International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
Volume 4, Issue 2, Mar-Apr-2026, PP: 01-16
ISSN:3048-7722

Impact of Central Bank Digital Currency (CBDC) on Banking Variables: Evidence from Indian Commercial Banks

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***Abstract* – Purpose — The following research will look into the empirical relationship of introduction of Central Bank Digital Currency (CBDC) to two important banking variables, deposit growth and credit growth in the Indian commercial banking system. The rationale behind the study is the rising policy concern over the world about CBDC and the critical poverty of bank level empirical data on its impacts especially in the case of large emerging economies where the financial structure, regulatory framework, and digital infrastructure system vary significantly with the advanced economies where prevailing theoretical frameworks are optimized Design/Methodology/Approach — A quantitative, non-experimental research design is implemented. The results of the analysis of panel data on 19 Indian commercial banks in the period between the fiscal years 2018 and 2025 provide 151 bank-year observations. Two Ordinary Least Squares (OLS) regression equations are estimated in which the deposit growth is the dependent variable and the credit growth is the dependent variable. The CBDC variable is operationalised as a binary dummy variable, which will be set to 1 between 2022 to 2025 Indias Digital Rupee (e- INR) pilot programme and to 0 between 20182021 which is the pre-pilot period. This includes GDP growth rate and RBI repo rate that are the control variables in the macroeconomy and the current monetary policy condition and environment respectively. Findings — The results indicate that there is an asymmetric pattern of association. There is no statistically significant difference in the growth of deposits between the two periods of CBDC introduction (b3 = [?]0.0148, p = 0.605), which means that there is no statistically significant deposit displacement throughout the pilot period. GDP growth alone (b1 = 0.0301, p < 0.001) and the repo rate (b2 = [?]0.0338, p = 0.025) have the largest negative effect on deposit behaviour, which is secondary. The deposit growth model has a good level of explanatory power (R2 = 0.453). Conversely, the CBDC dummy variable relates positively and significantly to credit growth (b3 = 0.0698, p = 0.008), which is an unexpected result that contradicts the theoretical account of disintermediation of the bank, but is in line with complementarity arguments and the institutional aspects of the pilot phase. There is less explanatory power of the credit growth model (R2 = 0.099). Research Limitations and Implications — The CBDC dummy records the time of introduction and not the actual intensity of adoption, allowing the CBDC coefficient susceptible to omitted variable bias in simultaneous structural changes like the post-COVID credit recovery of India. The lack of bank-level control variables and fixed effects is a known weakness. Despite this, the research offers empirical data that the conservatively designed e-INR pilot in India has not upset deposit mobilisation, and the positive credit association can be credited to the digital infrastructure complementarities, and not direct CBDC impacts. The results have a direct implication on the design calibration of the CBDC and a gradual scaling of the e-INR programme. Originality/Value — The research may be described as one of the first attempts to make use of bank-level OLS panel regression to empirically measure the relationship between the introduction of CBDC and the banking performance in the Indian environment. Available literature in this field has been largely theoretical, simulation oriented or biased on developed economies. The study adds a new empirical layer, previously lacking the country-specific, institution-level, quantitative evidence of the current policies, to a literature that has so far remained devoid of CBDC policy dummy and macroeconomic control.**

***Keywords* – Central Bank Digital Currency (CBDC), Digital Rupee (e-INR), Indian Banking System, Deposit Growth, Credit Growth, Commercial Banks.**

I. INTRODUCTION

The growing popularity of Central Bank Digital Currency (CBDC) is an indicator of a larger change in financial systems, which is determined by the gradual digitalisation of the economic life, by the secularisation of the use of physical money, and by the increased need to find more efficient payment methods. CBDC is currently explored or piloted by central banks in a significant range of jurisdictions, and central banks have goals of reducing the efficiency of payment systems and enhancing the effectiveness of monetary policy transmission, as well as financial inclusivity and cutting the cost of cross-border payments (BIS, 2018; Engert and Fung, 2017). By 2024, it was estimated that more than 130 nations, comprising over 98 percent of the world GDP, had been at some level of CBDC exploration, and China, the Bahamas, Nigeria and Jamaica were already in the most advanced stages of live implementation.

In the literature, CBDC is widely understood as a type of digital central bank liability that may be directly usable by the general population and can be used to make payments, save money, and settle bills (Grym, 2018). Compared to cryptocurrencies issued privately, e.g. Bitcoin or Ethereum, CBDC is an assignment of claim of action against the central bank, and it bears the entire faith and credit of the sovereign issuer. More importantly, the characteristics of its design, such as the interest bearing nature and the presence of holding limits, the level of its interaction with the current banking architecture via commercial bank intermediaries, and the level of programmability, define the scale and orientation of its dynamic interaction with the current banking structures (Agur et al., 2021; Auer and Bohme, 2020). These design variables are hence not just technical

ISSN:3048-7722

decisions but they are actually consequential to the stability of commercial bank funds and credit generation.

In India, the pilot of the Digital rupee (e-INR)- India's retail and wholesale CBDC- was initiated as a pilot by the Reserves Bank of India (RBI) starting in late 2022. The retail pilot that, initially with the participation of a small number of commercial banks, such as State Bank of India, HDFC Bank, ICICI Bank, and Axis Bank, was later extended to other banking and non-banking affiliates, was aimed at testing the viability of operations, as well as the social acceptance of a sovereign digital currency. The Indian CBDC was set in a conservative way: the e-INR is not held with interest, has limits to holding and was meant to be used in addition to bank deposits and not to substitute them. This establishes a clear empirical situation, according to which the relation between the introduction of CBDC and bank-level results can be discussed within a certain time frame, with the help of the data of participating and closely related institutions.

The theoretical literature on CBDC provides mixed forecasts on the impacts of the practice on commercial banking. The most widely discussed is the mechanism of bank disintermediation: in case households and firms convert funds on bank deposits into CBDC wallets, and are driven by the safety or convenience or yield benefits of a central bank liability, the deposit base of commercial banks may contract, limiting their ability to issue credit (Infante et al., 2022; Munoz and Soons, 2024). Even a small deposit movement in a fractional reserve banking system like that of India can cause disproportionate impacts on the credit in the market. On the other hand, there is also a literature branch that believes that CBDC can be as functionally close to bank deposits as suited policy frameworks would allow, meaning that a well-calibrated digital currency would not necessarily cause issues with financial intermediation (Brunnermeier and Niepelt, 2019; Niepelt, 2018). The third view is that CBDC can be a complementary effect, namely, enhancing digital financial infrastructure, lowering transaction cost, and promoting efficiency in credit origination, which facilitates but does not limit banking activity (Morales-Resendiz et al., 2021).

Although these contributions have been comprehensive, the research on the relationship between CBDC and bank-level performance is still conspicuously thin. Theoretical modelling, simulation, or conceptual analysis has been the most prominent methodological approach in the literature (Agur et al., 2021; Hess, 2025; Matsuoka and Watanabe, 2025). There is significantly a lack of bank level, data based empirical research directly looking at the relationship between the introduction of CBDC and deposit and credit growth based on observational data of real pilot programmes- a gap that is especially severe in less developed economies. (Priyadarshini & Kar, 2021) lament this lack in the Indian context particularly, which states that the probability of CBDC effect is influenced by country-specific variables in the manner in which theoretical frameworks that have been developed to fit the context of advanced economies cannot effectively attend to.

This paper fills these knowledge gaps by examining these banks at the bank level through an empirical study of panel data on 19 commercial banks in India during the study period, 2018 to 2025. To test the statistical relationships between the introduction of CBDC and (a) deposit growth and (b) credit growth, two Ordinary Least Squares (OLS) regression models are estimated, which factor in the macroeconomic conditions that are accepted determinants of the banking behaviour, namely

GDP growth rate and the RBI repo rate. The research does not purport to show causality, which would necessitate identification methods beyond the data and design of the present data; instead, it will just characterise the statistical relations between the CBDC period and banking performance, and place the relations in the context of the theoretical literature and Indian policy.

The research work adds to the literature in three major ways. It presents, first, bank level panel evidence of the Indian CBDC pilot, which is empirically new as there is a lack of research done with data in this field. Second, it combines the growth of deposits and credit in a single analytical structure with the macroeconomic controls, which enables concurrent evaluation of the liability- side and asset-side implications of CBDC. Third, it offers context-specific knowledge based on the institutional nature of Indian banking and the policy formulation of the RBI, thus, extending the majority of literature with Western-focused economies to the fifth-largest economy in the world and a significant emerging market. The rest of this thesis is structured in the following way.

Section 2 is the overview of the current theoretical and empirical literature. The research methodology is explained in Section 3. The regression outcome has been provided in section 4. The section 5 talks about the findings. Section 6 concludes. The limitations, direction of future research, and policy implications are discussed in sections 7, 9 and 8 respectively.

II. LITERATURE REVIEW

This part will examine the theoretical and empirical research of CBDC and its impact on the commercial banking system especially in terms of deposit mobilisation, credit growth, and financial intermediation. The review is structured thematically, and it starts with conceptual background of CBDC research up to the channel impacts on banking and the research gaps. The section ends with the positioning of the current study into the available body of knowledge and expressing the particular contributions of the current study.

Theoretical Underpinnings of CBDC.

As early as the mid-2010s, the academic literature on Central Bank Digital Currency started to merge, originally

ISSN:3048-7722

due to its policy implications (about the decreasing popularity of physical cash and the blistering development of personal digital payment systems and cryptocurrencies). In a working paper that forms the basis of Bank of Canada thinking on the subject, Engert and Fung (2017) place the CBDC within the framework of policy response to these structural changes, exploring both the reasons why it should be issued, and the impact of this change on monetary policy and the payment system. In 2018, the Bank for International Settlement (2018) offered one of the first and most commonly used models of categorizing the digital currencies based on the dimensions of the issuer, form, accessibility, and underlying technology- a taxonomy that later formed the basis of much of the subsequent literature.

The conceptually different approach was provided by Grym (2018), who states that digital currencies can be better considered as modifications of the current monetary accounting systems and not as entirely new tools. This input refuted the fact that CBDC is a qualitative break to the previous monetary forms and focused more on continuity in the economic role of money. Although these pioneering studies formed the conceptual vocabulary of CBDC studies, they were not constructed to, and did not study, the observable effects of CBDC on banking variables. They are important to the current research because they offer both a definitional and taxonomic basis on which the operationalisation of the CBDC construct utilized in the research design takes place.

Kahn et al. (2018) and Said (2019) further developed the initial conceptual argumentation by discussing the potential use of CBDC to enhance the effectiveness of the existing payment systems and advance the process of financial inclusion and at the same time signify the potential competitive implications of commercial banks due to the direct delivery of a risk-free electronic payment mechanism by the central bank. Auer and Bohme (2020) then suggested an extensive technological design way of retail CBDC, focusing on trade-offs between user privacy, security, and accessibility and operational resiliency design choices that have direct and material implications regarding whether CBDC can displace or complement bank deposits.

CBDC and Financial Intermediation.

One of the outstanding issues in the theoretical literature is that CBDC has the potential to destabilise financial intermediation, which would have consequences on deposit mobilisation and supply of credit. The review of the macroeconomic effects of CBDC by Infante et al. (2022) was one of the most comprehensive ones, in the conclusion of which the authors found that the impact of this policy on bank credit fundamentally depends on the design characteristics, in particular, whether CBDC is interest-bearing and whether there are limits on its holding. Bank disintermediation is a major risk that they point to: individual replacement of bank deposits with holdings of CBDA deprives the bank of a stable source of funds, which under a fractional reserve system has multiplied effects on the ability to extend credit. Hypothesis 1 of the current study is based on this mechanism.

Muñoz and Soons (2024) modelled this issue in a Diamond-Dybvig banking model, and showed that even a CBDC introduced as a store of value (especially when it provides greater safety or liquidity compared to deposits in a bank), can trigger a partial (but significant) substitution of deposits. The scale and welfare impacts of this substitution however emerge to be extremely sensitive to the beliefs of the agents regarding the bank bankruptcy and the parametric form of the CBDC tool. Bindseil et al. (2024) also applied this literature to central bank balance sheets and showed that the issuance of CBDC influences central bank profitability, risk exposure, and capital structure, and the extent to which it does so is contingent on remuneration policy and the level of CBDC adoption.

Brunnermeier and Niepelt (2019) and Niepelt (2018) also developed the equivalence proposition, in which, under certain policy conditions, particularly, in case central bank intermediates CBDC via commercial banks and grants them equivalent refinancing facilities, the appearance of CBDC does not have to interfere with financial intermediation. In this context, the CBDC macroeconomic equilibrium corresponds to the status quo. Although the elimination of the central bank refinancing behaviour is theoretically elegant, it is based on assumptions about central bank refinancing behaviour that may not be highly accurate in practice, especially in emerging markets when the institutional relationships between central bank and commercial banks are institutionally complicated. Infante et al. (2023) also extended this framework and demonstrated that the liability management practices by the central bank are critical in defining whether the introduction of CBDC results into a contraction in deposits.

Chiu et al. (2019) and Davoodalhosseini (2021) have used formal models to investigate the impacts of CBDC on the power of banks in the market and their lending volumes. They conclude that the CBDC innovation would create competition in the deposit market, which would decrease the deposit margins and force the banks to change their funding policies. The overall impact on the credit volumes will be determined by the intensity of competition and the extent to which the banks will have access to alternative sources of funding. Agur et al. (2021) postulated that trade-off between payment efficiency gains and financial intermediation disruption is a key design consideration to the issuers of CBDC, and intermediate designs (those convenient enough to be widely adopted but unattractive enough to cause large-scale deposit substitution) were likely to reduce the system-level disruption. This point can be applied directly in relation to the conservative design decisions of the RBI towards the e-INR.

CBDC, Monetary Policy and Macroeconomic Outcomes.

Another related and developing line of study is the investigation of CBDC in the framework of transmission of

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www.ijnrefm.com
Volume 4, Issue 2, Mar-Apr-2026, PP: 01-16
ISSN:3048-7722

monetary policy and aggregate macroeconomic performance. Using agent-based stock-flow consistent model, Hess (2025) showed that CBDC could not only improve the transmission of monetary policy by creating a closer connection between the central bank policy rate and buying power by individuals but also impact the growth of GDP and the deposit stickiness. The model concludes that even though CBDC can foster economic activity by enhancing the efficiency of seigniorage and mechanisms of government spending, it can also raise the cost of funding available to commercial banks, and the second-order effects on lending behaviour and financial stability are required.

Assenmacher et al. (2024) and Auer et al. (2024) used simulation-based methods to investigate the commonwealth banking system equilibria under the macro prudential level. These analyses repeatedly come to the conclusion of such interdependence of the macroeconomic impact of CBDC with the rate and extent of adoption and policy parameters of issuance, such as holding limits, remuneration, and commercial banks as intermediaries. The analysis presented by Matsuoka and

Watanabe (2025) and Bidder et al. (2025) was furthered to understand CBDC in terms of its financial crisis-induced and bank-run-dynamics stabilising effects and destabilising effects related to enabling faster digital deposit withdrawals during financial crises. All these contributions add to highlight the significance of the institutional and macroeconomic environment in the development of the net effects of CBDC, which is the main focus of results interpretation in the Indian context.

Technological, Institutional and Regulatory Dimensions.

In addition to the macroeconomic and banking-channel literature, there is an increasing body of literature that covers the technological, institutional, and regulatory aspects of the implementation of CBDC. Ballaschk and Paulick (2021) reviewed the privacy aspect of CBDC systems, where they found a fundamental and thorny conflict between the principle of anonymity on the side of the user, enabling the adoption of the system in society, and regulatory compliance rules, such as anti-money laundering (AML) and know-your-customer (KYC). The authors stated that this trade-off is essential to manage in order to achieve a positive population response to the idea of the adoption of CBDC on a grand scale. This tension is especially severe in the Indian context, in which the RBI is implementing a highly strict system of AML-KYC regulation, which can limit the dynamic of e- INR implementation.

Arora et al. (2025) also applied the privacy analysis to privacy-enhancing technologies (PETs), including zero-knowledge proofs and trusted execution environments, and identified that whereas such technologies can significantly enhance the privacy of users, system complexity, operational costs, and possible latency that can hinder real-time transaction processing can all be introduced. Basing their work on the experience of early-mover CBDC jurisdictions (such as the Eastern Caribbean Digital Currency or the Sand Dollar of the Bahamas), Morales-Resendiz et al. (2021) and Kalash (2025) highlighted the necessity of gradual adoption pathways, strong cooperation between the state and business and cautious institutional coordination as the preconditions of a stable digital currency ecosystem. The observation that the context of implementation has a strong moderating effect on CBDC effect on banking behaviour is not a new one within this body of institutional literature, as well as part of what the present study was theoretically justified by conducting a country-specific, pilot-stage investigation.

Deposit Substitution and the Disintermediation Hypothesis

The deposit substitution mechanism—whereby consumers transfer savings from bank deposits to CBDC wallets, reducing banks' funding base—occupies a central position in the theoretical risk assessment of CBDC. The severity of this mechanism is theoretically contingent on the attractiveness of CBDC relative to bank deposits across multiple dimensions: safety (CBDC carries no default risk), yield (if interest-bearing), convenience (settlement finality and 24/7 availability), and programmability. In the Indian context, the e-INR has been deliberately designed to minimise competitive pressure on deposits: it is non-interest-bearing, subject to per-wallet holding limits, and intended primarily as a payment instrument rather than a savings vehicle.

Theoretical work by Muñoz and Soons (2024) and Fernández-Villaverde et al. (2020) demonstrates that even a non-interest-bearing CBDC can attract deposit substitution if its safety and convenience advantages are sufficiently pronounced. However, the magnitude of substitution in these models is sensitive to assumptions about the degree of financial development and the availability of alternative savings instruments. In India, the relative abundance of safe and liquid savings alternatives—including government savings bonds, post office deposits, and fixed deposits with scheduled commercial banks—may limit the marginal appeal of CBDC as a store of value, thereby constraining the extent of deposit displacement. Agur et al. (2021) make a directly analogous argument when they observe that CBDC designs calibrated to function primarily as payment instruments are likely to have limited impact on deposit levels, which aligns precisely with the conservative design of the e-INR.

Credit and Lending Impacts of CBDC

The credit channel effects of CBDC operate both through the liability side and through supply-side digital infrastructure improvements. On the liability side, if CBDC-induced deposit substitution reduces banks' funding base, theory predicts a contraction in credit supply consistent with the bank lending channel articulated by Bernanke and Blinder (1988) and formalised in the context of monetary policy transmission by Kashyap and Stein (2000). In their framework, banks constrained in their

ISSN:3048-7722

access to insured deposits must curtail lending or seek more expensive alternative funding, both of which reduce credit availability. A CBDC-induced deposit outflow would operate through an analogous mechanism.

Conversely, the CBDC literature increasingly acknowledges that the digital infrastructure accompanying CBDC deployment—including improved payment rails, expanded interoperability, and reduced transaction costs—may support credit expansion by reducing the operational cost of loan origination, disbursement, and repayment processing. Hess (2025) and Morales-Resendiz et al. (2021) both point to this complementary channel as a pathway through which CBDC may stimulate rather than suppress credit activity. Infante et al. (2022) further note that to the extent CBDC improves financial inclusion—extending banking access to previously underserved segments—it may also expand the addressable market for credit, thereby supporting lending volumes. The theoretical literature thus offers competing predictions for the credit growth outcome, with the net effect depending on which mechanism dominates: the disintermediation-driven contraction or the infrastructure-driven expansion.

Empirical Evidence and Research Gap

Despite the richness of the theoretical literature, empirical evidence on CBDC's banking-channel effects remains sparse and methodologically limited. Luu et al. (2023) provided cross-country evidence suggesting that CBDC development indices are associated with improvements in financial stability indicators and lending activity, but their macro-level analysis does not isolate causal effects at the bank level, nor does it control for country-specific institutional characteristics. Georgarakos et al. (2025) examined consumer attitudes towards the digital euro in European households, finding that information availability significantly moderates willingness to use CBDC—a behavioral finding with implications for adoption trajectories, but one that does not directly address deposit or credit growth outcomes. Jiang and Zhang (2017) employed experimental methods to study currency competition dynamics in a laboratory setting, but their results are not directly applicable to real- world bank-level outcomes.

In the Indian context, the empirical gap is particularly pronounced. Priyadarshini and Kar (2021) discussed the CBDC initiative from a policy perspective, examining issues of monetary sovereignty and digital infrastructure readiness, but did not conduct empirical testing. Given that India's financial structure, regulatory framework, and level of digital infrastructure development differ substantially from those of advanced economies in which the dominant theoretical models are typically calibrated, conclusions drawn from either theoretical models or pilot experiences in other jurisdictions cannot be extrapolated to the Indian case without empirical verification.

Taken together, the existing literature reveals four consistent and significant gaps. First, there is a predominance of theoretical and simulation-based approaches over empirical analysis using real observational data. Second, there is a notable absence of bank-level panel studies that exploit variation in banking outcomes before and during actual CBDC pilot phases. Third, there is a lack of an integrated analytical framework that simultaneously examines CBDC's relationships with deposit growth, credit growth, and macroeconomic conditions. Fourth, there is limited country-specific evidence from large emerging economies, and virtually no rigorous empirical evidence from India specifically. The present study addresses all four of these gaps by employing OLS panel regression on bank-year data from 19 Indian commercial banks, incorporating GDP growth and repo rate as macroeconomic controls, and focusing explicitly on deposit and credit growth as the twin outcomes of theoretical interest.

III. RESEARCH METHODOLOGY

Research Design

This study adopts a quantitative, non-experimental research design. A non-experimental design is appropriate because the introduction of CBDC in India constitutes a policy event implemented at the national level through a regulatory mandate of the Reserve Bank of India, and accordingly cannot be randomly assigned to individual banks or otherwise manipulated by the researcher. The study therefore operates in the tradition of observational panel econometrics, exploiting temporal variation in CBDC status—before versus during the pilot phase—to identify its statistical associations with banking outcomes, while controlling for macroeconomic conditions that independently influence those outcomes.

Ordinary Least Squares (OLS) regression is selected as the estimation method for several substantive and practical reasons. First, OLS is the appropriate estimator when the dependent variables are continuous, which is the case for both deposit growth and credit growth as defined in this study. Second, OLS produces transparent, directly interpretable coefficient estimates that maintain a clear one-to-one correspondence with the study's hypotheses, facilitating both statistical and economic interpretation. Third, given the dataset of 151 observations derived from 19 banks across eight years, more complex estimation strategies—including two-way fixed effects models, dynamic GMM estimators, or instrumental variable approaches—would impose substantial degrees-of-freedom constraints that may undermine estimator reliability. The choice of pooled OLS is therefore consistent with both the data constraints and the inferential scope of the study, and is aligned with similar empirical analyses in the nascent CBDC-banking empirical literature, including Luu et al. (2023). The acknowledged limitation that pooled OLS does not control for unobserved bank-specific heterogeneity is addressed explicitly in Section 7, alongside an assessment of its implications for the interpretation of results.

Data and Sample

International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
Volume 4, Issue 2, Mar-Apr-2026, PP: 01-16
ISSN:3048-7722

The data for this study were obtained from the official publications and statistical tables of the Reserve Bank of India (RBI), accessed in March 2026. The RBI's annual reports, statistical handbook, and the DBIE (Database on Indian Economy) portal provided the primary sources for bank-level deposit and credit figures, as well as macroeconomic indicators. The sample comprises 19 Indian commercial banks observed over the fiscal years 2018 to 2025, yielding an unbalanced panel of 151 bank-year observations.

The sampled institutions include both public sector and private sector banks that participated in or were closely associated with India's CBDC pilot programme and together represent a substantial share of the Indian banking system's aggregate assets and liabilities.
The 19 banks in the sample are: Axis Bank Limited, Bank of Baroda, Bank of India, Bank of Maharashtra, Canara Bank, Federal Bank Ltd, HDFC Bank Ltd, ICICI Bank Limited, IDBI Bank Limited, IDFC First Bank Limited, Indian Bank, IndusInd Bank Ltd, Karnataka Bank Ltd, Kotak Mahindra Bank Ltd, Punjab National Bank, State Bank of India, UCO Bank, Union Bank of India, and Yes Bank Ltd. This group encompasses the largest public sector undertakings in Indian banking—including State Bank of India and Punjab National Bank—as well as major private sector institutions such as HDFC Bank, ICICI Bank, and Axis Bank, thereby providing meaningful cross- sectional variation in bank size, ownership structure, business model, and geographic reach. The inclusion of both public and private sector banks is important because these two categories have historically exhibited different deposit mobilisation dynamics, credit risk appetites, and digital infrastructure investment patterns.

Variable Operationalisation

- Dependent Variables

Deposit Growth is defined as the year-on-year percentage change in total deposits for each bank in the sample. Bank deposits—comprising savings deposits, current deposits, and term deposits— constitute the primary funding source for commercial banks in India's financial architecture. They represent the core liability-side variable through which CBDC-induced disintermediation would first be manifested: if consumers shift funds from bank accounts to CBDC wallets, total deposit levels would be expected to moderate, and deposit growth rates would decline. Framing the outcome as a growth rate rather than a level is methodologically appropriate because it removes the influence of bank size and controls for persistent cross-sectional differences in deposit scale (Infante et al., 2022; Muñoz & Soons, 2024).

Credit Growth is defined as the year-on-year percentage change in total advances—comprising loans, overdrafts, and credit facilities—for each sampled bank. Credit extension is the primary asset- side function of commercial banks and the mechanism through which the banking system creates broad money and channels resources to productive uses. If CBDC-induced deposit contraction reduces banks' funding base, theory predicts a corresponding decline in credit growth through the bank lending channel (Bernanke & Blinder, 1988; Kashyap & Stein, 2000). Conversely, if CBDC operates as a complementary digital infrastructure investment, credit growth may be supported or even enhanced through reduced origination friction (Hess, 2025).

Independent Variable

CBDC is operationalised as a binary dummy variable, coded 1 for fiscal years 2022 to 2025—the period corresponding to the active phase of India's CBDC pilot initiative, the Digital Rupee (e- INR)—and 0 for fiscal years 2018 to 2021, representing the pre-pilot baseline period. This binary operationalisation is consistent with the established approach in empirical studies examining policy shock events where granular adoption data are unavailable or not yet publicly released (Luu et al., 2023). The dummy captures the period of CBDC introduction rather than actual adoption intensity, a limitation that is discussed in detail in Section 7. Any other structural change occurring after 2022 that is correlated with both the CBDC introduction and the dependent variables may be partially absorbed into the CBDC coefficient, introducing the possibility of omitted variable bias.

Control Variables

GDP Growth Rate (%) is included to capture the aggregate macroeconomic income environment prevailing in each year. GDP growth is theoretically expected to be positively associated with both deposit growth and credit growth: rising aggregate incomes increase household and corporate savings, augmenting the deposit base; simultaneously, rising economic activity stimulates credit demand from both businesses and consumers (Bernanke & Blinder, 1988; Kashyap & Stein, 2000). Omitting GDP growth would confound the CBDC coefficient with underlying cyclical trends in economic activity, particularly given that the CBDC period (2022–2025) partially overlaps with India's post-COVID economic recovery.

Repo Rate (%) represents the policy interest rate set by the Reserve Bank of India—the rate at which the RBI lends overnight funds to commercial banks. The repo rate is the primary instrument of monetary policy in India and is expected to influence both the cost of bank funding and the demand for credit. A higher repo rate generally raises the cost of borrowing, suppressing credit demand and potentially encouraging portfolio substitution away from bank deposits towards higher-yielding instruments such as treasury bills and government bonds (Calza et al., 2003). The repo rate is included in both models to control for the monetary policy stance prevailing in each year.

Model Specification

Two separate OLS regression models are estimated, corresponding to the two hypotheses of the study:
Model 1 (Deposit Growth):
$\text{Deposit\_Growth}_{it} = \beta_0 + \beta_1\ \text{GDP\_Growth}_t + \beta_2\ \text{Repo\_Rate}_t + \beta_3\ \text{CBDC}_t + \varepsilon_{it}$

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Model 2 (Credit Growth):

$$Credit\_Growth_{it} = \beta_0 + \beta_1 GDP\_Growth_t + \beta_2 Repo\_Rate_t + \beta_3 CBDC_t + \varepsilon_{it}$$

In both specifications, i denotes the individual bank, t denotes the fiscal year, β_0 is the intercept representing expected outcome when all regressors are zero, β_1 through β_3 are slope coefficients capturing the marginal associations of each predictor with the dependent variable, and ε_{it} is the idiosyncratic error term. Standard significance thresholds of 1% ($p < 0.01$) and 5% ($p < 0.05$) are applied in the interpretation of results, with marginal significance noted at the 10% threshold. Heteroskedasticity-robust standard errors are employed in both models to account for the possibility that the variance of the error term is not constant across banks or time periods, which is a common feature of financial panel data.

Research Hypotheses

Based on the theoretical literature reviewed in Section 2 and the variable operationalisations described above, the following hypotheses are proposed:

H1 (Null): The introduction of CBDC is not associated with a statistically significant change in bank deposit growth ($\beta_3 = 0$ in Model 1).

H1 (Alternative): The introduction of CBDC is associated with a statistically significant change in bank deposit growth ($\beta_3 \neq 0$ in Model 1).

H2 (Null): The introduction of CBDC is not associated with a statistically significant change in bank credit growth ($\beta_3 = 0$ in Model 2).

H2 (Alternative): The introduction of CBDC is associated with a statistically significant change in bank credit growth ($\beta_3 \neq 0$ in Model 2).

H1 directly tests the disintermediation hypothesis by examining whether the CBDC period is associated with any measurable change in deposit growth relative to the pre-pilot baseline. A statistically significant negative coefficient for the CBDC dummy ($\beta_3 < 0$) would be consistent with the theoretical prediction of deposit displacement advanced by Muñoz and Soons (2024) and Infante et al. (2022). H2 examines the credit channel effect, testing whether the CBDC period is associated with a significant change in credit growth after controlling for macroeconomic conditions. A significant negative coefficient would support the view that CBDC-induced deposit outflows constrain credit supply; a significant positive coefficient would be inconsistent with the disintermediation narrative and would invite examination of alternative explanatory mechanisms.

IV. RESULTS

Dataset Overview

The panel dataset covers 19 Indian commercial banks over fiscal years 2018 to 2025, comprising 151 bank-year observations. The CBDC dummy variable takes the value of 1 for fiscal years 2022 to 2025—corresponding to the active phase of India's e-INR pilot—and 0 for the pre-pilot baseline period of 2018 to 2021. Two separate OLS regression models are estimated: Model 1 examines the association between CBDC introduction and deposit growth, while Model 2 examines the analogous relationship with credit growth. In both models, GDP growth rate and the RBI repo rate serve as macroeconomic control variables. Heteroskedasticity-robust standard errors are used throughout. The results of both models are presented in turn below.

Regression Results: Deposit Growth (H1)

Table 1 presents the full OLS regression results for the deposit growth model.

Table 1: OLS Regression — Dependent Variable: Deposit Growth

Variable	Coefficient	Std. Error	t-Statistic	p-value
Intercept	0.1104	0.0765	1.4431	0.1511 (ns)
GDP Growth Rate (%)	0.0301	0.0029	10.4660	0.0000 ***
Repo Rate (%)	−0.0338	0.0149	−2.2679	0.0248 **
CBDC (Dummy)	−0.0148	0.0286	−0.5177	0.6054 (ns)
R-squared	0.4527		Adj. R^2	0.4416
F-statistic	40.5364		Sig. F	0.0000
N	151			

Intercept (0.1104, p = 0.151)

The intercept of 0.1104 is not statistically significant at conventional levels (p = 0.151). It represents the estimated baseline deposit growth when all independent variables take the value of zero—a scenario without direct economic meaning but necessary for model identification. The non-significance of the intercept does not affect the validity or interpretation of the slope coefficient estimates, which are the substantively important quantities of interest.

GDP Growth Rate ($\beta_1 = 0.0301$, $p < 0.001$)

GDP growth rate is the dominant predictor in the deposit growth model and achieves high statistical significance ($t = 10.47$, $p < 0.001$). The coefficient of 0.0301 indicates that each one-percentage- point increase in GDP growth is associated with an increase in deposit growth of approximately 3.01 percentage points, holding the repo rate and CBDC status constant. This result is both statistically robust and economically intuitive: as aggregate output expands, household incomes and corporate cash flows rise, generating a larger pool of savings that is channelled into the banking system through deposit accounts. The finding is entirely consistent with the income hypothesis of deposit determination articulated in the banking literature by Bernanke and Blinder (1988) and Kashyap and Stein (2000), confirming the procyclical character of deposit mobilisation in the Indian banking system. The extraordinarily high t-statistic underscores that macroeconomic growth, rather than any monetary or digital currency policy variable, is the overwhelming driver of deposit accumulation.

ISSN:3048-7722

International Journal for Novel Research in Economics , Finance and Management
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Repo Rate ($\beta_2 = -0.0338$, $p = 0.025$)
The repo rate is significantly and negatively associated with deposit growth ($t = -2.27$, $p = 0.025$). A one-percentage-point increase in the RBI repo rate is associated with a 3.38-percentage-point reduction in deposit growth, holding other variables constant. While the conventional intuition might suggest that higher interest rates attract savings into bank deposits, the negative coefficient is consistent with the portfolio substitution effect that characterises monetary tightening in the Indian financial context. When the RBI raises the repo rate—typically in response to inflationary pressures—the accompanying tighter financial conditions slow economic activity and household income growth, suppressing the underlying savings flow into deposits. Simultaneously, rising rates may divert a portion of investible surplus toward higher-yielding alternatives such as government securities, mutual funds, and post office saving schemes, thereby moderating deposit inflows. This interpretation is supported by Calza et al. (2003) and is consistent with the empirical pattern documented in successive RBI annual reports covering the monetary tightening episodes of 2022– 2024.

CBDC Dummy ($\beta_3 = -0.0148$, $p = 0.605$)
The CBDC dummy variable does not exert a statistically significant association with deposit growth. The coefficient of −0.0148 is modest in magnitude, and the p-value of 0.605 is far removed from any conventional significance threshold. The null hypothesis H1—that CBDC introduction is not associated with a significant change in deposit growth—cannot be rejected at any standard significance level. This finding implies that, at the current pilot stage of the e-INR, CBDC has not produced a measurable reduction in deposit behaviour among the sampled banks. The negative sign of the coefficient, while not statistically distinguishable from zero, is directionally consistent with the disintermediation concern raised by Muñoz and Soons (2024) and Infante et al. (2022); however, the magnitude is too small to be separated from random sampling variation given the current dataset. As discussed in Section 5, this absence of significant effect is entirely consistent with the conservative design features of the e-INR pilot, and with the broader institutional context of Indian banking.

Model Fit
The deposit growth model exhibits satisfactory explanatory power with an R-squared of 0.453 and an adjusted R-squared of 0.442. The three independent variables jointly account for approximately 45 percent of the variation in deposit growth across the panel. The overall model achieves strong statistical significance ($F = 40.54$, $p < 0.001$), confirming the collective relevance of the predictors. The explanatory power is driven overwhelmingly by the GDP growth rate variable, consistent with the dominant role that macroeconomic income conditions play in determining deposit mobilisation. The relatively high R-squared for this type of observational banking panel regression validates the choice of macroeconomic controls and provides confidence in the model's ability to isolate the effect of the CBDC variable.

Hypothesis 1 Outcome: The null hypothesis H1 is not rejected. The CBDC dummy variable is not significantly associated with deposit growth ($\beta_3 = -0.0148$, $p = 0.605$). The model provides no evidence that CBDC introduction has materially altered deposit behaviour in the sampled banks during the pilot phase.

Regression Results: Credit Growth (H2)
Table 2 presents the OLS regression results for the credit growth model.

Table 2: OLS Regression — Dependent Variable: Credit Growth

Variable	Coefficient	Std. Error	t-Statistic	p-value
Intercept	0.2059	0.0698	2.9477	0.0037 ***
GDP Growth Rate (%)	0.0050	0.0026	1.8912	0.0606 (†)
Repo Rate (%)	−0.0267	0.0136	−1.9576	0.0522 (†)
CBDC (Dummy)	0.0698	0.0261	2.6751	0.0083 ***
R-squared	0.0991		Adj. R^2	0.0807
F-statistic	5.3897		Sig. F	0.0015
N	151			

Unlike the deposit model, the intercept in the credit growth model is statistically significant at the 1% level ($t = 2.95$, $p = 0.004$). The estimated baseline credit growth of approximately 20.59 percent—independently of the macroeconomic and CBDC variables—reflects the structural momentum of credit expansion in a large, growing developing economy where credit penetration continues to deepen over time. This baseline is consistent with the multi-year trend of double-digit credit growth observed in India prior to the CBDC pilot period.

GDP Growth Rate ($\beta_1 = 0.0050$, $p = 0.061$)
GDP growth is marginally associated with credit growth ($p = 0.061$), falling just above the conventional 5% threshold. The coefficient of 0.0050 implies a small positive directional relationship between aggregate economic expansion and credit growth, which is directionally consistent with the income and credit demand nexus documented in the banking literature. However, the evidence falls short of the standard significance threshold, suggesting that the GDP-credit relationship is less tight in this sample than the GDP-deposit relationship observed in Model 1. The weaker statistical association likely reflects the fact that credit growth in India is determined by a broader range of supply-side factors—including non-performing asset (NPA) levels, capital adequacy constraints, sectoral credit policies, and regulatory provisioning requirements—that are specific to individual banks and not captured by macroeconomic GDP growth alone.

ISSN:3048-7722

International Journal for Novel Research in Economics , Finance and Management
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Repo Rate ($\beta_2 = -0.0267$, $p = 0.052$)
The repo rate exhibits a marginally negative association with credit growth ($p = 0.052$), approaching but not reaching the conventional 5% significance threshold. A one-percentage-point increase in the repo rate is associated with a 2.67-percentage-point decline in credit growth. This directional finding is consistent with the standard monetary transmission mechanism: higher policy rates increase the cost of bank borrowing and raise lending rates, which reduces credit demand from households and firms. The near-significant result—rather than a clearly significant one—may reflect the well- documented imperfect and lagged pass-through of RBI policy rate changes to commercial lending rates in India, a feature attributable to the structural rigidities in the pricing of credit and the presence of fixed-rate loan portfolios (RBI Annual Reports, 2022–2024). The marginal nature of this result suggests that credit growth in the sample responds to monetary policy with some delay and with considerable bank-level heterogeneity.

CBDC Dummy ($\beta_3 = 0.0698$, $p = 0.008$)
The CBDC dummy variable is the most statistically significant predictor in the credit growth model, achieving significance at the 1% level ($t = 2.675$, $p = 0.008$). The positive coefficient of 0.0698 indicates that the CBDC period (2022–2025) is associated with a credit growth increase of approximately 6.98 percentage points relative to the pre-CBDC baseline, after controlling for GDP growth and the repo rate. This is the most substantively significant finding of the study. The positive association between the CBDC period and credit growth indicates, unambiguously, that CBDC introduction has not suppressed lending activity in the sampled banks; indeed, the association runs in the opposite direction to what the bank disintermediation hypothesis would predict. The plausible explanations for this association, and the important caveats surrounding its interpretation, are discussed in detail in Section 5.

Model Fit
The credit growth model has an R-squared of 0.099 and an adjusted R-squared of 0.081, indicating that the included variables collectively explain approximately 10 percent of the variation in credit growth across the panel. While this is substantially lower than the deposit growth model's R-squared of 0.453, the overall model achieves statistical significance ($F = 5.39$, $p = 0.002$), confirming that the predictors carry meaningful joint explanatory power. The limited R-squared is not unexpected in a parsimonious specification with only macroeconomic controls: credit growth in commercial banking is driven by a rich set of bank-specific factors—including NPA ratios, capital adequacy ratios, net interest margins, sectoral credit composition, and borrower creditworthiness—that are unavailable in the current dataset and represent important drivers of lending behaviour. Conclusions drawn from this model should accordingly be treated with appropriate caution, and the significant CBDC coefficient should be understood as identifying a robust statistical association rather than a comprehensive explanation of credit dynamics.

Hypothesis 2 Outcome: The null hypothesis H2 is rejected. The CBDC dummy variable is positively and significantly associated with credit growth ($\beta_3 = 0.0698$, $p = 0.008$). This indicates that the CBDC period is associated with higher credit growth relative to the pre- CBDC period, after controlling for GDP growth and the repo rate. The direction of this association does not support the bank disintermediation hypothesis in the credit channel.

Summary of Hypothesis Outcomes

Table 3: Summary of Hypothesis Outcomes

Hypothesis	CBDC Coefficient (β_3)	p-value	Outcome
H1: Deposit Growth	−0.0148 (no significant change)	0.605	H1 null NOT rejected
H2: Credit Growth	0.0698 (significant positive)	0.008	H2 null REJECTED

H1: Deposit Growth −0.0148 (no significant change) 0.605 H1 null NOT rejected
H2: Credit Growth 0.0698 (significant positive) 0.008 H2 null REJECTED
Note: CBDC dummy = 1 for fiscal years 2022–2025; 0 for 2018–2021. A non-directional null hypothesis is tested in both cases.

V. DISCUSSION

The results presented in Section 4 reveal an asymmetric and theoretically significant pattern: CBDC introduction is not associated with a measurable disruption to deposit growth, while it is positively and significantly associated with credit growth. This combination of outcomes invites careful interpretation in the light of existing theoretical frameworks and the specific institutional context of India's CBDC pilot. This section engages critically with both findings in turn, before drawing attention to the broader asymmetric pattern and its theoretical implications.

CBDC and Deposit Growth: No Evidence of Disintermediation
The most theoretically anticipated—and policy-concerning—outcome of CBDC introduction is the disruption of bank deposit mobilisation through the disintermediation mechanism. The results do not support this concern. The CBDC dummy is not significantly associated with deposit growth (β_3 $= -0.0148$, $p = 0.605$), indicating that the introduction of the e-INR pilot did not produce a measurable shift in aggregate deposit behaviour among the 19 sampled banks. This finding is robust to the inclusion of GDP growth and the repo rate as controls, and the point estimate is small in

International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
Volume 4, Issue 2, Mar-Apr-2026, PP: 01-16
ISSN:3048-7722

magnitude, providing little support for even a directional trend of deposit displacement.

This outcome is broadly consistent with the theoretical arguments advanced by Brunnermeier and Niepelt (2019) and Niepelt (2018), who demonstrated that under appropriate policy conditions— specifically, when the central bank provides commercial banks with equivalent refinancing facilities to compensate for any CBDC-induced deposit outflows—CBDC may be functionally equivalent to bank deposits and therefore need not disrupt financial intermediation. The finding is also consistent with the pilot-stage assessment by Morales-Resendiz et al. (2021), who emphasised that disintermediation effects are ultimately contingent on adoption scale, which remains limited during the early phases of implementation. At the point of this study's data collection, the e-INR's registered user base and transaction volumes remain modest relative to the scale of the Indian banking system, making it implausible that CBDC adoption alone could generate a measurable impact on aggregate bank deposits.

The result, however, does not align with the theoretical predictions of Muñoz and Soons (2024) and Infante et al. (2022), who identify deposit substitution as a credible concern when CBDC is made broadly accessible as a store of value. This apparent tension may be explained by the distinctive design parameters of the Indian e-INR, which was deliberately calibrated to minimise competitive pressure on bank deposits. The e-INR is non-interest-bearing, subject to per-wallet holding limits, and intended primarily as a payment instrument rather than an investment vehicle. These design features substantially reduce the marginal appeal of CBDC as a deposit substitute. Agur et al. (2021) argue precisely that intermediate CBDC designs—those that achieve sufficient adoption for payment efficiency but do not offer the return or safety advantages necessary to trigger large-scale deposit substitution—tend to minimise disruption to financial intermediation. This may be characterised as the Indian context where a deliberate policy decision to design the e-INR conservatively has produced an outcome consistent with the equivalence proposition rather than the disintermediation hypothesis.

Deposit growth in the model is primarily driven by GDP growth ($\beta_1 = 0.0301$, $p < 0.001$), confirming that macroeconomic income conditions—rather than any monetary innovation—are the fundamental determinant of deposit mobilisation. This finding extends the well-established theoretical proposition of Bernanke and Blinder (1988) and Kashyap and Stein (2000) to the contemporary Indian banking panel, affirming the procyclical character of Indian deposit behaviour. The secondary negative association with the repo rate ($\beta_2 = -0.0338$, $p = 0.025$) is consistent with portfolio substitution dynamics observed during monetary tightening episodes in India, and is well-documented in the domestic banking literature and RBI annual reports for the 2022–2024 period. Taken together, these findings confirm that the macroeconomic environment—not the CBDC initiative—is the primary driver of deposit behaviour in the study period, and that the e-INR has not introduced a countervailing downward pressure that is detectable at this stage of the pilot.

CBDC and Credit Growth: A Positive and Significant Association

The statistically significant positive association between the CBDC period and credit growth ($\beta_3 = 0.0698$, $p = 0.008$) is the central and most consequential finding of this study. The result indicates that credit growth among the sampled banks was approximately 7 percentage points higher during the CBDC pilot period, after controlling for GDP growth and the repo rate. This outcome diverges from the theoretical bank disintermediation narrative, which would predict either no change or a decline in credit growth following CBDC introduction—on the logic that deposit displacement reduces the funding base available for lending.

One theoretically coherent interpretation of this finding is that CBDC has operated as a complementary mechanism within the financial system, rather than as a disruptive substitute. This interpretation is consistent with the argument advanced by Brunnermeier and Niepelt (2019) that a well-designed CBDC, coupled with appropriate central bank support for commercial bank liquidity, need not reduce bank lending capacity. More specifically, the CBDC pilot period in India coincided with substantial public and private investment in digital financial infrastructure—including the expansion of the Unified Payments Interface (UPI) network, the development of faster interoperable settlement systems, and improvements in digital credit assessment and underwriting tools. These infrastructure improvements may have reduced the cost and operational friction associated with credit origination, disbursement, and repayment collection, thereby facilitating credit expansion to segments that were previously expensive to serve. This interpretation aligns with the efficiency argument articulated by Infante et al. (2022) and Morales-Resendiz et al. (2021), who note that CBDC's contribution to payment system modernisation can, through complementary channels, support credit market development.

However, intellectual honesty requires that several important alternative explanations be considered, and that strong causal interpretation of the positive coefficient be avoided. First, the CBDC period (2022–2025) coincides with India's post-COVID credit recovery phase—a period of structurally elevated credit demand as businesses rebuilt inventories, households resumed consumption, and the government implemented demand-stimulating fiscal policies. While the GDP growth control is intended to absorb aggregate cyclical effects, it may not fully capture the composition, pace, or sectoral specificity of the post-COVID credit rebound, leaving residual cyclical credit effects to be absorbed into the CBDC dummy coefficient. Second, the pilot banks in this sample—which include State Bank of India, HDFC Bank, ICICI Bank, and Axis Bank—

ISSN:3048-7722

are among the largest and best- capitalised institutions in India, with structural advantages in credit market share, funding access, and risk management capacity. Their above-average credit growth during the CBDC period may reflect institutional strength and market positioning rather than any direct or indirect CBDC effect. Third, because the CBDC dummy is a time indicator rather than a measure of adoption intensity, any other structural change occurring after 2022—including changes in bank regulation, the normalisation of credit standards following COVID-era forbearance, or the Pradhan Mantri Mudra Yojana scheme expansion—may be partially captured in the CBDC coefficient. These alternative mechanisms cannot be disentangled in a pooled OLS framework without additional identification.

The low R-squared of the credit growth model ($R^2 = 0.099$) reinforces the importance of epistemic humility in interpreting this finding. A large and unquantified proportion of the variation in credit growth remains unexplained, indicating the presence of important omitted determinants—bank- specific NPA ratios, capital adequacy ratios, loan-to-deposit ratios, sectoral credit composition, and regulatory capital constraints—that are well-established drivers of lending behaviour but are unavailable in the current data. This observation is consistent with the broader finding in the banking econometrics literature that credit growth is inherently multidimensional and difficult to explain with parsimonious macro-level specifications (Kashyap & Stein, 2000; Bernanke & Blinder, 1988). The significant CBDC coefficient should therefore be understood as identifying a robust and interesting statistical association—one that merits serious scholarly attention and deeper investigation—rather than as a comprehensive or causal explanation of credit growth dynamics.

Asymmetric Effects and Theoretical Implications

The juxtaposition of the two results—no significant effect on deposit growth, and a significant positive effect on credit growth—constitutes a theoretically interesting asymmetry that the existing literature has not directly anticipated. The canonical bank disintermediation hypothesis predicts a symmetric and adverse outcome: if CBDC displaces deposits, both deposit growth and credit growth should decline, as reduced funding constrains lending. The observed pattern is categorically inconsistent with this joint prediction. Neither the deposit side nor the credit side evidence supports the disintermediation narrative: deposits are unaffected, and credit has grown. This suggests, at minimum, that the Indian CBDC pilot has not operated as a disintermediating force during the period under analysis.

The asymmetry is theoretically interesting for a second reason: it suggests that credit growth and deposit growth are driven by substantially different sets of forces, a proposition supported by the striking divergence in explanatory power between the two models ($R^2 = 0.453$ versus 0.099). Deposit growth in India is strongly tethered to macroeconomic income dynamics, responding predictably to GDP fluctuations with a coefficient that achieves a t-statistic of over 10. Credit growth, by contrast, is less responsive to macroeconomic conditions within this specification and is driven more by idiosyncratic supply-side factors at the bank level—factors that a parsimonious macroeconomic model cannot adequately capture. Hess (2025) makes an analogous observation in his agent-based simulation, noting that CBDC may affect credit creation and deposit stickiness through distinct channels operating with different transmission speeds and magnitudes.

This may be characterised as consistent with a scenario in which India's conservative e-INR design has successfully contained the deposit-side risk of CBDC adoption, while the digital ecosystem improvements accompanying the pilot—better payment infrastructure, improved data availability for credit assessment, and expanded financial inclusion—have contributed, at least partially, to the positive association with credit growth. Whether this interpretation survives the addition of bank- level controls, fixed effects, and a more granular measure of CBDC adoption is a question that future research must address. For the present, the finding stands as an empirically grounded challenge to the undifferentiated disintermediation narrative, and as an important data point for the RBI's ongoing evaluation of the e-INR's economic effects.

VI. CONCLUSION

This study examined the statistical association between CBDC introduction and two key banking variables—deposit growth and credit growth—using panel data from 19 Indian commercial banks over the period 2018 to 2025, yielding 151 bank-year observations. Two OLS regression models were estimated, with GDP growth rate and the RBI repo rate included as macroeconomic control variables, to assess the association between the CBDC pilot period and banking outcomes after conditioning on macroeconomic conditions.

The results yield two clear and theoretically significant findings. First, the introduction of CBDC— represented by a binary dummy variable capturing India's e-INR pilot phase—is not significantly associated with deposit growth ($\beta_3 = -0.0148$, $p = 0.605$). The null hypothesis H1 is therefore not rejected. This finding indicates that India's CBDC pilot has not produced a measurable disruption to bank deposit mobilisation during the study period. Deposit behaviour is overwhelmingly determined by macroeconomic income conditions—GDP growth emerges as the dominant predictor with a coefficient of 0.0301 and a p-value below 0.001—while the repo rate exerts a secondary and significant negative influence consistent with portfolio substitution dynamics. The e-INR, at its current pilot scale and conservative design, has not constituted a meaningful competitive alternative to bank deposits.

Second, the CBDC dummy variable is positively and significantly associated with credit growth (β_3

ISSN:3048-7722

= 0.0698, p = 0.008). The null hypothesis H2 is therefore rejected. This finding indicates that credit growth among the sampled banks was higher during the CBDC period, after controlling for macroeconomic conditions. This result runs counter to the bank disintermediation hypothesis, which would predict either no change or a decline in credit growth following deposit displacement. The finding is consistent with the complementarity hypothesis—the possibility that digital infrastructure improvements accompanying CBDC deployment have supported credit expansion—though the low explanatory power of the credit model (R^2 = 0.099) and the time-period nature of the dummy variable necessitate caution in attributing this association directly to the CBDC initiative.

Taken together, the findings offer an empirically grounded and contextually nuanced assessment of CBDC's early-stage effects on the Indian banking system. The study does not claim to establish causality; rather, it identifies and characterises statistical associations that are meaningful in their own right—particularly given the absence of prior bank-level empirical evidence in the Indian
CBDC literature—and that have direct implications for how policymakers, regulators, and bank management evaluate the ongoing e-INR programme. The absence of deposit displacement provides qualified empirical support for the RBI's conservative pilot-phase approach, while the positive credit association signals that CBDC introduction has not impaired and may have complemented commercial banking activity.

The study contributes to the literature in three principal respects: it provides bank-level panel evidence from an actual emerging-economy CBDC pilot—a contribution that is empirically novel; it integrates deposit and credit outcomes within a unified analytical framework with macroeconomic controls; and it grounds its interpretation in the institutional specificities of Indian banking and the RBI's regulatory approach. These contributions extend the predominantly theoretical and advanced- economy-focused CBDC literature into new empirical and geographic territory.

VII. LIMITATIONS OF THE STUDY

A rigorous and honest assessment of the study's limitations is essential for calibrating the confidence with which its findings are interpreted and for directing future research appropriately. Six substantive limitations are identified and discussed below.

Binary CBDC Operationalisation and Omitted Variable Bias

The most significant limitation of the study is the operationalisation of the CBDC variable as a binary time dummy, coded 1 for fiscal years 2022 to 2025 and 0 otherwise. This approach captures the period of CBDC introduction rather than the actual intensity of adoption—measured, for instance, through registered user counts, transaction volumes, or wallet balances. Consequently, the dummy variable is unable to distinguish between banks with high and low levels of CBDC engagement, nor does it capture the gradual trajectory of adoption within the pilot period. More critically, because the dummy is a time indicator, any structural change occurring after 2022 that is correlated with both the dependent variables and the CBDC introduction—including India's post-COVID credit recovery, regulatory changes in bank provisioning, or broad improvements in the digital banking ecosystem— may be partially absorbed into the CBDC coefficient, creating a risk of omitted variable bias. This limitation is particularly relevant to the interpretation of the positive and significant CBDC coefficient in the credit growth model.

Low Explanatory Power in the Credit Growth Model

The credit growth model explains approximately 10 percent of the variation in the dependent variable (R^2 = 0.099). This limited explanatory power reflects the complex and multidimensional nature of credit growth as a banking outcome: it is shaped by bank-specific factors—including gross NPA ratios, capital adequacy ratios, sectoral credit composition, borrower creditworthiness, and individual risk appetite—that are absent from the parsimonious specification employed in this study. Conclusions drawn from the credit growth model should therefore be treated with commensurate caution, and the significant CBDC coefficient should not be interpreted as a comprehensive or definitive explanation of credit dynamics during the study period.

Absence of Bank-Level Control Variables

The study does not include bank-specific variables in the regression models. Established determinants of deposit and credit growth at the bank level—including gross NPA ratios, capital adequacy ratios (CRAR), return on assets, net interest margins, bank size (total assets), and the loan- to-deposit ratio—are omitted from the current specification. The exclusion of these variables may bias the estimated macroeconomic and CBDC coefficients if the omitted bank characteristics are correlated with either the CBDC dummy or the included controls. Future research should incorporate bank-level fixed effects or time-varying bank-specific controls to address this limitation and improve the accuracy of coefficient estimation.

Absence of Fixed Effects and Causal Identification

The pooled OLS models estimated in this study do not control for unobserved bank-specific characteristics (cross-sectional heterogeneity) or for common macroeconomic shocks beyond those captured by the GDP growth and repo rate controls (time heterogeneity). In panel data analysis, the presence of uncontrolled bank-specific effects can bias slope coefficient estimates if those effects are correlated with the regressors—a condition known as the omitted variable bias due to unobserved heterogeneity. More fundamentally, the study establishes statistical associations between the CBDC period and banking outcomes, but does not establish causal relationships. Reverse causality—whereby banks with stronger credit growth were selectively chosen for the CBDC pilot—and common confounding

ISSN:3048-7722

factors operating after 2022 cannot be ruled out without the application of appropriate causal identification strategies, such as difference-in-differences designs that exploit variation in CBDC participation across banks, or instrumental variable estimation using an instrument that affects CBDC exposure but is otherwise unrelated to deposit and credit growth.

Pilot-Stage Data and Limited CBDC Adoption

As of the data collection window, India's CBDC remains in an early and deliberately limited pilot phase. The e-INR has been made available to a restricted user base, transaction volumes are modest relative to the overall scale of the banking system, and the instrument has not yet been exposed to the dynamics of widespread mass adoption. The findings therefore characterise the associations between banking outcomes and the period of CBDC announcement and partial introduction, not the effects of large-scale adoption. The long-term effects of CBDC at scale—particularly if accompanied by interest remuneration, removal of holding limits, or integration with broader financial services—may differ substantially from those documented in the pilot phase. The results should accordingly be interpreted as pilot-phase evidence, with their external validity conditional on the continuation of the current conservative CBDC design.

Sample Size and Bank Heterogeneity

The sample of 19 banks observed over eight fiscal years yields 151 observations—a dataset that is relatively modest for a formal panel analysis, particularly one that aspires to control for multiple dimensions of heterogeneity. The sample includes banks of substantially different sizes, ownership structures (public versus private sector), business models, and geographic footprints, all of which introduce significant cross-sectional heterogeneity that is not fully addressed in a pooled OLS framework. The very different balance sheet compositions and risk profiles of public sector banks (such as State Bank of India or Punjab National Bank) and private sector banks (such as HDFC Bank or Kotak Mahindra Bank) may affect the generalisability of results to either banking sub-sector, and the pooled estimates represent a weighted average of potentially quite different underlying relationships.

VIII. FUTURE RESEARCH DIRECTIONS

The limitations documented in Section 7 naturally give rise to a structured research agenda for future inquiry. The following directions represent the most promising and tractable pathways for advancing knowledge in this domain.

Panel Models with Fixed Effects and Dynamic Estimators

Future studies should address the pooled OLS estimation limitation by employing two-way fixed effects panel models that simultaneously control for time-invariant bank-specific heterogeneity and common time shocks. Such models would substantially reduce the omitted variable bias concern identified in Section 7.4 and would produce more credible estimates of the conditional associations between CBDC and banking outcomes. For datasets in which lagged dependent variables are relevant predictors—as is commonly the case in banking research, where prior-period credit growth is a predictor of current-period credit growth—dynamic panel Generalised Method of Moments (GMM) estimators, such as the Arellano-Bond system GMM, would provide both consistency in the presence of unobserved heterogeneity and instruments for the lagged dependent variable.

Continuous and Granular Measures of CBDC Adoption

As the e-INR pilot progresses and the RBI makes available more granular data on CBDC transaction volumes, registered user counts, digital wallet balances, and the proportion of retail transactions settled in e-INR, future research should replace the binary dummy with continuous and bank-level measures of CBDC adoption intensity. This would allow researchers to identify dose-response relationships—whether the effects on deposit and credit growth are proportional to the scale of CBDC engagement—and to distinguish between banks that are actively leveraging CBDC infrastructure and those with nominal participation. A continuous adoption measure would also reduce the omitted variable bias inherent in the time dummy by providing within-bank variation in CBDC exposure.

Incorporation of Bank-Level Financial Controls

Incorporating established bank-specific determinants of deposit and credit behaviour—including gross NPA ratios, capital adequacy ratios, return on assets, net interest margins, and the loan-to- deposit ratio—would substantially improve model specification and explanatory power. These variables are available from RBI's OSMOS database, scheduled bank financial statements, and commercial banking data providers, and their inclusion in future research would allow for a more credible isolation of the CBDC-related signal from confounding institutional characteristics. Future studies could also examine whether the relationship between CBDC and banking outcomes differs systematically between public sector and private sector banks, given their fundamentally different ownership structures, credit cultures, and digitisation trajectories.

International Comparative Studies

Countries that have advanced further along the CBDC adoption pathway than India—including China (digital yuan or e-CNY), the Bahamas (Sand Dollar), Nigeria (e-Naira), and Jamaica (JAM- DEX)—offer natural comparative cases for examining whether the absence of deposit displacement and the positive credit association documented in this study are replicated in other economic and regulatory contexts. Cross-country comparative studies would illuminate the extent to which the Indian findings are specific to the conservative design of the e-INR and the institutional characteristics of Indian banking, versus representing more general regularities of CBDC

ISSN:3048-7722

introduction in emerging markets. Such studies could employ difference-in-differences designs that exploit staggered timing of CBDC launches across countries to improve causal identification.

Mediation and Mechanism Analysis

A crucial gap in the current study—and in the broader CBDC empirical literature—is the absence of mechanism analysis. Future research should examine the pathways through which the CBDC period is associated with credit growth, employing mediation analysis or structural equation modelling to test whether the association operates through digital financial inclusion, payment system efficiency gains, reduced credit origination costs, or changes in competitive dynamics in the credit market. Potential mediating variables include UPI transaction volumes, digital lending platform adoption rates, the number of formally banked individuals, and measures of credit market concentration. Such mechanism analysis would substantially advance understanding beyond the reduced-form associations documented in the present study.

Loan Quality Implications of CBDC-Period Credit Expansion

If the CBDC period is associated with higher credit growth—as found in this study—it is important to examine whether this credit expansion has been accompanied by commensurate attention to loan quality, or whether it reflects an easing of underwriting standards in the context of competitive

lending during the pilot phase. Subsequent research should investigate the NPA implications of CBDC-period credit expansion by examining whether increases in credit growth during 2022–2025 are followed by higher non-performing loan ratios in subsequent periods. This question has direct implications for the long-term financial stability consequences of the CBDC-credit association documented here.

IX. POLICY AND MANAGERIAL IMPLICATIONS

Implications for Banking Regulation and CBDC Design

The finding that deposit growth has not been significantly disrupted during the e-INR pilot phase provides qualified empirical validation for the RBI's conservative CBDC design philosophy. The deliberate design choices embedded in the Indian e-INR—non-interest remuneration, per-wallet holding limits, and an emphasis on payment functionality rather than investment utility—appear to have been effective in limiting competitive pressure on bank deposits during the pilot phase. This outcome is consistent with the theoretical framework of Agur et al. (2021), who predict that intermediate CBDC designs minimise disintermediation risks, and with the practical lessons drawn by Morales-Resendiz et al. (2021) from early-mover jurisdictions.

The practical implication for the RBI and the Government of India is that the current calibrated approach to CBDC design should be maintained as the e-INR scales. Any changes to CBDC design parameters—particularly the introduction of interest remuneration, even at a modest rate, or the removal of holding limits—should be evaluated rigorously and cautiously against the potential for triggering deposit substitution at scale, using real-time monitoring data from the pilot. The theoretical analysis of Muñoz and Soons (2024) suggests that even small modifications to the competitive attractiveness of CBDC can have non-linear effects on deposit dynamics if adoption crosses a threshold. Policymakers should ensure that any CBDC scaling pathway preserves the commercial banking system's core role in deposit mobilisation and credit allocation, particularly for priority sector lending to agriculture, micro-enterprises, and underserved communities—sectors where public sector banks play an irreplaceable intermediation role.

Implications for Commercial Bank Management

Commercial banks should not, on the basis of the present evidence, treat CBDC in its current pilot form as an imminent or material threat to their deposit franchises. The absence of a statistically significant deposit displacement effect during the pilot phase suggests that the competitive impact of the e-INR on bank funding has been minimal to date. However, this finding reflects a specific phase of CBDC development—one characterised by limited adoption, restricted eligibility, and a non-interest-bearing design—and should not generate complacency about future trajectories. Bank management should proactively develop scenario analyses that assess deposit resilience under alternative CBDC design configurations, including an interest-bearing variant and broader interoperability with savings and investment accounts.

The positive association between the CBDC period and credit growth, while not causally attributable to the e-INR, signals that the digital financial ecosystem accompanying CBDC deployment has been conducive to lending expansion. Banks participating in the CBDC pilot should leverage the digital infrastructure advantages—including API integration with the e-INR settlement layer, improved digital identity verification through Aadhaar-linked KYC, and enhanced transaction data availability for credit scoring—to expand their credit origination capabilities. In particular, the potential to reach previously underserved borrowers in rural and semi-urban markets through digital channels represents a significant strategic opportunity that CBDC infrastructure can facilitate. Investment in digital credit origination systems, automated underwriting platforms, and real-time repayment tracking tools should be prioritised alongside CBDC integration efforts.

Implications for Investors and Financial Analysts

Financial analysts and institutional investors evaluating Indian bank equities should note that the CBDC introduction has not produced a measurable negative impact on core deposit metrics in the pilot sample. This finding

ISSN:3048-7722

mitigates one key risk concern that has been articulated in equity research on Indian banking—namely, that CBDC adoption could erode the low-cost deposit franchise that underpins the net interest margins and return on equity of Indian commercial banks. On the basis of the evidence available from the pilot phase, this risk does not appear to have materialised, and the results do not support the view that CBDC will necessarily erode the deposit-funded business model of Indian commercial banks in the near term.

Analysts should, however, maintain a monitoring posture rather than treat the pilot-phase evidence as definitive for the long term. The pace of e-INR adoption, any changes to CBDC design that could alter competitive dynamics in deposit markets, and the evolution of consumer preferences toward digital money should be tracked as leading indicators. The positive credit growth association during the CBDC period, while subject to interpretive caveats, provides a constructive data point for assessing the operational and strategic positioning of pilot-participant banks relative to institutions that are not part of the CBDC ecosystem.

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