria

In order to choose a model from several competing models, a popular croterian for making the decision is to use AIC. The AIC is used in a wide variety of settings, not just time series analysis. The model with the minimum value of AIC is selected as the best one among many possible models.

AIC is calculated by the following equation:

$$AIC = -2\frac{\log(likelihood)}{n} + 2\frac{k}{n}$$

Where,

n = number of observations

k = number of estimated parameters

3.6.2 Schwarz Criteria

This information criterian is also based on the likelihood function an it is very much close to the AIC Criterion but more powerfull than that.

$$SC = -2\frac{\log(likelihood)}{n} + 2\frac{k}{n}(\log n)$$

Where,

n = number of observations

k = number of estimated parameters

3.6.3 Hannan-Quinn Information Criterion

HQ Criterion is an alternative to AIC and SC criterions.

$$HQC = -2L_{max} + 2K \log(\log n)$$

Where,

L_{max} = log-likelihood

n = number of observations

k = number of estimated parameters

CHAPTER 04

DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of the data as set out in the Research Methodology in the Chapter three. The empirical study was carried out as stated in the chapter 3 and the results were analyses and showed descriptively in this chapter.

The variables used in this study and the type of the data are summarized in the below table.

Table 4.1: Summary of the variables

	Variable	Description	Type of data
Dependent Variable	ROA	Profit Before Tax (PBT) to Average Assets	Ratio %
Independent variables	POS	Total Volume of Point of Sale (POS) Terminal transactions during the period	No. of transactions
	Internet	Total Volume of Internet based financial transactions	No. of transactions
	MOBT	Total Volume of Customer Account based Mobile transactions (effected through mobile phones)	No. of transactions

Profit of the Banking Sector was measured by 'Return on Assets'. In the context of ROA, two determinants, ROA before Tax and ROA after Tax are available in CBSL database. This study uses ROA before Tax, which is given as a ratio. The explanatory variables, Internet transactions, POS machine transactions and Mobile banking transactions were given as number of units. Firstly, log form of the four independent variables were formed.

4.2 Descriptive Statistics

The basic graphs of the five variables are shown below, in order to give a basic picture of the data.

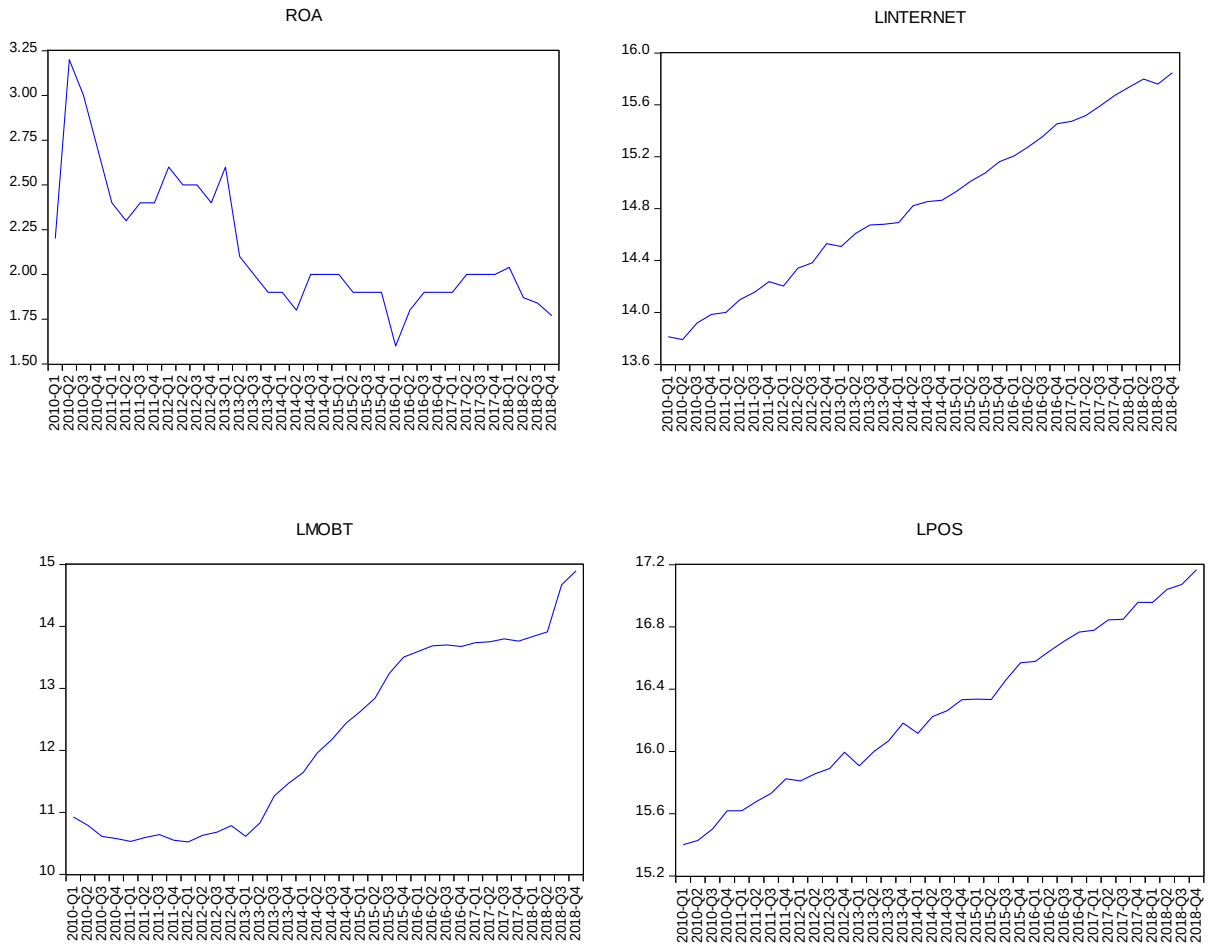


Figure 4.1: Graphs of the data series

It is observed that all the independent variables show an upward trend.

4.3 Test for Stationarity (Unit Root Test)

The purpose of performing the Unit Root Test is to check the stationarity of all the variables in the model. It is compulsory to test the economic time series for stationarity. Time series must be stationary, in order to be used in an economic model and used for meaningful analysis. When modelling time series data, though the variables are non-stationary, model can show a high R^2 value, showing spurious results. To avoid this problem, the variables must be checked to be stationary.

This study used Augmented Dickey Fuller Test (ADF Test) to check the stationarity of the variables. ADF Test is the most reliable and generally used method in unit root testing and it is easy to implement and interpret the results. The test was performed on the variables (ROA, LINTERNET, LPOS, LMOBT) at the level and the 1st difference.

Table 4.2: ADF Unit root test results

Variable	**Level**		**First Difference**		**Integrated Order**
	Test Statistic	**P Value**	**Test Statistic**	**P Value**	
ROE	-1.793	0.377	-9.591	0.000	I(1)
LINTERNET	-0.924	0.768	-5.296	0.000	I(1)
LPOS	1.417	0.998	-2.991	0.046	I(1)
LMOBT	1.515	0.999	-3.785	0.006	I(1)

The below hypothesis was tested and stationary levels were identified accordingly.

H_0: Series has a unit root

H_1: Series doesn't have a unit root

Table 4.2 summarizes the results of the ADF Test. The T-statistic and the respective p-value at the 5% significance level is shown.

The stationarity of the variables are checked individually, and it is observed that the p-values of the variables are greater than the critical value at 5% significance level. Hence the null hypothesis cannot be rejected and the conclusion was made that the variables are non-stationary at the level.

One of the basic methods of making non stationary time series, stationary, is differencing. Accordingly, the 1st difference of all the variables are checked to be stationary. The test showed that the p-values of the variables at the first difference are significant at the 5% level. Hence the null hypothesis can be rejected, and it is concluded that the variables are stationary. This implies that all the variables included in this study are integrated at the 1st difference, I(1).

4.4 Cointegration analysis

Confirmed that the variables used in this study are integrate at the 1st order, the cointegration among the variables must be checked whether to decide which kind of VAR model to be used. The concept of cointegration is, if there exists a long run relationship among two or more non stationary variables, disperse from this long run equilibrium is stationary. If the error term showing from the linear combination of two variables is stationary, the conclusion can be made that the two variables are cointegrated. If there is no cointegration among some variables, then there is no long run relationship among those variables.

Most prominent cointegration tests are Engle-Granger cointegration test and the Johansen cointegration test. In this study, Johansen cointegration test was imposed to check the cointegration among the four variables since according to the Table 4.2 all the four variables were integrated in the same order.

Table 4.3: Lag order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	37.17545	NA	1.48e-06	-2.073466	-1.890249	-2.012734
1	161.7841	210.2771	1.68e-09	-8.861507	-7.945422*	-8.557851
2	180.2319	26.51863	1.52e-09	-9.014491	-7.365538	-8.467910
3	211.5994	37.24898*	6.67e-10	-9.974964	-7.593143	-9.185457
4	237.4994	24.28119	4.79e-10*	-10.59371*	-7.479021	-9.561278*

The first step of cointegration analysis is to select the appropriate lag length. For selection of appropriate lag length, five criteria namely, sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterian (AIC), Schwarz information criterian (SC) and Hannan-Quinn information criterion (HQ) are used.

Table 4.3 shows selection of lag length to be used in this analysis. According to the FPE, AIC and HQ Criteria lag 4 is selected as the optimal lag length.

After selecting an appropriate lag length, Johansen's co-integration test was applied to check whether the series are cointegrated. Johansen test provides estimates of all possible cointegrating equations and provides a test statistic for the number of cointegrating equations. The cointegration test results are shown in the Table 4.4.

The Johansen Cointegration Test is based on the hypothesis,

H_0: There is no cointegration equation

H_1: There is at least one cointegration equation

Table 4.4: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.768015	78.71443	47.85613	0.0000
At most 1 *	0.398046	33.42086	29.79707	0.0183
At most 2 *	0.322039	17.68606	15.49471	0.0230
At most 3 *	0.166276	5.637436	3.841466	0.0176

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.768015	45.29357	27.58434	0.0001
At most 1	0.398046	15.73479	21.13162	0.2407
At most 2	0.322039	12.04863	14.26460	0.1088
At most 3 *	0.166276	5.637436	3.841466	0.0176

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

If the value of the Trace and Max-Eigen Statistic, greater than the 5% significance level, fail to reject the null hypothesis. According to the Table 4.4, the Trace test indicates four cointegration equations at the 5% level. Max-Eigen Statistic test indicates only one cointegration equation at the 5% level. These results prove that there is at least one cointegration equation exists among banking sector profitability and the digital banking aspects. It can be concluded that there exists a long run relationship among the variables under consideration.

Since the estimated model exhibits a co-integrating relationship among the variables, the analysis can be moved to further steps for the estimation of a Vector Error Correction Model (VECM).

4.5 Testing long run relationship

Observing the results of the Johansen Cointegration Test, it can be concluded that the variables share a common stochastic trend. With the proof of cointegration between the variables, the model suggests long run relationship among the variables.

'Speed of Adjustment' reflects attempts to correct deviations from the long-run equilibrium. It can be identified as the amount of disequilibrium conveyed each quarter. The VEC Model further contributes to check for the presence of cointegration relationship among the variables. It identifies the number of stationary long run relationships that exist among the integrating variables.

Identified long run equilibrium relation is illustrated in table 4.5 and they are used to identify the long run relationship among the variables.

Here the considered variables are as follows.

ROA – Return on assets of the banking sector

LINT – log (no. of internet transactions)

LPOS – log (no. of transactions done through POS terminals)

LMOBT– log (no. of mobile banking transactions)

Table 4.5: Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 11/06/19 Time: 12:19
Sample (adjusted): 5 36
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
ROA(-1)	1.000000
LINT(-1)	8.112044 (0.99087) [8.18683]
LMOBT(-1)	0.358756 (0.06812) [5.26627]
LPOS(-1)	-10.76790 (1.36193) [-7.90636]
C	48.32940

The independent variables represent long term elasticity measures since they are in the log form. It is cleared that that the digital banking features has a significant impact on bank profitability. Due to the normalization process of the model the signs are reversed to enable proper interpretation.

The long run cointegration relationship between the bank profitability and the digital banking aspects can be shown as,

ROA(-1) = -48.32 – 8.11 LINT(-1) + 10.76 LPOS(-1) – 0.35 LMOB(-1)

According to the above equation, POS machine transactions positively influences the banking sector profitability, while internet transitions and mobile banking transactions have negative impact on the profitability. Based on the coefficients, it can be interpreted that 1% increase in the number of the POS machine transactions results in 10.76%

increase in the banking sector profitability, in the long run. According to the results, 1% increase in the number of the internet transactions cause an 8.11% decrease of the profitability. Further, 1% increase in the number of the mobile banking transactions cause a 0.35% decrease in the profitability.

4.6 Vector Error Correction Model

Having determined the cointegration among the variables under consideration, there is an existence of long run equilibrium relation between the banks' profitability and the digital banking aspects as evident in the previous section. In that case, a VECM is implemented instead of VAR model in order to avoid misspecification errors in the analysis. The VEC model is estimated with three lags to estimate the short run and long run causal relationship between the variables.

The VECM equation is as follows:

D(ROA) = C(1)(ROA(-1) + 8.11*LINT(-1) + 0.36*LMOBT(-1) - 10.77*LPOS(-1) + 48.33) + C(2)*D(ROA(-1)) + C(3)*D(ROA(-2)) + C(4)*D(ROA(-3)) + C(5)*D(LINT(-1)) + C(6)*D(LINT(-2)) + C(7)*D(LINT(-3)) + C(8)*D(LMOBT(-1)) + C(9)*D(LMOBT(-2)) + C(10)*D(LMOBT(-3)) + C(11)*D(LPOS(-1)) + C(12)*D(LPOS(-2)) + C(13)*D(LPOS(-3)) + C(14)*

Table 4.6 gives vector error correction model for ROA, with relevant error correction term, showing the long run and short run dynamic relations among the variables. The error correction term as indicated as C(1) is the one period lag of residuals of the cointegration equation, giving out the information on the long-run equilibrium on the process. The information about the long run dynamic of the process is indicated by the sign and magnitude of this error correction coefficient. It indicates the direction and speed of adjustment towards the long run equilibrium path which should be negative and statistically significant.

The estimated error correction term is highly significant at the significance level of 1%. That depicts the existence of a very stable long run relationship. The negative sign of the coefficient implies that the model's deviation from the long run relation is corrected by increasing the dependent variable.

Table 4.6: VECM estimates of the model

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.633621	0.124704	-5.080980	0.0001
C(2)	-0.247075	0.166886	-1.480497	0.1560
C(3)	-0.222407	0.138659	-1.603986	0.1261
C(4)	-0.021920	0.109363	-0.200436	0.8434
C(5)	4.231315	0.862156	4.907829	0.0001
C(6)	2.903197	0.864728	3.357353	0.0035
C(7)	1.402306	0.733734	1.911191	0.0720
C(8)	-0.030655	0.178272	-0.171954	0.8654
C(9)	0.001320	0.226075	0.005837	0.9954
C(10)	0.257063	0.201072	1.278462	0.2173
C(11)	-4.561460	1.185916	-3.846359	0.0012
C(12)	-3.912581	1.051579	-3.720674	0.0016
C(13)	-1.931015	0.945167	-2.043041	0.0560
C(14)	-0.061968	0.119564	-0.518279	0.6106

R-squared	0.777677	Mean dependent var	-0.029063
Adjusted R-squared	0.617111	S.D. dependent var	0.150190
S.E. of regression	0.092935	Akaike info criterion	-1.614199
Sum squared resid	0.155464	Schwarz criterion	-0.972940
Log likelihood	39.82718	Hannan-Quinn criter.	-1.401640
F-statistic	4.843333	Durbin-Watson stat	2.253293
Prob(F-statistic)	0.001256		

The VECM model with substituted coefficients is shown as,

D(ROA) = -0.63(ROA(-1) + 8.11*LINT(-1) + 0.36*LMOBT(-1) - 10.77*LPOS(-1) + 48.33) - 0.25*D(ROA(-1)) - 0.22(ROA(-2)) - 0.02*D(ROA(-3)) + 4.23*D(LINT(-1)) + 2.90*D(LINT(-2)) + 1.40*D(LINT(-3)) - 0.03*D(LMOBT(-1)) + 0.001*D(LMOBT(-2)) + 0.26*D(LMOBT(-3)) - 4.56*D(LPOS(-1)) - 3.91*D(LPOS(-2)) - 1.93*D(LPOS(-3)) - 0.062*

As indicated by the coefficient C(1), the coefficient associated with Profitability is 0.63 and highly significant. Hence the hypothesis 'no cointegration' is rejected and confirmed the presence of a stable long run relationship among banks' profitability and digital

banking. This suggests that with absence of changes in independent variables, Internet transactions, POS terminal transactions and mobile banking transactions, the deviation of the model from the long run path is corrected by 63.36% increase in ROA per quarter. The error correction term shows the speed of adjustment towards long run equilibrium. The value is negative, statistically significant and between the expected standard range (-1 to 0). This implies that if the system is moving out of equilibrium, the model pull it back to the equilibrium after approximately 1.6 (1/0.63) quarters.

Further, high R2 value of 77% confirms that the overall goodness of fit of the VECM model implied is satisfactory. It can be concluded that the independent variables explain over 77%of the systematic variations in banking sector profitability during the period studied. The F-statistic is significant at 1% level, showing a good fit of the model. The Durbin-Watson stat shows absence of autocorrelation and hence the regression estimates seem unbiased.

4.7 Test for Short Run Relationship between the variables

As mentioned earlier in this chapter, that the VECM can be employed in estimating short run relationship. Wald Test was used to identify any possible short run relationship between profitability and digital banking. The Wald test results are presented as follows.

4.7.1 Short run relationship between internet transactions and profitability

Wald Test is applied to VEC Model, to estimate the Short run relationship between internet transactions and Profitability. The hypothesis used,

H_0: C(5)=C(6)=C(7)=0

H_1: at least one C(i) ≠0 for i=5,6,7

Table 4.7: Wald test statistics for the Short run relationship between internet transactions and profitability

Test Statistic	Value	df	Probability
F-statistic	8.282196	(3, 18)	0.0011
Chi-square	24.84659	3	0.0000

Null Hypothesis: C(5)=C(6)=C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	4.231315	0.862156
C(6)	2.903197	0.864728
C(7)	1.402306	0.733734

According to the results shown in the table 4.7, the p-value of Chi-square test statistic is significant under 1% level. It can be concluded that up to three lag values of internet transactions and bank profitability has a strong short run relationship.

4.7.2 Short run relationship between POS transactions and profitability

The hypothesis used,

H_0: C(11)=C(12)=C(13)=0

H_1: at least one C(i) ≠0 for i=11,12,13

Table 4.8: Wald test for the short run relationship between POS transactions and profitability

Test Statistic	Value	df	Probability
F-statistic	5.720919	(3, 18)	0.0062
Chi-square	17.16276	3	0.0007

Null Hypothesis: C(11)=C(12)=C(13)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(11)	-4.561460	1.185916
C(12)	-3.912581	1.051579
C(13)	-1.931015	0.945167

According to the results shown in the table 4.8, the p-value of Chi-square test statistic is significant under 1% level. It can be concluded that there is a strong short run relationship among three lag values of POS transactions and bank profitability.

4.7.3 Short run relationship between mobile banking transactions and profitability

Wald Test is applied to VEC Model, to estimate the short run relationship between internet transactions and Profitability. The hypothesis used,

H_0: C(8)=C(9)=C(10)=0

H_1: at least one C(i) ≠0 for i=8,9,10

Table 4.9: Wald test for the short run relationship between mobile banking transactions and profitability

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Test Statistic	Value	df	Probability
F-statistic	1.122414	(3, 18)	0.3662
Chi-square	3.367242	3	0.3384

Null Hypothesis: C(8)=C(9)=C(10)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(8)	-0.030655	0.178272
C(9)	0.001320	0.226075
C(10)	0.257063	0.201072

According to the Table 4.9, the p-value of Chi-square test statistic is 0.3384>0.05. Therefore H_0 is not rejected at 5% level of significance and can be concluded that there is no short run relationship among three lag values of mobile banking transactions and banks' profitability.

4.8 Test of Causal Relationship among the variables

This empirical study is carried out to examine the degree to which the considered digital banking aspects influence the profitability of the banking sector. Granger Causality test was used to test this.

Cointegration Test indicates that long run relationship exists between the variables but not describes the direction of the causal relationship. Engel and Granger suggests that if cointigration exist between the variables in the long run, then there must be either one way or both ways relationship between the variables. This study is done to test whether past values of a variable help to predict changes in another variable.

The Granger Causality Test results are shown in table 4.10.

The used hypothesis is,

H_0: *X* does not cause *Y* ; p >0.05

H_1: *X* cause *Y* ; p < 0.05

Table 4.10: Pairwise Granger Causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
LINT does not Granger Cause ROA	34	4.14608	0.0261
ROA does not Granger Cause LINT		0.49009	0.6176
LMOBT does not Granger Cause ROA	34	1.36022	0.2725
ROA does not Granger Cause LMOBT		2.22351	0.1264
LPOS does not Granger Cause ROA	34	2.73668	0.0815
ROA does not Granger Cause LPOS		0.01201	0.9881
LMOBT does not Granger Cause LINT	34	1.06910	0.3565
LINT does not Granger Cause LMOBT		3.28508	0.0518
LPOS does not Granger Cause LINT	34	3.07274	0.0616
LINT does not Granger Cause LPOS		2.23071	0.1256
LPOS does not Granger Cause LMOBT	34	2.34564	0.1137
LMOBT does not Granger Cause LPOS		3.60613	0.0399

According to the results shown in Table 4.10, the null hypothesis which indicated that 'Internet transactions does not Granger Cause ROA' is rejected and concluded that the Internet transactions does granger Cause ROA. The reverse is accepted and concludes that ROA does not Granger Cause Internet transactions. Hence, there exists a one way causality among Internet Transactions and ROA.

In the same way, POS machine transactions Granger cause ROA under 10% significance level. The null hypothesis 'POS machine transactions does not Granger Cause ROA' is rejected under 10% significance level. That too is one way causality among POS machine transactions and ROA.

Further the results show that the POS machine transactions granger cause internet transactions under 10% significance level and mobile banking transactions granger cause POS machine transactions under 5% significance level.

4.9 Innovative Accounting

Impulse Response Function (IRF) as Innovation Accounting, is used in analyzing the interrelationships among the variables chosen in the system.

4.9.1 Impulse Response Function (IRF) Analysis

Impulse Response function is done after Vector Error Correction Model analysis, in order to check the impact of the coefficients over time. The response of the system for an impulse is called as the impulse response function.

Results of Impulse response function can be interpreted graphically. Figure 4.2 depicts impulse response functions of variables. This function is used to analyze the time path of dependent variable to the shocks from all the explanatory variables. Here the impulse response function of the ROA is pictured to one generalized standard deviation shock in each independent variable.

The impulse response graphs illustrated here shows the effect over 10 quarters time. The x-axis is given in quarters and y-axis is given as a percentage.

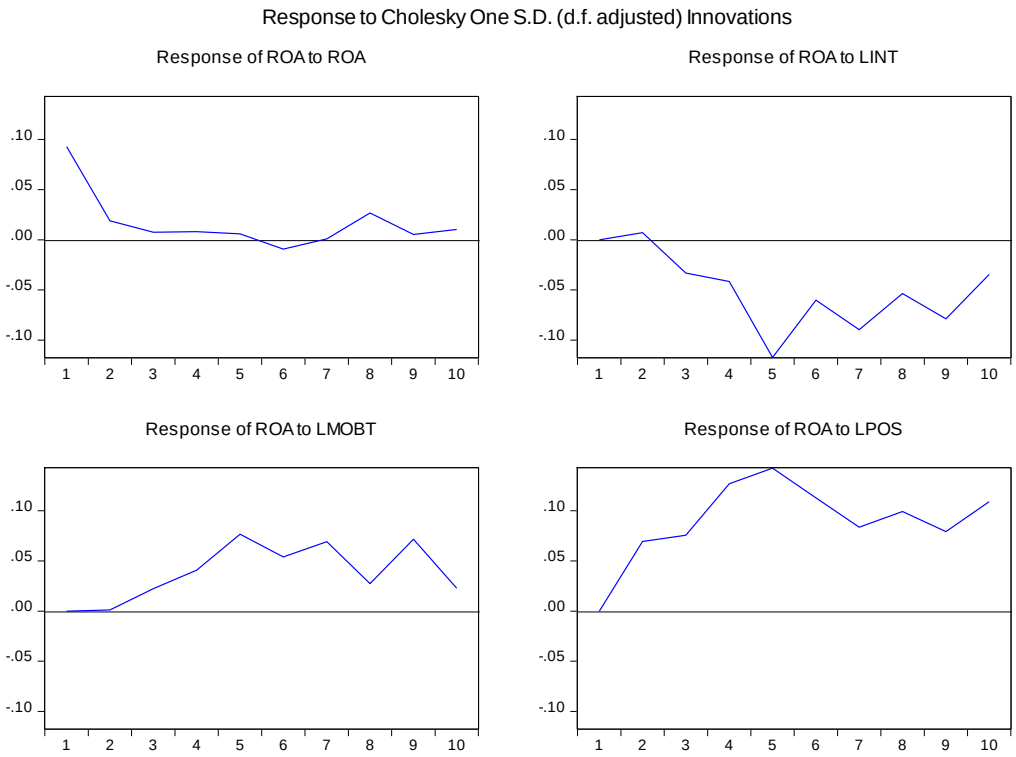


Figure 4.2: Impulse Response Function

These results are further analyzed using impulse response table which is shown in table 4.11.

Table 4.11: Impulse response function table

Period	ROA	LPOS	LINT	LMOBT
1	0.092935	0.000000	0.000000	0.000000
2	0.019056	0.064835	-0.001861	-0.025838
3	0.007479	0.072994	-0.043634	-0.008636
4	0.008078	0.125824	-0.059391	-0.011593
5	0.005868	0.143433	-0.138251	0.015403
6	-0.009253	0.115448	-0.076784	0.006069
7	0.000906	0.090473	-0.102997	0.031377
8	0.026687	0.093629	-0.067034	-0.013228
9	0.005406	0.088882	-0.091960	0.035303
10	0.010367	0.103507	-0.049275	-0.021239

Cholesky Ordering: ROA LPOS LINT LMOBT

The impulse response shows that ROA respond negatively to internet transactions (LINT). One standard deviation Cholesky positive innovation of internet transactions

cause downward effect on ROA. When considering the shock of mobile banking on ROA, it is seen that the responses are positive. Further, ROA responds positively to the shocks of POS transactions.

4.10 Residual Diagnostics Tests

To confirm the robustness of the results from the VEC model, some residual diagnosis tests were done.

4.10.1 Normality Test

This test is carried out to find out whether the residuals follow a normal distribution.

The tested hypothesis is stated as,

H_0: Residuals are normally distributed.

H_1: Residuals are not normally distributed.

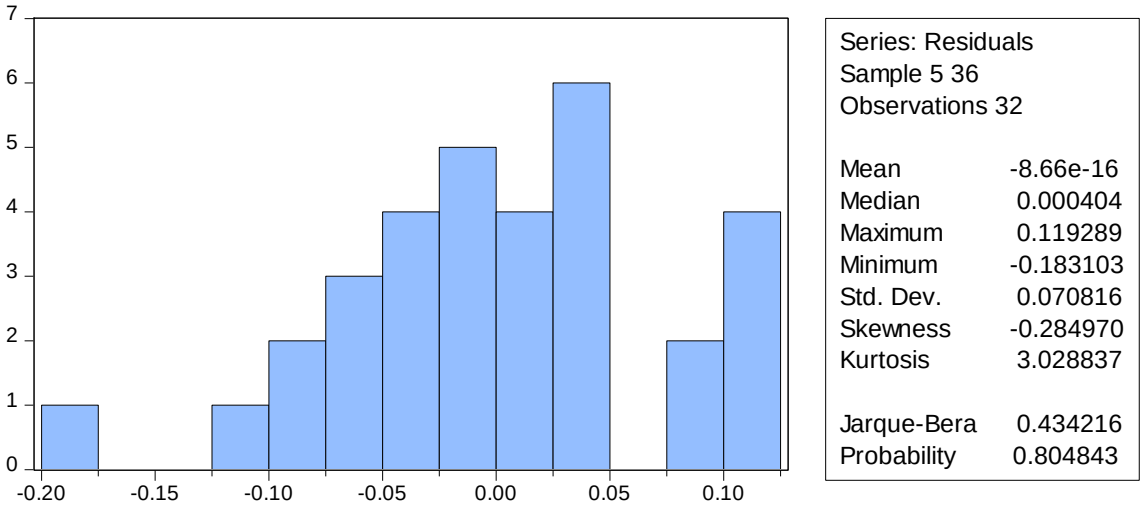


Figure 4.3: Histogram of residuals

Figure 4.3 illustrated that the residuals are normally distributed. The normality of the residuals is also confirmed by the Jarque-Bera test since the p- value (0.8048) is accepted by a critical value at 5% significance level.

4.10.2 Serial Correlation LM Test

Table 4.12: Serial Correlation Test results

F-statistic	0.835562	Prob. F(2,16)	0.4517
Obs*R-squared	3.026179	Prob. Chi-Square(2)	0.2202

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 11/06/19 Time: 13:09
Sample: 5 36
Included observations: 32
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.112577	0.153408	0.733839	0.4737
C(2)	0.229098	0.278859	0.821556	0.4234
C(3)	-0.053901	0.182792	-0.294877	0.7719
C(4)	0.045027	0.123137	0.365664	0.7194
C(5)	-1.661088	1.552301	-1.070081	0.3005
C(6)	-1.217649	1.376762	-0.884430	0.3896
C(7)	-0.193572	0.868175	-0.222964	0.8264
C(8)	-0.186196	0.230531	-0.807684	0.4311
C(9)	0.145656	0.267511	0.544486	0.5936
C(10)	-0.055485	0.213645	-0.259705	0.7984
C(11)	1.177990	1.504309	0.783077	0.4450
C(12)	0.118989	1.092908	0.108874	0.9147
C(13)	0.283525	1.014481	0.279478	0.7835
C(14)	0.127095	0.166467	0.763486	0.4563
RESID(-1)	-0.737651	0.572096	-1.289384	0.2156
RESID(-2)	0.215393	0.546171	0.394370	0.6985

R-squared	0.094568	Mean dependent var	-8.66E-16
Adjusted R-squared	-0.754274	S.D. dependent var	0.070816
S.E. of regression	0.093796	Akaike info criterion	-1.588542
Sum squared resid	0.140762	Schwarz criterion	-0.855674
Log likelihood	41.41668	Hannan-Quinn criter.	-1.345617
F-statistic	0.111408	Durbin-Watson stat	2.065580
Prob(F-statistic)	0.999946		

The presence of serial correlation is examined by Breusch-Godfrey Serial Correlation LM test, as shown in table 4.12. Residuals for VECM output is tested for serial correlation, using the hypothesis,

H_0: There is no Serial Correlation in the residuals

H_1: There is Serial Correlation in the residuals

The observed r-squared statistic on the Breusch-Godfrey serial correlation LM test result showed chi-square value of 0.2202. Null hypothesis cannot be rejected. Hence it is concluded that under 99% confidence level no Serial Correlation was shown in the residuals of the tested model. The absence of Serial Correlation on residuals, also confirmed by the Durbin Watson Stat of 2.06.

4.10.3 Heteroscedasticity Test

Hetroscedasticity of the residuals was examined in order to confirm the robustness of the estimated model. Breusch-Pagan-Godfrey Heteroscedasticity Test was used. On the presence of hetroscedasticity, the output cannot be relied on. This was examined using the hypothesis,

H_0: No hetroscedasticity in residuals

H_1: Hetroscedasticity exists in residuals

Results in Table 4.12 shows that a statistic of 11.8972 in observed R squared value with a probability chi-square of 0.7510. Null hypothesis cannot be rejected. Hence it is concluded that there is no heteroscedasticity in the residuals.

Table 4.13: Hetroscedasticity of residuals test results

F-statistic	0.554830	Prob. F(16,15)	0.8732
Obs*R-squared	11.89721	Prob. Chi-Square(16)	0.7510
Scaled explained SS	3.818628	Prob. Chi-Square(16)	0.9992

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/06/19 Time: 13:12
Sample: 5 36
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.253142	0.663687	-0.381419	0.7082
ROA(-1)	-1.37E-05	0.022411	-0.000612	0.9995
LINT(-1)	0.053741	0.067831	0.792279	0.4405
LMOBT(-1)	-0.001865	0.017911	-0.104146	0.9184
LPOS(-1)	0.034087	0.058919	0.578537	0.5715
ROA(-2)	0.007637	0.017552	0.435082	0.6697
ROA(-3)	0.000951	0.017271	0.055055	0.9568
ROA(-4)	9.97E-05	0.010494	0.009505	0.9925
LINT(-2)	-0.053118	0.058744	-0.904227	0.3802
LINT(-3)	0.026647	0.068339	0.389925	0.7021
LINT(-4)	-0.052045	0.065738	-0.791700	0.4409
LMOBT(-2)	0.014690	0.029542	0.497265	0.6262
LMOBT(-3)	-0.003664	0.033599	-0.109051	0.9146
LMOBT(-4)	-0.010241	0.022188	-0.461572	0.6510
LPOS(-2)	0.017101	0.059948	0.285262	0.7793
LPOS(-3)	-0.071812	0.060101	-1.194862	0.2507
LPOS(-4)	0.058179	0.084900	0.685265	0.5036

R-squared	0.371788	Mean dependent var	0.004858
Adjusted R-squared	-0.298305	S.D. dependent var	0.007031
S.E. of regression	0.008011	Akaike info criterion	-6.511190
Sum squared resid	0.000963	Schwarz criterion	-5.732518
Log likelihood	121.1790	Hannan-Quinn criter.	-6.253082
F-statistic	0.554830	Durbin-Watson stat	2.783151
Prob(F-statistic)	0.873181		

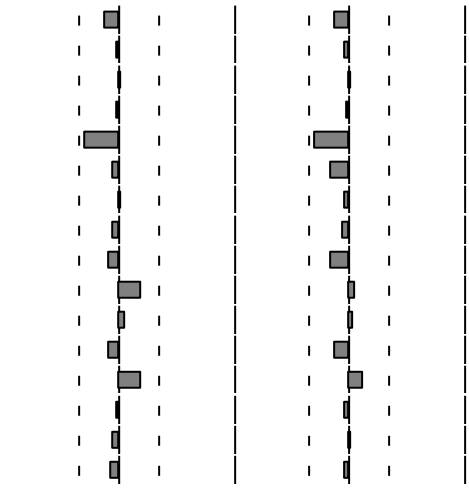
4.10.4 Correlogram Q-Statistic of residuals

This showed the autocorrelations and atrial autocorrelations of the equation residuals up to the specified number of lags and computed the Ljung-Box Q-statistics for the corresponding lags. To check whether the residuals are uncorrelated, the below hypothesis was tested.

H_0: Residuals are uncorrelated

H_1: Residuals are correlated

Date: 11/11/19 Time: 12:41
Sample: 1 36
Included observations: 32
Q-statistic probabilities adjusted for 13 dynamic regressors



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.131	-0.131	0.6044	0.437
		2	-0.010	-0.028	0.6083	0.738
		3	0.021	0.016	0.6244	0.891
		4	-0.020	-0.016	0.6404	0.958
		5	-0.305	-0.315	4.3889	0.495
		6	-0.064	-0.168	4.5582	0.602
		7	0.006	-0.047	4.5596	0.714
		8	-0.050	-0.062	4.6731	0.792
		9	-0.096	-0.163	5.1104	0.825
		10	0.203	0.048	7.1502	0.711
		11	0.065	0.035	7.3708	0.768
		12	-0.094	-0.120	7.8521	0.797
		13	0.195	0.129	10.020	0.692
		14	-0.013	-0.032	10.030	0.760
		15	-0.064	-0.004	10.295	0.801
		16	-0.079	-0.049	10.716	0.827

*Probabilities may not be valid for this equation specification.

Figure 4.4: Correlogram of residuals

In Figure 4.4, any pattern on ACF or PACF is not detected. Since, the p-values obtained are greater than 0.05 up to 16^{th} lag, null hypothesis is not rejected and it is clear that the residuals are uncorrelated at 5% significance level.

4.10.5 CUSUM Test

Stability diagnostic was done on the estimated model. To check the stability of the model, CUSUM Test and CUSUM of Squares Test were performed. Figures 1 and 2 plot the CUSUM and CUSUM of squares statistics for the estimated model. (Alimi R.S., (2014)) It can be seen that the plot of CUSUM and CUSUM of squares stays within the critical 5% bounds that confirms the long-run relationships among variables and thus shows the stability of coefficient.

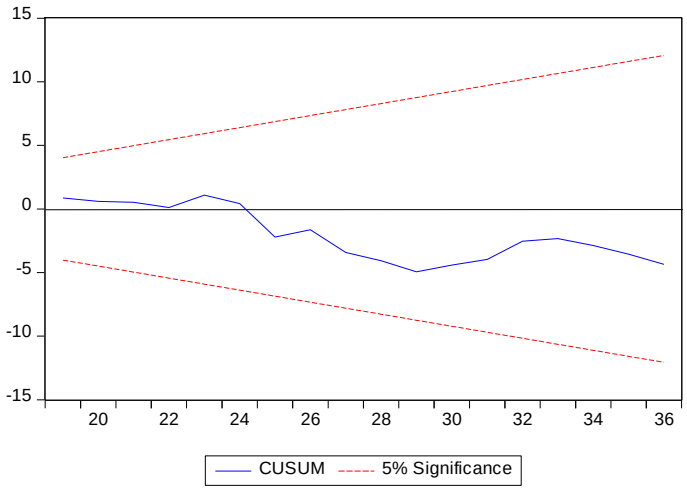


Figure 4.5: Cumulative Sum of Residuals

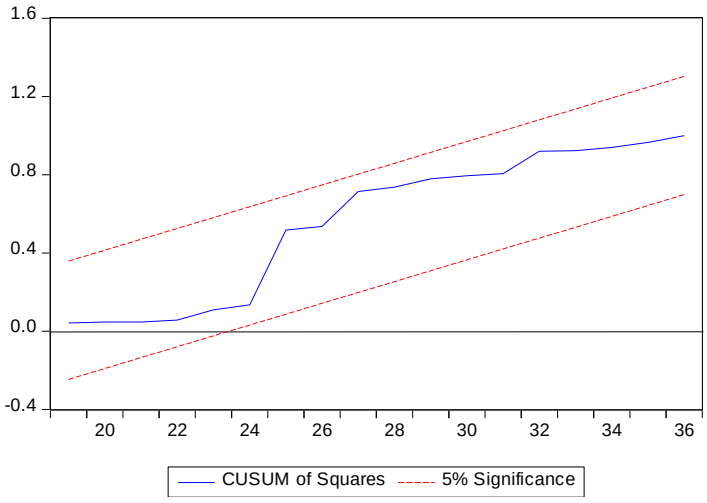


Figure 4.6: Cumulative Sum of Squared Residuals

4.11 Discussion of the results

With the evolution of information technology, a vast variety of digital banking products are emerged on banking sector, with the purpose of enhancing the stability of the banking sector. The stabilized banking sector is an important factor of GDP of a country, contributing to the economic wealth of a country. To stabilize the banking sector, the profitability is enriched by making the banking sector efficient through adding digital banking products to the banking sector.

Through this research, a practical study on the impact caused by digital banking on banks profitability is done. The profitability was measured by return on assets (ROA) before tax. The independent variables are, number of internet transactions, number of POS machine transactions and number of mobile banking transactions. The data set examined in this study is quarterly data for 9 years from year 2010 to year 2018.

The stationarity of the variables were tested as the first method in order to decide the model which must be used to examine the data. The stationarity test or Unit Root Test was performed using Augmented Dickey Fuller test (ADF). The test revealed that, all the variables show a unit root at level and become stationary at the 1^{st} difference. Hence VAR model was estimated. Then the lag length was obtained. Johansen cointegration Test was performed in order to find whether there exist any long run relationship among the considered variables. Trace test indicated four cointegration equations and Max-Eigen statistic test indicated only one cointegration equation at the 5% level. These results proved that there is at least one cointegration equation exists among banking sector profitability and the digital banking aspects. Hence VEC model was estimated to visualize the long run equilibrium in the means of cointegration equation.

It is illustrated by the VEC model, that the digital banking channels cause a long run impact on the profitability of the banking sector of the Country. It is observed that POS machine transactions positively influenced the banking profitability. Internet transactions and mobile banking transactions cause a negative impact on banks' profitability.

POS machine transactions are positively related to profitability. It is illustrated that 1% increase of POS machine transactions increase the profitability by 10.76%. According to studies in Pakistan banking sector, POS machine transactions makes a positive impact of the Bank Profitability of Pakistan also. Studied have proved similar results in Nigerian Banking Sector too. In the Sri Lankan context, POS machine usage is the highest among the selected variables. POS machine transactions are much popular among customers since it benefits banks, merchants and the customers in a wide array of possibilities. Since a considerable competition is aroused among the banks, numerous credit and debit card offers are given to the customers. Moreover, promotions such as wave of bank charges, 0% installment payments, free insurance package for selected card categories, are offered. Loyalty points scheme is also profits customers in a satisfactory level. On the other hand, merchants gain much profit through rise of sale. When the transactions are done through POS machines, merchants get their bank accounts credit automatically. Hence, risk of managing cash and physically banking is minimized. Banks get the commission on POS machine transactions. The popularity of the POS machine transactions can be recap as that.

Internet transactions have made a negative impact by causing an 8.11% decrease in bank's profitability by 1% increase in internet transactions. The negative impact of internet transactions on the profitability can be described as, that there is a drawback of using internet for transacting, because of the higher bank charges. This fact is even discussed in research done by Itah A. J. (2014). Also, Hernando and Nieto (2006) concludes that internet is not a substitute to the physical bank branches. But it is used as a complement. Further, that effect can be described as not getting the expected profitability on the cost incurred. Large investments have taken place in establishing internet banking. Further, due to lack of awareness the usage of internet banking is very low. Roche I. D shows that, though substantial investments were made on implementing of internet banking by the banking sector the usage is still at a low phase.

According to the study, mobile banking transactions also cause a negative impact of 0.35% on banks' profitability. With contrast to this study, mobile banking transactions has made a positive impact of bank profitability of Pakistan, according to previous studies. Kamboh, K.M and Leghari M.E.J. (2016) defines that LMOBT has positive and significant impact on banks profitability, which indicates that 1% increase in mobile banking transactions leads to 0.59% increase in banking profitability. Further, the study 'Effects of Mobile Banking on the Financial Performance of commercial Banks in Kenya' showed that there is a weak positive insignificant correlation among mobile banking transactions and financial presentation of banks in Kenya. Some studies in Nigeria showed that mobile banking is negatively related to banking sector profitability in Nigeria too. However despite the negative impact obtained in this study, the number of transactions done through mobile banking has increased over the years. This is clearly pictured in Figure 4.1.

In the short run, internet transactions and POS machine transactions are associated with bank profitability as revealed by the Wald Test. Mobile banking doesn't show any association with bank profitability in short run.

Cointegration test indicates that long run association exists among the variables but not describes the way of the causal relationship. The Granger Causality Test was performed to identify which way the causal relationship exist. It is observed that there exists a one way causality among internet transactions and ROA, and internet transactions does granger cause ROA. In the same way, POS machine transactions Granger caused ROA under 10% significance level. Further the results show that the POS machine transactions granger cause internet transactions under 10% significance level and mobile banking transactions granger cause POS machine transactions under 5% significance level.

An impulse response function was employed to trace the effect of a one standard deviation shock to one of the innovation (shock, impulse, residual and error term) on present as well as future values of the independent variables.

Further, in order to prove the quality of the estimated model, residual diagnosis tests such as Normality Test, Breusch-Pagan-Godfrey Heteroscedasticity Test, Serial Correlation LM Test, Correlogram Q-Statistic of residuals and CUSUM Test were performed.

CHAPTER 05
CONCLUSION

5.1 Conclusion

Banking system is considered as the heart of a country's economy. A stable banking system is very important as it allows maintenance of liquidity and smooth execution of transactions. Information technology is used in banking sector to enhance the effectiveness and efficiency of the services and achieve profitability in more productive manner. This study discusses the importance of association and application of information technology in the Banking. The advantages of digital banking is widely discussed. To study on the impact of digital banking on the Profitability is timely relevant. This study is carried out to address this effect on the profitability of the Sri Lankan banking sector. Data were gained from the Central Bank 2010 Quarter 1 to 2018 Quarter 4. Three digital Banking channels were identified over many other proxies, considering the popularity and the availability of the statistics of the selected channels. They are number of internet banking transactions, POS machine transactions and mobile banking transactions. The ratio of return on assets before tax (ROA) was taken as the dependent variable. Through an intensive analysis of data, it is concluded that POS machine transactions are positively influence the banking profitability. Internet transactions and mobile banking transactions cause a negative impact on banks profitability. 1% increase in the number of the POS machine transactions results in 10.76% increase in the banking sector profitability. 1% increase in the number of the internet transactions causes 8.11% decrease in the profitability. Further, 1% increase in the number of the mobile banking transactions cause a 0.35% decrease in tha profitability. It is also concluded that in the short run, there exists a strong association of internet transactions and POS machine transactions with the banks' profitability. Further, with the results of the granger causality test, it is concluded that internet transactions granger cause ROA under 5% significance level and POS transactions granger cause ROA under 10% significance level.

5.2 Recommendations

This study recommends that the adequate attention must be given on establishing the digital banking. Considering the vast development in IT, it is suggested that the higher management of the banks must get the technology involved in the qualitative improvements in the banking sector.

Another drawback identified here is less awareness of the presence of digital banking products. It is recommended that an adequate awareness must be given to the customers as well as bank employees. Further, it is suggested that regular awareness campaigns must be taken place to educate the public on the cashless banking channels. Security measures must be adopted in order to protect customers as well as banks from electronic theft.

Digital banking operations must be appraised consistently and effectively in quantitative and qualitative manner. Regulatory and economic policy frameworks must be enhanced in order to manage the new digital banking products.

Preventive measures must be taken on the system failures, network breakdowns in order to minimize customer dissatisfaction. There should be satisfactory rules on all characteristics of the operations of the e-banking and cashless system so that both the customers and the banks can be satisfactorily protected. Hence, this will avoid undue advantages and discourage impunity and hidden charges.

It is further recommended that the Central Bank of Sri Lanka being the regulator, must take the initiative and emphasize on Banks, to educate their customers and bank staff to use digital banking options, which will help them in cost reduction due to less traffic in branches and ultimately gain more profit.

5.3 Limitations of the study

The data utilized for this study were secondary data, thus this study is subjected to inherent limitation of the secondary data.

The study was carried out for quarterly data for 9 years from year 2010 to 2018, as available in Central Bank of Sri Lanka's e-Research database. The time period used in the study is considerably not a large time period. So it is recommended to re-estimate these variables, after about 5, 6 years.

Digital banking comprises with many other proxies too. There can be other variables that has an impact of the profitability of the banking sector. Variables such as SLIPS, telebanking and postal orders can also be included for the future studies.

References

Alimi R.S., (2014). ARDL Bounds Testing Approach to Cointegration: A Re Examination Of Augmented Fisher Hypothesis In An Open Economy. *Asian Journal of Economic Modelling, 2(2): 103-114*

Central Bank of Sri Lanka (2018). *Annual Report*.

Claessens S., Glaessner T. and Klingebiel D. (2001). E-Finance in Emerging Markets: Is Leapfrogging Possible? *Financial Sector Discussion Paper No. 7, The World Bank June*

Emeka N. and Aham K. U, (2016), Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation, *Journal of Statistical and Econometric Methods, vol.5, no.4, 2016*

Eze G. P., Egoro S. (2016), Electronic Banking and Profitability of Commercial Banks in Nigeria, *Journal of Finance and Economic Research (Vol. 3, No. 1; 2016)*

FATF and MENAFATF (2015), Money Laundering through the Physical Transportation of Cash, *FATF, Paris, France and MENAFATF, Manama, Bahrain*

Felix U. O., Rebecca U. I., Igbinoba O. K. (2015). Appraisal of the Impact of e-Banking and Cashless Society in the Nigerian Economy. *Management and Economics Research Journal, Vol 1, 34-45*

Gutpa N, Gupta S, (2017), Impact of Cashless Society on Banking Sector (with reference to the MEERAT Region)

Hernando I. and Nieto M. J, (2006), Is the Internet delivery channel changing banks' performance? The Case of Spanish Banks, *Journal of Banking and Finance*

Itah A. J. (2014). Impact of Cashless Banks 'Profitability (Evidence from Nigeria), *Asian Journal of Finance & Accounting Vol 6, No. 02*

Jaratin L, Mori K., Dullah M., Lim T. and Rozilee A. (2014), Exchange Rate Movement and Foreign Direct Investment in Asean Economies, *Economics Research International*

Kahandawa K., Wijayanayake J (2014), Impact of Mobile Banking Services on Customer Satisfaction:A Study on Sri Lankan State Commercial Bank, *International Journal of Computer and Information Technology (Vol 3, 2014)*

Kamboh, K.M and Leghari M.E.J. (2016). Impact of Cashless Banking on Profitability: A Case Study of Banking Industry of Pakistan. *Journal of Commerce, Economics and Social Sciences, 10 (2), 82-93*

Kamrul Hasan, E-Banking in Bangladesh: The Future of Banking

Kulkarni K (2018), Learn bitcoin and Blockchain

Magnus F. J, Bounds Testing Approach: An Examination on Foreign Direct Investment, Trade and Growth Relationships., *KNUST School of Business, Kwame Nkrumah University of Science & Technology*

Maldeni H. M. C. M and Jayasena S. (2009), Information and Communication Technology and Bank Branch Performance, *The International Journal on Advances in ICT for Emerging Regions 2009 02 (02)*

Mutua R. W. (2010), Effects of Mobile Banking on the Financial Performance of commercial Banks in Kenya

Nyoni T. and Bonga W. G. (2017). Cashless Transacting Economy: A Necessary Evil for Development! A Zimbabwean Scenario!, *Journal of Economic and Finance, Vol 2, 1-10*

Odior E. S. and Fadiya .B. B, Cashless Banking In Nigeria: Challenges, Benefits And Policy Implications, *European Scientific Journal, (June edition vol. 8, No.12)*

Okon A. N, Amaegberi M.A, Mobile Banking Transactions and Bank Profitability in Nigeria, (2018), *International Journal of Economics, Commerce and Management (Vol VI)*

Omar W.A.W., Hussin F., Asan A G H. (2015). The Empirical Effects of Islam on Economic Development in Malaysia. *Research in world Economy, Vol 6, No1.*

Onay C, Ozsoz E. Helvacioglu A. D, (2008), The impact of Internet-Banking on Bank Profitability - The Case of Turkey, *Oxford Business &Economics Conference Program*

Payments and Settlements Department, Central Bank of Sri Lanka (2018) *Payment Bulletin 4th Qtr 2018*

Payments and Settlements System and Money Laundering Activities, Interview (2019.05.06), *www.cbsl.gov.lk*

Pierre Monnin and Terhi Jokipii. (2010). The Impact of Banking Sector Stability on the Real Economy.

Roche I. D, An Empirical Investigation of Internet Banking Service Quality, Corporate Image and the Impact on Customer Satisfaction; With Special Reference to Sri Lankan Banking Sector, *Journal of Internet Banking and Commerce*

Shendge P. A. and Shelar B. G. (2017), Impact and Importance of Cashless Transaction in India, *International Journal of Current Trends in Engineering and Research (Vol 3, Issue 4, 22-28)*

Shobhit W, (2016), Impact of m-Banking on Profitability of Scheduled Commercial Banks in India, *International Journal of Control Theory and Applications (Vol 10, No. 40, 2016)*

Sumra S.H., Manzoor M. K., Sumra H.H. and Abbas M. (2011). The impact of E-banking on the Profitability of Banks: A study of Pakistani Banks. *Journal of Public Administration and Governance, 1(1), (31-38)*

World Payment Report-2018, Capgemini and BNP Paribas

Yang S, Li Z, Ma Y, Chen X (2017), Does Electronic Banking Really Improve Bank Performance? Evidence in China, *International Journal of Economics and Finance, (Vol. 10, No. 2; 2018)*

Appendix 1: Vector Error Correction Model Estimates

Vector Error Correction Estimates
Date: 11/14/19 Time: 13:30
Sample (adjusted): 5 36
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
ROA(-1)	1.000000
LINT(-1)	8.112044 (0.99087) [8.18683]
LPOS(-1)	-10.76790 (1.36193) [-7.90636]
LMOBT(-1)	0.358756 (0.06812) [5.26627]
C	48.32940

Error Correction:	D(ROA)	D(LINT)	D(LPOS)	D(LMOBT)
CointEq1	-0.633621 (0.12470) [-5.08098]	-0.028708 (0.05377) [-0.53387]	-0.023826 (0.04761) [-0.50044]	0.091895 (0.21215) [0.43315]
D(ROA(-1))	-0.247075 (0.16689) [-1.48050]	-0.035092 (0.07196) [-0.48763]	-0.075578 (0.06372) [-1.18618]	-0.351752 (0.28392) [-1.23893]
D(ROA(-2))	-0.222407 (0.13866) [-1.60399]	-0.041038 (0.05979) [-0.68634]	-0.057950 (0.05294) [-1.09467]	0.154021 (0.23589) [0.65293]
D(ROA(-3))	-0.021920 (0.10936) [-0.20044]	-0.037655 (0.04716) [-0.79847]	-0.061138 (0.04175) [-1.46425]	0.137009 (0.18605) [0.73640]
D(LINT(-1))	4.231315 (0.86216) [4.90783]	-0.506323 (0.37178) [-1.36190]	0.091583 (0.32916) [0.27823]	-1.857480 (1.46674) [-1.26640]
D(LINT(-2))	2.903197 (0.86473) [3.35735]	-0.339228 (0.37288) [-0.90974]	0.383363 (0.33014) [1.16120]	0.170210 (1.47112) [0.11570]

D(LINT(-3))	1.402306	-0.308556	-0.297234	0.405728
	(0.73373)	(0.31640)	(0.28013)	(1.24826)
	[1.91119]	[-0.97521]	[-1.06105]	[0.32503]
D(LPOS(-1))	-4.561460	-0.372012	-0.826270	-0.992483
	(1.18592)	(0.51139)	(0.45277)	(2.01754)
	[-3.84636]	[-0.72746]	[-1.82492]	[-0.49193]
D(LPOS(-2))	-3.912581	-0.362106	-0.575021	-2.239706
	(1.05158)	(0.45346)	(0.40148)	(1.78900)
	[-3.72067]	[-0.79854]	[-1.43225]	[-1.25193]
D(LPOS(-3))	-1.931015	-0.507293	-0.503540	0.146271
	(0.94517)	(0.40757)	(0.36086)	(1.60796)
	[-2.04304]	[-1.24467]	[-1.39541]	[0.09097]
D(LMOBT(-1))	-0.030655	-0.084653	0.067161	0.154133
	(0.17827)	(0.07687)	(0.06806)	(0.30329)
	[-0.17195]	[-1.10119]	[0.98675]	[0.50821]
D(LMOBT(-2))	0.001320	-0.125168	-0.136409	0.785348
	(0.22607)	(0.09749)	(0.08631)	(0.38461)
	[0.00584]	[-1.28394]	[-1.58040]	[2.04193]
D(LMOBT(-3))	0.257063	0.152749	0.106258	-0.224233
	(0.20107)	(0.08671)	(0.07677)	(0.34207)
	[1.27846]	[1.76170]	[1.38416]	[-0.65551]
C	-0.061968	0.194277	0.120679	0.280077
	(0.11956)	(0.05156)	(0.04565)	(0.20341)
	[-0.51828]	[3.76813]	[2.64367]	[1.37692]
R-squared	0.777677	0.554798	0.730177	0.546339
Adj. R-squared	0.617111	0.233263	0.535305	0.218695
Sum sq. resids	0.155464	0.028908	0.022661	0.449952
S.E. equation	0.092935	0.040075	0.035482	0.158105
F-statistic	4.843333	1.725468	3.746958	1.667477
Log likelihood	39.82718	66.74383	70.63949	22.82358
Akaike AIC	-1.614199	-3.296490	-3.539968	-0.551474
Schwarz SC	-0.972940	-2.655230	-2.898709	0.089786
Mean dependent	-0.029063	0.058217	0.048451	0.135079
S.D. dependent	0.150190	0.045767	0.052050	0.178870

Determinant resid covariance (dof adj.)	1.05E-10
Determinant resid covariance	1.05E-11
Log likelihood	222.7957
Akaike information criterion	-10.17473
Schwarz criterion	-7.426474