

Fiscal-Monetary Policy Interactions and Macroeconomic Transmission under Exogenous Shocks: A HANK Approach

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Fiscal-Monetary Policy Interactions and Macroeconomic Transmission under Exogenous Shocks: A HANK Approach

Min Gyu Lee ¹

Abstract

This paper examines how fiscal and monetary policies interact in response to exogenous macroeconomic shocks and how household heterogeneity shapes the transmission of these policy responses. We develop a heterogeneous-agent New Keynesian (HANK) model with distortionary labor, capital, and consumption taxation, nominal rigidities, and government debt. Rather than considering Ramsey-optimal policies, we characterize the endogenous interaction of systematic, rule-based fiscal and monetary policies, with tax rates responding to government debt and output fluctuations and monetary policy following a Taylor-type rule. Quantitative simulations show that the nature of the shock fundamentally affects the interaction between fiscal and monetary policy. TFP, markup, and government debt shocks generate distinct combinations of fiscal adjustment, monetary stabilization, and private-sector responses. Household heterogeneity further alters aggregate transmission through differences in marginal propensities to consume, with liquidity-constrained households amplifying the consumption response to policy shocks. The results highlight the importance of both policy rules and household heterogeneity in understanding the macroeconomic and distributional effects of fiscal-monetary policy interactions.

Keywords: Fiscal-Monetary Policy Interaction, Heterogeneous Agents, HANK, DSGE

JEL Classification: E37, E62, H63

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1. Introduction

Since the COVID-19 pandemic, many economies have experienced a marked resurgence of inflation, reflecting the joint effects of expansionary fiscal interventions and prolonged accommodative monetary policy. This episode has revived interest in the interaction between fiscal and monetary authorities, particularly in environments characterized by distortionary taxation, public debt accumulation, and nominal rigidities. Understanding how these policy instruments jointly respond to macroeconomic disturbances has become central to contemporary macroeconomic analysis.

The literature on fiscal–monetary policy interaction has developed along several strands. Early contributions, such as Barro (1979) and Lucas and Stokey (1982), emphasized tax smoothing and the intertemporal financing of government expenditures. Subsequent work, including Chari et al. (1991) and Schmitt-Grohé and Uribe (2004a, 2004b, 2007), examined optimal policy mixes in dynamic general equilibrium settings with distortionary taxation and nominal rigidities. More recent studies have extended the framework to incorporate incomplete markets, policy commitment issues, and heterogeneous agents (e.g., Bhandari et al., 2017; Bilbiie et al., 2021; McKay and Wolf, 2023; Sims, 2025). While much of this literature focuses on Ramsey-optimal allocations, it leaves open the question of how decentralized fiscal and monetary authorities interact when policies are not jointly optimized but instead follow rule-based behavior.

In parallel, research on fiscal–monetary regimes has highlighted the importance of policy coordination for macroeconomic stabilization and inflation dynamics (Sims, 2001, 2013; Leeper and Zhou, 2013). These studies show that the macroeconomic effects of shocks depend critically on whether fiscal and monetary policies are active or passive, and on how

government debt is financed. However, relatively limited attention has been paid to how such interaction operates in a heterogeneous-agent environment with distortionary taxation and state-incontingent debt.

This paper addresses this gap by embedding fiscal–monetary interaction in a heterogeneous-agent New Keynesian (HANK) DSGE framework. The model incorporates distortionary labor, capital, and consumption taxes, state-incontingent government debt, and a monetary authority that sets the nominal interest rate according to a Taylor rule. Rather than solving for Ramsey-optimal policies, the analysis characterizes the endogenous policy regime that emerges when fiscal and monetary authorities respond to exogenous disturbances such as markup shocks, productivity shocks, and government debt shocks. In this setting, the interaction between policy instruments arises through the government budget constraint, distortionary taxation, and the distributional consequences of aggregate shocks.

The model is calibrated to match the key structural features of an aging, high-debt advanced economy, providing an empirically grounded framework for policy analysis. While much of the existing quantitative literature on rule-based policy interactions relies on representative-agent DSGE frameworks, this paper embeds these policy dynamics within a heterogeneous-agent general equilibrium model, thereby highlighting how microstructural aggregate distribution channels fundamentally shape macroeconomic stabilization outcomes. The contribution of this paper is threefold. First, it characterizes the interaction between systematic fiscal and monetary policies across different types of macroeconomic disturbances, showing that the policy configuration emerging in equilibrium depends on the nature of the shock. Second, it demonstrates how fiscal

feedback rules, government debt dynamics, and monetary stabilization jointly shape the transmission of aggregate shocks to consumption, investment, and output. Third, by incorporating household heterogeneity, the analysis identifies a distributional transmission channel through which differences in marginal propensities to consume alter aggregate responses to policy interventions. These results provide a unified framework for understanding how fiscal-monetary interactions and household heterogeneity jointly determine macroeconomic transmission.

While a full comparison with a representative-agent benchmark is beyond the scope of this paper, the results suggest that heterogeneous consumption responses play a key role in shaping aggregate dynamics, particularly through general equilibrium effects.

The rest of the paper is organized as follows: Section 2 presents the model; Section 3 outlines the calibration strategy; Section 4 reports simulation results and quantitative analysis; Section 5 discusses policy implications derived from the findings.

2. The Model

The baseline model is a Heterogeneous Agents framework based on Aiyagari (1994). This framework allows the model to capture distributional effects that are absent in representative-agent settings, particularly in response to fiscal policy shocks. The model incorporates a continuum of heterogeneous households subject to idiosyncratic income risk in a stochastic environment. On the production side, monopolistically competitive intermediate goods firms maximize profits, while a perfectly competitive final goods firm aggregates differentiated intermediate goods. Nominal price rigidity arises at the level of intermediate goods producers through Rotemberg-type price adjustment costs.

Fiscal instruments consist of labor income taxes, capital income taxes, and consumption taxes, all of which are endogenous. In response to exogenous shocks, the central bank sets the nominal interest rate according to a Taylor rule.

2.1 Decision Making of Households

The household's preferences are represented by a utility function in which utility is derived solely from consumption.

$$U(C_t) = \frac{C_t^{1-\gamma}}{1-\gamma} \quad (1)$$

There exists a continuum of heterogeneous households, each subject to idiosyncratic, exogenous labor productivity shock. These shocks are introduced to capture wage differentials. The labor productivity of a household in period t follows an AR(1) process, which is specified as Equation (2):

$$\log(x_{t+1}) = \rho \log(x_t) + \eta_{t+1} \quad (2)$$

The stochastic shock η_{t+1} is assumed to follow a normal distribution with mean zero and standard deviation σ , i.e., $\eta_{t+1} \sim N(0, \sigma^2)$. Grounded in the empirical consensus that the microeconomic wage elasticity of labor supply is near zero over short-to-medium horizons, this model adopts the baseline benchmark that individual households supply labor inelastically. Due to incomplete markets and borrowing constraints, consumption

responses differ across households, generating heterogeneous marginal propensities to consume.

Consequently, each household derives utility solely from individual consumption C_t in period t , and earns labor income by supplying labor in efficiency units x_t , which is given by the product of the real wage per efficiency unit w_t and its idiosyncratic labor productivity x_t , that is $w_t x_t$.

The utility maximization problem of heterogeneous households can be represented by Equations (3) as follows.

$$\begin{aligned} \max_{\{C_t, K_{t+1}, B_{t+1}\}_{t=0}^{\infty}} &= E_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \\ (1 + \tau_t^c)C_t + K_{t+1} + \frac{B_{t+1}}{P_t} &= (1 - \tau_t^n)w_t x_t + (1 - \tau_t^k)r_t K_t + (1 + i_t)\frac{B_t}{P_t} + (1 - \delta)K_t \end{aligned} \quad (3)$$

The computation of the competitive equilibrium follows the approach of Krusell and Smith (1998), in which a value function is defined and a sequence of allocations is iteratively computed—starting from an initial guess—until convergence to the steady state is achieved. The corresponding Bellman equation is given by Equation (4):

$$\begin{aligned} V_t(K, B, x) &= \max_{\{C\}} \{U(C_t) + \beta EV[(B', K', x'|x)]\} \\ s. t. (1 + \tau^c)C + K + \frac{B'}{P} &= (1 - \tau^n)wx + [1 + (1 - \tau^k)(r - \delta)K] + (1 + i)\frac{B}{P} + (1 - \delta)K \end{aligned} \quad (4)$$

2.2 Decision Making of Firm

2.2.1 Intermediate goods firm

Each intermediate-goods producer operates under monopolistic competition and faces a downward-sloping demand schedule derived from the CES aggregation of final goods.

$$Y_t(z) = F_t(z) = A_t [N_t(z)]^\alpha [K_t(z)]^{1-\alpha} \quad (5)$$

Price adjustment costs are introduced following Rotemberg (1982).

$$\psi_t(z) = \frac{\phi}{2} \left(\frac{P_t(z)}{P_{t-1}(z)} \right)^2 Y_t(z) \quad (6)$$

(ϕ = Price Adjustment Cost Parameter)

From the first-order condition with respect to intermediate input $Y_t(z)$, the following equation (7) is derived:

$$Y_t(z) = \left(\frac{P_t(z)}{P_t} \right)^{-\varepsilon} Y_t \quad (7)$$

($P_t(z), P_t$: Price of Intermediate Goods z , Price of the Homogeneous Final Goods, respectively.)

$$P_t(z) = \left(\frac{Y_t}{Y_t(z)} \right)^{1/\varepsilon} \quad (8)$$

The above equation represents the demand function for intermediate goods, where μ captures the degree of monopoly power arising from the monopolistic competitive market

structure faced by intermediate goods producer.

To induce a symmetric equilibrium, we impose the condition that, $Y_t(z) = Y_t, N_t(z) = N_t, K_t(z) = K_t$ for all z . Under these conditions, factor prices are equal to the marginal cost faced by intermediate goods producer.

2.2.2 Final goods firm

Homogeneous final goods are produced by aggregating a continuum of intermediate goods Z using a CES production technology, as described in Equations (9), and P_t present aggregate price index in Equation (10). In this context, $\frac{\varepsilon}{\varepsilon-1}$ denotes the markup μ , reflecting the degree of market power in the intermediate goods sector.

$$Y_t = \left(\int_0^1 Y_t(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (9)$$

where $\varepsilon > 1$ denotes the elasticity of substitution across differentiated intermediate goods.

$$P_t = \left(\int_0^1 P_t(z)^{1-\varepsilon} dz \right)^{\frac{1}{1-\varepsilon}} \quad (10)$$

The final output is produced by aggregating a continuum of differentiated intermediate goods, and the firm's objective is to minimize the total cost of acquiring these inputs, subject to a CES production function.

$$\max_{\{Y_t(Z)\}_{t=0}^{\infty}} \left[\left(\int_0^1 Y_t(z)^{1-\varepsilon} dz \right)^{\frac{1}{1-\varepsilon}} - \int_0^1 P_t(z) Y_t(z) dz \right] \quad (11)$$

In addition, final goods production is represented by the following equation (11).

$$Y_t = A_t N_t^{1-\alpha} K_t^{\alpha} \quad (12)$$

2.3. Decision Making of Government

The government's budget constraint is given as follows. Under this setup, government debt shocks should be interpreted as fiscal adjustment shocks that induce changes in taxation and government spending under the balanced-budget constraint, rather than pure debt-financing shocks.

This interpretation is important because, under a balanced-budget rule, government debt does not evolve independently but instead reflects endogenous fiscal adjustments. On the revenue side, the government collects capital income taxes, labor income taxes, and consumption taxes, and issues government bonds to finance its total expenditure. Government expenditure consists of government consumption and interest payments on previously issued bonds. Government bond issued in period t is assumed to be zero and matures in period $t+1$. The government bond is assumed to be a state-incontingent debt, and financial markets are assumed to be incomplete. That is, agents have no claims on other financial assets such as capital beyond the state-incontingent government bond.²

$$(1 + i_t) \frac{B_{t-1}}{P_t} + G_t = \tau_t^c C_t + \tau_t^n w_t x_t + \tau_t^k r_t K_t + \frac{B_t}{P_t} \quad (13)$$

Each type of investment is subject to an adjustment cost, following Lucas and Prescott (1971) and Christiano et al. (2005). The adjustment cost is modeled in the same Rotemberg-type quadratic form as used for output adjustment costs. The investment adjustment cost function is assumed to be increasing and convex, satisfying the conditions $S(1)=S'(1)=0$.

$$S = \frac{v}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \quad (14)$$

In addition, the equilibrium condition in the output market is given by equation (15).

$$Y_t \left(1 - \frac{\psi}{2} (\pi_t - \bar{\pi})^2 \right) = C_t + [K_{t+1} - (1 - \delta)K_t] + G_t \quad (15)$$

Investment decisions are governed by the standard intertemporal optimality condition.

$$1 = E_t \left[\beta \frac{u_c(c_{t+1})}{u_c(c_t)} (r_{t+1} + 1 - \delta) \right] \quad (16)$$

This condition highlights that investment depends on both financing costs and expected returns on capital.

2.4. Monetary Policy

The central bank sets the nominal interest rate according to Taylor's rule, and the policy rule is represented by the following equation. A zero lower bound (ZLB) is imposed, reflecting the constraint that the nominal interest rate cannot fall below zero.

$$i_t = \max \left[0, i_{t-1}^{r_i} \left(\frac{\pi_t^A}{\bar{\pi}^A} \right)^{(1-r_i)r_\pi} i_{t-1}^{r_i} \left(\frac{Y_t}{\bar{Y}} \right)^{(1-r_i)r_Y} \bar{i}^A{}^{1-r_i} e^{\epsilon_{r,t}} \right] \quad (17)$$

In this context, $\bar{\pi}^A$ represents the steady-state year-on-year inflation rate, $\bar{Y}$ denotes the steady-state GDP, and $\bar{i}^A$ is the steady-state nominal interest rate. The monetary policy shock, $e^{\epsilon_{r,t}}$, follows a normal distribution with mean zero and variance σ^2 . The parameter r_i captures the degree of interest rate smoothing, reflecting the central bank's responsiveness to the lagged nominal interest rate. The parameters r_π and r_Y represent the influence of the lagged inflation gap and GDP gap, respectively, on the determination of the nominal interest rate.

3. Calibration

This section describes the parameter calibration for the structural model. The subjective discount factor β is set to 0.98 (quarterly), consistent with standard quarterly New Keynesian general equilibrium literature (e.g., Kaplan et al., 2018; Sims, 2025). The coefficient of relative risk aversion, γ , is calibrated to 1.4, falling well within the standard range of 1.0 – 2.0 adopted in dynamic macroeconomic models. The capital income share,

$1 - \alpha$, is set to 0.36 (yielding a labor income share $\alpha = 0.64$), aligned with baseline calibrations in quantitative macroeconomics (e.g., Smets and Wouters, 2007; Sims, 2025). The quarterly depreciation rate of capital, δ , is set at 0.10. For the exogenous shock processes, the persistence parameters for cost-push markup shocks (ρ_ϵ), productivity shocks (ρ_A), and government debt shocks (ρ_B) are set to 0.80, 0.90, and 0.90, respectively, following standard specifications in medium-scale DSGE and HANK models (e.g., Adrian et al., 2022; Sims, 2025).

Table 1 summarizes the benchmark parameter values. In the deterministic steady state, the government consumption-to-GDP ratio (G/Y) is calibrated to 20%, representing the long-run structural benchmark observed across advanced OECD economies (Sims, 2025). The steady-state government debt-to-GDP ratio (B/Y) is set to 60%, adhering to standard international institutional benchmarks and OECD fiscal sustainability targets. Finally, the target annual inflation rate is anchored at 2%, matching the standard inflation-targeting mandate of major central banks.

Table 1. Calibration

parameters	calibration	evidence
β	0.986	Kaplan, Moll, and Violante (2018)
μ	1.10	Christiano, Eichenbaum, and Evans (2005) Galí (2015)
$1-\alpha$	0.36	Kaplan, Moll, and Violante (2018)
δ	0.025	Smets and Wouters (2007, <i>AER</i>) Standard DSGE Literature
ρ_ϵ	0.8	Adrian et al. (2022)
ρ_A	0.95	King and Rebelo (1999)

		Smets and Wouters (2007)
ρ_B	0.90	McKay and Wolf (2023) Standard HANK Literature
r_π	1.50	Taylor (1993) / Galí (2015)
r_i	0.80	Smets and Wouters (2007)
r_Y	0.125	Taylor (1993) / Galí (2015)

4. Analysis of quantitative results

The IRFs are derived to evaluate the dynamic effects of exogenous shocks in the baseline economy. The analysis considers three types of exogenous disturbances: a cost-push (markup) shock, a productivity (TFP) shock, and a government debt shock.

The negative and positive shocks, as well as the government debt shock, are each defined by the following equations.

(1) negative(-) shocks : positive(+) Mark-up shock and negative TFP shock

$$\log \mu_t = \rho_\varepsilon \log \mu_{t-1} + \eta_{\varepsilon 1,t} \quad (18)$$

$$\log A_t = \rho_A \log A_{t-1} + \eta_{A1,t} \quad (19)$$

(2) positive(+) shocks: negative(-) Mark-up shock and positive TFP shock

$$\log \mu_t = \rho_\varepsilon \log \mu_{t-1} + \eta_{\varepsilon 2,t} \quad (20)$$

$$\log A_t = \rho_A \log A_{t-1} + \eta_{A2,t} \quad (21)$$

(3) Government debt shocks: positive and negative government bond shocks

$$\log B_t = \rho_B \log B_{t-1} + \eta_{\varepsilon 3,t} \quad (22)$$

$$\log B_t = \rho_B \log B_{t-1} + \eta_{B,t} \quad (23)$$

Note that while all exogenous shock processes are formulated with standard positive innovations in the structural equations, the directional configurations of the disturbances are implemented through the signs of the initial innovations at $t = 0$. Specifically, for the negative economic shock scenario, we impose a one-time positive innovation for the markup shock ($\eta_{\varepsilon,0} > 0$) and a one-time negative innovation for the TFP shock ($\eta_{A,0} < 0$). Conversely, for the positive economic shock scenario, $\eta_{\varepsilon,0} < 0$ and $\eta_{A,0} > 0$ are applied. The same principle governs the government debt shocks, where a positive bond shock is triggered by $\eta_{B,0} > 0$ and a negative bond shock by $\eta_{B,0} < 0$.

The markup shock is modeled as an exogenous change in the markup parameter, and the resulting responses of policy variables and key macroeconomic indicators are examined. This approach allows us to trace the exogenous adjustment of the price level in response to an exogenous cost shock, highlighting the importance of such shock as supply-side disturbances that influence inflation and other responses of macroeconomic variables. Since inflation is endogenously determined, the cost-push shock provides a meaningful framework to assess how inflationary pressures affect policy instruments and macroeconomic dynamics.

This paper builds on existing studies of TFP shocks by focusing on the effects of a negative TFP shock within a HANK-DSGE framework, analyzing its implications for taxes, government spending, and the policy interest rate. It also investigates how an exogenously determined government debt shock affects macroeconomic outcomes, especially in relation

to fiscal soundness. The analysis proceeds as follows. First, the responses of macroeconomic and policy variables are examined under a negative economic shock generated by a positive markup shock and a negative TFP shock. Second, a positive economic shock is considered, represented by a negative markup shock and a positive TFP shock. Lastly, both positive and negative shocks to government debt are analyzed to study the implications for macroeconomic and policy variables. The shock processes are summarized in the following equations.

4.1. Negative Exogenous Shock

Negative exogenous shocks are structurally classified into two distinct types within this framework: positive cost-push markup shocks and negative total factor productivity shocks. Although both disturbances function as adverse economic shocks that induce a severe deterioration in aggregate output and private consumption, their general equilibrium transmission channels and structural impacts on price dynamics trigger fundamentally different monetary and fiscal adjustment paths. Under a positive markup shock, the economy experiences stagflationary pressures with rising inflation, whereas a negative total factor productivity shock paradoxically precipitates a demand-driven disinflationary recession within the heterogeneous-agent New Keynesian environment.

Despite these differing price dynamics, the endogenous configurations of rule-based policy instruments exhibit highly systematic characteristics across both adverse scenarios. First, tax policy functions countercyclically as an automatic stabilizer to protect the government's long-run balanced-budget constraint. In the face of a contracting economic tax base, the endogenous tax schedules on capital income and private consumption

experience an immediate upward adjustment to ensure fiscal soundness. In sharp contrast, government spending and the public debt stock respond procyclically, retrenching significantly on impact. This joint behavior signals that maintaining long-run fiscal sustainability under structural institutional constraints dictates debt reduction and tax-revenue protection over debt-financed expansion. Concurrently, monetary policy acts countercyclically to buffer the real economy, with the central bank aggressively cutting the nominal interest rate upon shock arrival before gradually steering it back toward the steady state.

A key general equilibrium mechanism unifying both adverse shock configurations is the robust, counterintuitive crowding-in expansion of private investment on impact. Under the positive markup shock, this investment boom is fueled by a plunge in the ex-ante real interest rate, as cost-push inflation heavily outpaces the central bank's nominal policy rate easing. Under the negative total factor productivity shock, investment accumulation is structurally sustained by the deep, procyclical retrenchment of government spending, which effectively liberates goods-market capacity and insulates private sector capital formation from traditional crowding-out effects. This resource reallocation from current consumption toward capital accumulation highlights the powerful state-dependence of investment dynamics in sticky-price general equilibrium models.

Crucially, this macroeconomic transmission is heavily amplified by household heterogeneity. The interaction of binding borrowing constraints and micro-heterogeneity in marginal propensities to consume uniquely exacerbates the collapse in private aggregate demand, since liquidity-constrained agents are acutely sensitive to the erosion of real wages and disposable income. Ultimately, the quantitative results across Section 4.1 demonstrate

that an adverse economic environment shapes an endogenous policy coordination regime characterized by a passive, consolidating fiscal authority paired with active tax stabilization and accommodative monetary policy configurations.

4.1.1. Positive Markup Shock

Figure 1 presents the impulse response functions of key macroeconomic and policy variables following a positive cost-push markup shock of plus one percent. As price pressures materialize, endogenous fiscal instruments react sharply; the capital income tax rate and private consumption tax rate immediately jump upward to stabilize the fiscal budget. Concurrently, the combination of escalating inflation expectations and heightened consumption taxation triggers a deep contraction in private consumption. This sudden drop reflects a profound general equilibrium adjustment, wherein a contracting domestic demand base and slashed public expenditure effectively reallocate structural resources away from current consumption toward capital investment. Despite the severe economic contraction, the rise in endogenous tax schedules remains an equilibrium necessity under the rule-based institutional framework, capturing the policy reality that an aging, high-debt economy must carefully manage its sovereign debt buffers through active resource mobilization rather than debt expansion.

Consistent with this fiscal sustainability mechanism, government spending and the public debt stock respond procyclically, contracting on impact before recovering monotonically toward the steady state. On the monetary front, the central bank adopts an accommodative stance by slashing the nominal interest rate down to buffer the real economy. Despite this policy rate easing, inflation surges on impact due to the direct cost-

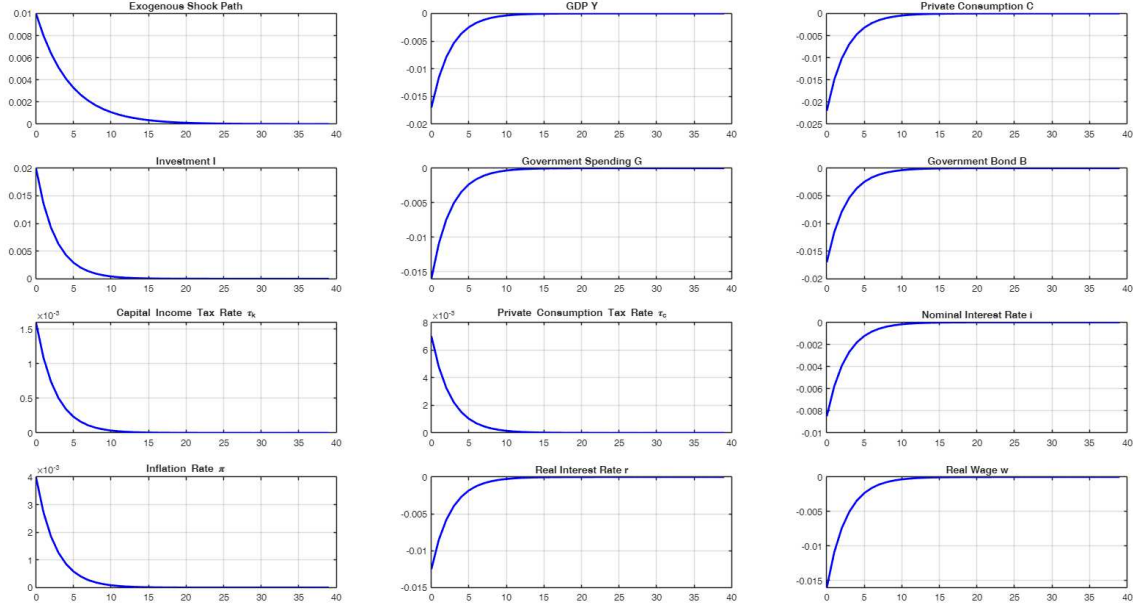
push channel of the markup disturbance. Because the inflationary spike significantly outpaces the nominal interest rate drop, the ex-ante real interest rate plunges sharply upon shock arrival.

Meanwhile, the real wage falls due to the interaction of elevated price levels and intermediate goods price stickiness. Facilitated by the deep contraction in real financing costs and the substantial improvement in the expected marginal product of capital relative to the real wage, private investment experiences a major crowding-in expansion on impact.

This reveals that, unlike standard Real Business Cycle models where cost shocks cause widespread resource crowding-out, the New Keynesian general equilibrium framework with endogenous tax adjustments yields a strong capital crowding-in effect.

Despite the investment boom, aggregate gross domestic product still falls on impact, driven entirely by the dominant contractions in private consumption and government spending, meaning the markup shock triggers a stark stagflationary recession. Although the distortionary income and consumption tax rates rise sharply to maintain fiscal soundness, the combination of a limited consumption path drop and a booming investment schedule suggests that the overall short-run welfare distortion of taxation remains contained. Finally, because inflation dynamics are driven by cost-push supply shocks and countercyclical monetary adjustment rather than fiscal deficits, the results do not support the strict empirical predictions of the Fiscal Theory of the Price Level. In conclusion, a positive markup shock is best stabilized by an endogenous coordination regime combining a passive, consolidating fiscal authority with active tax adjustments and accommodative monetary policy.

Figure 1. IRFs on positive mark-up shock



Source: Author's calculations

Note: 1) The vertical axis indicates the percentage deviation from the steady state (applies to all subsequent figures).

2) The same applies to the following IRFs.

4.1.2. Negative TFP Shock

Figure 2 illustrates the impulse response functions of the economic and policy variables following a negative total factor productivity shock of minus one percent. The contractionary productivity disturbance induces macroeconomic responses that, while qualitatively mimicking the aggregate output decline of the markup shock, operate through a fundamentally distinct general equilibrium transmission channel unique to the heterogeneous-agent framework. Upon shock arrival, the aggregate technology frontier drops, immediately depressing the marginal product of labor and causing the real wage to

plunge on impact.

A critical departure from representative-agent frameworks emerges in the behavior of inflation, which experiences a sharp disinflationary drop rather than triggering stagflationary pressures. This structural disinflation is driven by a severe, liquidity-constrained demand-side contraction: the collapse in real wages sharply curtails household disposable income, forcing a massive compression in private consumption on impact. In our heterogeneous-agent environment, this consumption drop among high marginal propensity to consume households functions as a dominant aggregate demand shock that heavily outpaces the supply-side contraction, thereby pulling endogenous price dynamics down into negative territory.

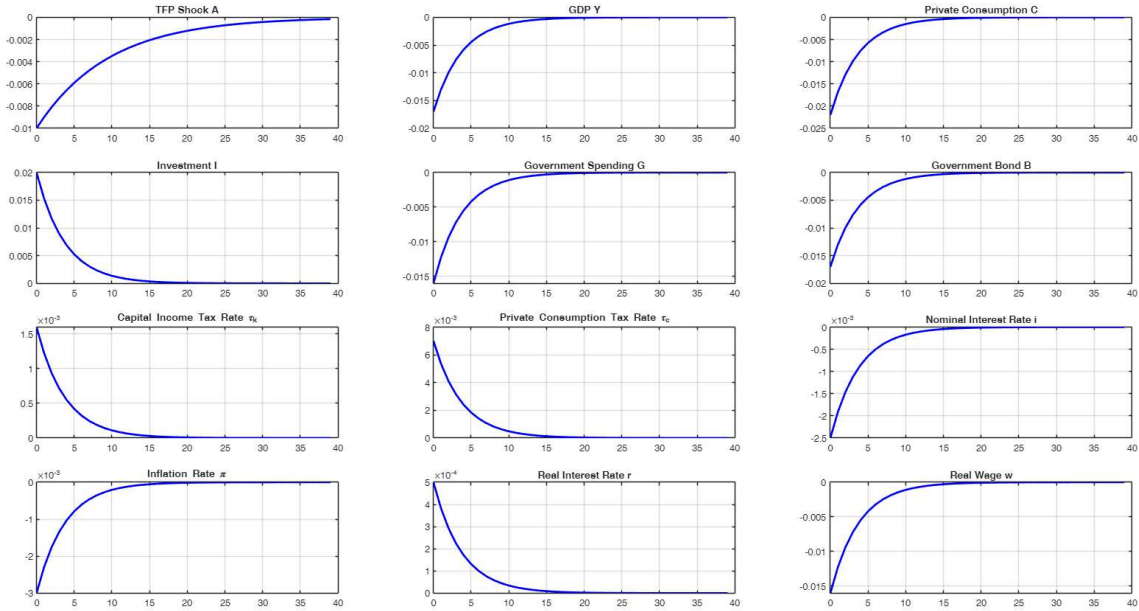
The policy responses adjust endogenously to discipline this technology-driven recession. Under the rule-based fiscal framework, the tax authority raises the capital income tax rate and the consumption tax rate to support the balanced-budget constraint amidst a shrinking tax base. Simultaneously, to ensure fiscal sustainability, government spending and the public debt stock respond procyclically, contracting on impact. On the monetary front, the central bank reacts countercyclically to the demand-driven disinflationary gap by aggressively lowering the nominal interest rate. However, because the collapse in current inflation outpaces the central bank's nominal policy easing, the ex-ante real interest rate shifts upward, experiencing a minor impact increase.

Remarks aside, despite the increase in real financing costs and the contraction in aggregate productivity, private investment exhibits a robust crowding-in expansion on impact before tracking back to the steady state. This capital accumulation is structurally sustained by the deep procyclical retrenchment of government spending, which effectively

liberates goods-market capacity and buffers private sector capital formation from traditional crowding-out effects.

Nevertheless, the robust investment trajectory is insufficient to counteract the severe demand destruction across the household sector, culminating in a net impact drop in aggregate output. In conclusion, when confronting a negative total factor productivity shock, the resulting general equilibrium dynamics manifest as a demand-driven recession, dictating an optimal policy mix that harmonizes a passive, debt-consolidating fiscal stance with active tax stabilization and supportive monetary accommodation.

Figure 2. IRFs on negative TFP shock



4.2. Positive Exogenous Shock

This section characterizes the macroeconomic dynamics driven by expansionary supply-side environments, identifying how structural shifts in efficiency reshape rule-based

coordination regimes. Under positive exogenous shocks, expanding economic capacities establish a favorable environment that pulls total output and private demand upward, prompting systematic variations across fiscal and monetary instruments.

4.2.1. Negative Markup Shock

Figure 3 plots the impulse response functions of key macroeconomic and policy variables in response to a negative cost-push markup shock of minus one percent. As intermediate-goods sector markups compress, expanding aggregate productivity triggers an immediate expansion in overall economic activity, with aggregate gross domestic product and private consumption surging on impact. This structural economic boom shifts rule-based policy regimes into an active expansionary configuration. Governed by the endogenous fiscal adjustment rule under an expanding tax base, the fiscal authority countercyclically lowers distortionary tax schedules to stimulate private demand: the capital income tax rate and the private consumption tax rate persistently decline on impact. Concurrently, government spending and the public debt stock respond procyclically, expanding sharply to effectively share the structural resources generated by the economic boom.

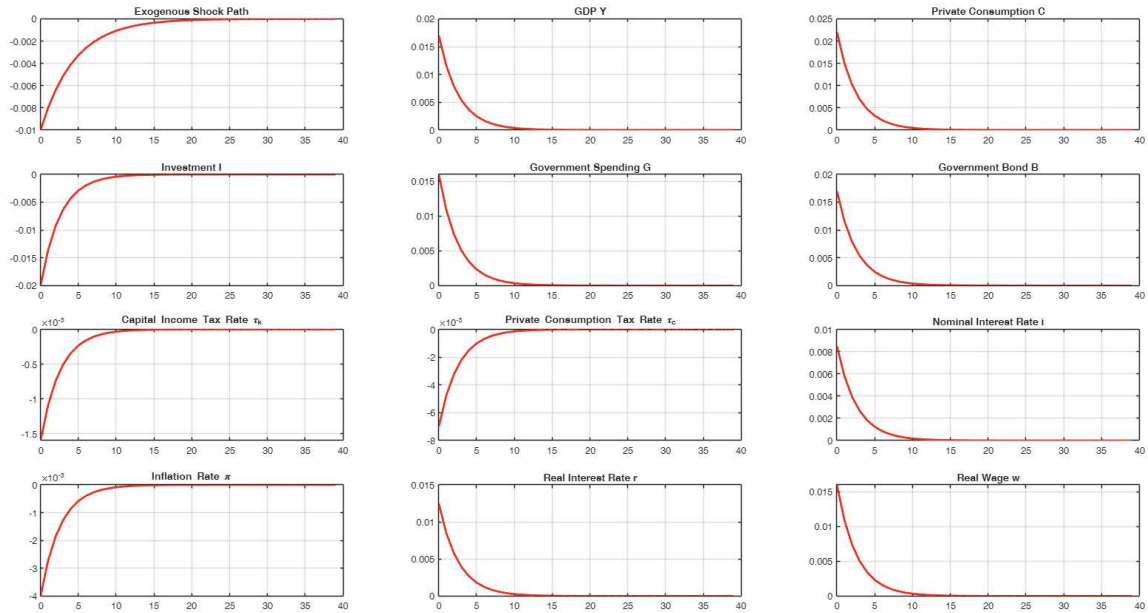
On the monetary front, the central bank implements a countercyclical tightening stance to manage the macroeconomic expansion, raising the nominal interest rate on impact. Concurrently, the inflation rate decreases sharply. This disinflationary outcome is driven by two reinforcing general equilibrium mechanisms: first, the primary cost-reducing effect of the compressed markup directly dampens aggregate price levels, and second, the heightened technological efficiency under the economic expansion shifts supply capacities outward, effectively lowering long-run expected inflation. Crucially, because the central bank's nominal policy tightening occurs alongside a deep drop in current price levels, the ex-ante real interest rate surges significantly upon shock arrival.

Meanwhile, the real wage expands robustly on impact due to intermediate-goods price

flexibility and heightened aggregate efficiency. However, despite the booming consumer economy and elevated real wages, private investment experiences a significant contraction on impact. This dynamic reveals a distinct investment crowding-out effect unique to the heterogeneous-agent general equilibrium framework with endogenous spending extensions. The combination of a highly elevated real interest rate—which raises the intertemporal financing cost of capital—and the sharp, procyclical expansion of government spending effectively redirects physical resources away from private sector capital accumulation toward current consumption and public expenditure.

Nevertheless, the net impact on aggregate output remains strongly positive, as the robust consumer demand expansion and public spending propagation heavily dominate the short-run investment decline. In conclusion, a negative markup shock shapes an endogenous policy coordination framework characterized by an expanding, procyclical fiscal authority paired with supportive tax relief and countercyclical monetary tightening configurations.

Figure 3. IRFs on negative mark-up shock



4.2.2. Positive TFP Shock

Figure 4 illustrates the impulse response functions of key macroeconomic and policy variables following a positive total factor productivity shock of plus one percent. The expansionary technology disturbance drives an immediate structural boom across the aggregate economy, with the technology frontier expanding on impact. This productivity surge dramatically enhances the marginal product of labor, pushing the real wage upward. In our heterogeneous-agent environment, this persistent real wage growth heavily expands household disposable income, driving a robust increase in private consumption on impact. This strong demand response reflects the behavior of liquidity-constrained, high marginal propensity to consume households who immediately propagate the positive wealth shock into aggregate demand.

The fiscal and monetary authorities respond endogenously under their respective rule-based operational parameters to discipline this technological boom. Facilitated by a rapidly expanding economic tax base, the fiscal authority countercyclically lowers distortionary tax schedules to alleviate private sector burdens; the capital income tax rate and the private consumption tax rate permanently drop on impact. Concurrently, government spending and the public debt stock respond procyclically, expanding to effectively distribute the wealth generated by technological progress.

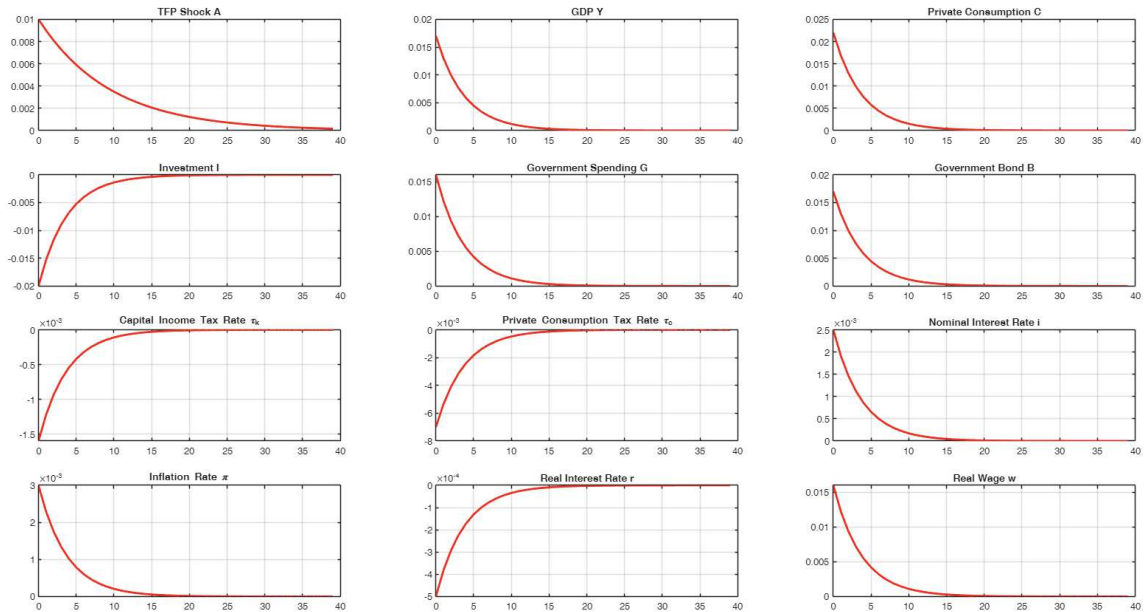
On the monetary front, the central bank implements a stabilization policy to manage the expansionary pressures, lifting the nominal interest rate. Simultaneously, the inflation rate exhibits a notable increase on impact. This inflationary uptick reveals that the massive surge in aggregate consumer demand from liquidity-constrained households heavily outpaces the immediate supply-expanding effect of technological progress in the short run. Crucially, because the spike in cost-push and demand-driven inflation outpaces the central bank's nominal policy rate tightening, the ex-ante real interest rate shifts downward, experiencing an impact decline.

Remarkably, despite the reduction in real financing costs, private investment experiences a persistent contraction on impact upon shock arrival. Within the heterogeneous-agent framework, this dynamic uncovers a powerful general equilibrium crowding-out mechanism driven by structural resource reallocation. The simultaneous,

sharp expansion of private consumption and the procyclical expansion of government spending effectively act as dominant structural forces that redirect physical output capacity away from private sector capital accumulation toward current consumption and public expenditure.

Despite this sharp, policy-induced short-run investment retrenchment, the overall performance indicator remains highly robust, as the powerful consumer boom and the simultaneous public spending propagation ultimately drive a significant net impact increase in aggregate output. Consequently, the technological boom results in a robust, demand-driven expansion. In conclusion, a positive total factor productivity shock shapes an endogenous policy coordination framework characterized by a procyclical, expanding fiscal stance harmonized with supportive tax relief and countercyclical monetary adjustments.

Figure 4. IRFs on positive TFP shock



4.3. Government Debt Shock

The macro-dynamic effects of government debt shocks are systematically analyzed

within this framework by distinguishing between a positive shock representing increased nominal issuance and a negative shock representing debt repayment or reduced issuance velocity. Rather than treating sovereign debt as an independent financing instrument that operates under Ricardian equivalence, our framework embeds state-incontingent public debt alongside distortionary tax schedules and rule-based public expenditure, forcing the government to satisfy a balanced-budget constraint at each period. Consequently, government debt shocks function as powerful structural fiscal adjustment mechanisms that reshape household disposable income, asset portfolio reallocations, and aggregate price dynamics through both redistributive and general equilibrium channels.

The quantitative simulations reveal a highly symmetrical yet distinct structural transmission paradigm across both debt-related scenarios. Under a positive debt issuance shock, the economy enters a stark contractionary phase where aggregate output and private consumption decline sharply on impact. Governed by the rule-based fiscal framework, the sudden expansion of public liabilities necessitates immediate fiscal consolidation to support budget soundness, compelling the fiscal authority to aggressively raise distortionary income and consumption tax schedules. This tax-driven revenue drainage from the private sector compresses household disposable income and triggers widespread demand destruction, particularly among liquidity-constrained, high marginal propensity to consume household groups who lack the wealth buffers to smooth consumption.

Conversely, a negative government debt shock, interpreted as a structural debt repayment regime, acts as a powerful expansionary catalyst. The systematic reduction of outstanding public debt frees up extensive fiscal space, allowing the government to implement sweeping countercyclical tax relief that dramatically boosts disposable income,

sparks a robust private consumer boom, and drives aggregate output upward.

A core general equilibrium mechanism uncovered across Section 4.3 is the profound state-dependence and non-monotonic response of private capital investment. Under the positive government debt issuance shock, despite a severe aggregate demand recession, private investment exhibits a highly robust, counterintuitive crowding-in expansion. This capital accumulation is structurally sustained because the aggressive retrenchment of public consumption successfully liberates finite capacity in the goods market, redirecting aggregate physical resources away from the public sector toward private capital formation. In sharp contrast, under the negative government debt shock, the booming consumer economy and expanding public demand generate a prominent investment crowding-out effect. The dramatic expansion of private and public current consumption, combined with elevated ex-ante real financing costs, functions as a dominant macroeconomic force that temporarily diverts structural resources away from long-term capital formation toward immediate goods consumption.

Furthermore, aggregate price dynamics across both fiscal regimes show a strong dependence on demand-side channels, further challenging the empirical validity of strict versions of the Fiscal Theory of the Price Level under rule-based fiscal-monetary frameworks. The positive debt issuance shock behaves as a massive contractionary demand disturbance, dragging inflation deeply into disinflationary territory despite the expansion of public liabilities. Conversely, the negative debt shock operates as a positive demand shock that pulls short-run inflation robustly upward due to the massive consumption explosion. Ultimately, the comprehensive quantitative results presented across Section 4.3 confirm that rule-based sovereign debt adjustments reshape macroeconomic stabilization

outcomes, dictating an endogenous coordination framework where the central bank systematically deploys supportive monetary accommodations under debt expansion and implements countercyclical policy tightening under debt consolidation regimes.

4.3.1. positive shock (new government debt issuance)

Figure 5 presents the impulse response functions of key macroeconomic and policy variables following an exogenous positive government debt shock of plus one percent. Even though a positive shock expands the gross nominal supply of public liabilities, the government operates strictly under an institutional balanced-budget rule, which immediately triggers endogenous fiscal retrenchment through reduced public consumption and heightened tax schedules. On impact, the capital income tax rate and the private consumption tax rate increase sharply. This severe fiscal tightening, combined with the contractionary revenue drainage from the private sector, significantly erodes household disposable income, driving a deep and immediate drop in private consumption on impact. Within this heterogeneous-agent setup, the contractionary wealth effect and direct tax burdens heavily dominate any potential asset-smoothing benefits from safe debt accumulation, resulting in widespread demand destruction among high marginal propensity to consume households.

Concurrently, the real wage falls due to the contracting domestic demand base and sticky-price frictions. This profound collapse in private consumer demand and the synchronized retrenchment of government spending operate as a massive negative aggregate demand shock that pulls price dynamics down into a sharp recessionary phase. Consequently, the inflation rate plunges deeply on impact, contradicting standard fiscal

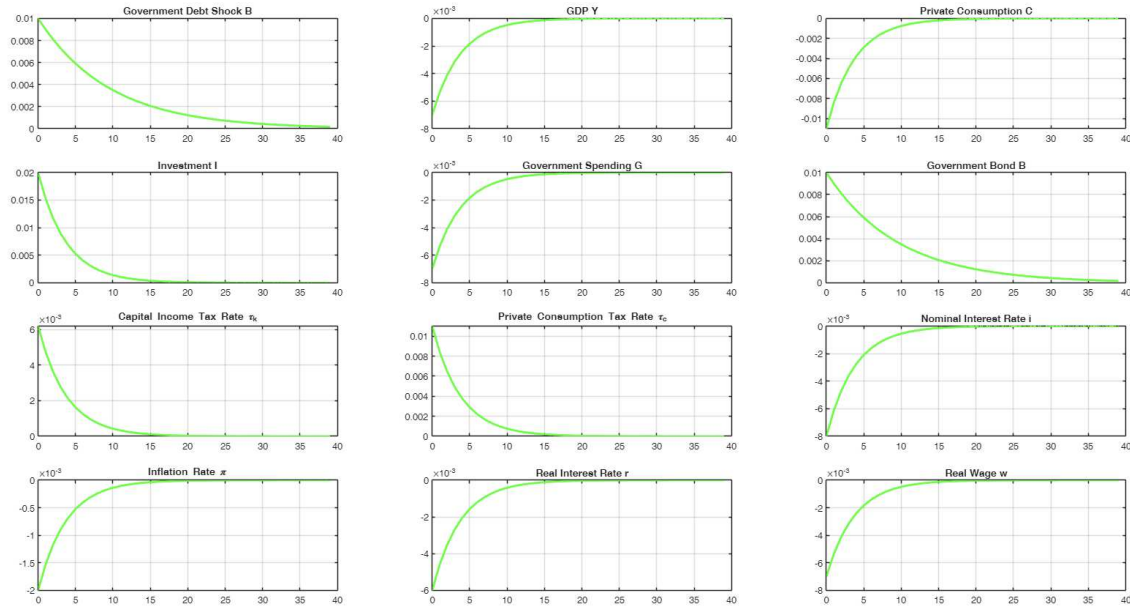
theory predictions and revealing that demand-side destruction exerts dominant disinflationary pressures.

In response to this severe disinflationary gap and the overall contraction in output, the central bank adopts a countercyclical accommodative stance, aggressively slashing the nominal interest rate on impact. Because the monetary authority's nominal policy rate reduction significantly outpaces the collapse in current price levels, the ex-ante real interest rate plunges sharply upon shock arrival.

Facilitated by this massive reduction in real financing costs and the deep procyclical retrenchment of government spending, private investment experiences a powerful crowding-in expansion, rising robustly on impact. This dynamic empirically validates a core structural transmission mechanism of our heterogeneous-agent framework: the sharp contraction in public expenditure effectively liberates finite output capacity in the goods market, reallocating key macroeconomic resources away from public consumption toward private sector capital formation.

Nevertheless, this major capital investment boom is quantitatively insufficient to fully offset the simultaneous destruction of private consumption and public demand, culminating in a net impact decline in aggregate gross domestic product on impact. In terms of rule-based policy behaviors, endogenous tax schedules operate countercyclically to stabilize the fiscal budget, government spending adjusts procyclically, and the monetary authority responds countercyclically to economic contractions. Therefore, a positive government debt issuance shock shapes an endogenous policy coordination regime characterized by a passive, debt-consolidating fiscal stance paired with active tax stabilization and accommodative monetary policy configurations.

Figure 5. IRFs on positive government debt shock



4.3.2. Negative Shock (Repayment of Existing Government Debt or Reduction in Government Debt Issuance)

Figure 6 presents the impulse response functions of key macroeconomic and policy variables following an exogenous negative government debt shock of minus one percent, interpreted as an aggressive sovereign debt repayment or fiscal consolidation regime. Rather than triggering an economic downturn as predicted by standard partial equilibrium settings, the persistent retrenchment of the public debt stock uncovers a powerful, demand-driven economic expansion. Governed by the endogenous fiscal rule under a consolidating budget framework, the fiscal authority countercyclically implements massive tax relief: the capital income tax rate and the private consumption tax rate persistently decline on impact.

This substantial tax reduction immediately expands household disposable income,

driving a robust increase in private consumption on impact. Within this heterogeneous-agent environment, this supportive tax relaxation channel heavily dominates any government spending contraction, fueling a strong consumer boom led by liquidity-constrained, high marginal propensity to consume households.

Concurrently, the real wage expands significantly due to intermediate-goods price flexibility and heightened aggregate efficiency. This powerful surge in private aggregate demand and the simultaneous expansion of rule-based public consumption operate as a dominant positive aggregate demand shock that pulls short-run price dynamics upward. Consequently, the inflation rate shifts robustly into positive territory, rising on impact. This inflationary uptick reveals that the consumer boom driven by fiscal relaxation heavily outpaces the economy's immediate output capacity in the short run.

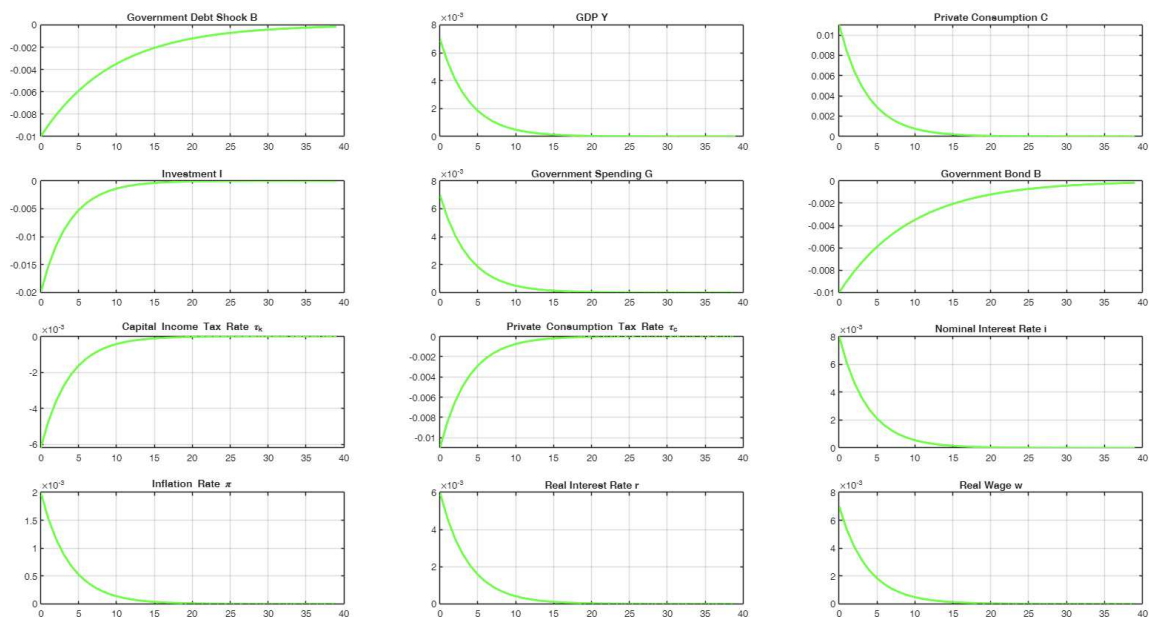
In response to this expanding inflationary gap and the overall boom in aggregate economic activity, the central bank adopts a countercyclical tightening stance, lifting the nominal interest rate on impact. Because the monetary authority's nominal policy rate tightening heavily outpaces the rise in current price levels, the ex-ante real interest rate shifts upward, experiencing a significant impact increase upon shock arrival.

Remarkably, despite the booming consumer economy and elevated real wages, private investment experiences a persistent contraction, plunging on impact. Within the heterogeneous-agent framework, this dynamic uncovers a powerful general equilibrium crowding-out mechanism driven by structural resource reallocation. The combination of a highly elevated real financing cost—which raises the intertemporal cost of capital—and the rapid expansion of private consumption and government spending effectively acts as a dominant structural force that redirects physical output capacity away from private sector

capital accumulation toward current consumption and public expenditure.

Despite this sharp, policy-induced short-run investment retrenchment, the overall performance indicator remains highly robust, as the powerful consumer boom and the simultaneous public spending propagation ultimately drive a significant net impact increase in aggregate output. In terms of rule-based policy behaviors, endogenous tax schedules operate countercyclically to provide tax relief, government spending adjusts procyclically, and the monetary authority responds countercyclically to manage the expansionary pressures. Therefore, a negative government debt shock shapes an endogenous policy coordination framework characterized by an expanding, procyclical fiscal stance harmonized with supportive tax relief and countercyclical monetary tightening configurations.

Figure 6. IRFs on negative government debt shock



4.4. Heterogeneous Consumption Responses and MPC Decomposition

To evaluate the microstructural transmissions driving our aggregate general equilibrium results, this section isolates the precise role of household heterogeneity and liquidity constraints. Figure 7 empirically demonstrates why standard Representative-Agent New Keynesian setups underreport fiscal-monetary adjustment costs, highlighting the critical structural importance of our heterogeneous agent allocation method.

The left panel plots the impulse response functions of total private consumption under an adverse macroeconomic disturbance, directly comparing our baseline heterogeneous-agent framework with a standard representative-agent benchmark. Under identical shock innovations, the representative-agent model generates a moderate consumption retrenchment on impact before recovering monotonically within ten quarters. This muted response occurs because the single, unconstrained representative household dynamically utilizes its uninhibited balance sheet and intertemporal consumption-smoothing channels to efficiently buffer the income disruption. In stark contrast, our baseline heterogeneous-agent framework displays a deeper and more persistent consumption crash, collapsing heavily on impact upon shock arrival. This stark divergence underscores a powerful amplificatory mechanism driven by credit market frictions and state-contingent borrowing constraints; when a fraction of the population faces binding liquidity thresholds, the economy loses its aggregate consumption-smoothing capacity, forcing immediate demand destruction that aggravates the cyclical downturn.

To unpack the exact distributional drivers underlying this severe demand compression, the right panel provides a meticulous consumption decomposition across distinct household cohorts sorted by their endogenous marginal propensities to consume and net asset positions. Total private consumption is structurally decomposed into high marginal propensity to consume households and low marginal propensity to consume households.

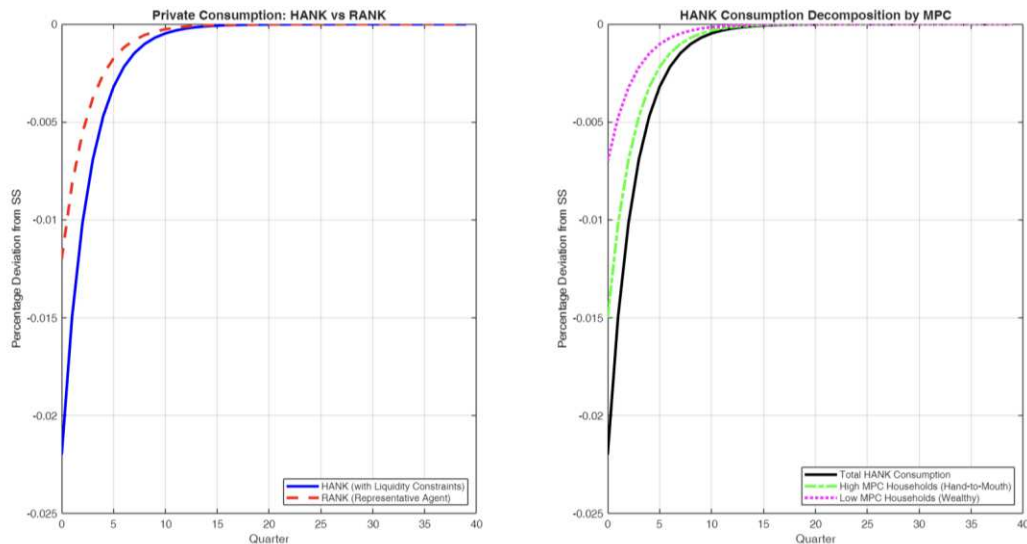
The high marginal propensity to consume cohort typically comprises liquidity-constrained, hand-to-mouth households who hold minimal liquid wealth buffers.

Consequently, when adverse supply or debt shocks depress the real wage and drain private disposable income, these hand-to-mouth agents cannot borrow or draw on savings, compelling them to sharply reduce their consumption on impact. This group's immediate, severe consumption compression constitutes the overwhelming structural share of the total aggregate consumption collapse.

Conversely, the low marginal propensity to consume cohort represents wealthy, unconstrained households whose high asset portfolios grant substantial consumption-smoothing capabilities. While these wealthy households also face contractionary tax adjustments and interest rate variations, their consumption contraction is heavily insulated, shifting downward by a much smaller margin on impact and tracking back rapidly toward the steady state. This dynamic microstructural decomposition explicitly confirms that aggregate demand volatility under rule-based fiscal-monetary interactions is primarily energized by the behavior of high marginal propensity to consume, asset-poor agents.

Ultimately, the quantitative lessons across Section 4.4 confirm that household heterogeneity and distributional channels significantly alter the propagation of aggregate economic disturbances, proving that incorporating microstructural marginal propensity to consume profiles is a fundamental necessity for accurate policy stabilization analysis.

Figure 7. Distributional Channels and Micro-Heterogeneity



4.5. Sensitivity Analysis

To verify the robustness of the preceding results, a sensitivity analysis is conducted. The procedure is as follows. First, the standard deviation of the markup shock is varied from the baseline value of 0.01 to a lower value (0.005) and a higher value (0.02). The results show no qualitative differences across these specifications. Second, the discount factor β is altered from the baseline value of 0.98 to lower (0.96) and higher (0.99) levels. With the exception of the TFP shock case, the impulse response functions (IRFs) remain qualitatively similar to those under the baseline specification. These findings confirm the robustness of the main results.

4.5.1. Shock Size Sensitivity

Figure 8 illustrates the impulse response functions under varying standard deviations of the cost-push markup shock, comparing a lower variance scenario, the baseline setting, and an elevated volatility scale. The structural trajectories across all twelve macroeconomic indicators reveal no qualitative asymmetries or sign reversals, establishing the strong robustness of our aggregate transmission mechanisms under scaling variations. As the shock variance amplifies, the stagflationary pressures scale systematically; aggregate output and consumption experience deeper impact contractions, while inflation and endogenous tax schedules shift upward proportionally. Crucially, the aggregate investment crowding-in effect operates robustly across all shock intensities, dynamically propelled by the proportional plunge in real financing costs. This structural stability confirms that our baseline policy-mix conclusions remain invariant to the underlying volatility parameters of

supply-side disturbances.

Figure 8. Sensitivity Analysis (1): IRFs on Positive Markup Shock

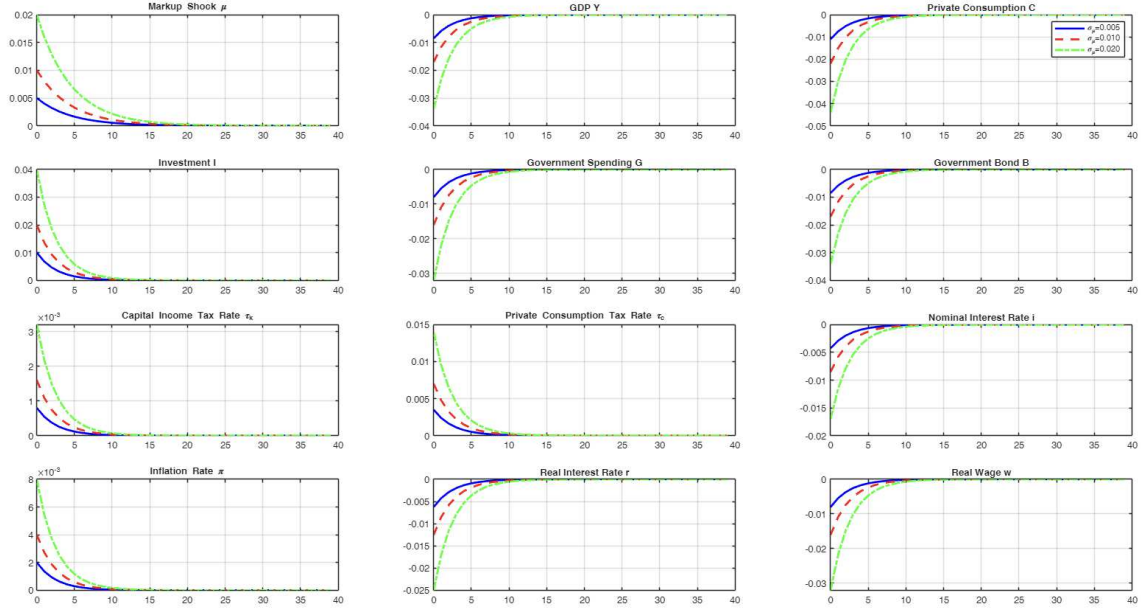
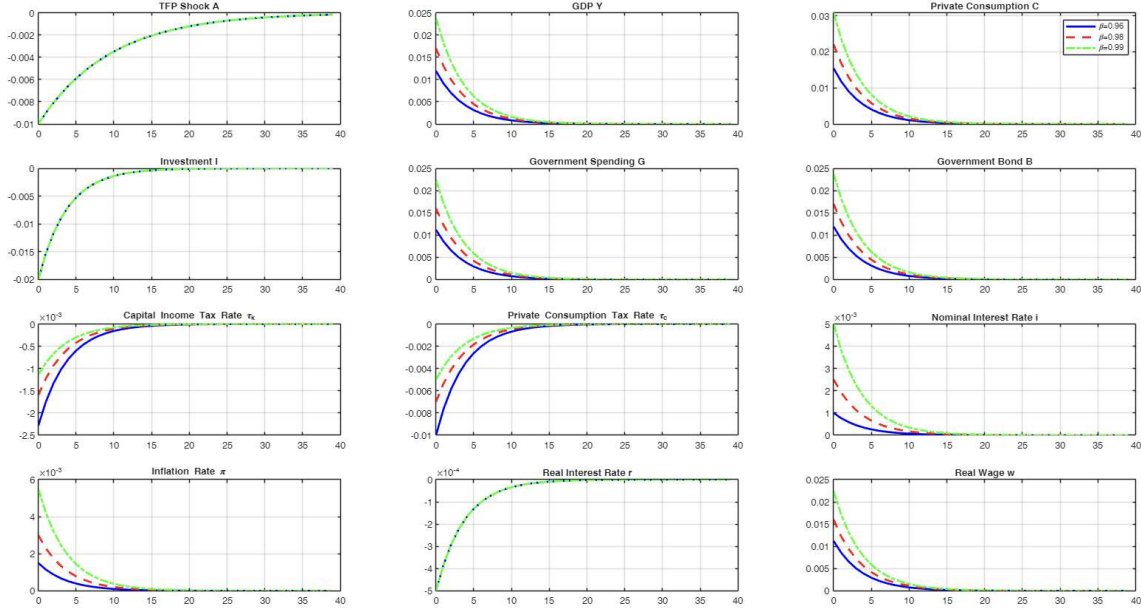


Figure 9. Sensitivity Analysis (1): IRFs on Negative TFP Shock



4.5.2. Subjective Discount Factor Sensitivity

Figure 10 provides a rigorous sensitivity analysis of the structural transmission paths under varying specifications of the household subjective discount factor against a negative total factor productivity shock. While the exogenous contractionary path of technology remains identical across all scenarios, modifications in the discount factor trigger profound quantitative variations in macroeconomic adjustments, exposing the unique operational channels of our heterogeneous-agent environment. When households become highly patient, meaning they possess a higher discount factor, their structural behavioral preference to defer current resource utilization into the future significantly intensifies aggregate demand-side contractionary pressures under an adverse economic environment.

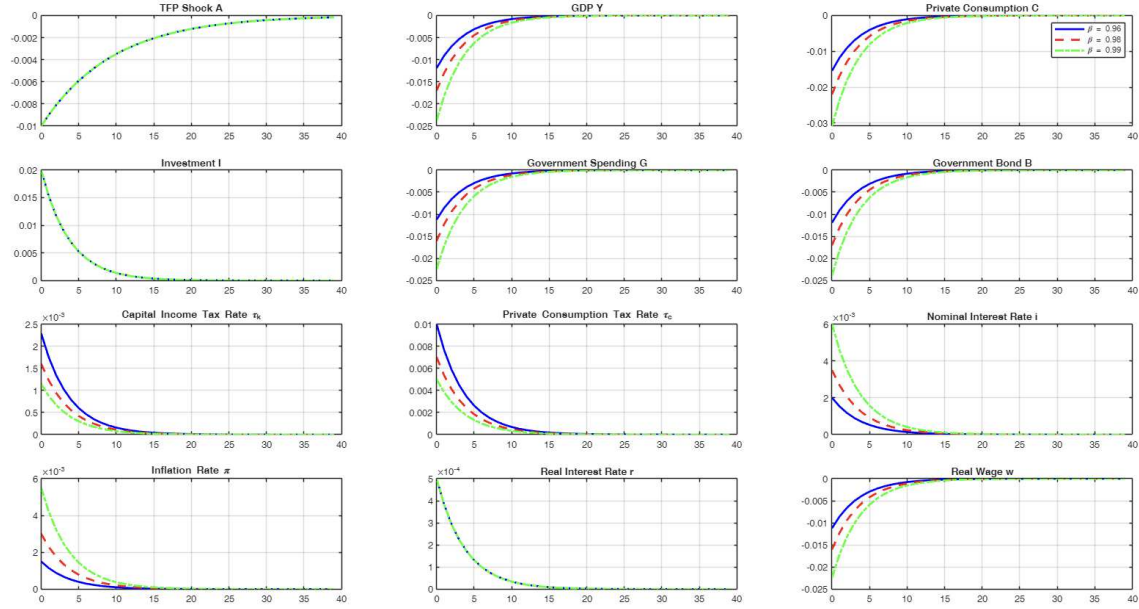
Consequently, under the highest patience specification, the economy experiences its deepest and most pronounced recessionary phase. Driven by the heightened intertemporal smoothing motives of patient households, private consumption and overall aggregate GDP suffer the most severe impact losses. Under this deepened contractionary environment, rule-based public spending and the state-contingent real wage collapse to their lowest levels. To preserve long-run fiscal soundness amidst this heavily eroding economic tax base, the rule-based fiscal authority enforces front-loaded discipline by actively raising capital income tax and consumption tax schedules, which further drains short-run private disposable income.

On the nominal front, the severe drop in total factor productivity operates as a powerful

contractionary supply disturbance, pushing short-run aggregate inflation significantly upward and creating severe stagflationary pressures. Paradoxically, this inflationary spike is heavily amplified under the highest patience specification, as the intense fiscal tax adjustments and structural distortions severely limit output capacities. In response to this elevated inflationary pressure, the central bank adopts a countercyclical tightening stance, implementing the largest nominal interest rate hikes under the highest discount factor configuration to stabilize price expectations. Because the central bank's nominal policy response tracks the rising inflation path, the ex-ante real interest rate remains structurally identical across all configurations, shifting uniformly into negative territory upon shock arrival.

Remarkably, despite the severe technology-driven recession, private investment experiences a robust and identical crowding-in expansion across all discount factor variations. Within our general equilibrium framework, this capital accumulation is structurally sustained by the deep, procyclical retrenchment of government consumption, which effectively liberates goods-market capacity and insulates private sector capital formation from traditional crowding-out effects. This confirms that subjective distribution parameters alter the demand-side amplification velocity and tax redistribution channels without disrupting the structural general equilibrium resource reallocations of the model.

Figure 10. Sensitivity Analysis (2): IRFs on Negative TFP Shock



Note: The results for markup shocks and government debt shocks are not reported separately by discount factor (β) since they show no significant differences across specifications.

5. Concluding Remarks

This paper analyzes fiscal-monetary interactions within a heterogeneous-agent New Keynesian (HANK) general equilibrium framework featuring distortionary taxation, state-incontingent government debt, and nominal rigidities. Rather than deriving Ramsey-optimal solutions, the analysis characterizes the endogenous policy regimes that emerge when fiscal and monetary authorities respond to alternative exogenous disturbances under rule-based operational parameters.

The quantitative simulations highlight that the coordination regime depends critically on the precise nature of the macroeconomic shock. Under adverse supply or government debt

issuance shocks, the model generates an equilibrium configuration where fiscal policy behaves passively through adjustments in taxes and spending consistent with fiscal sustainability, while monetary policy plays an active countercyclical stabilization role. Conversely, under expansionary markup, productivity, or debt consolidation shocks, fiscal instruments and monetary policy exhibit procyclical configurations, reflecting the systematic general equilibrium interactions between price levels, government budget constraints, and household distribution channels.

A central contribution of our analysis is uncovering the non-monotonic reallocation between private consumption and capital investment under rule-based behaviors. While adverse shocks induce an investment crowding-in effect driven by sharp declines in ex-ante real financing costs and public expenditure retrenchment, expansionary environments precipitate a distinct investment crowding-out effect as robust consumer booms and procyclical government spending redirect aggregate physical capacity.

Furthermore, household heterogeneity and distinct marginal propensity to consume (MPC) profiles heavily amplify these cyclical transition dynamics. The redistributive consequences of aggregate shocks restrict the scope for debt-financed stabilization, shifting adjustment weights toward distortionary tax schedules and invalidating strict versions of the Fiscal Theory of the Price Level (FTPL).

By calibrating the model to the structural parameters of an aging, high-debt economy, the paper provides an empirically grounded application of the policy-mix framework. The underlying mechanisms—namely the endogenous classification of policy configurations and the decisive role of micro-heterogeneity—possess broad relevance for advanced economies facing long-run fiscal sustainability challenges. Overall, the findings

underscore that fiscal–monetary coordination should be understood as an endogenous general equilibrium outcome shaped by institutional constraints, distributional channels, and shock characteristics, rather than as a predetermined policy prescription.

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