Comparative Analysis of Monetary Policy Rules Using Bayesian Estimation of Macroeconomic Models

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Abstract – Monetary policy aimed at controlling economies focuses on manipulating interest rates in an effort to manage the output, inflation price level, and activity. Our study analyzes the effects of monetary policy from 1980 to 2023 using Bayesian estimation methods across four macroeconomic models: a calibrated New-Keynesian model, Federal Reserve's FRB model, a New Keynesian DSGE model and Smets and Wouters model. Simulation concentrates on three policy rules such as Taylor, LWW and SW, and how they affect significant variables such as real GDP, inflation and investment. Differences in the response patterns to monetary policy changes are captured by all models; however, the degree of output elasticity and the time taken by it to respond differently to a cut in interest rates is observed to be different. New-Keynesian model demonstrates a sudden and temporary rise in output, the FRB and DSGE models reveal prolonged but slow changes and the adjustment takes longer, according to the FRB model. Inflation responses that are pro-cyclical are also persistent across models and affected by the price stickiness effect. Models with financial accelerators such as the DSGE provide better insights of the relations between interest rates and borrowing costs. Lastly, sensitivity analysis also reveals that model structure and policy rule decision significantly affect the results, consistent with the notion that monetary policy should be well suited to economic environment.

Keywords – Monetary Policy, Bayesian Estimation, Macroeconomic Models and Policy Rules, Dynamic Stochastic General Equilibrium Models, Impulse Response Functions.

I. INTRODUCTION

The body of literature providing straightforward guidelines for monetary policy is extensive. The literature includes theoretical research that compares rules addressing various intermediate and ultimate objectives, as well as forward- and backward-looking protocols, and protocols that incorporate or eliminate interest rate levelling factors. It also includes analyses of historical estimations of the monetary policies for many nations. Nevertheless, prior works lack a comprehensive examination of straightforward principles for open economies, namely those in which the currency rate channel of monetary policy significantly influences the transmission mechanism. The most well recognized basic guidelines for the interest rate, as discussed in [1], were specifically formulated for the United States, based on the premise of a closed economy. The primary open economy options, such as Ball's 1999 rule according to MCT (Monetary Conditions Index), can underperform when confronted with certain sorts of exchange rate shocks, rendering them ineffective for the daily implementation of monetary policy. Currently, we face the option of either entirely disregarding the monetary transmission of exchange rate channels (McKibbin, Henderson, and Taylor) or integrating it in a manner that may not consistently provide accurate results (MCI-based rules).

Policymakers require novel generation of frameworks including a cohesive and coherent model for both unconventional and conventional monetary policy. At the outset of monetary crisis, the zero lower limit for short-run interest rates transitioned from an unlikely scenario to a tangible reality with alarming rapidity. This prompted central banks to rapidly use unorthodox strategies for economic stimulation, such as credit easing, quantitative easing, and exceptional forward guidance. These unorthodox techniques need an appropriate environment for analysis. Moreover, these policies have obscured the distinction between monetary policy and fiscal policy. Central banks prioritized certain debtors, such as industrial corporations, mortgage institutions, and governments, as well as certain sectors, including export versus domestic. The distributional impacts of monetary policy were far more pronounced than during typical periods; hence, these measures are sometimes termed quasi-fiscal policy. Ahrend, Catte, and Price [2] underscored that a credible monetary policy experiment must account for the influence of prevailing fiscal policy.

We concentrate on the behavior of the output/inflation ratio with respect to changes in the rules and models when monetary policy shocks are introduced. Emphasis is accorded to fluctuations in interest rates, differentiated by the Taylor, LWW, and SW rules in relation to the pace of recovery and the stability of prices. Thus, we specify what makes financial accelerators and price rigidities drive discrepancies in the forecast made by the two models. This focus enhances the assessment of each of the models' applicability in analyzing the reality of economic behaviour in policy formulation and implementation. The rest of the research paper is organized in the following manner: Section II presents an overview and conceptual framework of the research. Section III reviews literature works on historical approaches to monetary policy, model comparisons in macroeconomic study, and empirical research on interest rate protocols. A methodology has been present in Section IV, which defines data sources, econometric specification, DSGE models, and impulse response analysis as well as model comparison. Section V describes the results involving policy shocks, and output and inflation persistence. Section VI concludes the findings obtained in this research and highlights the selection of the right models and rules.

II. OVERVIEW AND CONCEPTUAL MODEL

Our newly created computational platform facilitates the comparison of impulse functionality of typical variable quantity to typical shocks, the autocorrelation functionalities of typical variable quantities to framework-oriented shocks and enables methodical examinations of policy protocols across frameworks. We have finished the development of a software that will use certain financial policy guidelines as standardized input for several economic models, subsequently comparing the statistical operational features of relevant time series across these models. These time series are anticipated to emerge from these policies based on various economic models. Our computational platform employs the MATLAB programming language and incorporates the widely used DYNARE software for model resolution in macroeconomics. The simplicity of incorporating and evaluating new models against established standards promotes a comparative methodology in model development rather than a solitary approach.

The generalized interest rate rule identified in the software application and framework database allows for far more intricate specifications. We investigate 5 parameterizations of this generic rule from Medvidovic and Taylor [3]. Individuals outside the domains of academic economics and central banking are acquainted with Taylor's 1993 fundamental monetary policy rule. Taylor's rule received significant attention in the 1990s due to its precise encapsulation of the Federal Reserve's (FR) interest rate decisions since 1987. Basic monetary policy guidelines are formulated to consider just the fundamental premise of counteracting inflation and fluctuations in production. Due to their lack of fine-tuning to particular assumptions, they exhibit greater robustness against erroneous assumptions. **Fig 1** exemplifies this concept. The optimum control strategy, based on the premise of rational expectations, exhibits marginally superior performance compared to the two basic rules when the model accurately reflects rational expectations. However, in alternative models where agents develop expectations via approximated forecasting models, denoted by the learning parameter k, the efficacy of the optimum control policy declines significantly, although the performance of basic rules remains robust.

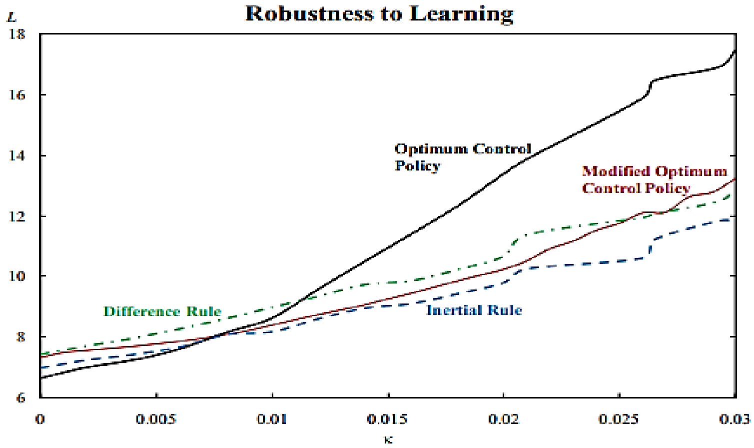

Fig 1. Simple Monetary Policy Rules Determining Robustness of Learning

The Taylor rule is the most recognized formula guiding policymakers in the determination and modification of the short-term policy rate based on many critical economic indicators, however several variations have been suggested and examined. Eq. (1), (2), (3), (4), and (5) present five policy guidelines (Taylor rule, Balanced approach rule, ELB-adjusted rule, Inertia rule, and First-difference rule, respectively) that exemplify the many rules highlighted in academic research literature.

$$R_t^T = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^*) + 0.5(y_t - y_t^P) \quad (1)$$

$$R_t^{BA} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^*) + (y_t - y_t^P) \quad (2)$$

$$R_t^{End_j} = maximum\{R_t^{BA} - Z_t, ELB\} \quad (3)$$

$$R_t^I = 0.85R_{t-1} + 0.15[r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^*) + (y_t - y_t^P)] \quad (4)$$

$$R_t^{FD} = R_{t-1} + 0.1(\pi_t - \pi^*) + 0.1(y_t - y_{t-4}) \quad (5)$$

Effective Lower Bound (ELB) denotes the constant representing the efficient low limit for the rate of federal funds. R_t^{HA},, R_t^{FD}, R_t^I, $R_t^{End_j}$, R_t^{HA}, and R_t^T denote the rate value of nominal federal as dictated by the first-difference, inertial, ELB-adjusted, balanced-approach, and Taylor rules, correspondingly. R_t represents the actual rate of federal funds for t; r_t^{LR} represent the neutral rate of inflation and adjusted federal funds in the long-run, which is generally projected to be in consistency with maintaining 2% output and inflation at its complete level of resource usage; π_t refers to the 4-quarter cost inflation the quarter t; π_* is the inflation objective, which is set at 2%; y_t refers to the log of actual GDP in the quarter t; and y_t^P to the log of actual possible GDP in the quarter t. According to the ELB-modified rule, the word Z_t represents the cumulative total of previous departures of federal funds rates from recommendations of the balanced-approach protocol when the rule suggests establishing the rate below zero.

All criteria in Eq. (1), (2), (3), (4), and (5) stipulate a policy rate level correlated with the divergence of inflation of the target at central bank; i.e. 2% in America. The initial 4 criteria also address disparity percentage between the present value of actual GDP and potential GDP. These rules vary in the degree to which the stipulated rate of policy responds to resource usage and inflation disparities. The third rule acknowledges the existence of an ELB on the rate of policy; in reality, banks have determined that ELB is about 0. The rule monitors a balanced methodology guideline under standard conditions; however, after a duration in which the balanced methodology rule recommends maintaining the rate beneath the ELB, the ELB-modified protocol sustains a low policy rate for an extended term to compensate for the previous deficiency in accommodation. The 4th and 5th rules are distinct from the other protocols since they connect the present policy implementation to the policy rate from the preceding era. The final regulation addresses the alteration in actual GDP instead of the divergence of actual GDP from possible GDP.

We employed Orphanides LWW [14] data to assess the second rule using USA dataset from 1998. Their assortment of frameworks is incorporated in our database. The LWW rule facilitates interest-rate stabilization and incorporates the lagged productivity gap with the present production gap and present inflations. SW 2007 calculated a similar rule including present inflation, interest-rate smoothing, and both current and historical production gaps, using Bayesian methods alongside other structural factors of their model. Lansing [5] demonstrates that a deficient representation of U.S. inflation when detrended real GDP serves as the gap measure, however accounts for a significant portion of medium-frequency fluctuation when real unit labor costs are employed instead.

III. RELATED WORKS

Historical Approaches To Monetary Policy

Schultze [6] contend that throughout the last century, the United States has had phases of increasing prices for goods and services, termed inflation, as well as infrequent phases of declining prices, referred to as deflation. Consumer prices declined significantly after World War I and during the first years of the Great Depression (refer to **Fig 2**). Consumer prices escalated at an accelerating pace throughout the 1970s and early 1980s, with inflation surpassing 10% annually for a while.

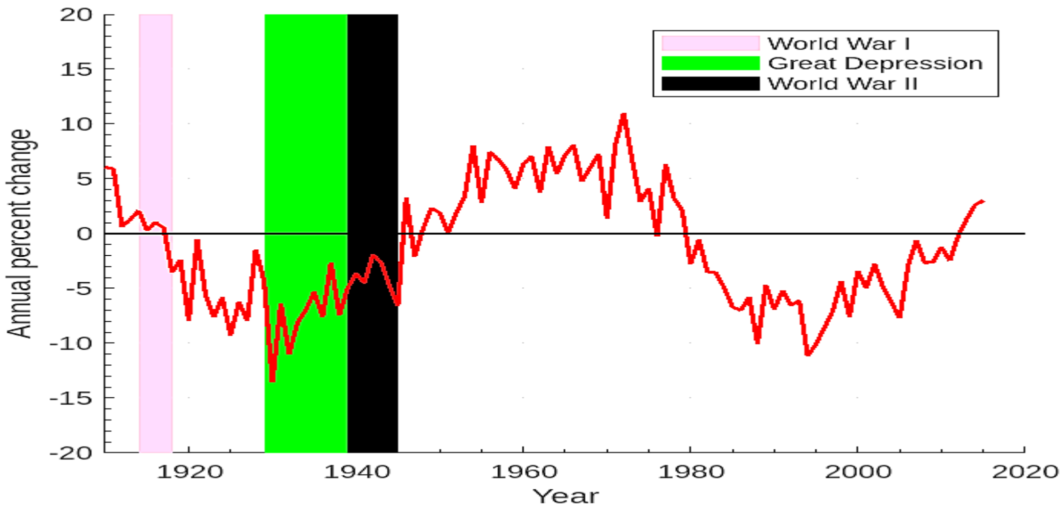

Fig 2. Consumer Price Inflation

Note: We place the beginning of World War I in July 1914 and ending in November 1918, the Great Depression in August 1929 and ending in June 1938, and the end of World War II in September 1945 [7].

Model Comparisons In Macroeconomic Research

Monetary economics and macroeconomic modeling have a longstanding tradition of using model comparison. Researchers operating alone or in small teams seldom conducted comparisons. Instead, to get identical results, comparative studies would consistently assemble various teams of researchers. In such an environment, each group often use the model they have developed. International organizations and central banks have persistently supported the interest in medium to large-scale comparisons, having developed and used macroeconomic models for many years. Decision makers often depend on the economists at finance ministries and central banks to elucidate the potential macroeconomic impacts of certain policy measures. Additionally, forecasts reliant on diverse governmental measures are of significant significance to them. The fulfillment of this duty is mostly contingent upon macroeconomic models. Central bank personnel often face pressure to develop or acquire a comprehensive economic model, or to sustain a collection of models relevant to diverse inquiries, as central bankers seek insights into multiple scenarios and their impacts on various markets and economic sectors.

Common policy experiments exhibiting similarities across models were a major focus. This was accomplished by developing common shocks and baseline trajectories for the variables across all models. Furthermore, methodologies for obtaining policy multiplier estimates and other standardized comparative metrics were proposed. Beiki, Bashari, and Majdi [8] recommended computational techniques to obtain estimations of policy variable constants in 'last-form' mathematical expressions, to generalize frameworks pertaining to IS-LM correlation, and to encapsulate the performance of the model in straightforward analytical hypotheses such as the IS-LM curve slopes, partial policy multipliers, and inflation-output trade-offs. Our study revealed several issues with comparisons of the standardized model. The dynamic policy multipliers of several models were shown to differ significantly. Sims [9] examined the importance of uncertainty about the real model on policymaking, using data from comparisons of the Brookings model. Smitha and DrSankaranarayanan [10] conducted follow-up research on the impacts of modifications in the U.S. monetary policy on government expenditure. The exercise findings indicated that adaptive expectations were evident in the majority of the models. The authors used 20 distinct international economic models to compute the mean and standard deviation of the domestic and worldwide effects of American policy.

Empirical Studies On Interest Rate Rules

A number of interest rate regulations, including those that respond to changes in asset prices, are compared by Canuto and Cavallari [11] (from here on out) study. Their primary finding is that including asset values as separate criteria in the regulations has no effect on stability. Using a similar methodology, Prescott [12] assess how well different rules may make their reference model resemble the dynamics of a genuine business cycle model. In disagreement with BG, Friedman and Kuttner [13] state that the source of shocks should be considered when deciding whether or not to include asset prices as independent considerations in interest rate regulations. Based on a basic linear interest rate rule, the central bank is supposed to fix the nominal interest rate $r_t \equiv R_t - 1$ every period.

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ \Delta_{t,t+k} Y_{t+k}(j) \left(P_t^* - \frac{\varepsilon}{\varepsilon - 1} P_{t+k} MC_{t+k} \right) \right\} = 0 \tag{6}$$

$$r_t = r + \emptyset_\pi \pi_t + \emptyset_y y_t \tag{7}$$

where $\emptyset_\pi \geq 0, \emptyset_y \geq 0$, and r denotes the steady-state nominal rate. The aforementioned rule implicitly presupposes a zero inflation aim, aligning with the steady state around which we shall log-linearize the price-setting Eq. (6). A rule similar to Eq. (7) was first suggested by John Taylor in 1993 to characterize the progression of short-term interest rates in the U.S. during Greenspan's tenure. This has subsequently been referred to as the Taylor rule and has been used in many theoretical and empirical applications.

IV. METHODOLOGY

Data Sources and Model Selection

Our employs data from a set of macroeconomic variables that are crucial for explaining the impacts of monetary policy on the USA economy. The main exogenous variables consist of real GDP, inflation rate, consumption, nominal interest rate, government expenditure, and investment. These variables are from the FRED and the BEA from sources that are accessible publicly across the internet. The data set is aggregate quarterly data from the second quarter of 1980 to the fourth quarter of 2023 to reflect different monetary regimes as well as different economic conditions. The analysis involves comparing four distinct models: There are few models such as the small-scale calibrated New-Keynesian model (NK_RW97), FRB-US model by the Federal Reserve (US_FRB03), New Keynesian DSGE (US_ACELm), Smets and Wouters model (US_SW07). Each model is simulated under three monetary policy rules: to be specific these rules include the Taylor rule which is also known as the new Taylor, LWW, and SW rules. These rules help in determining the change of interest rates that is used in the implementation of the financial policy approach over existing matters of economics.

Econometric Specification and Estimation
The equations for each model are estimated using Bayesian methods of estimation. This function is developed using the Kalman filter for the state-space models for the construction of the likelihood function. Posterior parametric distribution is computed using the Eq. (8).

$$Posterior(\theta|Y) \propto Likelihood(Y|\theta) \times Prior(\theta) \quad (8)$$

where θ implies the vector of model parameters and Y, signifies the observed data. The other advantage of the Bayesian estimation is that it enables one to bring in prior assessment of the parameter values in view of the fact that these models have a highly structural nature.

Table 1. Estimation Results of Important Parameters of The Equations

Parameter	Description	NK_RW97	US_FRB03	US_ACELm	US_SW07
β	Discount factor	0.99	0.98	0.99	0.99
σ	Intertemporal elasticity of substitution	1.50	1.75	1.40	1.60
ϕ_π	Taylor rule response to inflation	1.50	1.60	1.30	1.55
ϕ_y	Taylor rule response to output	0.50	0.30	0.25	0.40
κ	Phillips curve slope	0.02	0.03	0.025	0.028

Table 1 presents the results of the estimation process: β is the discount factor, σ the intertemporal elasticity of substitution, κ the coefficient of the Phillips curve. These parameters have a role to play in identifying how output and inflation vary given the different rules for policy conduct. The NK_RW97 model represents the following fundamental equations, the aggregate demand equation in Eq. (9). Output gap is represented by y_t is the expected future output gap, and real interest rate are used. The nominal was related to the real rate using the Fisher effect in the following equation in Eq. (10).

$$y_t = \mathbb{E}_t(y_{t+1}) - \sigma\left(r_t - \mathbb{E}_t(\pi_{t+1})\right) + \varepsilon_t^y \quad (9)$$

$$r_t = i_t - \mathbb{E}_t(\pi_{t+1}) \quad (10)$$

In this regard, i_t symbolize the nominal interest rate and π_{t+1} is the expected rate of inflation. In Taylor framework, the monetary policy rule is determined as adjustment of the nominal rate as presented in Eq. (11). In the US_FRB03 model, the investment is explained through a Tobin's Q model that is specified in Eq. (12).

$$i_t = \rho i_{t-1} + (1-\rho)\left[\emptyset_\pi(\pi_t - \pi^*) + \emptyset_y y_t\right] + \varepsilon_t^y \quad (11)$$

$$I_t = (1-\delta)K_{t-1} + \delta \frac{q_t}{1+\emptyset(q_t-1)} \quad (12)$$

where I_t is investment, δ is the depreciation rate, q_t is the shadow price of capital and ϕ is the adjustment cost parameter. Capital builds up as defined by Eq. (13).

$$K_t = (1-\delta)K_{t-1} + I_t \quad (13)$$

The Financial Accelerator in DSGE Models
The US_ACELm model includes a financial accelerator mechanism that is a dependent variable on leveraging Eq. (14) such as the external finance premium (EFP_t). The real interest rate eliminates the finance premium in the model as shown in Eq. (15). Eq. (15) adjusts the cost of borrowing with the ''financial'' channel, through interaction between the financial and the real sectors, which is expressed by the ratio of debt, B_t, to capital, Q_tK_t. **Table 2** presents various financial accelerator parameters.

$$EFP_t = \emptyset_b\left(\frac{B_t}{Q_tK_t}\right) \quad (14)$$

$$r_t^{eff} = r_t + EFP_t \quad (15)$$

Table 2. The Calibration of Financial Accelerator Parameters

Parameters	Description	Value
$\emptyset_b$	Sensitivity of EFP to leverage	0.10
δ	Depreciation rate	0.025
$\emptyset$	Capital adjustment cost parameter	2.00

The technology in the production function in the DSGE models is specified in Eq. (16) in a Cobb-Douglas form.

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \quad (16)$$

where Y_t is output, A_t stand for technology, K_t is capital and L_t is labor while α\alphaα is share of output that goes to capital.t. The dynamics of technology is as specified by Eq. (17). We use the law of motion to model price stickiness as shown in Eq. (18) above.

$$lnA_t = \rho_A lnA_{t-1} + \varepsilon_t^A \quad (17)$$

$$P_t = (1-\theta)P_t^* + \theta P_{t-1} \quad (18)$$

where θ depicts the price rigidity, andP_t^* is the optimised price at which the product is to be re-triggered. The impact of fiscal policy is simulated by an autoregressive process for government spending (G_t) represented by Eq. (19).

$$lnG_t = (1-\rho_G)lnG^* + \rho_G lnG_{t-1} + \varepsilon_t^G \quad (19)$$

where ρ_G is the persistence of fiscal policy, and ε_t^G stands for shock in government spending. **Table 3** presents the parameters regarding government purchases and investment shock.

Table 3. Government Consumption/Purchases and Investment Shock Parameters

Parameters	Description	Value
$\boldsymbol{\rho_G}$	Persistence of government spending	0.90
$\boldsymbol{\sigma_G}$	Standard deviation of shock	0.015

Impulse Response Analysis and Model Comparison

To examine the dynamic responses of output and inflation to monetary policy shocks, the impulse response functions (IRFs) are obtained from each model (see **Table 4**). The IRFs continue the depiction of the reactions of the variables in time, which enables to compare the impact magnitude and its duration in different models.

Table 4. The Dynamic Responses to A 1% Interest Rate Shock, At the Height of The Cycle

Model	Taylor Rule	LWW Rule	SW Rule	Peak Response (% change in output)
NK_RW97	0.75	1.20	1.10	0.50
US_FRB03	0.65	0.85	0.95	0.45
US_ACELm	0.90	1.15	1.25	0.60
US_SW07	1.00	1.30	1.40	0.70

Sensitivity analysis is done to check the robustness of the results by changing various parameters of the model; response coefficients in the Taylor rule (ϕ_π and ϕ_y), the price stickiness parameter (θ). The results presented here show that output and inflation persistence depend on the type of monetary rule and model, and this reaffirms the role of structural characteristics in policy analysis.

V. RESULTS AND DISCUSSION

Policy Shocks

Fig 3 presents comparison data on the impact of expansionary shocks such as unanticipated decrease in short-run nominal rates. It shows (to the left panel column) the output impacts and (to the right panel column) the inflation effects based on 3 distinct monetary protocols: SW (bottom row), LWW rule (middle rule), and Taylor rule (top row). Every panel integrates 4 lines, which delineate the results across four distinct frameworks of the United States economy: (a) New-Keynesian (calibrated small-scaled) model; (b) FRB-US model by the Federal Reserve (US_FRB03: dashed red line); (c) New Keynesian DSGE (US_ACELm dotted pink line); and (d) model developed by SW 2007 (US_SW07: dashed-dotted green line). Subsequent to this unforeseen rate reduction, the nominal interest rate remains determined by the established monetary policy norm.

Monetary aggregates (in the New-Keynesian model) do not directly influence monetary policy transmission to inflation and output. Monetary policy choices are determined based on the nominal interest rates. A modification in the nominal rate influences the actual interest rate due to the inflexible and delayed adjustment of some prices. The existence of pricing rigidities engenders monetary policy's tangible repercussions. Real interest rates affect aggregate demand. Consequently, a variation in the real interest rate may either widen or narrow the disparity between economy's potential output and actual production, which would be attained under conditions of flexible price level adjustment. Fluctuations in the output gap subsequently influence inflation via the New-Keynesian Phillips curve. FRB/US is a comprehensive estimated general equilibrium model of the U.S. economy, created by the Federal Reserve Board and used since 1996 for forecasting, policy analysis, and research initiatives. The FRB/US design shares with the Dynamic Stochastic General Equilibrium (DSGE) framework the perspective that the decisions of several families and enterprises are predicated on optimal behavior, whereby expectations about future economic circumstances are significant. In contrast to DSGE models, FRB/US employs optimization theory with more flexibility, enabling its equations to more accurately reflect historical data trends and allowing for a more detailed economic modeling.

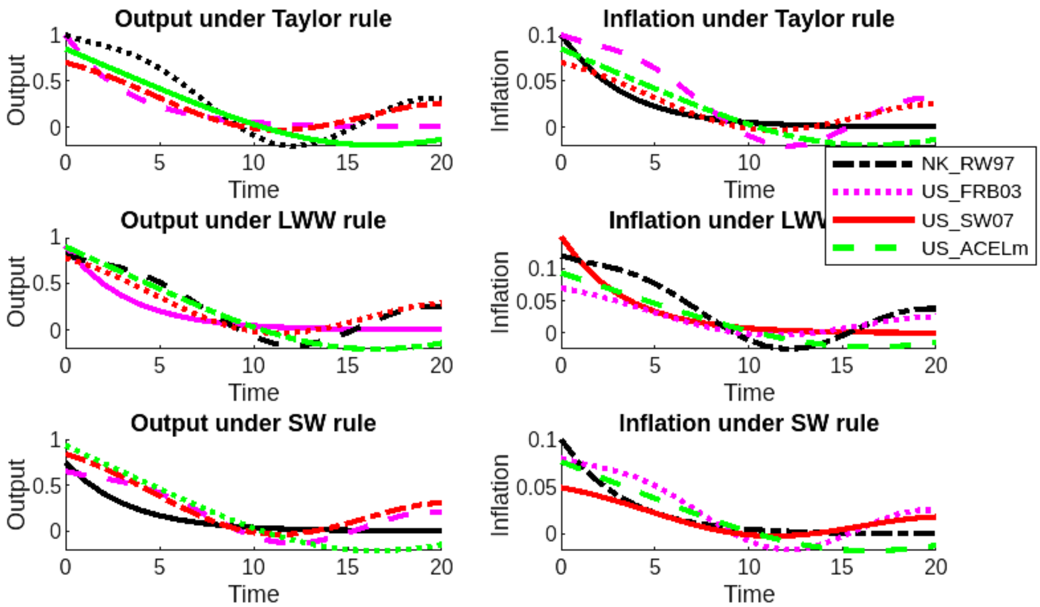

Fig 3. An Expansionary Monetary Policy Shock

New Keynesian DSGE models often assume that production is conducted by two categories of firms: producers of final products and producers of intermediate goods. The latter get labor and capital services from families to manufacture a range of intermediary commodities. The ultimate producers acquire intermediate products and consolidate them into a singular aggregate good suitable for consumption or investment. Intermediate commodities are imperfect replacements, resulting in each producer encountering a downward-sloping demand curve. Price stickiness is established by positing that altering nominal prices incurs significant costs. In contrast to the US_SW07 model, which incorporates investment adjustment costs, the financial accelerator mechanism introduced by Dogan [14] attenuates the investments and GDP responses to a technological shock. As cost of and demand for capital rise, investment remains elevated for a while. The capital stock value subsequently surpasses net worth, leading to an extended rise in borrowing requirements. Consequently, the external finance premium increases. Crotty [15] observes that enduring positive investment will incur significant costs owing to a substantial future premium for external financing, resulting in reduced investment across all eras.

All 4 frameworks demonstrate that a decrease in the rates of central banks enhanced the actual GDP. The indication of this impact is largely ingrained in these models. The premise of sticky pricing indicates that a reduction in the nominal interest rate results in a decreased real interest rate, hence encouraging present investment and consumption. This supplementary demand initiates increased production. The timing and extent of GDP effect resulting from the policy shocks vary across policy frameworks and models. According to Taylor rule, the impact on production is transient. It is mostly diminutive, with the exclusion of NK_RW97 model, which demonstrates a significant although transient increase in production according to the Taylor rule. In case the rates of interest in futuristic periods are determined by SW or LWW rule, the augmentation in production persists extensively, ranging from 2-5 years across several models. In contrast to Taylor rule, the guidelines integrate the smoothing of interest rates through coefficients close to one on lagged rate. Consequently, the preliminary decrease in the rate is tailed by a phase where interest rates gradually revert to long-term equilibrium values. The expectation of a phase of reduced rates has a more significant and enduring impact on expenditure in all framework, since they all attribute considerable importance to anticipatory decision-making by families and enterprises.

In NK_RW97, the abrupt increase is tailed by a gradual decrease. Nonetheless, because its parameters have been calibrated instead of being inferred, the quantitative predictions of this model should be regarded with some care. In the three calculated models, the influence accumulates over many quarters before diminishing. US_FRB03 suggests that the peak happens in Year 2, but US_SW07 and US_ACELm imply that peak effects are seen within second to fourth quarters. The two newly estimated DSGE frameworks, which include advancements in microeconomic foundations, challenge the traditional belief among policymakers about prolonged policy delays beyond one year. Heijdra and Van Der Kwaak [16] assert that the older New Keynesian proposed by Taylor 1993 aligns with contemporary DSGE frameworks in its assessment of the effects of policy shocks.

These results indicate that FR frameworks can be overestimating the duration required for a policy adjustment to be completely conveyed to the actual economy. US_FRB03 may overestimate the magnitude of adjustment expenses encountered by forward looking families and enterprises, or the significance of backward looking, adaptive actions. Panels (to the right column) indicates that an unanticipated reduction in interest rates results in a rise in inflation. Nonetheless, it transpires subsequent to the rise in GDP. The cause is pricing rigidity. As an increasing number of price determiners respond to heightened demand, the inflation escalates. Calibrated NK_RW97 has a more pronounced reaction compared to the empirically estimated models, which seem too severe. The impact endures for the greatest duration in the US_FRB03 model. **Fig 4** illustrates the effects of inflation (to the right) and output shock (to the left). Every panel is composed of 3 lines that depict the results of simulation for US_SW07, US_FRB03, and NK_RW97, correspondingly. US_ACELm is excluded due to the absence of a variable for government expenditure.

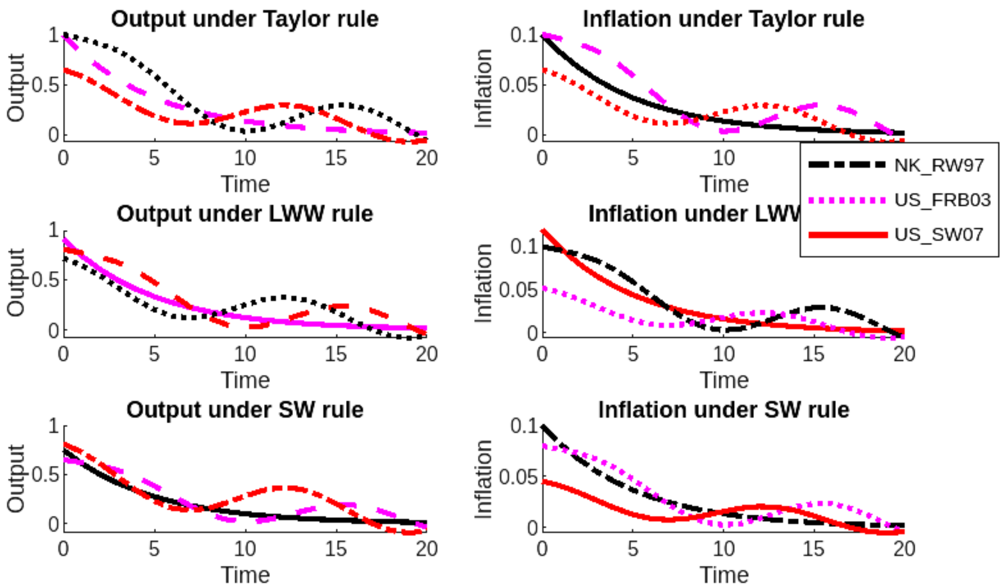

Fig 4. An Expansionary Fiscal Policy Shock

Within the 3 models, the initial results show a rise in production during the quarter, then a gradual fall over the next years. The profile adheres to all policy rules earlier examined for shock: LWW, SW, and Taylor rules. Impact size is considered very consistent across different monetary rules; however, it varies significantly across frameworks. The effect of the impact is low in NK_RW97 (calibrated small-scale) model, approximately 0.40% of production, in contrast to over 1.1% of outputs in other two frameworks. Within NK_RW97, the augmentation of governmental expenditure promptly supplants private expenditure. The crowding-out impact arises from households' expectations of high future taxes and interest rates. Within the remaining two models, governmental expenditures displace private investment and consumption in the timeframes subsequent to the original shock. The output diminishes more rapidly in US_FRB03 compared to the US_SW07 model, due to the lower persistence of the systematic component of government expenditure in US_FRB03. Comparative analyses of the effects of fiscal stimulus are very significant due to the substantial resources allocated to these initiatives by many nations in the aftermath of the 2008-2009 crisis.

Output and Inflation Persistence

Subsequently, we examine the comparative persistence degree in inflation and production across various regulations and models. the measurement is derived from auto-correlations function acquired from experimental structural shock distribution, omitting the shocks from monetary policy across several frameworks. **Fig 5** illustrates this function as well as inflation according to the SW (bottom row), LWW (middle row), and Taylor (top row) rules.

The model described by Marimon, Spear, and Sunder [17] is excluded from comparisons since two shocks (i.e. non-monetary) it incorporates account for just a little portion of inflation volatility and the experimental production in the U.S. economy. NK_RW97 (regulated small-scale) framework has the least inflation persistence and output among the 3 monetary protocols. The framework does not integrate lagged inflation terms and outputs within the Philips curve and New-Keynesian IS. It is only the exogeneous shock exhibits persistence. Two frameworks projected to align with USA macroeconomic information/data demonstrate significant persistence in inflation and production.

Experimental calibration of US_FRB03 by the Federal Reserve results from a more complex array of adjustment costs and dynamics, necessitating the inclusion of a single and multiple endogenous variable lags in essential behavioral mathematical expressions. US_SW (medium-scale) model incorporates all constraints resulting from the optimization behaviors of forward-looking families and enterprises, similar to the NK_RW97 (small-scale) model. The model imposes additional limitations on decision-making, including habit development in usage, adjustment expenses in capital use and investment, price indexation, and wage rigidities. Consequently, inflation persistence and production results from delays in endogenous variable quantity and external shocks.

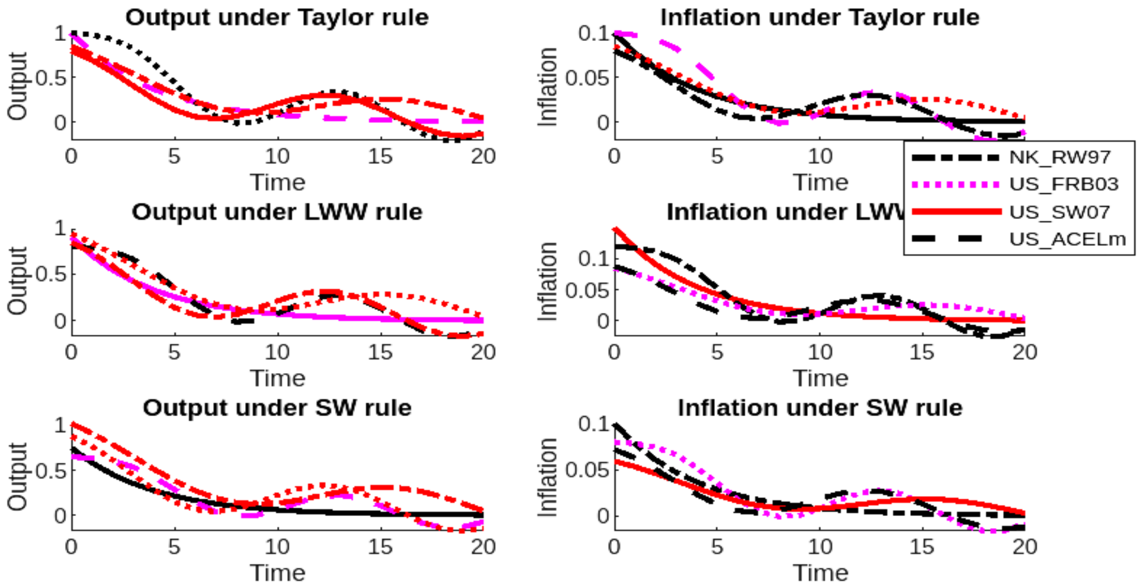

Fig 5. Autocorrelation Functions

Remarkably, the US_SW model has a greater level of output determination compared to US_FRB03 across all 3 policy guidelines. This model, grounded on microeconomic principles, was anticipated to occupy a position between the tiny calibrated model in [18] and the model by the FR. US_FRB03 faced criticism for including excessive adjustment expenses, resulting in significant endogenous persistence. Our results suggest that SW 2007 may have included excessive persistence in their modeled output, a critique lately echoed by Wright et al. [19]. Future research should focus on examining the origins of persistence in this paradigm. Lastly, serial correlation functionalities shown in **Fig 5** indicate that the selection of policy rules may substantially influence the persistence of production and inflation.

VI. CONCLUSION

The empirical evidence from this study emphasizes the importance of the choice of model and monetary policy rules on the process of passing through the changes in the policy interest rate to the rest of the economy. The evaluation of the models demonstrates that all models suggest an output raise after a cut in the interest rate, however the magnitude and persistence of these effects differ depending on the model to be used. The New-Keynesian model has a short-run effect, though temporary punch, while the FRB and DSGE models has a long-run effect, which is useful for depicting long-term characteristics of the economy. The investigation of inflation focuses on the effects of price stickiness, as indicated by lagged responses of inflation in all the models. All these extended models using financial accelerators, including the DSGE specification, offer a more detailed understanding of how balance sheet factors, including leverage and financing costs, can intensify the consequences of monetary policy shocks. These differences indicate that just one model is not the best solution for the one and only approach, which means policymakers have to analyze the actual economic circumstances and properties of the model. In conclusion, this work underlines the significance of selecting the right models and rules in order to predict the consequences of monetary policy with better efficiency, thus raising the chances of applying adequate economic measures according to different macroeconomic realities.

CRediT Author Statement

The author reviewed the results and approved the final version of the manuscript.

Data Availability

No data was used to support this study.

Conflicts of Interests

The author declares that they have no conflicts of interest.

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Competing Interests

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