ESSAYS ON TRANSACTION TECHNOLOGY AND PAYMENT SYSTEM

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Certified that the Thesis Entitled

Essays on Transaction Technology and Payment System submitted by me for the award of the degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my own work carried out under the supervision of Dr. Malabika Roy, Professor, Department of Economics, Jadavpur University. Neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere/elsewhere.

..... ……..

Countersigned by the Supervisor Prof. Malabika Roy Candidate:

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Dated:

Dedicated to,

My beloved Parents Smt. Rina Dutta and Sri. Goutam Dutta
My lovely sister Sneha Dutta and
My beloved husband Sri Aakash Deb for inspiring me to be fearless and shaping my world view.

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Content

Chapter Name Page Number

Chapter One: **Introduction**

1.1. Overview 2

1.2. Objective of The Research 6

1.3. Methodology 8

1.4. Contribution 9

1.5. Overview of the Thesis 11

Chapter Two: **Literature Review**

2.1. Introduction 14

2.2. Literature on changing pattern of cashless transaction 15

2.3. Literatures on Acceptance of Cashless Transaction and Socio Economic Conditions 23

Chapter Three: **Index of Cashless Transaction**

3.1. Introduction: 32

3.2. Methodology and Data: 35

3.2.1. Data 35

3.2.2. Construction of indices 36

3.3. Results: 41

3.3.1 Analysis: Individual Dimensions 41

3.3.1.1. Graphical Plot Analysis of The Dimensions 42

3.3.1.2. Trend Analysis of The Individual Dimensions 46

3.3.2. Analysis of Indices 60

3.3.1.1. Graphical Plot Analysis of The Dimensions 60

3.3.1.2. Trend Analysis of The Individual Dimensions 61

3.4. Conclusion: 66

Chapter Four: **Determinants of Digital Transaction: A Theoretical Approach**

4.1. Introduction 71

4.2. Description of the Theoretical Model: 72

4.2.1. Description of the Model without Direct Taxation: 73

4.2.1.1. Equilibrium Education 82

Comparison between cash transaction

of A type and B type in respect of education 82

Comparison between Cash Transaction of A Type and Debit Card Transaction with Respect to Education 83

Comparison between Cash Transaction of 'B' Type
and Debit Card Transaction with Respect to Education 85

4.2.1.2. Equilibrium Income 87

Comparison between Cash Transaction of A Type
and B Type in Respect of Level of Income 87

Comparison between Cash Transaction of A Type
and Debit Card Transaction with Respect to Income 88

Comparison between Cash Transaction of 'B' Type
and Debit Card Transaction with Respect to Income 90

4.2.2. Description of The Model with Direct Taxation: 91

4.2.2.1. Comparison of Net Benefit Functions of Cash Transactions
with either Only White or Only Black Money 94

4.2.2.2. Comparison of Net Benefit Functions of Debit Card Transactions with White Money and Cash Transaction with Black Money 95

4.2.2.3. Optimal Distribution between White Money & Black Money 96

4.4. Conclusion: 99

Chapter Five: **Determinants of Digital Transaction: An Empirical Analysis**

5.1. Introduction: 104

5.2. Data and Methodology: 106

5.2.1. Description of Data 106

5.2.2. Detailed Methodology 111

5.2.3. Logistic Regression 114

5.3. Results: 116

5.3.1. Justification Behind Credit Card Ownership as a

Proxy for the Usage of Cashless Transaction 116

5.3.2. Results of Logistic Regression 120

5.4. Conclusion: 129

Chapter Six: **Conclusion**

6.1: Introduction 133

6.2: Summary of the Findings 134

6.3: Limitations 137

6.4: Policy Prescription 138

6.5: Future Research Agenda 141

Bibliography 143

Appendix 149

LIST OF THE TABLES

Title of Table **Page Number**

Table 3.1: The list of the Dimensions Used in the Construction of Three Different Indices 38

Table 3.2: Summary Table Based on Graphical Plot after Smoothing 46

Table 3.3: Summary Table of the Dimensions' based on Structural Break Analysis 58

Table 3.4: Summary Table of the Individual Transaction Types, Based on Structural Breaks 59

Table 3.5: Regression Results of Per Capita Volume Index 64

Table 3.6: Regression Results of Per Capita Value Index 64

Table 3.7: Regression Results of Value/ GDP Index 64

Table 3.8: Summary Table of the Indexes based on Structural Break Analysis 66

Table 4.1: Relationship Between Tax rate and Proportion of income Understated 99

Table 5.1: Details of the Independent Variables 108

Table 5.2: Correlation between Different Types of Cashless Transactions and No. of Credit Card Outstanding 117

Table 5.3: Summary Output Table No. of credit card outstanding regressed on

Per Capita Volume of Cashless Transaction Index 118

Table 5.4: Summary Output Table of No. of credit card outstanding regressed on Per Capita Value of Cashless Transaction Index 119

Table 5.5: Summary Output Table of No. of credit card outstanding regressed on Value of Cashless Transaction as a Proportion of GDP Index 119

Table 5.6: Panel Logistic Regression 1 Result (reporting marginal effect and odds ratio) 120

Table 5.7: Panel Logistic Regression 2 Result 121

Table 5.8: Effect of Education at Different Income Level Based on Panel Logistic Regression2 123

Table 5.9: Logistic Regression 1 Result for the Year 2011-12 124

Table 5.10: Logistic Regression 2 Result for the Year 2011-12 126

Table 5.11: Effect of Education at Different Income Level Based on Logistic Regression 2 128

Table A3.1: Descriptive Statistic of All the Dimensions 150

Table A3.2: Dimension Wise Fitted Time Trend 151

Table A3.3. Correlation Matrix between the Dimensions of Value GDP Index. 152

Table A3.4. Principal Component Matrix for Value as a Proportion of GDP Index. 152

Table A3.5. Total Variance Explained for Per Capita Value Index 152

Table A3.6. Correlation Matrix between the Dimensions of Per Capita Value Index. 152

Table A3.7. Principal Component Matrix for Per Capita Value Index. 153

Table A3.8. Total Variance Explained for Per Capita Value Index. 154

Table A3.9. Correlation Matrix between the Dimensions of Per Capita Number Index.154

Table A3.10. Principal Component Matrix for Per Capita Number Index. 154

Table A3.11. Total Variance Explained for Per Capita Number Index 155

Table A5.1: Correlation coefficient Test Result 157

Table A 5.2: VIF Test for Multicolinearity 157

Table A5.3: Hausman Test Result for panel data analysis 157

Table A5.5: Hosmer Lemeshow Test Result for logistic Regression 1 for 2011-12 158

Table A5.6: Hosmer Lemeshow Test Result for logistic Regression 2 for 2011-12 158

Table A5.7: Logistic Regression 1 for 2004-05 Reporting Odds Ratio (To Capture the Effect of Education) 159

Table A5.8: Logistic Regression 1 for 2004-05 Reporting Marginal Effect (To Capture the Effect of Education) 159

Table A5.9: Hosmer Lemeshowof Logistic Regression 1 for 2004-05 159

Table A5.10: Logistic Regression to Capture the Effect of Income for 2004-05

(Reporting Odds Ratio) 160

Table A5.11: Logistic Regression to Capture the Effect of Income for 2004-05

(Reporting Marginal Effect) 160

Table A5.12: Hosmer Lemeshow of Logistic Regression 2 for 2004-05. 161

LIST OF THE FIGURES

Title of Figures	Page Number
Figure 3.1: No. of Cards per 1000 Adults	42
Figure 3.2: POS Transaction	42
Figure 3.3: NEFT Transactions	43
Figure 3.4: RTGS Transactions	43
Figure 3.5: IMPS Transactions	44
Figure 3.6: ECS+NACH Transaction	44
Figure 3.7: Cusum Plot Per Capita No. of POS	48
Figure 3.8: Cusum Plot Per Capita Value	49
Figure 3.9: Cusum Plot POS/ GDP	49
Figure 3.10: Cusum Plot Per Capita Value of IMPS	49
Figure 3.11: Cusum Plot Per Capita Value of IMPS	50
Figure 3.12: Cusum Plot IMPS/ GDP	50
Figure 3.13: Cusum Plot Per Capita Value of NEFT	50
Figure 3.14: Cusum Plot Per Capita No. of NEFT	51
Figure 3.15: Cusum Plot Per Capita Volume of RTGS	52
Figure 3.16: Cusum Plot Per Capita Value of IMPS	52

Figure 3.17: Cusum Plot Value of IMPS/ GDP 52

Figure 3.18: Cusum Plot Per Capita Volume of IMPS 53

Figure 3.19: Cusum Plot No. of Cards/ 1000 Adults 54

Figure 3.20: Per Capita Volume of POS 54

Figure 3.21: Cusum Plot Per Capita Value of POS 54

Figure 3.22: Cusum Plot Value POS/GDP 55

Figure 3.23: Cusum Plot Per Capita Value of NEFT 55

Figure 3.24: Cusum Plot Value NEFT/ GDP 55

Figure 3.25: Cusum Plot Per Capita Value of RTGS 56

Figure 3.26: Cusum Plot Value of RTGS/ GDP 56

Figure 3.27: Cusum Plot Per Capita Volume of ECS+NACH 57

Figure 3.28: Graphical Plot of Three Different Indices 60

Figure 3.29: Cusum plot of Per Capita Volume Index 65

Figure 3.30: Cusum Plot of Per Capita Value Index 65

Figure 3.31: Cusum Plot of Value/ GDP Index 65

Figure 4.1: Diagrammatic Representation of Equilibrium Level of Education

Between Cash Transaction of A-type and Debit Card Transaction 85

Figure 4.2: Diagrammatic Representation of Equilibrium Level of Education

Between Cash Transaction of B-type and Debit Card Transaction 86

Figure 4.3: Graphical Representation of the Relationship between Tax Rate and

Proportion of declared Income 99

CHAPTER **1**

INTRODUCTION

1.1. Overview:

The digital ecosystem has experienced rapid growth across the globe in the past few decades, playing a significant role in driving successful economies. With the emergence of wireless handheld devices and internet services, the digital financial transaction market has undergone tremendous transformation. The resource cost of a nation's payment system can account for as much as 3% of its GDP (Humphrey Pulley, and Vesala, 2000). Electronic payment systems enjoy two clear advantages over cash-based or paper-based non-cash payment systems. First, since most electronic payments cost only around one-third to one-half as much as paper-based non-cash payments (such as cheque payments), shifting to electronic modes should considerably reduce the economic cost of the payment system. Secondly, under cashless transactions, the documentation of each transaction is complete and accurate compared to cash transactions, reducing the possibility of creating dark money and increasing transparency and tax compliance.

The notion of using anything other than cash to pay for goods or services can be traced back to the late 19th century when credit vouchers were issued by some retailers in the UK. These allowed customers to purchase certain items and settle the debt at a later date. Many advances towards payment cards in the 20th century occurred in the USA and tended to focus on credit cards rather than debit cards. The US Diner's Club card was one of the first such cards, and their use became widespread throughout the 1950s. Diners Club cards also became one of the first credit cards used in the UK when introduced into the country in the early 1960s, followed by American Express entering the UK market soon after. Barclays became the first British bank to issue a credit card in 1966 with their Barclaycard, followed closely by other British banks such as NatWest, Lloyds, and RBS introducing their own bank cards in that 1970s. The advent of the debit card as we know it today was still some distance off, bur the creation of the world’s

first ATM seemed to hasten its arrival. According to the AU small finance bank, In the US by The Bank of Delaware first launch a pilot project involving Debit Cards in 1966. By the 1970s, many other banks started working on similar ideas. In India in the year 1987 the first ATM was introduced in 1987. Though it took time for Indians to switch from cash to card payments, but now debit cards have become one of the essential part of everyday life.Starting from 2016, the promotion of cashless transactions has been one of the policy priorities of the Government of India. According to the Press Information Bureau in December 2016, the government adopted several measures for the promotion of digital and cashless transactions under the scheme of 'Cashless India' right after the demonetization[1] in November 2016. Following the demonetization policy, other measures were launched on November 30, 2016, by NPCI (National Payment Corporation of India), which include Unstructured Supplementary Service (USSD)[2], Aadhaar Enabled Payment System (AEPS)[3], the scheme Digital Finance for Rural India[4], creating awareness and access through CSCs, and others. Examples of these initiatives include:

Petroleum PSUs offered a 0.75% discount on the sale price on the purchase of petrol/diesel through digital means.

[1] On 8th November 2016 Govt. of India decided to ban two highest denominations of currency notes of Indian rupee. Demonetization was motivated by the belief that the maximum portion of the black money was kept with those two highest currency notes. It was also believed that people would adopt the habit of cashless transaction Rekha (2019).

[2] Govt. of India with the help of NPCI (National Payment Corporation of India) Launched on 30.11.2016 Unstructured Supplementary Service Data (USSD) this payment service Individual can do mobile banking transactions using *99#, without Internet from basic mobile phone.

[3] AADHAAR ENABLED PAYMENT SYSTEM (AEPS**)** has launched, in this scheme financial transaction can be done at POS (Point of Sale / Micro ATM) using the Aadhaar authentication.

[4] The scheme entitled *'Digital Finance for Rural India: Creating Awareness and access through CSCs',* from December 2016. Govt. hosts awareness programs regarding policies and digital payment system for rural populations, besides enabling various mechanisms of digital financial services for example IMPS, UPI, Bank POS machines etc.

The Central Government extended financial support for the deployment of 2 POS devices each in 1 lakh villages with a population of less than 10,000 and issuing "Rupay Kisan Cards" to 4.32 crore Kisan Credit Card holders with the help of NABARD, enabling them to make digital transactions at POS machines/Micro ATMs/ATMs.

Railways provided a discount of up to 0.5% through its suburban railway network for monthly or seasonal tickets from January 1, 2017, on digital payments only.

The Central Government ensured that transaction fees/MDR (Merchant Discount Rate, the cost paid by a merchant for accepting payment via credit or debit cards every time) charges shall not be passed on to the consumers, and all such expenses shall be borne by them. No service tax will be charged on digital transaction charges/MDR for transactions up to Rs. 2000 for transaction.

The Digital India and Cashless India programs are flagship initiatives of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy. "Faceless, Paperless, Cashless" is one of the professed roles of Digital India. As part of promoting cashless transactions and converting India into a less-cash society, various modes of digital payments are available, including credit & debit cards, USSD[5], AEPS[6], UPI[7], mobile

[5] The Government of India, with the help of NPCI (National Payment Corporation of India), launched Unstructured Supplementary Service Data (USSD) on November 30, 2016. This payment service allows individuals to conduct mobile banking transactions using *99# without internet access from basic mobile phones.

[6] AEPS (Aadhaar Enabled Payment System) is a bank-led model that allows online interoperable financial transactions at Point of Sale (POS) terminals or Micro ATMs through business correspondents of any bank using Aadhaar authentication.

[7] Unified Payments Interface (UPI) is a system that integrates multiple bank accounts into a single mobile application, merging several banking features and enabling seamless fund routing and merchant payments. It also facilitates "Peer to Peer" collect requests, which can be scheduled and paid as per requirement and convenience. Each bank provides its own UPI app for Android, Windows, and iOS mobile platforms.

wallets[8], bank payment cards[9], point of sale[10], internet banking[11], mobile banking, and micro ATMs.

Different types of online transactions included in the appendix A1.

The present thesis focuses on contemporary issues related to cashless digital transactions in India, with a core focus on the trend of the cashless transactions and the factors influence consumers to use cashless transactions. Following the significant demonetization event in India on November 8, 2016, the promotion of cashless transactions became a policy priority for the Indian economy. The government of India has implemented various measures to encourage less-cash transactions, starting with the controversial demonetization move. With the development of digital India schemes, increasing mobile usage, internet availability, and the impact of demonetization-related policies, the payment structure of the population has undergone significant transformation.

While the importance of cashless transactions is widely acknowledged, there is a lack of a proper yardstick to measure the extent of such transactions in the economy. Through exploring the reasons behind and effects of demonetization in the economy, I found initial inspiration for my research. The "cashless India" or "Cash Mukt Bharat" policy of the government of India

[8] A mobile wallet is a way to carry cash in digital format. Users can link their credit card or debit card information to a mobile wallet application or transfer money online to the mobile wallet. Instead of using physical plastic cards to make purchases, users can pay with their smartphones, tablets, or smart watches. Most banks offer their e-wallets, and there are also options from private companies such as Paytm, Freecharge, Mobikwik, Oxigen, and others.

[10] Point of Sale refers to transactions using debit or credit cards while purchasing goods and services by swiping cards at the merchant's counter, as well as during online transactions using debit or credit cards. Banking cards offer consumers more security and convenience than any other payment method. The wide variety of cards available – including credit, debit, and pre-paid – offers enormous flexibility as well. These cards provide two-factor authentication for secure payments, such as secure PIN and OTP. Examples of card payment systems include RuPay, Visa, and MasterCard. Payment cards empower individuals to purchase items in stores, on the internet, through mail-order catalogues, and over the telephone. They save both customers and merchants time and money, enabling ease of transactions.

[11] Internet banking, also known as online banking, e-banking, or virtual banking, is an electronic payment system that enables customers of a bank or other financial institution to conduct a range of financial transactions through the financial institution's website.

led me to delve deeper into the details of cashless transactions and the financial landscape of the economy. Based on these explorations, I decided to focus my research related to the cashless digital transactions.

This thesis aims to address some concerns related to the cashless transactions which includes the trend and the extend of the cashless payment structure of the Indian economy over time, the impact of policies aimed at increasing cashless transactions, and factors influencing cashless transaction lastly further policy prescriptions, using empirical and theoretical analysis. The thesis develops methods to measure the volume and value of less-cash transactions in the economy using three different indexes. It also explores the relationship between socio-economic backgrounds and the selection of payment modes between cash and cashless methods using a theoretical structure.

Furthermore, the thesis conducts empirical testing of the theoretical models discussed earlier, focusing on estimating the relationship between cashless transactions and socio-economic backgrounds such as financial status, household status, demography, and education.

1.2: Objectives of the Research:

The present dissertation focuses on three broad issues that either have not been addressed in the existing literature or have been investigated only to a limited extent using different methodology. Three distinct empirical as well as theoretical models have been developed to study the following three research questions that to the best of our knowledge, are not examined before:

- The present thesis measures the extent of cashless transactions in the Indian economy over time (from 2012 – 2023), including the period of the Pradhan Mantri Jan Dhan Yana (PMJD) in 2014, the demonetization in November 2016, and the COVID-19 pandemic in 2020. As it is one of the policy priority of the government of India to promote financial services and cashless transactions, starting with the PMJDY in 2014. Though the significance of cashless transactions is acknowledged, a proper measuring stick is needed to gauge the degree and efficiency of the policies for promoting cashless transactions in an economy, this work is inadequate in the literature given the importance of this issue. In the 3rd chapter, we endeavour to fill this gap by utilizing the multi-dimensional index formulated by the UNDP. The goal is not only to seize the amount of cashless transactions in the Indian economy over time but also to determine the effectiveness of the policies and events on the overall scenario of the cashless transactions of the economy.

- The present thesis analyses the socio-economic determinants of digital transactions — in simpler terms, ascertaining how the socio-economic conditions of the buyer impact the selection of cashless payment methods. For this purpose a theoretical framework is developed focused on modelling the transaction costs of both cash and cashless transactions (debit card) separately from the buyer's perspective corresponding to the different education level and income level. By comparing the transaction cost structures the main objective is to find out the combination of education and income levels where the cashless transactions will be used, in an environment where debit cards and currency (legal tender) are competing payment channels. It explores the impact of education and income on the selection of payment modes between cash and cashless transactions by examining changes in transaction costs of cash transactions and cashless

transactions across different income and education levels with and without the presence of direct taxation.

- The present thesis also empirically validates the theatrical postulates developed earlier. In the process we also investigate the socio economic determinants of use of the cashless transaction through a comprehensive statistical analysis of data, taking into account the intricate interplay between various socio economic variables in influencing cashless transaction usage. Especially interaction term between different socio economic variable has been implemented to unveil the joint effect of the variables on the likelihood of possessing cashless transaction, such that the effect of level of education behind the selection of cashless mode of payment is depend on the level of income the household holds or not and weather the effect of level of income behind the selection of cashless mode of payment is depend on the level of education the household holds or not.

The aforementioned research topics have been drawn from various literature on digital cashless transaction that have notably inspired us to take on these three aforementioned issues. The dissertation intervenes in existing literature with three comprehensive empirical and theoretical analysis that will blend real-life problems with prevailing theories and unveil key outcomes. Before detailing the key findings of the dissertation briefly, a succinct illustration of the methodology has been presented in the subsequent section.

1.3. Methodology:

The dissertation engages a variety of standard empirical modelling as well as theoretical structures of cashless digital transactions to address the research questions mentioned previously. Multi-dimensional index construction and time series trend analysis have been

used to identify the efficacy of government policies in promoting digital transactions in the Indian economy. The Cusum test of structural break analysis is utilized to verify the stability and breaks in the trend of each index of cashless transactions in the Indian economy. The transaction cost approach for both cash transactions and cashless transactions has been employed in each theoretical structure, thereby enabling a comparative exercise between the two types of transactions. Last but not least, panel logistic regression analysis and logistic regression analysis, to estimate different parameter values, have been conducted in the last chapter to support the theoretical findings derived in Chapter 4.

1.4. Contribution:

Digital transaction or cashless transaction possesses a great value to academics and policy practitioners for its expeditious growth and other benefits the economy gains from adopting cashless transaction. . Although there exists a host of literature explaining different issues related to digital transaction, only few of them discuss about the recent trend in the cashless transaction and factor behind its growth. The present research casts light on the underexplored sphere of knowledge concerning digital transaction and explores the issue both theoretically and empirically to institute some valuable intuitions that contribute to the large body of literature. We present a detailed analysis on each of these research questions on the ensuing chapters, however, here we highlight the crucial results.

- The empirical result suggests that while demonetisation and post-demonetisation policies had a temporary effect on the overall value as well as volume of the cashless transaction there is an increase in volume of the cashless transaction after the adaptation of Pradhan Mantri Jan Dhan Yojona (PMJDY). This result bears a significant practical implication as to finding out the effectiveness of the controversial policy such as

"demonetisation" to increase the overall cashless transaction into the economy, the effect was very temporary.

- The theoretical result indicates the significant joint impact of education and income on payment mode choices. Tax policies also intricately shape payment mode selection. Detecting and deterring tax evasion through advanced monitoring systems is vital, alongside initiatives to promote education level and income of the households incentivize cashless transactions among educated individuals. Overall, this research provides actionable insights for policymakers seeking to navigate the complex interplay of tax dynamics, education levels, and income level and payment preferences toward fostering a more efficient, cashless economy.
- Additionally, this research attempts to validate empirically the theoretical model developed in the second chapter of our PhD work. This research unveils the nuanced relationship between education, income, and cashless transaction usage. The inclusion of interaction terms in panel logistic regression models elucidates the joint influence of education and income, emphasizing their dynamic nature over time. Findings underscore the importance of targeted financial literacy initiatives and highlight factors like age, computer knowledge, and economic class in shaping cashless transaction adoption. Policymakers and financial institutions can utilize these insights to tailor interventions promoting financial inclusion and understanding the evolving landscape of digital transactions, ultimately fostering a more inclusive and efficient financial ecosystem. This integration of theoretical and empirical approaches enhances the comprehensiveness and applicability of our research, offering a deeper understanding of the dynamics driving cashless transaction adoption.

The most prominent contribution of the present thesis is the development of comprehensive research models that could explicitly describe the latest events occurring in the domain of Digital Transaction and payment system.

1.4 Overview of This Thesis:

The thesis intervenes in the existing literature with three prevailing research proposals which has been organised in the three core chapters. The ensuing chapters are organized as follows.

The present chapter sets out a concise discussion on the emergence of digital transaction platforms and backdrop of the research problems. It outlines the recent digital transaction scenario with carefully explaining the objectives of present thesis. Particularly, the significant empirical theoretical findings of our study and their practical & economical relevance have been expounded. Next, the contribution of the thesis is thoroughly and extensively presented.

A rich volume of literature on the studies related to digital or cashless transaction has been exhaustively surveyed in the Chapter 2 entitled *"Review of Literature"*. The key findings of each of these studies have been extracted and elaborated to describe the recent trends in digital transaction. The articles reviewed explore both the analytical and theoretical models relating digital transaction. Based on the existing findings, research gaps have been identified which embark the foundation of each of our research questions. On the basis of the detailed literature survey and research proposals, theoretical and empirical methodologies have been adopted for each research objective. Each chapter uses these methodologies to answer the research questions and analyze key findings. Our contribution is contained in three core chapters which are discussed below.

Chapter 3 entitled *"Index of Cashless Transaction"* sets forth the impact of Pradhan Mantri Jan Dhyan Yojana (PMJDY), demonetisation and post demonetization policies, and Covid-19

pandemic on the overall trend of the cashless transaction of the Indian economy, by analysing three different indices following UNDP HDI methodology. A trend analysis and structural break analysis is carried out as well to find out the effectiveness of the different events on the general trend of the cashless transaction.

In chapter 4 titled *"Determinants of Digital Transaction: A Theoretical Approach"* we develop a theoretical framework aimed at modelling the transaction cost of cash and cashless transactions (debit card) in the absence of direct taxation as well as including direct taxation. The theoretical structure focuses on the buyer's perspective and we tried to find out the threshold level of education and income where the cashless transactions will be used when debit cards and currency (the legal tender) are competing payment media. In the other words we investigate the effect of education and income behind the selection of payment mode between cash and cashless transactions, considering both stated and understated income through the analysis of the changes in the transaction cost and net benefit of the cash and cashless transactions with the changes in the level of income and education.

Chapter 5 titled *"Determinants of Cashless Transaction: An Empirical Analysis"* investigates the socio economic determinants of usage of the cashless transaction through a comprehensive analysis of panel data spanning the years 2011-12 and 2004-05. This research also delves into the intricate interplay between income and education levels in influencing cashless transaction usage, interaction term education and income to unveil the joint effect of education and income on the likelihood of possessing cashless transaction.

Chapter 6 concludes the thesis summarizing the crucial findings obtained in Chapters 3 to 5 on different relevant issues on digital transaction and sets off the avenues for future research endeavours. Bibliographical references is appeared thereafter.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction:

The advent of digital transactions marks a pivotal moment in the evolution of Transaction and finance. Rapid technological advancements, coupled with shifting consumer preferences and global connectivity, have catalysed the proliferation of digital transaction systems, transforming the way individuals and businesses exchange value. From online payments and mobile wallets to UPI transactions, the digital transaction landscape encompasses a diverse array of technologies, platforms, and modalities that facilitate seamless and efficient exchanges of goods, services, and assets across borders and time zones.

The rise of digital transactions has been driven by a convergence of factors, including advancements in information and communication technologies (ICTs), the ubiquity of internet connectivity, and the growing demand for convenient and secure payment solutions in an increasingly digitalized world. Enabled by secure encryption protocols, distributed ledger technologies, and mobile computing devices, digital transactions offer unprecedented opportunities for financial inclusion, innovation, and economic empowerment.

However, the widespread adoption of digital transactions also presents a host of challenges and complexities that warrant careful consideration. Concerns regarding data privacy, cybersecurity, regulatory compliance, and equitable access underscore the need for robust governance frameworks, technological safeguards, and user-centric design principles to ensure the integrity, security, and inclusivity of digital transaction ecosystems. Moreover, the rapid pace of innovation and disruption in the fintech landscape necessitates ongoing research and dialogue to understand the implications of digital transactions for individuals, businesses, and society at large.

Against this backdrop, the present thesis seeks to explore the multifaceted nature of digital transactions, examining their technological foundations, socio-economic impacts, and regulatory implications. By synthesizing insights from literature, empirical studies, and industry reports, this study aims to elucidate the dynamics shaping the digital transaction landscape and identify opportunities and policy intervention. Through a comprehensive analysis of key trends, challenges, and future directions, this research aims to contribute to a deeper understanding of the transformative potential of digital transactions in an increasingly digitalized and interconnected world.

Before going into the detailed analysis of those issues in the following chapters, the present chapter offers a succinct and concise overview of both the analytical and empirical literature concerning various themes related to cashless digital transaction for better understanding of the literature gap. We essentially investigate the studies on those issues we have explored in the upcoming chapters.

2.2. Literature on changing pattern of cashless transaction:

As in the 3rd chapter our main objective is to analyse the extent of cashless transaction in the Indian economy over time from 2012-2023 and also to identify the changing pattern of the cashless transaction with the introduction of some policies like PMJDY in 2014, demonetisation in 2016 and its subsequent policies and also to identify the changing pattern of cashless transaction of the Indian economy after the outbreak of COVID-19. There are very few literatures that resemble our work and objectives. This objective have received importance in recent articles which we will discuss in the following.

First, we consider the relevant studies which focus on the advantages of the cashless transaction and the initiatives taken by the Indian govt. to promote cashless transaction of the economy for

the better understanding of the government's objectives regarding the cashless transactions into the economy.

Goel and Garg (2022) highlights the benefits and initiatives driving the transition towards a cashless economy in India. Emphasizing the advantages of digital transactions, such as enhanced transparency, accuracy, and accountability, their study underscores how this shift not only facilitates faster transactions but also saves considerable time and money. The government's commitment to bolstering physical and digital infrastructure, along with security measures, underscores its vision of making infrastructure universally accessible. Initiatives like the Bharat Interface for Money (BHIM) [12]App exemplify governmental efforts to promote cashless transactions. Furthermore, the study underscores the broader agenda of 'Digital India,' aiming to propel the nation into a more robust digital and knowledge-based economy. The transformation toward cashless commerce is positioned as a futuristic business model with potential benefits for both companies and governments, fostering efficiency in fund management. Overall, the literature provides a comprehensive view of the motivations, strategies, and potential outcomes associated with India's journey towards becoming a cashless society, encapsulating its societal and economic implications succinctly

Aggarwal, Gupta, Rishikesh and Batra (2023) underscores the Indian government's Digital India initiative, aimed at fostering technological advancement and promoting digital payments. Secondary data analysis reveals a steady rise in digital transactions, with key contributors being Unified Payments Interface (UPI), credit cards, and mobile banking. This study highlights the pivotal role of government initiatives and emerging digital payment platforms in driving India's transition towards a digitally empowered society.

[12] BHIM app is an app made by Govt. of India to make payment digitally using the Unified Payments Interface

Now, we consider the relevant studies focused on to finding out the effectiveness of some policies and events on the overall extent of the cashless transaction of the economy, Mentioning first the international studies

Starting from the World Bank report (2021) creates the Global Findex database based on the primary survey in the different countries and tries to find out the effect of COVID-19 on the financial inclusion and digital transaction, using the time series data of account ownership and active accounts. The study is more exploratory in nature with primary focus on account holding and rigorous methodology is missing.

Trisnowati, Muditomo, and Adriana (2020) seeks to examine the variations in the volume of cash, retail intrabank, interbank, and electronic transactions under normal circumstances compared to those during the COVID-19 pandemic, analysing whether there was an increase or decrease in transactions throughout 2020. It was an empirical investigation utilizing secondary data gathered from January to March 2019 and January to March 2020, sourced from the Indonesia Central Bank (BI) Statistics Data and Financial Services Authority (OJK) Statistics Data. The collected data were evaluated using paired sample t-tests. The findings reveal a statistically significant difference in the number of electronic money transactions before and after the onset of COVID-19, whereas no significant differences were observed for other electronic retail payment methods, including credit and debit cards, intra-bank transfers, and interbank transactions. During the pandemic, cash and retail transactions saw a slight uptick, while the volume of intrabank and interbank transactions declined in comparison to the prior normal conditions. A notable increase of 2,117% was recorded in electronic money transactions using.

The studies discussed above are basically focused on developed economies, which essentially differ from a developing economy like India in several ways, such as the extent of digital

literacy, access to technology, income distribution etc. None of the studies consider the different aspects of cashless transaction encompassing the different components. In other words, none of the studies consider an index of cashless transaction combining the different types of cashless transaction to get an overall view of the extent of adoption of cashless technology.

Next, we consider studies pertaining to India mainly focused on the effects of Demonetisation on the digital transaction of the Indian economy.

Podile & Rajesh (2017) underscores the significant shift towards electronic payments in India following demonetization period. It highlights the gradual transition from a cash-dependent economy to a cashless one, where transactions primarily occur through cards or digital means, minimizing the circulation of physical currency. The paper aims to investigate public perception in India regarding cashless transactions based on documentary and analytical method and a variety of secondary data sources, including books, journals, government publications, and online platforms, are actively consulted. A thorough literature research is part of the technique, when analysing data, qualitative techniques are used to classify topics, identify patterns, and determine trends.

Balaji and Balaji (2017) examine the demonetization process in India initiated on November 8, 2016 and the study seeks to analyse the shift of the consumers towards digital payment methods post-demonetization. However, this paper is purely conceptual. The study is a collection of secondary information gathered from Research papers, government and non-government websites, books etc.

Bhuvana and Vasantha (2017) has studied the effect of demonetization towards the adaptation of cashless payment system, based on the primary data and based on the perception of the

observation and using percentage analysis. This study has not construct any index, and has not include the effect on various types of cashless transactions separately.

Sivathanu (2019) investigates the actual usage (AU) of digital payment systems during the demonetization period in India, from November 9 to December 30, 2016. It utilizes the Unified Theory of Acceptance and Use of Technology (UTAUT 2) and Innovation Resistance (IR) theory as conceptual frameworks. Through a survey of 766 respondents and employing partial least squares (PLS)-structural equation modeling (SEM), the study finds that behavioral intention (BI) to use and innovation resistance (IR) significantly influence the usage of digital payment systems. Furthermore, it reveals that the relationship between BI and AU is moderated by stickiness to cash payments. The study offers valuable insights for economists, policymakers, and digital payment service providers, emphasizing the importance of understanding consumer behavior and attitudes towards digital payments during the demonetization period in India. However, the purpose of the study is completely different from our study. While their focus is to identify the behavioral factors that influence digital transaction at the micro level, we want to understand the Macro level dynamics of digital transaction.

The study we found that analyses average digital transaction per capita over time, in the Indian context is the RBI report (2019). The report aggregates the various types of cashless transactions to arrive at a measure of cashless transaction. It has used the per capita aggregate number of the digital payment (adding the volume of NEFT, POS, RTGS, UPI, IMPS etc.) as well as the aggregated value of the digital transaction as a proportion of GDP to measure the extent of cashless transaction in Indian economy over time. However, the study has some methodological limitations. The study uses simple arithmetic mean as a method of aggregation, which creates several problems. First, in using arithmetic mean it is implicitly assumed that

various types of digital transactions are independent of each other, whereas some relationships exist among the various types of transactions as we will establish later. Secondly equal weights have been assigned to all types of digital transactions without providing any explanations. Thirdly**,** using arithmetic mean without weight as a method of aggregation also implies perfect substitutability between each pair of dimensions, which is not desirable. Empirically speaking debit card transaction can't be perfectly substitute to the electronic fund transfer. In the present chapter we attempt to find out an answer to a similar question viz. how the overall level of the cashless transaction of the Indian economy changes over time. But we geometric mean while constructing the indices, which takes care of the problems mentioned above. Also we use the period 2012 to 2023, capturing the effects of PMJDY, demonetization, and COVID-19 outbreak and post COVID-19 period within the same framework, whereas the RBI report has used the data from 2014 to 2019, leaving out the COVID-19 outbreak period. Besides we have adopted a more rigorous approach using the trend analysis checking for the stability of the trend over time to identify the effectiveness of the different policies specially the demonetization period and to identify the trend during Covid-19 pandemic and post period, which is missing in this RBI's report.

Parameshwar, Das, Mukherjee, Saha and Misra (2020) examine the factors that contribute to the limited adoption of digital transactions in India. It seeks to provide insights into the progress made towards digitalization and the remaining challenges. The study's design offers a comprehensive examination of both the acceptance and resistance to digital payment methods, particularly in the context of government initiatives such as demonetization. Additionally, the paper underscores the significance of digitalization in rural India, offering original insights into this aspect of the Indian economy.

Chakrabarty, Jha & Ray (2020) study the impact of demonetization on digital payment in the Indian context. They consider RTGS, NEFT & Mobile Banking transaction. They find that the impact is mostly transitory in nature. The objective of this paper is similar to the objective of this chapter but there is a methodological difference, we have constructed cashless transaction indices to analyse the effectiveness of demonetization and associated policies regarding cashless transaction. Besides we have we also consider the COVID-19 period as well to capture the effect of COVID-19 outbreak on the cashless transaction trend of the economy, which is missing in there study.

In the Indian context the report by National Payment Corporation of India (2020) studied the awareness, adoption and use of digital payment methods b of households of India. The analysis is based on primary survey of 35000 households for the year of 2016. Though they use rich data set, the methodology they used is not rigorous, they are more exploratory in nature. The key findings are, one third of Indian households are using it in some form or the other. It is heartening to note that almost a quarter of the households in the bottom 40% income group are using it as well and it has not remained rich or well-educated persons' precinct. 15% households in bottom and middle category would like to adopt digital payments. Online banking is less well developed than payments, but has potential. Finally, the Direct Benefit Transfer system has worked very well and even better during lockdown.

Following studies focused on the effects of COVID-19 on the digital transaction of the Indian economy.

Gopinath, Vevek and Sivaprakkash (2022) investigates the factors contributing to the limited adoption of digital transactions in India and explores potential strategies to bridge this gap. The study investigated impact of event COVID-19 on volume and value of the UPI, IMPS and NFS in India utilizing data from NPCI website spanning from October 2017 to February 2022. This

study haven't include both the demonetization period and covid-19 period, which we tried to incorporate in this chapter.

Tripathi, S., & Dave, N. (2022) find out the relationship between digital payment and e-commerce business during post COVID-19 period with the analysis of efforts toward cashless transactions, using primary survey, and structured questionnaire was used to analyse the objective of the study.

The study we found that analyses the impact of COVID-19 on the digital payments in the Indian context is the KPMG report (2020) .The report analyses the changes in the usage of different types of cashless transactions over time to measure the impact of COVID-19 pandemic on the digital payments of Indian economy. Analysis is based on the graphical plots of the various types of the cashless transaction over the period of analysis. Our opinion is that the period of analysis is too short, (from January 2020 to June 2020,) to draw important conclusion.

The only study that uses an index to examine the growth of digital payment is The Digital Payments Index (DPI) introduce in January 2021 by The Reserve Bank of India (RBI). This index was created to track the adoption and usage of digital payment methods in India over time. The DPI covers various parameters to measure the extent of digitalization in the payment ecosystem, including payment enablers, payment infrastructure, payment infrastructure penetration, payment performance, and consumer centricity. As detailed analysis is not provided by the RBI, we couldn't comment on this study farther.

We have not come across any study that has used a comprehensive index in measuring the impact of PMJDY, Demonetization and post demonetization subsequent policies along with the impact of COVID-19 outbreak on the extent of cashless transaction of any economy. So, in the 3rd chapter we attempt to fill this literature gap.

2.2. Literatures on Acceptance of Cashless Transaction and Socio Economic Condition

In the 4th and 5th chapter our objective is to analyse the socio-economic determinants of the usage of the digital transactions theoretically and empirically validate the results. In other words in the 4th and 5th ascertaining how the socio-economic conditions of the buyer impact the selection of cashless payment methods. For this purpose developing a theoretical framework focused on modelling the transaction costs of cash and cashless transactions (debit card) based on the different education level and income level. The analysis was done from buyer's point of view with and without the presence of direct taxation, within the market domain, in an environment where debit cards and currency (legal tender) are competing payment channels. The 5th chapter attempts to provide empirical validation to the theoretical analysis in the 4th chapter by estimating the impact of education and income along other socio economic variables on the selection of cashless payment modes between cash and cashless transactions in the Indian context using household level database. In this context, the analysis takes into account the interaction between income and education as a determinant of adoption of cashless transaction.

First ,we consider the theoretical literature. We have not come across any theoretical literature that addresses the issue relating to the impact of interaction between income and education on adoption of non-cash transaction. Here we discuss the literature that focus on the pricing and determinants of cashless transaction.

Shy and Tarkka (2002) develop a theoretical framework to model the pricing of electronic cash cards in a market where various payment media, including charge cards and currency, compete. They explore the transaction domains of different payment instruments, considering factors

such as fees and transaction values. This research is one of our initial motivation, but this study doesn't incorporate the socio economics factors like level of education and level of income.

Wright (2003) evaluates the social optimality of privately set interchange fees[13] and the adoption of a rule by payment systems to prevent merchants surcharging[14] for card transactions using two extremes of merchant pricing—monopolistic pricing and perfect competition.

Chakraborty and To (2007) analyse the equilibrium conditions of credit card acceptance between buyers, merchants, and issuers using a game-theoretic two-period model. Their findings suggest the existence of a credit card equilibrium under certain conditions and highlight the influence of externality where merchants, in equilibrium, choose to accept credit cards despite all being worse off.

Bolt, Humphrey, and Tallahassee (2007) study cross-border interoperability for electronic payments, finding that card transactions are likely to replace cash and checks. They estimate substantial cost efficiency gains when processing is consolidated across borders, encouraging greater replacement of small-value cash transactions.

Bolt and Chakravorti (2008) present a theoretical model exploring how consumers' utility and merchants' profits increase with additional sales resulting from enhanced security and access to credit lines through credit cards. They consider how the cost of the payment service is shared between the merchant and the customer, determined by the bank's cost to provide payment services.

[13] An interchange fee is the fee charged by banks to the merchant who processes a credit card or debit card payment.

[14] A surcharge, also known as checkout fee, is an extra fee charged by a merchant when receiving a payment by cheque, credit card, charge card or debit card (but not cash) which at least covers the cost to the merchant of accepting that means of payment, such as the merchant service fee imposed by a credit card company.

Kim and Lee (2010) offer an explanation for the increasing use of debit cards over time and the differences in usage across income classes. Their search-theoretic model incorporates a trade-off between cash and debit cards, demonstrating that as record-keeping costs decrease with technological development, the disutility cost of holding cash exceeds record-keeping costs, leading to widespread adoption of debit cards. The study also finds that the affluent use debit cards more frequently than the less affluent, highlighting two mechanisms that improve welfare as record-keeping costs decrease. The study doesn't include education level.

While existing studies explore various aspects of payment systems and mostly concerned with other issues like pricing of the cards, efficiency in card use etc. So we are trying to addressing an issue that has not been addressed before theoretically: namely the effect of interaction between education and income on adopting the cashless transaction theoretically with and without the presence of direct taxation. There is a gap in literature regarding the interaction issues between income and education, and the selection of payment modes. In 4th chapter, we attempt to fill this gap by developing a theoretical model differently to understand the influence of income and education on the selection of payment modes, namely choice between cash and cashless transactions. Our analysis aims at developing policy prescription, especially for developing countries, to promote cashless transactions.

Several studies based on empirical data analysis contribute to the understanding of factors influencing digital and cashless transactions. First we consider the international studies.

Westland, Kwok, Shu, Kwok and Ho (1998) studied the acceptance of electronic cash (Mondex e-cash) among the customers and merchants of Hong Kong using primary data from 77 merchants from different businesses. They found that user's acceptance of e-cash was low. Acceptance of credit and debit cards has been increasing. In this paper macro level analysis is missing.

Humphrey, Kim and Vale (2001), estimated the preference for electronic payments over cash in U.S, Europe, Norway and Japan using cash to GDP ratio and the number of non-cash transactions per person. They observed that Japan intensively uses the cash at the point-of-sale transaction, the U.S uses cheques, and Europe relies more on electronic debit cards. The period of analysis is backdated, the recent trend can't be identified from this study

In a two-period cross country comparative analysis based on cash holding per person, debit cards and credit cards transaction per capita and electronic fund transfer Drehmann, Goodhart and Krueger (2002) find that digital payment technologies have negligible impact on currency usage.

Kulisz, Bojanowska & Toborek (2021) discuss the changes in the current attitudes of the people towards cashless transactions and their perception of the related risk of Covid-19 infection. The research involved a survey of 1000 samples from Poland. The study concluded that people were less willing to pay with cash during the pandemic than beforehand. This is related to avoiding contact with cash, as well as easy documentation of transactions, increasing their transparency. This is also a microlevel study, macrolevel analysis is missing.

Borzekowski and Kiser (2008) used a new nationally representative survey of US household and transformed consumers' responses to open-ended questions on reasons for using debit cards to estimate a characteristics-based discrete-choice demand model that includes debit cards, cash, checks, and credit cards. The study is reflecting the improved access to credit that results from both a longer credit history and a higher income.

Scholnick, Massoud, Saunders, Carbo-Valverde and Rodríguez-Fernández (2008) conducted a critical survey of the literature on credit cards, debit cards, and ATMs. Although the study

provided a comprehensive review, it did not address the influence of socioeconomic factors on payment way choice empirically.

Khare and Singh (2012) investigated factors affecting credit card use in India, emphasizing convenience, use patterns, and status as determinants. Although the study provided valuable insights into credit card usage, it did not specifically consider the influence of earnings and education levels.

In a Denmark regional study, Xiao, Hedman, and Runnemark (2015) analyze consumers' perceptions of different consumption values associated with payment technologies, such as cash, payment cards, and Internet banking. The study based on the survey which was carried out by the national statistics institute in Denmark (Statistics Denmark). The sample came from the bi-annual payment study conducted by the Danish Central Bank. The study considers control variables like age, gender, and income to explain the relationship between these values and consumers' choice of technology. This study finds that people with higher income use card more often.

Xiao, Hedman, and Runnemark (2015) examined consumers' perceptions of consumption values associated with payment technologies in Denmark. While the study provided insights into consumer perceptions, it did not specifically address the influence of earnings and education levels on payment way choice.

Chern, Kong, Lee, Lim, and Ong (2018) aimed to examine the factors that affect the adoption of E-wallet among undergraduate students in UTAR Kampar, which represent the 90s generation. It also includes variables such as gender to determine the effect of different genders towards the independent variables. The study examines the adoption of E-wallet by including

independent variables of convenience, security, social influence and speed with the aid of UTAUT theory

Shy (2020) using 2014 survey data and a random utility model, identifies strong correlations between household income and the variety of payment instruments available to consumers. The computations leading that 24.5% of respondents with household income not exceeding $20,000 are unbanked and do not have credit or debit cards. This percentage drops to 5.9% for income between $20,000 and $30,000, and to 3.6% for household income between $30,000 and $40,000

Yang, Mamun, Mohiuddin, Nawi and Zainol (2021) explored the effect of perceived usefulness, perceived ease of use, social influence, facilitating condition, lifestyle compatibility, and perceived trust on both the intention to use an e-wallet and the adoption of an e-wallet among adults by using the unified theory of acceptance and use of technology (UTAUT). This quantitative study used a cross-sectional data from 501 consumers in Indonesia who had use e-wallet, using a Google Form. The collected data were analysed using partial least square structural equation modelling (PLS-SEM). This study includes age and gender variable to determine the effect of different age and gender towards the independent variables, such that both the age and gender of the respondents moderated the effect of lifestyle compatibility on intention to use an e-wallet. So, the study hasn't capture the effect of education and income level.

Next we consider similar studies in the Indian context. We have come across only two studies to the best of our knowledge, which address similar issues . Motwani (2012) conducts a study based on primary survey data from the Udaipur region, analysing customer adoption and satisfaction levels with internet banking services. The paper aims to identify factors affecting preference for internet banking, obstacles preventing adoption, differences in satisfaction levels

between public and private bank customers, and the impact of gender, age, and education on internet banking usage. The findings indicate that satisfaction levels are not significantly different between public and private bank customers, and internet banking usage is influenced by age (negatively) and educational qualifications (Positively), with no significant impact of gender differences. But the study doesn't include income level. Khare and Singh (2017) focus on credit card usage in India, exploring the impact of attributes, age, and gender on customers' credit card adoption. Notably, the study lacks consideration for variables such as education and income. "Lifestyle" factors, including convenience, usage patterns, and status, emerge as significant determinants of credit card adoption among Indian customers, with a higher likelihood among younger customers. Again in this study , income and education are not considered.

Despite the valuable contributions of these studies, prevailing empirical research on the relationship between education, age, earnings, and electronic transactions in India are often limited to particular regions or states. Moreover, the combined effect of education and earnings behind the usage of cashless transaction is absent in the literature. Our research in chapter 5 seeks to validate the theoretical model established in chapter 4 with empirical data in the context of Indian economy and chapter 5 also seeks to address the literature gap by examining the joint effect of level of education and income, along with other socio-economic situations, on the digital transaction usage, utilizing available secondary data.

From the above survey of all the scholarly articles on digital transaction, we find that some of the emerging and significant issues in cashless transaction either went completely unnoticed in the existing literature or, earned insufficient attention. The persistent and continuous growth graph of digital transaction has motivated us to evaluate three significant and comprehensive issues , first, to measures the extent of cashless transactions in the Indian economy over time

(from 2012 – 2023), including the period of the Pradhan Mantri Jan Dhan Yana (PMJD) in 2014, the demonetization in November 2016, and the COVID-19 pandemic in 2020, second, to theoretically explore the impact of education and income on the selection of payment modes between cash and cashless transactions by examining changes in transaction costs of cash transactions and cashless transactions across different income and education levels with and without the presence of direct taxation and lastly to investigate the socio economic determinants behind the use of the cashless transaction through a comprehensive statistical analysis of data to validate the theoretical analysis mentioned above, taking into account the intricate interplay between various socio economic variables in influencing cashless transaction usage. These issues have attracted the interest from both the policy-makers and academicians in recent years. By identifying the research gap in existing literature, we discuss these three major subjects in the following three core chapters of the thesis.

CHAPTER 3

INDEX OF CASHLESS TRANSACTION

 # NOTE: Some portion of this chapter has been published as Datta, S., & Roy, M. (2022). Index of Cashless Transaction. ***Arthaniti: Journal of Economic Theory and Practice*****, 09767479221119240**

3.1. Introduction:

Following RBI report[15] "Digital Transaction implies a payment transaction in a seamless system effected without the need for cash. This includes transactions made through digital / electronic modes wherein both the originator and the beneficiary use digital / electronic medium to send or receive money".

The resource cost of a nation's payment system can account for as much as 3 percent of its GDP (Humphrey, Pulley & Vesala, 2000). Electronic payment system has two clear advantages over the cash-based payment systems. First, since most electronic payments cost only around one-third to one-half of a paper-based non-cash payment (cheque payments), the economic cost of a payment system could be considerably reduced if it is shifted to electronic modes (Humphrey, Pulley & Vesala, 2000). Secondly, since under cashless transactions the documentation of each transaction is complete and accurate when compared to cash transactions, the possibility of creation of black money is less, thereby increasing transparency and improving tax compliance. Starting from 'Pradhan Mantri Jan Dhan Yojana' (PMJDY) in 2014, which was a national mission for Financial Inclusion for ensuring access to financial services to all Indians and transfer the benefits or subsidies directly to the beneficiaries' bank accounts, the promotion of cashless transaction has been one of the policy priorities of the Indian government.

According to the Press Information Bureau (December 2016) the government has adopted several measures for the promotion of digital and cashless transaction under the scheme of 'Cashless India' right after the demonetization strategy in November 2016.

[15]The report of the 'The High-level Committee on Deepening of Digital Payments' (2019)

Following demonetization policy[16], other measures were launched on 30th November 2016 by NPCI (National Payment Corporation of India), which included Unstructured Supplementary Service (USSD)[17], Aadhaar Enabled Payment System (AEPS)[18], the scheme of Digital Finance for Rural India[19], and others[20]. Then after COVID-19 outbreak from March 2020 a set of restrictive measures imposed by the government to limit the movement of people and curb the spread of the corona virus disease and government promoted contactless transactions.

So three major events potentially had an impact on the adoption of cashless transactions during the period of analysis, they are: PMJDY in 2014, as this was the initiative to make the people of the Indian economy financially included. Access to bank accounts is the prerequisite for making cashless transactions, so PMJDY is likely to have an indirect effect on the adoption of cashless transactions. The next major event that potentially had an impact on the adoption of cashless transactions is the Demonetization and post-demonetization policy interventions to promote cashless transactions which are discussed above in detail, the last but not the least

[16]On 8th November 2016 Govt. of India decided to ban two highest denominations of currency notes of Indian rupee. Demonetization was motivated by the belief that the maximum portion of the black money was kept with those two highest currency notes. It was also believed that people would adopt the habit of cashless transaction Rekha (2019).

[17]Govt. of India with the help of NPCI (National Payment Corporation of India) Launched on 30.11.2016 Unstructured Supplementary Service Data (USSD) . In this payment service Individual can perform mobile banking transactions using *99#, without Internet from basic mobile phone.

[18]In Aadhaar Enabled Payment System (AEPS**)** financial transaction can be performed at POS (Point of Sale / Micro ATM) using the Aadhaar authentication.

[19] Following the scheme titled 'Digital Finance for Rural India: Creating Awareness and access through CSCs', from December 2016. Govt. hosts awareness programs regarding policies and digital payment system for rural populations, besides enabling various mechanisms of digital financial services for example IMPS, UPI, Bank POS machines etc.

[20] Some examples are: the Petroleum PSUs offering 0.75% discount on the sale price on purchase of petrol/diesel through digital means; The Central Government extending financial support for deployment of 2 POS devices each in 1 Lakh villages with population of less than 10,000 and to issue "RupayKisan Cards" to 4.32 crore Kisan Credit Card with the help of NABARD to allow them to make digital transactions at POS machines/Micro ATMs /ATMs: Railway giving discount up to 0.5% through its sub urban railway network for monthly or seasonal tickets from January 1, 2017, on digital payments only. The Central Government ensured that transactions fee/MDR (Merchant Discount Rate, the cost paid by a merchant for accepting payment via credit or debit cards every time) charges shall not be passed on to the consumers and all such expenses shall be borne by them. No service tax will be charged on digital transaction charges/MDR for transactions up to Rs.2000 per transaction.

event which could have a direct impact on the adoption of the cashless transaction is the outbreak of a natural disaster, Covid-19 pandemic and the lockdown period.

It is important to find out the effectiveness of two major policy intervention, PMJDY and demonetization on the extent of cashless transaction of Indian economy, and it is also important to identify the current trend of cashless transaction of the Indian economy after the outbreak of COVID-19 pandemic. The present chapter proposes to study and analyze these important issues mentioned.

We must take into account the following information. According to the World Bank report [21] (2021), only 18% of adults in developing economies paid their utility bills directly from an account. About one-third of this adult population did so for the first time after the onset of the COVID-19 pandemic. The use of digital payments also increased after COVID-19. The report specifically noted that in India, 80 million people made their first digital payment during the pandemic. This report is the main motivation to include Covid-19 period in our analysis, to identify the post-COVID-19 trend of cashless transactions in the context of Indian economy.

The literatures discussed in the chapter 2 some are basically focused on developed economies, which essentially differ from a developing economy like India in several ways, such as the extent of digital literacy, access to technology, Income distribution etc. None of the studies consider the different aspects of cashless transaction encompassing the different components. In other words, none of the studies develop an index of cashless transaction combining the different types of cashless transaction to get an overall view of the extent of adoption of cashless technology. We have not come across any study that has been measuring the impact of PMJDY, Demonetization and post demonetization subsequent policies along with the impact

[21]The report of World Bank Global Findex Database "Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19" (2021).

of Covid-19 outbreak together on the extent of cashless transaction of any economy. So, in the present chapter we attempt to fill the literature gap. This analysis will assist policymakers in designing future policy interventions, after assessing the current extent of the cashless transactions in the Indian economy.

Therefore, our primary objective is to assess the impact of two major policy interventions on the growth of both the volume and value of different types of cashless transactions of the Indian economy. Additionally, we aim to understand the current state of cashless transactions in the Indian economy post COVID-19 pandemic and determine whether there has been a significant shift towards a cashless economy after the outbreak of COVID-19 pandemic or not. This chapter serves to fulfil the aforementioned objectives, as it is crucial for the government to evaluate the effectiveness of past policy interventions and understand the current scenario in order to implement any future policy initiatives efficiently.

The chapter is organized as follows. In the section 2 we describe the data & methodology. Section 3 discusses the result of empirical analysis of our methodology and finally section 4 concludes.

3.2. Data and Methodology:

The present section discusses the sources of data and detailed methodology of our analysis along with the details of the dimensions we use in the construction of the indices.

3.2.1. Data

We perform a month-wise analysis with 136-time points from September 2012 - December 2023. Our data sources are RBI Bulletins for the period 2012 -2023 which publishes bank wise and month wise data on value and volume of the POS, NEFT, RTGS, ECS and IMPS

transactions and total card outstanding. So, there are 2144 data points in total after smoothing.

GDP and GCF data have been collected from RBI database on Indian Economy. We have taken the quarterly GDP of India at current year prices from 2011-12 to 2022-23 and from that, we have calculated the monthly GDP (appendix). We take annual GCF data from 2011-12 to 2022-2023 and converted that into monthly GCF deflator.

Population data has been collected from World Bank (United Nation Population Division's world population prospects: 2022). We have collected data on total population, population between 15 years to 64 years of age and percentage of total population having the age 65 and above for the years from 2012-2023. From this dataset we get our desired total adult population of Indian economy over the years. Due to the unavailability of the data on population of 18 years and above we consider 15 years and above as adult age in our analysis. To derive the month wise total adult population, we compute the yearly growth rate of the adult population and from that we calculate the monthly growth rate by simply dividing the yearly growth rate by 12 (assuming constant growth rate over the months) and with the help of the monthly growth rate we compute the monthly adult population of India over time.

3.2.2. Construction of indices

The Index of cashless transaction is constructed following Sharma (2008) and Chakrabarty and Pal (2010) who provided alternative ways of constructing an index in the context of financial inclusion. However, in constructing Index of Cashless Transaction we adopt the methodology developed by UNDP (2010), as it satisfies more properties of an ideal index.[22]The only methodological difference is that UNDP assigns equal weights to the indicators of its HDI construction based on the normative judgment, whereas in the analysis of Index of Cashless

[22] This is discussed in the subsequent section

Transaction principal component analysis is used to calculate the weights assigned to the different dimensions.

The policies promoting cashless transaction can affect value of the cashless transactions differently from the volume of the cashless transaction. So, to get a comprehensive picture of the extent of the cashless transaction we consider alternative indices of cashless transaction measured in terms of value of cashless transaction as well as in terms of volume of the cashless transaction.

To this end, we construct three alternative indices of cashless transaction:

a) Per Capita Volume Index of the Cashless Transaction. (Per capita volume index)

b) Per Capita Value Index of the Cashless Transaction. (Per capita value index)

c) Value of Cashless transaction as a Proportion of GDP Index. (Value-GDP index)

The value and volume of the cashless transaction can be affected by exogenous factors like an increase in the population of the economy or the increase in the GDP. The value of the cashless transaction can also be affected by inflation. To identify the impact of the policy interventions to promote cashless transactions, the analysis has to be free from these exogenous influences. Therefore, to eliminate these exogenous influences from the value and volume of the cashless transactions, first we divide the values of the cashless transactions by the GCF Deflator separately, to eliminate the effect of inflation from the value of the cashless transaction. Next to eliminate the effect of population we have taken those values (after adjusted with GCF deflator) as a proportion of the adult population and construct 'Per Capita Value of the Cashless Transaction Index (Per capita value index) which is free from both the effect of population growth and inflation. Similarly, to eliminate the effect of population growth over the volume of the cashless transaction, we consider those volume as a proportion of adult population, and constructed Per capita volume of the cashless transaction index (Per capita volume index).

Alternatively, to eliminate the effect of changes in GDP from the value of the cashless transaction, we consider the Value of the cashless transaction as a proportion of GDP separately and construct a separate index called Value-GDP Index (As the effect of inflation is present in case of both value of the cashless transaction and on the GDP, so there is no need to eliminate the effect of inflation). The dimensions used to construct the three indices are described in table 3.1.

Per capita Volume Index	Per capital Value Index	value-GDP Index
i. The number of cards (both debit and credit card) per 1000 adult population **ii.** Number of POS[23] transaction per capita. **iii.** Number of NEFT[24] transaction per capita. **iv.** Number of RTGS[25] transaction per capita. **v.** Number of IMPS[26] transaction per capita. **vi.** Number of ECS debit & Credit + NACH[27] transaction per capita.	**i.** Per capita value of POS transaction. (per adult population) **ii.** Per capita value of NEFT transaction (per adult population) **iii.** Per capita value of RTGS transaction. (Per adult population) **iv.** Per capita value of IMPS transaction. (Per adult population) **v.** Per capita value of ECS debit & credit + NACH transaction. (Per adult population)	**i.** Value of POS transaction as a proportion of GDP. **ii.** Value of NEFT transaction as a proportion of GDP. **iii.** Value of RTGS transaction as a proportion of GDP. **iv.** Value of IMPS transaction as a proportion of GDP. **v.** Value of ECS debit & credit + NACH transaction as a proportion of GDP.

Table 3.1: The list of the Dimensions Used in the Construction of Three Different Indices

[23]Point of Sale refers to the transactions using debit or credit cards while purchasing goods and services by swiping cards at the merchant's counter as well as at the time of online transactions using debit or credit cards.

[24]National Electronic Fund Transfer is an electronic system to transfer money from a bank account to another bank account. It needs 1 to 2 working days to transfer the fund) the fund transfer limits are from 1 rupee to 10 lakh rupees. So, it is also important to incorporate this into our analysis.

[25]Real Time Gross Settlement is also a cashless fund transfer facility provided by banks from one bank account to account (nationally). It is real-time and transfer limit is from 2 lakh rupees to unlimited. It is also an important cashless transaction to incorporate.

[26]IMPS is real time cashless fund transfer system, can be done specially using mobile phones and Internet banking. With the advancement of Internet and mobile phones it is very much important to incorporate this to aggregate the cashless transaction of the economy. One can also do the NEFT and RTGS transaction using mobile phones and Internet banking but as we considered all the NEFT and RTGS transaction separately, to avoid the double counting problem, we have considered only IMPS transaction instead of Mobile banking transaction.

[27]ECS and NACH both are repetitive cashless fund transfer system, ECS debit is used to raising money from a number of accounts for affording a single credit to a particular institution. ECS Credit is used for affording credit to a multiple number of accounts by raising a single debit from an account. NACH is just like ECS transaction with an improved technology and technique it also has a unique mandate reference number alike ECS. As institutions and corporate houses are shifting from ECS to NACH nowadays so we have incorporated the sum of these three transactions (ECS debit & Credit and NACH transactions) together into our analysis.

The movement of the three indices over time together are expected to give a comprehensive understanding about the impact of two major policy events i.e. PMJDY in 2014, Demonetization and subsequent policies under "Cash Mukt Bharat" objective and finally the analysis of these three index will provide a broad picture about the current scenario of the extent of the cashless transaction in Indian economy after the outbreak of Covid-19 pandemic period and lockdown measures.

Next, we explain the methodology used in constructing the indices.

To eliminate the fluctuations from our data we consider three months moving average for each dimension. By normalizing each dimension, we got individual dimension index separately.

$$\boldsymbol{d_i = \left(\frac{x_i - m_i}{M_i - m_i}\right)} \quad \textbf{..... (3.1)}$$

Where, x_i is the actual attained value of the i^{th}dimension M_i is the maximum value (sample maximum over time) of dimension I and m_i is the minimum value (sample minimum over time) of dimension i^{th}. Here $M_i > m_i$. And M_i and m_i are attainable. And $x_i \in [M_i, m_i]$.

Normalization of each dimension enables us to capture the progress of each dimension compare to worst and best point of that dimension and it also contains the values between 0 to 1. Finally, by aggregating all the normalized dimensions together using geometric mean we get each desired index of cashless transaction. The exact formula is as follows:

$$\boldsymbol{I_r[d_1, d_2, \ldots d_k] = (d_1^{w_1} . d_2^{w_2} . d_3^{w_3} \ldots d_k^{w_k})^{1/k}} \quad \textbf{..... (3.2)}$$

Where k is the total number of dimensions and $w_i$is the weights to the i^{th} dimensions.

The index I_r considers the interdependent nature of the dimensions. Index I_r satisfies the properties of monotonicity[28] and homogeneity[29]. As geometric mean is used for constructing the index, substitutability between the dimensions is not perfect which is desirable because in our analysis POS transaction is not a perfect substitute to the NEFT or RTGS transaction. Also, in this methodology the dimensions need not be independent, as we have found significantly high correlation between the various types of cashless transaction (Appendix table A3.3, A3.6 & A3.9). In other words, the marginal effect with respect of each dimension is a function of other dimensions, which has been taken care by the index I_r.

In order to assess the importance of the dimensions and determine the weights for each of the dimensions, we use Principal Component Analysis. The results show that the factor loadings corresponding to the leading eigenvalue gives equal weights to the each of the dimensions for all the three indices (Appendix Table A3.4, A3.7 & A3.10).

To find out the trend of the cashless transaction we have fitted linear and nonlinear deterministic time trend based on the graphical representation (Enders, 1995) and goodness of fit. Along with the time trend, all the per capita value and volume dimensions as well as per capita value index and per capita volume index are regressed on nominal GDP as a proportion of the GCF deflator as a control variable. Similarly, all the values as a proportion of GDP as well as the value- GDP index are regressed on population (in billion) along with the time trend.

Further to analyze the effectiveness of this three major events on the cashless transaction, we have used CUSUM test (Brown, Durbin, and Evans 1975) of structural break

[28]Monotonicity implies that the value of the i^{th} dimension is a strictly increasing function of the actual value of that dimension. Given minimum & maximum value.

[29]Homogeneity means, the entire individual dimension must be independent of any unit of measurement. i.e., $d_i(x_i, m_i, M_i) = d_i(cx_i, cm_i, cM_i)$

to check the stability of the trend coefficients over the period of analysis.

3.3. Results:

In this section we present the trend analysis & structural break analysis of the individual dimensions of each index, as well as that of the aggregate indices.

3.3.1. Analysis: Individual Dimensions:

Here we discuss the individual dimensions in three steps, first we discuss the findings based on the graphical plots of the individual dimensions, followed by the trend regression analysis and finally discuss the Cusum plot analysis.

3.3.1.1.Analysis Based on Graphical Plot of the Dimensions

Figure 3.1 to 3.6 show the graphical representation of each of the individual dimensions used to construct the indices. From Figure 3.1 we observe a jump in the trend of the dimension "number of cards per 1000 adults" near January 2015 right after the 'Pradhan Mantri Jan Dhan Yojana' policy intervention to promote financial inclusion. There is no such jump after the demonetization period. But after December 2018 it starts declining drastically till the end of 2019, this could be a reason for an economic slowdown in the year of 2019 in Indian economy, but during the period of pandemic there is a smooth increment in the no. of cards per 1000 adults. the reason could be the promotion of contactless payment system people were more intent towards having debit or credit cards.

Figure 3.2 presents a graphical plot of 3 types of POS transactions (per capita value, per capita volume and value-GDP of POS transaction), We find that the number of POS per capita, the value of POS per capita and the value of POS as a proportion of GDP increased sharply

immediately after the demonetization period. This is understandable as just after the demonetization period, people were forced to use debit and credit cards to make their payments as the two highest currency notes were removed from circulation and ATMs were usually out of cash, but surprisingly afterwards it reverted to the previous trend. But from the starting period of the Covid-19 pandemic, there is a sharp decline in all three measures of POS transactions, which is indeed understandable. During November 2020, the trend line starts increasing. But, did not come back to the previous trend (Figure 3.2).

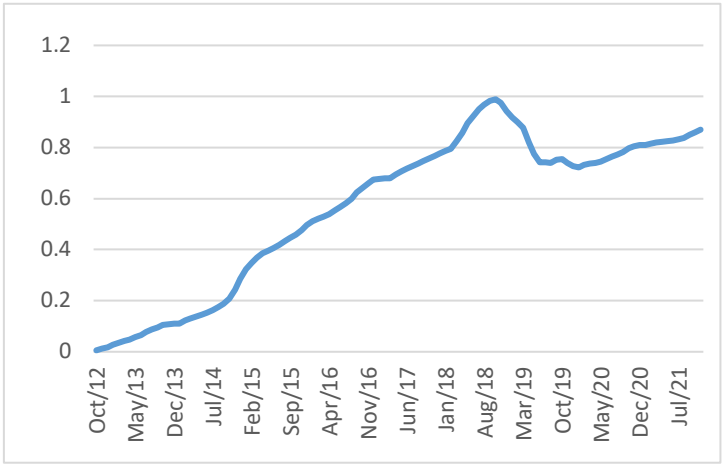


Figure 3.1: No. of Cards per 1000 Adults
Source: Own

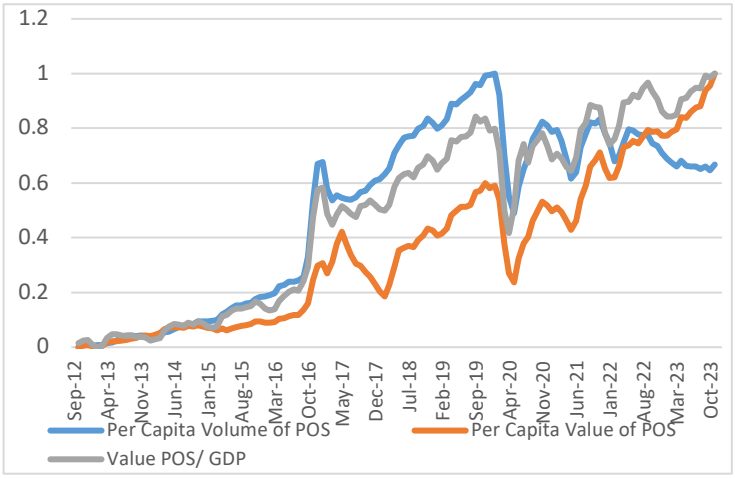


Figure 3.2: POS Transaction
Source: Own

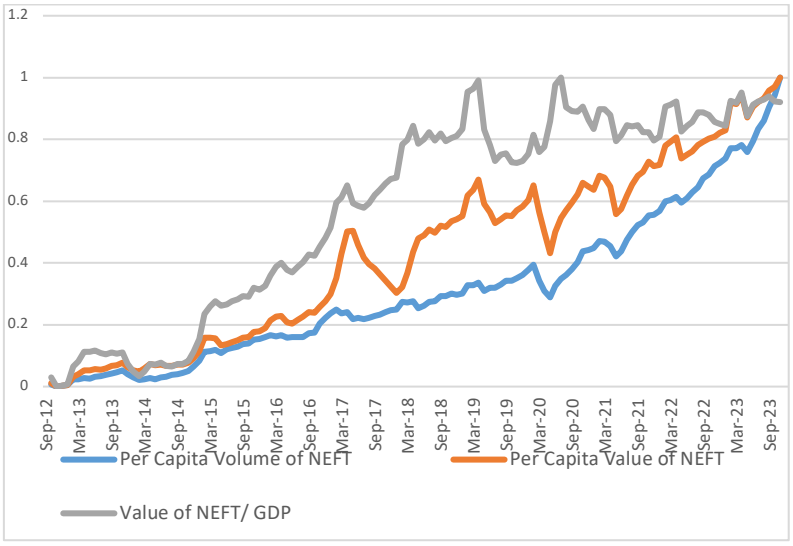


Figure 3.3: NEFT Transactions
Source: Own.

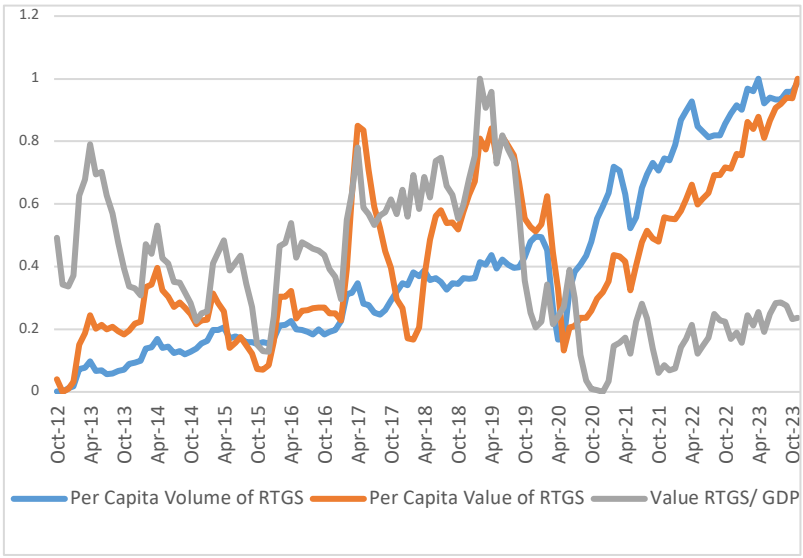


Figure 3.4: RTGS Transactions
Source: Own

All three measures of NEFT are presented together in figure 3.3. We can identify that, there are marginal increments in all three measures of NEFT transactions immediately after the demonetization, which again is understandable. But all three measures of NEFT transactions reverted back to their previous trend after few months of demonetization. There is a sharp decline in both per capita measures just after the pandemic happened, but not in the case of Value NEFT/GDP. The Per capita value and volume of NEFT transactions recovered very well

from that downturn.

From figure 3.4 we can observe that all three measures of RTGS transactions show fluctuations over the period, but there are visible declines during the pandemic period, but per capita number of RTGS has recovered, Per capita value of RTGS also recovered partially, but value of RTGS/ GDP hasn't started recovering.

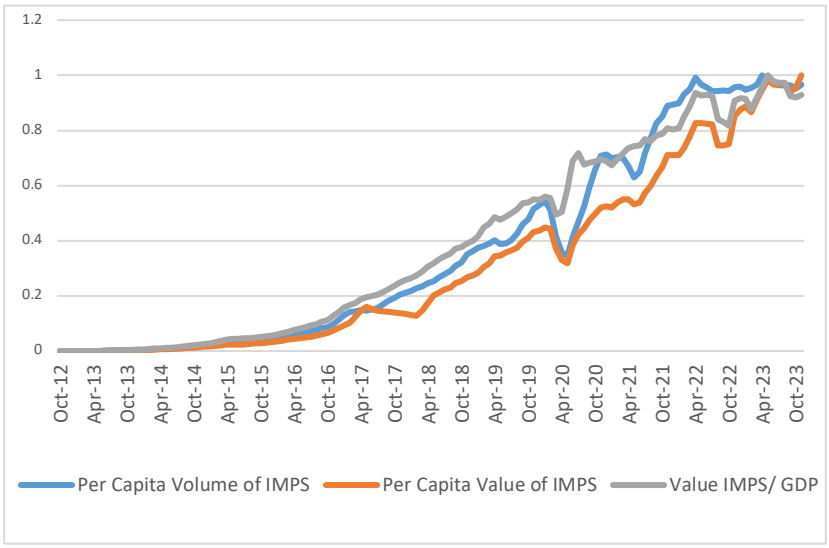


Figure 3.5: IMPS Transactions
Source: Own

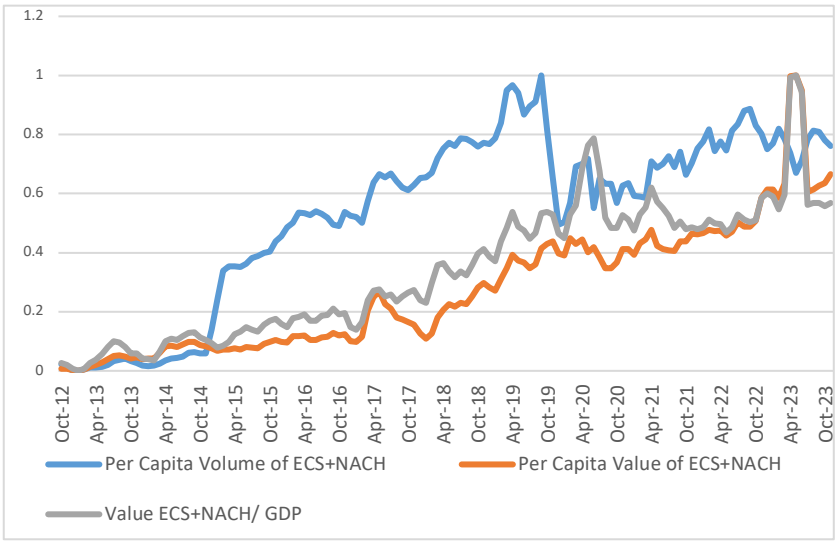


Figure 3.6: ECS+NACH Transaction
Source: Own

Figure 3.5 presents all three measures of the IMPS transactions. We observe that they have

been steadily increasing at an increasing rate. The effect of the demonetization on IMPS transactions is not so prominent in contrast to the POS transactions. All Three measures of IMPS transactions declined during the period of the pandemic, but all three measures recovered a few months later, which could be the reason for the promotion of contactless transactions using mobile phones and the internet.

Figure 3.6 represents three types of ECS+NACH transactions together, the per capita value of ECS & NACH transactions and the value of ECS & NACH as a proportion of GDP have increased steadily over time. In the case of only the per capita value of the ECS+NACH transaction, there is a visible temporary increment in the trend line after the introduction of PMJDY near the end of 2014, indicates a positive impact of the PMJDY scheme. and there is a visible decline in the trend line during the period of the pandemic. In case of both per capita measures of ECS+NACH transaction, there is a sharp decline during the outbreak of Covid-19. The decline is more prominent in case of Per capita number of ECS+NACH transaction. The economic logic could be that lockdown had a huge negative impact on the economy. The economy was facing downturn and recession, as a result of that individuals were unable to meet their ECS and NACH payments. In case of ECS+NACH as a proportion of GDP there is a sharp increment in the values but it comes back to the previous trend after few months, this is possibly because of the declined GDP due the lockdown. In case of other two per capita measures the decline in the trend line has been improved partially but doesn't come back to the previous trend.

Variable	Event		
	PMJDY	**Demonetization**	**Pandemic**
Number of cards (both debit and credit card) per 1000 adult	Positive impact	Negative impact	Negative impact
POS Transaction	No impact	Temporary Positive impact	Negative impact
NEFT Transaction	No Impact	Temporary Positive impact	Temporary negative impact
RTGS Transaction	No impact	Volatile process	Per capita No. of RTGS has temporary negative impact, but Per capita value of RTGS and RTGS/GDP has negative impact.
IMPS transaction	No impact	Temporary positive impact	Positive impact
ECS + NAACH transaction	Per Capita No. of ECS+NACH has positive impact.	Per capita value of ECS+NACH has temporary positive impact, Per capita No. of ECS+NACH has no impact and ECS+NACH/GDP has temporary positive impact	Per capita no. of ECS+NACH has negative impact, but and Per capita value of ECS+NACH has no impact ECS+NACH/ GDP has temporary positive impact.

Table 3.2: Summary Table Based on Graphical Plot after Smoothing
Source: Own

To summarize, based on the graphical plots of the individual dimensions, it is observed that the effect of demonetization is most prominent in the case of POS transactions. But not so prominent in the case of other types of transactions, and there is no effect on the number of cards. Considering the COVID-19 Pandemic, this event has negative impact on the Number of cards Per 1000 adults and all three measures of POS transaction but all three measures of IMPS transaction has positive impact, other types of cashless transactions has temporary negative impact as those type of cashless transactions have been started to recover, and revert to the previous trend. Table 3.2 summarizes the effects based on graphical plot.

3.3.1.2. Trend analysis of the Individual Dimensions

To find out the effects of different events more accurately we have performed CUSUM plot of structural break analysis which is based on the deterministic trend analysis. Here all the dimensions are regressed on time, along with nominal GDP as a proportion of GCF (Gross

Capital Formation) deflator (to remove the effect of inflation from the GDP) as one of the control variable in the cases of per capita dimensions, and all the value as a proportion of GDP dimensions are regressed on adult population along with time trend separately.

In the following we first discuss the Cusum plot of all the dimensions only. We choose between linear and non-linear deterministic time trend and stochastic trend for each of the dimensions based on the graphs and also based on goodness of fit (Appendix table A3.2).

In this analysis linear deterministic trend is fitted in case of "no. of cards per 1000 adult", Per "Capita No. of POS", "Per Capita Value of POS", "POS/GDP", "Number of NEFT per capita", "Per Capita Value of NEFT" "Number of IMPS per capita", "Per Capita value of IMPS", "IMPS/ GDP" and "Per capita value of ECS+NACH" For these variables the trend equation is as follows:

$$\boldsymbol{d_{it} = C + \beta_1 t + \beta_2 X_t + U_{it}} \text{..... (3.3)}$$

Where d_{it} is the ith dimension at t time point, t is time, β_1 is the time coefficient, X_t denotes control variable, such as 'GDP as a proportion of GCF (Gross Capital Formation) deflator' in cases of per Capita value as well as per capita volume dimensions and adult population (in billions) is one of the control variable in cases of value as a proportion of GDP dimensions, β_2 is the coefficient of control variable,U_i is the error term.

For rest of the dimensions i.e. "Value of NEFT/ GDP", "Per capita volume of RTGS transaction" "Per capita value of RTGS transaction", "Value of RTGS/ GDP", "Per capita volume of ECS+NACH" and "Value of ECS+NACH/ GDP" have nonlinear deterministic trend. The following is the trend equation:

$$\boldsymbol{d_{it} = C + \beta_1 t + \beta_2 t^2 + \beta_3 X_t + U_{it}} \text{..... (3.4)}$$

The pattern of structural break of different dimensions can be divided into five categories: First, the dimensions that show structural breaks during demonetization and post demonetization period, second, the dimensions that do not show any structural break during the period of analysis, third, the dimension that shows negative structural breaks during demonetization and post demonetization period, forth, the dimensions that show a positive structural break during Covid-19 and post Covid-19 Pandemic period and last the dimensions that show a negative impact of Covid-19 and post covid-19 pandemic period.

Dimensions that show positive structural break post demonetization are, Per Capita No. of POS, Per Capita Value of POS, value of POS/ GDP temporary in nature, Per Capita No. of IMPS, Per Capita Value of IMPS, IMPS/ GDP and Per Capita Value of NEFT presented in the figure 3.7 to 3.13. This indicates that after the demonetization event people shifted to use debit and credit cards and IMPS transfer more than before to pay for expenses.

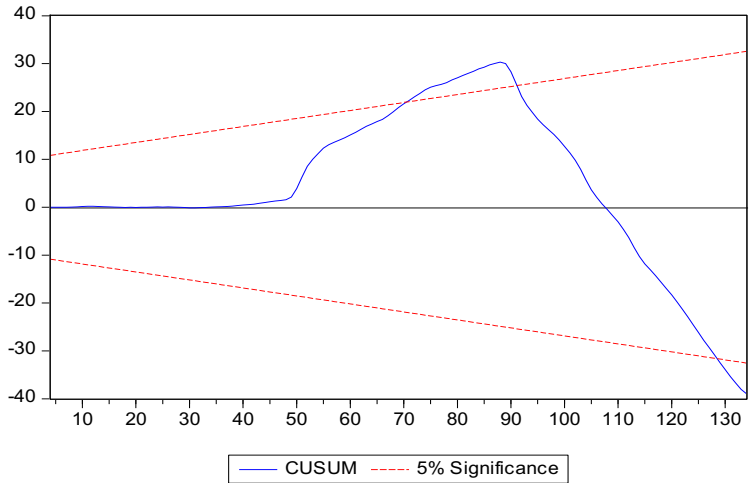


Figure 3.7: Cusum Plot Per Capita No. of POS
Source: Own

Note: Point 20 denotes (June 2014) Pradhan Mantri Jan Dhan Yajona (PMJDY) event, point 50 denotes (December 2016) demonetization event and point 90 denotes (April 2020) COVID-19 outbreak event in the horizontal axis of the Cusum plot.

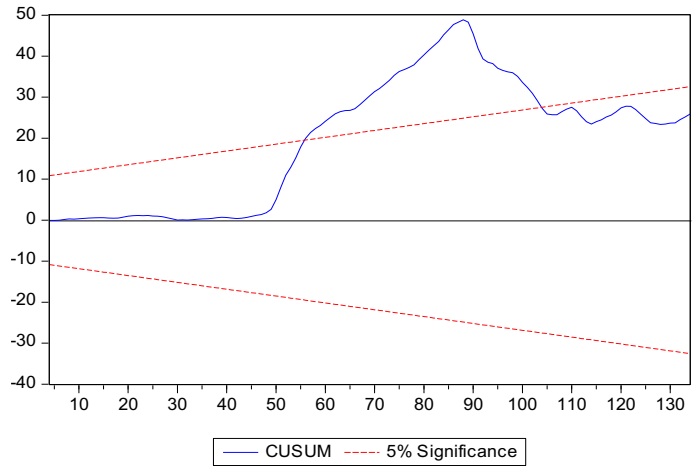


Figure 3.8: Cusum Plot Per Capita Value of POS
Source: Own

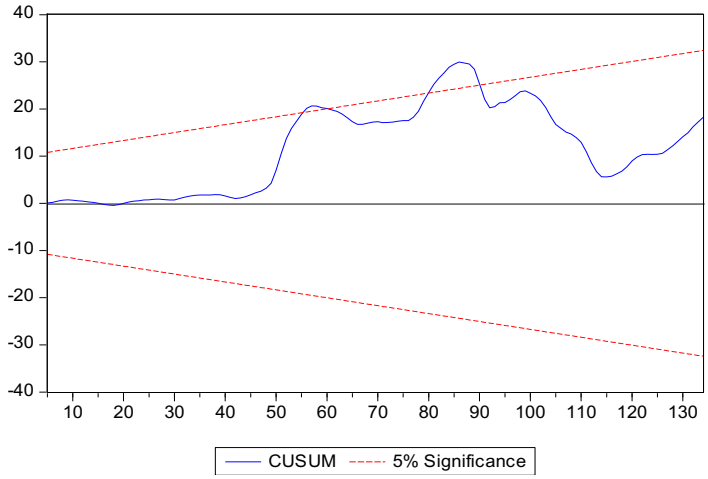


Figure 3.9: Cusum Plot POS/ GDP
Source: Own

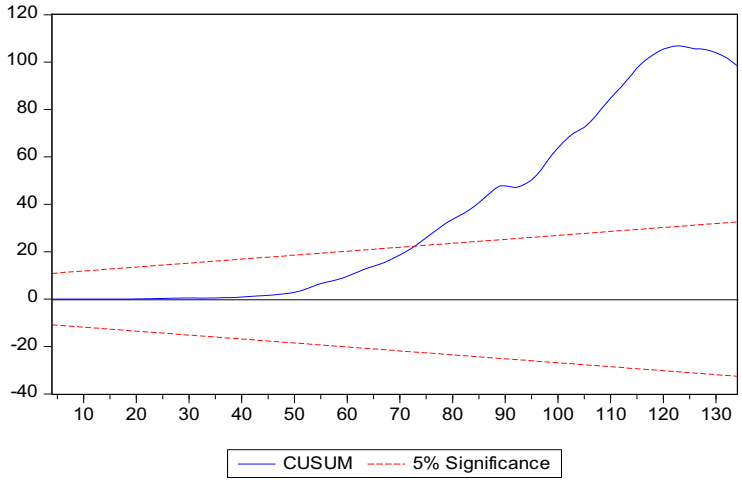


Figure 3.10: Cusum Plot Per Capita Value of IMPS
Source: Own

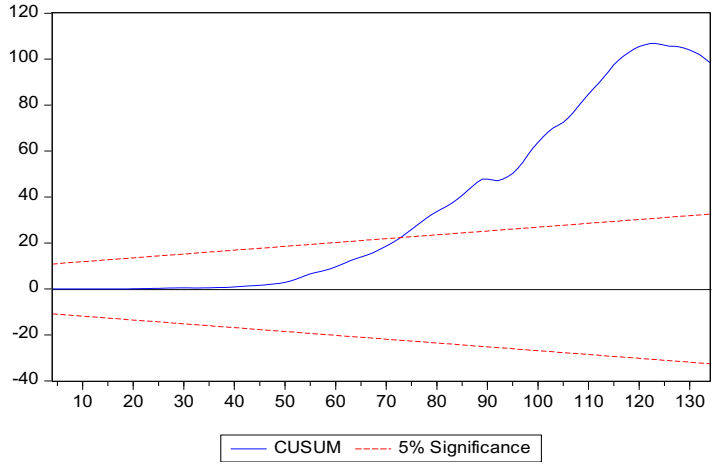


Figure 3.11: Cusum Plot Per Capita Value of IMPS
Source: Own

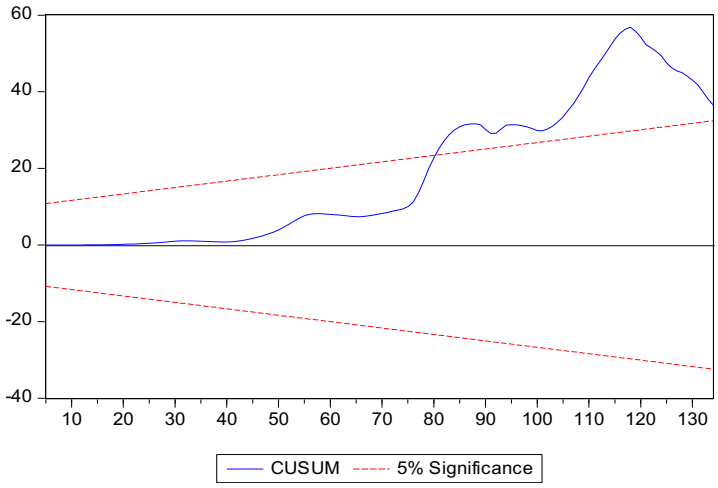


Figure 3.12: Cusum Plot IMPS/ GDP
Source: Own

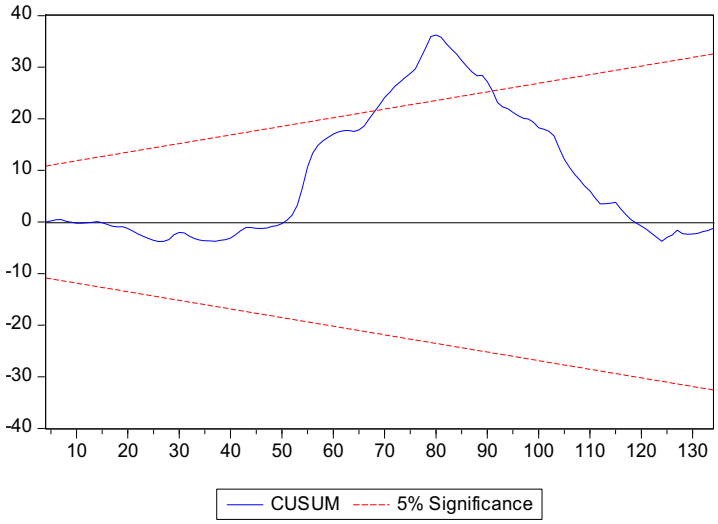


Figure 3.13: Cusum Plot Per Capita Value of NEFT
Source: Own

The dimensions that have no impact of demonetization are No. of Cards/ 1000 Adults, Per Capita No. of NEFT, Per Capita Value of RTGS, NEFT/ GDP, RTGS/ GDP, ECS+NACH/ GDP.

The dimensions that have positive structural break after the outbreak Covid-19 pandemic and post period are: Per Capita No. of NEFT, Per Capita No. of RTGS, Per Capita No. of IMPS, Per Capita Value of IMPS, per capita value of IMPS/ GDP presented in the following figures 3.14, 3.15, 3.16, 3.17 & 3.18.

In the figure 3.14 and 3.15 we could observe that per capita volume of NEFT transaction and per capita volume of RTGS transaction have a positive structural break after 1 year from the outbreak of COVID-19. From figure 3.16, 3.17, & 3.18 we can find out that all three measures of the IMPS transaction have sustained structural break during the Pandemic and post pandemic period, which is a clear indicator of increased habit of making contactless payment using cashless mode through IMPS, post COVID-19 period.

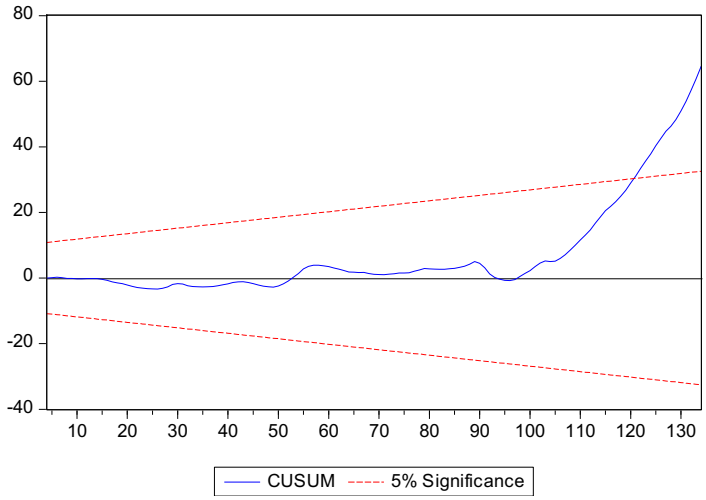


Figure 3.14: Cusum Plot Per Capita No. of NEFT
Source: Own

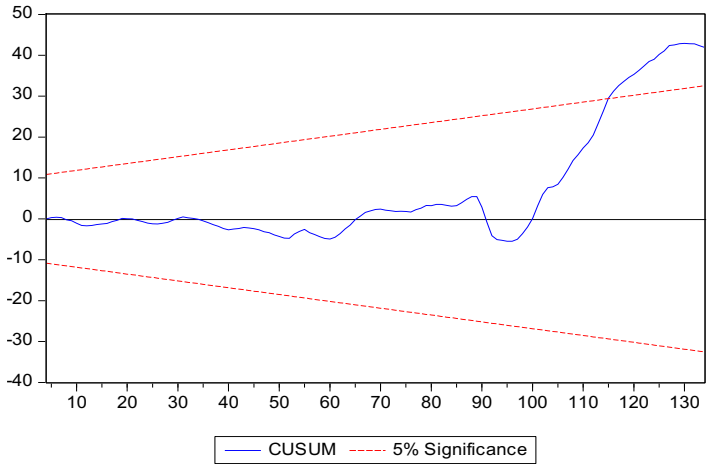


Figure 3.15: Cusum Plot Per Capita Volume of RTGS
Source: Own

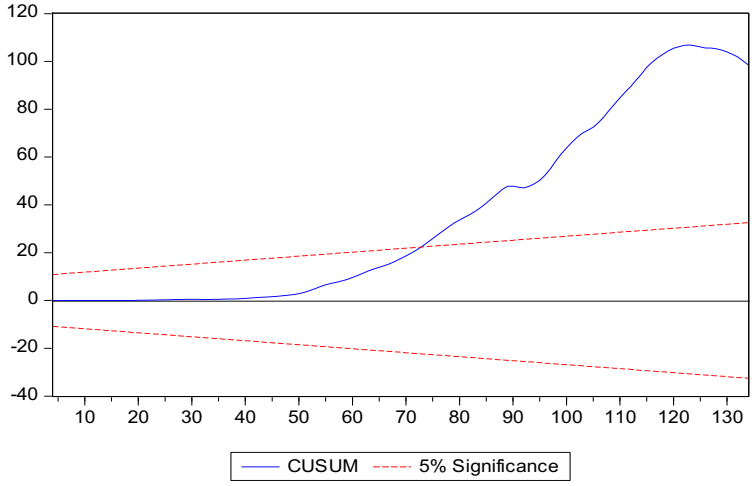


Figure 3.16: Cusum Plot Per Capita Value of IMPS
Source: Own

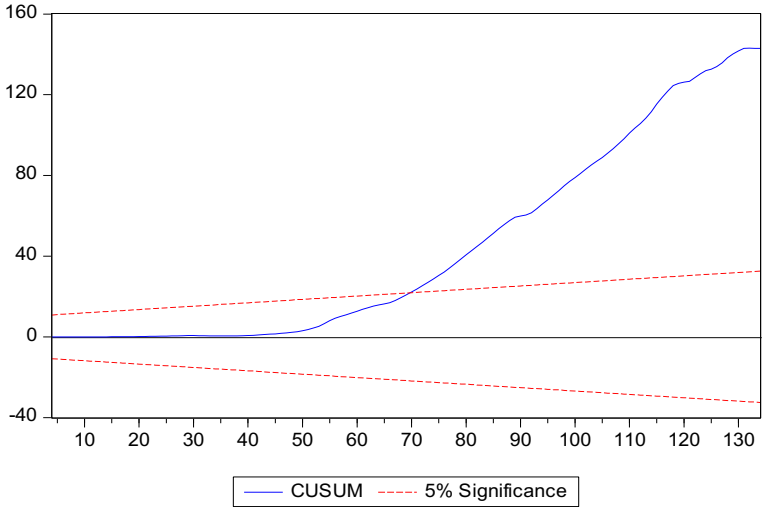


Figure 3.17: Cusum Plot Value of IMPS/ GDP
Source: Own

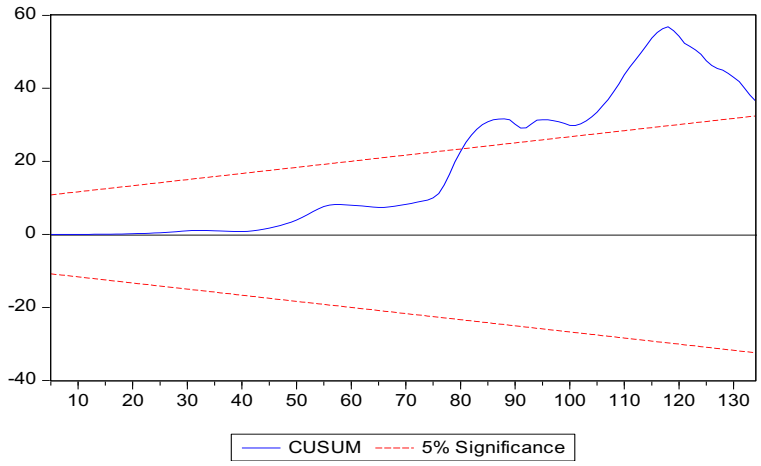


Figure 3.18: Cusum Plot Per Capita No. of IMPS

Source: Own

The dimensions that have negative structural break post COVID-19 pandemic period are No. of Cards/ 1000 Adults, Per Capita No. of POS, Per Capita Value of POS, POS/ GDP, Per capita Value of NEFT, NEFT/ GDP, Per Capita Value of RTGS, RTGS/ GDP and Per Capita volume of ECS+NACH Figure 3.19 to 3.27 present the Cusum plots of those dimensions that show negative structural breaks during the period of Covid-19 pandemic and post. In case of all three measures of POS transaction and also in case of per capita value of NEFT transaction the positive impact of post demonetization period was removed during post pandemic period, those transactions reverted back to the initial trend (Figure 3.20, 3.21, 3.22 & 3.23), this is a clear indicator that individuals are avoiding POS transactions using debit and credit card to avoid contacts with other individuals and negative impact on per capita value of NEFT transaction indicates economic downfall due to the outbreak of COVID-19. So, we can conclude that COVID-19 pandemic has negative impact on all three measures of POS transaction and in case of per capita value of NEFT transaction.

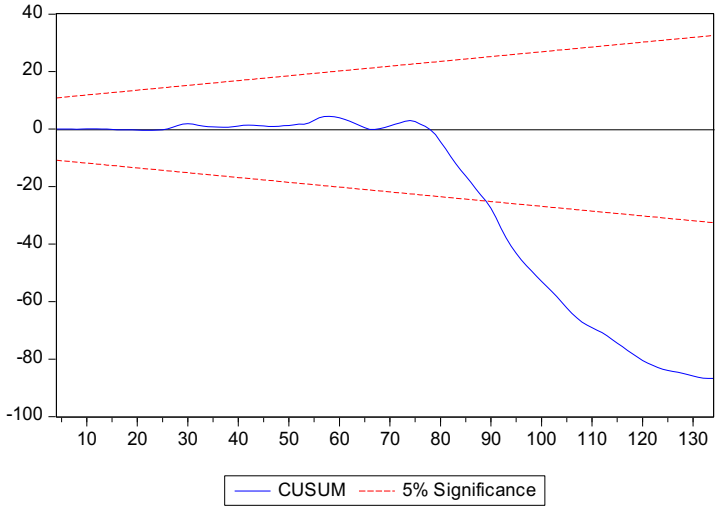


Figure 3.19: Cusum Plot No. of Cards/ 1000 Adults
Source: Own

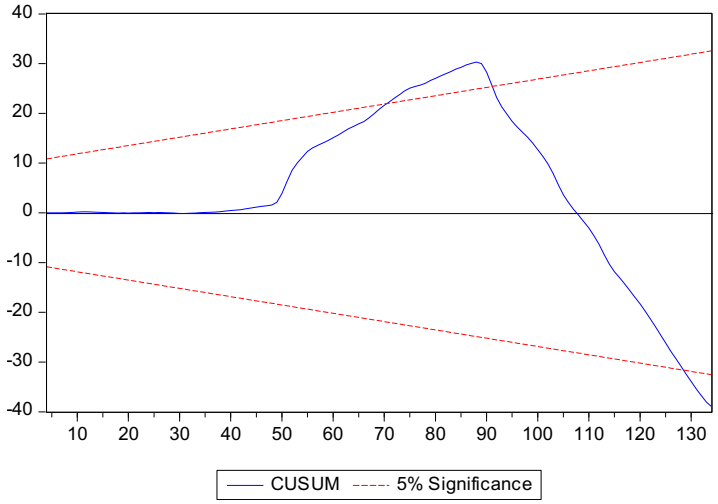


Figure 3.20: Per Capita Volume of POS
Source: Own

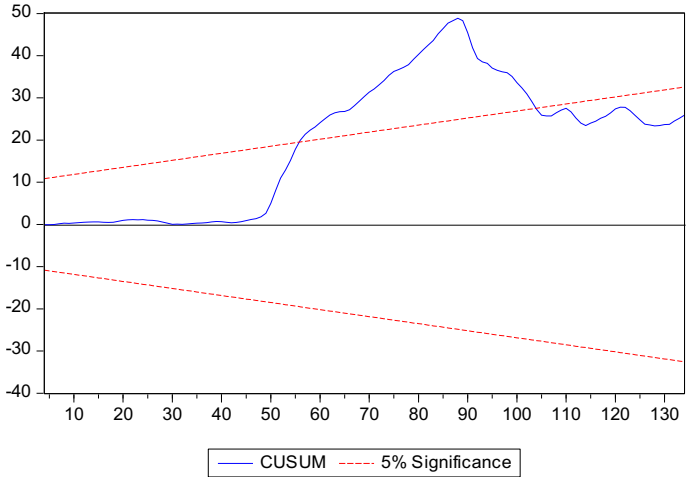


Figure 3.21: Cusum Plot Per Capita Value of POS
Source: Own

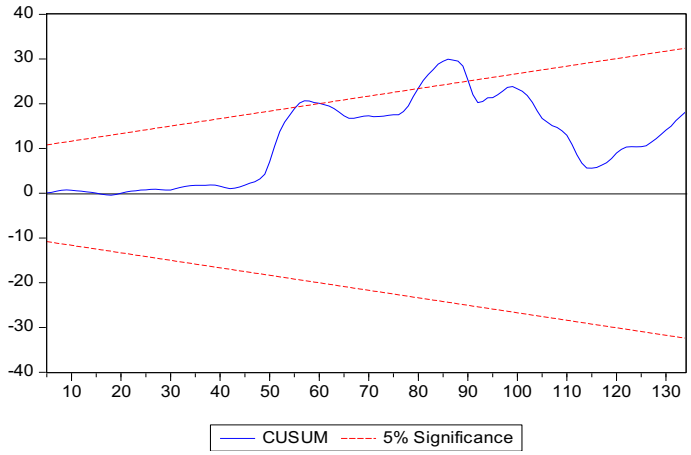


Figure 3.22: Cusum Plot Value POS/GDP
Source: Own

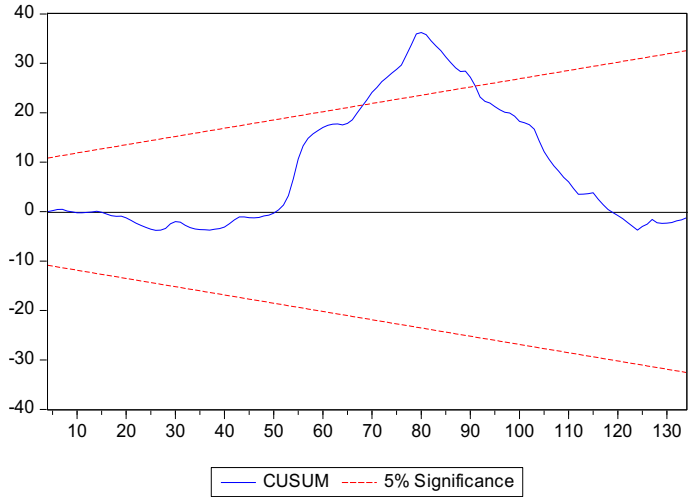


Figure 3.23: Cusum Plot Per Capita Value of NEFT
Source: Own

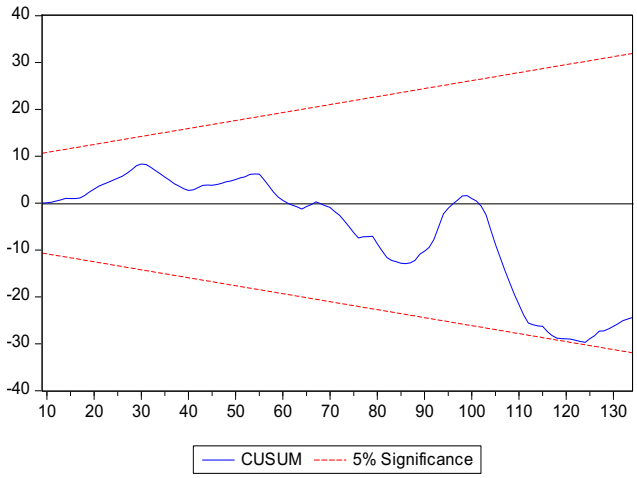


Figure 3.24: Cusum Plot Value NEFT/ GDP
Source: Own

In figure 3.24 it can be shown that COVID-19 pandemic has temporary negative impact on the value of NEFT/ GDP. In case of Per capita value of RTGS and RTGS/ GDP the negative impact of COVID-19 was temporary (Figure 3.26 & 3.27), these two measures come back to the previous trend after some months of pandemic outbreak, that temporary negative impact indicates economic downfall immediately after the outbreak of COVID-19 but also indicates economic recovery situation also. Figure 3.27 represents that COVID-19 pandemic outbreak has persistent negative impact on the per capita volume of ECS+NACH transaction, here also the effect of economic slowdown due to pandemic outbreak and lockdown measures is prominent on the per capita volume of ECS+NACH transaction.

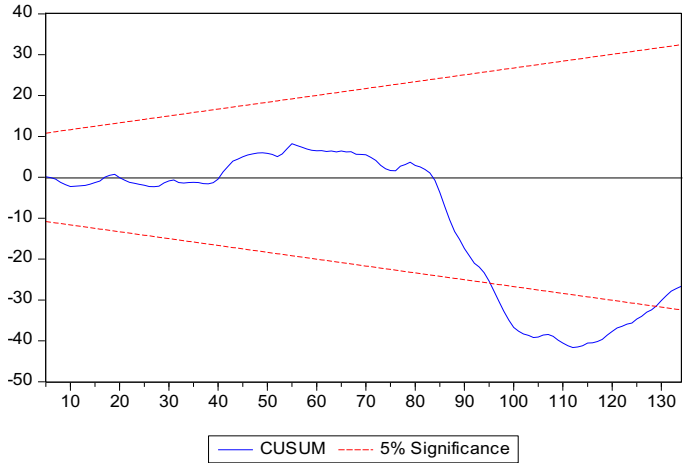


Figure 3.25: Cusum Plot Per Capita Value of RTGS
Source: Own

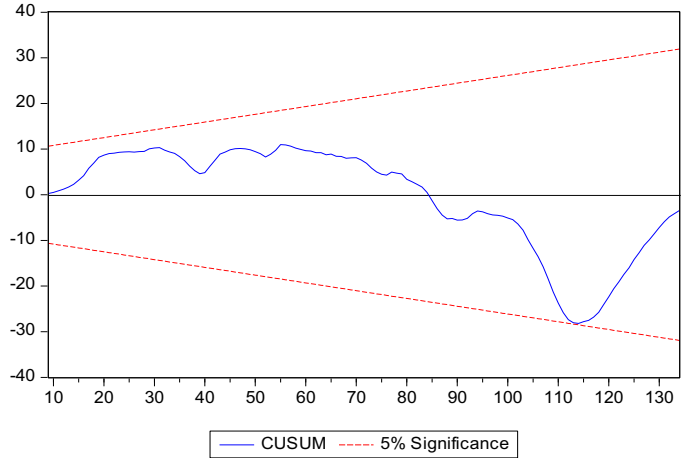


Figure 3.26: Cusum Plot Value of RTGS/ GDP
Source: Own

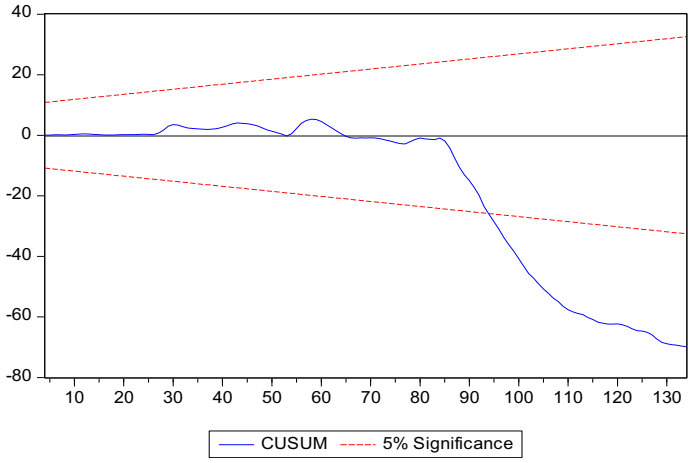


Figure 3.27: Cusum Plot Per Capita Volume of ECS+NACH
Source: Own

The following table 3.3 and 3.4 summarizes the results for better understanding. From Table 3.4, it is observed that demonetization and post-demonetization policies have a positive impact on all measures of POS transactions. However, the COVID-19 pandemic has had a negative effect on all three measures of POS transactions. Both demonetization and the COVID-19 pandemic have a positive impact on all measures of IMPS transactions. In the case of both NEFT and RTGS transactions, the COVID-19 pandemic has had a positive effect on the Per capita volume measures of NEFT and RTGS transactions. However, COVID-19 has negatively affected the per capita value and value/GDP measures of NEFT and RTGS transactions. That indicates that after the COVID-19 outbreak, people are using NEFT and RTGS transactions more than before. However, a negative economic growth rate due to lockdown measures after the COVID-19 pandemic outbreak is more prominent in the value of NEFT and RTGS transactions.

Effect	Event		
	PMJDY	**Demonetization**	**Pandemic**
Positive effect	No Positive impact	• Per Capita No. of POS • Per Capita Value of POS • Value of POS/ GDP (temporary) • Per Capita Value of NEFT (temporary) • Per Capita No. of IMPS • Per Capita Value of IMPS • Value of IMPS/ GDP	• Per Capita No. of NEFT • Per Capita No. of RTGS • Per Capita No. of IMPS • Per Capita Value of IMPS • Value of IMPS/ GDP
Negative effect	No negative impact	There is no negative impact of Demonetization on any dimensions.	• No. of Cards/ 1000 Adults • Per Capita No. of POS • Per Capita Value of POS • Value of POS/ GDP • Per capita Value of NEFT • Value of NEFT/ GDP (temporary) • Per Capita Value of RTGS (temporary) • Value of RTGS/ GDP (temporary) • Per Capita No. of ECS+NACH (temporary)
No effect	No impact	• No. of Cards/ 1000 Adults, • Per Capita No. of NEFT • Value of NEFT/ GDP • Per Capita Value of RTGS • Value of RTGS/ GDP • Per Capita Volume of ECS+NACH • Per Capita Value of ECS+NACH • Value of ECS+NACH/ GDP	• Per Capita Value of ECS+NACH • Value of ECS+NACH/ GDP

Table 3.3: Summary Table of the Dimensions' based on Structural Break Analysis
Source: Own

Transaction Type	Measures	Effect of Demonetization (0=No effect, + = positive effect, - = Negative effect)	Effect of COVID-19 (0=No effect, + = positive effect, - = Negative effect)
Cards Ownership	**Cards/1000 Adults**	0	(-)
POS Transaction	**Per Capita Volume of POS**	(+)	(-)
	Per Capita Value of POS	(+)	(-)
	Value of POS/GDP	(+)	(-)
NEFT Transaction	**Per Capita Volume of NEFT**	0	(+)
	Per Capita Value of NEFT	(+)	(-)
	Value of NEFT/GDP	0	(-)
RTGS Transaction	**Per Capita Volume of RTGS**	0	(+)
	Per Capita Value of RTGS	0	(-)
	Value of RTGS/ GDP	0	(-)
IMPS Transaction	**Per Capita Volume of IMPS**	(+)	(+)
	Per Capita Value of IMPS	(+)	(+)
	Value of IMPS/ GDP	(+)	(+)
ECS+NACH Transaction	**Per Capita Volume of ECS+NACH**	0	(-)
	Per Capita Value of ECS+NACH	(+)	0
	Value of ECS+NACH/ GDP	0	0

Table 3.4: Summary Table of the Individual Transaction Types, Based on Structural Breaks

From Table 3.4, it is observed that demonetization and post-demonetization policies have a positive impact on all measures of POS transactions. However, the COVID-19 pandemic has had a negative effect on all three measures of POS transactions. Both demonetization and the COVID-19 pandemic have a positive impact on all measures of IMPS transactions. In the case of both NEFT and RTGS transactions, the COVID-19 pandemic has had a positive effect on the Per capita volume measures of NEFT and RTGS transactions. However, COVID-19 has negatively affected the per capita value and value/GDP measures of NEFT and RTGS transactions. That indicates that after the COVID-19 outbreak, people are using NEFT and RTGS transactions more than before. However, a negative economic growth rate due to lockdown measures after the COVID-19 pandemic outbreak is more prominent in the value of NEFT and RTGS transactions.

3.3.2. Analysis of Indices

In the present section we analyse the indices. The previous section clearly establishes that the individual dimensions of cashless transaction show sufficient variation on their trends over the period. So, it is important to study the overall trend of the cashless transaction by combining the individual dimensions into an index.

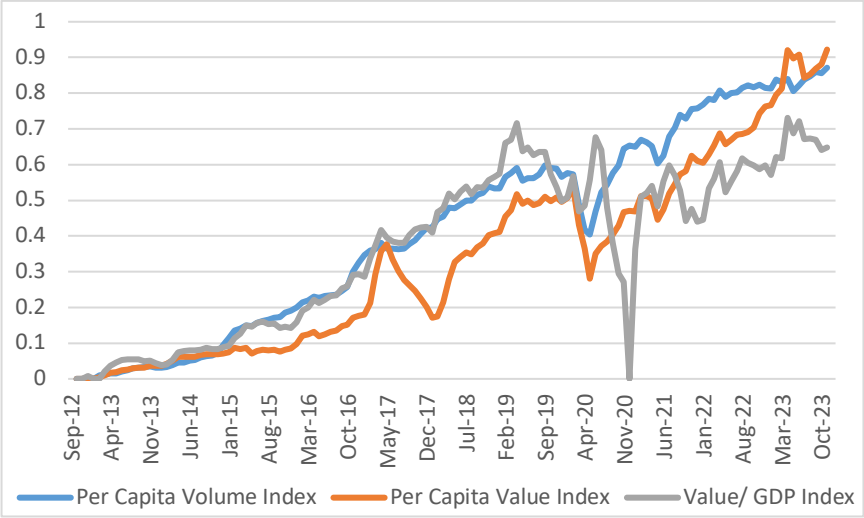


Figure 3.28: Graphical Plot of Three Different Indices
Source: Own.

3.3.2.1. Graphical Plot Analysis of The Indices:

As already mentioned, we have constructed three alternative indices to study the trend in the cashless transaction specially to capture a comparative effect of demonetization and Covid-19 Pandemic on the overall trend of the cashless transaction of the economy. Figure 3.29 shows the graphical plots of the three indices. From figure 3.28 we observe that the per capita value index of the cashless transaction increased smoothly till November 2016. But, after the demonetization in November 2016 the index shows an abrupt increase, that is, the immediate effect of the demonetization was to push up the overall value of the cashless transaction of the economy, as is expected. As the government banned the highest currency notes from 8th November 2016 and the ATMs went cashless for long periods, people who had the means,

were forced to use the electronic medium for the transaction.

However, the point to note is that the demonetization could not create a permanent impact as the index reverted to the trend after a period of time. With the starting of 2019 the trend line of per capita value index starts increasing beyond trend but with the starting of pandemic period there is a sharp decrease in the trend line but it improved after few months. Value GDP index shows fluctuations. But after the pandemic hit there is a sharp reduction in the trend line which is possibly a result of sharp decline in GDP because of the outbreak of COVID-19 pandemic and consequent lockdown that followed, but it is important to mention that the index value improves after few months, which indicates economic recovery s but the index value doesn't come back to the previous trend. In the case of the Per capita volume index of cashless transaction, based on the graphical plot there is a permanent shift in the trend line long before the demonetization period (from January 2015) right after PMJDY policy implementation, unlike the case of the other two indices. This indicates that PMJDY in 2014 encourage more population to use cashless transaction. After demonetization in November 2016, the index graph has gone up slightly as expected, but again the effect was temporary like the case of the other two indices, but post pandemic period the fall in the trend line is very much sharp which improved very well till date, indicates recovery from the economic down fall.

3.3.2.2. Trend Analysis of the Indices

While selecting the trend equations for all three indices, we have regressed Per capita value and per capita volume indices on "Nominal GDP as a proportion GCF deflator" along with deterministic time trend. In the case of the value GDP index, we consider the "adult population" as one of the regressor along with deterministic time trends, we checked for both linear and non-linear deterministic trends. In the case of both the per capita volume index of the cashless transaction and the per capita value index of the cashless transaction linear deterministic trend

is a relatively good fit. In the case of the value of the cashless transaction as a proportion of the GDP index, the non-linear deterministic trend is a relatively good fit.

The regression equation to check the stability of both the per capita value index of the cashless transaction and the per capita volume index of the cashless transaction is following:

$$\boldsymbol{Index_t = C + \beta_1 t + \beta_2 X_t + U_t} \ldots\ldots\ldots\ldots \textbf{(3.5)}$$

Where, $Index_t$ implies the value of the index at time point t, t denotes deterministic time trend, β_1 is the time coefficient, x_t is Nominal GDP as a proportion of GCF deflator as one of the regressor because increase in the overall value of the cashless transaction can be the result of economic growth, so changes in the GDP is important to incorporate in the model, β_2 is coefficient of GDP, U_t is the error term.

From table 3.5 it can be found that time coefficient is significant (at 1% level of significance), indicating that the per capita volume index has been increasing overtime, from table 3.5 it can be also found that nominal GDP is insignificant (at 1% level) i.e. has no impact on the per capita volume index. The CUSUM chart of the per capita volume index has positive structural break during post demonetization period but the break came to the previous trend during the pandemic period (represented in figure 3.30). So, it can be summarized that demonetization event were effective to increase the overall volume of the cashless transaction of the economy but that positive impact has been permanently removed by the event of COVID-19 pandemic outbreak, the per capita volume of cashless transaction index value come back to the pre demonetization trend.

From table 3.6 it can be observed that time coefficient is significant (at 1% level of significance), indicating that the per capita value index has been increasing overtime, from table 3.6 it is also observed that nominal GDP has also significant (at 1% level) positive impact

on the per capita value index. The CUSUM chart of the per capita value index has positive structural break during post demonetization period near the end of 2017 but the break temporarily came to the previous trend after the outbreak of COVID-19, but then after few months again it has positive structural break (represented in figure 3.31). So, we can conclude that both demonetization and post demonetization policies and COVID-19 pandemic has positive impact on the overall per capita value of the cashless transaction of the economy.

From table 3.7 it can be also found that the value GDP index has been increasing at an increasing rate overtime, (significant at 1% level). The regression equation to check the stability of the value GDP index of the cashless transaction is following:

$$\boldsymbol{Index_t = C + \beta_1 t + \beta_2 t^2 + \beta_3 X_t + U_t} \ldots\ldots\ldots\ldots \textbf{(3.6)}$$

Where, $Index_t$ implies the value of the index at time point t, t denotes time trend, β_1 is the time coefficient, $\boldsymbol{\beta_2}$ is the non-linear time coefficient, x_t is adult population as one of the regressor because increase in the overall value of the cashless transaction can be the result of increase in the adult population growth, so changes in the a adult population is important to incorporate in the model, β_3 is coefficient of adult population, U_t is the error term.

The CUSUM chart of the value GDP index represented in the figure 3.32, says that post demonetization period has no impact on the overall value of the cashless transaction as a proportion of GDP (No structural break during post demonetization period), but during post pandemic period it has negative structural break, indicates negative impact of COVID-19 pandemic scenario on overall economic conditions, but the negative effect doesn't last long, during the end of 2022 it came back to the previous trend, indicates economic recovery as well as increment in the overall value of the cashless mode transaction.

Dependent Variable: PER CAPITA NO INDEX
Method: Least Squares
Date: 03/23/24 Time: 17:10
Sample: 1 134
Included observations: 134

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIME	0.006879	0.000243	28.30933	0.0000
GDP/GCFDEF	2.91E-06	2.64E-06	1.105659	0.2709
C	-0.079305	0.019866	-3.992017	0.0001
R-squared	0.974689	Mean dependent var		0.421719
Adjusted R-squared	0.974302	S.D. dependent var		0.280176

Table 3.5: Regression Results of Per Capita Volume Index
Source: Own

Dependent Variable: PER CAPITA VALUE INDEX
Method: Least Squares
Date: 03/23/24 Time: 17:11
Sample: 1 134
Included observations: 134

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIME	0.003109	0.000225	13.82497	0.0000
GDP_GCFDEF	4.09E-05	2.44E-06	16.75170	0.0000
C	-0.385378	0.018387	-20.95915	0.0000
R-squared	0.975627	Mean dependent var		0.339364
Adjusted R-squared	0.975255	S.D. dependent var		0.264266

Table 3.6: Regression Results of Per Capita Value Index
Source: Own

Dependent Variable: VALUE/ GDP INDEX
Method: Least Squares
Date: 03/23/24 Time: 17:14
Sample: 1 134
Included observations: 134

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIME	0.007649	0.006613	1.156595	0.2496
TIME^2	3.69E-05	9.15E-06	4.027195	0.0001
ADULTPOPU	1.723314	5.122302	0.336433	0.7371
C	-1.605600	4.513521	-0.355731	0.7226
R-squared	0.824895	Mean dependent var		0.368614
Adjusted R-squared	0.820854	S.D. dependent var		0.227426

Table 3.7: Regression Results of Value/ GDP Index
Source: Own

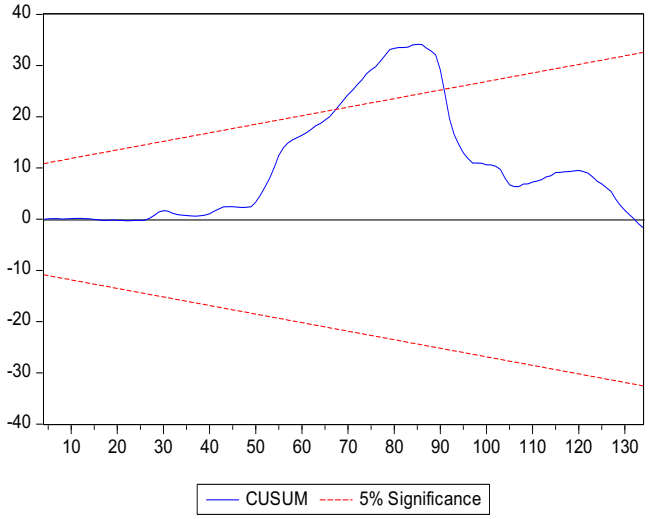


Figure 3.29: Cusum plot of Per Capita Volume Index
Source: Own.

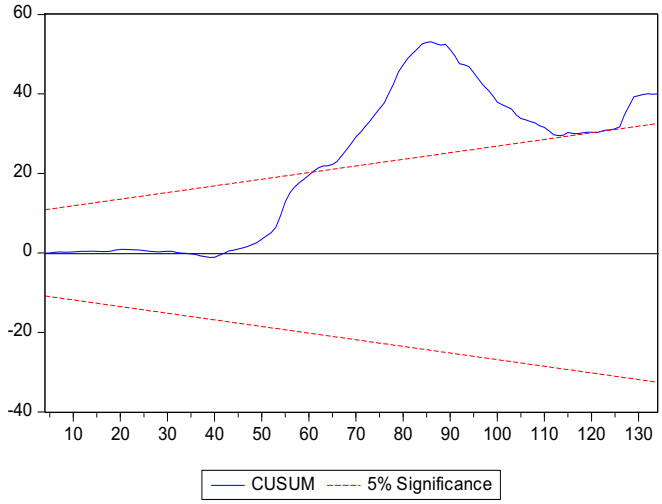


Figure 3.30: Cusum Plot of Per Capita Value Index
Source: Own.

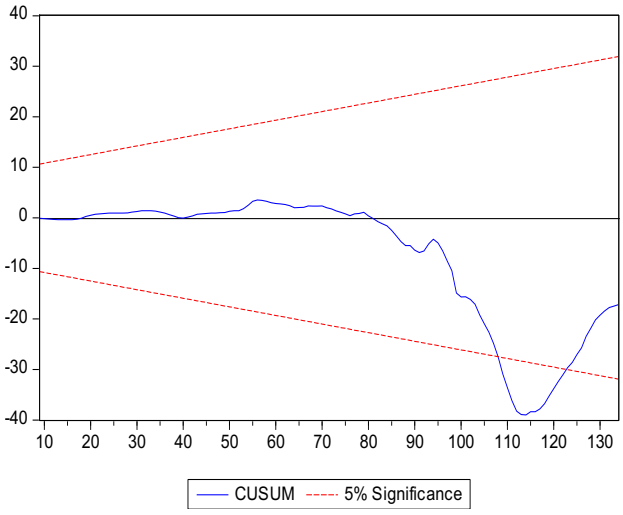


Figure 3.31: Cusum Plot of Value/ GDP Index
Source: Own

The following Table 3.8 summarizes the results.

	Impact of event: Nature of structural break		
Index	**PMJDY**	**Demonetization**	**Pandemic**
Per capita volume index	Has No impact	Has Positive impact,	Has Negative impact
Per capita value index	Has No impact	Has Positive impact	Has Positive impact
Value-GDP index	Has No impact	No impact	Has temporary negative impact

Table 3.8: Summary Table of the Indexes based on Structural Break Analysis

Source: Own

3.4. Conclusion:

The study of the three indices of cashless transactions reveals some patterns in the trend. Both the per capita value index and per capita volume index are significantly increasing with a linear trend. The value-GDP index is considerably increasing at an increasing rate. Nominal GDP has a significantly positive impact on the per capita value index only, indicating that the people who were doing cashless transactions before, those same people are still using cashless transactions on more valued goods and services than before, which reveals that not more people have started using cashless transactions than before.

If we consider the stability of the trends, the per capita value index has experienced a positive trend break both after demonetization and also after Covid 19 pandemic. The per capita volume index experienced a positive structural break post-demonetization period also. This trend persisted till before the COVID-19 pandemic. However, the COVID-19 pandemic hurt the trend of the per capita volume index. As a result, the trend reverted to the pre-demonetization stage. This reveals the fact that during post COVID-19 pandemic people are using cashless

modes of payment for higher-valued transactions than before, but this is not the case more people have started using cashless transactions than before. Govt. should emphasize more on the policies which promote financial inclusion rather than the policies which increase the value of cashless transactions. Demonetization doesn't have any impact on the value-GDP index. The COVID-19 pandemic has had a temporary negative impact on the value-GDP index, which is possibly a result of the economic downturn due to the pandemic. But the negative effect didn't persist, it came back to the previous trend by the end of 2022, indicating economic recovery as well as an increment in the overall value of the cashless mode transaction.

So, we can conclude while demonetization and post demonetization policies had a definitive positive impact on both the per capita volume as well as per capita value index, pandemic period had a permanent positive impact on per capita value index only.

The individual dimensions show considerable variations in their responses to the demonetization experiment and the Covid-19 pandemic. No. of cards per 1000 adults, per capita No. of POS, Per Capita Value of POS, POS/GDP, Number of NEFT per capita, Per Capita Value of NEFT, Number of IMPS per capita, Per Capita value of IMPS and value of IMPS/ GDP have linear increasing deterministic time trends. Value of NEFT/ GDP, Per capita volume of RTGS transaction, Per capita value of RTGS transaction, Value of RTGS/ GDP, Per capita volume of ECS+NACH, per capita value of ECS+NACH and Value of ECS+NACH/ GDP measures have nonlinear deterministic trend over the period of analysis.

Corresponding to the trend regressions and based on structural break analysis, the dimensions where both demonetization and the COVID-19 pandemic positively impact are the Per capita volume of IMPS, Per capita value of IMPS and Value of IMPS/ GDP transactions that indicates that people on Indian is more preferred IMPS transactions using mobile phones

or internet banking. In the case of all three measures of POS transactions, demonetization has a positive impact. After the outbreak of COVID-19 that positive shift turned into a negative trend, which implies that after the outbreak of the COVID-19 pandemic and lockdown measures buyers don't prefer to use debit and credit cards to make payments, this could be a reason that due to the lockdown measures overall consumption has been reduced by the consumers or the use of debit card and credit card has been substituted by the use of UPI transaction to avoid the contact as well as due to the easy access to the internet and UPI technology. As the data about the volume and value of the UPI payment is not available for the entire period of analysis, we can't capture that scenario, which could be considered a limitation. In future, we could do further studies by including the UPI transactions in our analysis if more data will be available. The dimensions where demonetization has no impact are No. of Cards per 1000 Adults, Per Capita volume of NEFT, value of NEFT/ GDP, Per Capita Value of RTGS, value of RTGS/ GDP, value of ECS+NACH/ GDP.

The dimensions where only Covid-19 pandemic has positive impact are per capita volume as well as value of IMPS, Value of IMPS/ GDP, per capita volume of NEFT and per capita volume of RTGS. The dimensions where Covid-19 pandemic has negative impact are No. of Cards/ 1000 Adults, all three measures of POS transactions, per capita value of NEFT, Value of NEFT/ GDP, per capita value of RTGS and Value of RTGS/ GDP.

The trends of the indices as well as the individual dimensions establish that the cashless transaction of the Indian economy was already growing at a fast pace especially after the demonetization period. The individual dimension analysis as well as all three-index analysis suggests that in case of Per capita Volume index, the per capita volume of individual dimensions that have declined after Covid-19 outbreak, had more impact on the index than the per capita volume of individual dimensions that have increased after Covid-19 pandemic. Same

in the case of Value/ GDP index. But in case of per capita value index, the dimensions that have positive impact after Covid-19 outbreak out way the negative impacts of some individual dimensions not right after the outbreak of Covid-19 but near the start of 2023.

CHAPTER **4**

DETERMINENTS OF DIGITAL TRANSACTION: A THEORETICAL APPROACH

4.1. Introduction:

RBI report[30] (2019) states that "Digital Transaction means a payment transaction in a seamless system effected without the need for cash at least in one of the two legs, if not in both." This includes transactions made through digital / electronic modes wherein both the originator and the beneficiary use digital / electronic medium to send or receive money".

The transaction cost of a certain amount of money depends on the type of transaction mode. For instance, the transaction cost of a cash transaction could vary from the transaction cost of a debit card or credit card transaction. Analysing the transaction costs associated with the particular mode of payment, the optimum type of transaction could be possible to identify, which ensures the fuller utilisation of resources. Now the question is, what are the factors which might have some influence over the total transaction cost associated with a particular type of payment mode? The motivation for the present chapter lies in identifying the differences in the transaction costs across individuals with different levels of income and education. For instance, individuals with lower incomes, the gain in interest by keeping income in a bank account might be outweighed by the annual charge of maintaining a debit card. Additionally, the skill required for executing digital payments is closely related to the level of education. Individuals with lower education levels may find it challenging to complete cashless transactions, as the potential for technical faults is higher, which may create a psychological barrier. In this chapter, our goal is to establish a theoretical relationship between an individual's choice of payment medium—cash or cashless—and its determinants mainly education & income. The chapter aims to establish, theoretically, the influence of education and income on the selection of transaction modes.

[30] The report of the 'The High-level Committee on Deepening of Digital Payments' (2019)

While existing literature discussed in chapter 2 has studied the relationship between education, age, and income with cashless transactions, many of these studies are limited to specific regions or states based on empirical data. While existing studies explore various aspects of payment systems and some socio economic conditions, mostly concerned with other issues like pricing of the cards, efficiency in card use etc. So we are trying to addressing an issue that has not been addressed before: namely the effect of interaction between education and income in adopting the cashless transaction. There is a gap in literature regarding the interaction issues between income and education, and the selection of payment modes. In this chapter, we attempt to fill this gap by developing a theoretical model differently to understand the influence of income and education on the selection of payment modes, including cash and cashless transactions. Our analysis aims to inform policy-making, especially for developing countries, to promote cashless transactions.

The chapter is organized as follows: In section 2, we discuss existing literature, both empirical and theoretical, along with gaps in this area of research. Section 3 covers the theoretical model with assumptions and equilibrium conditions. In section 4, we discuss the results with policy implications. Finally, section 5 concludes.

4.2. Description of the Theoretical Model:

This section describes the model in detail. The first part of this discussion considers the absence of direct taxation. In the other part of this section, we incorporate the presence of direct taxation in the model and discuss it in detail to reach conclusions.

4.2.1. Description of the Model without Direct Taxation:

Time is divided into discreet periods (week/month). Buyers get the income at the beginning of the period and spend their income over the period. For instance individuals get their income in the first week of every month and spend that income over the month to meet their expenses

Buyer spend their entire incomes to purchase commodities and services. We have ruled out savings but savings can easily be accommodated in this frame work.

The analysis is concerned with one representative individual and one representative period .The period is divided into $\boldsymbol{f}$ equal intervals and. buyer will make transaction $\boldsymbol{f}$ times over the period Here 'f' is constant for every level of income and education.

In each period buyer spends an amount $\boldsymbol{C}$, and $\boldsymbol{C}$ is an increasing function of income this assumption is motivated by the fact that, as income increases the level of expenditure also increases due to the inclusion of more expensive commodities as well as inclusion of greater varieties in the consumption basket. $C.f = Y$

For each transaction, the buyer can pay either with cash or with debit card; there is no other payment option available. Payment technology is unchanged over the period. i.e. no easier payment technology becomes available over the period of analysis. There is zero probability of theft from house.

Now in each period the representative individual can make payments in one of the three ways:

Case 1: He can withdraw the total amount of money required to meet his total expenditure of that period at the beginning of the period from the bank account and then he can pay in cash each time of the purchased. (We call it type A transaction).

Case 2**:** He can withdraw C amount each time from his account each time he makes a purchase and then make payment in cash. (We call it type B transaction).

It should be noted that both type A and type B transactions are cash transactions

Case 3: H makes payment using debit card at the time of each purchase. (We call it Debit card transaction).

Transaction cost of any type of payment mode involves two types of costs: the first is the cost incurred before the actual purchase. This include banking cost while withdrawing money from bank, inconvenience cost of carrying cash to the shops etc. So the first type of cost is inconvenience cost plus transport cost. The second is the transaction cost at the shop floor. For cash transaction the transaction cost incurred at the shop floor include loss of time and handling cost to transact each unit of money with cash, which is the value of time associated with giving currency notes and coins, counting it, checking for counterfeits. For debit card transaction shop floor cost includes the time loss and handling cost includes the cost of technical fault[31] and mistakes associated with the transaction with debit card at the shop floor This we name transaction cost.

Let $\emptyset$ **denote** the coefficient of inconvenience cost. As the representative individual withdraws c amount $\boldsymbol{f}$ times. So total inconvenience due cost will be $\emptyset \boldsymbol{c}.\boldsymbol{f}$, which we can write as $\emptyset \boldsymbol{Y}$ (by putting the value of $\boldsymbol{f}$ as $\frac{\boldsymbol{Y}}{\boldsymbol{C}}$ **,** as the consumer spend all of his **Y** income by spending **C** amount each time over the period). Where **Y** is the total income of the buyer and buyer will spend his entire income over that period. So, here we consider inconvenience cost is an increasing function of income. The other component of the first type of cost is the banking cost of

[31] cost of technical fault means if money will go to a different account due to mistake in typing the wrong account no. and so on or any type of technical miss lead.

withdrawing money from the bank account, which is denoted as **b**, as we assume that buyer will get his entire income for that period in his bank account at the beginning of that period. This banking cost includes transportation cost as well as time loss and all other cost associated with withdrawing money from bank account and which is constant each time.

The second type of transaction cost of cash transaction at the shop floor is closely associated with the level of education. For zero level of education this cost is $\boldsymbol{\tau_R}$. This shop floor cost for each unit of money will reduced at the rate; $\mathbf{e_R}$with the increase in level of education. In other words, $\mathbf{e_R}$ is coefficient associated with education i.e. with the increase in 1 year of education the shop floor cost of each unit of money will reduce by $\mathbf{e_R}$. Let **E** denotes level of education, then ($\boldsymbol{\tau_R - e_R E}$) will be the shop floor cost per unit of money transacted using A type of cash transaction .Therefore, the total shop floor cost to transact **C** amount of money using A type of cash transaction *f* times over that period with **E** level of education will be

$$(\boldsymbol{\tau_R - e_R E})\boldsymbol{C.f}$$

$$\textbf{Or, } (\boldsymbol{\tau_R - e_R E})\boldsymbol{Y} \quad \textbf{[as } \boldsymbol{C.f = Y}\textbf{]}$$

However, a very high level of education is not required to complete a cash transaction most efficiently. So we assume that beyond a certain level of education denoted as $\boldsymbol{E_R}$ improvement in education do not have any further effect on cost of transaction. That is beyond this level the shop floor cost can't be reduced further by increase in education.

So the relation between education and the shop floor cost (C_A) of type A cash transaction to transact *C* amount of money each *f* times is as follows:

$$C_A = \begin{cases} (\boldsymbol{\tau_R - e_R E})\boldsymbol{C.f} & \forall \boldsymbol{E < E_R} \\ (\boldsymbol{\tau_R - e_R E_R})\boldsymbol{C.f} = \overline{\boldsymbol{\tau_R}}. & \forall \boldsymbol{E \geq E_R} \end{cases}$$

There is a third type of cost associated with type A transaction, which is the loss of interest by the amount $\boldsymbol{i.Y}$, for withdrawing all his income in cash at the beginning of that period. Here I is the interest per period.

So the total transaction cost function of Cash transaction of A type ($\boldsymbol{TC_A}$) by combining all the four types of cost mentioned above is

$$\boldsymbol{TC_A} = \begin{cases} (\boldsymbol{\tau_R} - \boldsymbol{e_R E})\boldsymbol{Y} + \emptyset\boldsymbol{Y} + \boldsymbol{i.Y} + \boldsymbol{b} & \boldsymbol{for\ E < E_R} \\ \overline{\boldsymbol{\tau_R}}.\boldsymbol{Y} + \emptyset\boldsymbol{Y} + \boldsymbol{i.Y} + \boldsymbol{b} & \boldsymbol{for\ E \geq E_R} \end{cases} \qquad \textbf{.....(4.i)}$$

(Where **R** in the subscripts of above cost function denotes cash transaction)

Now in case of B type transaction the total transaction cost could be divided in the same two parts. The second type of transaction cost that is the transaction cost at the shop floor will be the same for A type transaction and B type transaction.

The difference occurs in case of first and third type transaction costs. If we consider the first type of transaction cost it will be higher . As the buyer is withdrawing money $\boldsymbol{f}$ times from the bank and each time incurring the constant banking cost $\boldsymbol{b}$, the total banking cost of withdrawing money $\boldsymbol{f}$ times from the bank is $\boldsymbol{b.f}$.

Next we consider the third type of cost , namely the cost arising out of lost interest income. This cost will be lower as all the money is not withdrawn at the beginning of the period. That is by withdrawing money periodically(f times) the representative individual enjoys an interest gain . This is explained in appendix 4A. From the appendix we find this gain to be $(g.Y)$

Where $\boldsymbol{g} = \frac{1}{f}\left[\frac{f+i}{i}\left(1 - \left(1 + \frac{i}{f}\right)^{(f-1)}\right) - (f-1)\right]$ and $\boldsymbol{g.Y}$ is the interest gain

So total interest loss should be the difference between the interest gain from keeping all of his/her income into the bank account for that total period and the total interest s/he get after withdrawing some money each time over the period, i.e. total interest loss will be

$$\left\{\boldsymbol{Y.i}-\frac{\boldsymbol{Y}}{\boldsymbol{f}}\left[\frac{\boldsymbol{f+i}}{\boldsymbol{i}}\left(\mathbf{1}-\left(\mathbf{1}+\frac{\boldsymbol{i}}{\boldsymbol{f}}\right)^{(\boldsymbol{f}-\mathbf{1})}\right)-(\boldsymbol{f}-\mathbf{1})\right]\right\}$$

For simplification we are considering total interest loss will be $(\boldsymbol{Y.i}-\boldsymbol{g.Y})$

here, $\boldsymbol{g}=\frac{\mathbf{1}}{\boldsymbol{f}}\left[\frac{\boldsymbol{f+i}}{\boldsymbol{i}}\left(\mathbf{1}-\left(\mathbf{1}+\frac{\boldsymbol{i}}{\boldsymbol{f}}\right)^{(\boldsymbol{f}-\mathbf{1})}\right)-(\boldsymbol{f}-\mathbf{1})\right]$ and $\boldsymbol{g.Y}$ is the interest gain

So, the total transaction cost function of cash transaction of B-type B is as follow

$$\boldsymbol{TC_B}=\begin{bmatrix}(\boldsymbol{\tau_R}-\boldsymbol{e_R E})\boldsymbol{Y}+\emptyset\boldsymbol{Y}+\{\boldsymbol{y.i}-\boldsymbol{g.Y}\}+\boldsymbol{b.f} & \boldsymbol{for\ E\le E_R}\\ \overline{\boldsymbol{\tau_R}}.\boldsymbol{Y}+\emptyset\boldsymbol{Y}+\{\boldsymbol{y.i}-\boldsymbol{g.Y}\}+\boldsymbol{b.f} & \boldsymbol{for\ E>E_R}\end{bmatrix} \qquad \textbf{……..(4.ii)}$$

Now if he pays for goods and services each time with debit card every time directly, then the transaction costs are as follows:

$\boldsymbol{\tau_D}$ is the time loss and handling cost which includes the fear of technical fault[32] and mistakes associated with the transaction of one unit of money with debit card at the shop floor when level of education is zero. $\boldsymbol{\tau_D}$ is shop floor cost per unit of money transacted using debit cards. Total shop floor cost will increase with the increase in the amount of money transacted each time. This could be a physiological cost or could be an actual cost if some mistakes could happen in real. This is the cost of fear of sending money to wrong account no. which will increase if the amount of transaction is much higher compare to the cost of fear in case of very little amount of transaction, this cost associated with handling a debit card transaction. This

[32] cost of technical fault means if money will go to a different account due to mistake in typing the wrong account no. and so on or any type of technical miss lead.

shop floor cost per unit of money could reduce with the increase in the level of education. The effect of increase in the level of education in the reduction of shop floor cost could be divided into three stages, first when the level of education less than $\boldsymbol{E_{D1}}$ level, second when the level of education more than $\boldsymbol{E_{D1}}$ level but less than $\boldsymbol{E_{D2}}$ level and lastly when level of education more than $\boldsymbol{E_{D2}}$ level**.** Initially when level of education is less than $\boldsymbol{E_{D1}}$ then the marginal effect of education on the reduction of shop floor cost is $\boldsymbol{e_{D1}}$, which is less than the marginal effect of education on the reduction of shop floor cost when the level of education is more than $\boldsymbol{E_{D1}}$ but less than $\boldsymbol{E_{D2}}$ (marginal effect denoted as e_{D2}). Lastly when level of education is more than $\boldsymbol{E_{D2}}$ then the shop floor cost will be lowest because after availing a certain level of education buyer can handle debit card transaction efficiently. **So,** here $\boldsymbol{e_{D1}}$, $\boldsymbol{e_{D2}}$ both are coefficients of education related to debit card transaction for the level of education less than $\boldsymbol{E_{D1}}$ and for the level of education more than $\boldsymbol{E_{D1}}$ but less than $\boldsymbol{E_{D2}}$. where $\mathbf{e_{D1} < e_{D2}}$.

So, $(\boldsymbol{\tau_D - e_{D1}E})$ is the amount of shop floor cost related to each unit of money transacted using debit card each time at **E** level of education which is lesser than $\boldsymbol{E_{D1}}$ level of education. If '$\boldsymbol{c}$' amount of money will transact using debit card each '$\boldsymbol{f}$' time then total shop floor cost debit card transaction of that period will be

$$(\boldsymbol{\tau_D - e_{D1}E}).\boldsymbol{C}.\boldsymbol{f}$$

$$\boldsymbol{Or,}\ (\boldsymbol{\tau_D - e_{D1}E}).\boldsymbol{Y} \quad \textbf{[as } \boldsymbol{C.f = Y}\textbf{]}$$

Similarly when the level of education is more than $\boldsymbol{E_{D1}}$ level but lesser than $\boldsymbol{E_{D2}}$ then shop floor cost and related to transact $\boldsymbol{Y}$ amount of income using debit card

Will be $(\boldsymbol{\tau_D - e_{D2}E})\boldsymbol{Y}$ which is lesser than$(\boldsymbol{\tau_D - e_{D1}E})\boldsymbol{Y}$.

The shop floor cost stops falling beyond the level of education $\boldsymbol{E_{D2}}$. So, $(\boldsymbol{\tau_D - e_{D2}E_{D2}})$ denotes the lowest shop floor cost of debit card transaction per unit of money, which is constant . Let $(\boldsymbol{\tau_D - e_{D2}E_{D2}}) = \overline{\boldsymbol{\tau_D}}$. To transact **Y** level income with debit card the lowest amount of shop floor cost will be $(\boldsymbol{\tau_D - e_{D2}E_{D2}})\boldsymbol{Y}$ or $\overline{\boldsymbol{\tau_D}}.\boldsymbol{Y}$ when the $E \geq \boldsymbol{E_{D2}}$.

Other cost associated with debit card transaction is interest loss which is same as B type cash transaction. As the representative individual will be debiting exactly equal amount from the bank account each time using debit card like in the case of B-type transaction.

The fourth type of cost uniquely associated with debit card is annual fee $\boldsymbol{F_a}$, for availing debit card facility .

So, the total transaction cost function of debit card transaction is

$$\boldsymbol{TC_D} = \begin{bmatrix} (\boldsymbol{\tau_D - e_{D1}E})\boldsymbol{Y} + \boldsymbol{i}.\boldsymbol{Y} - \boldsymbol{g}.\boldsymbol{Y} + \boldsymbol{F_a} & \boldsymbol{for\ E < E_{D1}} \\ (\boldsymbol{\tau_D - e_{D2}E})\boldsymbol{Y} + \boldsymbol{i}.\boldsymbol{Y} - \boldsymbol{g}.\boldsymbol{Y} + \boldsymbol{F_a} & \boldsymbol{for\ E_{D1} < E < E_{D2}} \\ \overline{\boldsymbol{\tau_D}}.\boldsymbol{Y} + \boldsymbol{i}.\boldsymbol{Y} - \boldsymbol{g}.\boldsymbol{Y} + \boldsymbol{F_a} & \boldsymbol{for\ E \geq E_{D2}} \end{bmatrix} \quad \textbf{.....(4.iii)}$$

here, $\boldsymbol{g} = \frac{\boldsymbol{1}}{\boldsymbol{f}}\left[\frac{\boldsymbol{f+i}}{\boldsymbol{i}}\left(\boldsymbol{1} - \left(\boldsymbol{1} + \frac{\boldsymbol{i}}{\boldsymbol{f}}\right)^{(\boldsymbol{f-1})}\right) - (\boldsymbol{f-1})\right]$ and $\boldsymbol{g}.\boldsymbol{Y}$ is the interest gain.

Here the subscript D denotes debit card transaction

Here we make two assumptions. The first assumption is that $\boldsymbol{E_R < E_{D2}}$. This implies that, the education level beyond which there is no further fall in cash transaction cost that is the level of education where is less than the education level beyond which, there is no further fall in the transaction cost of debit card transaction. In other words the level of education at which the transaction cost of cash transaction reaches a minimum feasible level is less than the level of education at which transaction cost of debit card transaction reaches a minimum feasible level. To handle cash transaction efficiently, the minimum level of education requires $(\boldsymbol{E_R})$ is lesser

than the minimum education required ($\boldsymbol{E_{D2}}$) to handle debit card transaction efficiently. The basis of this assumption is that to complete cash transaction efficiently basic primary education is sufficient most of the time, much higher level of education is not required for efficient handling of cash. But basic primary education may not be sufficient to complete a debit card transaction and handle its related activities efficiently. Much higher level of education compare to cash transaction is require to complete a debit card transaction most efficiently.

The second assumption we adopt is $\boldsymbol{e_{D1} < e_R < e_{D2}}$. This assumption implies that initially with the increase in one extra year of education for education level less than $\boldsymbol{E_{D1}}$ marginal effect of one extra year of education on the reduction in transaction cost of debit card is less than the marginal effect of one-year extra education on the reduction of shop floor cost of cash transaction. This is because with a very low level of education it is more difficult to deal with debit card transaction related activities i.e. dealing with the pin, OTP, SMS, email notifications technical fault etc. In contrast when the individual crosses a level of education which is higher than $\boldsymbol{E_{D1}}$ level but lesser than $\boldsymbol{E_{D2}}$ then the marginal effect of one-year extra education on the reduction in transaction cost of debit card is higher than the marginal effect of one extra year of education on the reduction in transaction cost of cash transaction.

The third assumption we adopt is $\boldsymbol{\tau_R < \tau_D}$. This assumption implies that at zero level of education the shop floor cost of debit card transaction per unit of money ($\boldsymbol{\tau_D}$) is higher than the shop floor cost of cash transaction per unit of money ($\boldsymbol{\tau_R}$). This assumption is motivated by the fact that with zero level of education it is very much hard to do a Debit card transaction because of the huge fear of technical fault, rigidity of technical knowhow etc. but due to the familiarity with the currency since childhood and universal acceptability, handling the currency transaction is easier than handling debit card transaction even at the zero level of education.

The fourth assumption $\overline{\boldsymbol{\tau_R}} > \overline{\boldsymbol{\tau_D}}$ implies that after achieving minimum education require for each type of transaction the minimum shop floor cost is lower in case of debit card transaction than in case of cash transaction. Currency transaction is more time consuming than debit card transaction as a lot of time is spent in counting money by both buyer and seller. In contrast, debit card transactions require only insertion and punching in a four-digit code (if any). With education the apprehension of sending money into wrong account no. gets reduced which reduce the overall shop floor cost of debit card transaction.

The fifth assumption is $\{\boldsymbol{\tau_R} + \boldsymbol{b} + \emptyset + \boldsymbol{g}\} < \boldsymbol{\tau_D}$**;** it implies that the shop floor cost each unit of money using debit card at zero level of education ($\boldsymbol{\tau_D}$) is higher than the summation of shop floor cost of each unit of cash transaction at zero level of education ($\boldsymbol{\tau_R}$), banking cost of withdrawing money from bank ($\boldsymbol{b}$) , inconvenient cost of carrying one unit of money in cash ($\emptyset$) and interest gain from one unit of money each time ($\boldsymbol{g}$). Where $\boldsymbol{g} = \frac{\mathbf{1}}{\boldsymbol{f}}\left[\left(\frac{\boldsymbol{f+i}}{\boldsymbol{i}}\right)\left(\mathbf{1} - \left(\mathbf{1} + \frac{\boldsymbol{i}}{\boldsymbol{f}}\right)^{(\boldsymbol{f}-\mathbf{1})}\right) - (\boldsymbol{f} - \mathbf{1})\right]$. '$\boldsymbol{g}$' could be interpreted as the interest gain over the period when **c** amount of money is being withdrawn each '$\boldsymbol{f}$' times between a fixed interval.

This assumption basically describes that the access to the bank is easy so the banking cost to withdrawing the money from bank account is much lower ($\boldsymbol{b}$)**.** The inconvenient cost of carrying one unit of cash to the shop is also much lower ($\emptyset$) and the interest gain from one unit of income (g) is also much lower. And that's the reason the summation of these three with the shop floor cost of one unit of cash transaction at zero level of education ($\boldsymbol{\tau_R}$) is much lower than the shop floor cost of one unit of debit card transaction at zero level of education ($\boldsymbol{\tau_D}$), because at zero level of education the shop floor cost which includs fear of technical cost is much higher compare to the above mentioned three cost related to the cash transaction, as usually individuals are more familiar with the cash transaction since childhood.

The last assumption is $\boldsymbol{F_A > b.f}$, this implies that there is easy access to the banks such that the total banking cost of withdrawing money from the bank $\boldsymbol{f}$ times is less than the annual fees charged by the banks for availing debit card.

4.2.1.1. Equilibrium Education

In this section, we establish the existence of an equilibrium level of education among the three types of transactions mentioned above by comparing two types of transactions at a time with respect to the level of education. Here Equilibrium education denotes the level of education where the transaction cost of any two modes of the transaction will be equal to each other. Beyond the equilibrium level of education, the transaction cost of one type of transaction mode will be lower than the other type. This equilibrium level of education determines the choice of transaction mode.

Comparison between cash transaction of A type and B type in respect of level of education

If we compare cash transaction of A-type with cash transaction of B type we can't get any such equilibrium level of education at which level there is a cross over from one type of transaction to the other. he argument is that transaction cost at the shop floor, where education matters, the cost is the same for cash transaction of A type and B type. In the shop floor, the handling costs and time loss are the same for cash transaction of A type and B type. It's the travelling cost to the bank and the interest cost that are different. So here education level will not make any difference. So, depending on the level of all other parameters either the cash transaction of A-type or B-type will remain higher than the other one with respect to every level of education.

Comparison between Cash transaction of A type and debit card transaction with respect to education

To find out the existence of equilibrium level of education (given the level of income) beyond where transaction cost of cash transaction of A-type will be higher than the total transaction cost of debit card transaction each time we can consider following equation:

$\boldsymbol{TC_D \leq TC_A}$ (considering education level greater than E_{D1} otherwise no intersections will be there in figure 1)

$$\Rightarrow (\boldsymbol{\tau_D - e_{D2}E})\boldsymbol{Y} + \{\boldsymbol{Y.i - g.Y}\} + \boldsymbol{F_a} \leq (\boldsymbol{\tau_R - e_R E})\boldsymbol{Y} + \emptyset\boldsymbol{Y} + \boldsymbol{i.Y} + \boldsymbol{b}$$

From the above equation we can get the equilibrium level of education beyond where transaction cost of debit card becomes less costly. That threshold level of education is

$$\Rightarrow \boldsymbol{E} > \frac{(\boldsymbol{\tau_D - \tau_R}) - \emptyset - \boldsymbol{g}}{(\boldsymbol{e_{D2} - e_R})} + \frac{(\boldsymbol{F_a - b})}{(\boldsymbol{e_{D2} - e_R}).\boldsymbol{Y}} \left(= \widehat{\boldsymbol{E_{AD}}}\right) \quad \textbf{.....(iv)}$$

Following the assumptions.

$$\textbf{Where } \boldsymbol{g} = \frac{\mathbf{1}}{\boldsymbol{f}}\left[\frac{\boldsymbol{f+i}}{\boldsymbol{i}}\left(\mathbf{1} - \left(\mathbf{1} + \frac{\boldsymbol{i}}{\boldsymbol{f}}\right)^{(\boldsymbol{f-1})}\right) - (\boldsymbol{f} - \mathbf{1})\right]$$

Here $\widehat{\boldsymbol{E_{AD}}}$ is the threshold level of education, beyond which transaction cost of debit card transaction will be lesser than the cash transaction, $\widehat{\boldsymbol{E_{AD}}}$ is positive from considering the assumptions.

$\widehat{\boldsymbol{E_{AD}}}$ also depend on the level of income such that When $Y \to 0$ then $\widehat{\boldsymbol{E_{AD}}} \to \infty$ i.e. for any level of education buyer will always prefer cash transaction of A type.

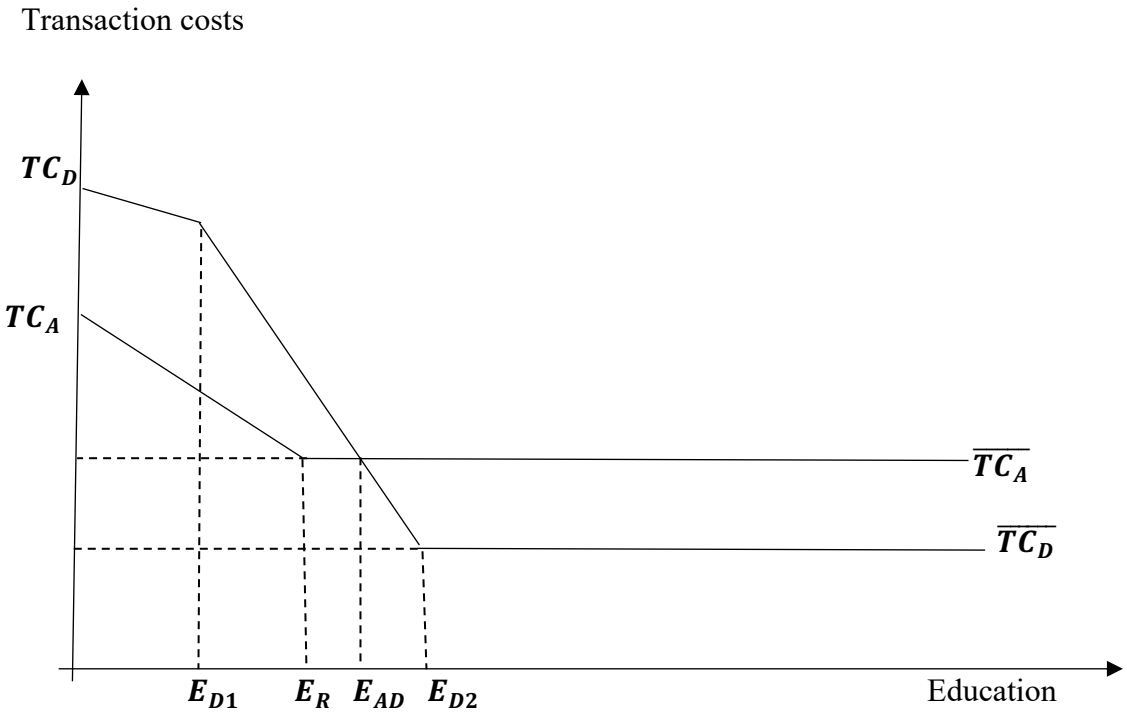
When Y→ ∞ then $\widehat{\boldsymbol{E_{AD}}} = \frac{(\tau_D - \tau_R) - \emptyset - g}{(e_{D2} - e_R)}$**(>0)** $(as\ \{\tau_R + \emptyset + g\} < \tau_D\ and\ e_{D2} > e_R)$ i.e. beyond $\widehat{\boldsymbol{E_{AD}}}$ level of education buyer will always prefer debit card transaction. So Education level more than $\widehat{\boldsymbol{E_{AD}}}$, $\boldsymbol{TC_D < TC_A}$,

i.e. the education require to make the debit card transaction cheaper than the cash transaction of A type is depend on the level of income of the buyer.

PPROPOSITION 1: Beyond the education level $\widehat{\boldsymbol{E_{AD}}}$ *buyer will choose debit card transaction instead of A type cash transaction and* $\widehat{\boldsymbol{E_{AD}}}$ *is a decreasing function of income.*

Figure 1 is the diagrammatic representation of the cost functions and equilibrium level of education between cash transaction of A-type and debit card transaction, where $\overline{\boldsymbol{TC_A}}$ and $\overline{\boldsymbol{TC_D}}$ represent a constant transaction cost with lowest shop floor cost in case of cash transaction of A-type and debit card transaction respectively. Point $\boldsymbol{E}$ represents the equilibrium point where both the transaction cost is equal to each other, it could be anywhere between the education level $\boldsymbol{E_{D1}}$ and $\boldsymbol{E_{D2}}$. In the diagram we represent equilibrium level of education by $\boldsymbol{E_{AD}}$.

Figure 4.1: Diagrammatic Representation of Equilibrium Level of Education Between Cash Transaction of A-type and Debit Card Transaction



Comparison between Cash transaction of 'B' Type and debit card transaction with respect to education

Similarly debit card transaction will be costlier than the cash transaction of B type for the level of education where: $TC_D \leq TC_B$

Or, $(\tau_D - e_{D2}E)Y + \{Y.i - g.Y\} + F_a \leq (\tau_R - e_R E)Y + \emptyset Y + \{Y.i - g.Y\} + b.f$

$$E > \frac{(\tau_D - \tau_R)Y + (F_a - b.f - \emptyset Y)}{(e_{D2} - e_R)Y} (= \widehat{E_{BD}}) \qquad \text{.....(v)}$$

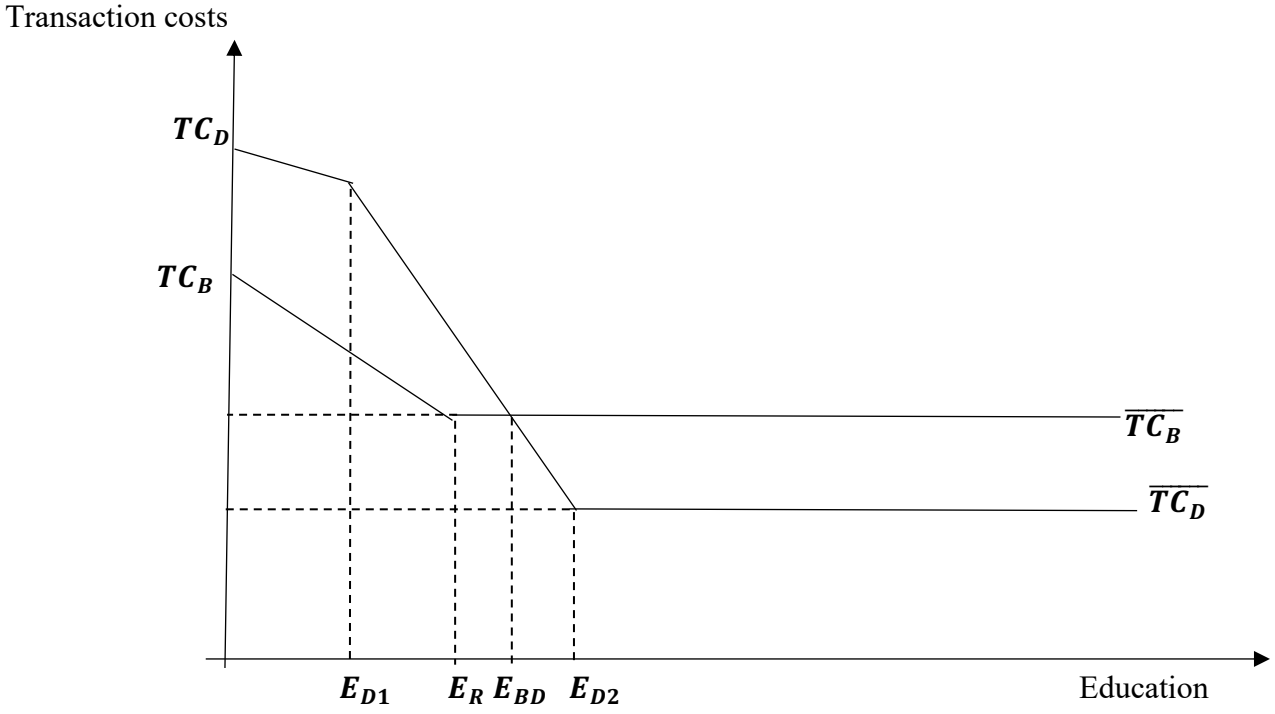
As per the equation **v,** for all the education level more than $\widehat{E_{BD}}$ debit card transaction cost will be much lesser than the cash transaction of B type. So, for any education level more than $\widehat{E_{BD}}$ buyer will choose debit card transaction. But when education level is less than $\widehat{E_{BD}}$ then buyer will choose cash transaction each time to pay for his expenses.

$\widehat{E_{BD}}$ is also a function of income. This is an decreasing function of level of income.

PROPOSITION 2: Beyond the education level $\widehat{E_{BD}}$ buyer will choose debit card transaction instead of cash transaction of 'B' type $\widehat{E_{BD}}$ is a decreasing function of income.

Figure 2 is the diagrammatic representation of the cost functions (with respect to education levels) and equilibrium level of education between Cash transaction of B-type and debit card transaction, where $\overline{TC_B}$ and $\overline{TC_D}$ represent a constant transaction cost with zero level of education and given income, in case of cash transaction of B-type and debit card transaction respectively. Point E represent the equilibrium point where both the transaction cost is equal to each other, it could be anywhere between the education level E_{D1} and E_{D2}. In the diagram we represent equilibrium level of education by $\widehat{E_{BD}}$.

Figure 4.2: Diagrammatic Representation of Equilibrium Level of Education Between Cash Transaction of B-type and Debit Card Transaction



4.2.1.2. Equilibrium Income:

In this section we establish the existence of an equilibrium level of income between the three types of transactions mentioned above by comparing any two types of transactions at a time in respect of the level of income of the buyer. Here Equilibrium income denotes the level of income where the transaction cost of any two modes of the transaction will be equal while comparing the two types of transaction mode in respect of the level of income at a time. Beyond the equilibrium level of income, the transaction cost of one type of transaction mode will be lower than the other type. Then we can conclude that level of income has some influence behind the selection of a particular payment mode.

Comparison between Cash Transaction of A type and B type with respect of Income Level

Now we want to find out whether there exists any equilibrium level of income or not beyond where cash transaction of B type will be cheaper than the cash transaction of A type. i.e. the level of income where,

$$\boldsymbol{TC_B \leq TC_A}$$

$$\boldsymbol{\Rightarrow (\tau_R - e_R E)Y + \emptyset Y + Y.i - g.Y + b.f \leq (\tau_R - e_R E)Y + \emptyset Y + Y.i + b}$$

$$\textbf{Or, } \boldsymbol{Y \geq \frac{b(f-1)}{g} (= \widehat{Y_{AB}})} \qquad \textbf{.....(vi)}$$

i.e. income level greater than $\boldsymbol{\widehat{Y_{AB}}}$ cash transaction of B type will be much cheaper than the cash transaction of A type. (Given all other parameters). $\boldsymbol{\widehat{Y_{AB}}}$ is a decreasing function of interest gain from each unit of money each time (g). This indicates that with the increase in the rate of interest buyer will shift to cash transaction of B type with much lower level of income to avail the interest gain by keeping the income into the bank account over the period.

PROPOSITION 4: Beyond the income level $\widehat{Y_{AB}}$ *buyer will choose cash transaction of 'B' type instead of cash transaction of 'A' type.*

Comparison between Cash Transaction of 'A' Type and Debit Card Transaction with respect of Income Level

If level of education is zero then the value of $\widehat{Y_{AD}}$ will be negative (as the denominator of $\widehat{Y_{AD}}$ ratio will be negative as per the assumption 5 i.e, $\{\tau_R + b + \emptyset + g\} < \tau_D$)

$$\widehat{Y_{AD}}\Big|_{\substack{at\ zero \\ education}} = \frac{F_a - b}{(\tau_R - \tau_D) + \phi + g} < 0$$

So, for any income greater than a negative value of $\widehat{Y_{AD}}$ means for any positive value of Y (income) cash transaction of A type will be cheaper than debit card transaction cost. In other words, for any positive level of income if buyer has zero level of education will always pay in cash to make payments for his expenses.

Now we want to check the existence of any equilibrium level of income beyond where debit card transaction becomes cheaper than the cash transaction of A type considering level of education lesser than E_{D1} level. That is the level of income where;

$$TC_A \leq TC_D \quad \text{(Given education level lesser than } E_{D1})$$

$$\textbf{Or, } (\tau_R - e_R E)Y + \emptyset Y + Y.i + b \leq (\tau_D - e_{D1} E)Y + \{y.i - g.Y\} + F_a$$

(By putting the values of the cost functions)

$$or, Y \leq \frac{F_A - b}{(\tau_R - e_R E) - (\tau_D - e_{D1} E) + \phi + g} \left(= \widehat{Y_{AD}}\Big|_{at\ E < E_{D1}} < 0\right) \qquad \textbf{…….(4.vii)}$$

From the above equation we can interpret that given education level less than E_{D1}, as the shop floor cost of debit card transaction $(\tau_D - e_{D1} E)$ will be higher than the shop floor cost of cash

transaction ($\boldsymbol{\tau_R - e_R E}$). Then $\widehat{\boldsymbol{Y_{AD}}}$ will be negative, implying for any level of **Y** greater than a negative value of $\widehat{\boldsymbol{Y_{AD}}}$ debit card transaction will be much costlier for the buyer compare to the transaction cost of cash transaction of A type. So, for any positive income level buyer will then choose cash transaction only, to pay for his expenses.

Now we want to check the existence of any equilibrium level of income beyond which debit card transaction becomes cheaper than the cash transaction of A type for education level $\boldsymbol{E_{D2}}$>E> $\boldsymbol{E_{D1}}$. That is we want to determine the level of income for which

$$\boldsymbol{TC_D \leq TC_A} \quad \text{given } \boldsymbol{E_{D2}}\text{>E> } \boldsymbol{E_{D1}}$$

$$\textbf{Or, } \boldsymbol{(\tau_D - e_{D2} E)Y + \{Y.i - g.Y\} + F_a \leq (\tau_R - e_R E)Y + \emptyset Y + Y.i + b}$$

(By putting the values of the cost functions)

$$\boldsymbol{or, Y \geq \frac{F_a - b}{(\tau_R - e_R E) - (\tau_D - e_{D2} E) + \phi + g}} \left(= \widehat{\boldsymbol{Y_{AD}}}|_{at\ E_{D1} < E < E_{D2}}\right) \qquad \textbf{.....(4.viii)}$$

At a particular level of education more than $\boldsymbol{E_{D1}}$ but lesser than $\boldsymbol{E_{D2}}$ level the shop floor cost of debit card transaction ($\boldsymbol{\tau_D - e_{D2} E}$) will be less than the shop floor cost of cash transaction ($\boldsymbol{\tau_R - e_R E}$), on that point $\widehat{\boldsymbol{Y_{AD}}}|_{at\ E_{D1} < E < E_{D2}}$ will exist (considering all the assumptions and parameters fixed) beyond which transaction cost of debit card transaction will be much cheaper than the transaction cost of cash transaction of A-type.

So, we can conclude that conditional upon a particular level of education, people with higher level of income (beyond a threshold level) will choose debit card transaction.

Now, the **threshold level of education** is a decreasing function of '$\boldsymbol{g}$', inconvenient cost of carrying cash, difference between education coefficient, the difference between shop floor cost

at zero level of education (i.e. $(\boldsymbol{\tau_R - \tau_D})$) and banking cost of withdrawing money from bank. But increasing function of annual fees charged by bank for availing debit card.

PROPOSITION 5: There will exist a level of education beyond which a positive threshold level of income $\widehat{\boldsymbol{Y_{AD}}}$ *will exist above which buyer will choose debit card transaction instead of cash transaction of 'A'.*

PROPOSITION 6: When education is zero, buyer will always choose cash transaction of 'A' type over debit card transaction irrespective of any level of income.

Comparison between Cash Transaction of B type and Debit Card Transaction with Respect of level of Income:

To find out that whether there any threshold level of income exists or not from where individual buyer will prefer cashless transaction each time over the cash transaction of B type we have to consider followings;

$$\boldsymbol{TC_D \leq TC_B}$$

$$\boldsymbol{\Rightarrow (\tau_D - e_{D2}E)Y + \{Y.i - g.Y\} + F_a \leq (\tau_R - e_RE)Y + \emptyset Y + Y.i - g.Y + b.f}$$

$$\textit{or, } \boldsymbol{Y \geq \frac{F_A - b.f}{(\tau_R - e_RE) - (\tau_D - e_{D2}E) + \emptyset} (= \widehat{Y_{BD}})} \qquad \textbf{.....(4.x)}$$

From the above equation, we can interpret that income greater than $\widehat{\boldsymbol{Y_{BD}}}$ the transaction cost of debit card will be cheaper than the transaction cost of cash B type, conditioned that the buyer has a particular level of education or more than that. The explanation is same as the case of previous comparison. Any education level lower than a particular level where $(\boldsymbol{\tau_R - e_RE}) < (\boldsymbol{\tau_D - e_{D2}E})$ then the value of $\widehat{\boldsymbol{Y_{BD}}}$ will be negative and then for any positive income level buyer will choose cash transaction of 'B' type to pay for his expenses (as then $\widehat{\boldsymbol{Y_{BD}}} \leq \boldsymbol{0}$)

So, people with a lower level of income will choose cash transaction of B-type and the people with a higher level of income beyond a threshold will choose cashless transaction conditioning a certain level of education exist otherwise not.

Now at zero level of education the denominator of $\widehat{Y_{BD}}$ ratio will be negative as the denominator of $\widehat{Y_{BD}}$ function will be negative then (considering assumption 13). So, the threshold level $\widehat{Y_{BD}}$ will be negative, and as income can't be negative then for any positive level of income cash transaction (of 'B' type) will always cheaper than the transaction cost of debit card and buyer will then always choose cash transaction over cashless mode.

PROPOSITION 7: Beyond the income level $\widehat{Y_{BD}}$ *buyer will choose debit card transaction instead of cash transaction of 'B' type conditioning a particular level of education exists.*

PROPOSITION 8: When education is very low (near zero)buyer will always choose cash transaction of 'B' type over debit card transaction irrespective of any level of income.

4.2.2. Description of The Model with Direct Taxation:

Understating income to evade income taxes is a widespread phenomenon observed across various income levels and educational backgrounds. For certain types of service holders , understating the income is not possible as income is declared by the employer. The relation between understatement of income and education is complex .While some individuals disclose their actual income due to moral considerations, others with higher education and income may engage in understating income. It also depends on socio-political environment and ethical culture of the polity , factors which we are not brining into focus in our simple structure. In the present section, we will explore the payment mode preferences and understatement of income of individuals with different income levels, along with the other key factors influencing their choice. We keep the level of education fixed.

We start with a simplified scenario where the individual buyer understates all of his income or declares whole of it. Srinivasan (1972) has elucidated the factors influencing the optimal proportion of income to understate. Our objective is to determine how individual's payment mode choice between cash and cashless options is related to either declaring or understating full income.

Let's consider two types of individuals: one with zero understated income and the other concealing all income to evade taxes. Assuming both have the same level of education surpassing $E_{D2}$and an identical income, understating income provides the opportunity for higher consumption due to tax evasion. However, this increased consumption also results in higher transaction costs and probability of detection. To ascertain the benefits of understating income and the preferred payment mode, constructing net benefit functions for each payment mode (white - declared income, and black - understated income) is essential for drawing conclusions.

We assume that the buyer has a constant marginal utility from consumption, denoted as 1, for simplification. That implies, from Y amount of consumption buyer get Y utility.

It is also true that the gain from the consumption of 1 unit of money is assumed to be higher than the transaction cost associated with the transaction of 1 unit of money. Otherwise it is not worthwhile to consume anything for which transaction cost is more than the gain from the consumption.

The net benefit function is defined as the difference between consumption gain and transaction cost for transacting a specific amount using a particular payment mode.

Now, let's consider an individual who has reported all of his actual income to the government and paid a direct tax amount of tY. If he transacts all his expenses with cash, the net benefit function of cash transactions with white money is as follows:

$$\boldsymbol{\pi_{RW} = (Y - tY) - \{\overline{\tau_R}.Y_{net} + iY + \emptyset Y_{net}\}} \qquad \textbf{.....(4.xi)}$$

Where π_{RW} represents the net benefit function of cash transaction with white money (zero understated money income) where R represents cash transactions and W represents white income. $\boldsymbol{Y_{net}}$ is the disposable income after tax, calculated as $\boldsymbol{Y_{net} = (Y - tY)}$, here$\boldsymbol{(Y - tY)}$ is the total gain from consumption in this case and, the term $\{(\overline{\tau_R})Y_{net} + iY + \emptyset Y_{net}\}$ represents as transaction cost of transacting $\boldsymbol{Y_{net}}$ level of income with cash, as discussed earlier in this chapter.

Suppose an individual has 100% understated income (Black money) to avoid the TY amount of direct tax. If he transacts all his expenses in cash, the net benefit function of cash transactions with black money is given by:

$$\boldsymbol{\pi_{RB} = Y - \{\overline{\tau_R}.Y + iY + \emptyset Y + \gamma_R(P.Y)\}} \qquad \textbf{.....(4.xii)}$$

According to equation 4.**xii** the consumer can consume all of his **Y** level of income resulting in a higher gain from consumption compared to the individual who paid **tY** as tax. However, there is a chance of getting caught, which adds to the total transaction cost. $\boldsymbol{\gamma_R}$ is the probability of getting caught by the income tax department when all black money is kept in cash, and $\boldsymbol{P.Y}$ is the penalty charged after getting caught, for not reporting **Y** level of income to the government to avoid the income tax, here $\boldsymbol{\gamma_R(P.Y)}$ is the additional transaction cost along with the previously discussed transaction costs.

Here $\boldsymbol{P}$ is greater than $\boldsymbol{t}$, i.e. the penalty charge rate is always more than the income tax rate.

Now, let's consider the case where the buyer has reported all of his actual income to the government and paid tY amount of direct tax. If he keeps and transacts all of his expenses through bank accounts using debit cards, the net benefit function of debit card transactions with white money is as follows:

$$\boldsymbol{\pi_{DW} = (Y - tY) - \{\overline{\tau_D}.Y_{net} + iY - g.Y_{net} + F_a\}} \qquad \textbf{.....(4.xiii)}$$

In equation **xiii,** $\boldsymbol{(Y - tY)}$ is the gain from consumption in this case

and, $\boldsymbol{\{\overline{\tau_D}.Y_{net} + iY - g.Y_{net} + F_a\}}$ is the transaction cost of transacting $\boldsymbol{Y_{net}}$ level of income with debit card, as mentioned earlier in this chapter.

4.2.2.1. Comparison of Net Benefit Functions of Cash Transactions with either Only White or Only Black Money:

If the buyer chooses to exclusively transact with cash, it is essential to examine whether there exists a threshold level of income tax rate beyond which maintaining either black money or white money becomes more advantageous. The comparison between the net benefit functions of cash transactions with black money and white money is crucial in this context. The following presents this comparison:

$$\boldsymbol{(\pi_{RB} > \pi_{RW})}$$

$$\boldsymbol{Y\{1 - \overline{\tau_R} - i - \emptyset - \gamma_R(P)\} > (Y - t.Y) - \{\overline{\tau_R}.Y_{net} + iY + \emptyset Y_{net}\}}$$

$$\boldsymbol{Y\{1 - \overline{\tau_R} - i - \emptyset - \gamma_R(P)\} > Y(1 - T) - \overline{\tau_R}.Y(1 - t) - iY - \emptyset Y(1 - t)}$$

$$\boldsymbol{\{1 - \overline{\tau_R} - i - \emptyset - \gamma_R(P)\} > (1 - t) - \overline{\tau_R}.(1 - t) - i - \emptyset(1 - t)}$$

$$\boldsymbol{-\gamma_R(P) > -t + \overline{\tau_R}.t + \emptyset.t}$$

$$t\{1 - \overline{\tau_R} - \emptyset\} > \gamma_R(P)$$

$$t > \frac{\gamma_R(P)}{\{1-\overline{\tau_R}-\emptyset\}} = \overline{t_R} \quad \text{..... (4.xiv)}$$

From this comparison, we can deduce that if an individual has chosen to conduct transactions exclusively using cash, then any tax rate exceeding $\overline{t_R}$ makes it more advantageous for the individual to maintain all income in the form of black money. A tax rate surpassing $\overline{t_R}$ ensures that the ultimate benefit from cash transactions with black money exceeds the benefit from cash transactions with white money, regardless of the income level. This threshold tax rate is an increasing function of the probability of detection γ_R and the penalty rate P.

4.2.2.2. Comparison of Net Benefit Functions for Debit Card Transactions with White Money and Cash Transactions with Black Money:

The following presents a comparison between the net benefit functions of debit card transactions with white money and the net benefit functions of cash transactions with black money. Through this analysis, we aim to determine whether there is a threshold level of income beyond which either debit card transactions with white money or cash transactions with black money become more advantageous.

$$\pi_{RB} > \pi_{DW}$$

$$Y\{1 - \overline{\tau_R} - i - \emptyset - \gamma_R(P)\} > (Y - tY) - \{\overline{\tau_D}.\ (Y - TY) + iY - (Y - tY).g + F_A\}$$

$$tY - \overline{\tau_D}.tY + Yt.g > \ -\overline{\tau_D}.Y + Y.g + \overline{\tau_R}.Y + \emptyset Y + \gamma_R(PY) - F_A$$

$$t\{Y - \overline{\tau_D}.Y + Y.g\} > -\overline{\tau_D}.Y + Y.g + \overline{\tau_R}.Y + \emptyset Y + \gamma_R(PY) - F_A$$

$$t > \frac{(\overline{\tau_R}-\overline{\tau_D})+g+\emptyset+\gamma_R(P)}{1-\overline{\tau_D}+g} - \frac{F_A}{Y(1-\overline{\tau_D}+g)} => \overline{t_D} \qquad \text{.....(4.xv)}$$

From the above equation, it can be seen that if the tax rate is higher than $\overline{\mathbf{t_D}}$, the net benefit by keeping only black money and do the cash transaction will be higher than keeping only white money and do the debit card transaction. Now $\overline{\mathbf{t_D}}$will be positive only when

$$(\overline{\tau_R} - \overline{\tau_D})Y + Y.g + \emptyset Y + \gamma_R(P)Y > F_A$$

i.e. when $Y > \frac{F_A}{(\overline{\tau_R} - \overline{\tau_D}) + g + \emptyset + \gamma_R(P)} = \overline{Y_D}$ ……. ***(4.xvi)***

The aforementioned calculation confirms that, with a combination of a significantly higher income beyond the level $\overline{Y_D}$ and a higher tax rate surpassing $\overline{t_D}$, the buyer becomes more inclined to retain all of his income in the form of black money (100% understated income) and engage in cash transactions. As the probability of detection γ_R and penalty charges P increase, the threshold level $\overline{t_D}$ beyond which the buyer opts for keeping only black money and conducting cash transactions will also increase. Here, $\overline{\tau_R}$ and $\overline{\tau_D}$ represent the efficient level of time shop floor cost of debit card transactions and cash transactions, respectively, after achieving a sufficient level of education. If income is less than $\overline{Y_D}$, then for any tax rate buyer will keep only black money, the reason is that as the probability of detection is an increasing function of the income, so when buyer has low level of income then the annual cost of keeping debit card transaction will be much higher than the cost of getting caught, so he will prefer to keep black money and will do the cash transaction. If and only if the buyer has income more than $\overline{Y_D}$ and the tax rate in less than $\overline{t_D}$, then only buyer will prefer to keep only white money and will do the debit card transaction.

4.2.2.3. Optimal Distribution between White Money & Black Money

In the present section we consider Now, if the individual decides to declare only a portion of his actual income, let's say the individual wants to declare θ proportion of his total income,

implying that $\boldsymbol{\theta Y}$ is his total amount of white money, and $\boldsymbol{(1-\theta)Y}$ is his total understated black money. Additionally, he chooses to transact black money with only cash and white money using a debit card. The following represents the net benefit function for this individual with both black and white money:

$$\pi = \boldsymbol{\theta}[(\boldsymbol{Y} - \boldsymbol{t}.\boldsymbol{Y}) - \overline{\boldsymbol{\tau_D}}(\boldsymbol{Y} - \boldsymbol{t}.\boldsymbol{Y}) - \boldsymbol{iY} + \boldsymbol{g}.\boldsymbol{Y}] - \boldsymbol{F_a} + (\boldsymbol{1} - \boldsymbol{\theta})[\boldsymbol{Y} - \overline{\boldsymbol{\tau_R}}\boldsymbol{Y} - \boldsymbol{iY} - \emptyset\boldsymbol{Y} - \boldsymbol{\gamma_R}\boldsymbol{PY}]$$

…….(4.xvii)

The first bracketed portion of equation (4.**xvi)** represents the net benefit function of debit card transactions with θ proportion of white money. The second bracketed portion of 4.**xvi** is the net benefit function of cash transactions with a proportion $(1-\theta)$ of black money.

In this case, penalty charges are assumed to be a decreasing function of the proportion of declared income θ, i.e. $\mathrm{P} = \bar{P} - \bar{P}\theta$, $P'(\theta) < 0$, where $\bar{P}$ is a constant. This implies that penalty charges will increase with the increase in the proportion of understated income and penalty charges will decrease with the increase in the proportion of declared income.

Now we would examine whether an optimal level of θ exists where the net benefit from the transaction will be maximised. The derivation of the optimum level of θ where the π will be maximum is described below .

Now the first order derivation of profit function gives us:

$$\frac{\boldsymbol{d\pi}}{\boldsymbol{d\theta}} = (\boldsymbol{Y} - \boldsymbol{Yt}) - \overline{\boldsymbol{\tau_D}}.(\boldsymbol{Y} - \boldsymbol{tY}) - \boldsymbol{i}.\boldsymbol{Y} + \boldsymbol{g}.(\boldsymbol{Y} - \boldsymbol{tY}) + \boldsymbol{\gamma_R}.\overline{\boldsymbol{P}}.\boldsymbol{Y} - \boldsymbol{Y} + \overline{\boldsymbol{\tau_R}}.\boldsymbol{Y} + \boldsymbol{i}.\boldsymbol{Y}$$

$$\emptyset.\boldsymbol{Y} + \boldsymbol{\gamma_R}.\overline{\boldsymbol{P}}.\boldsymbol{Y} - \boldsymbol{2\gamma_R}.\overline{\boldsymbol{P}}.\boldsymbol{\theta}.$$

$$\boldsymbol{or,}\frac{\boldsymbol{d\pi}}{\boldsymbol{d\theta}} = -\boldsymbol{tY} - \overline{\boldsymbol{\tau_D}}.(\boldsymbol{Y} - \boldsymbol{tY}) + \boldsymbol{g}.(\boldsymbol{Y} - \boldsymbol{tY}) + \overline{\boldsymbol{\tau_R}}.\boldsymbol{Y} + \emptyset.\boldsymbol{Y} + \boldsymbol{2\gamma_R}.\overline{\boldsymbol{P}}.\boldsymbol{Y} - \boldsymbol{2\gamma_R}.\overline{\boldsymbol{P}}.\boldsymbol{\theta}.\boldsymbol{Y}$$

Setting $\frac{d\pi}{d\theta}$ equal to zero will give us value of θ, that will maximise the net benefit from transaction i.e.

$$\widehat{\boldsymbol{\theta}} = \frac{(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+2\gamma_R.\overline{P}+\emptyset-t}{2\gamma_R.\overline{P}}$$

$$\widehat{\boldsymbol{\theta}} = 1 + \frac{(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+\emptyset-t}{2\gamma_R.\overline{P}} \quad \textbf{……(4.xviii)}$$

Thus, $\widehat{\boldsymbol{\theta}}$ represents the optimum proportion of declared income that maximizes the net benefit from the transaction. Second Order Condition for maximisation is satisfied

As $\widehat{\boldsymbol{\theta}}$ can't be more than 1 so**,** from equation 4.xviii, $\frac{(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+\emptyset-t}{2\gamma_R.\overline{P}}$ must be negative and with the increase in the γ_R **or** $\overline{P}$ the proportion of white money will increase.

$\frac{(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+\emptyset-t}{2\gamma_R.\overline{P}}$ will be negative when:

$$(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+\emptyset-t<0$$

$$\mathbf{t<}\frac{(\overline{\tau_R}-\overline{\tau_D})+\emptyset+g}{(1-\overline{\tau_D}+g)}=\hat{t}\mathbf{>0} \quad [33]\textbf{……(4.xix)}$$

Now if tax rate is less than $\hat{\boldsymbol{t}}$ then buyer will keep $\widehat{\boldsymbol{\theta}}$ proportion of his income in white money form and will do cashless transaction with that white money.

Now $\hat{\theta}$ will be 1, i.e. buyer will keep only white money and will not understate his actual income and will do only debit card transaction from equation **4.xix** we can write that when

$$(\overline{\tau_R}-\overline{\tau_D})+\overline{\tau_D}t+g.(1-t)+\emptyset-t=0$$

[33] $\hat{t}$ is positive as $1>\overline{\tau_D}+i-g+F_a$, mean gain from the consumption of 1 unit of money (is 1) must be greater the transaction cost of 1 unit of money using debit card so $1+g>\overline{\tau_D}$ so $\hat{t}$ will be positive

$$or, t = \frac{(\overline{\tau_R} - \overline{\tau_D}) + \emptyset + g}{\{1 - \overline{\tau_D} + g\}} = \tilde{t} < \hat{t} \qquad \text{.....(4.xx)}$$

So, any tax rate lesser or equal to $\tilde{t}$, $\hat{\theta}$ will be 1, i.e. buyer will only do cashless transaction and will keep 100% of his income in the white money form.

Following table 4.1 and figure 4.3 summarizes the relationship between tax rate and proportion of income understated discussed above.

When $\tilde{t} < t < \hat{t}$	$0 < \theta < 1$	combination of both cash transaction with black money and cashless transaction with white money.
When $t < \tilde{t}$	$\theta = 1$	Only white money and cashless transaction.
When $t > \hat{t}$	$\theta = 0$	Only black money and cash transaction.

Table 4.1: Relationship between Tax rate and Proportion of income Understated.

Source: Own.

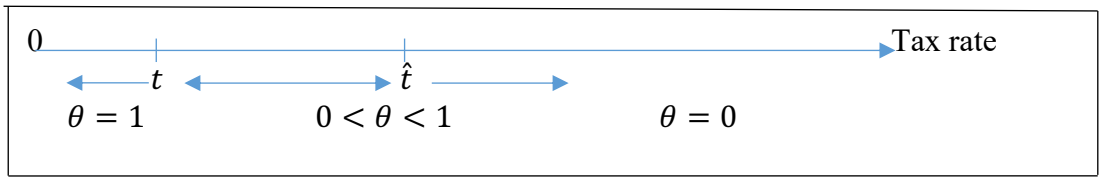


Figure 4.3: Graphical Representation of The Relationship between Tax Rate and Proportion of declared Income

Source: Own.

4.3. Conclusion:

This research examines the complex system of income, education, and taxation to identify how the different factors influence the choice between cash and the cashless transactions. The findings underline the joint role of education and income in shaping the payment mode preferences, with a notable emphasis on joint influence of education with level of income surpassing critical thresholds as a catalyst for adopting cashless modes.

A comparative theoretical study between the two types of cash transaction and one type of cashless transaction establishes a few results. The level of education has positive influence on the selection of payment mode. If the buyer has higher level of education beyond a threshold level then he will choose cashless transaction over cash transaction to make payment for his expenses each time, as beyond a particular level of education transaction cost of debit card will be much lesser than the transaction cost of cash transaction at a given level of income.

The level of income has also a strong influence on the selection of payment mode. If the income level of the buyer is higher than a particular level, then the transaction cost of a debit card transaction will be lower than the transaction cost of a cash transaction, this will be true only when the buyer has a certain level of education otherwise, the proposition will not true. That is, the buyer is likely to choose the cashless mode of payment to meet his expenses when the buyer has a higher level of income beyond a particular level. However this is conditional upon the fact that the buyer already holds a certain level of education.

If the buyer has zero education or less than a particular level then irrespective of the level of income the buyer will always choose cash transaction to pay for his expenses.

The transaction domains of the different payment mode are as follows;

In the absence of income tax, the analysis establishes a critical threshold of education level, beyond which buyers prefer cashless transactions, conditional on the fact that the buyer already has achieved a threshold level of income or beyond. Also a critical threshold level of income exists beyond which buyer will prefer cashless transaction but again conditional on the fact that the buyer already has a threshold level of education or beyond. This underlines the joint influence of education and income behind selection of a particular payment mode. To promote

cashless transactions, the government should prioritize efforts to elevate both education levels along with the income level.

However, when income tax is introduced, the analysis unveils critical insights into the payment mode choices between cash and cashless transactions, taking into account the complex interplay of tax evasion, income understatement, and transaction costs. Key findings include:

The study identifies the combination of a threshold level of income and a threshold tax rates that determine the advantageous choice between maintaining all of their income either in white money form or in black money form. Beyond these thresholds, individuals adopt specific payment modes so that their net benefit from transaction could be optimised.

Tax rates play an important role in shaping individual preferences for payment modes. Combination of a tax rate and income exceeding a certain threshold prompts a shift towards maintaining all of his income in black money form for cash transactions. On the other side, combination of higher level of income and lower tax rates, favour cashless transactions with white money.

The research identifies an optimal proportion of income understatement that maximizes the net benefit from transactions. This optimal proportion is influenced by factors such as income level, tax rates, probability of detection, and penalty charges.

Policymakers should consider setting tax rates strategically to align with the thresholds identified in the study. Striking a balance that discourages tax evasion while promoting cashless transactions could enhance overall economic efficiency. Strengthening measures for detecting income understatement and tax evasion, such as improving monitoring systems and employing advanced technologies, can deter individuals from keeping substantial black money. Policymakers may evaluate penalty rates to ensure that they are sufficiently deterrent yet not

overly punitive. A judicious balance can discourage tax evasion while providing individuals with incentives to adopt cashless transactions.

Given the significant impact of education on transaction costs, policymakers may consider educational initiatives to improve financial literacy and promote the benefits of cashless transactions, contributing to a more informed and efficient payment landscape.

In conclusion, this research offers comprehensive insights into the intricate interplay of tax policies, income and education dynamics, and payment preferences. The nuanced understanding derived from this study provides actionable guidance for policymakers aiming to optimize economic outcomes and foster a transition towards a more efficient, cashless economy.

CHAPTER **5**

DETERMINANT OF CASHLESS TRANSACTION:

AN EMPIRICAL ANALYSIS

5.1. Introduction:

Cashless transaction has grown in importance across the world. The global shift towards digital payments have accelerated in recent years, driven by advances in technology, changing consumer preferences, and the need for more efficient and secure transaction methods. The Cashless transactions has the potential to improve economic efficiency, promote financial inclusion, and foster transparency in financial systems. In the 4th chapter of the thesis, we developed a theoretical framework to explore the relation between payment mode selection (between cash and cashless transactions) and the income and education levels of buyers. The theoretical analysis establish that the level of income and level of education jointly influence the preference for cashless transactions. Higher income levels beyond certain threshold lead to an increased likelihood of choosing cashless payment. However, individuals with very high income but very low education tend consistently to choose cash transactions, indicating that education and income jointly determine cashless payment modes. Higher education levels beyond a certain threshold lead to an increased likelihood of choosing cashless payment.,

Present chapter aims to empirically test the influence of education, and income on the usage of cashless transactions along other with other socioeconomic conditions. We utilize available secondary data to examine the relationship. The underlying economic interpretation is that transaction costs associated with debit or credit card usage, as well as cash transactions, vary across individuals with different socioeconomic backgrounds. For example, individuals with lower income face higher transaction costs when using debit or credit card transactions, it may also differ based on individuals' levels of education and financial literacy. Furthermore, prior studies suggest that the credit cards are perceived to be symbols of luxury or higher status, and that perception influences individuals from diverse household status to exhibit different preferences for cashless transaction (Gen et al., 2008). Age also potentially influences

transaction mode selection, with younger individuals being more inclined to adopt modern technologies compared to the elderly (Khare, Khare & Singh, 2012). Therefore, it is crucial to empirically determine the exact relationship between socioeconomic background and the probability of adopting cashless transactions within an economy. As the data regarding use of cashless transaction at the household level is unavailable, the ownership of the credit card is used as a proxy for cashless transaction usage, with sufficient justification provided for this approach. Furthermore, the available data[34] allows for an examination of how socioeconomic conditions influence changes in cashless transaction patterns over time, as it covers the same households at two different time points. Understanding the factors that influence the adoption of cashless payment modes, particularly in the context of socioeconomic conditions, is crucial for the policymakers and stakeholders seeking to drive the transaction toward a cashless economy. By identifying the socioeconomic variables that shape individuals' preferences for cashless transactions, policymakers can develop the targeted interventions, educational programs, and incentives to encourage wider adoption and use of digital payment method.

Against the backdrop, the objectives of this chapter are twofold. First, we aim to empirically examine the relationship between socioeconomic factors, specifically education and income, and the probability of adopting cashless payment modes. By analysing the available secondary data, we seek to provide empirical evidence of the influence of education and income levels on individuals' preferences for cashless transactions. Secondly, we investigate how this factors evolve overtime by utilising longitudinal data that captures the same households at two different time points. This allows us to explore changes in cashless transaction patterns and understand how socio economic conditions may influence the buyer to use cashless mode of payment. Despite the valuable contributions of the existing studies discussed in chapter 2,

[34] Source: India Human Development Survey database.

prevailing empirical research on the relationship between education, age, earnings, and digital transactions in India are often limited to particular regions or states. Moreover, capturing the combined effect of education and earnings is absent in the literature. Our research seeks to address this space by examining the joint effect of level of education and income, along with other socio-economic situations, on the electronic transaction usage, utilizing available secondary data.

By addressing these objectives, this chapter aims to contribute to the existing literature by filling up the gap in our understanding of the relationship between the socio economic background and the adoption of cashless payment modes. Overall, the present research endeavours to shed light on the complex dynamics between education, income, and cashless payment adoption, paving the way for evidence-based policymaking and initiatives that foster financial inclusion and economic development.

The chapter is organised as follows: Section 2 discusses the existing literature gap, Section 3 describes the data and methodology employed, section 4 presents the empirical implications of the methodology, and finally, section 5 provides the conclusion.

5.2. Data &Methodology:

This section will provide the details about the data sources and construction and also discuss the detailed methodology used for this research.

5.2.1. Description of data

In order to validate the theoretical results of chapter four we needed to empirically study the effect of income and education on use of cashless transaction at the household level. To study the effect of income, education and other socioeconomic variables on use of cashless

transaction we needed household level data on use of cashless transaction along with other variables for India economy. Unfortunately, after a thorough search, we could not find a household level data source, which included data on usage of cashless transaction along with all other socio economic background of the households. So we utilized data at the household level from the India Human Development Survey datasets[35]. Although this database did not directly provide information on the usage of cashless transactions, it contained several variables that can act as proxies for cashless transaction usage. Given the lack of specific household level data on cashless transaction usage and an absence of alternative secondary sources, our investigation focused on studying credit card ownership as a proxy for overall cashless transaction usage.

To investigate the impacts of socioeconomic conditions on the probability of owning a credit card, we used a sample of 25,000 observations from the India Human Development Survey for the year 2004-05 and for the year 2011-12 simultaneously. Credit card ownership was considered a proxy for non-cash transactions, supported by empirical analysis demonstrating a significantly positive relationship between the number of credit cards issued and the usage cashless transactions. Analysis involving regressions was carried out by regressing the number of outstanding credit cards, derived from monthly data across different banks in the Indian economy, on the value and volume index of cashless transactions constructed in the 3rd chapter of this thesis. Detailed results of this regression analysis can be found in Section 4 of this chapter.

Seven categories of socio-economic variables were chosen as explanatory variables. Out of the following explanatory variables, "Financial Inclusion status", "Digital literacy and Access" and

[35] 1st and 2nd round survey for the year 2004-05 and 2011-12

"Household Status" variables are constructed by us, combining several variables using PCA method. The explanatory variables are:

a. Financial Inclusion Status

b. Income

c. Digital literacy and access

d. Household Status

e. Education

f. Age

g. Economic Class

The summary of the independent variables is provided in Table 5. 1

Independent Socio-Economic Variables	Details Of The Dimensions
Income	i. Monthly income of the household
Household Status	i. No. of Assets ii. No. of rooms iii. Wall type iv. Floor type
Economic Class (Poor/ Middle/ Comfort)	Based on the individual perception
Age	Log Age of the male head of the family
Education	Highest adult education of the household
Digital Literacy and access	i. Computer Knowledge (yes or no) ii. Own computer or not iii. Own mobile phone or not iv. Internet/ Cable charges
Financial Inclusion Status	i. Have Saving bank account or not ii. Debt from bank or not iii. Own FD or not iv. No. of insurance

Table 5.1: Details of the Independent Variables

The detailed discussions about the selected independent variables are as follows:

a. Log Income - Income plays a crucial role in determining the selection of cashless payment methods. For seeking empirical support for our theoretical analysis provided in chapter 4 of this thesis, it is important to incorporate Income in our empirical analysis. Also Income is a key factor in defining the financial status of a household, aligning with Friedman (1957)[36], which posits that repetitive permanent income determines the household's consumption expenditure. Therefore, including the income variable is essential in this analysis. The purpose of taking log is to reduce the variability in the wide income range.

b. Household Status Index - Household status is included as a variable because credit cards are often associated with luxury or a higher status in the literature (Gan et al., 2008). Bernthal et al. (2005) suggest that credit cards have the potential to propel customers towards a particular lifestyle. Household status is a multi-dimensional concept, consisting of multiple aspects. Hence, a multi-dimensional index for household status is constructed, incorporating:

Number of rooms in the house: Reflecting the size and quality of the household's living space.

Floor type (kachha/ Pakka): The type of flooring as a symbol of higher status.

Wall type (kachha/ Pakka): Similar to floor type, a symbol of household status.

Total number of assets: Used as a proxy for wealth due to the unavailability of data on the value of total assets.

[36] Friedman, M. (1957). The permanent income hypothesis. In *A theory of the consumption function* (pp. 20-37). Princeton University Press.

c. Digital Literacy and Access - Completing cashless transactions and online payments requires a higher level of digital literacy compared to cash transactions. Individuals need to keep track of credit card bills and repay them on time. Therefore, digital literacy and access are prerequisites for cashless transactions. The dimensions considered for this variable are:

Computer knowledge: Indicates the individual's ability to operate computers and smartphones for cashless transactions (data available only for 2011-12).

Ownership of a computer or laptop: Access to a computer is important for cashless transactions.

Ownership of a mobile phone: Mobile phones can serve as substitutes for computers, so ownership is relevant.

Internet/Cable charges: Higher monthly charges indicate more intense internet usage, implying higher digital literacy and access.

d. Education - In Chapter 4, theoretical analysis suggests that level of education influences the selection of payment modes between cash and cashless transactions. To support that theoretical analysis, it is important to include education variable in this empirical analysis. Here the highest level of adult education in the household is considered, it is denoted as the no. of years of schooling/Education, ranging from 1 to 16 (where 16 denotes education level above graduation)

e. Log Age - Sharma (2011) stated that "In order to make e-Banking more popular, banks must separate their customers based on demographic priority and customize e-Banking services as per their needs and requirements". Younger individuals are more likely to adopt modern technologies, including cashless transactions, compared to the elderly, regardless of income

and education levels. Here in our study, the log of the age of the male head of the household is considered to reduce the variability of the data.

f. Economic Class - This data is based on the household's perception of their social class, three categories were considered in the survey: poor, middle, and comfortable. It is important to examine whether the individuals who consider themselves to belong to comfortable class are availing credit cards and doing cashless transactions more than the other two classes, as there is a societal notion that credit cards symbolize luxury.

g. Interaction Between Education and Income – In the analysis we include an interaction term between income and education. This term captures the combined effect of education and income on the likelihood of owning a credit card. According to the theoretical model in chapter 4, the effect of income on the usage of cashless transactions depends on the education level of the household, and vice versa. To test this empirically, it is important to incorporate this interaction term in this analysis.

By combining the dimensions according to the principal component analysis we got the each socio economic indexes.

5.2.2. Detailed Methodology

In the present study, we employed two types of regression analysis. First, two separate panel logistic regression model are estimated to examine the effects of education and income separately, on the usage of cashless transactions including all data, the points covering the two time periods. Two separate models were estimated to address the problem of multicolinearity between years of education and income level, discussed below. These two models capture the

effects of time and other independent socioeconomic variables (except "Economic class belongs" as this data is not available for the year 2004-05) believed to influence individuals' use of cashless transactions, peroxide by credit card ownership.

Additionally, four separate logistic regressions were conducted – two for 2004-05 and another two for 2011-12 – to examine the effects of education and income on the usage of cashless transactions. In Table A5.1 (Appendix), a strong association between education level and household income (correlation coefficient: 0.728) was observed. Furthermore, Table A5.2 highlighted very high Variance Inflation Factor (VIF) values for income and education variables, suggesting potential multicollinearity. To address this, two separate logistic regressions were performed for each time point. In both the equations seven independent variables were included as stated below. The economic logic behind the inclusion of each variable has already been discussed in section 3.1.

In one regression, the focus was on the effect of income on the probability of owning a credit card in 2004-05 and separately for 2011-12. The regression equation is as follows:

$$\boldsymbol{Log(odds\ of\ owning\ credit\ card)_i = \beta_0 + \beta_1(Log\ Income)_i + \beta_2(log\ age)_i + \beta_3(computer\ knowledge\ and\ access)_i + \beta_4(financial\ inclusion\ status)_i + \beta_5(household\ status)_i + \beta_6(education\ x\ log\ income)_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(5.i)}$$

The coefficients are the estimated effects of the corresponding independent variables on the log odds of owning a credit card. Exponentiation of these coefficients yields odds ratios, indicating the multiplicative effect on the odds of owning a credit card. The significance of the interaction term between education and income lies in capturing their joint effect on the log of odds of owning a credit card. In other words, the effect of changes in income on the odds of

owning a credit card depends on the highest adult education level within a household. This implies that the effect of income level on the log of odds of owning a credit card varies based on the level of education, a result we have already established theoretically in the 4th chapter. If we compare households with similar income levels, those with a higher level of education are more likely to own a credit card as compared to households with lower levels of education l. Thus the overall effect of change in the income level on the log of odds of probability of owning credit card is equal to the $(\boldsymbol{\beta_1 + \beta_2 * Education_i})$ (from equation 5.i) and the effect of income with zero level of education has been captured solely by $\boldsymbol{\beta_1}$.

In the second regression, the effect of education on the probability of owning a credit card was analysed, including an interaction term between education and income. The regression equation is:

$$\boldsymbol{Log(odds\ of\ owning\ credit\ card)_i = \beta_0 + \beta_1(education)_i + \beta_2(age)_i +}$$
$$\boldsymbol{\beta_3(computer\ knowledge\ and\ access)_i +}$$
$$\boldsymbol{\beta_4(financial\ inclusion\ parameter)_i + \beta_5(household\ status)_i +}$$
$$\boldsymbol{\beta_6(education\ x\ log\ income)_i} \quad \textbf{..... (5.ii)}$$

As per the theoretical analysis from chapter 4, the effect of level of education behind the selection of cashless payment mode is depend on the existing level of Income the household holds, to give empirical support, here also we incorporate interaction term between education and log income of the households'. The overall effect of education on the log odds of owning a credit card is equal to $(\beta_1 + \beta_2 * logIncome)$ as per equation 5.ii. These separate analyses allowed us to examine the independent effects of education and income while exploring their interaction effect and the effect of all other socio economic background.

The model was estimated using the STATA package, and the validity of the model was tested using the Hosmer Lemeshow test of goodness of fit.

5.2.3. Logistic Regression:

While analysing regression in social science, the numbers of categories of qualitative dependent variables, are two. Logistic regression is a method widely used statistically suited for binary classification tasks. This is used when the dependent variable is categorical in nature, typically taking the form of two classes, such as "yes" or "no," "success" or "failure," or "1" or "0."

Consider a problem of classification binary, where the variable dependent is denoted as Y and values are taking on either 0 or 1. We have a set of independent variables (predictors) denoted as $X = (X_x, X_2, ..., X_p)$, where p represents the number of predictors.

The logistic regression model uses the logistic function, is defined as follows:

Logistic Function = 1 / (1 + e^(-z))

where z is the linear combination of predictors and coefficients:

$z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_x X_p$

Here, $\beta_0, \beta_1, \beta_2, ..., \beta_p$ are the coefficients or parameters to have be estimated.

The log-odds ratio is estimated by the logistic regression model, which the natural logarithm of the odds of the event is occurring. The odds ratio is defined as the probability of the event occurring divided by the probability of the event not occurring. Mathematically, it can be represented as:

odds = $P(Y = 1) / P(Y = 0)$

log-odds = log(odds) = $\log[P(Y = 1) / P(Y = 0)]$

The logistic regression model assumes that the log-odds ratio is a linear function of the predictors. Mathematically, this can be written as:

log-odds = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_p X_p$

or equivalently,

$\log[P(Y = 1) / P(Y = 0)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_p X_p$

The coefficients (β_0, β_1, β_2, ..., β_p) of the logistic regression model are estimated using estimation of maximum likelihood (MLE). The aim is to find the value of the coefficients that maximizes the likelihood of observing the given outcomes. In other words, we look for coefficients that make the data observed most probable.

Once the model is estimated, the coefficients can be interpreted as the log-odds ratio or the change in the log-odds of the event occurring for a change of one unit in the corresponding predictor holding other predictors constant. By exponentiation of the coefficients, we can get the odds ratio, which represents the multiplicative change in the odds of the event occurring.

For evaluating the performance of the logistic regression model, various measures can be used, including accuracy, precision, recall, F1 score, and area under the receiver operating characteristic curve (AUC-ROC). These measures assess the predictive power and reliability of the model.

5.3. Results:

In the present section we report the regression results. We start with providing an empirical justification behind using ownership of credit card as a proxy for usage of cashless transaction in section 4.1. Section 4.2 reports the results of logistic regression.

5.3.1. Justification Behind Credit Card Ownership as a Proxy for the Usage of Cashless Transaction:

As has already been mentioned, non-availability of household level data on usage of cashless transaction was a major hurdle in our attempt to validate the theoretical results we developed in chapter 4. However, data on credit card ownership was available from India Human Development Survey datasets, we consider both 1st and 2nd round of the survey for the year 2004-05 and 2011-12. So we used this variable as a proxy for usage of cashless transaction. The present section provides empirical support to the use of this proxy.

Credit card ownership can be a useful proxy for the use of cashless transactions for several reasons: First Credit cards are a form of electronic payment, and their ownership indicates that individuals have access to a payment instrument that does not rely on physical cash. When people own credit cards, they have the means to make other types of electronic transactions as well. Secondly, Reserve Bank of India provides extensive data on credit card use as well as the usage of other types of cashless transactions. If we can establish a statistically significant positive relationship between the credit card ownership and the value and volume index of the cashless transaction (constructed in the 3rd chapter of this thesis) overtime, this could be used as sufficient justification for using credit card ownership as a proper proxy of the usage of cashless transactions. For our analysis, we conducted a correlation coefficient test between the No. of Credit Cards Outstanding and usage of different types of cashless transactions (Monthly

data from 2012-2021 provided by RBI) Table 5.2 shows a strong correlation between the no. of credit cards outstanding and usage of different types of cashless transactions (except with the value of RTGS).

	No of outstanding Credit cards
No of outstanding Credit cards	**1**
POS amount	**0.931639049**
NEFT NO.	**0.95818575**
NEFT amount	**0.929964545**
RTGS volume	**0.888565739**
RTGS Value	**0.163257681**
Mobile Banking Volume	**0.853829856**
Mobile Banking Value	**0.902603686**
ECS+NACH Volume	**0.748324897**
ECS+NACH Value	**0.969851559**
IMPS Volume	**0.969109083**
IMPS Value	**0.978358218**

Table 5.2: Correlation between Different Types of Cashless Transactions and No. of Credit Card Outstanding
Source: Own.

For the justification of proxy we also regressed the number of credit cards outstanding, obtained from monthly data across various banks, on the value and volume index of cashless transactions developed in chapter 3.

In chapter 3, we constructed three different indices, which aggregated the overall value and volume of the cashless transaction of the Indian economy over the period of time (from November 2012 to December 2018), those indices are Per Capita Number of Cashless Transaction Index, Per Capita Value of the Cashless Transaction Index and Value of Cashless Transaction as a Proportion of GDP Index.

We have regressed number of credit card outstanding on all the three indexes separately to avoid the multicollinearity problem.

In the first case we regressed the number of credit card outstanding on the per capita volume index, the regression equation is;

$$(CC)_t = \alpha + \beta(PCVo)_t + \epsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(5.iii)}$$

Where $(CC)_t$ is the credit card outstanding over the months including all the banks in India and $(PCVo)_t$ denotes per capita volume index of cashless transaction of Indian economy over the months (all data points are from September 2012 to December 2023).

Dependent Variable: No of Credit Card Outstanding
Method: Least Squares
Sample (adjusted): 1 134
Included observations: 134 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PER_CAPITA_VOLUMEINDEX	1.056965	0.032475	32.54707	0.0000
C	0.173896	0.016423	10.58829	0.0000

R-squared	0.889198	Mean dependent var	0.619638
Adjusted R-squared	0.888358	S.D. dependent var	0.314045
S.E. of regression	0.104931	Akaike info criterion	-1.656206

Table 5.3: Summary Output Table No. of credit card outstanding regressed on Per Capita No. of Cashless Transaction Index

Table 5.3 describes the summary output of the regression equation (5.iii), it reveals that there is a statistically significant (1% level of significance) positive relationship between the number of credit card outstanding and the per capita volume index.

Also, we regress no. of credit card outstanding on the per capita value index and also separately on the value GDP index. The regression equations are;

$$(CC)_t = \alpha + \beta(PCVa)_t + \epsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(5.iv) And}$$

$$(CC)_t = \alpha + \beta(VGDP)_t + \epsilon_t \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(5.v)}$$

Where $(CC)_t$ is the credit card outstanding over the months including all the banks in India and $(PCV)_t$ denotes per capita value index of the cashless transaction of Indian economy over the months and $(VGDP)_t$ denotes the value-GDP index of Indian economy over the months (both from September 2012 to December 2023).

Dependent Variable: CC
Method: Least Squares
Included observations: 134 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PER_CAPITA_VALUEINDEX	1.024654	0.052390	19.55819	0.0000
C	0.271908	0.022502	12.08356	0.0000

R-squared	0.743452	Mean dependent var	0.619638
Adjusted R-squared	0.741508	S.D. dependent var	0.314045
S.E. of regression	0.159667	Akaike info criterion	-0.816636

Table 5.4: Summary Output Table of No. of credit card outstanding regressed on Per Capita Value of Cashless Transaction Index

Table 5.4 also reveals significantly positive relationship between the number of credit card outstanding and the per capita value of the cashless transaction.

Dependent Variable: CC
Method: Least Squares
Included observations: 134 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VALUE_GDP_INDEX	1.266806	0.047832	26.48455	0.0000
C	0.152676	0.020696	7.377108	0.0000

R-squared	0.841619	Mean dependent var	0.619638
Adjusted R-squared	0.840419	S.D. dependent var	0.314045
S.E. of regression	0.125454	Akaike info criterion	-1.298947

Table 5.5: Summary Output Table of No. of credit card outstanding regressed on Value of Cashless Transaction as a Proportion of GDP Index

Table 5.5 also reveals a significantly positive relationship between the total number of credit card outstanding and the value of the cashless transaction as a proportion of GDP index. This significant relationship justified the use of the ownership of credit card as a proxy for the usage of the cashless transaction.

5.3.2. Results of logistic regression

In this section we present the analysis of Panel data and logistic regression for the years 2011-12 and 2004-05. The fixed effect model utilized in this analysis account for specific characteristics that are individual-specific and may influence the outcome variable over time (probability of owning a credit card). By including fixed effect model, the model controls for unobserved heterogeneity across individuals, thereby reducing biases in the estimated effects of the independent variables. The choice of fixed effect comes from Hausman test, included in the appendix table A5.3.

	Marginal effect	Odds ratio
Time	-0.0038761	.6619542
Log income	0.002149	1.257006
Education * income	.0001411**	1.015128**
Computer Knowledge and Access	0.0051994	1.739165
Household Status	0.008293*	2.417376*
Financial Inclusion	0.0047231	1.653209
Log Age	-0.0151981**	0.041226**

Table 5.6: Panel Logistic Regression 1 Result (reporting marginal effect and odds ratio)

Table 5.6 reports the result of the panel data analysis.

Time: The "time" variable is insignificant at 5% level, we reject the alternative hypothesis so we can conclude that with the change in the time there is no effect on the likelihood of owning credit card.

Interaction term between education and income (Eduincome): The interaction between education and income affects the odds of owning a credit card. This is an interaction term that captures the combined effect of education and income on the probability of owning a credit card. Since the coefficient of log of income variable is not significant, its individual effect can be considered negligible. Therefore, the interaction term captures the full effect of income, in

addition to education level, on owning a credit card. The result suggests that level of income and level of education has joint influence on the likelihood of credit card ownership. An increase of one unit in "eduincome" is associated with a 0.014% increase in the odds of having a credit card, and this effect is statistically significant ($p < 0.001$). This suggests that the effect of increase in the level on income is depend on the level of education also indicating that with increased education, the effect of income increases.

Log Age (logage): An increase of one unit in "logage" leads to a 1.52% decrease in the probability of having a credit card, and this effect is statistically significant at 1% level. This implies that younger people are more likely to use cashless transaction.

Computer Knowledge and Access (Comkno): The variable "comkno" does not have any significant impact on the probability of having a credit card, as shown by the insignificance of the coefficient at 5% level.

Financial Inclusion Status (Fininclu): The variable "fininclu" does not have any significant impact on the probability of having a credit card, as shown by the insignificance of the coefficient at 5% level.

Household Status (Hhstatus): An increase of one unit in "hhstatus" leads to a 0.83% increase in the probability of having a credit card, and this effect is statistically significant at 5% level of significance.

	Marginal effect	Odds ratio
Time	-0.0189848	0.5849155
Education	-0.0089695**	0.7761775**
Education * income	0.0023512**	1.068674**
Computer Knowledge and Access	0.0204708	1.782942
Household Status	0.008293*	2.038826*
Financial Inclusion	0.0176072	1.644394
Log Age	-0.0534998**	0.532516**

Table 5.7: Panel Logistic Regression 2 Result

Table 5.7 reports the panel logistic regression result of education. The interpretations of the result are given below:

Time: The odds ratio of “Time” variable is statistically insignificant.

Education (Edu): An additional unit increase in `edu` (education level) is associated with a 0.90% decrease in the probability of `cards`. This effect is statistically significant at 1% level of significance. This is mainly the effect of change in education on the probability of owning a credit card when income of the household is zero. Economic justification is that, when income of the consumer is very low then it is not worth to keep your money into the bank account and avail a debit card or credit cards facilities for cashless transaction, because whatever small interest the buyer will get, the annual fees or charges for availing credit or debit cards will be much more so the consumer will lose some amount of money, and this understanding will come with the increase in the level of education. So, at zero level of income, the probability of owning credit card will reduce with the increase in the education to safe guard the ultimate monetary lose from availing credit card facility from banks.

Education and income interaction (variable: eduincome): The marginal effect of 0.0023512 indicates that the interaction between education and income has a positive effect on the probability of owning a credit card. This suggests that the effect of changes in education on the probability of owning a credit card depends on the income level of the household. A one-unit increase in "eduincome" is associated with a 0.23% increase in the probability of having a credit card, and this effect is statistically significant ($p < 0.001$).

The ultimate effect of education will increase with the increase in the level of income, it is observed that the negative marginal effect of the "Edu" when level of income is zero is stronger than the positive marginal effect of the "eduincome" variable when the income level is lower

than 7000/- per month, table 5.8 summarize this result for better understanding. However, beyond that income threshold (7000/- monthly), the ultimate effect of education on the likelihood of having a credit card becomes positive as well as increased with the increase in the level of income. This approves the theory established in the chapter 4, that, the combined effect of education and income influences the likelihood of using cashless transaction (proxied by owning a credit card).

Effect of Education at a particular income level $(\beta_1 + \beta_2 * logIncome)$	**Marginal effects**
At Zero level of Income	-0.0089695*
At income level 5000/- per month	(-0.0089695 + 0.0023512* 3.7) = -0.00027006
At income level 7000/- per month	(-0.0089695 + 0.0023512* 3.84) = 0.000059108
At income level 10,000/- per month	(-0.0089695+ 0.0023512* 4) = 0.0004353
At income level 20,000/- per month	(-0.0089695 + 0.0023512* 4.30) = 0.00114066
At income level 40,000/- per month	(-0.0089695 + 0.0023512* 4.60) = 0.00184602

Table 5.8: Effect of Education at Different Income Level Based on Panel Logistic Regression2

Log of Age (logage): The marginal effect of -0.05349 indicates that for each unit increase in age, there is a negative effect on the probability of owning a credit card by 5.35%. This suggests that younger individuals are more likely to own a credit card.

Computer knowledge (comkno): computer knowledge does not significantly impact the likelihood of owning a credit card.

Financial inclusion status (fininclu): Financial inclusion status does not significantly impact the likelihood of owning a credit card.

Household status (hhstatusasset): The marginal effect of 0.008293 suggests that higher household status have a positive effect on the probability of owning a credit card by 0.83%. This implies that individuals with higher household status and assets are more likely to own a credit card.

The logistic regression results reported in Table 5.9 reveals the estimated marginal effect for each predictor variable in the model respectively for the year 2011-12. These marginal effects allow us to interpret the impact of each predictor on the probability of the event "owning credit card" occurring.

	Marginal effect	Odds ratio
Log income	0.0097542	1.46746
Education * income	0.0004444*	1.017629*
Computer Knowledge and Access	0.0528423*	7.986462*
Household Status	0.0126982	1.647551
Financial Inclusion	0.0555211*	8.873586*
Log Age	-0.0299931**	0.194874**
Economic Class 2	0.0268369*	2.872613*
Economic Class 3	0.0447118*	5.801176*

Table 5.9: Logistic Regression 1 Result for the Year 2011-12

Following is the interpretation of the logistic regression results based on Table 5.8 which is based on the regression equation (5.iv), capturing the effect of income along with the other socio-economic variables except education, on the probability of owning credit card:

Log Income (logincome): for a one-unit increase in the income level when the education level is considered to be zero, there is no effect on the probability of owning a credit card, as the marginal effect is statistically insignificant at 5% level.

Education and income interaction (eduincome): The interaction variable between education level and income level affects the probability of owning a credit card. As the "log of income" variable is statistically insignificant, it implies that it does not have a significant independent effect on credit card ownership. In this case, the total effect of income on credit card ownership would be solely represented by the interaction term, "eduincome."

The effect of changes in income on the probability of owning a credit card depends on the highest adult education level within a household. The effect of income level on the probability

of owning a credit card varies based on the level of education. When comparing households with similar income levels, those with a higher level of education are more likely to own a credit card compared to households with lower education levels. An additional unit increase in interaction term (between education and income) increases the probability of owning credit card by approximately 0.04%. Furthermore, this interaction variable, "eduincome," is statistically significant at 1% level. This also empirically proved the theory in chapter 4.

Log of Age (logage): For a one-unit increase in the age of the male head of the household, the probability of owning a credit card decrease by a 3% (approx.), This variable is statistically significant at 5% level.

Computer Knowledge and Access (Comkno): If the household has computer knowledge and access, the probability of owning a credit card increase 5.28%, that is with the increase in the variable of computer knowledge and access, the probability in favor of owing credit card will increase. This variable also statistically significant at 1% level of significance.

Household Status (hhstatus): Household status doesn't have a significant impact on the probability of owning credit card, the marginal effect of household status is statistically insignificant.

Financial Inclusion Status (Fininclu): A higher financial inclusion parameter for the household leads to increased probability of owning a credit card. For a one-unit increase in financial inclusion, the probability will increase by 5.55%, and the variable is also statistically significant at 1% level of siginificance.

Economic class "Middle class" (ecoclass 2): if the household upgrades to the middle class from poor class, then the probability of owning a credit card increase by 2.68%. This variable is statistically significant.

Economic Class 3 "Comfort class" (ecoclass 3): if the household upgrades to the comfort class, the probability of owning a credit card increase by 4.47%. This variable is statistically significant at 1% level of significance.

Overall, the logistic regression analysis suggests that variables such as age, computer knowledge and access, financial inclusion, education-income interaction and belonging to the middle or comfort class have significant effects on the likelihood of owning a credit card, while household status and income level (when education is zero) do not have significant effects.

	Marginal effect	Odds ratio
Education	-0.0071468*	0.753962*
Education * income	0.0016912*	1.069113*
Computer Knowledge and Access	0.0525293*	7.97045*
Household Status	0.0122137	1.620335
Financial Inclusion	0.0549653*	8.775832*
Log Age	-0.0185833*	0.084099*
Economic Class 2	0.0268723*	2.89181*
Economic Class 3	0.0431247*	5.496479*

Table 5.10: Logistic Regression 2 Result for the Year 2011-12

Table 5.10 shows the results of a logistic regression analysis based on equation (5.2), here the effect of education along with the other socio-economic variable are being captured for the year 2011-12. The marginal effect represents the multiplicative change in the odds of owning credit cards for a one-unit increase in the respective independent variables.

These findings can guide policymakers and stakeholders in understanding and addressing the factors that affect the probability of the outcome of interest. For instance, enhancing community knowledge and financial inclusion could be effective strategies for increasing the likelihood of cards. Conversely, understanding the reasons behind the negative association with higher education could provide deeper insights into the dynamics at play.

Here's the interpretation of the odds ratios for each variable:

Education (Edu): An additional unit increase in `edu` (education level) is associated with a 0.72% decrease in the probability of `cards`. This effect is statistically significant at 1% level of significance. This is mainly the effect of change in education (years of schooling) on the probability of owning a credit card when income of the household is zero. Economic justification is that, when income of the consumer is very low then it is not worth to keep your money into the bank account and avail a debit card or credit cards facilities for cashless transaction, because whatever small interest the buyer will get, the annual fees or charges for availing credit or debit cards will be much more so the consumer will lose some amount of money, and this understanding will come with the increase in the level of education. So, at zero level of income, the probability of owning credit card will reduce with the increase in the education to safe guard the ultimate monetary lose from availing credit card facility from banks.

Interaction between Education and Income (Eduincome): The marginal effect of the interaction term between education and income indicates that an additional unit increase in "Eduincome" (education-related income) increases the probability of owning credit cards by approximately 0.18%. The interaction between education and income has a positive effect on the probability of owning a credit card. This suggests that the effect of changes in education on the probability of owning a credit card depends on the income level within a household. This effect is statistically significant at 1% level of significance, hence statistically supports the theory in chapter 4.

It is observed that the negative effect of the "Education" variable when level of income is considered to be zero is stronger than the positive effect of the "eduincome" variable when the income is lower than 10000/- (indicates log income 4). However, beyond that 10000/- income threshold, the ultimate effect of education on the likelihood of having a credit card becomes positive and will increase with the increase in the level of income of the household, hence

supports the theory of chapter 4. Table 5.11 explains the effect of education at different income levels for better understanding.

Effect of Education at a particular income level ($\beta_1 + \beta_2 * logIncome$)	**Marginal effects**
At Zero level of Income	-.0072098*
At income level 5000/- per month	(-.0072098 + .0018142* 3.7) = -.00030844
At income level 8000/- per month	(-.0072098 + .0018142* 3.9) = -.00012881
At income level 10,000/- per month	(-.0072098 + .0018142* 4) = 0.000047
At income level 20,000/- per month	(-.0072098 + .0018142* 4.30) = 0.0005912
At income level 40,000/- per month	(-.0072098 + .0018142* 4.60) = 0.0011355

Table 5.11: Effect of Education at Different Income Level Based on LogisticRegression2

Log of Age (logage): An additional unit increase in logarithm of age, decreases the probability of owning credit card by approximately 2.12%, which is also statistically significant at 1% level.

Computer Knowledge and Access (comkno): An additional unit increase in computer knowledge and access increases the probability of owning credit cards by approximately 5.70%. This effect is also statistically significant at 1% level.

Household Status (hhstatus): For a one-unit increase in the household status (e.g., income or employment status), the probability of owning credit cards increase by approximately 2.19%. However, this effect is not statistically significant at conventional significance levels.

Financial Inclusion Status (fininclu): An additional unit increase in financial inclusion status increases the probability of owning credit card by approximately 5.91%.This effect is also statistically significant at 1% level.

Economic class : Middle class (Ecoclass2) and Comfort class (Ecoclass3): These variables capture the effect of different levels of economic class, these are the dummy variables.

For households in economic class 2 (Middle class), the effect on the probability of owning credit card is approximately 2.69%. Similarly, for households in economic class 3, the effect on the probability of owning credit card is approximately 4.31%. Both effects are statistically significant ($p < 0.001$).Its indicates that the higher economic class the buyer belongs there is higher probability that the buyer owns credit cards.

Table A5.11 and A5.12 in the appendix represents the Hosmer-Lemeshow test results corresponding to the logistic regression test 1 and 2 respectively.

The Hosmer-Lemeshow tests suggest that there is no significant evidence to conclude that the logistic regression models provides a poor fit to the data.

The logistic regression results for the year 2004-05 are included in the appendix section. As all the socio economic coefficients are statistically insignificant in the year 2004-05. This could be the result of lack of awareness about the digital transaction literacy in the year of 2004-05.

5.4. Conclusion:

The main objective of the present chapter is to find empirical justification to the theory developed in the 4th chapter of the present thesis. In the 4th chapter, we developed a theoretical framework to explore the relationship between the selection of mode of payment (between cash and cashless transactions) and the income and education levels of buyers. The theoretical analysis establishes that income and education jointly influence the preference for cashless transactions—higher income levels beyond a certain threshold lead to an increased likelihood of choosing cashless payment. However, individuals with very high incomes but deficient education tend to prefer cash transactions. On the other hand higher education levels lead to an

increased likelihood of choosing cashless payment. However, individuals with a high level of education but a low level of income, tend consistently to prefer cash transactions, indicating that education and income jointly determine cashless payment modes.

The logistic regression models reported in this study aims to investigate the empirical validation of the theoretical model developed in the 4th chapter. To this end we use India Human Development Survey for the years 2004-05 and 2011-12. As a strong association between education level and household income was observed, we could not consider education and income in the same model, so we used separate regression analysis to capture the effect of education and effect of income along with other socio economic variables of the households such as age, household status, financial inclusiveness, computer knowledge and access and economic class belong.

To find evidence for our theoretical results, we incorporate an interaction term between education and income levels in every logistic regression analysis, to capture the complex interplay between education and income levels in influencing cashless transactions. Significantly positive value of the coefficients of the interaction terms in all the regression results (except for 2004-05) highlight the joint effect of income and education level on cashless transaction usages within a household. This complex relationship suggests that the effect of changes in income depends on educational attainment of the household members, and the effect of changes in education level on the likelihood of selecting cashless mode of payment, depends on the existing income level of the household, Very high level of income but zero education level doesn't have any effect on the likelihood of selecting cashless mode of payment. In summary, these findings support the theoretical analysis of chapter 4. Policymakers, financial institutions, and researchers can uses these joint insights to tailor interventions addressing the interplays between educations, income, and usages of cashless transactions.

Panel data analysis allows us to identify the effect of change in time period along with the other socio economic variables on the likelihood of the usage of cashless transactions.. The variable "time" has no effects on cashless transaction, while Household statues, and financial inclusiveness have significantly positive effects, age shows significantly negative impact.

Furthermore, logistics regression analysis for the years 2011-12 explores the effects of income, educations, age, computer knowledge, financial inclusiveness, economic classes, and household statuses on cashless transaction usages. The result emphasizes the importance of age, computer knowledge, financial inclusiveness, and economic class in shaping the likelihood of engaging in cashless transactions. The logistic regression results for the year 2004-05 are included in the appendix, as all the socio-economic coefficients are statistically insignificant in the year 2004-05. This could be the result of lack of awareness about the digital transactions in the year of 2004-05.

To conclude, the interaction term illustrates that changes in income on cashless transactions usages rely on the highest adult educations level within a household. And changes in level of education on cashless transaction usages rely on the income level of the household. This results fulfilled our objective to empirically establish the theoretical approach of the determinants of cashless transaction in 4h chapter.

CHAPTER **6**

CONCLUSION

6.1. Introduction:

The present thesis investigates several aspects of the digital transaction, the transaction without the involvement of currency notes and coins. Since digital payment systems enjoy two clear advantages over cash-based or paper-based non-cash payment systems. First, since most electronic payments cost only around one-third to one-half as much as paper-based non-cash payments (such as cheque payments), shifting to electronic modes should considerably reduce the economic cost of the payment system. Secondly, under cashless transactions, the documentation of each transaction is complete and accurate compared to cash transactions, reducing the possibility of creating black money and increasing transparency and tax compliance. Starting from 2016, the promotion of cashless transactions has been one of the policy priorities of the Government of India. The present thesis focuses on the trend of the digital transactions as well as identifying the role of some factors behind the usage of the digital cashless transactions. It addresses three research questions: first, the extent of the digital cashless transaction in Indian economy over time and how the some policies and events affects the trend of the cashless transaction of the economy; second, the thesis attempts to theoretically establish a relationship between income, education and cashless transaction; the thesis also seeks empirical validation of the theory and focuses on the role of other socio economic factors behind the usage of the cashless transaction. The present chapter concludes the thesis by summarizing the results. It also outlines the limitations of the study, discusses the policy recommendations and the agenda for future research.

6.2. Summary Findings:

There are three core chapters of the thesis chapter 3: Index of Cashless Transaction, chapter 4: Determinants of Digital Transaction: A Theoretical Approach, and chapter 5: Determinants of Digital Transaction: An Empirical Analysis.

Chapter 3 focuses on assessing the impact of two major policy interventions(PMJDY and demonetization) on the growth of both the volume and value of different types of cashless transactions of the Indian economy. Additionally, the aim is to understand the current state of cashless transactions in the Indian economy post COVID-19 pandemic and determine whether there has been a significant shift towards a cashless economy after the outbreak of COVID-19 pandemic. Chapter 3 concludes that both demonetization and the COVID-19 pandemic have a positive effect on the per capita value index of the cashless transactions for the Indian economy. The per capita volume index experienced a positive trend break post-demonetization period, but this trend persisted till before the COVID-19 pandemic. However, the COVID-19 pandemic hurt the trend of the per capita volume index, as a result, the trend reverted to the pre-demonetization stage. This reveals the fact that during the COVID-19 pandemic, people are using cashless modes of payment for higher-valued transactions than before, but it is possibly not the case more people have started using cashless transactions than before. The government should emphasize more on the policies, which promote financial inclusion rather than the policies which increase the value of cashless transactions. Demonetization doesn't have any impact on the value-GDP index. The COVID-19 pandemic has had a temporary negative effect on the value-GDP index, which is possibly a result of the economic downturn due to the pandemic. But the negative effect didn't persist, it came back to the previous trend by the end of 2022, indicating economic recovery as well as an increment in the overall value of the cashless mode of transaction.

The types of cashless transactions where both demonetization and the COVID-19 pandemic have positive effect are the Per capita volume of IMPS, Per capita value of IMPS and Value of IMPS/ GDP transactions. In the case of all three measures of POS transactions, demonetization has a positive impact, but after the outbreak of COVID-19 that positive shift turned into a negative effect, which implies that after the outbreak of the COVID-19 pandemic and lockdown measures buyers didn't prefer to use debit and credit cards to make payments. The types of cashless transactions where demonetization has no impact are No. Of Cards per 1000 Adults, Per Capita volume of NEFT, the value of NEFT/ GDP, Per Capita Value of RTGS, the value of RTGS/ GDP, the value of ECS+NACH/ GDP. The types of cashless transactions where only the COVID-19 pandemic has a positive impact are per capita volume as well as the value of IMPS, Value of IMPS/ GDP, per capita volume of NEFT and per capita volume of RTGS. This indicates an increase in total volume of online transfer of funds. The type of cashless transaction where the COVID-19 pandemic has a negative impact is No. Of Cards/ 1000 Adults, per capita volume and value of POS, per capita volume of ECS+NACH, per capita value of NEFT, per capita value of RTGS, POS/ GDP, NEFT/ GDP and Value of RTGS/ GDP. This may indicate that there has been a shift in the preference across different forms of online fund transfers. More specifically ease of IMPS transactions may have resulted in a substitution of NEFT and RTGS transactions by IMPS transactions. The decline in per capita volume and value of POS may also indicate a substitution of card transaction by UPI based transactions , which we could not investigate due to paucity of time series data.

Chapter 4 develops a theoretical structure to study the effect of interaction between education and income on adoption of the cashless transaction. The analysis is carried out in two stages: without any taxation and in the presence of direct taxation . Chapter 4 concludes that in the absence of income tax, a critical threshold of education level exists, beyond which buyers prefer cashless transactions, conditional upon the representative buyer already having a threshold

level of income or beyond. On the other hand, a critical threshold level of income exists beyond which representative buyer will prefer cashless transactions but again conditional upon the buyer already having a threshold level of education or beyond. This underlines the joint influence of education and income behind the selection of a particular payment mode. However, when income tax is introduced, the study identifies the combination of a threshold level of income and threshold tax rate that determine the advantageous choice between maintaining all of the income of the representative individual either in white money form and doing the cashless transaction using debit cards or in black money form and doing the cash transaction. The combination of a tax rate and income exceeding a certain threshold prompts a shift towards maintaining all of the representative buyer's income in black money form for cash transactions. On the other side, a combination of higher levels of income and lower tax rates, favour cashless transactions with 100% white money. The research also identifies an optimal proportion of income understatement that maximizes the net benefit from transactions. This optimal proportion is influenced by factors such as income level, tax rates, probability of detection, and penalty charges.

The main objective of the 5th chapter is to find empirical validation for the theory developed in the 4th chapter of the present thesis. In the 5th chapter to empirically support our theoretical results, we incorporate an interaction term between education and income levels in every logistic regression analysis, to capture the complex interplay between education and income levels in influencing cashless transactions. A significantly positive value of the coefficients of the interaction terms in all the regression results (except for 2004-05) highlights the joint effect of income and education level on cashless transaction usage within a household. This complex relationship suggests that the effect of changes in income depends on the educational attainment of the household members, and the effect of changes in education level on the likelihood of selecting the cashless mode of payment, depends on the existing income level of

the household, Very high level of income but zero education level doesn't have any effect on the likelihood of selecting the cashless mode of payment. In summary, these findings support the theoretical analysis of Chapter 4. Furthermore, logistics regression analysis for the years 2011-12 explores the effects of income, education, age, computer knowledge, financial inclusiveness, economic classes, and household statuses on cashless transaction usage. The result emphasizes the importance of age, computer knowledge, financial inclusiveness, and economic class in shaping the likelihood of engaging in cashless transactions. The logistic regression results for the year 2004-05 are included in the appendix, as all the socio-economic coefficients are statistically insignificant in the year 2004-05. This could be the result of a lack of awareness about the digital transactions in the year of 2004-05.

6.3. Limitations:

A major limitation of the current study is its data limitation. In chapter 3 it is empirically tested that after the outbreak of the COVID-19 pandemic and lockdown measures Indian buyers don't prefer to use debit and credit cards to make payments, this could be a reason that due to the lockdown measures overall consumption has been reduced by the consumers or the use of debit card and credit card has been substituted by the use of UPI transaction to avoid the contact as well as due to the easy access to the internet and UPI technology. As the data about the volume and value of the UPI payment is not available for the entire period of analysis, we can't capture that scenario, which could be considered a limitation. The other major possible limitation of the results derived in the 3rd chapter could be the existence of autocorrelation in the time series regression analysis having an impact on identification of the variables of interest. One of the possible way to remove the autocorrelation from the regression analysis is by considering the lagged values of all the variables and by removing trends from the data and making the process stationary. But as the objective of that research is to identify the trend of the cashless transaction

of the Indian economy over the period of time and to identify the trend breaks after certain events to capture the impact of those events, removing trends using lagged values to address the autocorrelation problem will not help us to fulfil our research objective.

In chapter 5 a major limitation is its data limitation To study the effect of income, education and other socioeconomic variables on use of cashless transaction we needed household level data on use of cashless transaction along with other variables for India economy. Unfortunately, after a thorough search, we could not find a household level data source, which included data on usage of cashless transaction along with all other socio economic background of the households. So we utilized data at the household level from the India Human Development Survey database. The data base does not directly provide information on the usage of cashless transactions, it contained several variables that can act as proxies for cashless transaction usage. Given the lack of specific household level data on cashless transaction usage and an absence of alternative secondary sources, our investigation focused on studying credit card ownership as a proxy for overall cashless transaction usage. Although this database is not up to date but the similar study could be possible to conduct in future using recent years data when it will be available.

6.4. Policy Recommendation:

The thesis brings up several important policy recommendations. The analysis in Chapter 3 shows that both demonetization and COVID-19 pandemic have positive impact on the per capita value index of the cashless transaction. Demonetization has positive impact on the per capita volume index of the cashless transaction, but after the outbreak of COVID-19 that positive impact was removed and per capita volume of the cashless transaction reverted back to the pre demonetization trend but during the end of 2023 there is a positive trend break again.

This indicates during post COVID-19 pandemic people are using cashless modes of payment for higher-valued transactions than before, but it may not be the case that more people have started using cashless transactions than before. Govt. should emphasize more on the policies which promote financial inclusion rather than the policies which increase the value of cashless transactions. Demonetization doesn't have any impact on the value-GDP index. The COVID-19 pandemic has had a temporary negative impact on the value-GDP index, which is possibly a result of the economic downturn due to the pandemic. But the negative effect didn't persist, it came back to the previous trend by the end of 2022, indicating economic recovery as well as an increment in the overall value of the cashless mode of transaction. The only transaction where Covid-19 pandemic has positive impact on the all three measures is IMPS transaction and the only type of transaction where COVID-19 pandemic has negative impact on the all three measures is POS transaction, COVID-19 has also negative impact on the No. Of cards per 1000 adults, this result clearly indicates that post COVID-19 Indians more prefer contactless transactions, they don't prefer card transactions. Policy makers should emphasis more on contactless type of cashless transactions than on the card transactions.

In the 4th chapter it is established that in the absence of income tax, a critical threshold of education level, beyond which buyers prefer cashless transactions, conditioning that the buyer already has a threshold level of income or beyond. On the other way a critical threshold level of income exists beyond which buyer will prefer cashless transaction but conditioning that buyer already has a threshold level of education or beyond. This underlines the joint influence of education and income behind selection of a particular payment mode. To promote cashless transactions, the government should prioritize efforts to elevate both education levels along with the income level rather than merely focusing on income augmentation. However, when income tax is introduced, the analysis unveils critical insights into the payment mode choices between cash and cashless transactions, taking into account the complex interplay of tax

evasion, income understatement, and transaction costs. The study identifies the combination of a threshold level of income and a threshold tax rates that determine the advantageous choice between maintaining all of one's income either in the form of white money or in the form of black money. Beyond these thresholds, individuals are influenced to adopt specific payment modes so that their net benefit from transaction could be optimised. Tax rates play an important role in shaping individual preferences for payment modes. Combination of a tax rate and income exceeding a certain threshold prompts a shift towards maintaining all of his income in the form of black money for cash transactions. On the other hand , combination of higher level of income and lower tax rates, favour cashless transactions with white money. The research identifies an optimal proportion of income understatement that maximizes the net benefit from transactions. This optimal proportion is influenced by factors such as income level, tax rates, probability of detection, and penalty charges. Policymakers should consider setting tax rates strategically to align with the thresholds identified in the study. Striking a balance that discourages tax evasion while promoting cashless transactions could enhance overall economic efficiency. Strengthening measures for detecting income understatement and tax evasion, such as improving monitoring systems and employing advanced technologies, can deter individuals from keeping substantial black money. Policymakers may evaluate penalty rates to ensure that they are sufficiently deterrent yet not overly punitive. A judicious balance can discourage tax evasion while providing individuals with incentives to adopt cashless transactions. Public awareness campaigns and incentives for adopting cashless transactions, especially among those with higher education levels, can contribute to reducing the prevalence of black money and enhancing overall transaction efficiency. Given the significant impact of education on transaction costs, policymakers may consider educational initiatives to improve financial literacy and promote the benefits of cashless transactions, contributing to a more informed and efficient payment landscape. Furthermore, logistics regression analysis in the 5th chapter for

the years 2011-12 explores the significant effects of age, computer knowledge, financial inclusiveness, economic classes, and household statuses on cashless transaction usage The nuanced understanding derived from this study provides actionable guidance for policymakers aiming to optimize economic outcomes and foster a transition towards a more efficient, cashless economy.

6.5: Future Research Agenda:

During the process of writing this thesis has opened further questions related to the cashless digital transaction of an Economy. These questions pertain to the future trend of digital transactions as well as its relationship with the socio-economic background, using recent data on the economy. This section gives an overview of three research questions for future research.

In the 3rd chapter, the analysis of the index of cashless transactions over the period of the introduction of PMJDY to the Demonetization period till the COVID-19 and post-COVID-19 period helps to investigate the effects of these three major events on the overall trend of the cashless transaction into the Indian economy. This analysis can be extended over future periods to identify and analyse the future trends and scenarios of the cashless and digital transactions of the economy for any future policy implications. Redistribution of volume and value across different types of online modes of transactions (IMPS, NEFT, RTGS etc) is indicated by the analysis in the 4^{th} chapter. However further and deeper analysis is required to understand the economic logic behind the nature of this redistribution.

Another future research agenda could be that, if the global level digital transaction data will be available then country-wise comparative analysis and ranking could be possible to give using these Index of Cashless transactions. This country wise ranking may provide the broader

picture of the trend of the cashless transaction globally, as it is one of the policy priority of many countries to promote the cashless transaction to avail the benefits associated with the cashless transaction

The theoretical structure developed in chapter 4 can be further extended in several ways. The chapter exclusively focuses on the representative buyer's perspective. The representative seller's perspective can be included modifying the frame work and generating an equilibrium price level, which will be a function of income and education. In the analysis of effect of direct taxes we have altogether ignored the effect of education. Education can be brought in to examine the interplay between education , income and direct taxes on choice of mode of payment. Further the effect of indirect taxes and tax evasion can be considered along with direct taxation.

There is a great deal of scope in extending the analysis of the 5th chapter. As already discussed to empirically validate the results of the 4th chapter we had to depend on secondary survey data , which included only the ownership of credit card that could be used as a proxy for cashless transaction. The best way to validate the results of the 4th chapter is to conduct a primary survey that can include questions on the use of various forms of cashless transactions. Form a primary survey we can develop a more complete understanding not only about the factors influencing overall use of cashless transactions but also about the different components of cashless transactions and the factors that encourage their usage and substitutions among them.

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Appendix

A1: Different Types of Cashless Transactions:

National Electronic Fund Transfer (NEFT): NEFT is a nationwide payment system facilitating one-to-one funds transfer. Individuals, firms, and corporates can electronically transfer funds from any bank branch to any individual, firm, or corporate having an account with any other bank branch in the country participating in the scheme. NEFT operates in hourly batches and facilitates transactions even for individuals who do not have a bank account, with cash remittances restricted to a maximum of Rs. 50,000 per transaction.

Real Time Gross Settlement (RTGS): RTGS is the continuous settlement of funds transfers individually on an order-by-order basis in real-time. Payments through RTGS are final and irrevocable and take place in the books of the Reserve Bank of India. RTGS is primarily meant for large-value transactions, with a minimum amount of Rs. 2 lakh and no upper ceiling for transactions. The service is available during specific hours on weekdays and Saturdays.

Electronic Clearing System (ECS): ECS is an alternative method for effecting payment transactions, particularly for utility bill payments, insurance premiums, card payments, loan repayments, etc. It obviates the need for paper instruments and facilitates improved customer service by enabling efficient collection and receipt of payments.

Immediate Payment Service (IMPS): IMPS offers a real time interbank digital fund transfer service using mobile phones or internet banking. It allows for digitally transfer of money in real time between the banks through mobile phones, internet, and ATM channels.

Mobile Banking: Mobile banking is a service provided by banks or financial institutions that allows customers to conduct various financial transactions remotely using a mobile device such

as a mobile phone or tablet. Each bank provides its own mobile banking app for Android, Windows, and iOS platforms

Micro ATM: A micro ATM is a device used by millions of Business Correspondents (BCs) to deliver basic banking services. It enables BCs to conduct instant transactions such as deposits, withdrawals, fund transfers, and balance inquiries. Micro ATMs are low-cost devices connected to banks across the country and facilitate transactions regardless of the bank associated with a particular BC. Customers can authenticate their identity using their UID (Unique Identification Number) and perform banking transactions conveniently

	Mean	Std. Deviation
Cardsper1000	.566132	.2998490
PerCapNoPOS	.450451	.3221814
PerCapNoNEFT	.394020	.2438491
PerCapNoRTGS	.354613	.1868524
PerCapNoIMPS	.267444	.2800720
PerCapNoECSNACH	.424218	.2554245
	Mean	Std. Deviation
PerCapValuePOS	.264214	.2050402
PerCapValueNEFT	.409230	.2572145
PerCapValueRTGS	.378924	.1829041
PerCapIMPS	.256761	.2701179
PerCapValueECSNACH	.354936	.2583053
	Mean	Std. Deviation
POSGDP	.415484	.2863050
NEFTGDP	.457271	.2563263
RTGSGDP	.383646	.1393747
IMPSGDP	.331018	.3234872
ECSNACHGDP	.313019	.2155963

Table A3.1: Descriptive Statistic of All the Dimensions

Dimension	Variable	Coefficient	R- Square
No. of Cards per 1000 Adults	Time	0.008463*	0.810479
	GDP/GCF Deflator	8.35E-05*	
Per Capita No. of POS	Time	0.009179*	0.825811
	GDP/GCF Deflator	9.31E-05*	
Per Capita No. of NEFT	Time	0.007513*	0.965883
	GDP/GCF Deflator	7.42E-05*	
Per Capita No. of RTGS	Time	0.005362*	0.837970
	GDP/GCF Deflator	5.56E-05*	
Per Capita No. of IMPS	Time	-0.003024*	0.974810
	$Time^2$	9.93E-05*	
	GDP/GCF Deflator	8.13E-05*	
Per Capita No. of ECS+NACH	Time	0.006818*	0.724870
	GDP/GCF Deflator	6.67E-05*	
Per Capita Value of POS	Time	0.005952*	0.857395
	GDP/GCF Deflator	6.05E-05*	
Per Capita Value of NEFT	Time	0.007782*	0.931440
	GDP/GCF Deflator	7.69E-05*	
Per Capita Value of RTGS	Time	0.008784*	0.358649
	$Time^2$	-5.01E-05*	
	GDP/GCF Deflator	3.45E-05*	
Per Capita Value of IMPS	Time	-0.002882*	0.981472
	$Time^2$	9.57E-05*	
	GDP/GCF Deflator	7.74E-05*	
Per Capita Value of ECS+NACH	Time	0.007687*	0.901167
	GDP/GCF Deflator	7.26E-05*	
Value of POS/ GDP	Time	0.008454*	0.887082
	Population (Billion)	5.927707*	
Value of NEFT/ GDP	Time	0.007633*	0.902247
	Population (Billion)	5.354406*	
Value of RTGS/ GDP	Time		0.46897
	Population (Billion)		
Value of IMPS/ GDP	Time	-0.000879**	0.988677
	$Time^2$	9.38E-05*	
	Population (Billion)	6.863038*	
Value ECS+NACH/ GDP	Time	0.006358*	0.884805
	Population (Billion)	4.484983*	

*1% level of significant, ** 5% level of significant, ***10% level of significant.

Table A3.2: Dimension Wise Fitted Time Trend

		POSGDP	NEFTGDP	RTGS-GDP	Value IMPS GDP	ECSNACHGDP
Correlation	POSGDP	1.000	0.965	0.831	0.966	0.906
	NEFTGDP	0.965	1.000	0.871	0.966	0.943
	RTGSGDP	0.831	0.871	1.000	0.864	0.984
	ValueIMPSGDP	0.966	0.966	0.864	1.000	0.929
	ECSNACHGDP	0.906	0.943	0.984	0.929	1.000
Sig. (1-tailed)	POSGDP		0.000	0.000	0.000	0.000
	NEFTGDP	0.000		0.000	0.000	0.000
	RTGSGDP	0.000	0.000		0.000	0.000
	ValueIMPSGDP	0.000	0.000	0.000		0.000
	ECSNACHGDP	0.000	0.000	0.000	0.000	

Table A3.3. Correlation Matrix between the Dimensions of Value GDP Index.

	Initial	Extraction
POSGDP	1.000	0.930
NEFTGDP	1.000	0.961
RTGSGDP	1.000	0.882
IMPSGDP	1.000	0.953
ECSNACHGDP	1.000	0.967

Note: Extraction method: Principal component analysis.

Table A3.4. Principal Component Matrix for Value as a Proportion of GDP Index.

1	4.692	93.836	93.836	4.692	93.836	93.836
2	0.243	4.853	98.689			
3	0.035	0.700	99.389			
4	0.031	0.611	100.000			
5	–4.821E – 16	–9.642E – 15	100.000			

Note: Extraction method: Principal component analysis.

Table A3.5. Total Variance Explained for Per Capita Value Index

		Amnt POS popul	Amnt NEFT popul	Amnt RTGS Popul	Value IMPS popul	Value ECSNACHPopul
Correlation	AmntPOSpopul	1.000	0.976	0.945	0.971	0.950
	AmntNEFTpopul	0.976	1.000	0.974	0.970	0.976
	AmntRTGSPopul	0.945	0.974	1.000	0.950	0.945
	ValueIMPSpopul	0.971	0.970	0.950	1.000	0.963
	ValueECS-NACHPopul	0.950	0.976	0.945	0.963	1.000
Sig. (1-tailed)	AmntPOSpopul		0.000	0.000	0.000	0.000
	AmntNEFTpopul	0.000		0.000	0.000	0.000
	AmntRTGSPopul	0.000	0.000		0.000	0.000
	ValueIMPSpopul	0.000	0.000	0.000		0.000
	ValueECS-NACHPopul	0.000	0.000	0.000	0.000	

Table A3.6. Correlation Matrix between the Dimensions of Per Capita Value Index.

	Initial	Extraction
AmntPOSpopul	1.000	0.967
AmntNEFTpopul	1.000	0.989
AmntRTGSPopul	1.000	0.956
ValueIMPSpopul	1.000	0.972
ValueECSNACHPopul	1.000	0.964

Table A3.7. Principal Component Matrix for Per Capita Value Index.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.847	96.943	96.943	4.847	96.943	96.943
2	0.062	1.244	98.187			
3	0.051	1.014	99.201			
4	0.030	0.604	99.805			
5	0.010	0.195	100.000			

Table A3.8. Total Table

A3.8: Variance Explained for Per Capita Value Index.

		Nocard Per 1000	No POS popul	No NEFT popul	No RTGS popul	No IMPS popul	No ECS-NACHP opul
Correlation	NocardPer1000	1.000	0.940	0.988	0.932	0.919	0.984
	NoPOSpopul	0.940	1.000	0.948	0.905	0.966	0.895
	NoNEFTpopul	0.988	0.948	1.000	0.932	0.914	0.979
	NoRTGSpopul	0.932	0.905	0.932	1.000	0.904	0.905
	NoIMPSpopul	0.919	0.966	0.914	0.904	1.000	0.872
	NoECSNACH-Popul	0.984	0.895	0.979	0.905	0.872	1.000
Sig. (1-tailed)	NocardPer1000		0.000	0.000	0.000	0.000	0.000
	NoPOSpopul	0.000		0.000	0.000	0.000	0.000
	NoNEFTpopul	0.000	0.000		0.000	0.000	0.000
	NoRTGSpopul	0.000	0.000	0.000		0.000	0.000
	NoIMPSpopul	0.000	0.000	0.000	0.000		0.000
	NoECSNACH-Popul	0.000	0.000	0.000	0.000	0.000	

Table A3.9. Correlation Matrix between the Dimensions of Per Capita Number Index.

	Initial	Extraction
NocardPer1000	1.000	0.978
NoPOSpopul	1.000	0.941
NoNEFTpopul	1.000	0.977
NoRTGSpopul	1.000	0.916
NoIMPSpopul	1.000	0.915
NoECSNACHPopul	1.000	0.936

Table A3.10. Principal Component Matrix for Per Capita Number Index.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.662	94.372	94.372	5.662	94.372	94.372
2	0.183	3.055	97.427			
3	0.102	1.699	99.127			
4	0.035	0.583	99.710			
5	0.010	0.166	99.876			
6	0.007	0.124	100.000			

Table A3.11. Total Variance Explained for Per Capita Number Index

A3.12. Computation of Monthly GDP

First, we collected the quarterly growth rate data from the same source. Now to find out the monthly growth rate 'r' we have divided the quarterly growth rate G by 3 i.e. r = G/3.We assume that the GDP has grown at this (g) constant monthly growth rate over the months. So,

$$Y_2 = Y_1(1 + r)$$

$$Y_3 = Y_1(1 + r)^2$$

Where Y_1 is the monthly GDP of the 1st financial month $Y_2$is the monthly GDP of the 2nd financial month, $Y_3$is the monthly GDP of the 3rd financial month, such that $Q_1 = Y_1 + Y_2 + Y_3$. So, substituting the values of $Y_2 \& Y_3$ into previous question we have

$$Y_1 + Y_1(1 + r) + Y_1(1 + r)^2 = Q_1$$

$$or, \quad Y_1 = \frac{Q_1}{1 + (1 + r) + (1 + r)^2}$$

Given r and Q_1 we solved for Y_1. Once we have the value of Y_1 we easily generate the values of Y_2 and Y_3. Similarly, we have the values of the other months' GDP.

A4.1: Calculation of Interest Gain:

If the buyer will withdraw C amount each t times then the 1st c amount will not get any interest but the 2nd C withdraw will get interest by the amount $c\left\{\left(1+\frac{i}{f}\right)-1\right\}$

And the 3rd c withdraw will get interest by the amount $c\left\{\left(1+\frac{i}{f}\right)^2-1\right\}$

Similarly, the 4th c withdraw will get interest by the amount $c\left\{\left(1+\frac{i}{f}\right)^3-1\right\}$

.

.

.

And f th c withdraw will get interest by the amount $c\left\{\left(1+\frac{i}{f}\right)^{(t-1)}-1\right\}$

So, the total interest gain will be

$$= c\left\{\left(1+\frac{i}{f}\right)-1\right\}+ c\left\{\left(1+\frac{i}{f}\right)^2-1\right\}+c\left\{\left(1+\frac{i}{f}\right)^3-1\right\}+\cdots+c\left\{\left(1+\frac{i}{f}\right)^{(f-1)}-1\right\}$$

$$= c\left[\left(1+\frac{i}{f}\right)+\left(1+\frac{i}{f}\right)^2+\cdots+\left(1+\frac{i}{f}\right)^{(f-1)}-(1+1+\cdots+1)\right]$$

$$= c\left[\frac{\left\{\left(1+\frac{i}{f}\right)\left(1-\left(1+\frac{i}{f}\right)^{(f-1)}\right)\right\}}{\left\{1-\left(1+\frac{i}{f}\right)\right\}}-(f-1)\right]$$ (Using G.P series summation formula)

$$= c\left[\frac{f+i}{i}\left(1-\left(1+\frac{i}{f}\right)^{(f-1)}\right)-(f-1)\right]$$ (After simplifying)

	edu12	age12	comkno12	loginc~e	finin~12	hhsta~12	eduinc~e
edu12	1.0000						
age12	0.0740*	1.0000					
comkno12	0.4440*	0.0520*	1.0000				
logincome	0.7289*	0.1244*	0.4130*	1.0000			
fininclu12	0.2391*	0.1068*	0.2668*	0.2499*	1.0000		
hhstatus12	0.3752*	0.0921*	0.3980*	0.3808*	0.1971*	1.0000	
eduincome	0.6528*	0.1051*	0.4718*	0.5437*	0.2643*	0.4042*	1.0000

Table A5.1: Correlation coefficient Test Result
Source: Own

Variable	VIF	1/VIF
eduincome	123.36	0.008106
edu12	78.80	0.012691
logincome	9.67	0.103452
comkno12	1.45	0.688774
ecoclass2	1.39	0.720776
hhstatus12	1.36	0.735080
ecoclass3	1.29	0.775201
fininclu12	1.14	0.876829
age12	1.05	0.951889
Mean VIF	24.39	

Table A 5.2: VIF Test for Multicolinearity
Source: Own

```
               ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
        time |   -.5362879    -.3838037       -.1524841        .1703062
         edu |    -.253374    -.4389432        .1855692        .0622738
hhstatusas~t |    .7123742     .3559826        .3563916        .2530579
    fininclu |    .4973721     .4394155        .0579566        .2125769
      comkno |     .578265     .6085042       -.0302392        .5178865
      logage |    1.511277     .9661812        .5450961        .4347514
   eduincome |    .0664183     .1050101       -.0385919        .0130734
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtlogit
         B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       66.91
                Prob>chi2 =      0.0000
```

Table A5.3: Hausman Test Result for panel data analysis

```
Logistic model for cards12, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 | Exp_1 | Obs_0 |  Exp_0 | Total |
  |-------+--------+-------+-------+-------+--------+-------|
  |     1 | 0.0016 |     2 |   2.7 |  2520 | 2519.3 |  2522 |
  |     2 | 0.0029 |     5 |   5.5 |  2516 | 2515.5 |  2521 |
  |     3 | 0.0047 |    11 |   9.4 |  2510 | 2511.6 |  2521 |
  |     4 | 0.0075 |    20 |  15.1 |  2502 | 2506.9 |  2522 |
  |     5 | 0.0117 |    23 |  23.9 |  2498 | 2497.1 |  2521 |
  |-------+--------+-------+-------+-------+--------+-------|
  |     6 | 0.0181 |    46 |  37.0 |  2475 | 2484.0 |  2521 |
  |     7 | 0.0275 |    50 |  56.7 |  2472 | 2465.3 |  2522 |
  |     8 | 0.0432 |    80 |  87.7 |  2441 | 2433.3 |  2521 |
  |     9 | 0.0735 |   141 | 143.6 |  2380 | 2377.4 |  2521 |
  |    10 | 0.4930 |   329 | 325.4 |  2192 | 2195.6 |  2521 |
  +--------------------------------------------------------+

       number of observations =     25213
             number of groups =        10
      Hosmer-Lemeshow chi2(8) =         6.00
                  Prob > chi2 =         0.6469
```

Table A5.5: Hosmer Lemeshow Test Result for logistic Regression 1 for 2011-12
Source: Own

```
+--------------------------------------------------------+
  | Group |   Prob | Obs_1 | Exp_1 | Obs_0 |  Exp_0 | Total |
  |-------+--------+-------+-------+-------+--------+-------|
  |     1 | 0.0020 |     2 |   3.9 |  2520 | 2518.1 |  2522 |
  |     2 | 0.0032 |     5 |   6.6 |  2516 | 2514.4 |  2521 |
  |     3 | 0.0050 |    11 |  10.2 |  2510 | 2510.8 |  2521 |
  |     4 | 0.0074 |    17 |  15.3 |  2505 | 2506.7 |  2522 |
  |     5 | 0.0111 |    28 |  22.9 |  2493 | 2498.1 |  2521 |
  |-------+--------+-------+-------+-------+--------+-------|
  |     6 | 0.0166 |    35 |  34.6 |  2486 | 2486.4 |  2521 |
  |     7 | 0.0253 |    53 |  51.9 |  2469 | 2470.1 |  2522 |
  |     8 | 0.0401 |    90 |  80.4 |  2431 | 2440.6 |  2521 |
  |     9 | 0.0731 |   125 | 136.3 |  2396 | 2384.7 |  2521 |
  |    10 | 0.5740 |   341 | 344.9 |  2180 | 2176.1 |  2521 |
  +--------------------------------------------------------+

       number of observations =     25213
             number of groups =        10
      Hosmer-Lemeshow chi2(8) =         5.00
                  Prob > chi2 =         0.7581
```

Table A5.6: Hosmer Lemeshow Test Result for logistic Regression 2 for 2011-12
Source: Own

```
Logistic regression                                     Number of obs   =      15821
                                                        LR chi2(6)      =       1.20
                                                        Prob > chi2     =     0.9769
Log likelihood = -1288.4526                             Pseudo R2       =     0.0005

------------------------------------------------------------------------------
     cards05 | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         edu |   1.021911   .0913404     0.24   0.808     .8576913    1.217573
     logage |   1.003694   .0047321     0.78   0.434     .9944616    1.013011
     comkno |   1.221072   .7491825     0.33   0.745      .366852    4.064355
   fininclu |   1.090951   .3217249     0.30   0.768     .6120445    1.944587
  eduincome |   .9958706   .0195343    -0.21   0.833     .9583107    1.034903
   hhstatus |   .8780112   .2506798    -0.46   0.649     .5017353    1.536475
      _cons |   .0136005   .0036278   -16.11   0.000     .0080632    .0229407
------------------------------------------------------------------------------
```

Table A 5.7:Logistic Regression 1 for 2004-05 Reporting Odds Ratio (To Capture The Effect of Education)

```
Average marginal effects                        Number of obs   =      15821
Model VCE    : OIM

Expression   : Pr(cards05), predict()
dy/dx w.r.t. : edu05 age05 comkno05 fininclu05 eduincome05 hhstatus05

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       edu05 |   .0003384   .0013956     0.24   0.808    -.0023969    .0030737
    logage05 |   .0000576   .0000737     0.78   0.435    -.0000869     .000202
    comkno05 |   .0031182   .0095805     0.33   0.745    -.0156593    .0218956
  fininclu05 |    .001359   .0046048     0.30   0.768    -.0076662    .0103842
 eduincome05 |  -.0000646   .0003063    -0.21   0.833    -.0006649    .0005357
  hhstatus05 |  -.0020311    .004459    -0.46   0.649    -.0107706    .0067085
------------------------------------------------------------------------------
```

Table A 5.8:Logistic Regression 1 for 2004-05 Reporting Marginal Effect (To Capture The Effect of Education)

```
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 | Exp_1 | Obs_0 |  Exp_0 | Total |
  |-------+--------+-------+-------+-------+--------+-------|
  |     1 | 0.0146 |    24 |  22.5 |  1559 | 1560.5 |  1583 |
  |     2 | 0.0149 |    25 |  23.3 |  1557 | 1558.7 |  1582 |
  |     3 | 0.0152 |    26 |  23.9 |  1556 | 1558.1 |  1582 |
  |     4 | 0.0155 |    29 |  24.3 |  1553 | 1557.7 |  1582 |
  |     5 | 0.0158 |    20 |  24.7 |  1562 | 1557.3 |  1582 |
  |-------+--------+-------+-------+-------+--------+-------|
  |     6 | 0.0160 |    20 |  25.1 |  1562 | 1556.9 |  1582 |
  |     7 | 0.0163 |    18 |  25.6 |  1564 | 1556.4 |  1582 |
  |     8 | 0.0167 |    33 |  26.1 |  1549 | 1555.9 |  1582 |
  |     9 | 0.0173 |    22 |  26.9 |  1560 | 1555.1 |  1582 |
  |    10 | 0.0224 |    34 |  28.5 |  1548 | 1553.5 |  1582 |
  +--------------------------------------------------------+
       number of observations =     15821
             number of groups =        10
      Hosmer-Lemeshow chi2(8) =         9.40
                  Prob > chi2 =         0.3096
```

Table A5.9: Hosmer Lemeshowof Logistic Regression 1 for 2004-05

```
Logistic regression                                     Number of obs   =      15821
                                                        LR chi2(6)      =       1.67
                                                        Prob > chi2     =     0.9473
Log likelihood = -1288.2161                             Pseudo R2       =     0.0006

------------------------------------------------------------------------------
     cards05 | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 logincome05 |   .8740884   .1605796    -0.73   0.464       .60979    1.25294
       age05 |   1.003707   .0047329     0.78   0.433     .9944732    1.013026
    comkno05 |   1.207532   .7407761     0.31   0.759     .3628426    4.018641
  fininclu05 |   1.140956   .3418232     0.44   0.660     .6342407    2.052501
 eduincome05 |   1.000809   .0029118     0.28   0.781     .9951181    1.006532
  hhstatus05 |   .9337227   .2743184    -0.23   0.815     .5249807    1.660705
       _cons |   .0240547   .0192732    -4.65   0.000     .0050026    .1156655
------------------------------------------------------------------------------
```

Table A 5.10:Logistic Regression To Capture The Effect of Income for 2004-05 (Reporting Odds Ratio)

```
Average marginal effects                                Number of obs   =      15821
Model VCE    : OIM

Expression   : Pr(cards05), predict()
dy/dx w.r.t. : logincome05 age05 comkno05 fininclu05 eduincome05 hhstatus05

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 logincome05 |  -.0021009   .0028707    -0.73   0.464    -.0077275    .0035256
       age05 |   .0000578   .0000737     0.78   0.433    -.0000867    .0002022
    comkno05 |    .002944   .0095787     0.31   0.759      -.01583     .021718
  fininclu05 |   .0020586   .0046787     0.44   0.660    -.0071115    .0112288
 eduincome05 |   .0000126   .0000454     0.28   0.781    -.0000764    .0001017
  hhstatus05 |  -.0010706    .004587    -0.23   0.815    -.0100609    .0079197
------------------------------------------------------------------------------
```

Table A 5.11:Logistic Regression To Capture The Effect of Income for 2004-05 (Reporting Marginal Effect)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.0143	26	21.9	1557	1561.1	1583
2	0.0148	27	23.0	1555	1559.0	1582
3	0.0151	16	23.7	1566	1558.3	1582
4	0.0155	29	24.2	1553	1557.8	1582
5	0.0158	24	24.7	1558	1557.3	1582
6	0.0161	22	25.2	1560	1556.8	1582
7	0.0164	24	25.7	1558	1556.3	1582
8	0.0169	21	26.3	1561	1555.7	1582
9	0.0175	32	27.2	1550	1554.8	1582
10	0.0226	30	29.1	1552	1552.9	1582

number of observations = 15821
number of groups = 10
Hosmer-Lemeshow chi2(8) = 7.51
Prob > chi2 = 0.4831

Table A5.12: Hosmer Lemeshow of Logistic Regression 2 for 2004-05.

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