Optimal monetary and fiscal policy without fiscal backing for the Central Bank

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Introduction

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

Research Question

If the government budgets are **unconsolidated**,

(Treasury does not provide the **optimal fiscal support** to Central Bank)

does the optimal monetary-fiscal policy change?

What I do

Optimal monetary and fiscal policy without commitment

As in the literature,

- NK model where the government chooses policies to maximize the household utility subject to the equilibrium conditions.

New

1. Two interest-bearing liabilities, reserves and government bonds.
2. Constraint on transfers from Treasury to Central Bank.

What I find

Without the fiscal backing,

1. Central Bank tolerates higher inflation in response to the cost-push shock.
    - Key: An initial condition with large reserves

What I find

Without the fiscal backing,

1. Central Bank tolerates higher inflation in response to the cost-push shock.
2. Inflation rate is 3% more volatile over the business cycle.

What I find

Without the fiscal backing,

1. Central Bank tolerates higher inflation in response to the cost-push shock.
2. Inflation rate is 2-3% more volatile over the business cycle.
3. The welfare loss is small (<0.01% of consumption) in the typical business cycle.

   Conditional on a large cost-push shock, the fiscal backing reduces the welfare cost by 20%

Model

Environment

- **Time.** Discrete, infinite horizon.
- **Assets.** Reserves and government bonds (Differ in duration and liquidity value).
- **Agents**

Household consumes and works. Trades assets. Get a convenience yield.

Producers are NK model, facing cost-push and productivity shock.

Treasury finances public expenditure by a linear sales tax, government bonds, and remittance from Central Bank.

Central Bank issues reserves and buys government bonds.

Household

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

s.t.

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

- D_t is **reserves** directly held by the household and issued by Central Bank.
- B_t is long-duration **government bonds**. Duration is given by ρ.
- 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

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

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

- Central Bank trades reserves and government bonds.

Trade reserves

Trade government bonds

Remittance to Treasury

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

D is reserves. B^C is government bonds held by Central Bank.

- **Inequality constraint on the remittance**

$$H_t \geq H^*$$

Central Bank's Asset Purchase Policy

- Assume an exogenous asset purchase rule.

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

  - B^C is government bonds held by Central Bank.
  - B^T is total supply of government bonds.
  - α is a parameter.

- Reduces the size of the state space (4 states → 3 states).
- The goal of Central Bank's asset purchase policy is to stabilize the financial market.

Equilibrium

- Market Clearing Condition

$$\text{(Goods)} \quad Y_t = C_t + G_t + \frac{\varphi}{2}\left(\pi_t - 1\right)^2 Y_t$$

$$\text{(Government bonds)} \quad B_t^H + B_t^C = B_t^T$$

Optimal Policy (Discretion) – Unconsolidated Model

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

Choice

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

Euler Equations

NKPC

Market Clearing

Treasury

CB

Remittance $H_t \geq H^*$

Optimal Policy (Discretion) – Unconsolidated Model

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

The role of remittance when there is fiscal backing

- Relax one budget by tightening the other.

Why is Central Bank's loss an issue?

- Large reserves → Central Bank's loss.
- Downward-sloping demand curve.
- Price of reserves (= nominal interest rate) drops.

Why is the lack of fiscal support an issue?

- To reduce large reserves, funds from Treasury are required.

Euler Equations

NKPC

Market Clearing

Treasury

CB

Remittance $H_t \geq H^*$

Optimal Policy (Discretion) – Consolidated Model

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

Euler Equations

NKPC

Market Clearing

Consolidated Government

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

Solution

- **Discretion**. Markov-perfect equilibrium.
- State variables: Shock, reserves, and government bonds.
- Shock: Cost-push, productivity, or government expenditure.
- **Globally** solve the model.
  - Occasionally binding constraints, $H_t \geq H^*$.

Calibration

	Variable	Value	Description	Target	Model	Data
Standard NK	β	0.995	Discount factor	-	-	-
	σ	2	Risk aversion	-	-	-
	ν	7	Frisch Elasticity	Frisch Elasticity	1/7	-
	θ	10	Elasticity of substitution	Mark up	7%	-
	φ	100	Price adjustment cost	Slope of NKPC	0.05	-
	ρ^T	0.94	Duration of Treasury	Average maturity	4 years	4 years
	χ_1	0.0006	Utility from reserves	Steady-state reserves	15% of GDP	15% of GDP
	χ_2	0.0014	Utility from Treasury bond	Steady state Treasury	40% of GDP	80% of GDP
$(Q^c d)^{1-\gamma_1}$	γ_1	1.7	Curvature of utility from reserves	$\frac{\partial Q^C}{\partial d}$	0.1	0.05~0.2
$(Q^T b)^{1-\gamma_2}$	γ_2	1.5	Curvature of utility from Treasury	$\frac{\partial Q^T}{\partial b}$	0.05	0~0.1
	α	0.4	CB's asset holding	CB's Net worth	1	1
	H^*	-0.005	Lower bound on remittance	-	-0.5% of GDP	-

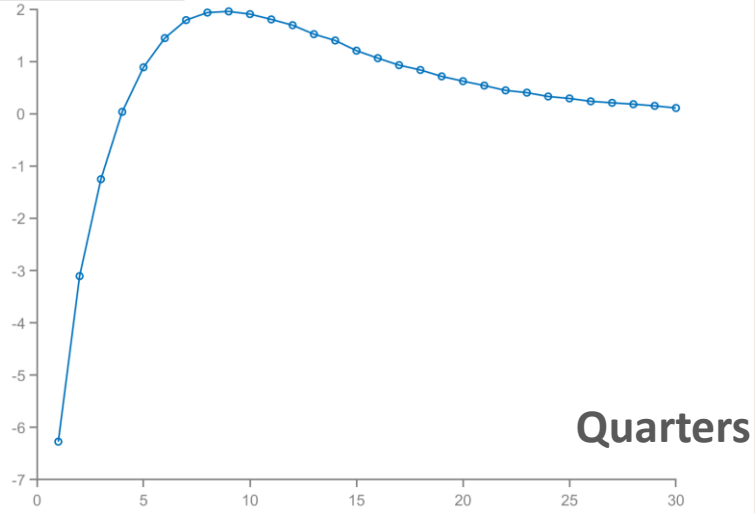
Results

Simulation

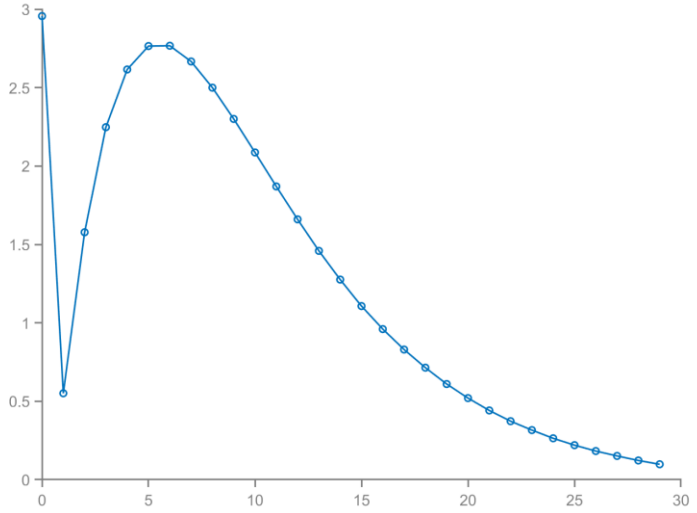
- Positive cost-push shock. 9% increase in wage mark-up.
- The size of the response is small (0.8% of the fall in output and 0.4% of the rise in inflation).
  - I do not finish solving the model with large shock.
- The initial state variables are large reserves (90^{th} percentile of simulated reserves).

Cost-push shock
Consolidated

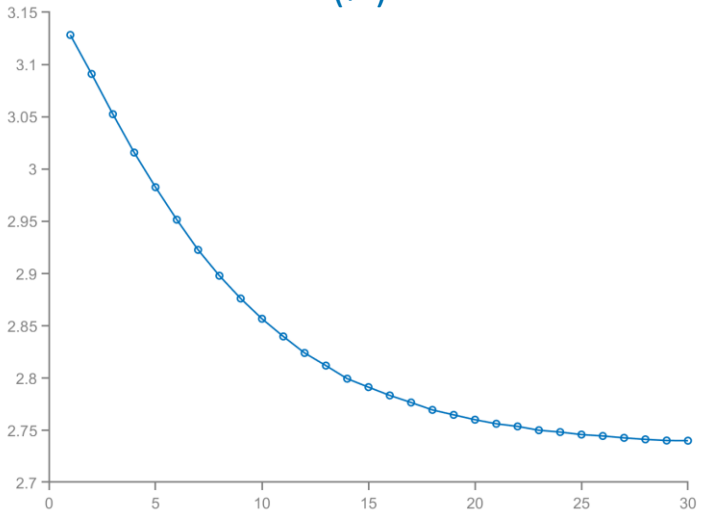
Tax rate
(SS deviation in %)



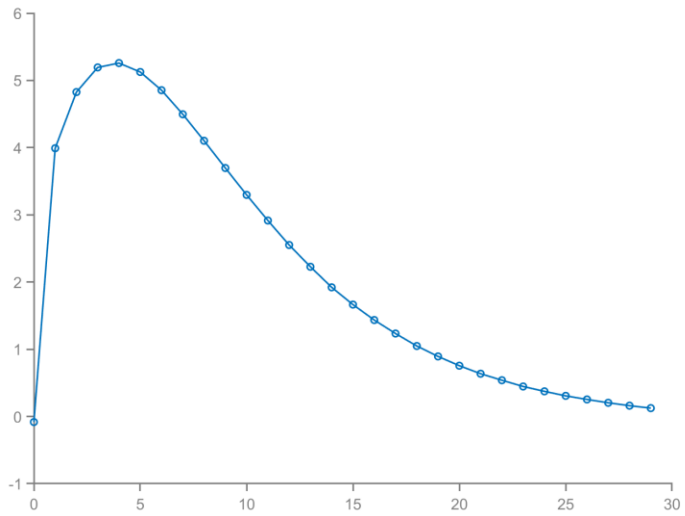
Reserves
(SS deviation in %)



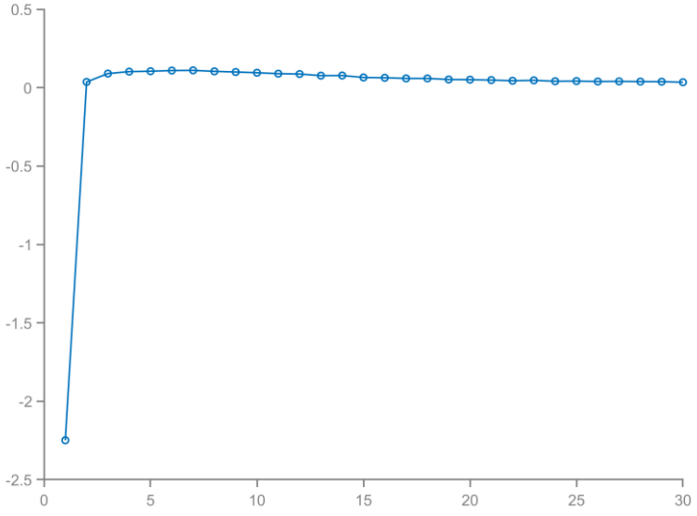
Inflation
(%)



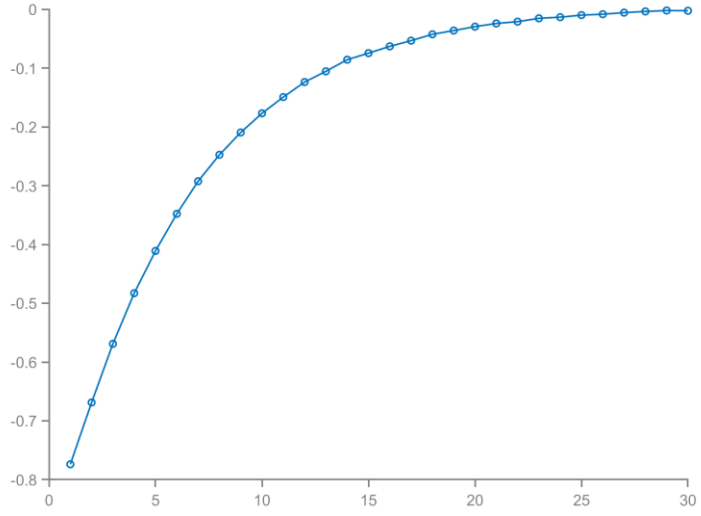
Government bonds
(SS deviation in %)



Remittance
(Ratio to GPD in %)

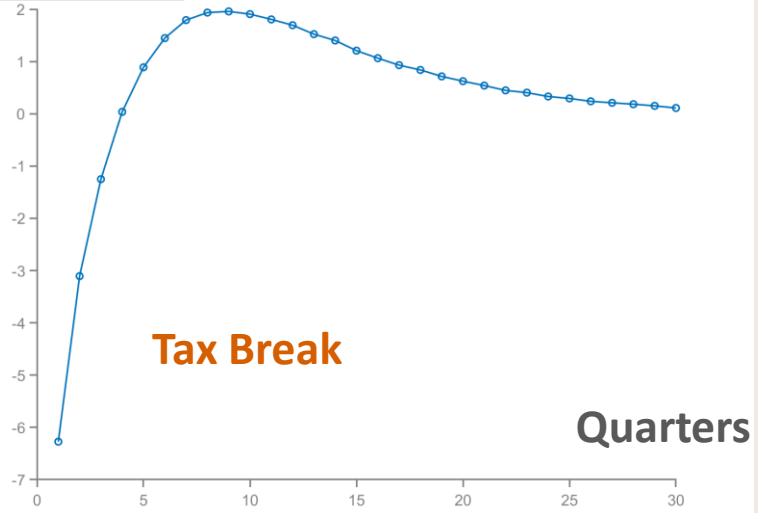


Consumption
(SS deviation in %)

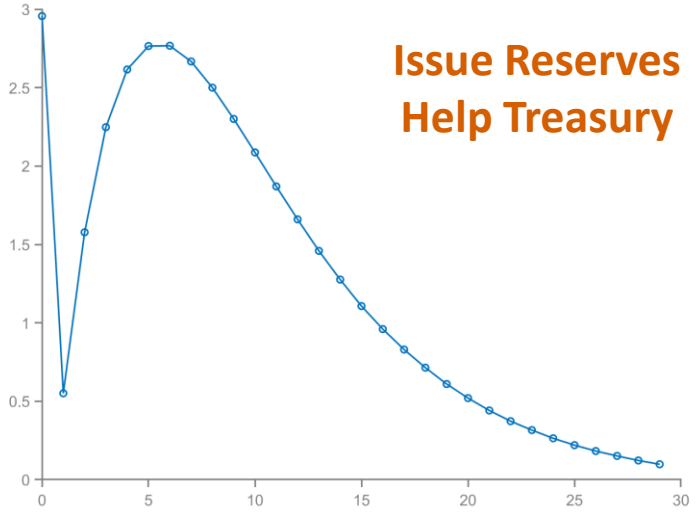


Cost-push shock
Consolidated

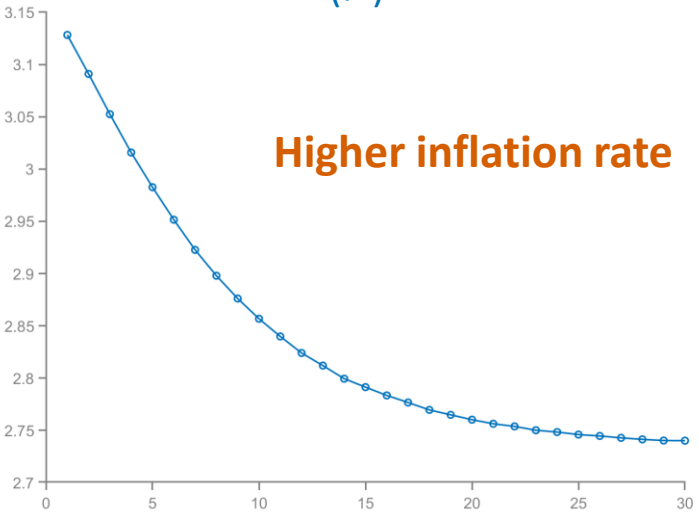
Tax rate
(SS deviation in %)



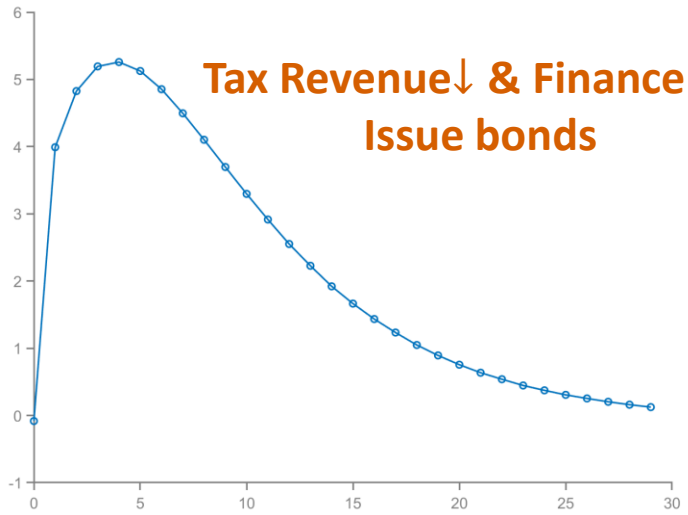
Reserves
(SS deviation in %)



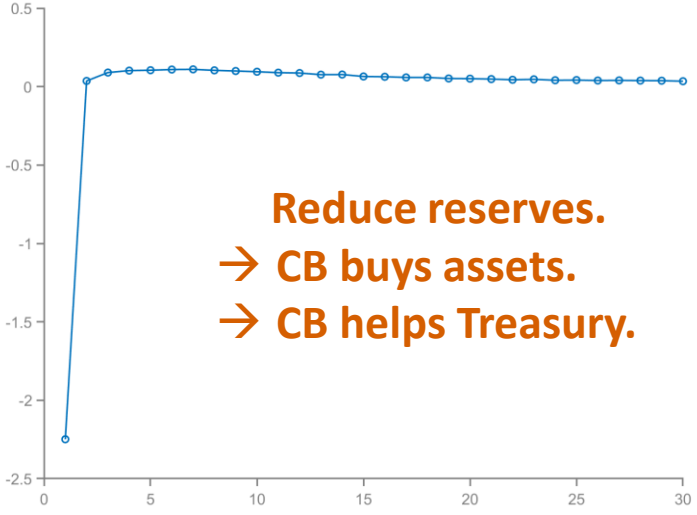
Inflation
(%)



Government bonds
(SS deviation in %)

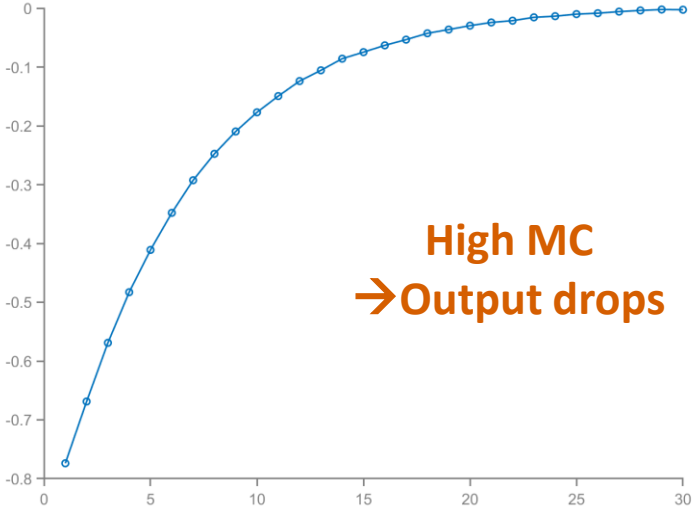


Remittance
(Ratio to GPD in %)

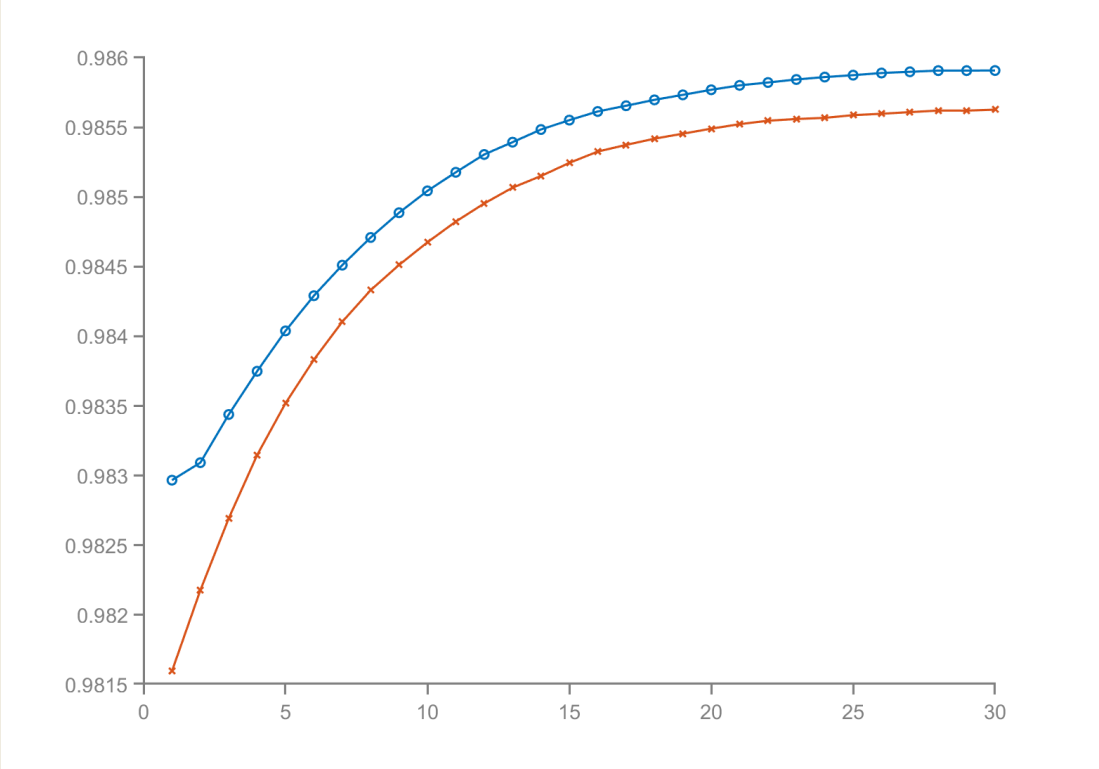


CB receives

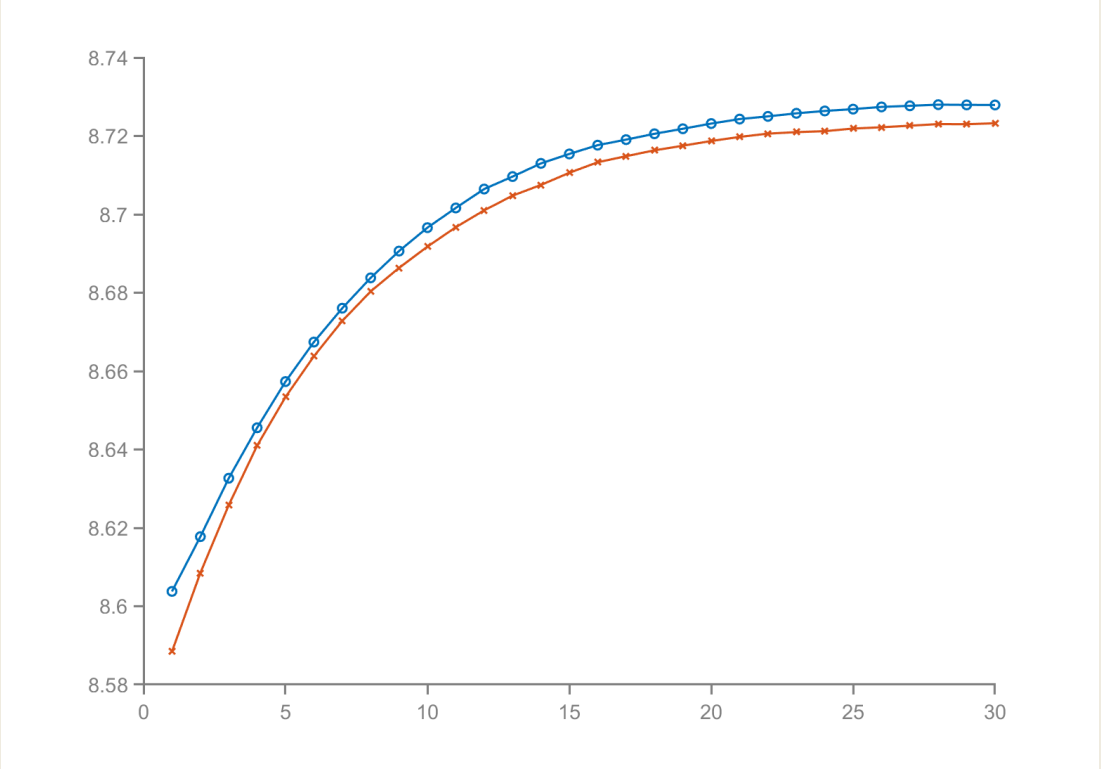
Consumption
(SS deviation in %)



Price of reserves

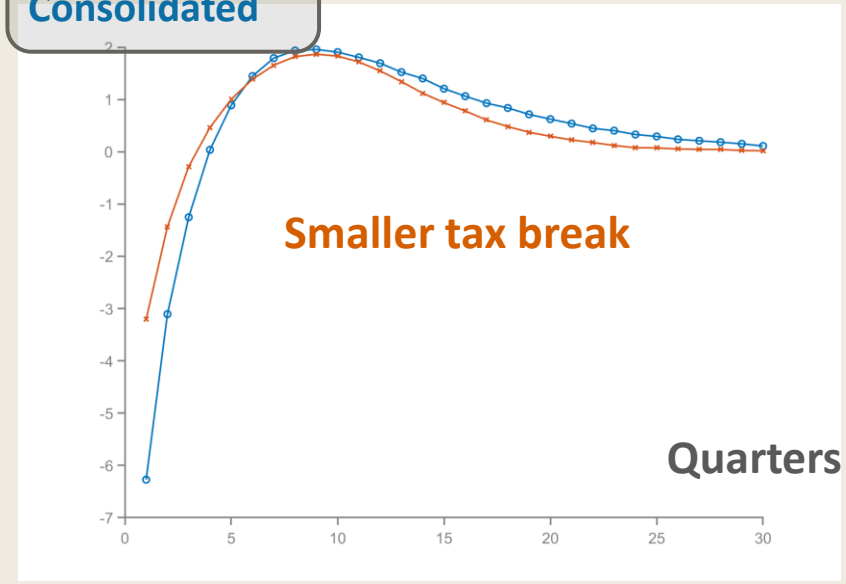


Price of government bods

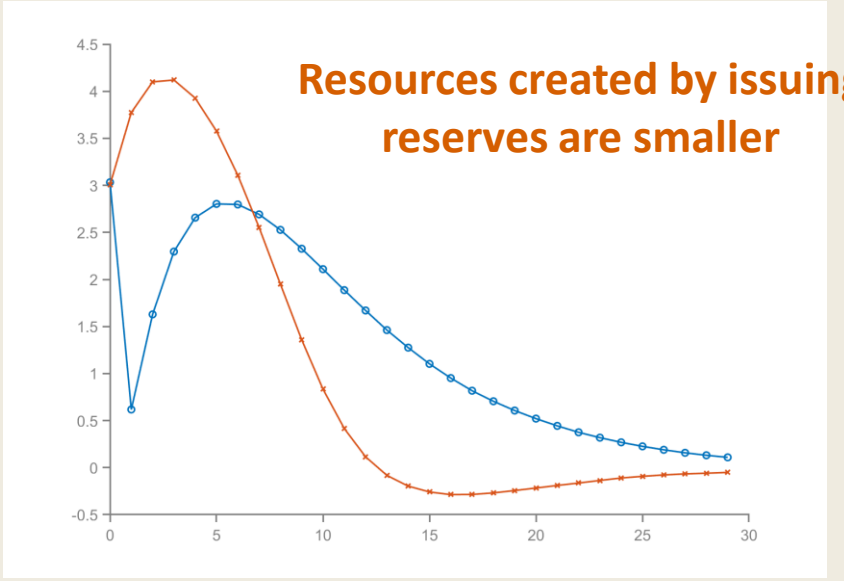


Unconsolidated
Consolidated

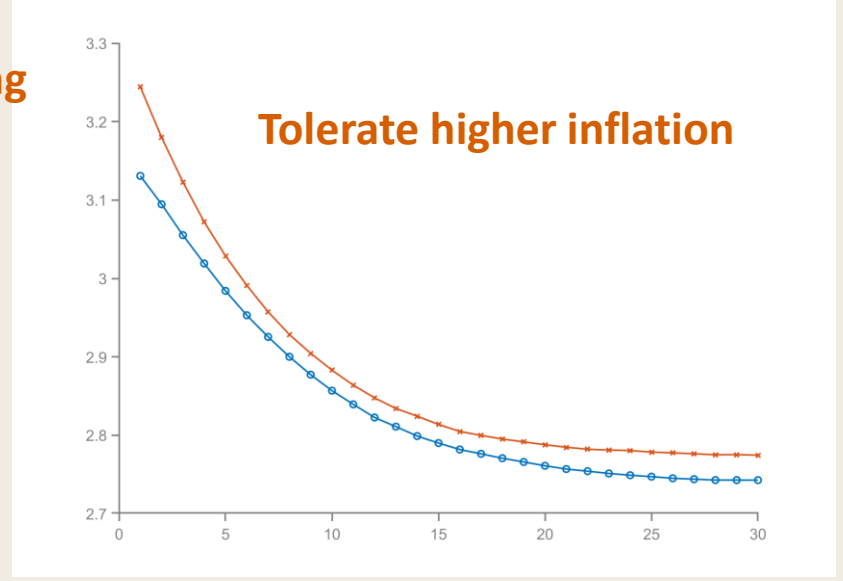
Tax rate



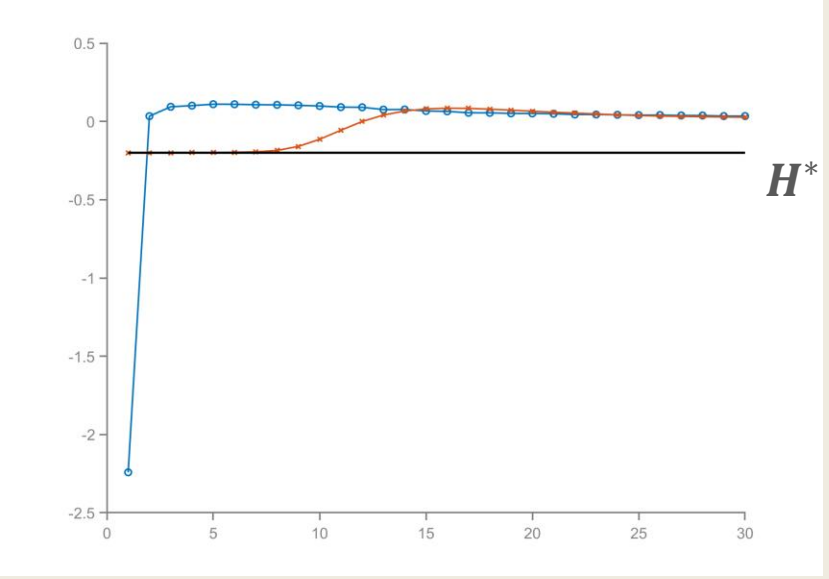
Reserves



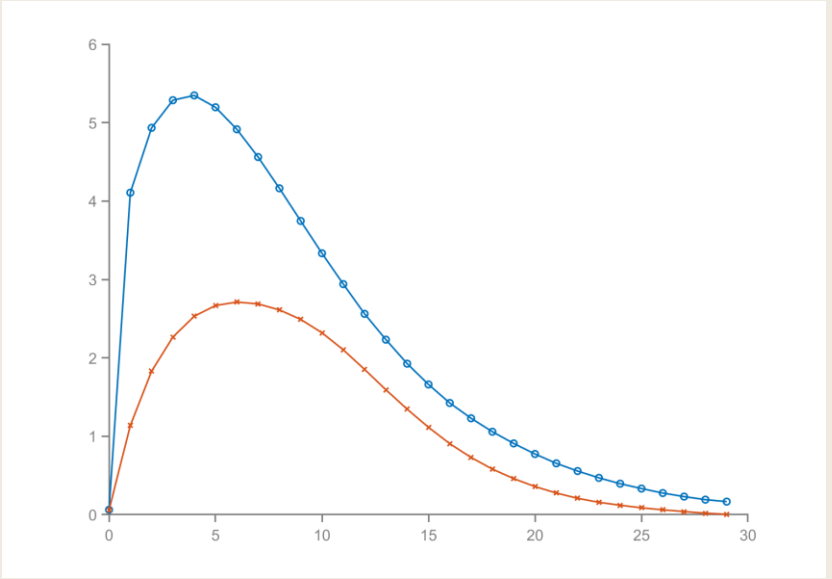
Inflation



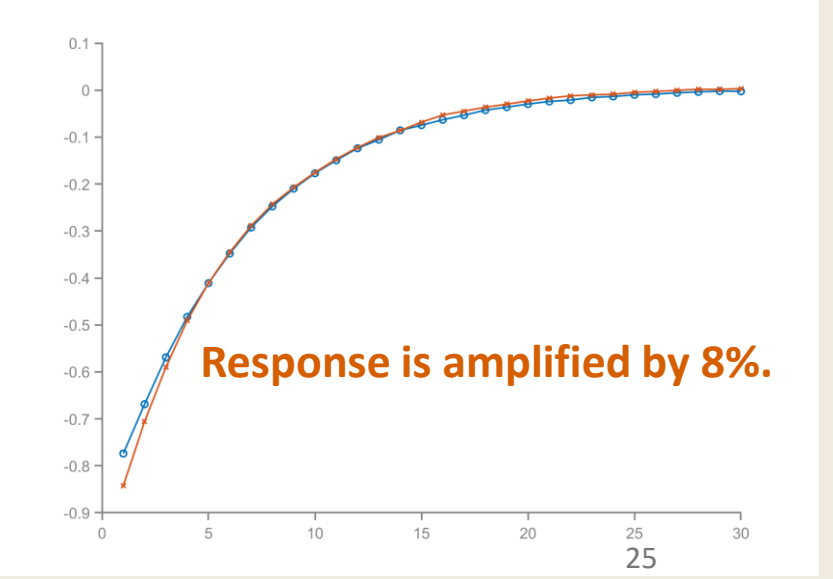
Remittance



Government Bonds



Consumption



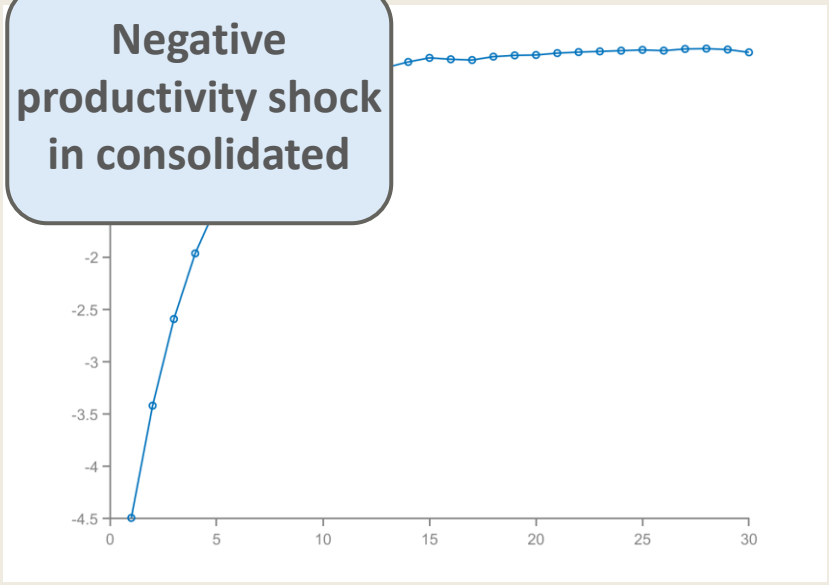
Primary Policy Tool and Central Bank's Role

- After cost-push shock, the primary policy tool is tax break.
- **Central Bank's role to issue reserves helps tax break**.

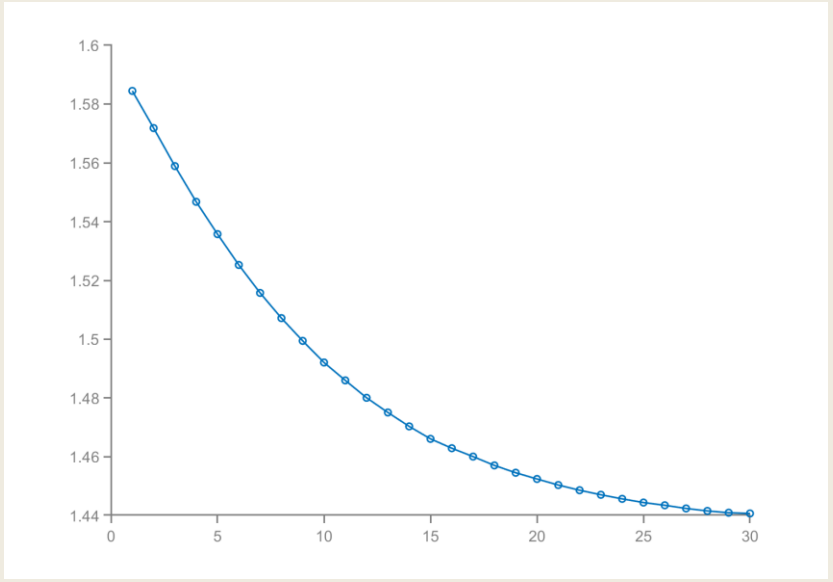
- After productivity shock, **Central Bank's role is to raise nominal interest rate enough**.
- When the household cannot absorb large reserves, the unconsolidated model gives difference.

Negative productivity shock in consolidated

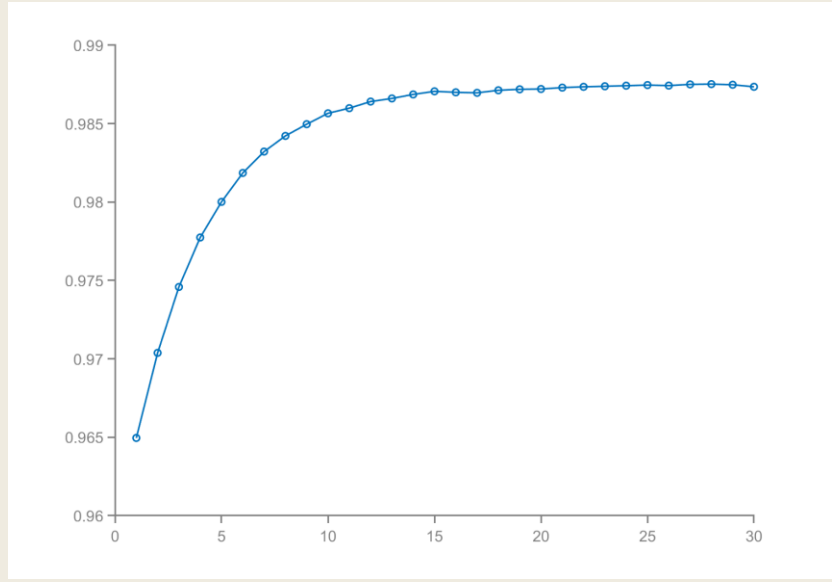
Consumption



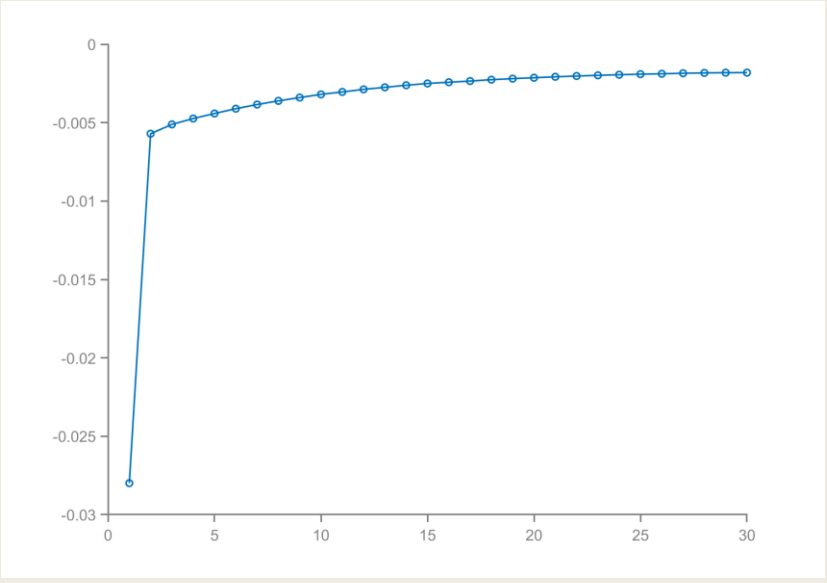
Inflation



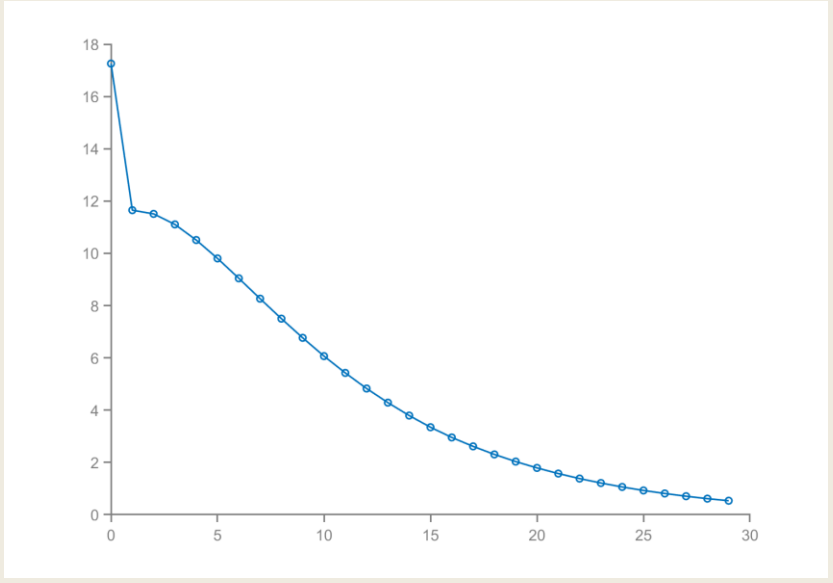
Price of Reserves



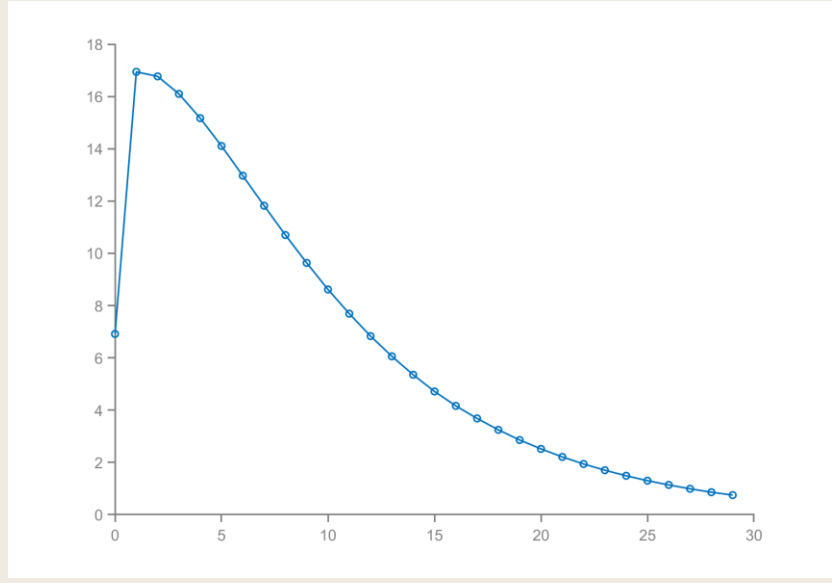
Remittance



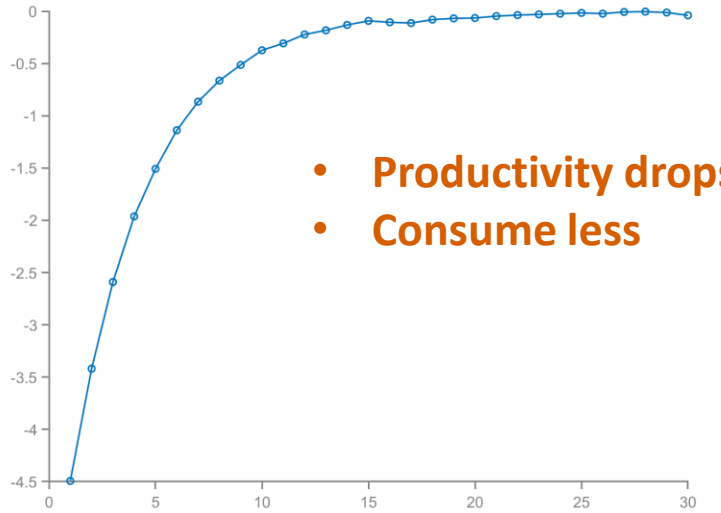
Reserves



Treasury liability

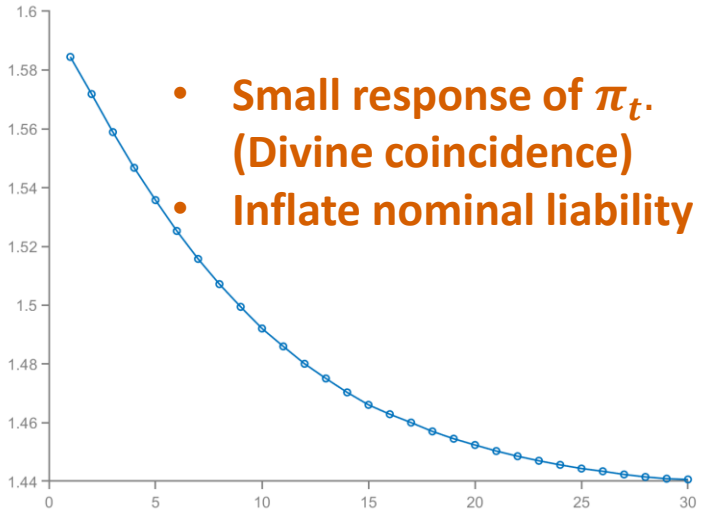


Consumption



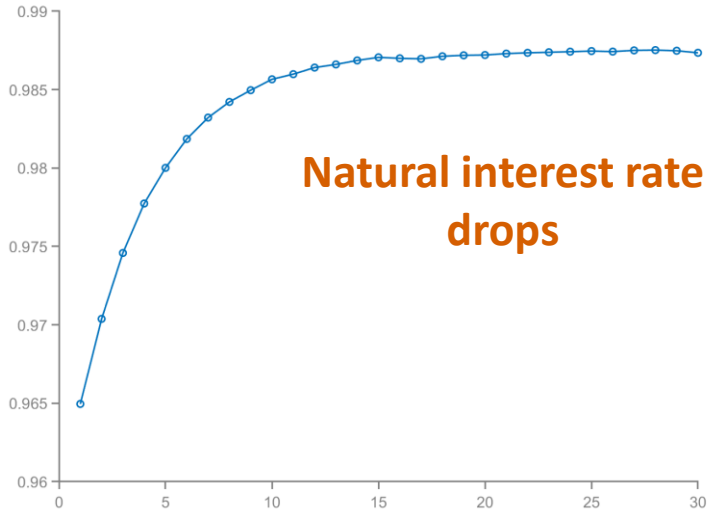
- Productivity drops
- Consume less

Inflation



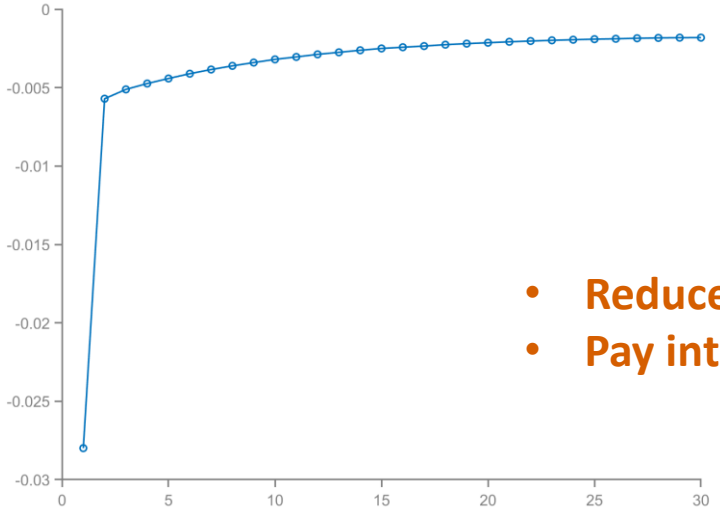
- Small response of π_t. (Divine coincidence)
- Inflate nominal liability

Price of Reserves



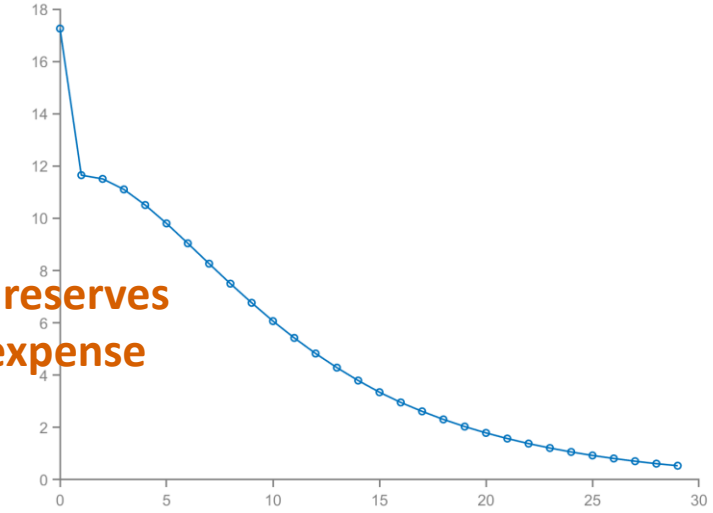
Natural interest rate drops

Remittance

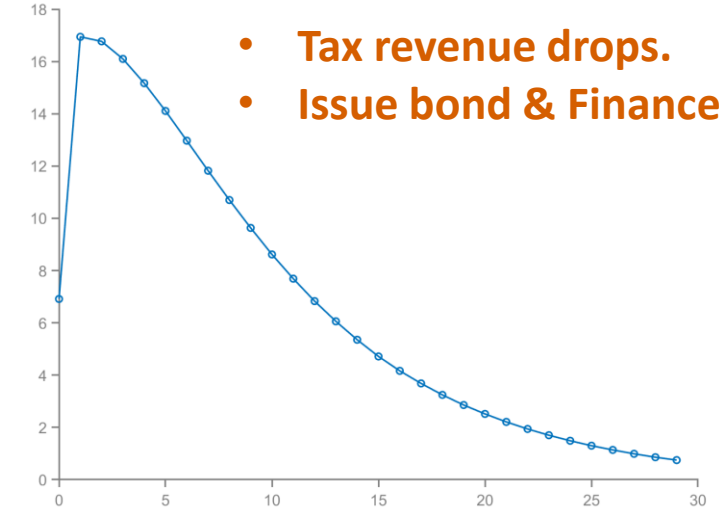


- Reduce large reserves
- Pay interest expense

Reserves

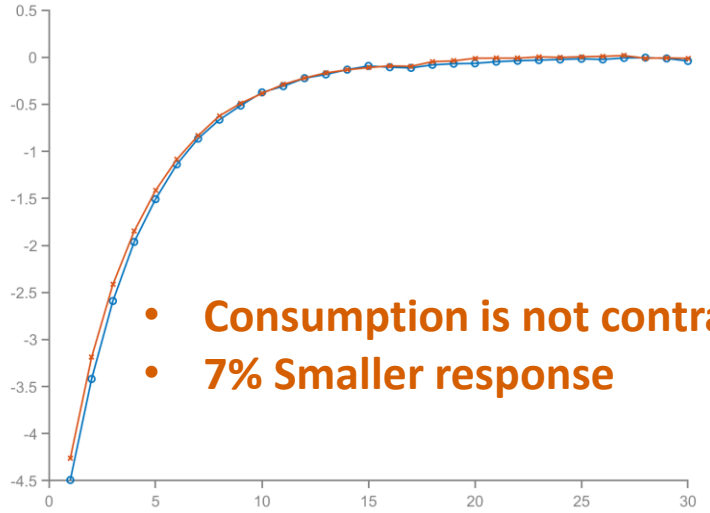


Treasury liability



- Tax revenue drops.
- Issue bond & Finance G_t

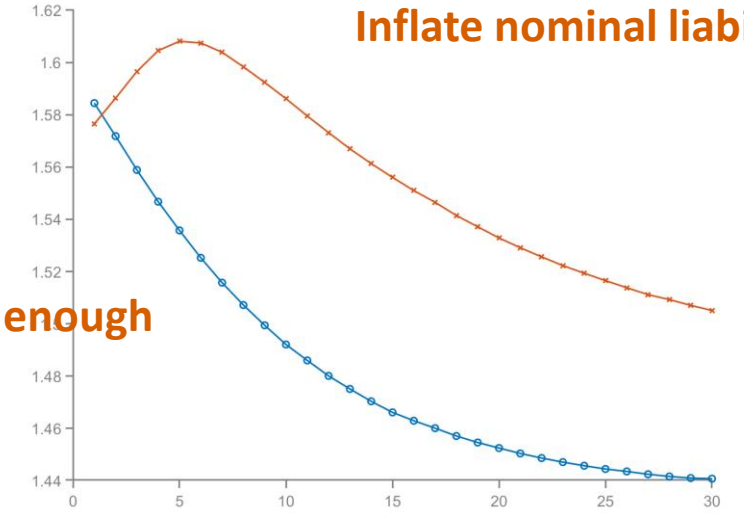
Consumption



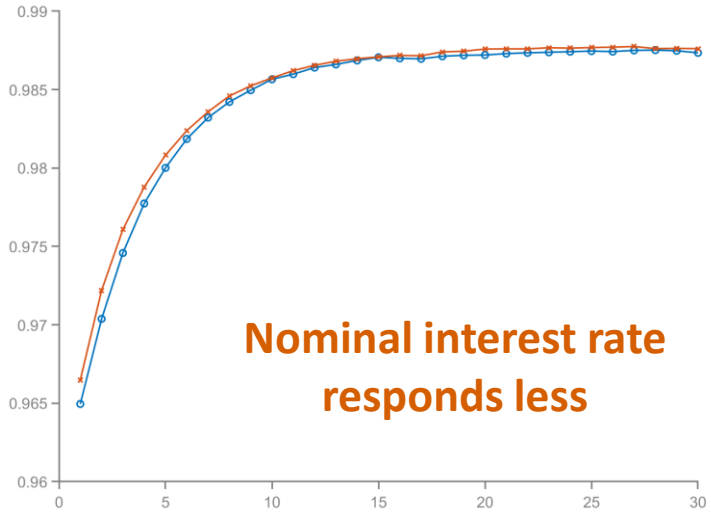
- Consumption is not contracted enough
- 7% Smaller response

Inflation

Inflate nominal liability

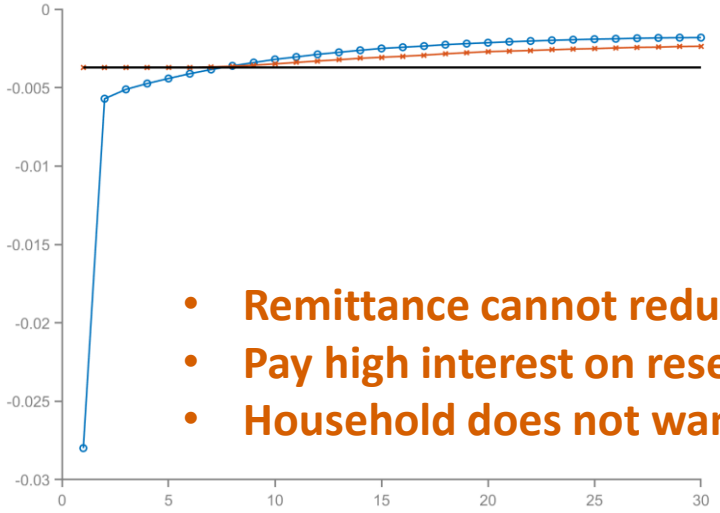


Price of Reserves



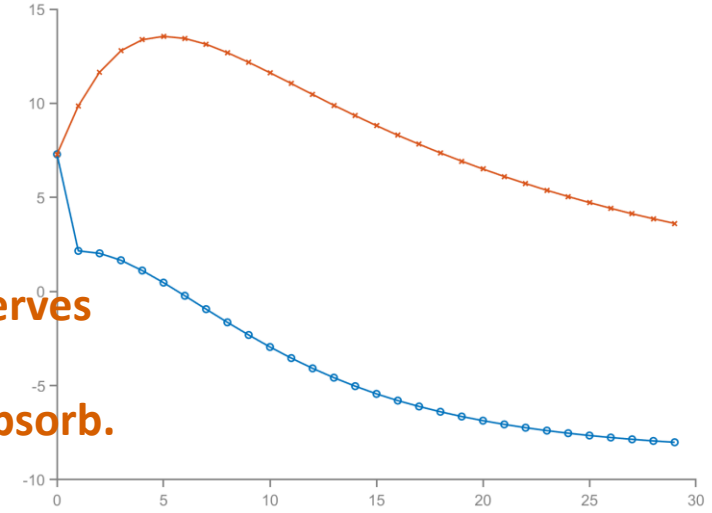
Nominal interest rate responds less

Remittance

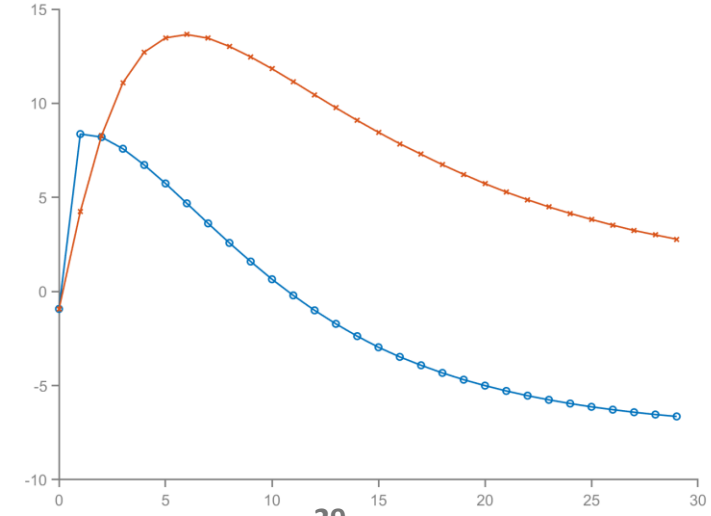


- Remittance cannot reduce reserves
- Pay high interest on reserves.
- Household does not want to absorb.

Reserves



Treasury liability



Dynamic Properties of the Optimal Policy

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

- I simulate the economy in the consolidated and unconsolidated model.
- Compute the variance of consumption, inflation, and tax rate.

- Show the change in volatility in the unconsolidated model compared to the consolidated model.

	Cost-push shocks	Government expenditure shock
Consumption	**+3%**	**+0.6%**
Tax	**-10%**	**+2%**
Inflation	**+3%**	**+2%**

The lack of fiscal backing constrains the size of tax break

The lack of fiscal backing limits tax smoothing

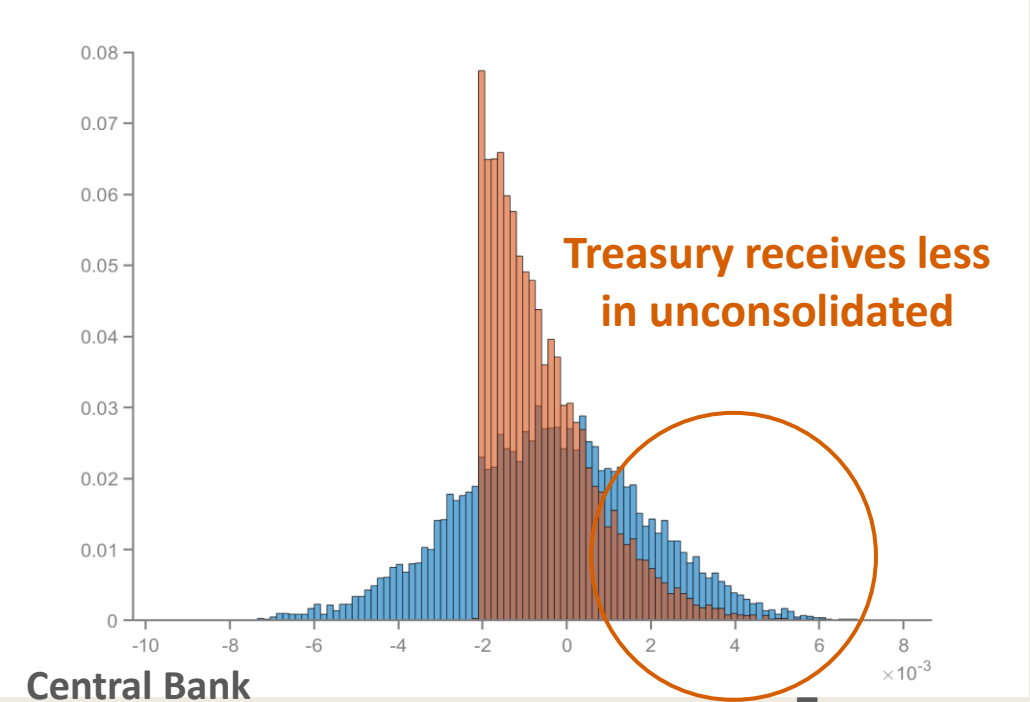
Retained Earnings by Central Banks

- Bank of Japan **retains 5% of profits** and transfers the rest to the Treasury.
- Bundesbank uses its financial buffers to cushion burdens.
- No reason to retain earnings if Central Bank and Treasury are consolidated.

Why do Central Banks transfer less?

Model implications

- A lower bound on remittance makes the upper tail thinner.
- Central Bank knows large reserves cannot be reduced through remittance.
- Less reserves and transfers. **Forward looking decision-making.**



- Simulated the economy with cost-push shock.
- Histogram for remittance in consolidated and unconsolidated.

The welfare gain of fiscal backing

The welfare gain of fiscal backing increases with the size of shock.

- Compute the welfare loss of cost-push shock compared to the steady-state.
- Show the welfare loss (horizontal) on the size of shock (vertical) for consolidated and unconsolidated.
- Fiscal backing can reduce the welfare loss by 20%.

The welfare gain of fiscal backing < 0.01% in consumption equivalence.

- I compute the welfare gain of increasing the lower bound on remittance, H^*.
- Simulate the economy for 1000 periods. Consumption equivalence compared to the case of $H^* = -\infty$.

(Intuition)

- Fiscal backing affects the variance but less the mean.