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Effects of Digital Rial Design on Iran's Macroeconomic Variables

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ABSTRACT

With the expansion of digital financial technologies, the issuance of the Digital Rial as a new form of central bank money has created new challenges and opportunities for monetary policy. The present study aims to investigate the effects of the issuance and design of the Digital Rial on the country's macroeconomic variables, including inflation, the output gap, and the policy interest rate. To analyze these effects, a Dynamic Stochastic General Equilibrium (DSGE) model with heterogeneous households is developed, in which the Digital Rial is modeled endogenously under two alternative regimes: non-interest-bearing and interest-bearing. The calibrated model is solved for the 2011–2024 period, and four policy scenarios are compared using dynamic model simulations, including the baseline scenario, the widespread non-interest-bearing Digital Rial issuance scenario, the interest-bearing and managed Digital Rial scenario, and the rapid and high-risk adoption scenario. The simulation results indicate that, in the baseline scenario, the Digital Rial functions solely as a payment instrument. The widespread issuance of a non-interest-bearing Digital Rial reduces the effectiveness of monetary policy by weakening the sensitivity of money demand to the interest rate and consequently increases fluctuations in inflation and the output gap. In contrast, the design of an interest-bearing and managed Digital Rial strengthens the interest rate transmission channel, contributes to macroeconomic stabilization, and improves the performance of the Taylor rule.

Keywords: Digital Rial, Monetary Policy, Dynamic Stochastic General Equilibrium Model, Heterogeneous Households, Inflation.

Introduction

The rapid development of digital financial technologies has fundamentally transformed the structure of monetary systems, payment mechanisms, and central banking operations worldwide. In recent years, the emergence of cryptocurrencies, electronic payment platforms, fintech innovations, and decentralized financial systems has challenged the traditional role of money and increased the need for central banks to redesign monetary policy instruments within the digital economy framework (1, 2). In response to these transformations, Central Bank Digital Currency (CBDC) has emerged as one of the most significant monetary innovations of the twenty-first century. CBDC refers to a digital form of sovereign money issued and guaranteed by the central bank, functioning as legal tender alongside physical cash and bank reserves (3, 4). Unlike private cryptocurrencies, CBDCs maintain monetary sovereignty, strengthen central bank control over liquidity, and provide a secure digital payment infrastructure (5). Consequently, many central banks around the world have initiated research, pilot programs, and experimental

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implementations of CBDCs in order to modernize payment systems, improve financial inclusion, and enhance monetary policy effectiveness (6, 7).

The increasing attention devoted to CBDCs is closely related to structural changes in monetary systems and the declining use of physical cash in many economies. Digital payments are gradually replacing traditional cash transactions, and this trend has accelerated due to technological development and changing consumer behavior. In this environment, central banks face the risk of losing direct influence over payment systems if private digital currencies or stablecoins become dominant (8). CBDCs are therefore considered strategic instruments for preserving monetary sovereignty and maintaining the effectiveness of monetary policy transmission channels (9). Furthermore, the global expansion of cross-border digital transactions has intensified concerns regarding exchange rate stability, capital mobility, and financial supervision, making the development of sovereign digital currencies increasingly important (2).

From a theoretical perspective, the emergence of CBDCs has generated extensive debate in monetary economics regarding the future of money, the banking system, and monetary policy transmission. Traditional New Keynesian monetary models emphasize the importance of the interest rate channel, inflation expectations, and nominal rigidities in determining macroeconomic dynamics (10, 11). However, the introduction of CBDCs modifies the structure of liquidity demand, alters household portfolio choices, and potentially changes the relationship between banks, depositors, and the central bank. As a result, conventional monetary policy mechanisms may operate differently in the presence of a widely adopted digital currency (12). The macroeconomic implications of CBDCs therefore extend beyond payment efficiency and directly influence inflation dynamics, output fluctuations, financial stability, and credit creation.

One of the most important issues in the literature concerns the effect of CBDCs on monetary policy effectiveness. In traditional monetary systems, commercial banks play a central role in transmitting monetary policy through credit creation and deposit intermediation. The introduction of CBDCs may alter this mechanism by enabling households and firms to hold digital central bank liabilities directly (13). Such changes can reduce bank deposits, weaken banks' balance sheets, and influence lending behavior. Consequently, the structure of monetary transmission may become more dependent on central bank policies and less reliant on private banking intermediation (9). This issue becomes particularly important when CBDCs are interest-bearing, as the Digital Rial interest rate may directly compete with bank deposit rates and reshape liquidity allocation across the financial system.

Recent studies indicate that the macroeconomic effects of CBDCs depend heavily on their institutional design. A non-interest-bearing CBDC primarily functions as a payment instrument and may have limited effects on monetary policy transmission. In contrast, an interest-bearing CBDC can become an active monetary policy instrument capable of strengthening the interest rate channel and improving policy transmission efficiency (12, 13). In this regard, Kumhof and Noone argued that the design of CBDC interest mechanisms significantly affects banking liquidity, credit supply, and monetary stability (9). Similarly, Bordo and Levin emphasized that properly designed CBDCs can enhance the effectiveness of monetary policy under low interest rate environments and provide central banks with additional stabilization tools (3). Therefore, the macroeconomic outcomes of CBDC implementation are not uniform and depend critically on design characteristics such as interest rate policies, convertibility rules, and the degree of integration with conventional banking systems.

Another important dimension of the CBDC literature concerns heterogeneous household behavior and distributional effects. Traditional representative-agent DSGE models often fail to capture the unequal effects of

monetary policy across income groups. Recent advances in Heterogeneous Agent New Keynesian (HANK) models demonstrate that household heterogeneity significantly affects monetary policy transmission through differences in consumption patterns, liquidity constraints, and asset holdings (14, 15). CBDCs may amplify these heterogeneous effects because different social groups exhibit varying preferences regarding digital money adoption, cash holdings, and bank deposits. Low-income households may benefit from improved financial inclusion and easier access to digital payments, whereas wealthier households may adjust their portfolios strategically in response to CBDC interest rates and financial market conditions. Therefore, understanding the interaction between CBDCs and heterogeneous household behavior is essential for evaluating their macroeconomic consequences.

The issue of financial inclusion is particularly relevant for developing economies. In many countries, a significant proportion of the population remains outside the formal banking system due to high transaction costs, limited banking infrastructure, or institutional barriers. CBDCs can reduce these limitations by providing households with direct access to digital payment systems and secure central bank liabilities (7). Moreover, CBDCs may reduce transaction costs, increase payment transparency, and facilitate the digitalization of economic activity (6). These potential advantages have encouraged many developing economies to accelerate CBDC experimentation and policy discussions. Nevertheless, concerns remain regarding cyber risks, bank disintermediation, inflationary pressures, and the possible destabilization of financial systems if CBDC adoption occurs rapidly and without appropriate regulatory frameworks (2).

In the context of Iran, the discussion surrounding the Digital Rial has become increasingly important due to structural challenges in the monetary and banking system. The Iranian economy has experienced persistent inflation, exchange rate volatility, banking sector imbalances, and limitations in international financial transactions over recent decades (16). These structural issues have weakened the effectiveness of traditional monetary policy instruments and increased the need for innovative monetary solutions. In response, the Central Bank of the Islamic Republic of Iran has initiated pilot programs and policy studies concerning the implementation of the Digital Rial as part of broader monetary modernization efforts (16). The Digital Rial is expected to improve payment efficiency, strengthen monetary supervision, reduce transaction costs, and enhance transparency in the financial system.

Despite these potential benefits, the implementation of the Digital Rial in Iran also raises important macroeconomic and policy concerns. The Iranian banking system remains highly dependent on deposit-based financing, and large-scale migration of deposits toward the Digital Rial could weaken banks' liquidity positions and reduce credit creation capacity. Furthermore, the impact of the Digital Rial on inflation dynamics and monetary policy transmission remains uncertain under conditions of structural inflation and macroeconomic instability. Therefore, understanding the macroeconomic implications of Digital Rial design is particularly important for policymakers in Iran.

Domestic studies on CBDCs in Iran have increasingly emphasized these policy dimensions. Vaziri and Nadri analyzed the effects of CBDCs on monetary policymaking and argued that digital currencies issued by central banks can reshape liquidity management mechanisms and alter policy transmission channels (17). Similarly, Sobhani and Shahidi examined the role of CBDC issuance in reducing banking network risk and highlighted the importance of proper policy coordination and regulatory design for ensuring monetary and financial stability in Iran (18). These studies indicate that the success of the Digital Rial depends not only on technological implementation but also on its compatibility with monetary policy objectives and macroeconomic stabilization requirements.

Although the existing literature provides valuable insights into the economic implications of CBDCs, several research gaps remain. First, many studies focus primarily on advanced economies, while the macroeconomic consequences of CBDCs in developing and inflation-prone economies remain underexplored. Second, a considerable portion of the literature analyzes CBDCs from institutional or technological perspectives rather than within fully specified macroeconomic equilibrium frameworks. Third, relatively few studies investigate the interaction between Digital Rial design, heterogeneous households, and monetary policy transmission simultaneously. Finally, limited attention has been devoted to comparing alternative CBDC design scenarios under varying levels of household adoption, interest rate policies, and financial risk conditions.

Given these gaps, the use of Dynamic Stochastic General Equilibrium (DSGE) models provides an appropriate analytical framework for evaluating the macroeconomic effects of the Digital Rial. DSGE models allow researchers to analyze interactions between households, firms, central banks, and financial markets under forward-looking expectations and stochastic shocks (10, 11). Moreover, incorporating heterogeneous households into DSGE frameworks enables a more realistic representation of liquidity preferences, financial inclusion, and distributional responses to monetary policy (14, 15). Such an approach is particularly useful for examining how different Digital Rial designs influence inflation, output fluctuations, and policy interest rates in the Iranian economy.

Accordingly, the present study aims to investigate the effects of Digital Rial design on Iran's macroeconomic variables, including inflation, the output gap, and the policy interest rate, using a heterogeneous-household DSGE framework under alternative policy scenarios of Digital Rial adoption and interest rate design.

Methods and Materials

The present model is based on a standard New Keynesian framework without capital accumulation and incorporates heterogeneous households. The economy consists of heterogeneous households (two types), New Keynesian firms with price stickiness, the government (neutral, transfer-only), and the central bank (monetary policy and Digital Rial policy).

Households are divided into two groups: households with access to the Digital Rial and households without access to the Digital Rial. In a heterogeneous household model, the introduction of Central Bank Digital Currency (CBDC) alters the composition of assets across different social classes. Extremely poor households continue to hold cash; middle-class households allocate part of their wealth to CBDC holdings; and wealthy households maintain a portfolio composed of deposits, CBDC, and cash. Consequently, a portion of low-income households that previously lacked bank accounts can now enter the financial system through CBDC. In countries with large unbanked populations, such as India, Indonesia, and Nigeria, CBDC can enhance financial inclusion. In summary, while CBDC may create short-term pressures on financial intermediation, it contributes to greater stability and efficiency in the long run.

Type-1 households derive utility from consumption C_t, leisure $1 - N_t$, and Digital Rial holdings (D_t)as follows:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} + \chi \frac{D_t^{1-\eta}}{1-\eta} \right)$$

where E_0denotes the expectations operator, $\beta$is the intertemporal discount factor, σrepresents the intertemporal elasticity of substitution in consumption, and ϕdenotes the labor supply elasticity. Furthermore, $\eta$is the utility elasticity of holding the Digital Rial, and χrepresents the utility weight assigned to Digital Rial holdings.

The budget constraint of Type-1 households is expressed as follows:

$$C_t + D_t + B_t = W_t N_t + (1 + i_{t-1})B_{t-1} + (1 + i_t^D)D_{t-1} + \Pi_t$$

where $i_t^D$is the Digital Rial interest rate, $B_t$denotes risk-free bonds, and $\Pi_t$represents firms' profits. The utility function and budget constraint of Type-2 households are similar to those of Type-1 households, except that the variable $D_t$is absent. The aggregate consumption function is defined as follows, where parameter αdenotes the consumption share of households with Digital Rial access, and δrepresents the elasticity of substitution between the two groups:

$$C_t = \left[\alpha C_{1,t}^{\frac{\delta-1}{\delta}} + (1-\alpha)C_{2,t}^{\frac{\delta-1}{\delta}}\right]^{\frac{\delta}{\delta-1}}$$

Each firm operates according to the following production function:

$$Y_t = A_t N_t$$

Given the study's focus on monetary transmission channels, capital accumulation is excluded from the model, and the framework is restricted to a simple New Keynesian structure. In this function, $A_t$denotes the technology level subject to a technology shock:

$$\ln A_t = \rho_a \ln A_{t-1} + \varepsilon_t^a$$

Prices are determined according to Calvo pricing:

$$P_t = (1-\theta_p)P_t^* + \theta_p P_{t-1}$$

where P_t^*denotes the optimal price and $\theta_p$represents the probability of price non-adjustment. Assuming Calvo price stickiness, where a proportion $\theta_p$of firms cannot adjust prices, the New Keynesian Phillips Curve is obtained as follows. In this equation, $\pi_t$denotes inflation, $x_t$represents the output gap, and κindicates the degree of price stickiness:

$$\pi_t = \beta E_t(\pi_{t+1}) + \kappa x_t$$

$$\kappa = \frac{(1-\theta_p)(1-\beta\theta_p)}{\theta_p}$$

Within the framework of the present model, the effects of fiscal policy are neutralized through the assumption of a balanced budget and the absence of government deficits. Therefore, the analysis focuses exclusively on monetary channels and the role of the Digital Rial in enhancing monetary policy transmission. Government expenditures are assumed to be fixed and non-responsive:

$$G_t = \bar{G}$$

1. 3.4. Central Bank

In the presence of the Digital Rial, the central bank pursues two objectives: price stability and financial stability (preventing excessive deposit outflows from banks). Accordingly, the augmented Taylor rule with an endogenous Digital Rial variable is specified as follows:

$$i_t = \rho_i i_{t-1} + (1-\rho_i)(\phi_\pi \pi_t + \phi_x x_t)$$

In this equation, $\phi_\pi$represents the monetary policy response to inflation, $\phi_x$denotes the monetary policy response to the output gap, and $\rho_i$indicates policy interest rate inertia. The Digital Rial interest rate rule is defined as follows:

$$i_t^c = \theta i_t + (1-\theta)(\psi_\pi \pi_t + \psi_x x_t)$$

If $\theta = 0$, the Digital Rial is non-interest-bearing; if $\theta > 0$, the Digital Rial is interest-bearing. In other words, θmeasures the degree of correlation between the Digital Rial interest rate and the policy interest rate. In this equation, $\psi_\pi$denotes the response coefficient of the Digital Rial interest rate to inflation, and $\psi_x$represents the response coefficient of the Digital Rial interest rate to the output gap. Finally, in the model, the Digital Rial adoption shock (ε_t^D), the monetary policy shock $\left(\varepsilon_t^i\right)$, and the Digital Rial interest rate shock $(\varepsilon_t^c)$are all assumed to follow normal distributions.

In general equilibrium, labor, goods, and money markets simultaneously clear. Household, firm, and government budget constraints hold, and equilibrium conditions exist between the supply and demand for cash, deposits, and the Digital Rial. The model is closed through the key equations governing the consumption-debt condition, the Phillips Curve, and the Taylor rule with the inclusion of the Digital Rial.

To analyze the macroeconomic effects of an endogenous interest-bearing Digital Rial on inflation, the output gap, and the policy interest rate, the proposed DSGE model requires the specification of key parameter values. In the present study, parameter values are selected based on previous studies, economic experience, and plausible scenarios. This calibration enables the comparison of different Digital Rial design and adoption scenarios and provides significant quantitative insights into the macroeconomic effects of the Digital Rial in the Iranian economy.

Table 1. Calibration of Model Parameters

Parameter Symbol	Parameter Definition	Value	Description/Source
$\boldsymbol{\beta}$	Intertemporal discount factor of consumption	0.99	Consistent with model structure
$\boldsymbol{\sigma}$	Intertemporal elasticity of substitution	1	Consistent with model structure
$\boldsymbol{\phi}$	Labor supply elasticity	1.5	Consistent with model structure
$\boldsymbol{\chi}$	Utility weight of the Digital Rial or intensity of preference for the Digital Rial	0.05–0.20	Barrdear and Kumhof (2016)
$\boldsymbol{\delta}$	Elasticity of substitution between the two household groups	0.8	Consistent with model structure
$\boldsymbol{\theta}$	Degree of correlation between the Digital Rial interest rate and policy rate	0–0.9	Consistent with model structure
$\boldsymbol{\rho_a}$	Persistence coefficient of technology shocks	0.92	Moshiri et al. (2011)
$\boldsymbol{\alpha}$	Consumption share of households with Digital Rial access	0.6	Consistent with model structure
$\boldsymbol{\kappa}$	Degree of price stickiness	0.1	Consistent with model structure
$\boldsymbol{\theta_p}$	Probability of price non-adjustment	0.73	Consistent with model structure
$\boldsymbol{\phi_x}$	Monetary policy response to output gap	0.5	Consistent with model structure
$\boldsymbol{\phi_\pi}$	Monetary policy response to inflation	1.5	Consistent with model structure
$\boldsymbol{\eta}$	Utility elasticity of the Digital Rial	1	Consistent with model structure
$\boldsymbol{\rho_i}$	Policy interest rate inertia	0.7	Based on Iran's banking interest rate and inflation experience

ψ_π	Response coefficient of Digital Rial interest rate to inflation	0.5	Consistent with model structure
ψ_x	Response coefficient of Digital Rial interest rate to output gap	0.2	Consistent with model structure
σ_ε^i	Standard deviation of policy interest rate shocks	1%	Scenario assumption
σ_ε^c	Standard deviation of Digital Rial interest rate shocks	1%	Scenario assumption
σ_ε^a	Standard deviation of productivity shocks	5%	Consistent with Iran's economy
σ_ε^D	Standard deviation of Digital Rial adoption shocks	1%	Scenario assumption

After calibrating the parameters and implementing the model designed in Dynare, impulse response functions are analyzed to simulate the Iranian economy over the 2011–2024 period.

Findings and Results

In this section, the effects of a positive Digital Rial shock are analyzed through simulation under four distinct scenarios. Shock values and variances are determined based on model simulation experience, actual data from the Iranian economy, and previous studies employing New Keynesian DSGE models. The parameter ranges are selected such that the shocks remain realistic and plausible while ensuring model stability under severe shock conditions. Sensitivity analysis indicates that the model results are particularly sensitive to the parameters representing households' preference intensity for holding the Digital Rial $(\chi)$and the degree of dependence between the Digital Rial interest rate and the policy interest rate (θ), whereas other policy and technological parameters exert secondary effects. Given the policy-oriented and innovative nature of the model, the sensitivity analysis focuses on parameters that play a decisive role in the monetary policy transmission channel and Digital Rial behavior. Other structural parameters that are well established in the DSGE literature are held constant.

The rationale for selecting the Digital Rial preference intensity parameter in the heterogeneous-agent model is that households exhibit different behavioral preferences; therefore, changes in this parameter directly affect the monetary policy transmission channel, aggregate demand, and consumption. An increase in the preference for the Digital Rial leads to deposit outflows from banks and reduces credit creation, thereby exerting contractionary effects on output and altering the inflation path. Consequently, sensitivity analysis with respect to this parameter demonstrates the extent to which Digital Rial policy remains stable and secure.

The parameter representing the degree of correlation between the Digital Rial interest rate and the policy interest rate indicates that if the Digital Rial interest rate is not aligned with the policy rate, monetary policy cannot fully transmit its effects, resulting in greater macroeconomic fluctuations. Sensitivity analysis for this parameter reveals the optimal Digital Rial interest rate design for achieving macroeconomic stability. Ultimately, these two parameters are selected because of their direct influence on household behavior and monetary policy effectiveness, and their examination provides clear policy implications. The sensitivity analysis results for inflation, the output gap, and the policy interest rate are evaluated under four different scenarios, including the baseline scenario, the widespread non-interest-bearing issuance scenario, the interest-bearing and managed Digital Rial scenario, and the rapid and high-risk adoption scenario (representing the risk of inflationary volatility).

Table 2. Summary of the Four Digital Rial Scenarios

Scenario	Key Parameters	Economic Interpretation
Baseline Scenario: Limited Non-Interest-Bearing Digital Rial	$\chi = 0.05$ $\theta = 0$	Limited pilot implementation, low transaction volume, and minor effects on monetary policy
Widespread Non-Interest-Bearing Digital Rial Issuance	$\chi = 0.10$ $\theta = 0$	Widespread Digital Rial adoption without an interest rate, causing changes in liquidity composition without policy responsiveness
Interest-Bearing and Managed Digital Rial	$\chi = 0.07$ $\theta = 0.5$	The central bank maintains stronger control through interest payments on the Digital Rial
Rapid and High-Risk Digital Rial Adoption	$\chi = 0.20$ $\theta = 0.9$	Rapid and widespread adoption of the Digital Rial with high persistence

According to Table 2, the baseline scenario represents the limited issuance of a non-interest-bearing Digital Rial, which generates minor fluctuations in inflation and the output gap, while the effectiveness of central bank monetary policy remains relatively weak. The widespread non-interest-bearing issuance scenario reflects an increase in households' preference for holding the Digital Rial (higher χ), resulting in greater volatility in inflation and the output gap because the interest rate channel is inactive and monetary policy effectiveness is limited. The interest-bearing and managed Digital Rial scenario demonstrates that linking the Digital Rial interest rate to the policy interest rate ($\theta = 0.5$)activates the monetary policy transmission channel. Consequently, inflation and output gap volatility decline relative to the non-interest-bearing scenario. The effectiveness of central bank monetary policy improves, and the economy returns to equilibrium more rapidly. Finally, in the rapid and high-risk adoption scenario, increases in both $\chi$and θ, together with rapid Digital Rial adoption, intensify short-term fluctuations. Inflation and the output gap reach significant peaks, and the return to economic equilibrium becomes more prolonged. This scenario represents the highest level of economic risk.

The results of the sensitivity analysis presented in Figure 1 and summarized in Table 3 indicate that inflation increases in the short run across all scenarios, as rising liquidity and consumption generate demand-side pressures. In the baseline scenario, inflation fluctuates within moderate bounds. In the widespread non-interest-bearing issuance scenario, inflation reaches its highest level and declines more slowly. In the interest-bearing and managed scenario, inflationary pressures are more effectively controlled and return more quickly to the target level. In the rapid and high-risk adoption scenario, inflation exhibits substantial volatility, indicating unstable expectations and uncertain policy responses.

The expansionary effects of the Digital Rial on inflation are significant. The design of interest-bearing mechanisms or liquidity absorption tools plays a crucial role in preventing persistent inflation.

The output gap variable (X_t)exhibits moderate behavior in the baseline scenario. Output increases, but the return to equilibrium occurs without severe shocks. The widespread non-interest-bearing issuance scenario generates a short-term increase in the output gap because liquidity expansion and aggregate demand are substantial. However, due to the absence of returns on Digital Rial holdings, demand becomes excessively stimulated, leading after several quarters to a sharp and even negative adjustment caused by rising inflation and supply-side pressures. In the interest-bearing and managed Digital Rial scenario, the response is milder and more stable. Control policies and the interest rate mechanism ensure that output growth is lower but more sustainable, and the positive output gap gradually converges toward equilibrium. In the rapid and high-risk adoption scenario, the output gap becomes more volatile, initially experiencing a strong surge, followed by contraction and renewed fluctuations. This behavior results from behavioral shocks, unstable expectations, and rapid changes in liquidity composition.

In the short run, the Digital Rial, particularly under widespread non-interest-bearing issuance, can stimulate economic growth and aggregate demand. However, in the absence of control instruments such as interest rate policies or fiscal measures, these effects rapidly weaken and may even become negative.

In all scenarios, the central bank raises the policy interest rate to contain inflation. In the widespread non-interest-bearing issuance scenario, the response occurs later because the initial positive effects on output are perceived as desirable, but the increase becomes relatively persistent and substantial. In the interest-bearing and managed scenario, the response is faster and stronger but also subsides more quickly, indicating a more active and efficient monetary policy framework. In the rapid and high-risk adoption scenario, the policy interest rate becomes more volatile because policymakers face a trade-off between inflation control and output stabilization. In the baseline scenario, the policy rate exhibits moderate behavior.

Monetary policy must be calibrated in a timely manner and according to the nature of the Digital Rial. Delayed responses reinforce inflationary effects, whereas excessively rapid responses may generate recessionary pressures.

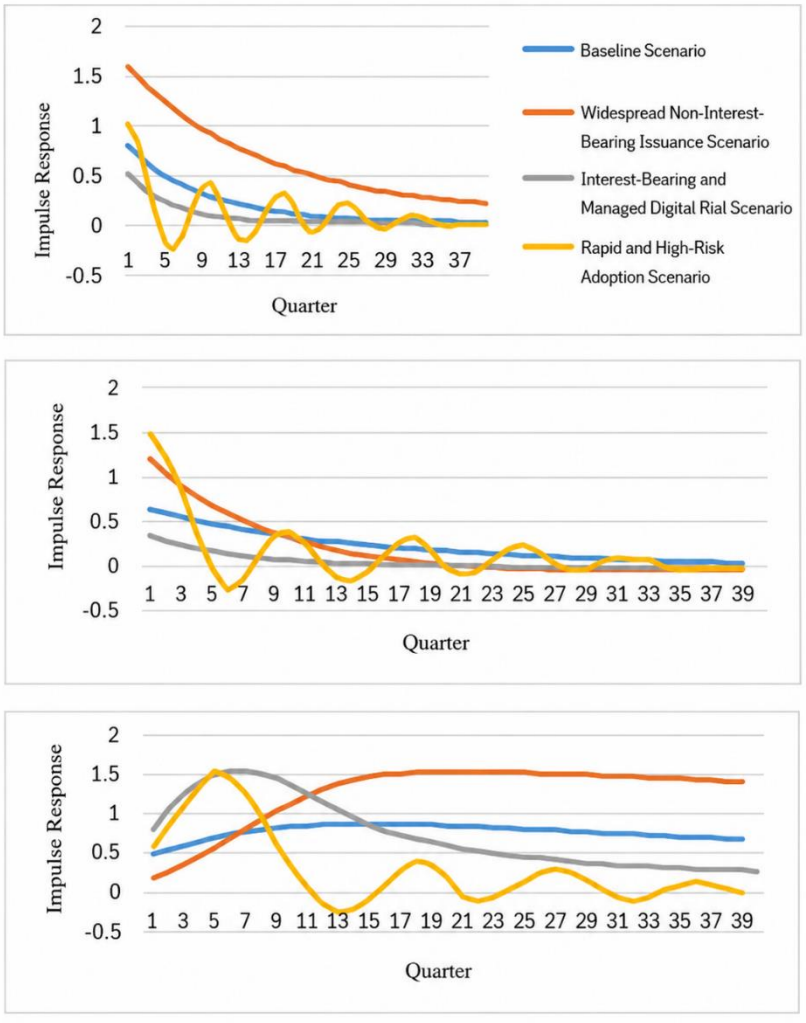

Figure 1. Comparison of the Impulse Responses of Inflation, Output Gap, and Policy Interest Rate Across the Four Scenarios (from top to bottom, respectively)

Simulation results indicate that the impact of the Digital Rial on inflation, the output gap, and interest rates is not constant but depends on its design and mode of integration into the economy. The optimal scenario consists of a combination of moderate Digital Rial preference and a high degree of correlation between the Digital Rial interest rate and the policy interest rate, which controls inflation and the output gap while preserving financial stability.

Table 3. Analytical Summary

Scenario	Effect on Output	Effect on Inflation	Policy Response	Economic Stability
Baseline	Mild positive effect on output	Moderate	Appropriate response	Stable
Widespread Non-Interest-Bearing Issuance	Highly positive but unstable	Very high	Delayed and persistent response	Unstable
Interest-Bearing and Managed	Mild and controlled	Controlled	Rapid and targeted response	Most stable
Rapid and High-Risk Adoption	Volatile and unstable	High and volatile	Volatile response	High-risk

Finally, it should be emphasized that monetary policymakers should view the Digital Rial not merely as a payment technology but as an active instrument within the monetary policy framework. Accordingly, a coordinated set of policy tools should be employed to control inflation, limit the output gap, and ensure the effective transmission of the interest rate mechanism.

Discussion and Conclusion

The findings of the present study demonstrate that the macroeconomic effects of the Digital Rial are highly dependent on its institutional design, interest rate structure, and the degree of household adoption. The simulation results indicate that the introduction of the Digital Rial, particularly under widespread non-interest-bearing issuance, increases inflationary pressures, intensifies fluctuations in the output gap, and weakens the effectiveness of monetary policy transmission. In contrast, the interest-bearing and managed Digital Rial scenario improves macroeconomic stability by strengthening the interest rate channel and facilitating a faster return of inflation and output to equilibrium conditions. These findings confirm that the Digital Rial cannot be considered merely a technological payment innovation; rather, it functions as an active monetary instrument capable of reshaping liquidity dynamics, financial intermediation, and macroeconomic stabilization mechanisms.

One of the most important findings of the study is the significant inflationary effect associated with widespread non-interest-bearing Digital Rial adoption. The simulation results showed that when households strongly prefer holding the Digital Rial while no interest rate mechanism exists, liquidity expansion stimulates aggregate demand and increases inflation volatility. This finding is consistent with the arguments presented by Barrdear and Kumhof, who emphasized that CBDC issuance can increase monetary aggregates and alter liquidity conditions depending on the design structure of the digital currency (12). Similarly, Bordo and Levin argued that poorly designed digital currencies may weaken monetary discipline and amplify inflationary pressures if they are not integrated into an effective monetary policy framework (3). The present findings therefore support the view that unrestricted Digital Rial expansion without an accompanying interest rate mechanism may destabilize price levels in inflation-prone economies such as Iran.

The results also indicate that inflation becomes more controllable when the Digital Rial is interest-bearing and closely linked to the policy interest rate. Under this scenario, the monetary authority can transmit policy signals more effectively, thereby reducing inflation persistence and improving macroeconomic stabilization. This result

aligns closely with the theoretical framework proposed by Woodford, who emphasized that modern monetary policy fundamentally depends on the management of interest rate expectations and the credibility of policy transmission channels (10). Likewise, Gali argued that in New Keynesian frameworks, inflation stabilization depends heavily on the effectiveness of monetary policy rules and nominal rigidities (11). By connecting the Digital Rial interest rate to the policy rate, the central bank gains a stronger mechanism for influencing household behavior, liquidity demand, and intertemporal consumption decisions. Consequently, the Digital Rial becomes an extension of the conventional monetary policy toolkit rather than a disruptive parallel instrument.

Another important finding concerns the behavior of the output gap under different Digital Rial scenarios. The study demonstrates that widespread non-interest-bearing issuance initially stimulates output growth due to higher liquidity and stronger aggregate demand. However, this positive effect is temporary and eventually reverses as inflationary pressures intensify and macroeconomic imbalances emerge. This finding supports the theoretical arguments of New Keynesian business cycle models, which suggest that expansionary monetary shocks can temporarily increase output but eventually generate inflationary adjustments and equilibrium corrections (11). The findings are also consistent with the redistribution channel theory developed by Auclert, who argued that monetary expansion affects consumption and production differently across heterogeneous households depending on their liquidity positions and asset holdings (15). In the present study, higher household preference for the Digital Rial altered liquidity allocation patterns and generated short-run demand expansion, but the absence of effective stabilization mechanisms ultimately reduced output sustainability.

The results regarding household heterogeneity are particularly important because they demonstrate that Digital Rial adoption affects different groups asymmetrically. The model shows that stronger household preference for the Digital Rial increases deposit outflows from banks, thereby reducing banks' lending capacity and affecting credit creation. This finding is consistent with the HANK literature emphasizing that monetary policy transmission depends significantly on household balance sheets, liquidity constraints, and portfolio composition (14). Kaplan et al. argued that heterogeneous-agent frameworks provide a more realistic explanation of monetary transmission because different households react differently to changes in liquidity and interest rates (14). The present study extends this perspective by showing that the Digital Rial itself can become a source of heterogeneity in financial behavior, thereby influencing aggregate macroeconomic outcomes.

The findings also confirm the critical importance of financial stability considerations in Digital Rial implementation. Under the rapid and high-risk adoption scenario, the economy experiences severe short-term fluctuations in inflation, output, and policy interest rates. This outcome reflects the destabilizing effects of abrupt changes in liquidity composition, household expectations, and financial market behavior. These results align with the concerns raised by Andolfatto regarding the potential impact of CBDCs on private banking systems and financial intermediation (13). Andolfatto argued that large-scale migration of deposits toward central bank digital liabilities could weaken bank funding structures and disrupt conventional lending mechanisms. Similarly, Kumhof and Noone emphasized that CBDC design directly affects central bank balance sheets and the stability of the banking system (9). The present findings therefore suggest that rapid and uncontrolled Digital Rial expansion may create systemic financial risks if appropriate regulatory and monetary safeguards are absent.

Another important implication of the findings relates to the role of monetary policy responsiveness. The simulations indicate that delayed monetary policy responses intensify inflation persistence, whereas timely and coordinated policy reactions improve macroeconomic stabilization. This finding strongly supports the Taylor-rule-

based monetary policy literature emphasizing the importance of systematic policy responses to inflation and output fluctuations (10, 11). In the interest-bearing and managed Digital Rial scenario, the policy rate reacts more rapidly and effectively because the Digital Rial interest mechanism reinforces policy transmission. This suggests that central banks may use CBDCs not only as payment innovations but also as instruments for strengthening monetary policy credibility and transmission efficiency.

The findings are also consistent with international institutional analyses regarding the strategic role of CBDCs in modern monetary systems. Reports by the International Monetary Fund and the Bank for International Settlements emphasize that CBDCs can improve payment efficiency, support financial inclusion, and modernize monetary infrastructure if they are carefully designed and appropriately regulated (1, 2, 6). However, these institutions also warn that CBDCs may increase macro-financial risks if adoption occurs too rapidly or without adequate coordination between monetary and financial authorities. The present study empirically supports these concerns by demonstrating that rapid Digital Rial adoption increases macroeconomic volatility and complicates policy stabilization efforts.

From the perspective of the Iranian economy, the findings have particularly important policy implications. Iran has experienced persistent inflation, structural liquidity growth, and banking sector imbalances over recent decades (16). Under such conditions, introducing a Digital Rial without an appropriate policy framework could amplify existing monetary imbalances rather than resolve them. The results of the present study therefore support the arguments presented by Vaziri and Nadri, who emphasized that CBDC implementation in Iran requires careful coordination with monetary policymaking mechanisms (17). Similarly, Sobhani and Shahidi argued that CBDC design should prioritize financial stability and banking network resilience in order to reduce systemic risks within the Iranian financial system (18). The current findings reinforce these conclusions by demonstrating that controlled and interest-bearing Digital Rial implementation generates significantly more stable macroeconomic outcomes than unrestricted non-interest-bearing issuance.

The study also contributes theoretically to the broader literature concerning the equivalence and interaction between public and private money. Brunnermeier and Niepelt argued that under certain conditions, public and private forms of money may perform equivalent macroeconomic functions (5). However, the findings of the present study suggest that this equivalence weakens when Digital Rial adoption substantially changes household liquidity preferences and banking sector funding structures. In such cases, the Digital Rial becomes an independent macroeconomic force capable of altering inflation dynamics, credit creation, and monetary transmission channels. This finding suggests that CBDCs may fundamentally reshape the institutional structure of monetary systems rather than simply digitize existing forms of money.

Furthermore, the study supports the view that CBDCs can strengthen financial inclusion while simultaneously introducing new policy challenges. Previous BIS surveys indicated that many central banks view financial inclusion as one of the primary motivations for CBDC development (7). In the present model, greater household access to the Digital Rial improves participation in the financial system and increases digital transaction capacity. Nevertheless, the findings demonstrate that expanded financial inclusion without proper policy coordination may generate inflationary and financial stability risks. Consequently, Digital Rial policy should balance the objectives of inclusion, monetary efficiency, and macroeconomic stabilization simultaneously.

Overall, the findings demonstrate that the macroeconomic effects of the Digital Rial depend fundamentally on policy design, household behavior, and the coordination between digital currency mechanisms and conventional

monetary policy instruments. A carefully managed and interest-bearing Digital Rial can strengthen monetary policy transmission, reduce macroeconomic instability, and improve policy effectiveness. In contrast, uncontrolled non-interest-bearing issuance or rapid adoption may intensify inflationary pressures, weaken banking intermediation, and increase macroeconomic volatility. Therefore, successful Digital Rial implementation requires an integrated monetary and financial policy framework that carefully manages liquidity, interest rates, and financial sector stability.

One limitation of the present study is that the model abstracts from several important dimensions of the financial system, including international capital flows, exchange rate dynamics, and informal financial markets, all of which may significantly influence the macroeconomic effects of the Digital Rial in the Iranian economy. In addition, the model assumes rational expectations and does not fully incorporate behavioral uncertainties or cyber-security risks associated with digital currencies. The calibration process is also partly based on hypothetical scenarios due to the limited availability of real Digital Rial implementation data in Iran. Consequently, the quantitative findings should be interpreted cautiously, particularly regarding the magnitude of long-term macroeconomic effects.

Future research can extend the present study by incorporating open-economy dynamics, exchange rate fluctuations, and international trade effects into heterogeneous-agent DSGE frameworks. Additional studies may also examine the interaction between the Digital Rial and banking sector balance sheets under conditions of financial stress or sanctions-related liquidity constraints. Moreover, future research could integrate behavioral finance approaches, adaptive expectations, and cyber-risk analysis to provide a more realistic representation of Digital Rial adoption dynamics. Comparative studies between Iran and other developing economies implementing CBDCs would also provide valuable insights regarding optimal digital currency design and monetary policy coordination.

From a practical perspective, policymakers should implement the Digital Rial gradually and within a carefully coordinated monetary and regulatory framework. The findings suggest that an interest-bearing and managed Digital Rial provides significantly greater macroeconomic stability than unrestricted non-interest-bearing issuance. Therefore, the central bank should align the Digital Rial interest mechanism with conventional policy rates to strengthen monetary transmission and reduce inflationary pressures. Regulatory authorities should also monitor banking sector liquidity conditions closely in order to prevent excessive deposit outflows and disruptions to credit creation. Finally, Digital Rial implementation should be accompanied by strong financial infrastructure, cyber-security protections, and transparent policy communication to ensure public confidence and long-term financial stability.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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