Optimal monetary and fiscal policy without fiscal backing for the central bank

Masayuki Okada

Introduction

- The Fed runs a large loss by paying interest on reserves after 2022.
  - Expenditure = Interest rate (5p.p.) * Reserve (15% of GDP)
  - Fed's loss / Treasury's tax revenue (2022 Q4 – 2024 Q3) = 2.5%
- The Fed transferred all profits to the Treasury before 2022.
- The Treasury does not offset the Fed's losses now.
- However, conventional macroeconomic models assume a consolidated government budget (Sargent and Wallace 1981).

Research Question

Do the **unconsolidated government budgets** change monetary-fiscal policy?

Treasury cannot provide the **optimal fiscal support** to the central bank.

What I do

Optimal monetary and fiscal Policy without commitment

The decision-making problem for the government.

- Maximize the household utility subject to the equilibrium conditions.
    1. NK model with two interest-bearing liabilities, reserves and Government bonds.
    2. Constraint an optimal resource allocation from Treasury to the central bank.

What I find

1. Study the inflationary episode after 2022 and negative productivity shock.

   Question.

   How does the impulse responses change when the central bank lacks fiscal backing?

   Answer.

   The central bank without fiscal backing tolerates higher inflation.

   The key is the large reserves as an initial condition.

What I find

1. Study the inflationary episode after 2022 and negative productivity shock.
2. Quantitatively characterize the dynamic property of the optimal policy.

Question.

Does the lack of fiscal support make the optimal monetary-fiscal policy volatile?

Answer.

Inflation is more volatile by 3% without the fiscal backing.

Tax is more volatile for productivity and government expenditure shocks, but less for cost-push.

What I find

1. Study the inflationary episode after 2022 and negative productivity shock.
2. Quantitatively characterize the dynamic property of the optimal policy.
3. **Question**

   From a normative point, should the Treasury support the central bank?

   Answer.

   The welfare gain of fiscal backing is small in the typical business cycle.

   <0.01% in consumption equivalence

   The key is 1.“typical” business cycle VS. Large reserves as an initial condition.

   2. Stochastic steady-state VS Dynamics.

Model

Environment

- **Time.** Discrete, Infinite horizon.

- **Agents**

Household consumes, works, and trades reserves and government bonds. Appreciate reserves and bonds as a liquidity value.

Producers are the simple New-Keynesian style.

Treasury provides public expenditure. Finance by distortionary sales tax, government bonds, and remittance from the central bank.

Central bank provides reserves. Purchases government bonds to stabilize net worth.

- **Market.** Reserves and government bonds are traded. They differ in duration and liquidity value.

Household

$$\max_{C_t, N_t(j), B_t^H, D_t^H} \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{1}{1+\nu} N_t^{1+\nu} + \frac{\chi_1}{1-\gamma_1} (Q_t^d D_t^H)^{1-\gamma_1} + \frac{\chi_2}{1-\gamma_2} (Q_t^b B_t^H)^{1-\gamma_2} \right]$$

s.t.

$$P_t C_t + Q_t^d D_t^H + Q_t^b B_t^H = D_{t-1}^H + (1 + \rho^T Q_t^b) B_{t-1}^H + P_t w_t \int_0^1 N_t(j) dj + P_t \Phi_t,$$

- D_t^H is **reserves** directly held by the household and issued by the central bank.
- B_t^H is a long-duration government bond. Duration is given by ρ^T.
- Φ is the firm's profit.

Firms

- Standard set up of the adjustment cost model.

$$\max_{p_t(i)} \quad E_t \sum_{T=t}^{\infty} \beta^T \Lambda_t \left(\underbrace{(1-\tau_t)}_{\text{Sales tax}} p_t(i) y_t(i) - \underbrace{\mu_t^w}_{\substack{\text{Exogenous} \\ \text{Cost-push shock}}} w_t N_t(i) - P_t \frac{\varphi}{2} \left(\frac{p_t(i)}{p_{t-1}(i)} - 1 \right)^2 Y_t \right)$$

$$\text{Production function} \quad y_t(i) = \underbrace{A_t}_{\substack{\text{Exogenous} \\ \text{Productivity}}} N_t(i)$$

Government

- Treasury's budget

Remittance from CB

$$Q_t^b B_t^T + P_t \tau_t Y_t + \overbrace{P_t H_t} = (1 + \rho^T Q_t^b) B_{t-1}^T + P_t G_t$$

B^T is the total supply of government bonds. The government expenditure, G_t, is exogenous.

- Central bank's budget

Remittance to Treasury

$$Q_t^d D_t^C + (1 + \rho^T Q_t^b) B_{t-1}^C = D_{t-1}^C + Q_t^b B_t^C + \overbrace{P_t H_t}$$

D^C is reserves. B^C is a Treasury's bond held by the central bank.

$$B_t^C = \alpha B_t^T$$

- **Inequality constraint on the remittance**

$$H_t \geq H^*$$

Equilibrium

- Market Clearing Condition

$$\begin{aligned}
\text{(Goods)} \quad & Y_t = C_t + G_t + \frac{\varphi}{2}\left(\pi_t - 1\right)^2 Y_t \\
\text{(Reserves)} \quad & D_t^H = D_t^C \\
\text{(Government bonds)} \quad & B_t^H + B_t^C = B_t^T
\end{aligned}$$

Optimal Policy (Discretion) - Unconsolidated Budgets

$$max \quad E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{1}{1+\nu} N_t^{1+\nu} + \frac{\chi_1}{1-\gamma_1} (Q_t^C b_t^C)^{1-\gamma_1} + \frac{\chi_2}{1-\gamma_2} ((1-\alpha) Q_t^T b_t^T)^{1-\gamma_2} \right]$$

Choice

C_t, N_t, π_t, Sales Tax
Two liabilities
Prices of liabilities
Remittance

Euler Equations

NKPC

Market Clearing

Treasury

$$Q_t^b B_t^T + P_t \tau_t Y_t + P_t H_t = (1 + \rho^T Q_t^b) B_{t-1}^T + P_t G_t.$$

CB

$$Q_t^d D_t^C + (1 + \rho^T Q_t^b) B_{t-1}^C = D_{t-1}^C + Q_t^b B_t^C + P_t H_t$$

Remittance

$$H_t \geq H^*$$

Optimal Policy (Discretion) - Unconsolidated Budgets

$$max \quad E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{1}{1+\nu} N_t^{1+\nu} + \frac{\chi_1}{1-\gamma_1} (Q_t^C b_t^C)^{1-\gamma_1} + \frac{\chi_2}{1-\gamma_2} ((1-\alpha) Q_t^T b_t^T)^{1-\gamma_2} \right]$$

Choice

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Market Clearing

Treasury

$$Q_t^b B_t^T + P_t \tau_t Y_t + P_t H_t = (1 + \rho^T Q_t^b) B_{t-1}^T + P_t G_t.$$

CB

$$Q_t^d D_t^C + (1 + \rho^T Q_t^b) B_{t-1}^C = D_{t-1}^C + Q_t^b B_t^C + P_t H_t$$

Remittance

$$H_t \geq H^*$$

Optimal resource allocation through remittance

For CB, Reduce abundant reserves & Increase scarce reserves.
For Treasury, help tax smoothing.

Optimal Policy (Discretion) - Consolidated Budgets

$$max \quad E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{1}{1+\nu} N_t^{1+\nu} + \frac{\chi_1}{1-\gamma_1} (Q_t^C b_t^C)^{1-\gamma_1} + \frac{\chi_2}{1-\gamma_2} ((1-\alpha) Q_t^T b_t^T)^{1-\gamma_2} \right]$$

Choice

C_t, N_t, π_t, Sales Tax
Two liabilities
Prices of liabilities
Remittance

Euler Equations

NKPC

Market Clearing

Consolidated Government

$$Q_t^d D_t^C + Q_t^b (1-\alpha) B_t^T + \tau_t P_t Y_t = D_{t-1}^C + (1 + \rho^T Q_t^b)(1-\alpha) B_{t-1}^T + P_t G_t.$$

Solution

- **Discretion**. Markov-perfect equilibrium.
- State variables … Shock, reserves, Treasury bond
- Shock… Cost-push, productivity, and government expenditure.
  - Include one shock and exclude the other two.
- **Globally** solve the model.
  - Occasionally binding constraints, $H_t \geq H^*$.
  - The steady state is a priori unknown (The stead state depends on $\frac{\partial\ Expectations}{\partial\ state\ variables}$).

Calibration

Variable	Value	Description	Target	Model	Data
β	0.995	Discount factor	-	-	-
σ	2	Risk aversion	-	-	-
ν	7	Frisch Elasticity	Frisch Elasticity	1/7	-
θ	10	Elasticity of substitution among goods	Mark up	7%	-
φ	100	Price adjustment cost	Slope of NKPC	0.05	-
ρ^T	0.9	Duration of Treasury	Average Maturity	10 quarters	32 quarters
χ_1	0.0002	Utility from reserves	Steady-state reserves	15% of GDP	15% of GDP
χ_2	0.0015	Utility from Treasury bond	Steady state Treasury	30% of GDP	80% of GDP
γ_1	2	Curvature of utility from reserves	$\frac{\partial Q^d}{\partial d}$	0.2	0.05~0.2
γ_2	2	Curvature of utility from Treasury	$\frac{\partial Q^b}{\partial b}$	0.2	0.2~0.5
α	0.4	CB's asset holding	CB's Net worth	1	1
H^*	-0.01	Lower bound on remittance	-	-1% of GDP	-

Standard NK

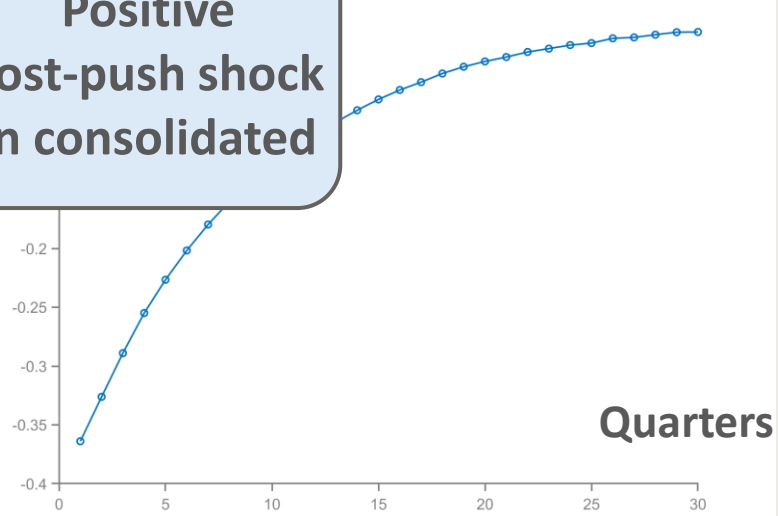
Results

Simulation

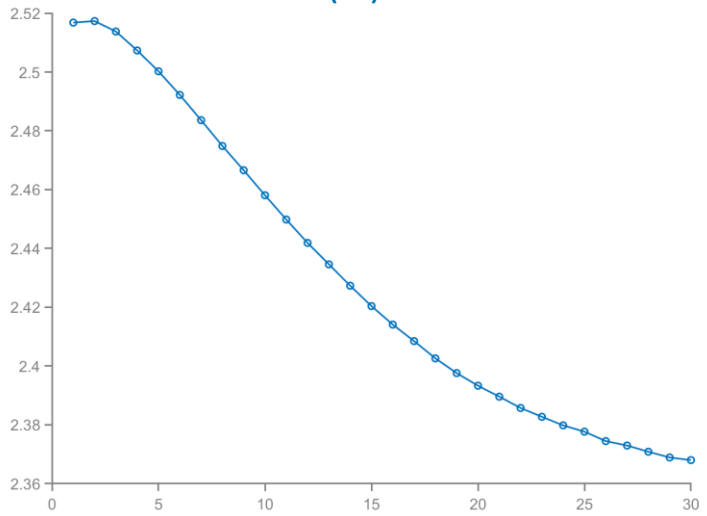
- The initial state variables are large reserves (90^{th} percentile of simulated reserves).
- The size of the shock is small (-0.3% of output decline and 0.2% of inflation increase).
  - I do not finish solving the model with large shock.

Positive cost-push shock in consolidated

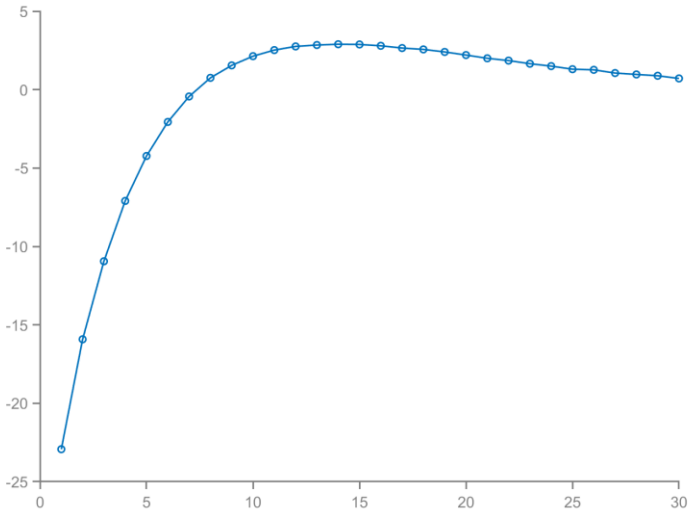
Consumption
(SS deviation in %)



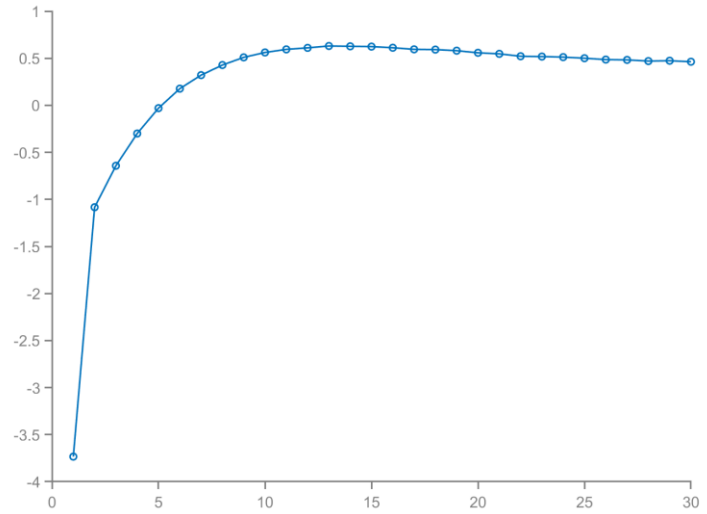
Inflation
(%)



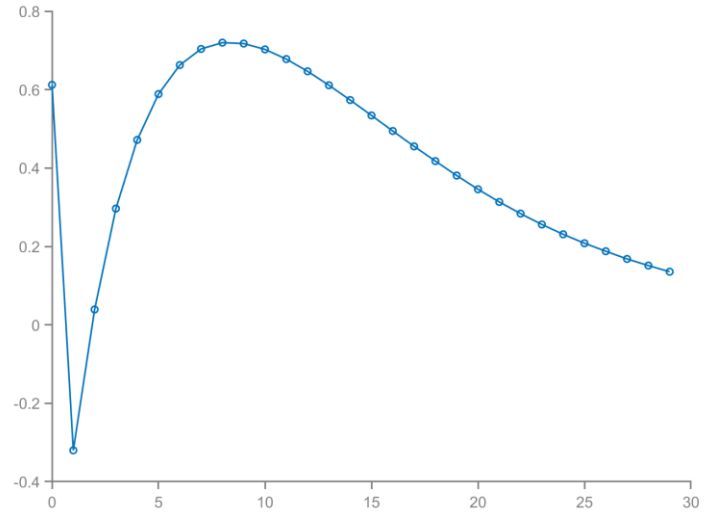
Tax rate
(SS deviation in %)



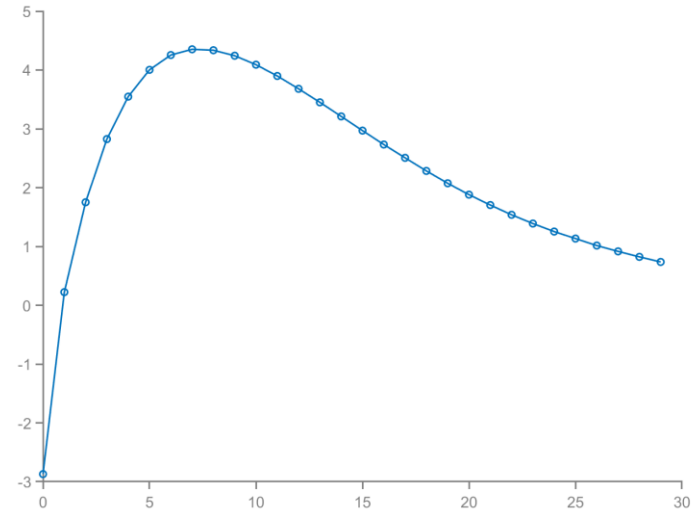
Remittance
(Ratio to GPD in %)



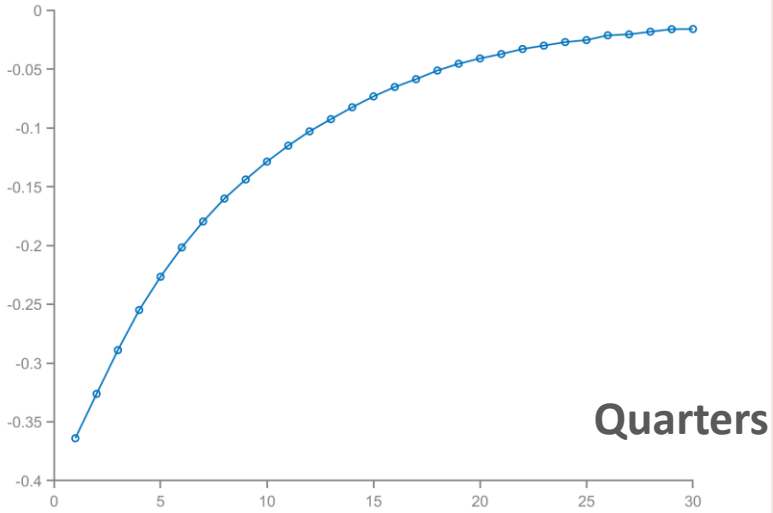
Reserves
(SS deviation in %)



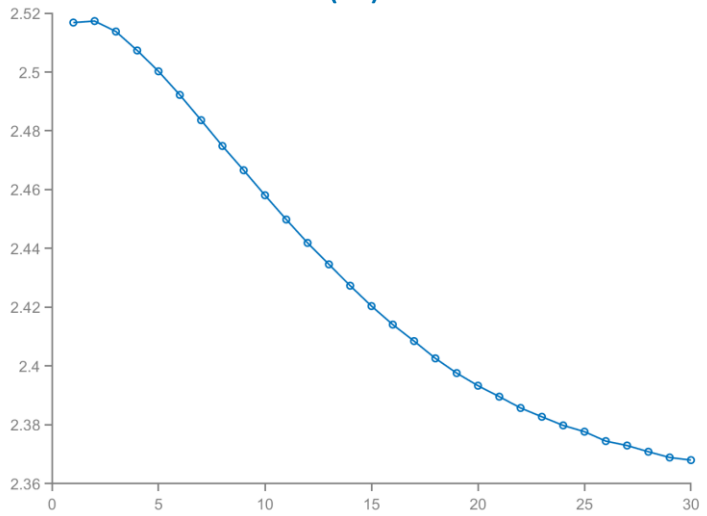
Treasury liability
(SS deviation in %)



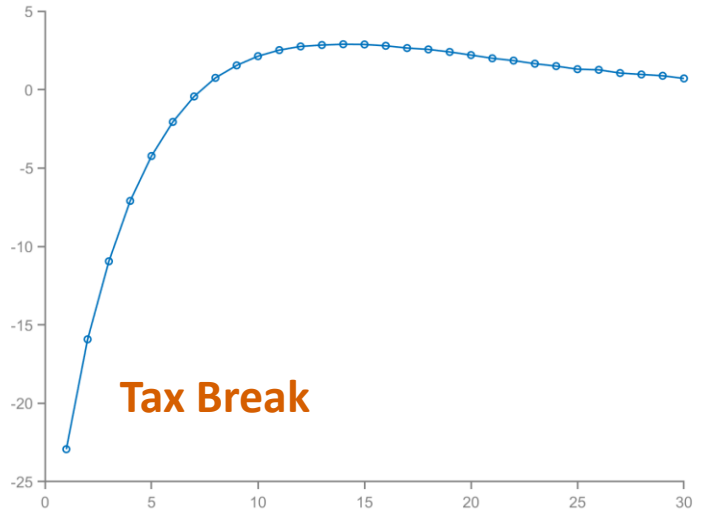
Consumption
(SS deviation in %)



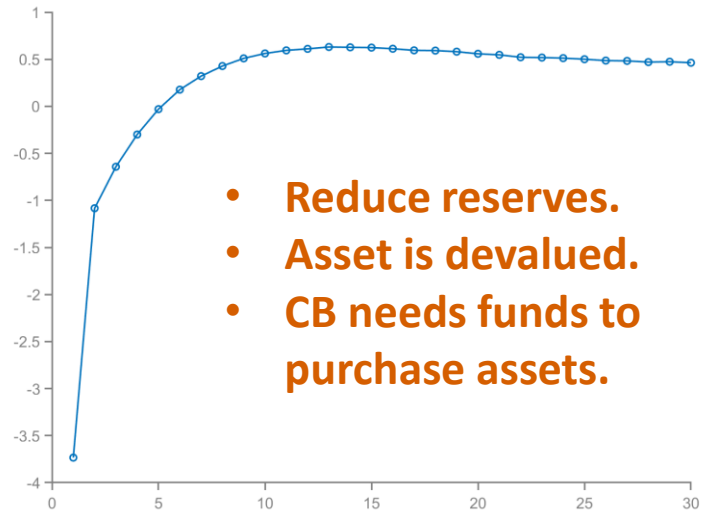
Inflation
(%)



Tax rate
(SS deviation in %)

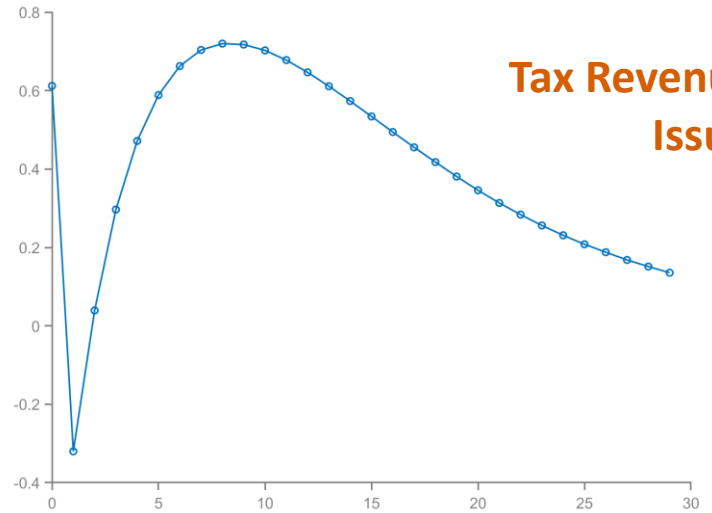


Remittance
(Ratio to GPD in %)



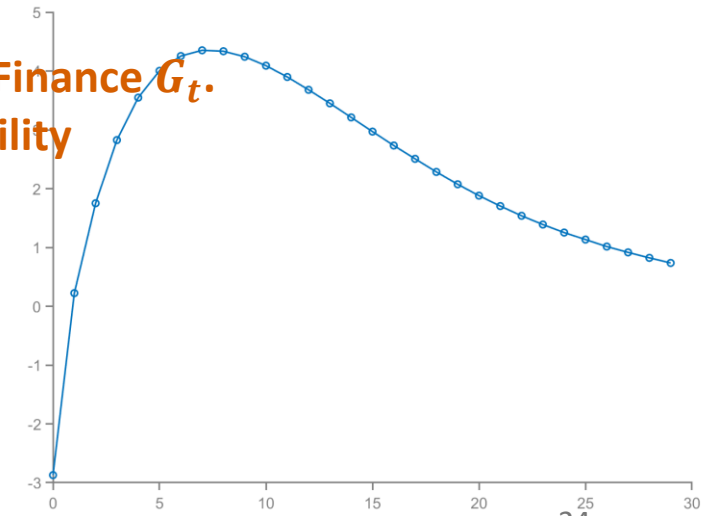
- **Reduce reserves.**
- **Asset is devalued.**
- **CB needs funds to purchase assets.**

Reserves
(SS deviation in %)

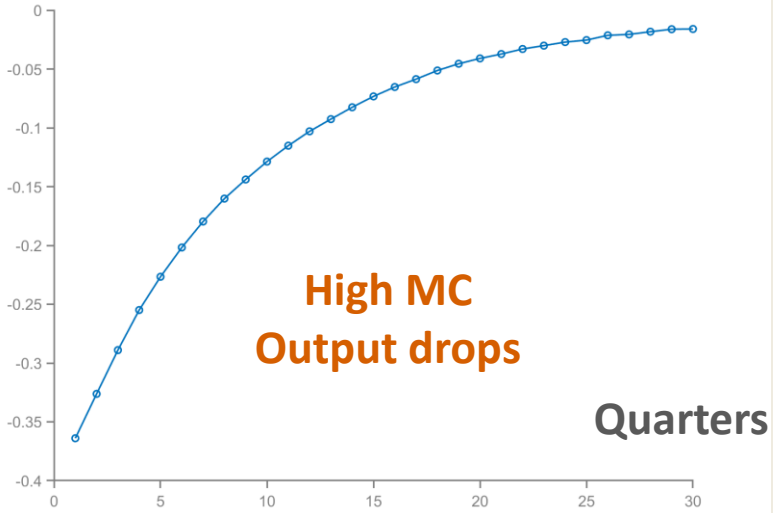


Tax Revenue↓ & Finance G_t.
Issue Liability

Treasury liability
(SS deviation in %)



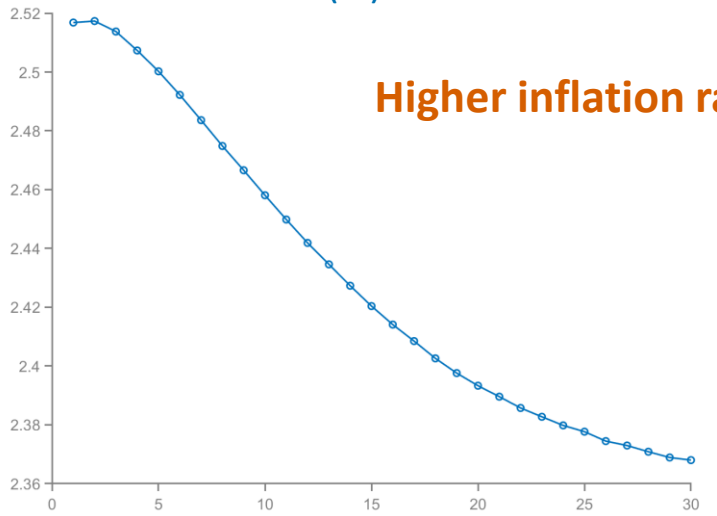
Consumption
(SS deviation in %)



High MC
Output drops

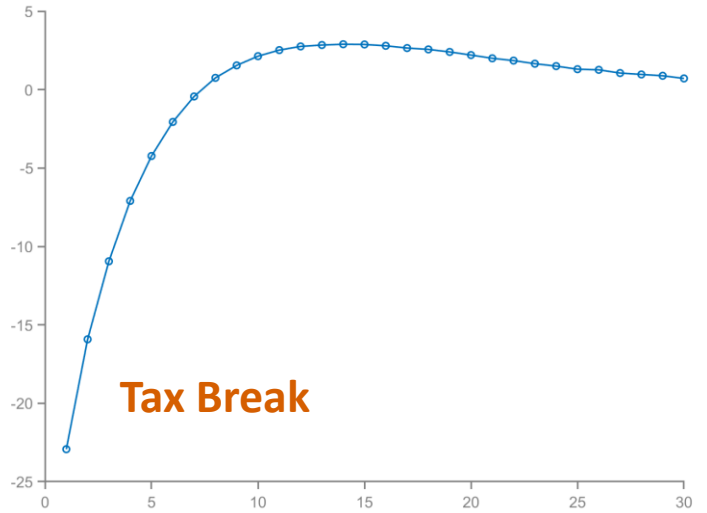
Quarters

Inflation
(%)



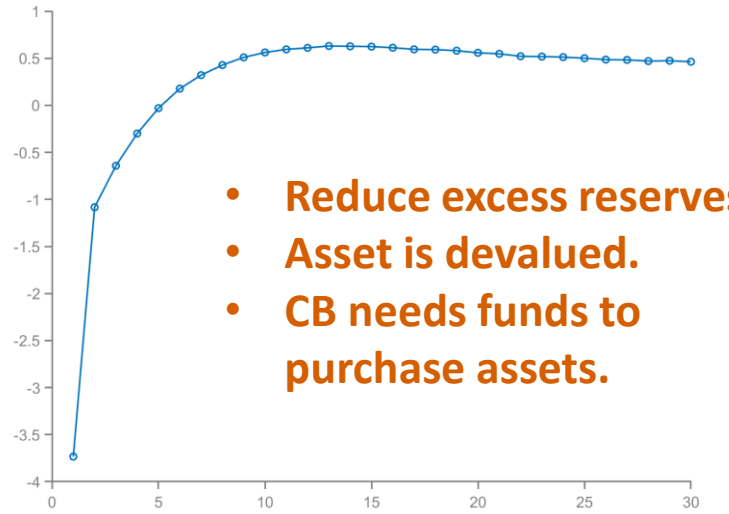
Higher inflation rate

Tax rate
(SS deviation in %)



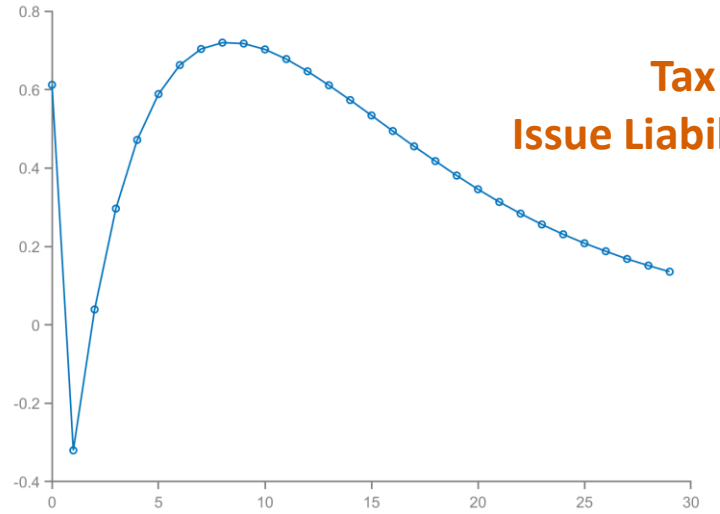
Tax Break

Remittance
(Ratio to GPD in %)



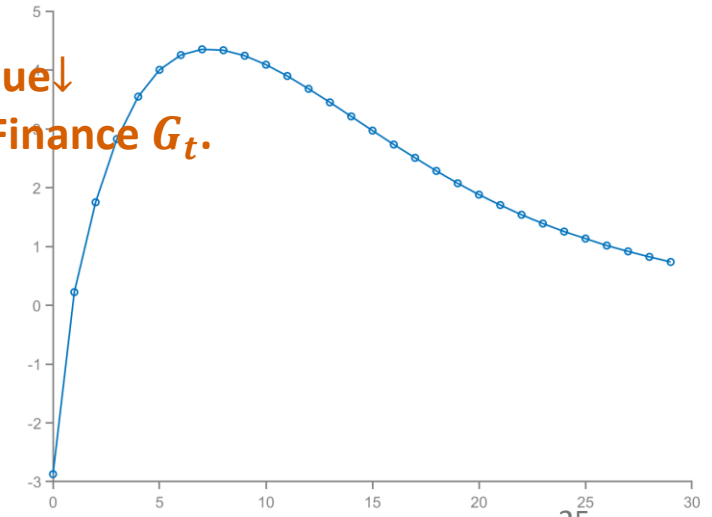
- **Reduce excess reserves.**
- **Asset is devalued.**
- **CB needs funds to purchase assets.**

Reserves
(SS deviation in %)

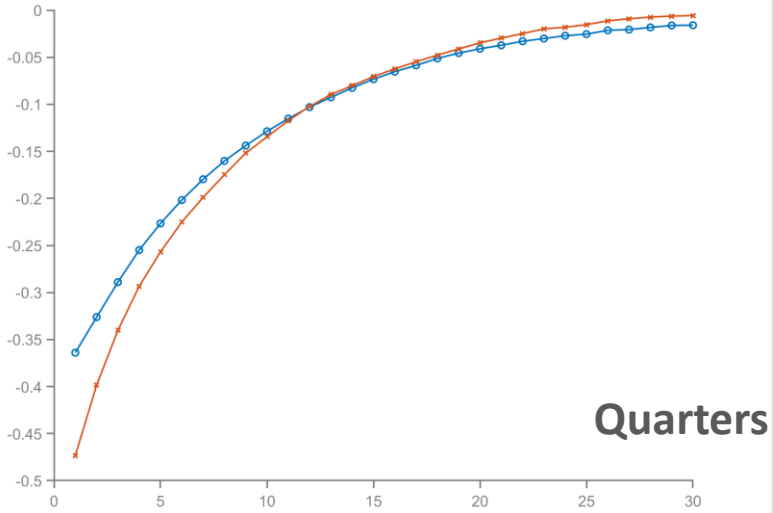


Tax Revenue↓
Issue Liability & Finance G_t.

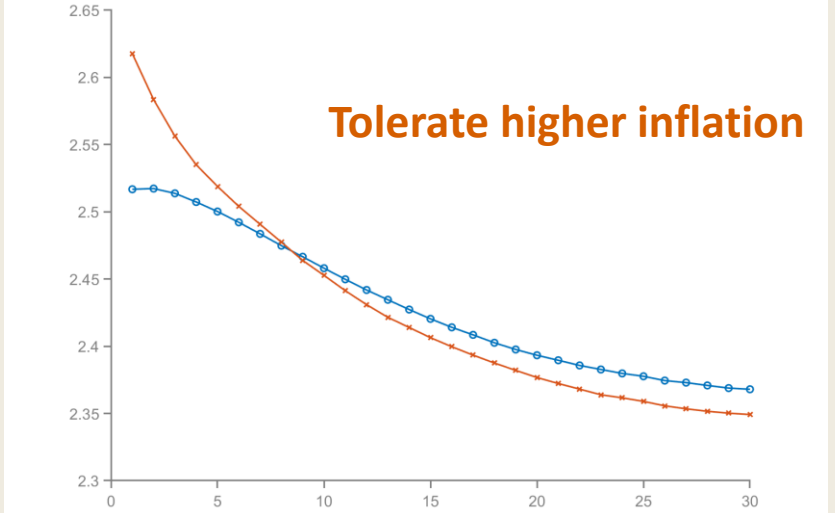
Treasury liability
(SS deviation in %)



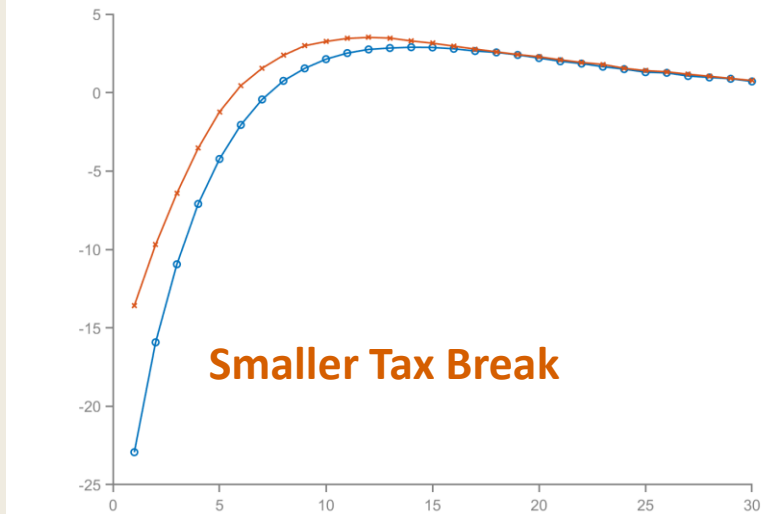
Consumption



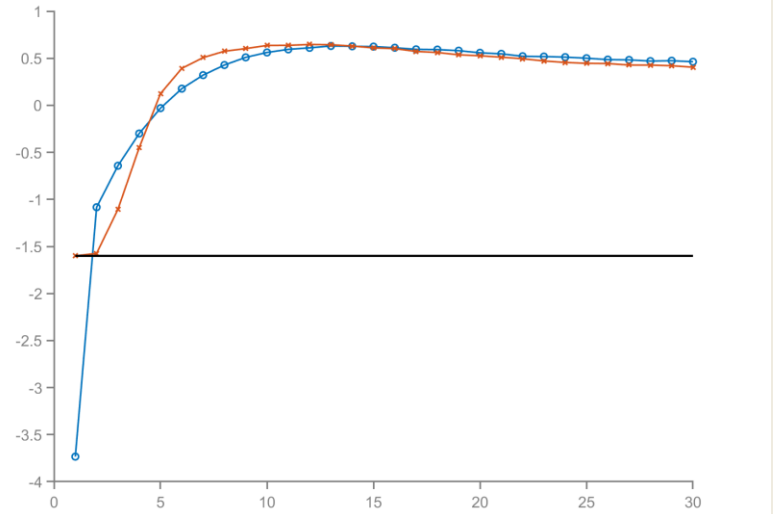
Inflation



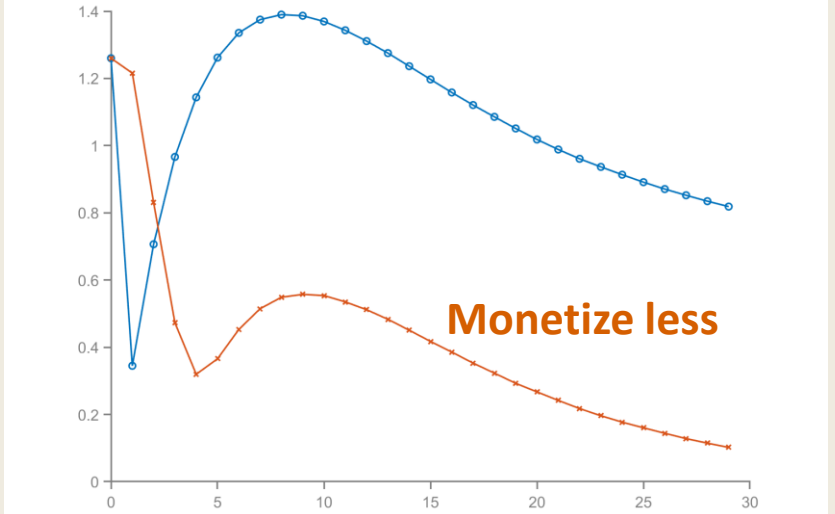
Tax rate



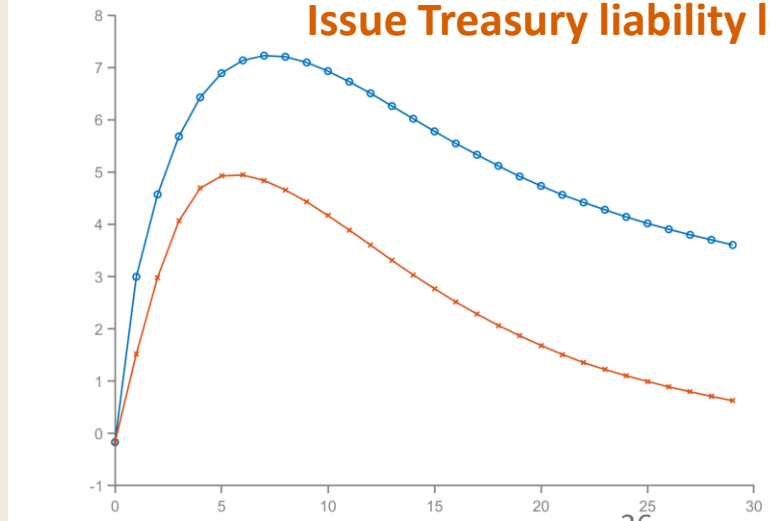
Remittance



Reserves



Treasury liability



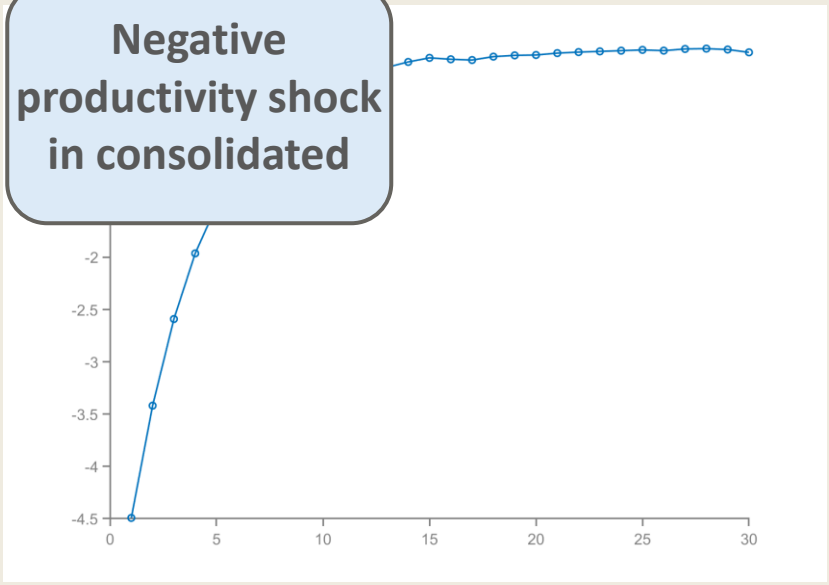
Primary Policy Tool and Central Bank's Role

- After cost-push shock, the primary policy tool is tax break.
- **The central bank's role to issue reserves helps tax break**.
  - The key parameter is Frisch elasticity and $(Q^C b^C)^{1-\gamma}$.

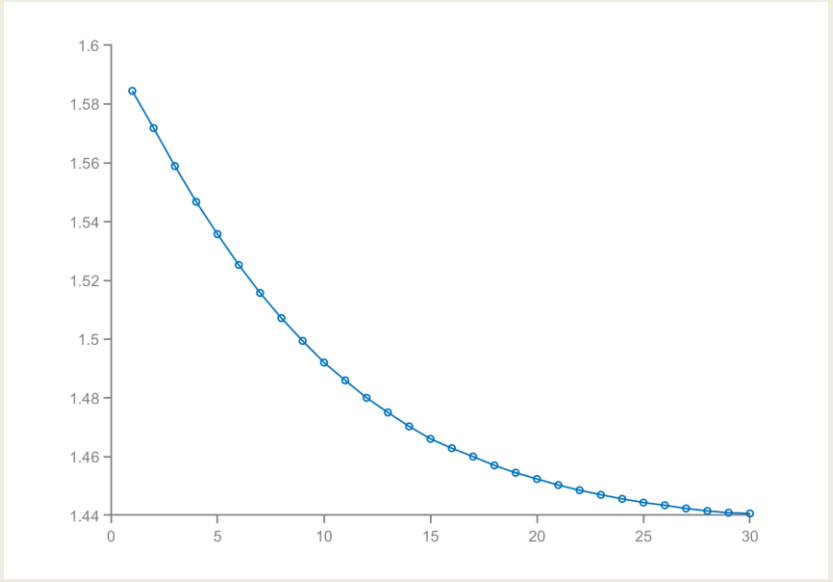
- After productivity shock, **the central bank's role is to raise nominal interest rate enough**.
- When the household cannot absorb large reserves, the unconsolidated model gives difference.
  - The key parameter is risk aversion and $(Q^C b^C)^{1-\gamma}$.

Negative productivity shock in consolidated

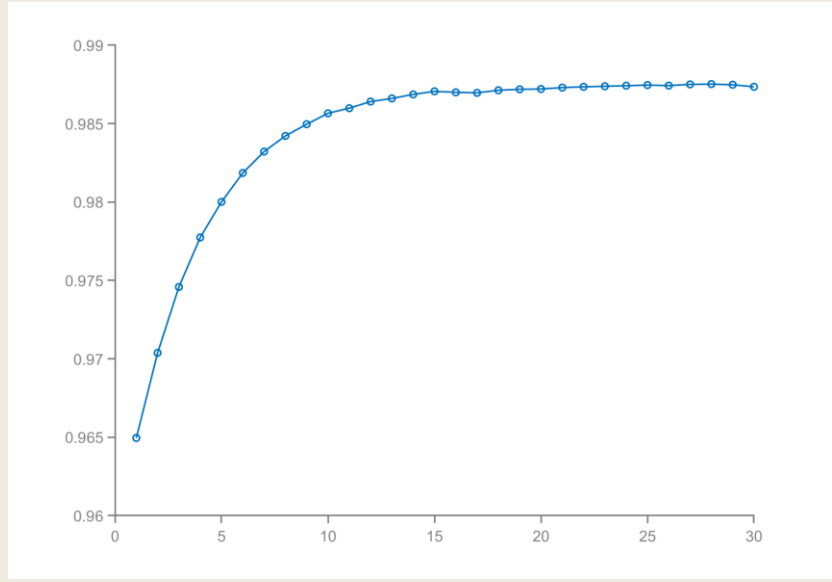
Consumption



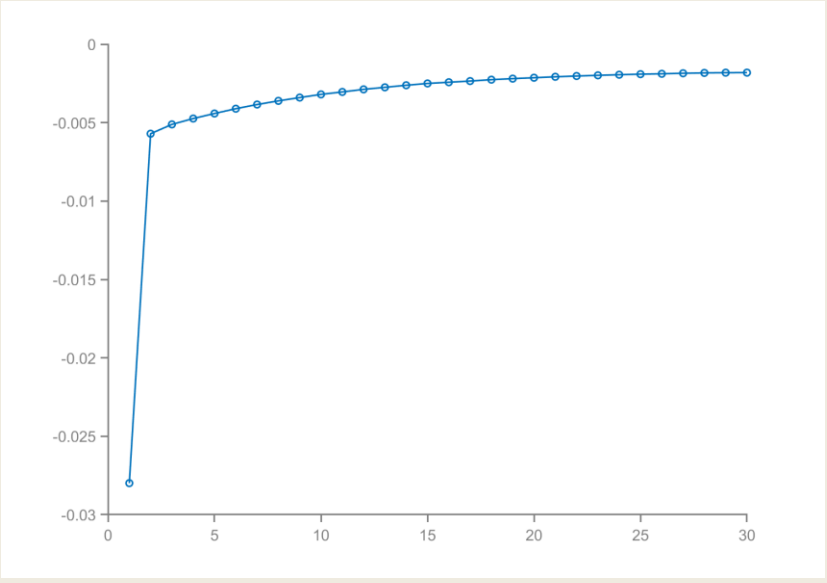
Inflation



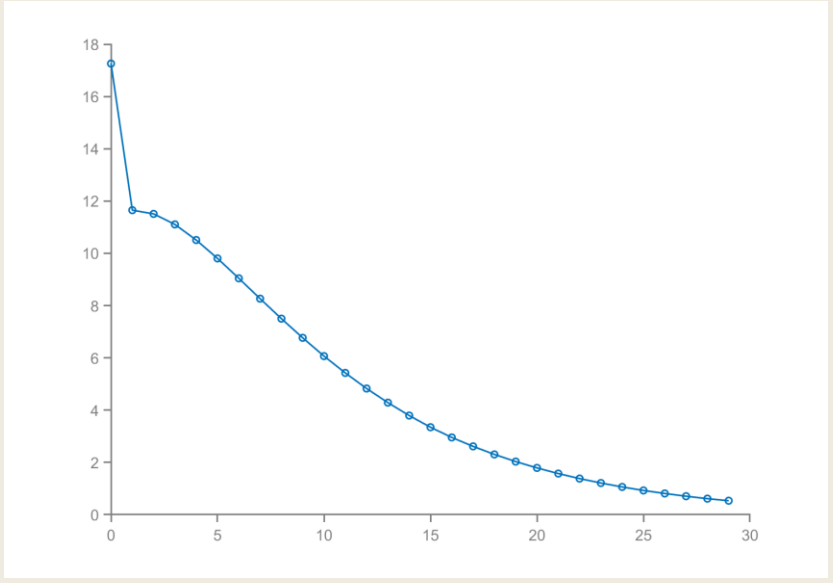
Price of Reserves



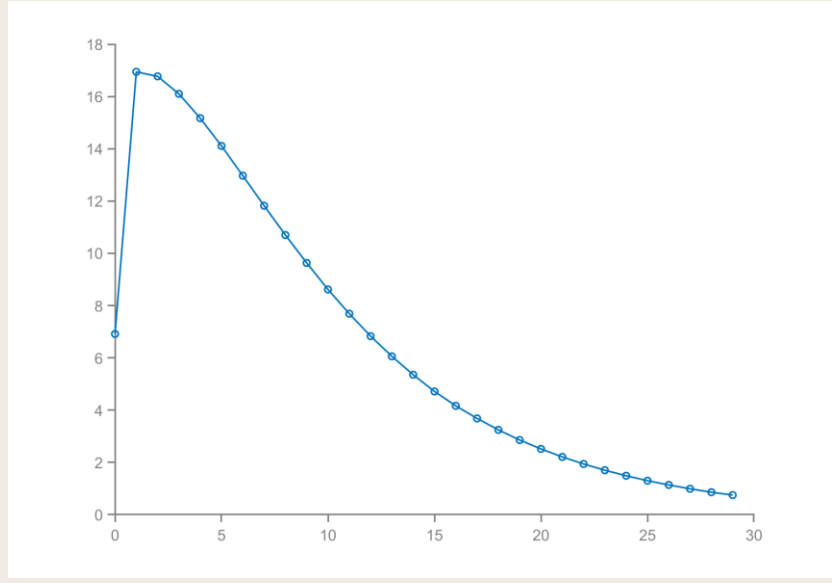
Remittance



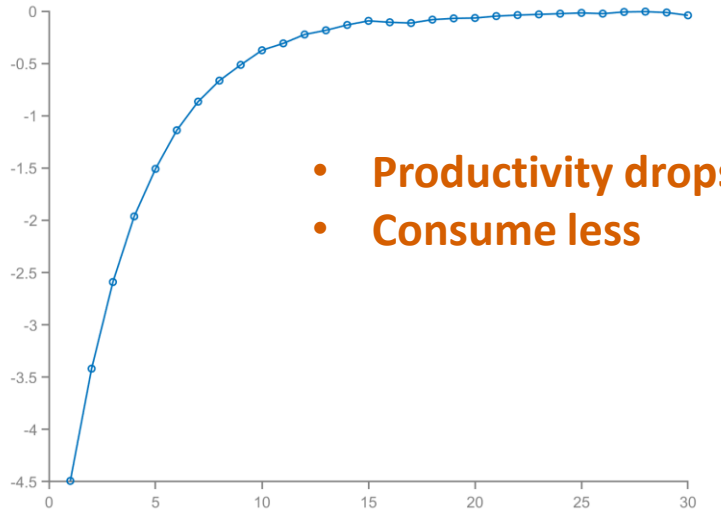
Reserves



Treasury liability

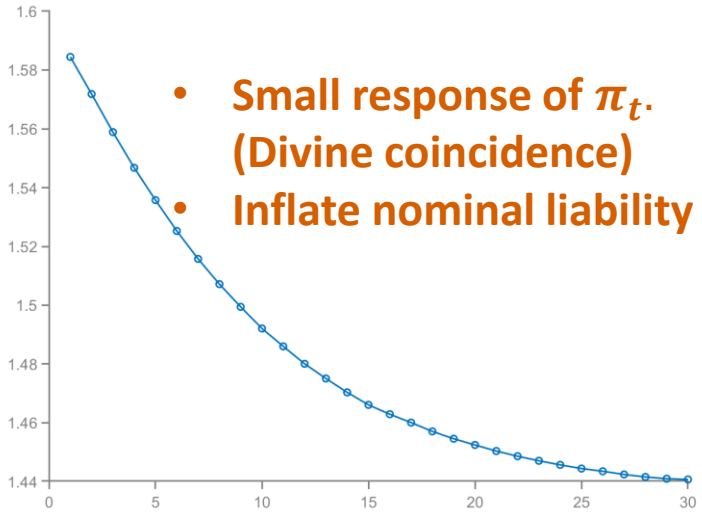


Consumption



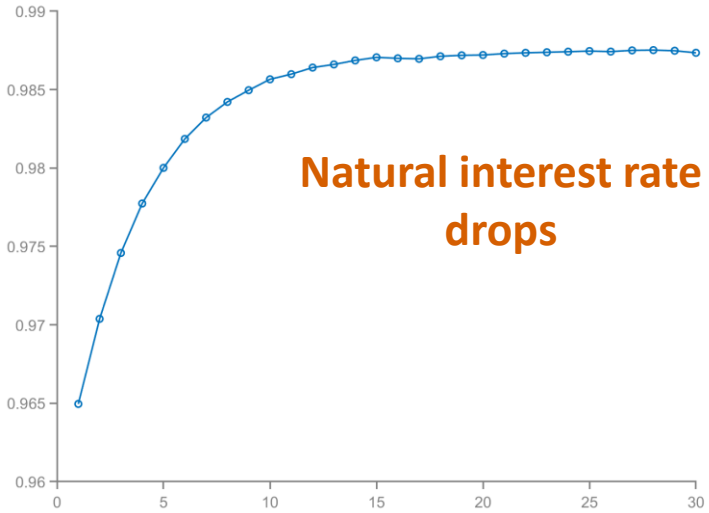
- Productivity drops
- Consume less

Inflation



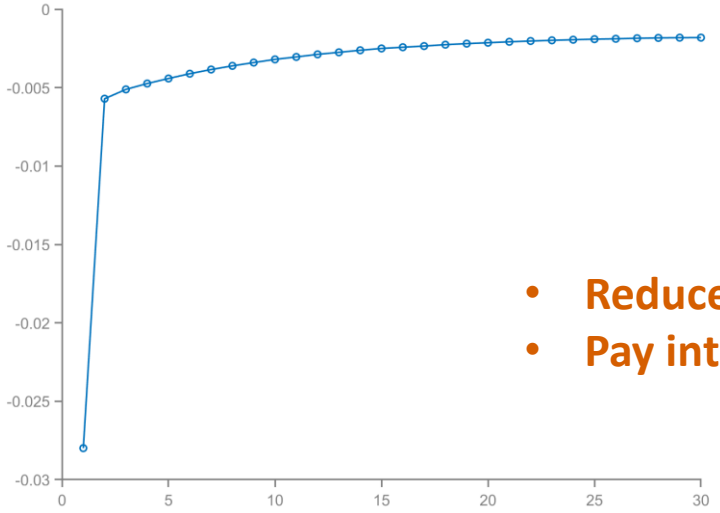
- Small response of π_t. (Divine coincidence)
- Inflate nominal liability

Price of Reserves



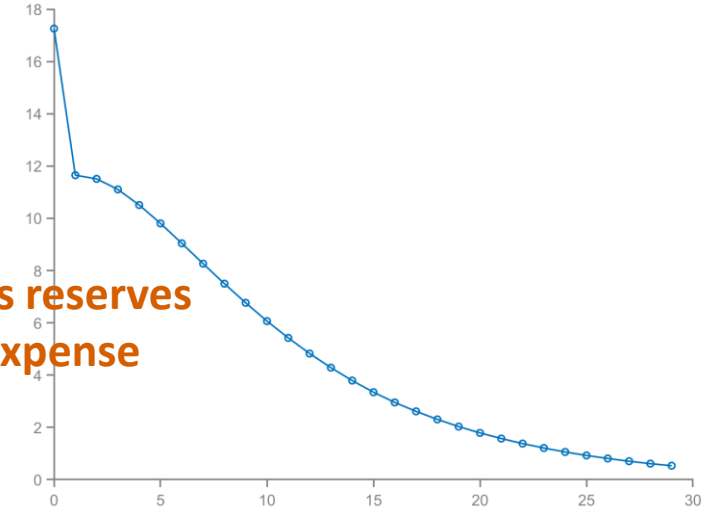
Natural interest rate drops

Remittance

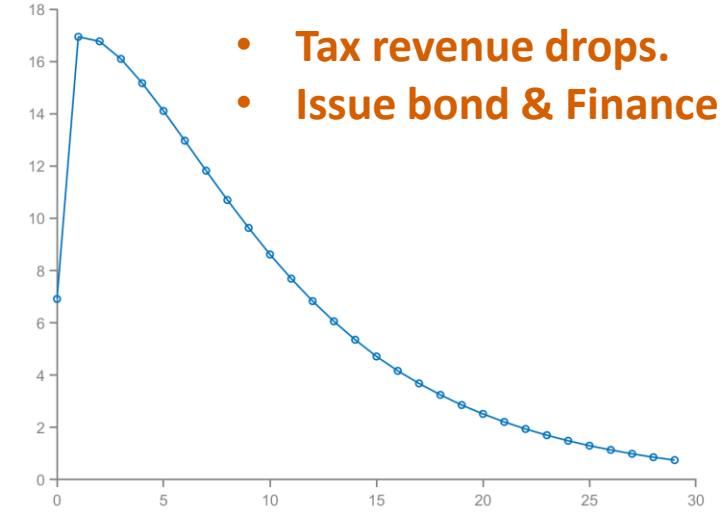


- Reduce excess reserves
- Pay interest expense

Reserves

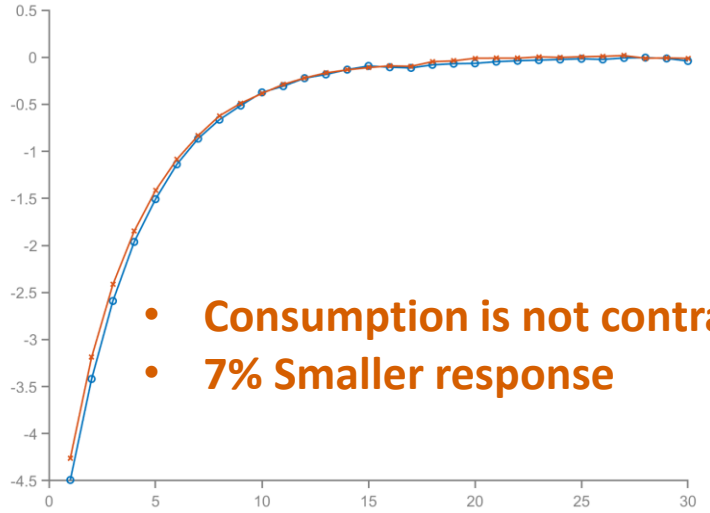


Treasury liability



- Tax revenue drops.
- Issue bond & Finance G_t

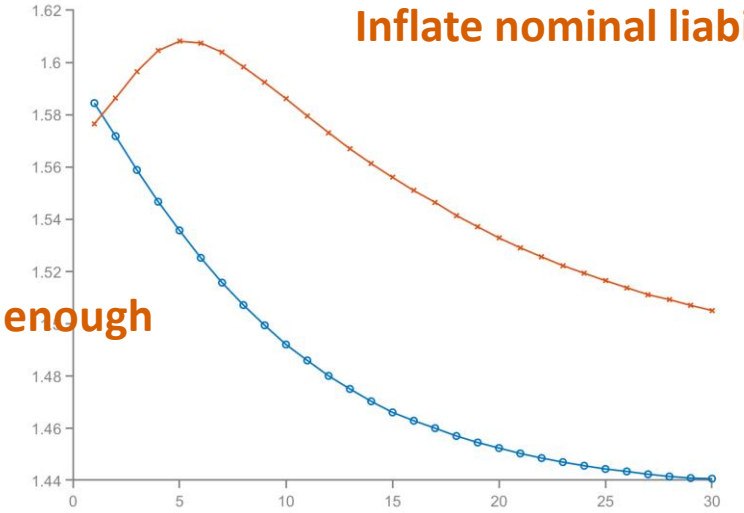
Consumption



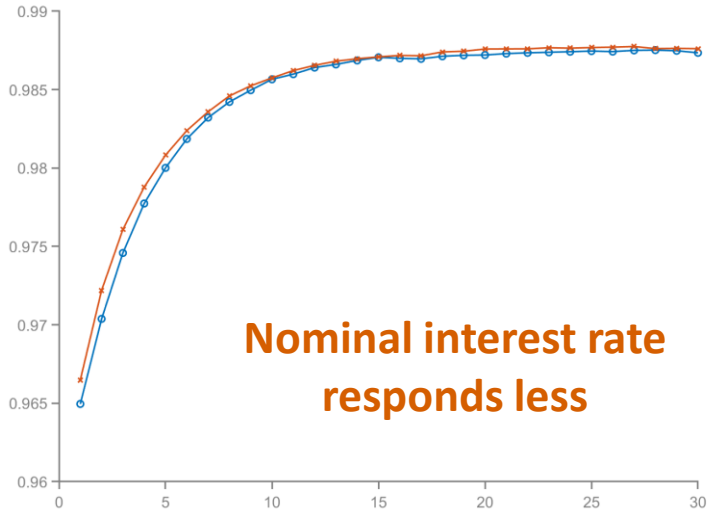
- Consumption is not contracted enough
- 7% Smaller response

Inflation

Inflate nominal liability

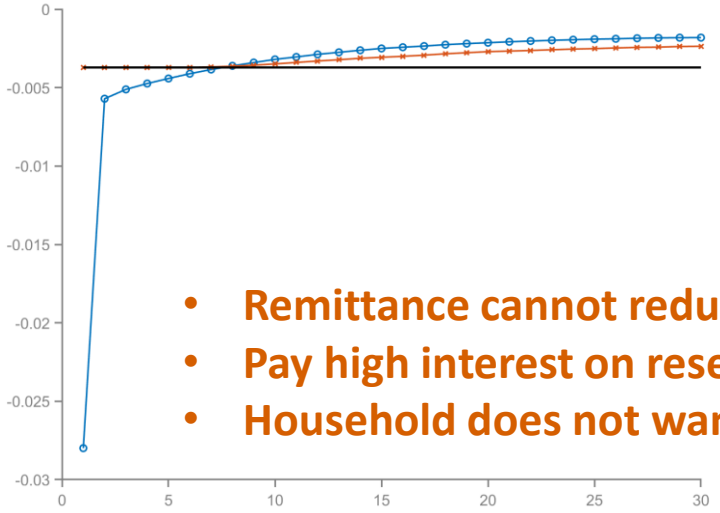


Price of Reserves



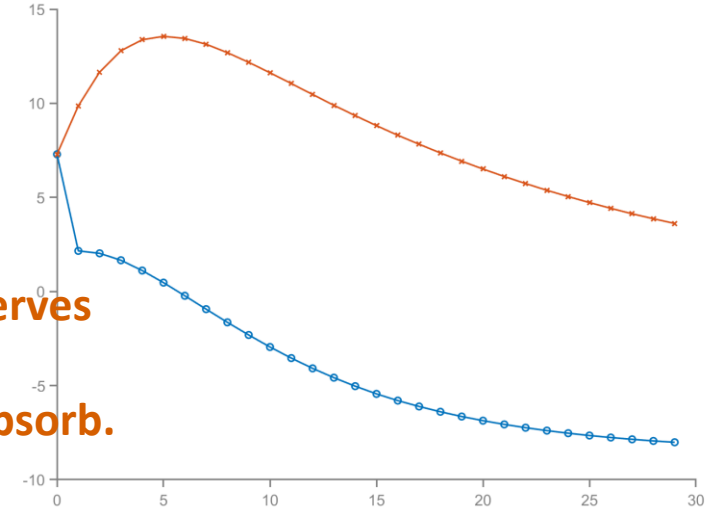
Nominal interest rate responds less

Remittance

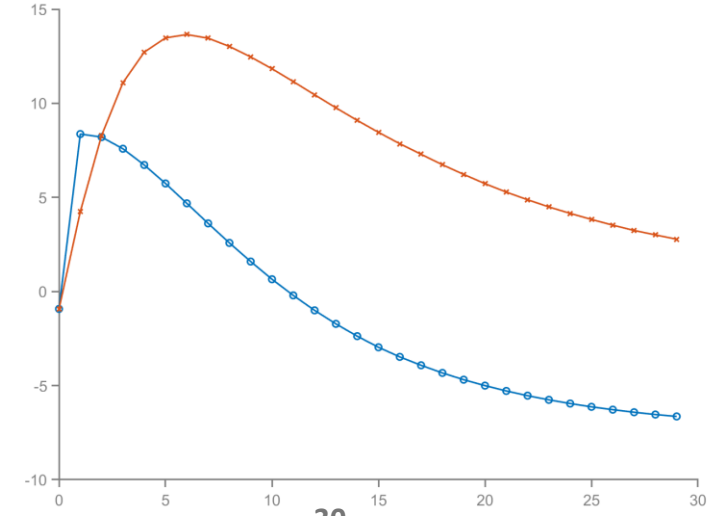


- Remittance cannot reduce reserves
- Pay high interest on reserves.
- Household does not want to absorb.

Reserves



Treasury liability



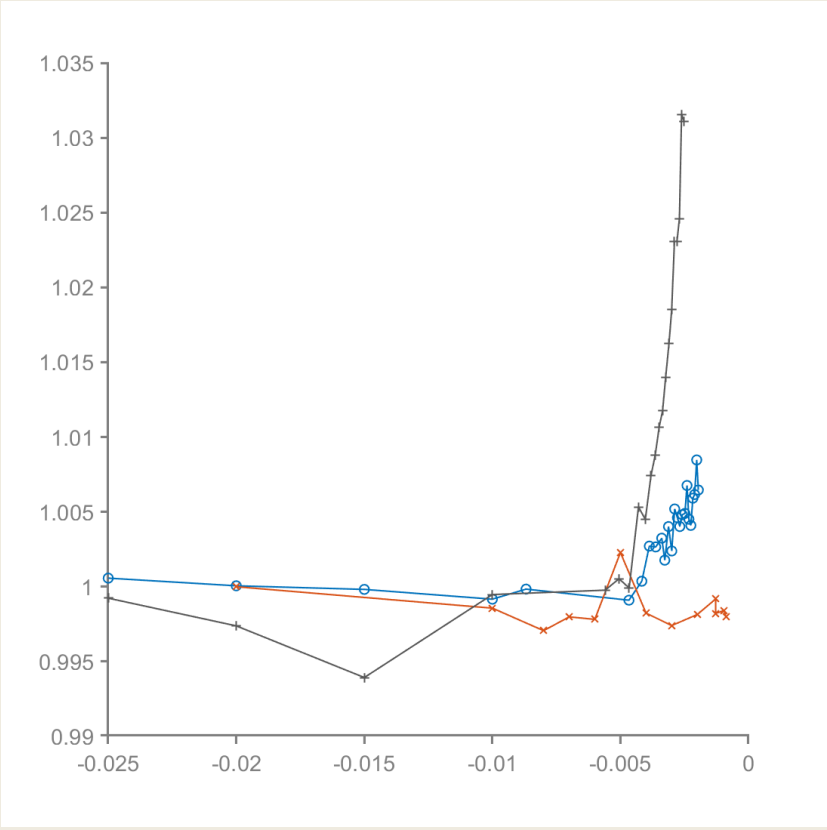
Dynamic Property of the Optimal Policy

Does the fiscal backing affect dynamic property of the optimal policy?

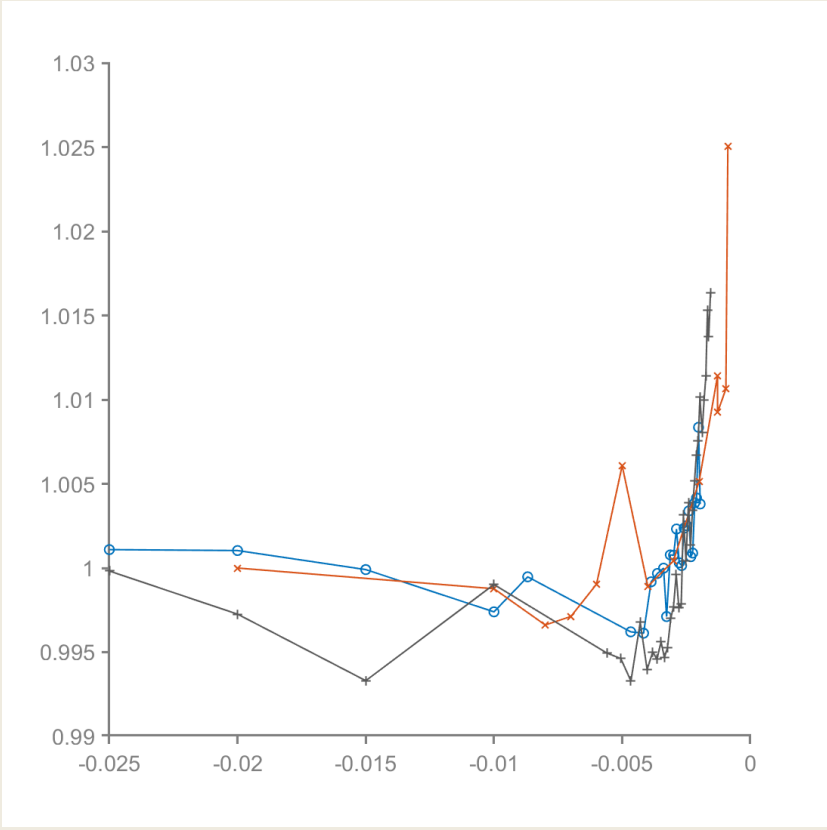
- Suppose the central bank has less fiscal support from the Treasury.
  - Increase the lower bound on remittance, H^*. $(H_t \geq H^*)$
- For each H^* and shock, I solve the model and simulate the economy.
- Compute the mean and variance of consumption, inflation, and tax rate.

- Horizontal is H^*. Vertical is **the volatility**. Normalized by the volatility in the consolidated model.
- Government expenditure (blue). Productivity (red). Cost-push (black).

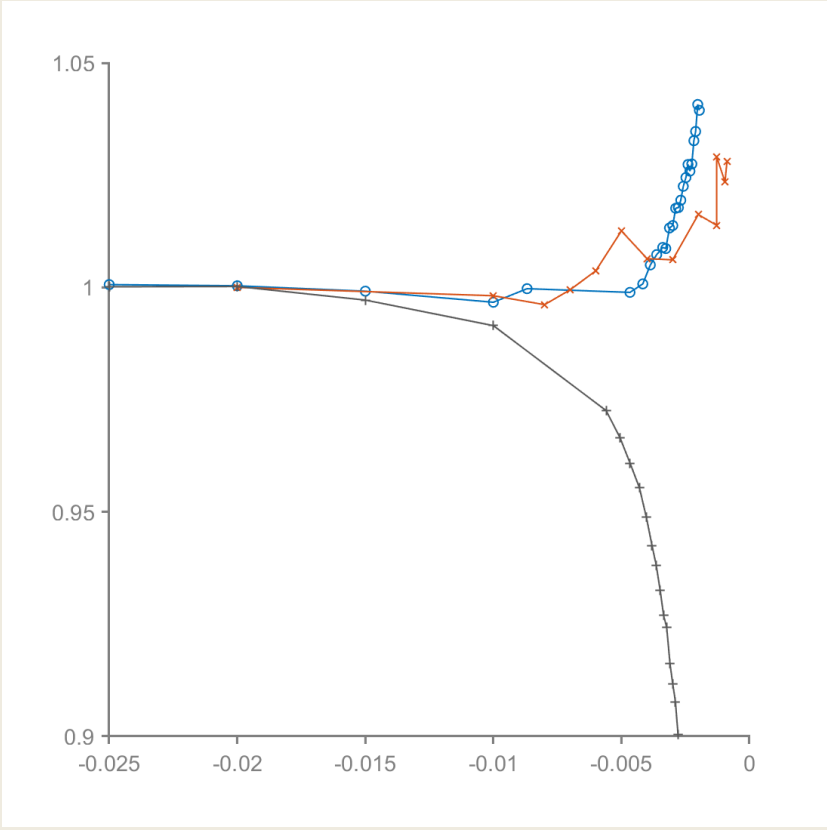
Consumption



Inflation



Tax rate



- How each variable's volatility changes as fiscal backing for the central bank decreases (i.e., $H^* \uparrow$).

	Cost-push	Government expenditure
Consumption	**+3%**	**+1%**
Tax	**-10%**	**+3%**
Inflation	**+1%**	**+2%**

Fiscal backing allows tax break

- How each variable's volatility changes as fiscal backing for the central bank decreases (i.e., $H^* \uparrow$).

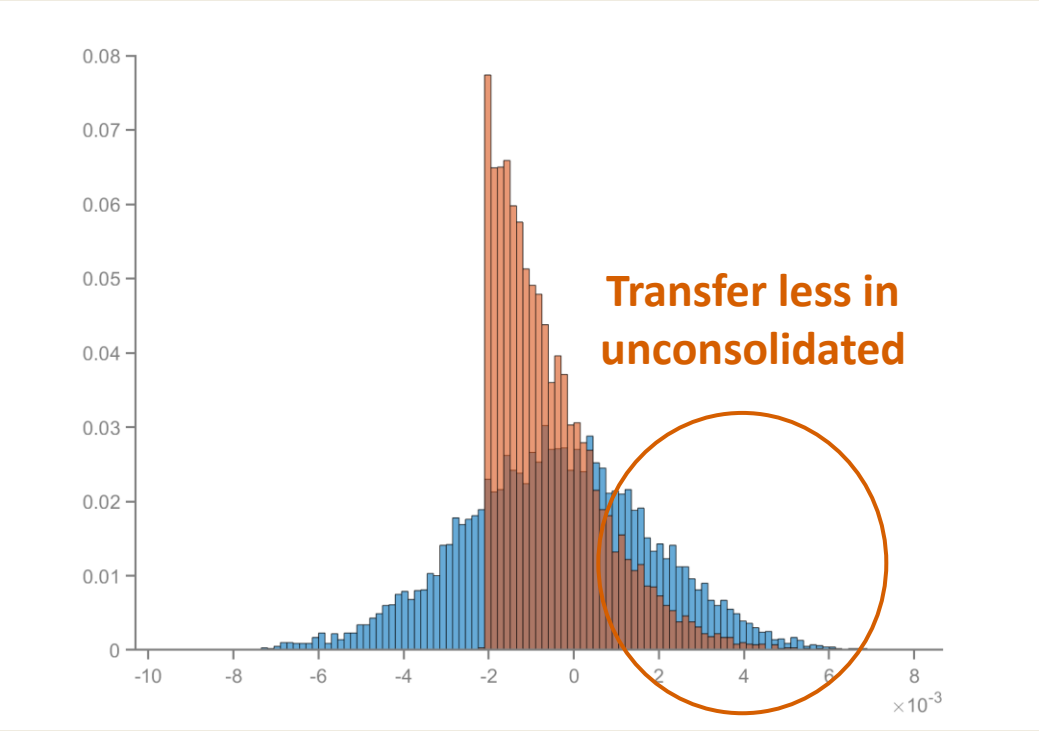
	Cost-push	Government expenditure
Consumption	**+3%**	**+1%**
Tax	**-10%**	**+3%**
Inflation	**+1%**	**+2%**
	Fiscal backing allows tax break	**Fiscal backing allows tax smoothing**

Retained Earnings by the central bank

- Bank of Japan **retains 5% of profits** and transfers the rest to the Treasury.
  - Large balance sheet (120% of GDP).
- Bundesbank uses its financial buffers to cushion burdens.
- No reason to retain earnings if the central bank and Treasury are consolidated.

Why do the central banks retain earnings?

- **Lower bound on remittance reduces the upper bound.**
- If CB prints reserves and transfer a lot now, increased reserves cannot be reduced through remittance later. ➔ **Forward looking decision-making.**



- Simulated the economy with cost-push shock.
- Remittance as histogram for consolidated and unconsolidated.

The welfare gain of fiscal backing

The welfare gain of fiscal backing is less than 0.01%.

- I compute the welfare gain of increasing the lower bound on remittance, H^*.
- Consumption equivalence compared to the case of $H^* = -\infty$.

(Intuition) Fiscal backing affects the variance but less the mean.

The lack of fiscal backing increases the average inflation by 0.25 bps.