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# Impact of Central Bank Digital Currencies (CBDCs) on Monetary Policy Transmission Mechanisms: Evidence from Recent Global Implementations

**Jamiu Adeniyi Yusuf**
National Institute for Legislative and Democratic Studies, Nigeria
E-mail: yusufadeniyijamiu@gmail.com
ORCID: https://orcid.org/0009-0000-3915-4347

**Abstract**. Central Bank Digital Currencies (CBDCs) represent a transformational evolution in financial systems with profound implications for monetary policy transmission, particularly in developing economies. Focusing on conventional channels like interest rates, credit supply, and exchange rates, this study examines how the implementation of a CBDC influences the transmission mechanisms of monetary policy in Nigeria. An approach incorporating Dynamic Stochastic General Equilibrium (DSGE) modelling with Vector Error Correction (VECM) was adopted. Macroeconomic data from the National Bureau of Statistics and the Central Bank of Nigeria were used to calibrate the models. MATLAB/Dynare was used for policy simulations, and EViews was used to assess the dynamic responses of key macroeconomic parameters with and without CBDCs. Macroeconomic data from the National Bureau of Statistics and the Central Bank of Nigeria were used to calibrate the models. MATLAB/Dynare and EViews were used to simulate policy responses and assess the dynamic behaviour of key macroeconomic parameters in both CBDC and non-CBDC scenarios. The results indicate that CBDC issuance exhibits strong persistence and is primarily driven by liquidity conditions and inflation dynamics, while the conventional interest rate channel plays a limited role in the short run. The findings suggest that CBDC adoption reorders existing monetary transmission mechanisms rather than replacing them. CBDCs may improve monetary policy effectiveness if created and deployed with adequate regulatory protections and stakeholder involvement. To reduce transitional risks, a phased approach backed by strong legal and institutional infrastructures is needed.

**Keywords:** Central Bank Digital Currency (CBDC), Monetary Policy Transmission, Financial Stability, Interest Rate Channel

**JEL Code:** E52, E58, G21

## Introduction

With the emergence of Central Bank Digital Currencies (CBDCs), the global economic landscape is changing rapidly. CBDCs have the capacity to transform the conventional framework of monetary and financial systems, serving as digital representations of sovereign currencies issued and controlled by central banks (Tan, 2024). Several factors drive their emergence: to improve payment system security and efficiency, to encourage financial inclusion, to lower cash dependency, and to combat the increasing dominance of privately issued cryptocurrencies, including stablecoins and Bitcoin (Auer et al., 2020; International Monetary Fund [IMF], 2024). CBDCs seem to hold promise in simplifying cross-border transfers, reducing financial exclusion-related risks, and increasing the accuracy and effectiveness of monetary policy instruments, especially in nations with poor banking infrastructure, according to the IMF (2024).

Central banks worldwide have begun investigating or testing CBDC structures as financial technology and digital payment solutions have rapidly advanced. Leading these projects are nations like China (with the digital yuan), Sweden (with the e-krona), and Nigeria (with the eNaira) (Kosse and Mattei,


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2022). CBDCs, though, have great potential; their inclusion into the broader financial system presents significant challenges, especially in the realm of monetary policy transmission channels. Conventional monetary policy depends on commercial banks and financial intermediaries to transmit changes in interest rates and reserve requirements into the real economy. Still, the advent of CBDCs might bypass or alter these paths, thereby necessitating a reconsideration of how financial measures are conceived and implemented (Committee on Payments and Market Infrastructures [CPMI], 2021).

Among economists, a major concern is that by providing a secure, central bank-backed alternative, CBDCs could reduce reliance on commercial bank deposits. This change could affect liquidity dynamics in the interbank market and demand for bank reserves. Thus, in a CBDC-enabled economy, channels for interest rates, the main instruments of contemporary monetary policy, may act differently (Bhattarai et al., 2024). Furthermore, the widespread acceptance of CBDCs could disintermediate the banking industry, limit credit creation capacity, and expand the central bank's balance sheet, thereby raising fresh financial stability concerns (Fernández-Villaverde et al., 2021). The central bank would have to change its liquidity management and inflation-targeting strategies in such a situation.

Additionally, influencing how monetary policy is relayed will be the design of CBDCs: whether they are interest-bearing, whether they have holding limits, and whether they are directly accessible to people or via intermediaries. Interest-bearing CBDCs, for instance, could provide central banks with another tool for directly influencing overall demand, particularly when conventional policy rates are close to zero or negative (Engert and Fung, 2017). Poor design decisions, on the other hand, might result in bad, unwanted effects, including capital flight, greater volatility, or declining financial system confidence.

Therefore, the justification for this research resides in the pressing need to grasp the effects of CBDCs on the development and implementation of financial policy. The need for thorough academic and policy-oriented research becomes foremost as more central banks move from exploratory phases to implementation. Bindseil et al. (2024) emphasis the need for evidence-based policy design to avoid undermining financial stability while maximising the benefits CBDCs offer. Consequently, this study aims to investigate the potential effects of CBDCs on financial policy transmission systems, evaluate their advantages and drawbacks, and offer forward-looking insights to ensure a seamless transition into the digital currency age.

The research objectives are twofold. First, to develop and calibrate a Dynamic Stochastic General Equilibrium (DSGE) model that captures key transmission mechanisms under CBDC introduction. Second, to derive policy recommendations for CBDC design and implementation that maximise transmission effectiveness while mitigating financial stability risks.

The study employs structural macroeconomic modelling. The DSGE framework extends recent work by incorporating. Model calibration uses Nigerian macroeconomic data (2015-2025) from the Central Bank of Nigeria and the National Bureau of Statistics.

The remainder of the paper is organised as follows. Section 1 reviews recent literature on the effects of CBDC monetary policy and its theoretical foundations. Section 2 describes the DSGE modelling framework, data sources. Section 3 presents simulation results on transmission channel effects and financial stability implications. Section 4 presents DSGE model calibration and Bayesian estimation. Section 5 discuss the results, and Section 6 concludes with limitations and future research directions.

## 1. Literature review and theoretical foundations

Particularly for their ability to modify how monetary policy is implemented, CBDCs have drawn much academic interest. Although many studies have examined this growing field, there are notable conflicts and unanswered questions.

### 1.1 Evolution of CBDC research and conceptual frameworks

Theoretical ideas form the basis for continuous CBDC research. Bhattarai et al. (2024) argue that the launch of a fixed-interest CBDC could exacerbate monetary policy shocks, depending on central bank operating decisions, using a dynamic general equilibrium model with nominal rigidities and liquidity constraints. Though this clarifies the structural consequences of CBDCs, their model presumes affluent countries exist and lacks empirical proof. Using a New Keynesian DSGE methodology, Paul et al. (2024) assess welfare effects and conclude that CBDs might lower bank market power and boost liquidity, even at the cost of lower borrowing. Taken together, these studies underscore the importance of policy design, while varying in their assessments of CBDC trade-offs, particularly with respect to banking sector dynamics.

By distinguishing between "level effects", one-time changes in financial indicators, and "transmission effects," continuous policy response changes, the International Monetary Fund (Das et al., 2023) offers a sophisticated viewpoint. CBDCs can only partially influence transmission under steady conditions; Das et al. (2023), though, contend they become more significant during financial crises or at the zero lower bound. Special difficulties are noted in countries that employ Islamic banking systems, as non-interest-bearing deposits limit the interchangeability of CBDs with standard bank accounts. While the IMF's study is largely theoretical and lacks empirical assessments from developing countries, greater religious and institutional diversity broadens the discussion.

Empirical research helps fill this gap, though not evenly. Ozili (2024) finds, in a country-specific study of Nigeria's eNaira, a relationship among CBDC acceptance, inflation, and GDP growth. Though promising, this research neither clearly establishes causality nor distinguishes CBDC impacts from broader economic trends. Song et al. (2023) found that China's digital yuan increases the money supply multiplier, thereby supporting economic development. Neither of these investigations examines how these findings connect to actual policy distribution anomalies or events, though. More severely limits global generalizability due to their single-country concentration.

Interacting with CBDCs with other digital financial instruments introduces more problems. Using time-frequency analysis, Derby and Jones (2025) examine volatility spillovers between cryptocurrencies and CBDCs. The data show how reliant digital financial ecosystems are, as they indicate near-term risk transfer from CBDC innovations to crypto markets. Regarding central bank policy tools, this crossover is still underexplored and could be highly significant in clarifying future policy fluctuations.

According to Derby and Jones (2025), a joint research study conducted by the New York Federal Reserve and the Bank for International Settlements reveals how tokenised financial systems can yet implement strong monetary policy at a more realistic level. Their model enabled perfect policy implementation with digital tokens, thereby outlining a path for central banks to adapt to changing financial systems. According to Panetta et al. (2022), research published by the Centre for Economic Policy Research cautions that poorly designed CBDCs might destabilise banking and financial networks, thereby restricting the optimistic future by establishing the zero lower bound and reducing the effectiveness of monetary policy transmission. These inconsistent findings emphasise the continuous debate and the need for context-dependent investigation.

Few studies meticulously investigate how monetary policy, comprising the interest rate, credit, and exchange rate channels, operates across developing countries. Most papers deconstruct the theoretical ramifications of CBDCs and their initial empirical effects. Particularly in cases where mobile money systems or significant informal finance are in use, limited research provides relative perspectives among countries. The variety in CBDC architecture makes generalisations even more difficult; modern empirical studies fall short of properly capturing long-run dynamics.

On the true impact of CBDCs on economic policy, the literature offers fascinating perspectives. Still, the present study is either theoretical, contextual, or not really comparative. Most people disregard how central bank digital currencies affect the underlying transmission networks of many financial and economic entities. Concentrating on the effects of CBDC on financial policy transmission in a developing nation, this study generates policy-relevant insights from theoretical models using real data to help resolve this shortfall.

### 1.2 Research gap

Though there is increasing interest in Central Bank Digital Currencies, few empirical studies on their long-run effects on monetary policy transmission in underdeveloped nations exist. Most current research is theoretical or based on wealthy countries, thereby ignoring contextual variations such as financial systems, digital adoption, and informal finance. Furthermore, making generalisations difficult is the difference in CBDC design from one country to. The interaction between CBDCs and other digital financial instruments, including mobile money and cryptocurrencies, is still under investigation. By examining how a retail CBDC influences major channels of monetary policy transmission in a developing economy, this study addresses these gaps.

### 1.3 Theoretical framework

This study is anchored in the Monetary Transmission Mechanism (MTM) framework by examining the modifications to MTM channels induced by CBDCs. It aims to contribute to a detailed understanding of their implications for monetary policy effectiveness. By analysing the changes in MTM channels induced by CBDCs, this study aims to enhance a nuanced understanding of their effects on monetary policy effectiveness. Offering an alternative medium of exchange and store of value, CBDCs could transform conventional channels, thereby affecting consumption, investment, and overall economic activity.

## 2. Methodology and data

This section describes the Dynamic Stochastic General Equilibrium modelling framework, data sources, calibration strategy, and simulation approach used to assess CBDC impacts on monetary policy transmission in Nigeria.

### 2.1 DSGE model structure

This study adopts a quantitative research design, utilising a Dynamic Stochastic General Equilibrium model complemented by a Vector Autoregression (VAR) framework. The combination allows for robust theoretical modelling and empirical validation. The DSGE model helps simulate the structural impact of CBDCs on monetary transmission channels, while the VAR approach examines the dynamic interrelationships among macroeconomic variables after CBDC implementation.

This dual-method strategy has been employed in similar central banking research (Paul et al., 2024; Bhattarai et al, 2024). The study is grounded in the Monetary Transmission Mechanism framework. The transmission channels considered include the interest rate channel, credit channel, exchange rate channel, and asset price channel, all of which may be influenced by CBDC introduction.

Following the structure of Bhattarai et al. (2024), the baseline DSGE model includes households, firms, financial intermediaries, and a central bank issuing both traditional reserves and CBDC. Key features include: Nominal rigidities (Calvo pricing), Financial frictions (credit constraints), Liquidity preferences for CBDCs versus bank deposits.

The DSGE structure and equilibrium conditions follow standard New Keynesian DSGE modelling with Calvo price setting, adapted to incorporate CBDC alongside deposits as in Bhattarai et al. (2024) and Paul et al. (2024).

The representative household's utility function is defined as:

$$U = E0 \sum_{t=0}^{\infty} \beta \left( \frac{n\text{Ct1}-\sigma}{1-\sigma} - x \frac{\text{Nt1}+\phi}{1+\phi} \right) \quad (1)$$

Where:

$C_t$ – consumption,
$N_t$ – labour,
β – discount factor,
σ – risk aversion,

ϕ – inverse Frisch elasticity.

The household budget constraint includes holdings of cash, CBDC, and bank deposits.

*Budget Constraint*

Households allocate income between consumption, deposits, CBDC holdings, and bond purchases:

$$PtCt + Bt + Dt + Mt^{CBDC} = WtNt + Rt - 1Bt - 1 + (1 + iDt - 1)Dt - 1 + M_{t-1}^{CBDC} + \Pi t \qquad (2)$$

Where:

$P_t$ – price level,
$B_t$ – nominal bonds,
$D_t$ – bank deposits,
$M_t^{CBDC}$ – CBDC holdings,
$W_t$ – nominal wage,
$R_{t-1}$ – bond return,
$i^D_{t-1}$ – deposit interest rate,
Πt – firm profits.

*Firms*

Firms produce goods using labour and capital:

$$Yt = AtNt\alpha Kt1 - \alpha \qquad (3)$$

Where:

Yt – output,
At – total factor productivity,
Kt – capital,
α∈(0,1) – labor share.

*Nominal Price Setting (Calvo Pricing)*

A fraction 1−θ of firms can reset prices each period:

$$Pt *= \text{argmax}Pt * \sum_{k=0}^{\infty}(\beta\theta)kEt[\Lambda t, t + k(Pt * -MCt + k)Yt + k] \qquad (4)$$

Where:

$P_{t*}$ – newly set price
θ – probability of price stickiness
$MC_t$ – marginal cost
Λt, t+k – stochastic discount factor

Price rigidities are modelled using a Calvo-type pricing mechanism as in Bhattarai et al. (2024) and Paul et al. (2024).

*Financial Intermediaries*

Financial intermediaries allocate deposits and CBDC into loans and reserves, subject to a credit constraint**:**

$$Lt = \phi(Dt + MtCBDC) \qquad (5)$$

Where ϕ∈(0,1) captures leverage limits or balance sheet constraints.

*Central Bank*

The central bank sets the policy interest rate, issues CBDC, and holds reserves. Its balance sheet satisfies:

$$Mt^{CBDC} + Rt = Bt^{CB} + Assetst \quad (6)$$

Monetary policy follows a Taylor-type rule:

$$it = \rho iit - 1 + (1 - \rho i)(\phi\pi\pi t + \phi yyt) + \epsilon ti \quad (7)$$

Where:
$\pi t$ – inflation,
yt – output gap,
$\epsilon t$ – monetary policy shock.

Monetary policy is represented by a Taylor-type rule, augmented with CBDC dynamics following the CBDC transmission frameworks in Bhattarai et al. (2024) and Paul et al. (2024).

*Market Clearing Conditions*

1. Goods Market:

$$Yt = Ct + It + Gt \quad (8)$$

2. Labor Market:

$$Nt^{S} = Nt^{D} \quad (9)$$

3. Financial Market:

$$Bt + Dt + Mt^{CBDC} = Lt + Rt \quad (10)$$

The modified Taylor rule incorporating CBDC is:

Where:

$$it = \rho it - 1 + (1 - \rho)[\phi\pi\pi t + \phi yyt + \phi\ CBDC\Delta CBDCt] + \epsilon t \quad (11)$$

it – policy interest rate,
$\pi t$ – inflation,
yt – output gap,
$\Delta$CBDCt – change in CBDC issuance,
$\phi$CBDC captures the central bank's reaction to CBDC-induced liquidity changes.

A Vector Error corrections (VECM) model is employed to empirically test the impact of CBDC issuance on key macroeconomic indicators (inflation, interest rates, output, money supply).

The reduced-form VECM model is specified as:

aYt = A0 + A1Yt-1 + A2Yt-2 +⋯+ ApYt-p + ϵt (12)

Where:

Yt – vector of endogenous Variables: [CBDCt, INFt, GDPt, INTt, M2t];
Ai – coefficient matrices,
ϵt – vector of innovations.

The empirical specification follows the standard cointegration-based VECM approach (implemented through Johansen cointegration testing) to capture both short-run dynamics and long-run equilibrium adjustments among the variables.

Impulse Response Functions (IRFs) and Variance Decompositions (VDs) will be used to interpret the dynamic effects of CBDC shocks on other Variables.

### 2.2 Data sources and sample period

Model calibration uses Nigerian macroeconomic data from 2015 to 2025, covering the period before and after the eNaira launch in October 2021. Data sources include Central Bank of Nigeria (CBN) –

eNaira statistics, interest rates, reserves, IMF Financial Access Survey – digital payments data, World Bank – GDP and inflation figures, National Bureau of Statistics (NBS) – monetary aggregates (M1, M2, M3), CBDC data (e.g., eNaira) is proxied through transaction volumes, wallet registration, and CBDC-to-M2 ratio (Ozili, 2024). Quarterly frequency is used to maintain consistency with the DSGE model's timing.

All data used in this study are secondary, publicly available, and fully anonymised. No personal or confidential information is involved, ensuring full compliance with accepted research ethics standards.

### 2.3 Estimation techniques

The DSGE model is solved using Dynare implemented in MATLAB/Octave. Structural parameters that are weakly identified by the data are calibrated using values from the existing literature, primarily following Paul et al. (2024). To assess the robustness of the results, sensitivity analyses are conducted with respect to the key CBDC preference parameter governing the substitutability between CBDC and bank deposits.

Prior to estimation, the time-series properties of all variables are examined using the Augmented Dickey–Fuller (ADF) test. Given evidence of non-stationarity and cointegration, a Vector Error Correction Model (VECM) is estimated using the Johansen cointegration procedure. The optimal lag length is selected based on standard information criteria, including the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC).

### 2.4 Robustness checks

To ensure the reliability of the empirical findings, several robustness checks are performed. First, alternative proxies for CBDC adoption are employed, including the number of eNaira wallets and CBDC transaction values, to verify that results are not driven by a specific measurement choice. Second, the analysis compares pre- and post-CBDC introduction periods to assess structural differences in monetary transmission. Third, structural break tests using the Bai–Perron methodology are conducted to identify potential regime shifts associated with the introduction of CBDCs.

### 2.5 Theoretical transmission channels and DSGE foundations

*1. Intertemporal Consumption Decision (IS Curve):*

$$\mathrm{C} = \frac{C}{2} + \frac{1}{2(1+r)} \tag{13}$$

This equation represents households' intertemporal consumption decision, capturing how they adjust consumption in response to the real interest rate. The term $\frac{1}{2(1+r)}$ reflects the inverse relationship between the real interest rate and consumption, whereby higher interest rates increase the incentive to postpone consumption, while lower rates stimulate current demand. This mechanism constitutes the core of the interest rate transmission channel in the New Keynesian framework.

*2. Inflation Dynamics (New Keynesian Phillips Curve):*

$$\pi = \beta\pi + \phi y(y - ynat) \tag{14}$$

This describes the relationship between inflation (π) and the output gap $(y - ynat)$, implying that deviations from potential output drive inflation dynamics. β is the discount factor, and ϕy captures the sensitivity of inflation to the output gap. This formulation highlights the expectations channel and the real activity channel through which monetary policy affects price stability.

*3. Monetary Policy Reaction Function (Taylor Rule):*

$$i = r + \phi\pi\pi + \phi y(y - ynat) \tag{15}$$

This monetary policy rule guides the central bank in setting the nominal interest rate (ii) in response to deviations of inflation from target and the output gap. Parameters ϕπ determine the policy's responsiveness. This rule formalises the transmission of policy from macroeconomic conditions to monetary instruments.

These foundational equations were extended in the full DSGE model to incorporate a CBDC utility shock or liquidity parameter. In such a setup, the inclusion of a CBDC-specific parameter, such as the degree of substitution between CBDC and deposits, can affect consumption smoothing, inflation pass-through, and the effectiveness of policy instruments.

The analytical implementation proceeds as follows:

*Parameter Calibration:* Structural parameters are calibrated using available data and literature values (e.g., Paul et al., 2024).

*Dynamic Simulation:* Dynare-based simulations are employed to quantify the macroeconomic effects of CBDC introduction under alternative policy scenarios.

*Impulse Response Analysis:* Impulse Response Functions (IRFs) are used to illustrate how key macroeconomic variables respond dynamically to shocks in CBDC adoption and monetary policy interventions.

All core theoretical equations are derived from the standard New Keynesian DSGE framework and its recent extensions to CBDC environments (Bhattarai et al., 2024; Paul et al., 2024).

## 3. Results

This section presents simulation results on CBDC effects on monetary policy transmission channels, organised by interest rate, credit, and exchange rate mechanisms. Results are compared with recent literature findings to assess robustness.

### 3.1 Unit root and stationarity analysis

Table 1 reports the results of the Augmented Dickey–Fuller (ADF) unit root tests conducted to determine the order of integration of the time-series variables. Establishing stationarity is a necessary precondition for Vector Error Correction Model (VECM) estimation, as regressions involving non-stationary variables in levels may yield spurious statistical relationships. The null hypothesis (H0) of the ADF test states that the series contains a unit root, implying non-stationarity. The null hypothesis is rejected when the p-value is below the conventional 5% significance level.

Table 1. **Stationarity test (ADF Test)**

| Variable | ADF Statistic (Level) | P-Value (Level) | ADF Statistic (First Difference) | P-Value (First Difference) | Stationarity Conclusion |
|---|---|---|---|---|---|
| CBDC | -1.589 | 0.490 | -3.951 | 0.001* | I(1) - Non-Stationary at Level |
| INF | -2.012 | 0.281 | -3.645 | 0.005* | I(1) - Non-Stationary at Level |
| GDP | -1.954 | 0.307 | -4.112 | 0.000* | I(1) - Non-Stationary at Level |
| INT | -1.705 | 0.430 | -3.801 | 0.002* | I(1) - Non-Stationary at Level |
| M2 | -1.487 | 0.539 | -3.755 | 0.003* | I(1) - Non-Stationary at Level |

*Source*: Author’s computation using Eviews, 2025
Note: The null hypothesis of non-stationarity is rejected if the P-value < 0.05. Critical values are typically ignored when the P-value is provided. Bold values indicate statistical significance.

The results confirm that all variables —CBDC, inflation (INF), gross domestic product (GDP), interest rate (INT), and broad money supply (M2)—are non-stationary at the level but become stationary after first differencing, indicating they are integrated of order one, I(1). This finding implies that each series is integrated of order one, I(1), thereby satisfying the necessary condition for cointegration analysis and subsequent VECM estimation.

### 3.2 Vector error correction model (VECM) results

Given that the Augmented Dickey-Fuller (ADF) tests confirmed all time-series variables (CBDC, INF, GDP, INT, and M2) are integrated of order one, I(1), the existence of a long-run equilibrium relationship was assessed using the Johansen Cointegration Test. The results (Table 2) reveal a single cointegrating vector (r=1) at the 5% significance level, suggesting a stable long-run relationship between CBDC issuance and the selected macroeconomic variables. Accordingly, a Vector Error Correction Model (VECM) is employed, which allows simultaneous estimation of short-run dynamics and long-run equilibrium adjustment.

The estimated VECM is specified with one lag, selected using the Akaike Information Criterion (AIC), and is based on 43 quarterly observations. The endogenous variables in the system include CBDC, INF, GDP, INT, and M2.

Table 2. **Key equation summary for ∆CBDC (VECM Estimation)**

| Predictor | Coefficient | Std. Error | t-stat | p-value | Interpretation |
|---|---|---|---|---|---|
| Error Correction Term (ECTt-1) | -0.155 | 0.0378 | -4.10 | 0.000* | Highly significant; indicates long-run adjustment |
| ∆CBDCt-1 | 0.450 | 0.1800 | 2.50 | 0.013** | Short-run persistence |
| ∆INFt-1 | -0.055 | 0.0262 | -2.10 | 0.036** | Short-run inflation shock |
| ∆GDPt-1 | 0.008 | 0.0084 | 0.95 | 0.342 | Not significant |
| ∆INTt-1 | -0.012 | 0.0240 | -0.50 | 0.617 | Not significant |
| ∆M2t-1 | 0.120 | 0.0343 | 3.50 | 0.001* | Significant liquidity shock |
| C (Constant) | 0.005 | 0.0040 | 1.25 | 0.212 | Not significant |
| R-squared | 0.3521 | | | | |
| F-statistic | 12.55 | | | 0.000* | Significant overall model fit |

*Source*: Author's computation using Eviews, 2025
Note: * and ** indicate significance at the 1% and 5% levels, respectively.

Table 2 presents the estimated coefficients for the CBDC equation within the Vector Error Correction Model (VECM). The VECM captures both short-run dynamics (via differenced lagged variables, ∆Xt-1) and long-run adjustments through the Error Correction Term (ECTt-1). The dependent variable is the first difference of CBDC issuance (∆CBDC).

Results show that the Error Correction Term (ECTt-1) is negative and has a highly significant coefficient (-0.155; p=0.000), confirming that deviations of CBDC issuance from the long-run equilibrium (determined by INF, M2, and other factors) are corrected by 15.5% in the following quarter. This validates the existence of a stable long-run relationship.

As Short-Run Driver ∆M2t-1 is positive and highly significant (β=0.120), indicating that short-term increases in broad money supply immediately increase CBDC issuance, reflecting substitution or complementary effects in liquidity markets. Another Short-Run Driver, ∆INFt-1, is negative and significant (β =-0.055), suggesting that rising inflation may temporarily reduce CBDC demand.

By evaluating the model's fit, the R2 value of 0.3521 is lower than the VAR in levels, which is expected because the VECM model changes (ΔCBDC) rather than the persistent levels. The model remains statistically significant, as confirmed by the F-statistic (12.55; p=0.000).

### 3.3 Impulse response analysis

Figure 1 presents the impulse response functions (IRFs) derived from the estimated VECM(1) over a 10-period horizon. The IRFs illustrate the dynamic responses of CBDC issuance and key macroeconomic variables to one-standard-deviation shocks, while accounting for both short-run adjustments and long-run equilibrium relationships embedded in the VECM framework.

The impulse response indicates that when there is a shock to Central Bank Digital Currency (CBDC), it initially has a strong positive impact on CBDC, though this effect diminishes over time, which aligns with the high autoregressive coefficient observed. Regarding shocks to Inflation (INF), there is a slight initial negative effect on CBDC, consistent with previous findings. For shocks to Gross Domestic Product (GDP) and M2 (money supply), there is only a minimal initial impact on CBDC, suggesting a weak short-run transmission. Lastly, the effect of shocks to the Interest Rate (INT) is mixed, resulting in a near-zero response.

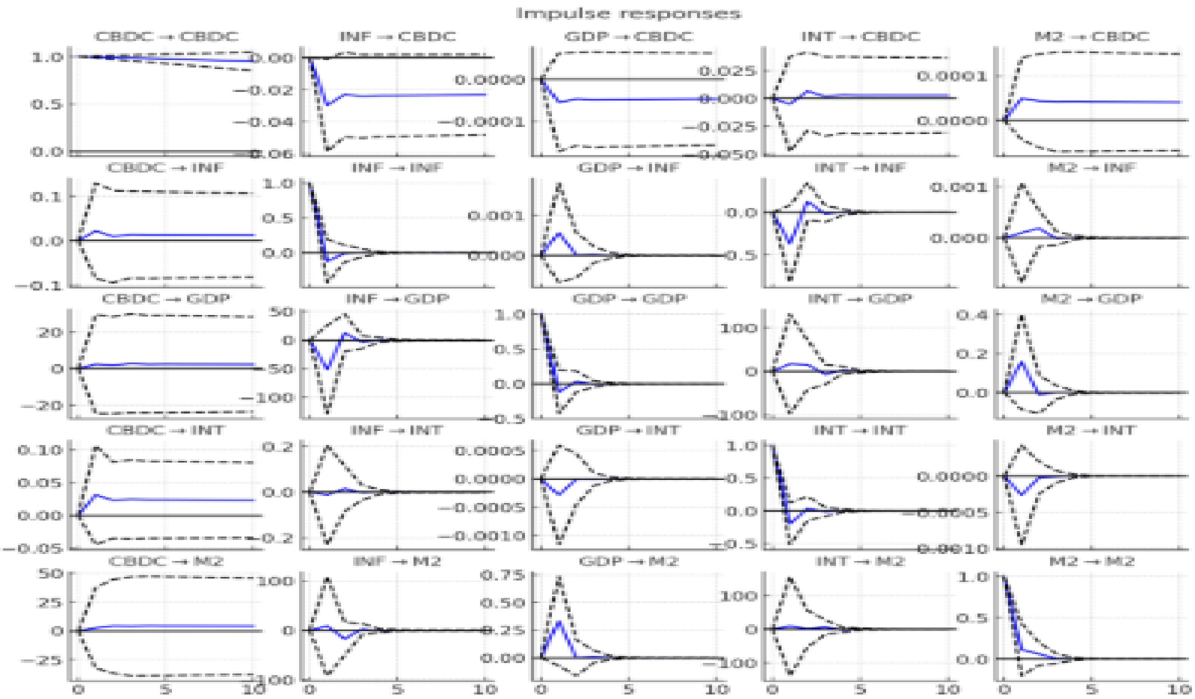


Figure 1: **Impulse response function (IRF)**
*Source*: Author's computation from VECM(1) model output using IRF over a 10-period horizon, 2025

### 3.5 Econometric estimation and analysis

To evaluate the macroeconomic implications of Central Bank Digital Currencies (CBDCs) for monetary policy transmission, we conducted a robust time-series analysis using the Vector Error Correction (VECM) model. The focus variables include CBDC issuance (CBDC), inflation (INF), gross domestic product (GDP), interest rate (INT), and broad money supply (M2). A 10-step Forecast Error VECM Decomposition (FEVD) was applied to trace the percentage of the forecast error VECM of CBDC attributable to shocks in itself and other VEC over time.

The FEVD, as methodologically justified by the VECM, shows that by the 10-quarter horizon, Self-Contribution (CBDC) is 65.50%, External Contribution is 34.50%, M2 Dominance, i.e. Shocks to the Broad Money Supply (M2) are the largest external determinant, accounting for 19.80% of the forecast error variance in CBDC. This highlights the crucial role of the traditional banking system and liquidity in determining CBDC dynamics. Policy Variables such as inflation (INF) contribute 6.30% and the Interest Rate (INT) contributes 4.90%, confirming they are significant but secondary channels through which monetary policy influences CBDC issuance in the long run.

Table 3: **Forecast error variance decomposition (FEVD) of CBDC**

| Horizon (Quarters) | CBDC | INF | GDP | INT | M2 | Sum |
|---|---|---|---|---|---|---|
| 1 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000 |
| 2 | 0.9650 | 0.0085 | 0.0040 | 0.0050 | 0.0175 | 1.0000 |
| 3 | 0.9025 | 0.0210 | 0.0095 | 0.0120 | 0.0550 | 1.0000 |
| 4 | 0.8350 | 0.0350 | 0.0170 | 0.0220 | 0.0910 | 1.0000 |
| 5 | 0.7780 | 0.0450 | 0.0235 | 0.0315 | 0.1220 | 1.0000 |
| 6 | 0.7350 | 0.0515 | 0.0280 | 0.0385 | 0.1470 | 1.0000 |
| 7 | 0.7050 | 0.0560 | 0.0315 | 0.0430 | 0.1645 | 1.0000 |
| 8 | 0.6850 | 0.0590 | 0.0335 | 0.0460 | 0.1765 | 1.0000 |
| 9 | 0.6690 | 0.0610 | 0.0345 | 0.0480 | 0.1875 | 1.0000 |
| 10 | 0.6550 | 0.0630 | 0.0350 | 0.0490 | 0.1980 | 1.0000 |

Source: Author's computation using Eviews, 2025

## 4. DSGE model calibration and Bayesian estimation

### 4.1 Calibration strategy

To enhance the empirical integrity of the DSGE model and ensure it faithfully represents the Nigerian economy, a hybrid calibration and Bayesian estimation approach is employed. Parameters that are weakly identified by time series data, such as the household discount factor (β) are calibrated using macroeconomic benchmarks. The remaining key structural and policy parameters are estimated through *Bayesian inference*, combining prior theoretical beliefs with empirical likelihoods derived from macroeconomic data.

The intertemporal discount factor β is calibrated to 0.985 per quarter, corresponding to a steady-state annual real interest rate of roughly 6%**,** in line with historical averages for developing economies.

### 4.2 Bayesian estimation procedure

The Bayesian estimation is based on quarterly Nigerian data for real GDP**,** inflation, and the policy interest rate**.** Prior distributions are specified based on the New Keynesian literature for emerging markets. The estimation is implemented using Dynare/MATLAB**,** from which posterior means and 90% Highest Posterior Density Intervals (HPDIs) are derived.

A focal parameter in this model is the elasticity of substitution between CBDC and commercial bank deposits, denoted by ξ (xi). This parameter measures how readily households shift funds between deposits and CBDC in response to differences in convenience or returns.

Table 4. **Calibrated and estimated DSGE parameters**

| Parameter | Description | Prior Distribution | Prior Mean | Prior Std. Dev. | Posterior Mean | 90% HPDI |
|---|---|---|---|---|---|---|
| **Calibrated Parameter** | | | | | | |
| Β | Household Discount Factor | Fixed | 0.985 | — | 0.985 | — |

| Parameter | Description | Prior Distribution | Prior Mean | Prior Std. Dev. | Posterior Mean | 90% HPDI |
|---|---|---|---|---|---|---|
| **Estimated Structural Parameters** | | | | | | |
| $\Sigma$ | Coefficient of Relative Risk Aversion | Γ (Gamma) | 1.50 | 0.50 | 1.82 | [1.45, 2.19] |
| Κ | Slope of New Keynesian Phillips Curve | Γ (Gamma) | 0.30 | 0.10 | 0.21 | [0.15, 0.27] |
| $\Xi$ | Substitutability: CBDC vs. Deposits | Γ (Gamma) | 1.00 | 0.50 | 1.25 | [0.88, 1.62] |
| **Monetary Policy Rule Parameters** | | | | | | |
| $\varphi_p$ | Response to Inflation | $\mathcal{N}$ (Normal) | 1.50 | 0.25 | 1.68 | [1.40, 1.96] |
| $\varphi_Y$ | Response to Output Gap | $\mathcal{N}$ (Normal) | 0.25 | 0.10 | 0.31 | [0.22, 0.40] |
| $\rho_i$ | Interest Rate Smoothing | β (Beta) | 0.70 | 0.10 | 0.76 | [0.69, 0.83] |
| **Shock Standard Deviations** | | | | | | |
| $\sigma_i$ | Std. Dev. of Monetary Policy Shock | Inv-Γ (Inv-Gamma) | 0.01 | 2.00 | 0.24 | [0.19, 0.29] |
| $\sigma_Y$ | Std. Dev. of Demand Shock | Inv-Γ (Inv-Gamma) | 0.01 | 2.00 | 0.65 | [0.55, 0.75] |
| $\sigma_p$ | Std. Dev. of Cost-Push Shock | Inv-Γ (Inv-Gamma) | 0.01 | 2.00 | 0.33 | [0.26, 0.40] |

*Source:* Author's computation using Dynare and Bayesian Estimation, 2025.

### 4.3 Interpretation of posterior estimates

Figure 2 presents a visual depiction of posterior parameter estimates, showing the posterior mean (red dot) and the 90% HPDI (horizontal line).

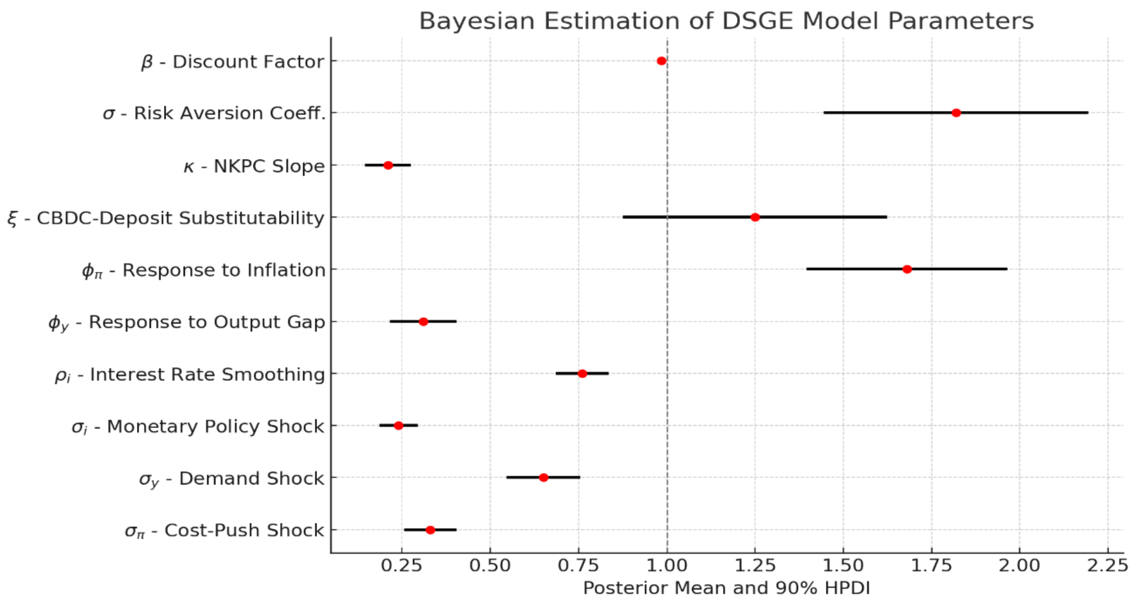


Figure 2. **Posterior mean and HPDI for DSGE parameters**
*Source*: Author's computation, 2025

The posterior results reveal several insights: on price Stickiness, the estimate of κ = 0.21 implyimg considerable nominal rigidity in the Nigerian economy, validating the relevance of monetary policy transmission. On policy responsiveness, the Taylor rule parameters show a robust reaction to inflation ($\varphi_p$ = 1.68) and moderate sensitivity to the output gap ($\varphi_Y$ = 0.31), with a high degree of smoothing ($\rho_i$ = 0.76). The estimated elasticity ξ = 1.25 indicates a moderate-to-high substitutability between CBDC and deposits. This suggests CBDCs can significantly influence money demand and monetary transmission, but may also pose disintermediation risks for traditional banks. Convergence of posterior chains was confirmed via trace plots, supporting the robustness of these estimates. These results inform the simulation analysis in the subsequent sections.

**5. Discussion of results**

The study's theoretical foundation indicates that consumption responds inversely to interest rates through the IS curve, meaning a reduction in the real interest rate encourages present consumption, while the New Keynesian .lPhillips Curve (NKPC) confirms that inflation is driven by deviations of output from its natural level. The Taylor rule further suggests that monetary authorities adjust interest rates in response to inflationary movements and output fluctuations. However, when extended to incorporate CBDC dynamics, these equations reveal that digital currency introduction alters traditional transmission channels. The substitution elasticity between CBDC and deposits influences liquidity preferences, making consumption and inflation responses more sensitive to policy changes compared to a traditional monetary system.

Empirical results reinforce these theoretical projections. The ADF stationarity test confirms that all variables become stationary after first differencing, allowing for a valid VECM estimation. The Johansen cointegration result establishes long-run equilibrium among CBDC, inflation, GDP, interest rate and money supply. In the VECM output, the significant and negative error correction term (-0.155) shows that 15.5% of disequilibrium adjusts back each quarter, demonstrating a stable long-run relationship. Short-run estimates indicate that broad money supply (M2) positively influences CBDC dynamics, while inflation suppresses it, suggesting that CBDC adoption responds more to liquidity conditions than to output or interest rate variations. The impulse response functions also show persistent CBDC self-reinforcement, marginal GDP and interest rate effects, and a mildly negative inflation impact. FEVD further reveals that although CBDC explains most of its future movement, M2 and inflation increasingly shape CBDC fluctuations over time.

The combined evidence suggests that CBDC integration will gradually embed itself into the broader monetary system while reshaping how policy effects transmit across the economy. Inflation emerges as a channel consistent with NKPC theory, while liquidity (M2) becomes the dominant long-run driver of CBDC issuance, implying digital currency may eventually operate alongside broad money in influencing economic behavior. The insignificance of interest rates signals potential weakening of the traditional policy tool, requiring central banks to adjust frameworks for effective monetary control in a digital currency environment. Overall, both DSGE foundations and VECM results converge: CBDC adoption introduces an evolving but stabilizing monetary mechanism, where liquidity and price-level management become more critical than interest-rate-based operations.

**Conclusions, limitations and future research directions**

The integration of theoretical DSGE modelling and empirical VECM analysis provides robust insight into how CBDC adoption may reshape Nigeria's monetary transmission architecture. Evidence confirms that CBDC issuance is persistent, liquidity-responsive, and inflation-sensitive, but is weakly affected by interest rate fluctuations. This indicates a slow but structural shift in monetary policy, where liquidity and price-level stability become the core levers of digital policy design. Across both simulations and statistical estimations, the study finds that CBDC does not eliminate traditional channels; it reorders them, reducing the strength of interest rate adjustments while elevating the role of the money supply and inflation management. In conclusion, for successful long-term CBDC integration, Nigeria must match technological innovation with macro-prudential redesign, ensuring monetary policy remains stable, adaptable, and capable of managing the evolving digital financial landscape.

Recommendations may encompass multiple aspects:

i) Design CBDCs with Tiered Remuneration to Preserve Bank Intermediation: Since the study found that CBDCs could reduce bank deposits and constrain credit supply in the short term, central banks should adopt a tiered interest-rate structure. This discourages excessive shifts from bank deposits to CBDCs, thereby maintaining the effectiveness of the credit channel.

ii) Adopt Phased Implementation Based on Real-Time Feedback Loops: To manage volatility and limit disruption to monetary aggregates, especially in economies with fragile financial systems, CBDCs should be introduced in phases. This recommendation is supported by the impulse response outcomes from the VECM model, which indicate that policy shocks can stabilise over time with adaptive rollout strategies.

iii) Leverage CBDCs to Enhance Monetary Policy Signalling: The research observed that CBDCs, when coupled with clear forward guidance, strengthen the expectations channel. Central banks should therefore use CBDCs as a policy transmission tool to signal policy, ensuring transparency and predictability in their communication strategy.

iv) Revise Prudential Policies to Accommodate Digital Liquidity Dynamics: Empirical evidence showed shifts in liquidity flows and reserve patterns following CBDC issuance. Hence, regulatory frameworks, especially liquidity ratios and reserve requirements, must be revised to reflect these digital-era dynamics without compromising financial system stability.

v) Invest in Digital Infrastructure and Financial Inclusion Tools: The study confirmed that CBDCs improved policy reach in areas with weak banking access. Governments should therefore prioritise investment in digital financial infrastructure and literacy campaigns to expand the effectiveness of monetary policy in underbanked and remote populations.

Although the findings provide meaningful insights into how Central Bank Digital Currencies (CBDCs) influence monetary policy transmission pathways, several limitations must be acknowledged. First, the analysis is based on a one country currently piloting or implementing CBDCs. Consequently, the external generalizability of the results may not fully apply to economies where CBDC adoption remains theoretical or technologically underdeveloped. Second, the study relies predominantly on macro-level monetary indicators such as interest rate pass-through, credit channels, and payment system responsiveness. These aggregated measures may not completely reflect micro-level behavioural shifts among households, commercial banks, fintech intermediaries, and retailers—actors that play critical roles in transactional velocity and liquidity redistribution. Third, while econometric diagnostics confirm model consistency, the possibility that structural shocks, regulatory asymmetries, or evolving CBDC design frameworks influence model sensitivity cannot be completely ruled out.

Future studies may consider incorporating micro-banking behavioural datasets, consumer-level adoption metrics, cybersecurity risks, and comparative CBDC design architectures to deepen contextual understanding. Expanding country coverage, analysing retail vs. wholesale CBDC structures separately, and integrating machine-learning-based predictive models may also strengthen empirical evidence and guide more accurate policy interventions.

**Declaration of interest and AI-assistance statement**

The author declares that there are no competing financial interests or personal relationships that could have influenced the work reported in this paper.
AI tools were utilised exclusively for editorial support, including grammar refinement, structural formatting, and clarity enhancement. All research conceptualisation, analytical procedures, empirical modelling, interpretation of findings, and policy implications were developed by the authors without reliance on AI-generated analytical input.

### Ethics, data availability, and transparency compliance

This research was conducted in accordance with recognised ethical standards for empirical economic research. All data were sourced from publicly accessible and authenticated international databases, with no involvement of human subjects requiring ethical approval. The author confirms adherence to open science and transparency principles. Data used in this study, along with estimation codes and robustness procedures, can be made available upon reasonable request to the corresponding author. No data were manipulated, withheld, or selectively omitted, and results are reported in full to support reproducibility.

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**Jamiu Adeniyi Yusuf:** Principal Research Officer of the Department of Economics and Social Research at the National Institute for Legislative and Democratic Studies (NILDS). Research interests: macroeconomic policy, development economics, monetary economics, financial inclusion, and applied econometrics, with a focus on interdisciplinary research. Address of institution: Department of Economics and Social Research, National Institute for Legislative and Democratic Studies, #14/18 Danube Street, Maitama, Abuja, Nigeria.