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Digital Banking through the Uncertain COVID Period: A Panel Data Study

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Abstract: This research investigates how the uncertainty caused by the COVID-19 pandemic has affected digital banking usage in India. The study is made by utilizing a panel of data consisting of 108 firm-month observations during covid period from 2020 to 2022, with data mainly collected to analyze the impact of COVID-19 uncertainty. Most of the determinants were collected from the RBI data website. The main emphasis of this study is on the utilization of digital banking services in the context of the pandemic, and the research assesses the factors that have influenced this trend, including the number of physical bank branches, the utilization of debit and credit cards at automated teller machines (ATMs) and points of sale (PoS), as well as the level of economic policy uncertainty (EPU). The analysis was conducted using panel regression analysis, a suitable method for handling the error components in the model that are either fixed or random. The findings indicate that the uncertainty caused by the pandemic has had a negative impact on the use of digital banking services. Additionally, the study highlights that the usage of debit and credit cards at PoS has significantly contributed to promoting the progress of digital banking services during the pandemic. Overall, this study provides valuable insights into how digital banking services have evolved during a period of significant uncertainty and disruption.

Keywords: digital banking; uncertainty; COVID; panel regression analysis



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1. Introduction

The term “digital banking” refers to using technology to conduct banking business via digital channels such as the internet, mobile phones, ATMs, and other electronic devices (Kaur et al. 2021). Online banking, e-banking, and internet banking are other terms for digital banking. Due to the India’s aim for a cashless economy, rising smartphone use, and increased internet usage, digital banking has become more popular in India in recent years (Chandrasekaran and Narayanan 2020). The provision of digital banking services facilitates access to a diverse range of financial products and services, such as account creation, deposit and withdrawal functions, bill payments, money transfers, as well as access to loans and other financial instruments (Ahmad Sheikh and Rajmohan 2017; Çalli 2022; Ali et al. 2022; Upadhyay et al. 2022).

In this context, the Reserve Bank of India (RBI) has implemented regulations and standards to ensure the safety and security of users engaging in digital banking activities

in India. Furthermore, various Indian banks have developed their own digital banking platforms with the aim of providing customers with an effortless and seamless banking experience.

Apart from public banks, private banks have also played a significant role in promoting and enhancing the growth of digital banking in India (Sarkar and Thapa 2021). Private banks in India have taken a leading role in innovating and incorporating novel technologies to enhance the overall banking experience for their customers. Some of the key initiatives taken by private banks include the following: the first mobile banking applications in India were released by private banks, enabling consumers to use their cellphones to access their accounts, conduct transactions, and access other financial services; in India, private banks have made it possible for consumers to register a new account online without going to a bank location; by developing solutions, such as mobile wallets, UPI, and other digital payment systems, private banks have been instrumental in advancing digital payments in India; by the provision of individualized and targeted services, real-time customer assistance, and other value-added services, private banks in India have used technology to enhance the client experience (Naskar 2021).

The introduction of new technology, improved user experiences, and promotion of digital payments have all contributed to the expansion of digital banking in India. This research, which looked at digital banking using a panel data method, offers helpful insights by demonstrating how it connects with uncertainty. The authors specifically examined different banking determinants and their effect on digital banking usage (Jindal and Jaspal 2020).

Since people were urged to remain at home to avoid the COVID-19 outbreak, digital banking witnessed a surge in global adoption (Kamesh 2021). People widely used internet banking to handle their money as a result of mobility limitations and social distance norms. Online money transfers, utility purchases, and online purchasing all saw a spike in many Indian banks (Adil and Hatekar 2020; Emara and Zhang 2021). Additionally, the epidemic increased demand for online financing services in India. During covid pandemic, the need for instant cash has arisen for many individuals, and to meet this demand, various online lending services and financing apps, such as Payzap, ICCI Paylater, and Paytm Postpaid, have facilitated the process of availing credit in a quick and convenient manner. Additionally, in order to help customers with their financial requirements, Indian banks have amplified their customer support via digital channels, such as applications and video conferences (Kamesh 2021).

The study of banking technology has been extensively researched across various countries for many years, as noted previously (Karthika 2021; Yamaoka 2019; Anong and Routh 2022). However, little research has been conducted on the factors that determine digital banking usage, particularly from the perspective of uncertainty. Consequently, this study aims to bridge this gap by examining the determinants of digital banking usage data from the top three private banks in India. The literature on digital banking is reviewed in the following section to provide context for the empirical analysis. The paper then presents the study's findings, followed by a discussion and conclusions, along with suggestions for future research.

2. Historical Perspective

Online and digital banking both have their origins in the 1980s, when banks started using technology to automate their back-office processes. However, the majority of financial transactions were still made at that time using conventional channels, including phone lines, branches, and ATMs (Yamaoka 2019).

Although, online banking was made possible in the 1990s due to the emergence of the World Wide Web (www) and improvements in internet technology. In 1994, Stanford Federal Credit Union introduced the first online banking service in the United States, which allowed users to access their account balances and perform money transfers via the internet (Kumar et al. 2021).

Between 2000 and 2010, a significant number of leading global banks provided digital banking services, thereby promoting the widespread adoption of such services. As smartphone use increased in the 2000s and 2010s, banks started to create mobile banking applications that let users access their accounts and complete transactions while on the move (Tiwari et al. 2019). This further drove the acceptance of digital banking. Nowadays, the majority of clients use online and mobile banking services to manage their accounts, making digital banking an integral aspect of the banking industry (Potter 2014). Artificial intelligence, machine learning, and Blockchain are just a few of the new technologies that have emerged in digital banking that are being utilized to improve user experience and allow the speed and security of financial transactions (Anong and Routh 2022). The historical viewpoint of digital banking demonstrates how technology has changed the banking sector and improved clients' access to, convenience with, and efficiency of the sector (Haralayya 2021).

2.1. Digital Banking (Theoretical Perspective)

A theoretical perspective of digital banking provides a framework that lists the essential elements and procedures related to the banking industry. Mainly, the digital banking process involve numerous layers (See Table 1) that each reflect a particular component of online banking.

Table 1. Digital User Enablers.

Enablers	Meaning	References
User Interface	The front-end of digital banking, which includes the online and mobile banking platforms that clients use to communicate with their bank, is represented by the user interface layer. Features including account information, transaction history, bill payment, money transfers, and other banking services are included in this layer.	(Srivastava and Vishnani 2021; Wardhani and Wijaya 2020; Kinjo et al. 2017; Bagana et al. 2021)
Middleware Layer	The user interface layer is linked to the bank's back-end systems, such as the payment gateway, core banking system, and other financial systems, through the middleware layer. This layer is responsible for performing the transaction processing, data validation, and other operations necessary for digital banking.	(Patil and Pawar 2016; Hung et al. 2007)

Table 1. Cont.

Enablers	Meaning	References
Core Banking System	The central database that houses all client and account information, transaction data, and other financial data is known as the core banking system. The actual processing of financial transactions, including as deposits, withdrawals, and money transfers, is within the purview of this layer.	(Andarwati 2016; Krishnamoorthy and Shivkumar 2020; Ari 2013; Hariharan and Reeshma 2015)
Security and Compliance	The incorporation of a security and compliance layer ensures the safety of digital banking operations while conforming to legal standards. To safeguard client data and stop fraud, this layer consists of procedures including encryption, multiple-factor authentication, and other security methods.	(Ammirato et al. 2019; Belás et al. 2016; Demirgüç-Kunt et al. 2013; Freitas and Maciel 2019; Singh et al. 2023)
Analytics and Reporting	To enhance digital banking services and inform corporate strategy, the analytics and reporting layer offers insights into consumer behavior and use trends.	(Hamidi and Worthington 2021; Rönnqvist and Sarlin 2017; Niankara 2019; Kekwaletswe and Lesole 2016)

In general, this above process offers a framework for comprehending the interrelated systems that make up digital banking and how they function as a whole to provide clients with a simple and comfortable banking experience.

Mainly, there are several parties engaged in digital banking who contribute to its development, implementation, and usage. Prior research has asserted that banks play a pivotal role in the development, execution, and provision of digital banking services to clients, thus positioning them as the principal participants within this industry (Shankar et al. 2022). Additionally, stakeholders are also recognized as key contributors to this domain. However, banks spend money on technology to make banking simple and easy while also guaranteeing the security of the transactions. On the other side, regulators establish the rules and regulations for the operation and use of digital financial services, hence, regulators also play a crucial role in the world of digital banking. Moreover, legal entities ensure that banks comply with legal standards pertaining to safeguarding client data, preserving privacy, and preventing fraudulent activities. From a technical perspective, technology vendors are responsible for supplying the necessary software and hardware solutions required for the development and implementation of digital banking services. It is worth noting that digital banking serves as a driving force behind enterprise evolution. In the process of banking enterprise evolution, the stakeholders provide services including payment gateways, mobile and online banking platforms, core banking systems, and other digital banking-enabling technology. Other partners include merchants, third-party suppliers, and other companies that work with banks to provide clients with digital banking services. E-commerce sites, suppliers of mobile wallets, and other companies that supply clients with value-added services might all fall under this category.

As per the above discussion, the development and implementation of digital banking solutions that suit client expectations while also maintaining the security and compliance of the system include a number of players.

This section examines the literature related to various determinants that can affect the digital banking usage.

The COVID-19 epidemic has caused unseen disruptions in both individuals' personal and professional lives (Emara and Zhang 2021). The lockdowns and social isolation practices used in India to stop the virus's spread have had a significant effect on the banking industry, spurring a rise in the use of digital banking services.

Banks and other financial organizations have had to quickly adjust to manage consumer demands and habits as a result of the epidemic, which has served as a wake-up call. The closure of physical locations and reduction in customer mobility has resulted in customers being forced to rely on digital banking channels for their financial transactions. As a result, digital banking is now India's most popular method of banking, ushering in a new standard for the sector.

The primary forces behind this acceptance have been the ease of use and security provided by digital banking. Customers no longer need to travel to a real location to conduct their financial operations because of online banking. Customers now have easier access to financial services, which has decreased the risk of malware exposure. The study comprises a list of variables that could have potentially exerted a substantial impact on the utilization of digital banking services amid the COVID-19 pandemic (See Table 2).

Table 2. Measures of DV and IDVs.

Determinants	Measure	Source
Digital Banking Usage (Dependent Variable)	$\frac{\text{Value of Mobile Banking Usage}}{\text{Volume of Mobile banking usage}}$	(RBI Data Base n.d.)
Uncertainty (Independent Variable)	Economic Policy Uncertainty Index	Baker et al. (2016)
Debit Card Usage at ATM (Independent Variable)	$\frac{\text{Value of Transaction}}{\text{No of Transaction}}$	(RBI Data Base n.d.)
Debit Card Usage at PoS (Independent Variable)	$\frac{\text{Value of Transaction}}{\text{No of Transaction}}$	(RBI Data Base n.d.)
Credit Card Usage at ATM (Independent Variable)	$\frac{\text{Value of Transaction}}{\text{No of Transaction}}$	(RBI Data Base n.d.)
Debit Card Usage at PoS (Independent Variable)	$\frac{\text{Value of Transaction}}{\text{No of Transaction}}$	(RBI Data Base n.d.)

2.2. Economic Policy Uncertainty (EPU)

In the context of banking, for individuals who are customers of a bank, the COVID-19 epidemic has caused an immense degree of uncertainty (Yang and Yang 2021). Lockdowns, social distance policies, and economic uncertainty have changed consumer behavior and expectations, with banks expected to respond swiftly to meet customer demands (Ahmed and Sarkodie 2021; Qian et al. 2021; Mokni et al. 2022). The pandemic's physical branch closures have been one of the major problems for bank customers. Prior to the onset of the COVID-19 pandemic, customers were already encountering challenges when attempting to execute tasks that necessitated their physical presence, such as opening accounts and depositing cash. This study has incorporated the Economic Policy Uncertainty (EPU) index developed by Baker et al. (2016) as a valuable tool to evaluate the impact of economic policy uncertainty on DBU (Baker et al. 2016). The EPU index has proven especially useful in monitoring the impacts of uncertainty on the Indian economy during the COVID-19 pandemic (Qian et al. 2021).

The COVID-19 epidemic has caused a substantial rise in uncertainty in India, based on the EPU index. Numerous variables, such as the government-enacted lockdowns and social segregation policies, the pandemic's economic effects, and the unknown course of the virus, have contributed to this uncertainty. Therefore, the study hypothesizes:

H1. *There is a reverse association between uncertainty and digital banking usage.*

2.3. Debit Card Usage at ATMs

The COVID-19 epidemic has significantly increased debit card usage at ATMs (Kantur and Özcan 2021; Yakean 2020). The closure of actual bank offices during the lockdown is one of the primary causes of the rise in debit card utilization at ATMs. Customers found it challenging to access financial services, such as monetary deposits and account creation, that call for real presence. The comfort and ease of such services also contribute to the rise in debit card utilization at ATMs. Customers frequently choose to use debit cards at ATMs because they are fast, secure, and require little physical interaction during the epidemic (Dong et al. 2021; Seiler 2020). A lot of banks have also improved their digital networks to make it simpler for clients to use their debit cards at ATMs. Therefore, the study hypothesizes:

H2. *There is a positive association between debit card usage at ATMs and digital banking usage.*

2.4. Debit Card Usage at PoS

During the COVID-19 pandemic, there were several challenges associated with using debit cards at PoS terminals (Dong et al. 2021; Kantur and Özcan 2021; Yakean 2020). Due to lockdowns and societal distancing measures, there were lesser real PoS devices available, which was one of the major causes of this challenge. The reduced frequency of purchases during the epidemic was another element making it challenging to use debit cards at PoS (Al-Maliki and Al-Assam 2021; Trütsch 2016; Dey et al. 2019). There were considerably fewer individuals leaving their homes and moving around less, which reduced the number of sales at real shops. This resulted in a decrease in the number of PoS devices that were accessible for use because some retailers were unable to rationalize the expense of keeping and running them. Therefore, the study hypothesizes:

H3. *There is a reverse association between debit card usage at PoS and digital banking usage.*

2.5. Credit Card Usage at ATMs

Several reasons have contributed to a decrease in credit card utilization at ATMs during the COVID-19 epidemic (Kantur and Özcan 2021; Carbó-Valverde and Rodríguez-Fernández 2014). Many people have opted for digital banking services, such as online purchases and mobile banking, in order to prevent physical interaction and reduce the risk of transmission in light of the lockdowns and social distance measures that have been put in place. Due to consumers choosing more digital alternatives, there is a decline in the use of credit cards at ATMs (Anong and Routh 2022; Aliapoulos et al. 2021; Scholnick et al. 2008). However, there has been a rise in the use of digital financial services as a result of the decrease in credit card use at ATMs. Due to the accessibility and simplicity of IT, many customers use mobile banking and internet purchases as a substitute for using credit cards at ATMs (Anong and Routh 2022; Aliapoulos et al. 2021; Gao et al. 2021). As a consequence, consumers have used digital banking more frequently generally during the epidemic as they become more acquainted with these services and advantages. Therefore, the study hypothesizes:

H4. *There is a reverse association between credit card usage at ATMs and digital banking usage.*

2.6. Credit Card Usage at PoS

The implementation of lockdown and other social distancing measures has led to a reduction in credit card usage for in-person purchases, resulting in a decline in credit card usage at PoS terminals (Al-Maliki and Al-Assam 2021). The decline in credit card usages has also been attributed to the pandemic's decreased access of physical PoS devices. Furthermore, the closure of many small businesses during the lockdown has resulted in a reduction in the number of PoS devices. As a result, customers faced difficulties in using their credit cards for purchases (Sahin et al. 2013; Von Solms 2016). Nevertheless,

the decrease in credit card usage at PoS has resulted in a rise in the popularity of digital payment alternatives. The COVID-19 pandemic has resulted in a significant increase in the adoption of digital banking services, including online transactions and mobile banking, as customers have become more comfortable with these digital payment methods (Mahboub 2018; Kantur and Özcan 2021). In response, many merchants have introduced contactless payment options such as mobile payment applications and digital wallets to promote the adoption of digital payments. Therefore, the study hypothesizes:

H5. *There is a reverse association between credit card usage at PoS and digital banking usage.*

3. Brief Descriptions of India's Top 3 Private Banks' Digital Banking

3.1. HDFC Bank (Source Rbi Database)

Amidst the COVID-19 pandemic, HDFC Bank, one of the leading private sector banks in India, has been a trailblazer in the country's digital banking initiatives. In India, HDFC Bank has introduced a number of significant digital banking projects, including mobile banking, internet banking, digital wallet, chatbots, and biometric authentication (Garg et al. 2016).

The mobile banking application developed by HDFC Bank has enabled customers to manage their accounts, carry out financial transactions, and avail other banking services on their personal mobile devices. The software furnished by the bank offers a range of features to enable customers to perform diverse banking operations, such as bill payments, fund transfers, credit card utilization, among others. Customers can access their accounts and other banking services using a web browser using HDFC Bank's online banking platform (Nagamani and Kumar 2019). The portal offers functions including online bill payments, financial transfers, and account opening. PayZapp, a digital wallet provided by HDFC Bank, enables users to pay bills, take advantage of promotions, and manage their cards and accounts from a single app. PayZapp allows customers to pay bills, make reservations, purchase items online, and perform other financial tasks (Source: www.hdfcbank.com, accessed on 10 February 2023). In order to provide clients real-time help and support, HDFC Bank has implemented chatbots also on both its website and mobile banking application. Artificial intelligence and natural language processing are the main features used by the chatbots to comprehend and reply to client inquiries. The HDFC Bank has expanded its mobile banking application by incorporating biometric identification functionality, permitting users to access and perform transactions through the use of their fingerprints. This feature provides customers with an additional level of convenience and security, as evidenced (Karthika 2021).

In India, HDFC Bank's digital banking efforts have improved consumer interactions with the bank overall by enhancing accessibility, convenience, and security. In a fast shifting digital market, the bank has used technology to provide creative solutions that address the changing demands of consumers (Borthakur 2022). However, during the COVID-19 pandemic period, there was a negative relationship between the usage of digital banking and economic policy uncertainty (see Figure 1).

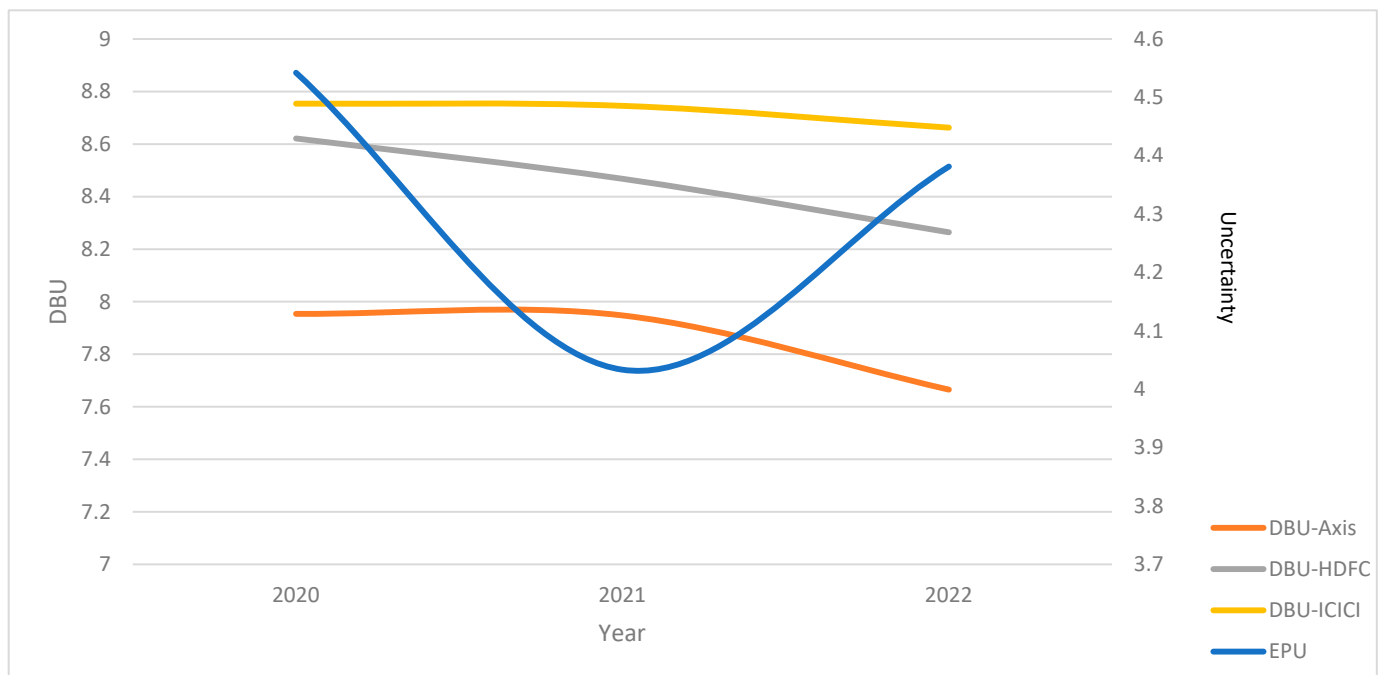


Figure 1. Uncertainty and DBU (Source: composed by authors according to RBI reports for DBU and Economic Policy Uncertainty Database).

3.2. ICICI Bank

Amidst the COVID-19 pandemic, ICICI Bank, also a one of the largest private sector banks in India, has been at the vanguard of the country's digital banking endeavors. ICICI Bank in India has undertaken many significant digital projects, some of which include Mobile Banking, Internet Banking, Digital Wallet, Video Banking, Voice Banking, and Robotics (Manjula Bai 2019).

ICICI Bank's mobile banking application enables customers to manage their accounts, execute financial transactions, and utilize a range of other banking services on their personal mobile devices. The software developed by ICICI incorporates a multitude of features, including bill payments, fund transfers, credit card usage options, and additional functionalities (Jha 2018). In addition, it enables customers to access their accounts and other banking services using a web browser using ICICI Bank's online banking platform (Ayswarya et al. 2019). The portal offers functions including online bill paying, financial transfers, and account opening. In addition to net banking, it allows customers to make payments, take advantage of incentives, and manage their cards and accounts from a single app using ICICI Bank's digital wallet, known as "Pockets", with which most kinds of bills can be paid, tickets can be booked, internet shopping can be performed, and more. Moreover, ICICI Bank provides virtual banking services that let clients communicate with bank employees through video conferencing (Source: www.icicibank.com, accessed on 10 February 2023). Opening accounts, requesting loans, and using other financial services are all possible via such digital service. Recently, ICICI Bank launched voice banking services that let clients use voice commands to access their accounts and complete transactions. Artificial intelligence and natural language processing are the main features that used in this function to comprehend and address client inquiries. To automate back-end procedures and boost productivity, ICICI Bank has used robotic process automation (RPA). Account reconciliation, check clearing, and other repetitive, time-consuming processes are some of the functions that RPA is employed for (Abdulkareem 2020). Figure 1 depicts the association between the utilization of digital banking services by ICICI Bank and the level of uncertainty experienced during the COVID-19 pandemic.

In general, ICICI Bank's digital banking efforts have improved consumer interactions with the bank and have made banking more easy, accessible, and safe. In a fast-shifting

digital market, the bank has used technology to provide creative solutions that address the changing demands of consumers (Parameswar et al. 2017).

3.3. Axis Bank

Axis Bank, one of the leading private sector banks in India, has launched several digital initiatives to enhance its services and attract customers, especially during the COVID-19 pandemic. Some of the key digital initiatives taken by Axis Bank include Mobile Banking, Internet Banking, Contactless Payments, Digital Savings Account, Chatbot, AI-Powered Risk Management, and Blockchain-Based Trade Finance (Leepsa and Singh 2017).

Axis Bank has made available a mobile banking application that allows its customers to perform various financial activities on their mobile phones (Kaila et al. 2019). The app offers a number of services, including account management, bill payment, credit card payment, and money transfers. In addition, Axis Bank provide access to internet banking services, enabling customers to conduct financial activities anytime, anywhere. The bank's online banking system includes tools for managing accounts, paying bills, transferring money, and payments using credit cards. Near-field communication (NFC) technology is used by Axis Bank's Tap & Go cards, a kind of contactless payment option, to process transactions at merchant locations (Kavitha 2018). Axis Bank has recently introduced a digital savings account that can be managed completely online (Source: www.axisbank.com, accessed on 10 February 2023). Using the bank's website and mobile app, Axis Bank has introduced a chatbot named Axis Aha! that employs artificial intelligence to provide immediate client support and assistance. Axis Bank has put in place a real-time risk identification and management system that is driven by AI. The system uses machine learning techniques to analyze large amounts of data and identify potential threats. To make the trade finance process simpler and more efficient for its clients, Axis Bank has deployed a blockchain-based trade finance system. The technology shortens the processing time for trade finance transactions and allows clients to follow the progress of their transactions in real-time (Arun and Singh 2019). Figure 1 depicts the association between the utilization of digital banking services by Axis Bank and the level of uncertainty experienced during the COVID-19 pandemic.

These digital efforts of Axis Bank show the bank's dedication to offering its clients cutting-edge and practical financial services (Maharana et al. 2015).

4. Data and Methodology

An empirical analysis was conducted between 2020 and 2022 to test the hypotheses by selecting a group of Indian private banks using data from the Reserve Bank of India (RBI) database. The RBI regulates the Indian financial system and provides papers, studies, and instructional resources on banking and Indian economic time series. RBI bulletins were utilized to track digital banking data across the population, and data for the Covid years (2020–2022) was extracted to form a panel dataset. To maintain data accuracy, any incomplete data for the six factors during the study period for firm-months were removed, and only observations with 36 consecutive months of uninterrupted time series data records were included. Outliers that had extremely high or extremely low significance and fell outside of the three-standard deviation area of the mean measurement were also removed. This resulted in 108 firm-months observations for three financial companies covering the 2020–2022 Covid time span. The natural log transformation was used in the study to normalize the dependent variable (DBU) with respect to the mean and variation (Nevill and Holder 1995).

As the research relies on a panel data set, the use of pooled-OLS may lead to inaccurate estimations (Myovella et al. 2020). To address potential issues of heteroscedasticity and serial correlation, three test statistics were utilized to determine the most appropriate methods. The first test used was the Hausman test, which determines whether a fixed effects model or a random effects model is more suitable for the analysis. The results of the Hausman test indicated that a fixed effects model was appropriate for the study at a

significance level of 0.05, as evidenced by the calculated Chi² value of 469.74 and a *p*-value of 0.000. The second test, the Pesaran test, was used to examine serial correlation, and its results showed a calculated chi square value of 2.55, with a *p*-value of 0.010, which was within the serial correlation range (Pesaran et al. 2008). The third test, the Modified Wald test (XTTEST3), was utilized to investigate heteroscedasticity, and its results revealed a heteroscedasticity concern with a calculated Chi square value of 251.62 and a *p*-value of 0.000 (Gujarati 2003; King et al. 2017). Based on these findings, the GLS regression model was selected as the most suitable method to deal with the problem of serial correlation and heteroscedasticity.

5. Results

The descriptive statistics for digital banking usage during the COVID period have been identified and are presented in Table 3 below.

Table 3. Digital Banking Usage of Selected Banks.

Year	Observation	Mean	Standard Deviation	Minimum	Median	Maximum
AXIS Bank						
2020	12	7.95	0.23	7.64	7.88	8.31
2021	12	7.94	0.28	7.51	7.84	8.42
2022	12	7.66	0.07	7.57	7.64	7.80
HDFC Bank						
2020	12	8.62	0.04	8.50	8.62	8.69
2021	12	8.46	0.07	8.37	8.47	8.56
2022	12	8.26	0.07	8.16	8.24	8.37
ICICI Bank						
2020	12	8.75	0.08	8.56	8.76	8.87
2021	12	8.74	0.10	8.61	8.75	8.93
2022	12	8.66	0.04	8.61	8.65	8.74
Total	108	8.34	0.40	7.51	8.47	8.93

Table 3 shows that digital banking usage (DBU) had an average value of 8.34 during the COVID period, suggesting that digital banking usage was positive during the pandemic. Furthermore, the selected banking firms experienced a continuous decrease in DBU throughout the duration of the study.

Table 4 presents descriptive statistics for all selected variables. The mean value for DBU is 8.34, and its standard deviation is 0.40, which suggests that the distribution of DBU is less skewed. The economic policy uncertainty (EPU) during the pandemic period is less diverse, as reflected by the mean value of 4.31 and standard deviation of 0.37. The mean number of branches is 5277, and its standard deviation is 517.00, indicating a considerable variance across all the firms. Therefore, due to the high variance, the natural log values of branches were used in this study. The average debit card utilization rate at ATMs is 8.76, whereas at PoS it is 7.65, indicating that this behavior for making card transactions is effective but customers who tend to rely more on using their debit cards for purchases at ATMs rather than at PoS. The average credit card usage at ATMs is 8.49, which is somehow similar to debit card usage at ATMs. However, credit card usage at PoS has a higher mean value than debit card usage at PoS, indicating that customers prefer using credit cards over debit cards for purchases at PoS.

Table 4. Descriptive statistics.

Variable	N	Mean	Standard Deviation	Minimum	Median	Maximum
Branch	108	5277	517.0	4451	5261	7175
DBU	108	8.34	0.40	7.51	8.47	8.93
EPU	108	4.31	0.37	3.15	4.33	5.12
DEBIT-C@ATM	108	8.76	0.61	8.48	8.67	13.24
DEBIT-C@PoS	108	7.65	0.16	7.22	7.68	7.93
CREDIT-C@ATM	108	8.49	0.30	6.90	8.50	8.82
CREDIT-C@PoS	108	8.19	0.15	7.60	8.20	8.53

Prior to analyzing the panel regression model, the Pearson correlation coefficient was employed to assess the relationship between the independent variables and the dependent variable DBU.

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{[\sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2]^{1/2}}$$

The Pearson correlation coefficient (Lee Rodgers and Nicewander 1988) is represented by the formula: $r = (X_i \text{ and } Y_i \text{ for } i\text{th observation})$, which denotes the values of any two variables for the $i\text{th}$ observation.

Table 5 displays that there exists a significant and positive association between DBU and credit card usage at PoS and ATMs. Conversely, DBU has a negative correlation with EPU, utilizing a debit card at an ATM, and utilizing a debit card at a point of sale.

Table 5. Pearson correlation coefficients.

	Branch	DBU	EPU	DEBIT-C@ATM	DEBIT-C@PoS	CREDIT-C@ATM	CREDIT-C@PoS
Branch	1	0.422 **	−0.031	0.081	0.303 **	0.171	0.305 **
DBU	0.422 **	1	−0.003	−0.068	−0.162	0.218 *	0.188
EPU	−0.031	−0.003	1	0.003	−0.386 **	0.062	−0.499 **
DEBIT-C@ATM	0.081	−0.068	0.003	1	0.197 *	−0.025	−0.029
DEBIT-C@PoS	0.303 **	−0.162	−0.386 **	0.197 *	1	−0.174	0.472 **
CREDIT-C@ATM	0.171	0.218 *	0.062	−0.025	−0.174	1	0.242 *
CREDIT-C@PoS	0.305 **	0.188	−0.499 **	−0.029	0.472 **	0.242 *	1

* Significant at the 0.05 level; ** Significant at the 0.01 level.

Table 6 indicated the presence of heteroscedasticity, as revealed by the XTTEST, leading to the adoption of GLS regression for the analysis in this study instead of fixed effect panel regression.

Table 6. Fixed Effect Panel Regression Analysis Hausman $\chi^2 = 469.74$ (0.000); $F = 15.35$ (0.0000); R^2 (within) = 0.4820, between = 0.8005.

	Coef.	Std. Err.	t	P > t	[95% Conf. Interval]	
CREDIT-C@ATM	0.0388	0.0490	0.7900	0.4300	−0.0584	0.1361
CREDIT-C@PoS	0.3103	0.1273	2.4400	0.0170	0.0577	0.5629
DEBIT-C@ATM	−0.0089	0.0216	−0.4100	0.6790	−0.0517	0.0338
DEBIT-C@PoS	−0.4945	0.1310	−3.7800	0.0000	−0.7544	−0.2346
EPU	−0.0347	0.0419	−0.8300	0.4100	−0.1177	0.0484
Branch	−1.1796	0.3595	−3.2800	0.0010	−1.8930	−0.4662
Cons.	19.5866	3.0217	6.4800	0.0000	13.5909	25.5823

Table 7 presents the outcomes of the panel regression model, which was applied to identify the variables that may have an impact on DBU. The statistical analysis confirms that the model is significant and effectively takes into account all the variables that were examined to evaluate their impact on the selected firms' DBU. This is evidenced by a Wald χ^2 value of 49.95 and a significance level of 0.01 (see Table 7). The results indicate that

the use of a credit card at PoS has a positive effect on DBU than using it at the ATM, as demonstrated by the positive coefficients of the t-statistic for credit card usage at PoS. Conversely, debit card usage at PoS has a negative coefficient, indicating an adverse effect on DBU. Moreover, the statistical analysis reveals that there is no significant difference in the impact of economic policy uncertainty (EPU), and credit and debit card usage at ATMs on DBU at the 0.05 level of significance.

Table 7. GLS Regression Analysis; Modified Wald test (XTTEST3) = 251.62 (0.000); Pesaran = 2.55 (0.01); Wald $\chi^2(6)$ = 49.95 (0.000).

	Coef.	Std. Err.	z	P > z	[95% Conf. Interval]	
CREDIT-C@ATM	0.0162	0.1176	0.1400	0.8900	−0.2143	0.2466
CREDIT-C@PoS	0.5469	0.2814	1.9400	0.0520	−0.0046	1.0983
DEBIT-C@ATM	−0.0115	0.0539	−0.2100	0.8310	−0.1171	0.0942
DEBIT-C@PoS	−1.0199	0.2495	−4.0900	0.0000	−1.5089	−0.5310
EPU	−0.0491	0.1048	−0.4700	0.6390	−0.2544	0.1562
Branch	2.0618	0.3751	5.5000	0.0000	1.3266	2.7970
Cons.	−5.8236	3.2574	−1.7900	0.0740	−12.2079	0.5607

6. Discussion

The descriptive findings indicate an inverse relationship between economic policy uncertainty and digital banking usage among Indian private banks (see Figure 1). This study adds to the existing literature on the use of digital banking, which includes works by (Kaur et al. 2021; Kamesh 2021; Emara and Zhang 2021). The research reveals that a company's adoption of digital banking is substantially influenced by the level of uncertainty it faces. This is the first study of its kind to examine the association between uncertainty and digital banking usage in private Indian banking firms. Previous studies have shown that uncertainty and digital banking usage have a negative association due to risk aversion and a lack of information about uncertain events, as emphasized in the previous literature (Wibowo and Aumeboonsuke 2020; Syed et al. 2022).

The negative coefficient observed for debit card usage at PoS implies that customers were less inclined to use debit cards for making purchases during the uncertain times of the pandemic, and instead opted to use credit cards. This could be because credit cards generally offer better protection against fraud compared to other cards. In case of fraudulent transactions on a credit card, the cardholder can dispute the charge and the card issuer is likely to investigate the matter. In contrast, using a debit card for an unauthorized transaction can be more challenging to recover the lost funds since the money is immediately deducted from the account.

Credit cards also provide the flexibility of postponing payments until the end of the billing cycle, which can be advantageous for managing cash flow during uncertain times. Additionally, many credit cards offer incentives and rewards such as cashback or points for using the card for purchases. This makes credit cards a more attractive option for customers who want to maximize the benefits of their expenditures.

The positive coefficient for branches provides evidence to support the idea that there is a significant and positive relationship between the number of bank branches and the usage of digital banking by private Indian banks. Previous research suggests that during situations where physical branches are closed or access is restricted due to social distancing measures, customers tend to rely more heavily on digital banking services. This could be an advantage for banks with a greater number of branches as they can reach a larger audience and provide more convenient access to digital services.

However, banks with fewer branches may face a disadvantage because they may not have the same level of infrastructure or customer support for digital banking. This could make it more challenging for customers to adopt and use digital banking services, especially if they encounter technical difficulties or are unfamiliar with the technology.

As per previous findings, India's private banks have made a substantial contribution to the country's banking industry and to the expansion of the economy. The Indian banking industry, which has historically been dominated by public sector banks, is becoming more competitive due to the entry of more private banks. As a result, private banks now provide better technology, quicker services, and new products, improving services and raising customer satisfaction. Although, private banks in India have been leaders in the introduction of cutting-edge banking products and services, including digital payment alternatives, internet banking, and mobile banking (Bansal 2020a). The utilization of digital banking has also led to the provision of investment products and wealth management services customized to the inclinations of affluent individuals. In addition, India's private banks have made a significant contribution to job creation in the country by expanding their operations and opening new branches, which has, in turn, created job opportunities in various other segments. Therefore, it can be asserted that in India, the use of financial services has increased primarily due to private banks. Furthermore, private banks have expanded the availability of financial services to consumers in the remotest parts of the country by leveraging their extensive branch networks and offering innovative products and services. India's private banks have led the way in using new technologies in the banking industry. They have made significant investments in technology, resulting in the creation of new goods and services, and they have embraced emerging innovations such as Blockchain, artificial intelligence, and machine learning quickly (Srivastava et al. 2019). Overall, private banks in India have contributed significantly to the growth of the banking industry by fostering competition, innovation, employment, and greater access to financial services. The pivotal role played by private banks in driving the adoption of new technologies has facilitated the growth of the financial sector, ultimately contributing to the advancement of the nation's economy.

7. Theoretical and Policy Implications

Regarding the policy implications of digital banking, it is apparent that government officials need to ensure that the employment of digital banking by private banks is governed by explicit regulations. This would include laws governing consumer protection, fraud prevention, and data privacy and security. Policies should also be in place to guarantee that there is no monopolistic activity in the digital banking sector and that all institutions, including private banks, follow fair competition procedures (Shettar 2019). While digital banking has the potential to be a significant instrument for financial inclusion, authorities must make sure that everyone can take advantage of its advantages, especially those who live in rural places or have restricted access to technology. The spread of digital banking services to these underserved regions should be encouraged through policies, and private banks should be encouraged to take part in such programs. As more of the population use technology, there is a heightened risk of cyberattacks and data breaches. Therefore, to secure the data of the clients, private banks must employ strong cybersecurity procedures, which should be mandated by laws and regulations (Gupta 2018). Government officials should support private banks' innovation in digital banking services while ensuring that consumers are adequately protected. This would include giving private banks the freedom to test out novel products and services and establishing a legal framework that permits experimentation without sacrificing security and privacy. To support the expansion of the digital banking industry, policymakers should encourage cooperation between private banks and other financial organizations. This would include encouraging the creation of open banking frameworks, which allow private banks to exchange data and engage with other financial institutions to provide their clients cutting-edge and practical services (Bansal 2020b). Therefore, regulators must create laws and rules that encourage private banks to expand into the digital banking market while guaranteeing that everyone can benefit from it and that consumer protection, cybersecurity, and ethical business practices are to be in place.

India's private banks have contributed significantly to the expansion and improvement of the nation's banking industry. The country's economy has benefited from its digital banking efforts since they have boosted competition, innovation, and accessibility to financial services. To make sure that everyone can benefit from digital banking and that there is sufficient consumer protection, cybersecurity, fair competition, and cooperation with other financial institutions, authorities must take into consideration a variety of policy consequences. Private banks may continue to fuel the growth and development of the digital banking industry in India with the correct rules and regulations in place, eventually assisting in the expansion and development of the Indian economy. In addition, private banks' adoption of digital banking has complicated regulatory ramifications. As a result, there may be disagreements about the optimal strategy for ensuring that all banks operate on an equal footing while fostering the expansion of the digital banking industry. Moreover, it is crucial to concern that the banking industry is always changing, and new advancements may occur that might have an influence on the function of private banks in India and their digital banking activities.

8. Conclusions

The study's descriptive outcome suggests that there is an inverse relationship between economic policy uncertainty and digital banking usage among private banks in India. This finding is supported by previous literature that indicates a negative association between uncertainty and digital banking usage due to risk aversion and a lack of information about uncertain events. The study also highlights the advantage of credit card usage at PoS over ATMs during uncertain times due to better protection against fraud and the flexibility of postponing payments. Moreover, the positive coefficient for branches suggests that banks with a larger number of branches have a greater advantage in reaching a larger audience and providing convenient access to digital services. The study concludes that private banks in India have made significant contributions to the growth of the banking industry by fostering competition, innovation, employment, and greater access to financial services through the adoption of new technologies. As per the study, both microeconomic and macroeconomic variables hold significance in determining the adoption of digital banking. This study investigated the potential effects of macro-level factors, especially economic policy uncertainty, while mostly earlier studies tended to concentrate on micro-level factors. The research findings suggest that banks should take into consideration the potential adverse effects of uncertainty when devising digital banking policies, as these effects may be similar in magnitude to those resulting from making an unfavorable decision. The results of the study have significant implications for banking firms, financial organizations, policymakers, and experts in addressing the micro and macro-level factors that could impact digital banking usage.

Since this study relied solely on data from the COVID period, it is suggested that future research should incorporate time-series data from a larger number of companies to more comprehensively generalize the results by incorporating other identifiable variables, such as the type of government aid offered, the market segment, and economic factors, among others. In addition, future research can concentrate on public sector banks also rather than solely on private banks.

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