Modeling the Mechanisms and Outcomes of Credit and Financial Shocks Using a Dynamic Stochastic General Equilibrium (DSGE) Model

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Abstract

In the Iranian economy, changes in bank deposit interest rates—as tools for implementing credit and monetary policies—have become a major concern for policymakers and macroeconomic authorities, due to the various channels and mechanisms through which they affect the economy and contribute to economic fluctuations. An examination of the Central Bank's monetary and credit policies and the trend of bank deposit interest rates over the past two decades affirms this concern. Monetary authorities, in response to inflationary changes on the one hand, and the need to finance the production sector on the other, have consistently been compelled to alter deposit interest rates. Simultaneously, the financial asset market has repeatedly experienced conditions of recession, expansion, and severe volatility. Therefore, it appears crucial that, in order to design and implement effective credit policies for Iran's economy, a thorough investigation into the impacts of both stochastic and non-stochastic credit and financial shocks on key macroeconomic variables be conducted. Such policies should account for the mechanisms through which these shocks are transmitted to the economy and consider the implications of changes in deposit interest rates and lending rates. Particularly within the framework of models based on microeconomic theoretical foundations, the absence of a comprehensive and cohesive domestic body of literature on this topic underscores its significance even further. Previous studies indicate that incorporating the banking sector within DSGE models enhances the explanatory and fitting power of the models, aligning simulation results more closely with the actual behavior of macroeconomic variables in Iran. Prior research also reveals that financial frictions, financial and credit volatility, and changes in bank interest rates significantly affect the behavior of variables within the real economy. Consequently, the banking sector plays a critical role in triggering and amplifying macroeconomic fluctuations. The findings suggest that, in the event of both technology and oil revenue shocks, an inflation-targeting policy scenario induces less volatility in output and employment levels compared to an exchange rate-targeting scenario.

Keywords: *Inflation rate, macroeconomic fluctuations, bank lending, credit shocks, financial shocks.*

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1. Introduction

When economists began to more closely examine the mechanisms of monetary transmission, new financial theories demonstrated that monetary policy can affect the economy through channels other than interest rates [1, 2]. In particular, these theories illustrate how changes in monetary policy influence the financial capabilities of lenders and borrowers and alter credit risks and defaults, which in turn impact the overall supply of credit [3-5].

It is worth noting that because changes in financial factors are persistent, credit and balance sheet channels in new theories effectively explain the delayed effects of monetary policy (Alfaro, García-Santana, & Moral-Benito, 2019).

In line with examining the mechanisms of monetary transmission in Iran, over the past few decades, the New Keynesian model with financial and banking components has been introduced to explore the role of financial markets and variables, as well as the position of the credit and banking sectors, in the transmission of shocks to the real economy and in shaping business cycles [6-8]s.

In this context, empirical evidence suggests that financial and credit sectors play a significant role in transmitting shocks to the real economy and are considered key factors in the formation of business cycles [9]. In explaining the role of financial and banking components, Bernanke and colleagues (1999) and Kiyotaki and Moore (1997) argue that in the money market (banking sector), a positive interest rate shock leads to increased household inclination toward saving and reduced consumption, decreased firms' willingness to invest, and reduced net trade, the latter due to a decline in the real foreign exchange rate, which ultimately results in lower real output and income, a decline in the value of financial and physical assets, and the emergence of business cycles [10].

On the other hand, in capital markets (stock market) and other financial and physical asset markets—including gold, currency, real estate, and property markets—a decline in asset prices leads to reduced net wealth for both firms and households [11]. Under the assumption of asymmetric information, which increases the cost of external financing relative to internal financing, financial frictions arise, reducing borrowing capacity and financial strength of firms and households, thereby decreasing investment [12]. Thus, declining prices of financial and physical assets reduce credit availability and, consequently, reduce investment, perpetuating this cycle. This mechanism is referred to in the literature as the financial accelerator [13].

This feedback mechanism is also supported by standard theories such as Tobin's Q theory and Friedman's permanent income hypothesis. Based on Tobin's Q theory, a decrease in the price of financial assets reduces the ratio of market value to replacement cost of capital, thereby decreasing investment in capital markets [14]. According to Friedman's consumption theory, a decrease in asset values, through the wealth effect, reduces consumption [15].

In Iran's economy, despite the existence of various financing methods and advancements in financial markets in recent years, the banking system still plays a dominant role in financing, and the decisions of various economic agents are closely tied to the functioning of the banking system [6-8]. Moreover, the banking sector acts as the main channel for implementing monetary policy. Therefore, analyzing monetary and financial aspects of economic fluctuations without accounting for the banking sector is practically infeasible. Additionally, the household sector in Iran's economy is faced with a broad spectrum of investment decisions. Investments in stocks, foreign currency, gold, housing, and bank deposits constitute five major investment avenues among Iranian households. Empirical evidence shows that speculative and emotional behaviors of investors have led to the formation of artificial bubbles and significant fluctuations in various asset markets [16]. For example, negative real bank interest rates in 2011 (1390 in the Iranian calendar) triggered speculative investor behavior, causing individuals to reduce their bank savings and redirect part of their deposits into speculative flows toward financial and physical asset markets such as stocks, currency, gold, and real estate, in an attempt to preserve the value of their financial resources. This behavior resulted in instability and severe fluctuations in stock, gold, and foreign exchange markets during that period [17].

In light of the above considerations, this study aims to explain the mechanism and outcomes of credit shocks—including deposit and loan interest rate shocks—and also the mechanisms and outcomes of financial shocks—including fiscal policy shocks and shocks in the prices of financial and physical assets—on key real economic variables as well as on the demand for financial and physical assets such as stocks, currency, gold, and real estate. In this regard, within the framework of a Dynamic Stochastic General Equilibrium (DSGE) model that includes financial components and the banking sector for Iran, the optimal dynamic behavior of households in allocating assets—including stocks, gold, currency, housing, and bank deposits—will be modeled, and the effects of deposit and loan interest rate shocks on household financial savings decisions and a range of real sector variables will be analyzed. Furthermore, the transmission mechanisms of monetary, credit, and financial shocks, considering banking and financial sectors, will be examined in detail.

2. Methodology

Dynamic Stochastic General Equilibrium (DSGE) models must clearly define the following economic aspects. First, the preferences and objectives of economic agents must be explicitly specified. For instance, the household and firm sectors respectively maximize their expected utility and expected profit functions over time based on an intertemporal budget constraint. Second, production capacity and technology must be defined. For example, the firm sector has a specified production function and determines its output based on labor input, capital stock, and other parameters. Additionally, the adjustment costs of capital and labor hiring are defined. Third, institutional constraints, laws, and regulations related to monetary and fiscal policies are established. Monetary and financial agents make their decisions while considering these imposed constraints.

DSGE models are micro-founded optimization-based models that have evolved over the past few decades in the macroeconomic literature. The methodology of DSGE models relies on general equilibrium modeling, employing stochastic intertemporal optimization techniques to solve decision-making problems for household and firm agents. DSGE models are expressed in terms of key structural parameters such as preference parameters, production technologies, and probabilistic distributions of individual tastes. In practice, very simplified forms are chosen for these functions, such as a power utility function and a Cobb-Douglas production function. The resulting optimal decision rules are complex functions of macroeconomic variables. Their approximate values are derived from the steady-state algebraic values of macroeconomic variables, thereby obtaining a linear-logarithmic system of rational expectations equations with lagged and forward-looking components. This modeling approach implicitly assumes that the representative agent framework is acceptable and that the underlying process under investigation will remain stable indefinitely. Although this latter assumption is rarely acknowledged explicitly, it allows the derivation of the present expected value of discounted future variables required in rational expectations solutions.

DSGE models not only capture the long-run relationships between macroeconomic variables but also explicitly demonstrate the dynamic responses of these variables to given shocks. It is argued that traditional Keynesian models are inherently static in nature, and temporal dynamics are arbitrarily introduced via investment accelerators, nominal rigidities in wage and price setting, or partial adjustment mechanisms. According to this argument, the lack of coherence in extracting long-term dynamic properties in large-scale macroeconomic models is one of the fundamental weaknesses of traditional SEMs. This reinforces the view that the long-term evolution of the macroeconomy can be considered independently of short- and medium-term fluctuations. In contrast, DSGE models involve no such inconsistency or dichotomy between the factors determining long-term and short-term fluctuations. Although long-term dynamics are not explicitly modeled in DSGE frameworks, real-world data are often arbitrarily filtered before being sufficiently analyzed.

In fact, a distinction can be drawn between two stages in the development of DSGE models, each with separate implications for modeling macroeconomic dynamics. Initially, one of the central ambitions in designing DSGE models was to demonstrate that dynamic macroeconomic responses are consistent with a model in which there are no market failures, the outcomes are Pareto optimal, and any intervention by a social planner to alter agent behavior would reduce welfare. This approach, rooted in Real Business Cycle theory, minimized the role of monetary policy in generating economic fluctuations and instead emphasized the significance of real shocks. Many of the estimation and parameterization techniques employed during this initial phase largely ignored the role of the monetary sector.

Subsequently, it quickly became apparent that the initial stage of DSGE model development required revisions to properly explain economic fluctuations. As a result, the first generation of DSGE models was extended to incorporate features such as adjustment costs, signal extraction and learning, generalization, endogenous technological progress, and informational heterogeneity. Nevertheless, it remained unclear whether a model could be developed to simultaneously and satisfactorily account for all these features, and even if so, whether it would offer greater transparency and interpretability compared to existing large-scale macroeconomic models. Moreover, by focusing solely on specific sources of dynamics, first-generation DSGE models following this approach may have included excessive restrictive assumptions. As later evidence showed, these models often underperformed when confronted with actual data.

The second stage of DSGE model development reflected a partial return to the simpler and more fundamental characteristics of early DSGE models, emphasizing the micro-foundations of macroeconomic fluctuations. At the same time, greater attention was paid to monetary factors affecting business cycles. Early efforts were made to incorporate money into DSGE models.

In this model:

Households:

- are consumers;
- decide how much to consume and invest;

- are monopolistic suppliers of various types of labor.

Households aim to maximize their expected utility over an infinite horizon, subject to budget constraints. We assume households make decisions across two periods, aiming to maximize the following utility function:

$$\max: U(C_0) + E_0 \beta U(C_1)$$

Subject to the intertemporal budget constraint:

$$P_1 C_1 = (W_0 - P_0 C_0)(1 + i_0)$$

Where U denotes utility, β is the discount factor, C_0 and C_1 are consumption levels in periods 0 and 1, P_0 and P_1 are their corresponding prices, W is wealth, and i is the interest rate. Subscripts denote the time period.

Firms:

- hire labor;
- hire capital;
- are monopolistic suppliers of different goods and have pricing power.

Firms aim to maximize the present value of their expected profits over an infinite horizon, taking into account the demand curve, nominal price rigidity, and the labor supply curve. We assume that a proportion $(1 - \omega)$ of firms can adjust their prices in the current period, while a proportion ω maintains their previous prices. Thus, the average price level follows:

$$p_t = (1 - \omega)p_t + \omega p_{t-1}$$

Based on internal optimization (e.g., equating wages to marginal cost) and external optimization (e.g., maximizing profits), the following relationship is derived, where $\hat{x}_t$ denotes the output gap (actual output above full employment level):

$$\hat{x}_t = (\alpha\omega / (1 - \omega)(1 - \beta\omega)) (\hat{\pi}_t - \beta E_t \hat{\pi}_{t+1})$$

$$\hat{\pi}_t = (1 / (1 + \beta)) E_t \hat{\pi}_{t+1} + ((1 - \beta\omega)(1 - \omega) / \omega) \hat{x}_t$$

According to this relationship, current-period inflation is influenced by the output gap and expected future inflation. If inflation expectations are positive, current inflation will rise accordingly.

Both households and firms face considerable nominal frictions (e.g., sticky wages and prices) that limit their ability to adjust these variables. In the real sector, capital is accumulated endogenously, and real constraints exist due to adjustment costs, as well as fixed and variable capital utilization costs. Consumption habits introduce inertia in household consumption. Household utility is defined over consumption, leisure, and real money balances. Fiscal policy is Ricardian in nature. Monetary policy is determined by an interest rate feedback rule that responds to deviations in interest rates and certain economic activity indicators.

This baseline model incorporates stochastic structures related to various types of shocks, such as:

- **Supply shocks** (productivity and labor);
- **Demand shocks** (investment preferences and government spending);
- **Monetary shocks** (interest rate and other policy targets).

These shocks generally follow a first-order autoregressive process.

In other words, a simple New Keynesian DSGE model includes an IS curve linking output to the expected real interest rate, a Phillips curve linking inflation to output and expected inflation (measured by deviations from trend), and a policy rule linking the nominal interest rate to output and inflation. The IS curve is derived from optimal household behavior, while the Phillips curve is based on profit-maximizing price-setting behavior by monopolistically competitive firms. The policy rule reflects a policymaker optimizing a welfare-based objective function defined over output and inflation. As is common across DSGE models, decisions by households, firms, and policymakers are interdependent and realized over time, resulting in explicit and dynamic economic structures.

These models place special emphasis on the stickiness present in pricing and contractual processes. Such modeling assumptions have important implications for the dynamic properties of DSGE models, their data-fitting ability, and their use in monetary policy analysis. In fact, modeling approaches adopted by some researchers demonstrate that this second generation of DSGE models is capable of incorporating more flexible dynamics. Using Bayesian estimation techniques, they can provide relatively good performance in explaining various macroeconomic cycles and forecasting future behavior.

3. Findings and Results

After designing the dynamic stochastic general equilibrium (DSGE) model, solving the model requires that the parameter values also be specified. Determining model parameters necessitates the use of certain econometric techniques. In DSGE models, two main approaches exist for parameter identification: the first is calibration, and the second is Bayesian estimation. In some empirical studies, Bayesian estimation is omitted in favor of the calibration technique. Calibration implies that most model parameters are derived from findings in other applied fields of economics. The remaining parameters are selected in a way that ensures the closest match between the model-generated moments and those from sample data.

The second approach—Bayesian estimation—is a combination of calibration and parameter estimation. The major advantage of this integrative approach is a better fit of model results with real economic conditions and the direct incorporation of real data into parameter estimation. The Bayesian approach requires prior information about the parameters to be estimated. These priors can be derived from other studies or from estimated regressions. In other words, priors for model parameters are formed using their observed values in different studies (calibrated values) or simple regression estimates. More precisely, priors reflect the parameter estimates from other studies before analyzing the latent information in the sample data. Posterior information is derived by combining the prior probability density function with the likelihood function from the sample observations. The result of this multiplication is a new distribution known as the posterior distribution.

Calibration is one of the most important stages in empirically evaluating DSGE models in both the Real Business Cycle and New Keynesian frameworks. In developed economies such as those of North America and Western Europe, due to the abundance of studies applying DSGE models, researchers typically incorporate parameter values from reputable and numerous prior studies without major concerns regarding data accuracy. However, in developing economies in general, and in oil-dependent developing economies like Iran in particular, the absence of a significant research background presents specific challenges for calibration. Nevertheless, this article attempts to assign values to model parameters using existing data and prior national studies.

The goal of this section is to assign values to the structural parameters of the model. Calibration typically involves adopting parameters from the existing literature that shares similar economic structures and/or estimating parameters using time series data for a specific economy—or combining both. Calibration provides an initial sense of model strength or weakness. A well-calibrated model offers an accurate and valuable representation of the data. Microeconomic studies are also employed for calibration, though care must be taken when aggregating to a macroeconomic level.

Key reasons for using calibration include:

- Lack of available data: When data are absent, parameters can be calibrated.
- Small data sample sizes.
- Expected specification bias in the model: Specification errors can lead to inconsistent parameter estimates.

Evaluating the success of the proposed model in New Keynesian DSGE studies is often based on how well the model's calibrated moments match real-world data. The moments typically include: the standard deviation of key variables such as output or consumption, which reflect macroeconomic volatility; the ratio of the standard deviation of these variables to that of benchmark variables like output or investment, which explain relative fluctuations; and the correlation coefficients between time series of certain variables, which indicate comovement.

In the past decade, the literature on monetary and fiscal policy has seen major advancements—from calibrating DSGE models to estimating them, often using the Bayesian approach. In DSGE modeling, calibration is performed for several reasons: to analyze the dynamics of the model, to assess the model's similarity to real-world data, and to evaluate the policy implications under logical assumptions. As these models encompass issues like model misspecification and real data features, it is crucial to calibrate the deep parameters that arise. It is also important to note that calibrated DSGE models are not always accurate for subsequent calibrations. Bayesian estimation is a suitable solution to calibration issues because it provides a clear method for estimating parameters using both prior knowledge and empirical data. One of the strengths of the Bayesian approach is that it creates a framework for policy design that addresses uncertainty in parameter estimation.

Calibration, therefore, can be considered a final tool or means. Researchers often calibrate DSGE models because they are capable of analyzing compelling economic questions. In such cases, Bayesian estimation or maximum likelihood should follow calibration, as these techniques provide precise methods for estimating parameter values. When maximum likelihood techniques are used for DSGE model estimation, parameter estimates are extracted solely from the data, without accounting for prior values. Even if Bayesian techniques are used and priors are confidently specified, there is no need to worry whether the estimates come from the prior or the data—as long as the posterior estimates are logical. This occurs only when both the priors and the data are logically defined.

One of the earliest contributions in the field of calibration is the work by Kydland and Prescott, who used calibration for the empirical analysis of business cycles and selected parameters based on long-run data characteristics and, in some cases, microeconomic evidence. They employed the neoclassical growth model, calibrated using macroeconomic ratios, to study real business cycles.

Kydland and Prescott, along with Hansen, Heckman, and Sims, significantly contributed to the experimental methods associated with calibration literature. Cooley argued that estimation is a comprehensive approach, as estimation itself facilitates parameter specification. He also emphasized the interaction between theory and measurement. King and Rebelo explored the differences between traditional econometric methods and calibration. Typically, parameters chosen for calibration differ depending on the model's source and the sample data, a point also noted in an instructional paper by Campbell.

Cooley and Prescott stated that many parameters are derived from the balanced growth path of the model and the long-run features of the sample (e.g., sample means). Some studies refer back to earlier papers, while others use microeconometric evidence for calibration.

Thus, after parameter selection, the model is ready to be solved and simulated. The model's initial performance is then evaluated based on how well it aligns with observed realities using sample data. In short, researchers select likely parameter values by analyzing the data or using previous empirical studies. Ideally, these processes should utilize data characteristics.

In this section, before conducting the simulation and impulse-response analysis, the calibration results for the structural model parameters are presented. Some parameters have been calibrated or estimated based on available data and econometric computations. All required time series data were obtained from the Central Bank of Iran’s Time Series Database.

Now, the findings related to the calibration of the structural parameters of the model and the computation of the steady-state values of the model variables are reported. Subsequently, the simulation and analysis of the impulse response functions are presented. In Table 1, the parameters of the model are assigned values based on previous studies, empirical evidence, and available statistical data, after which the model is solved. In this study, the Dynare package within MATLAB was used for calibration and simulation.

Table 1. Calibrated Parameter Values of the DSGE Model

Sector	Parameter Name	Definition	Value
Household	β_s	Discount factor for saver households	0.963
	β_b	Discount factor for borrower households	0.954
	ζ	Habit formation parameter	0.500
	ν_h	Loan-to-wealth ratio	0.750
	φ_w	Weight of wage income in borrowing constraint	0.800
	η	Inverse elasticity of labor supply w.r.t. real wage	2.170
	γ_s	Relative risk aversion (savers)	1.570
	γ_b	Relative risk aversion (borrowers)	1.570
	γ_m	Inverse elasticity of substitution between money and consumption	2.390
Entrepreneurship	φ_k	Capital value weight in borrowing constraint	0.250
(Wholesale Producers)	α	Capital share in production function	0.420
	δ_e	Depreciation rate of fixed capital	0.042
	κ_i	Investment adjustment cost	4.000
	ν_e	Loan-to-equity ratio	0.550
Retail	θ_R	Price stickiness (retail)	0.740
	γ_p	Degree of price indexation	0.715
External	α_c	Share of imported goods in consumption basket	0.110
	α_i	Share of imported goods in investment expenditure	0.350
	η_c	Substitution elasticity: imported vs. domestic consumer goods	1.560
	η_i	Substitution elasticity: imported vs. domestic capital goods	1.500
Government & Central Bank	ρ_Or	AR(1) coefficient of log oil revenues	0.830
	ρ_ex	AR(1) coefficient of log exchange rate	0.840
	T/G	Tax-to-government spending ratio	0.350
	M/MB	Currency-to-base money ratio	0.330
	D/MB	Deposit-to-base money ratio	0.750
	κ_π	Monetary policy rule coefficient on inflation	0.890
	κ_y	Monetary policy rule coefficient on output	0.360
	ρ_Θ	AR(1) coefficient of money growth rate	0.820

It is worth noting that the discount factor of savers (β_s) and borrowers (β_b) was calculated using the average interest rate on bank deposits and bank loans during the study period based on time-series data from the Central Bank of Iran.

The consumption habit parameter (ζ) is adopted as the average from various studies. Due to limited data, the weight of wage income in the borrowing constraint (φ_w) is set at 0.8, consistent with values used by Hollander and Liu.

The parameter for the inverse labor supply elasticity with respect to the real wage (η) is based on the studies by Taee and Tavakolian. The risk aversion coefficients (γ_s and γ_b) are drawn from Tavakolian's research.

The capital value weight in the borrowing constraint (φ_k) is computed as the average ratio of stock-listed firms' capital stock to their current liabilities between 1997 Q1 and 2021 Q4.

The capital share in the production function (α) is based on the studies by Amiri and Tavakolian, and for parameters concerning imported consumer and capital goods, values from the comprehensive work by Amiri and Khiyabani were used.

The depreciation rate of fixed capital (δ_e) was calculated from the average ratio of gross fixed capital formation to capital stock over the study period, matching results by Amini and Neshat Haji.

The investment adjustment cost (κ_i) was assigned using findings from Hollander and Liu, and Amiri et al.

The AR(1) coefficients listed in the table were all estimated through regression analysis over the study period.

Finally, interest rates and lending rates were computed using the average one-year deposit and participatory loan rates from the Central Bank of Iran over the sample period.

In Table 2, the steady-state and long-run values of selected model variables are computed and reported based on the calibrated parameters from Table 1 and the log-linear equations of the Iranian economy.

Table 2. Steady-State and Long-Run Values of Selected Model Variables

Value	Variable	Value	Variable
1	$\bar{l}$	1.9	$\bar{y}$
1.3	$\bar{\pi}$	1.4	$\bar{c}$
1.72	$\overline{(q^\psi)}$	2.5	$\overline{(k^e)}$
2.3	$\overline{(m^2)}$	1.1	l_t

In this section, based on the calibrated parameters and the log-linearized model, the long-run equilibrium values of the model's endogenous variables are simulated. The simulation process consists of two main parts: the first involves generating data for the model's variables, and the second examines the effects of the exogenous shocks defined in the model on the endogenous variables through impulse response functions.

Accordingly, the structure of this section is as follows: first, the simulation and generation of data for the endogenous variables are performed. Then, based on various moments, the model's power and accuracy in replicating the actual trends of Iranian macroeconomic variables are assessed. Subsequently, the impulse response functions to the proposed shocks are analyzed.

These functions demonstrate the dynamic effect of shocks on the behavior of variables as predicted by the model.

The simulation process was executed in Dynare using a time frame consistent with real Iranian economic data. The real-world data includes quarterly time-series for variables such as total domestic consumption (c_t), investment (i_t), capital stock (k_t^e), gross domestic product (y_t), inflation (π_t or pi_t), total bank credit (l_t), nominal exchange rate (ex_t), total financial asset index (q^ψ_t), and broad money (m_t^2), covering the period from 1997 Q3 to 2020 Q4.

Since the model is expressed in a log-linearized form, the variables are incorporated as deviations from their long-run equilibrium values; thus, the model simulates variable gaps. Consequently, to compare real-world data trends with those from the simulation, the time series of the actual variables must be transformed into deviation-from-trend form. For this purpose, the Hodrick-Prescott filter is used.

After preparing the gap series of the log-transformed real variables, the power of the simulated model is evaluated. These moments include the mean of the real and simulated time-series, their standard deviations, correlations, and co-movement measures between the simulated and actual series and the benchmark variable—output gap. The results of these moments are presented in Table 3.

As previously mentioned, Table 3 compares the moments of the model's endogenous variables with those of actual data and evaluates the model's success in replicating the economic realities of the target variables. To extract the cyclical component of the time series, the natural logarithm of the data is taken, followed by the application of the Hodrick-Prescott filter using a smoothing parameter λ = 1600, a value commonly used by researchers for quarterly data. For the computation of the moments of actual data, quarterly national account data from 1997 Q3 to 2020 Q4 were obtained from the Central Bank of Iran and the Securities and Exchange Organization.

The mean and standard deviation of deviations of real and simulated data from their long-term values for variables such as GDP, private consumption, gross fixed capital formation, capital stock, total loans to households and firms, inflation, the aggregate financial asset index, and broad money supply are very close. This indicates the model performs well in simulating real economic dynamics. The first-order autoregressive coefficient of GDP is 0.80 in the real data and 0.819 in the simulation. For inflation, the AR(1) coefficient is 0.46 in the real data and 0.431 in the simulated model. As shown in Table 3, no substantial or obvious differences are found in the other variables' moments that would suggest simulation failure.

Table 3. Comparison of Moments: Real Data vs. Simulated Data

Variable	Mean (Real)	Mean (Simulated)	SD (Real)	SD (Simulated)	AR(1) (Real)	AR(1) (Simulated)
Gross Domestic Product	0.91	0.88	0.062	0.059	0.801	0.819
Private Consumption	1.03	1.00	0.080	0.077	0.785	0.880
Private Investment	1.10	1.00	0.060	0.062	0.710	0.690
Capital Stock	2.20	2.05	0.210	0.210	0.960	0.997
Total Loans	0.86	0.90	0.010	0.013	0.537	0.614
Inflation Rate	1.11	1.001	0.040	0.038	0.461	0.430
Stock Price Index	0.94	1.00	0.046	0.040	0.674	0.692
Money Supply (M2)	1.45	1.39	0.080	0.083	0.923	0.910

This section analyzes the model's predictive capacity by examining the dynamic impact of exogenous shocks through impulse-response functions. These functions depict the response of the model's endogenous variables to an exogenous shock over a specified time horizon. In other words, they illustrate how, over a specific time frame, an exogenous shock leads to a percentage deviation in an endogenous variable from its long-run equilibrium, and how long this effect persists.

Charts (1) through (4) present the impulse-response functions resulting from a financial asset index shock, a household credit capacity shock, a firm collateral shock, and a bank lending rate shock on key macroeconomic variables.

Chart 1 analyzes the immediate response of macroeconomic variables in Iran to a one standard deviation positive shock in the aggregate financial asset index over a 5-year horizon. Financial markets, particularly the real sector, play diverse roles in macroeconomics through channels such as wealth effects, financial accelerators, and bank balance sheets. As these markets expand, the complexity of interactions between them and the real economy increases. Larger financial markets can amplify an initial shock through expectation changes, emotional reactions, and systemic disruptions, broadening the scope of real business cycles. Therefore, following the 2007–2008 financial crisis, monetary and economic authorities must pay close attention to real sector dynamics within macroeconomic performance.

According to empirical findings, the real sector has a limited role in Iran's economy, and the channels through which financial assets influence macroeconomic outcomes possess significant unrealized potential. These include mobilizing liquidity for long-term investment, financing household consumption (e.g., via mutual funds), and creating credit for economic agents—thus supporting optimal resource allocation.

As shown in Chart 1, in response to a financial shock that incentivizes more investment and future returns for saver households, aggregate consumption declines initially. However, it returns to equilibrium within two quarters and remains slightly above the initial level by the end of the period. This result clearly reflects the intertemporal smoothing of consumption due to increased financial wealth over households' life cycles in Iran. The expansion of Iranian financial markets and the activation of diverse investment and risk-hedging tools—such as options, futures, and true privatization—are expected to strengthen the stock wealth channel and enhance consumer confidence in financing durable goods consumption through the real economy.

Following a positive financial shock, at the same interest rate levels, bank deposits decline by 0.05% in the same period—indicating a reallocation of household funds toward higher-yielding financial assets. Over 5 to 6 quarters, deposits gradually return to their initial equilibrium levels (Chart 1).

This shock also leads to an immediate increase in investment and capital stock. Investment spending rises by approximately 0.01% above its equilibrium within three quarters, then gradually returns to its previous level. Capital stock, driven by accumulated investment, follows a concave trajectory with diminishing growth rates, continuing to rise up to 0.001%. Some resources shift from labor-intensive projects toward capital formation, initially reducing labor and output. However, both return to equilibrium within three quarters, and due to higher consumption and investment, exceed equilibrium before returning by quarters 6–7.

As a result of the shock, due to accelerated market-based capital formation, the price of physical capital rises and continues to increase for three quarters, then gradually declines toward equilibrium over 13 quarters, eventually stabilizing slightly below the initial level. Real wages decrease below equilibrium due to reduced labor demand but gradually increase toward equilibrium. Inflation declines and returns to equilibrium within 10 quarters, leaving no lasting effect on inflation. Contrary to expectations, bank capital declines—possibly due to weak linkages between the banking system and capital formation in Iran’s real economy. Bank lending also decreases, likely due to strict loan conditions and high interest rates, making firms prefer financing through capital markets. However, because Iran’s real economy lacks the capacity for widespread financing, total bank lending gradually returns to its initial levels within six quarters (Chart 1).

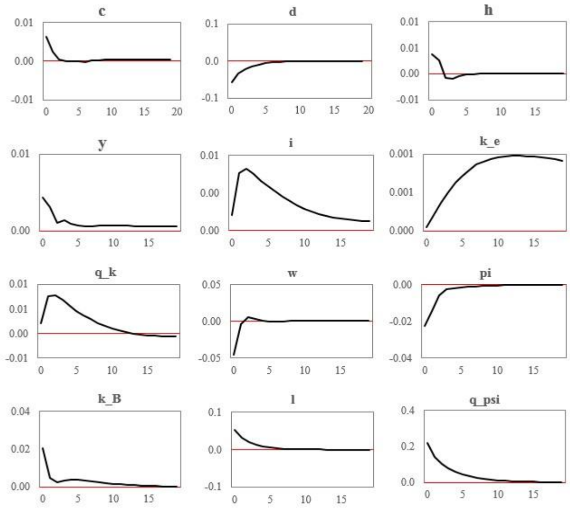


Figure 1. Effect of Financial Asset Index Shock

From both a theoretical and empirical perspective, liquidity constraints and the impossibility of infinite access to financial resources consistently hinder households in shaping and smoothing their consumption expenditure over the life cycle. Based on the simulation findings of the present model, a positive shock to household credit capacity leads to an immediate positive reaction in consumption, deposits, labor, and output, all of which gradually return to their equilibrium levels. This shock directs households toward obtaining more loans and credit for consumption, resulting in a negative response in investment and capital accumulation. However, investment gradually reverts to its initial equilibrium. The price of physical capital and wages follow a similar, but more subdued, pattern (Chart 2).

In response to this exogenous shock and the resulting increase in aggregate demand, the inflation rate becomes positive but gradually returns to equilibrium within three quarters. Due to increased demand for credit following the positive credit shock, bank capital declines in the same period. Thus, maintaining capital adequacy and assessing borrower risk become especially critical. Since the mid-2010s, Iran's banking sector has encountered severe challenges that have significantly disrupted its operational effectiveness. Reports from the Central Bank of Iran on bank credit allocation highlight that one of the main issues in this sector is the substantial volume of non-performing loans and doubtful receivables, stemming from inadequate risk assessment and failure to secure proper collateral—factors that have pushed the banking system toward insolvency. These findings indicate that stronger linkages between the real economy and the banking sector could ease the capital pressures on banks and delegate responsibilities like credit evaluation of borrowers to the real sector (Chart 2).

As a result of this credit shock—mainly reflecting the acceptance of stock assets as collateral in lending—stock prices rise. However, the impact of the credit impulse on stock prices quickly dissipates (Chart 2).

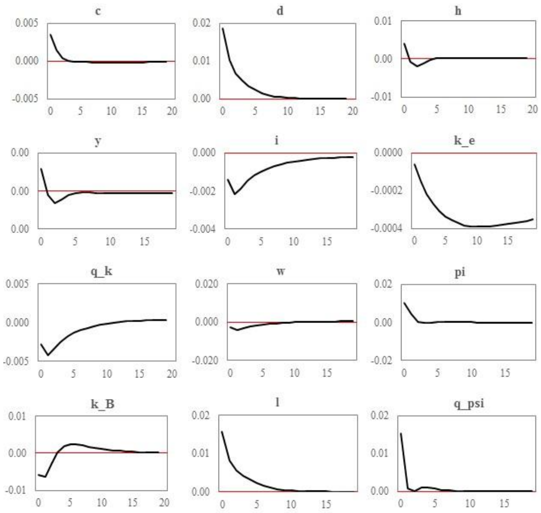


Figure 2. Effect of Household Credit Shock (Loan-to-Wealth Ratio)

Firms also face liquidity constraints in financing their investment projects. A review of Iran’s annual budget laws over the past two decades reveals that banking loans and credits have often been allocated based on preferential or mandated rates determined by monetary authorities and the government. Since considerations of effective returns and capital recovery have been mixed with political and social justifications, these credits have not yielded the desired efficiency in the Iranian economy. Consequently, bank resources have become trapped in depreciating assets such as real estate and semi-public enterprises. The vast amount of non-performing loans and government debt to the banking sector has severely undermined the sector’s core functions, particularly in short-term lending. As a result, firms face serious difficulties in financing working capital and investment plans. These conditions cause firms’ balance sheets to shift toward financially fragile structures, reducing their net worth. With declining net worth, firms' credit capacity is reduced, limiting access to credit and loans. This adversely impacts their investment and employment decisions, and thus their future product value and creditworthiness (Chart 3).

According to the findings, there is a direct relationship between firm credit shocks and variables such as consumption, employment, wages, and output. Furthermore, the recessionary conditions that have prevailed in Iran in recent years underscore the structural (balance sheet-related) and liquidity challenges faced by both firms and banks. In recent years, despite the large volume of overdue loans in bank balance sheets and the increasing accumulation of principal, interest, and penalties on delinquent debts, most of these have been restructured with new terms, rather than leading to new credit contracts. As a result, financial costs consume firms' profits, depriving them of the capacity to utilize idle resources or undertake new investment (Chart 3).

Having analyzed various financial shocks, we now examine whether the model's simulation results align with existing studies. Chart 4 illustrates the effect of a one standard deviation positive shock to the bank lending rate—commonly treated as a structural shock in both domestic and international studies—on Iran’s real macroeconomic variables. Following the shock, variables such as output, consumption, investment, deposits, capital accumulation, the price of physical capital, wages, bank capital, credit volume, and stock prices all rise immediately.

Output, consumption, investment, and deposits increase by more than 0.02, 0.03, 0.005, and 0.02 percentage points respectively within 2–3 periods, and then return to their equilibrium levels by the end of the simulation horizon. The impact of the lending rate shock on real variables remains persistent until the end of the period. The nature of this shock—as capital-biased—is evaluated based on its positive impact on capital accumulation and its negative impact on labor. The price of physical capital and wages increase and gradually return to their previous equilibrium levels. As expected, the initial effect of the lending rate shock is to reduce inflation; however, by the third period it reaches zero, becomes slightly positive in the fourth period, and returns to the initial level by the seventh period, neutralizing the primary effect. Thus, the macroeconomic variables' responses to the bank lending rate shock in this model are consistent with theoretical expectations and the findings of other studies, reinforcing confidence in the robustness of other simulation results and model estimations (Chart 4).

Bank loans and credit volume also increase in response to the positive lending rate shock, encouraging firms to invest in technologies that improve returns to credit. Ultimately, the shock improves firm profitability expectations in the same period, leading to a 0.1% rise in stock prices. This effect gradually diminishes over 10 quarters, with stock prices returning to their previous levels (Chart 4).

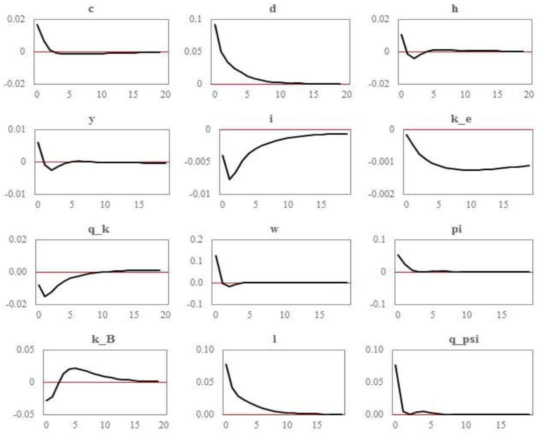


Figure 3. Effect of Firm Credit Shock (Loan-to-Net-Worth Ratio)

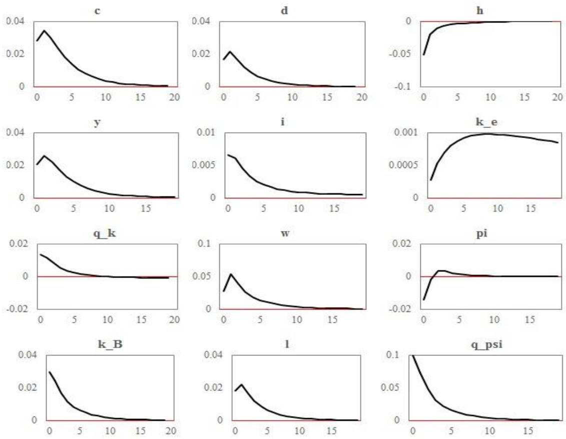


Figure 4. Effect of Bank Lending Rate Shock

Physical Asset Shock

In response to a household physical asset shock, consumption decreases. However, due to habit persistence and life-cycle consumption smoothing behavior, households utilize part of their deposits and financial asset wealth to finance future consumption expenditures. Firms, in anticipation of rising prices and to increase profits, raise their demand for labor, investment, capital accumulation, and output. Inflation, capital prices, and bank lending volumes increase. Real wages and bank capital decline in proportion to the volume of loans extended.

Exchange Rate Shock

Iran's exchange rate regime is based on a managed floating system, and the Central Bank is tasked with maintaining currency market stability. Nevertheless, over the past two decades, the Iranian economy has experienced several exchange rate shocks that have had persistent impacts on its macroeconomic structure. Here, the effects of an exchange rate shock on the model's endogenous variables are analyzed. One of the major causes of such a shock can be attributed to the imposition of international sanctions following the acceleration of Iran's nuclear development program during the 2000s (Solar Hijri calendar), which culminated in a significant economic impact in the early

2010s. In this period, sanctions targeting Iran's oil, petrochemical, and petroleum product exports led to a sudden and substantial depreciation of the national currency, causing extensive disruptions across macroeconomic indicators, culminating in the stagflation crisis observed in 2018–2019.

As the simulation results of this study’s model show, following an exchange rate shock, household consumption immediately declines. Despite households’ efforts to smooth consumption using their deposits and financial wealth, they are unable to do so, and consumption fails to return to its previous equilibrium level by the end of the period, indicating a permanent decline in household consumption and purchasing power. Household deposits also decline due to reduced purchasing power and a shift toward foreign exchange-based returns, but gradually return to equilibrium levels over time. Labor demand initially increases but then declines as firms’ competitiveness deteriorates due to the rising cost of imported inputs and capital goods. The inflationary effects persist for up to five quarters. Output, investment, and capital accumulation all decline in response to the shock, and these effects remain persistent. Capital prices and wages experience a slight increase and gradually return to equilibrium over ten quarters. The demand for credit by households and firms rises initially but returns to equilibrium afterward. The stock price index, which initially increases due to higher profitability expectations for export-oriented firms, turns negative by the third quarter as firm competitiveness weakens, and this negative deviation from equilibrium persists through the end of the period.

Oil Shock

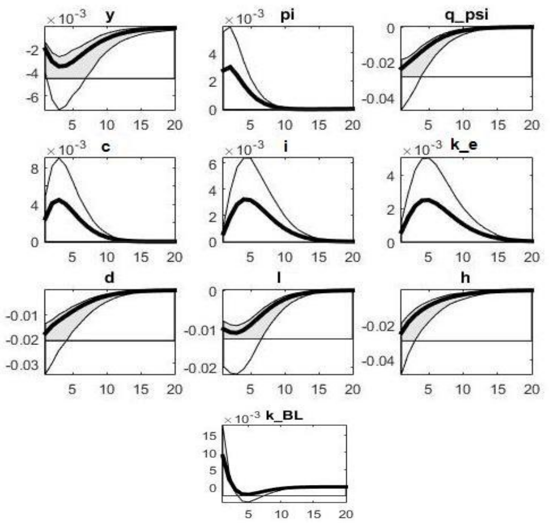
One of the most salient features of the Iranian economy is the government’s and the national budget’s reliance on foreign currency revenues from oil and petroleum product exports. Numerous studies have examined the effects of oil shocks on Iran’s economy. The findings of this study are not inconsistent with previous results, which affirms the reliability of the present model. Notably, a positive oil shock leads to a decline in firm investment in the same period, which gradually returns to equilibrium over time. This can be interpreted as further evidence of the Dutch disease phenomenon in the Iranian economy, and the crowding-out effect of public capital expenditures on private sector investment. Financial assets also react positively to oil revenue shocks but return to equilibrium over approximately ten quarters.

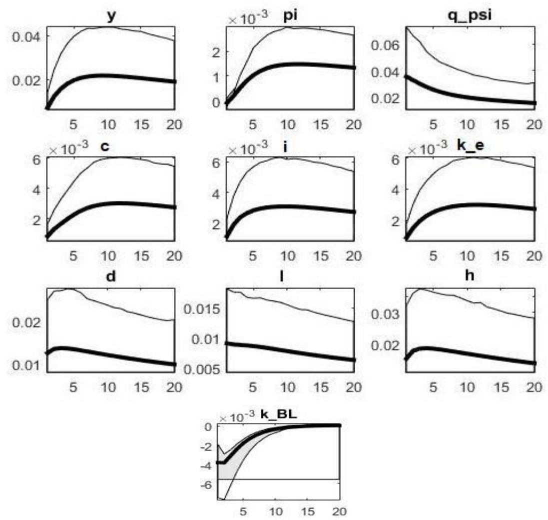
Monetary Policy Shock

As predicted by the model, the most important tools of monetary policy in Iran are liquidity volume and the growth rate of the monetary base, both of which have consistently been employed by the Central Bank for policy implementation over the past two decades. The findings of this study show that macroeconomic variables react positively to an unanticipated monetary policy shock, and in most cases, variables return to their original equilibrium levels within a few periods. Financial assets also respond positively to this shock, but after three to five periods of oscillation around the equilibrium level, they converge back, suggesting that monetary policy shocks do not have a lasting impact on financial assets.

Monetary Shock

Chart 5 presents the effects of a monetary shock—such as a shift in household preferences toward holding more money—on the endogenous variables under study.





Impulse Response Functions – Productivity Shock

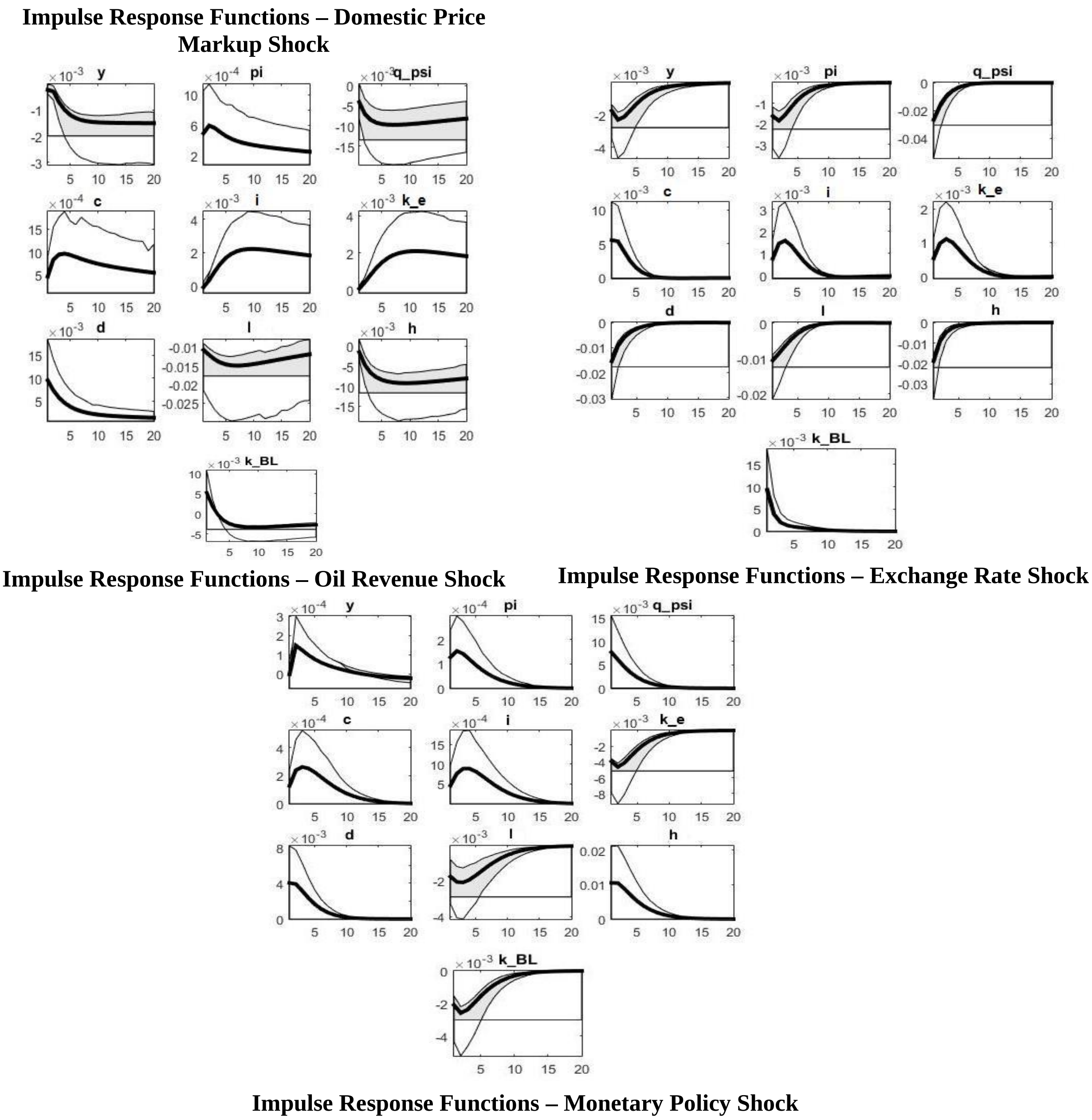


Figure 5. Estimated Impulse Response Functions of the Model

4. Discussion and Conclusion

This study investigates the dynamic effects of various macroeconomic shocks—including financial, credit, exchange rate, oil price, and monetary policy shocks—on Iran's economy using a Dynamic Stochastic General Equilibrium (DSGE) model. The findings provide insights into the transmission mechanisms of these shocks and their implications for macroeconomic variables.

The analysis reveals that a positive shock to the financial asset index leads to an immediate decrease in household consumption, as households reallocate resources towards investment in financial assets. However, consumption gradually returns to its equilibrium level, indicating a temporary substitution effect. This behavior aligns with the wealth effect theory, where increased asset values lead to higher perceived wealth and, consequently, higher future consumption [18, 19]. Additionally, the shock stimulates investment and capital accumulation, reflecting the role of financial markets in facilitating capital formation.

A positive shock to household credit availability results in increased consumption, labor supply, and output in the short term. This finding supports the credit channel of monetary transmission, where enhanced access to credit boosts aggregate demand [2, 14]. However, the effect on investment is negative initially, suggesting that increased consumption may crowd out investment due to limited resources. Over time, investment returns to its equilibrium level, indicating a rebalancing of resource allocation.

An improvement in firms' collateral value enhances their borrowing capacity, leading to increased investment, employment, and output. This outcome corroborates the financial accelerator mechanism, where stronger balance sheets amplify the effects of shocks on the real economy [9, 17]. The positive response of macroeconomic variables underscores the importance of firm-level financial health in influencing aggregate economic performance.

An unexpected increase in bank loan rates exerts a contractionary effect on the economy, reducing consumption, investment, and output. The higher cost of borrowing dampens aggregate demand, consistent with the traditional interest rate channel of monetary policy transmission [15, 18]. The results highlight the sensitivity of Iran's economy to changes in lending rates, emphasizing the need for careful calibration of monetary policy instruments.

A depreciation of the domestic currency leads to a decline in consumption and investment, as imported goods become more expensive and uncertainty rises. While exports may become more competitive, the overall effect is contractionary due to Iran's reliance on imported capital goods and intermediate inputs. This finding aligns with previous studies indicating that exchange rate volatility can hinder economic growth in developing countries [6-11, 17].

Given Iran's status as a major oil exporter, fluctuations in oil prices have significant macroeconomic implications. A positive oil price shock boosts government revenues, leading to increased public spending, investment, and output. However, the benefits are not uniformly distributed, and the economy remains vulnerable to oil price volatility. The results echo the literature on the resource curse, where dependence on commodity exports can lead to economic instability.

An expansionary monetary policy shock, characterized by increased money supply, stimulates consumption and investment in the short term. However, the effects dissipate over time, and inflationary pressures may emerge. The findings suggest that while monetary policy can provide short-term stimulus, its effectiveness is limited in the absence of structural reforms and fiscal discipline.

This study has several limitations. First, the DSGE model assumes rational expectations and representative agents, which may not capture the heterogeneity and bounded rationality observed in real-world economies. Second, the model abstracts from informal economic activities and sectoral differences, which are significant in Iran's context. Third, data limitations may affect the precision of parameter estimates and shock calibrations.

Future research could address these limitations by incorporating heterogeneous agents and behavioral elements into the model to better reflect the diversity of economic actors. Additionally, extending the model to include sectoral disaggregation and informal economic activities would provide a more comprehensive analysis. Employing alternative modeling approaches, such as agent-based models, could also offer valuable insights into the complex dynamics of Iran's economy.

Policymakers should prioritize diversifying the economy to reduce dependence on oil revenues and enhance resilience to external shocks. Strengthening financial institutions and improving access to credit can support investment and economic growth. Moreover, maintaining exchange rate stability and implementing prudent monetary policies are essential for macroeconomic stability. Structural reforms aimed at increasing productivity and competitiveness will further bolster the economy's capacity to withstand shocks.

Authors’ Contributions

Authors equally contributed to this article.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in this study were under the ethical standards.

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