Analysis of the US Macroeconomic Dynamics: A DSGE Model Perspective

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Abstract

This paper investigates the dynamic properties of a medium-scale New Keynesian DSGE model (M1002). We perform several experiments, including Impulse Response Function (IRF) analysis for monetary and technology shocks, and sensitivity tests on key structural parameters. Our results highlight the importance of the Taylor rule's aggressiveness and price stickiness in shaping the transmission of shocks to the real economy.

1 Introduction

Modern macroeconomics relies heavily on Dynamic Stochastic General Equilibrium (DSGE) models for policy analysis and forecasting. This study focuses on the M1002 model, which incorporates several frictions, including price and wage stickiness, habit formation, and financial frictions.

2 The Model

The model is a medium-scale New Keynesian framework with several nominal and real rigidities. Key structural parameters are summarized in Table 1.

2.1 Key Equilibrium Equations

The dynamics of the economy are governed by a system of linearized stochastic difference equations. Some of the most critical equations include:

Table 1: Model Parameters

Name	Symbol	Value	Description
alp	α	0.1596	
zeta_p	ζ_p	0.8940	
iota_p	ι_p	0.1865	
h	h	0.5347	
ppsi	ψ	0.6862	
psi1	ψ_1	1.3679	
psi2	ψ_2	0.0388	
psi3	ψ_3	0.2464	
rho	ρ_R	0.7126	
pi_star	π_*	1.0050	

- **Consumption Euler Equation:** Deriving from the household's optimization problem with habit formation h:

$$c_t = \frac{h/e^{z^*}}{1 + h/e^{z^*}} c_{t-1} + \frac{1}{1 + h/e^{z^*}} E_t[c_{t+1}] - \frac{1 - h/e^{z^*}}{\sigma_c(1 + h/e^{z^*})}(R_t - E_t[\pi_{t+1}] + E_t[z_{t+1}])$$

  where z_t is the technology growth rate and σ_c governs the intertemporal elasticity of substitution.

- **New Keynesian Phillips Curve (NKPC):** Inflation π_t depends on future expected inflation, past inflation (via indexation ι_p), and marginal cost mc_t:

$$\pi_t = \frac{\iota_p}{1 + \beta\iota_p} \pi_{t-1} + \frac{\beta}{1 + \beta\iota_p} E_t[\pi_{t+1}] + \kappa mc_t + \lambda_{f,t}$$

  where κ is a function of the Calvo price stickiness parameter ζ_p.

- **Taylor Rule:** The central bank follows a smoothed interest rate rule:

$$R_t = \rho R_{t-1} + (1 - \rho)[\psi_1(\pi_t - \pi^*) + \psi_2(y_t - y_t^f)] + \psi_3 \Delta y_t + r_{m,t}$$

  where y_t^f is the level of output that would prevail under flexible prices.

- **Resource Constraint:** Output is split between consumption, investment, and government spending:

$$y_t = \frac{c^*}{y^*} c_t + \frac{i^*}{y^*} i_t + g_t + \ldots$$

2.2 Data and Identification

The model is designed to be estimated using live macroeconomic data from the Federal Reserve Economic Data (FRED) database. We utilize 13 key observables:

1. **Output Growth**: Real GDP per capita growth (GDP, CNP16OV).

2. **Inflation**: GDP Deflator (GDPDEF) and Core PCE (PCEPILFE).

3. **Interest Rates**: Effective Federal Funds Rate (DFF).

4. **Labor Market**: Average weekly hours and compensation (AWHNONAG, COMPNFB).

5. **Financial Spreads**: BAA-10Y Treasury spread.

Raw data is transformed from levels to log-deviations or growth rates to match the model's stationary states.

2.3 Calibration and Methodology

The model parameters are calibrated or estimated using a Bayesian approach. Parameters like the depreciation rate ($\delta = 0.025$) and the steady-state capital share ($\alpha = 0.3$) are often fixed to standard values, while others like price stickiness (ζ_p) and Taylor rule coefficients (ψ_i) are estimated by maximizing the posterior density:

$$\mathcal{P}(\theta|Y) \propto \mathcal{L}(Y|\theta)\pi(\theta)$$

where $\mathcal{L}(Y|\theta)$ is the likelihood computed via the Kalman Filter and $\pi(\theta)$ represents the prior distributions.

3 Experiments and Results

3.1 Baseline Impulse Responses

We analyze how the economy reacts to exogenous shocks over a 40-quarter horizon. Figure 1 shows the impact of a contractionary monetary policy shock.
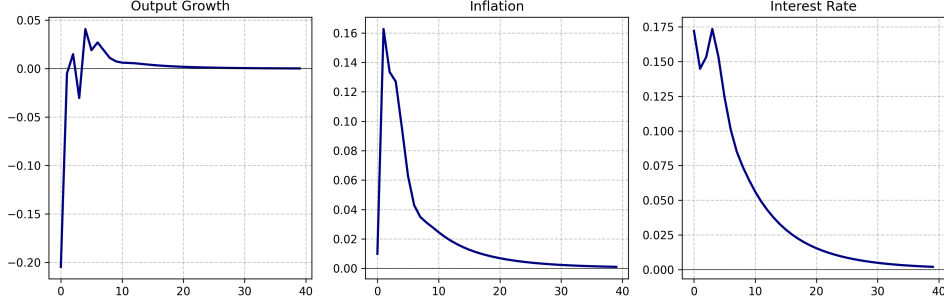

Figure 1: IRFs - Monetary Policy Shock (40 Quarters)

Figure 2 displays the response to a neutral technology shock. A boost in productivity increases output while putting downward pressure on inflation.
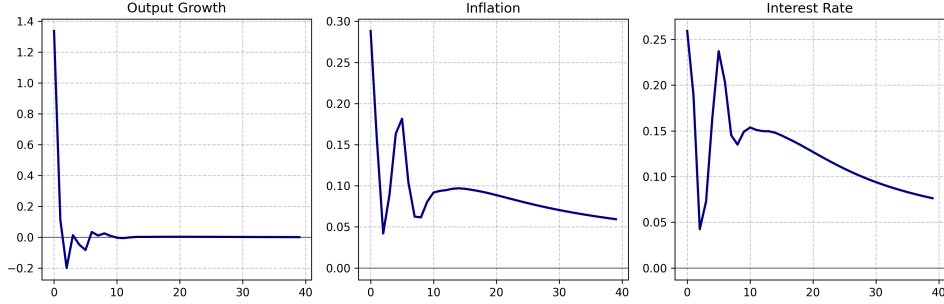

Figure 2: IRFs - Technology Shock (40 Quarters)

3.2 Sensitivity Analysis: Taylor Rule Sweep

We perform a detailed parameter sweep for the inflation response coefficient (ψ_1), ranging from 1.1 to 3.0. Figure 3 illustrates the results. As the central bank becomes more aggressive, the volatility of inflation is reduced, but at the cost of more significant initial fluctuations in the nominal interest rate and a sharper, more front-loaded output contraction.

4 Conclusion

The M1002 model provides a robust framework for understanding macroeconomic fluctuations. Our experiments underscore that the effectiveness of monetary policy and the inherent rigidities in price setting are critical determinants of economic stability.
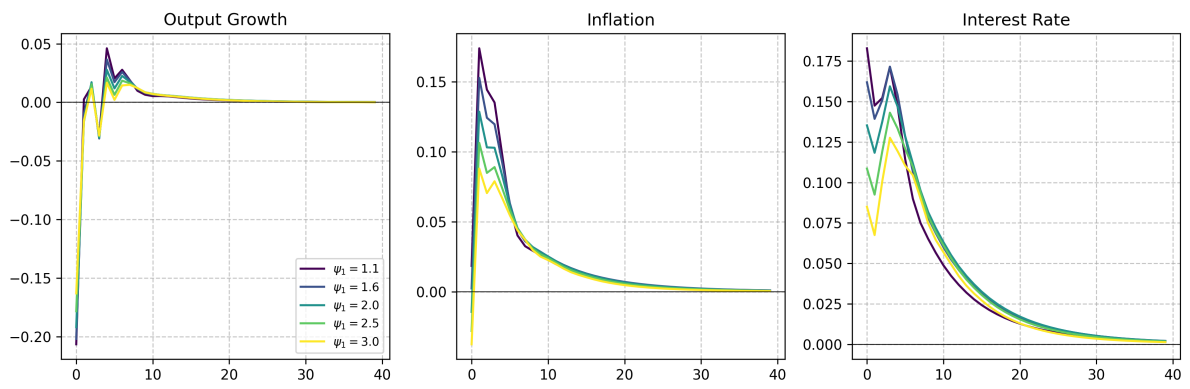
Figure 3: Sensitivity Sweep: Varying ψ_1 from 1.1 (light) to 3.0 (dark)