

A Fiscal Decomposition of Unexpected Inflation: Cross-Country Estimates and Theory

Livio C. Maya

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Introduction: The Fiscal Sources of Unexpected Inflation

■ The Valuation Equation of Public Debt

$$\frac{\text{Market Value of Debt (**Bond Prices**)}}{\text{Price Level}} = \text{Intrinsic Value (**Discounting, Surpluses**)}.$$

■ Unexpected inflation $\Delta E_t \Pi_t$ must accompany news about:

- Bond prices Q_t
- Real surpluses $\{s_{t+k}\}$
- Real discounting $\{R_{t+k}\}$

$$\Delta E_t \Pi_t = \Delta E_t \left[Q_t - \{s_{t+k}\} + \{R_{t+k}\} \right]$$

- If unexpected inflation exists, it must nowcast/forecast some of these variables
- What are these forecasts? How do they change across countries? How can theory explain them?

Introduction: Exercises, Motivation, Results

■ This paper.

1. Estimate a Bayesian-VAR to measure the decomposition for 25 countries
 - Variance decomposition: $\text{var} [\Delta E \Pi] = \text{cov} [\Delta E \Pi, \quad Q + \{-s\} + \{R\}]$
 - "Aggregate demand" shock: recession + low inflation
2. Estimate a New-Keynesian model to reproduce B-VAR decompositions

■ Motivation. How do you read Debt/Price = Discounted Surpluses?

- Active fiscal: *"How does inflation react to changes in discounted surpluses?"*
 - Surpluses x Inflation in a given economy
 - Surpluses x Inflation across countries
 - Role of monetary policy?
 - Theory: which shocks cause inflation surprises?
- Active monetary: *"How should discounted surpluses adjust to unexpected inflation?"*

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Introduction: Preview of Key Results

- The variance of unexpected inflation is accounted for by discounted surpluses (all countries)

$$\underset{> 0}{\text{var} [\Delta E \pi]} = \underset{< 0}{\text{cov} [\Delta E \pi, Q]} + \underset{> 0}{\text{cov} [\Delta E \pi, \{-s\} + \{R\}]}$$

- Most relevant terms (Surplus-to-GDP, GDP growth and Real discounting) vary
 - Monetary policy trades current for future unexpected inflation
- Lower inflation in recessions: low discounting + higher subsequent surpluses
- Productivity shocks reproduce findings in NK model
 - Policy shocks do not
- Different policy rules explain differences in variance decomposition across countries

■ **Fiscal Theory of the Price Level.** Cochrane (2022a) and Cochrane (2022b).

- Analysis of multiple countries + more general debt instruments
- NK model estimated to reproduce decompositions + Productivity shocks

Leeper (1991), Sims (1994), Cochrane (1998), Cochrane (2005), Sims (2011), Leeper and Leith (2016), Bassetto and Cui (2018), Cochrane (2022c), Brunnermeier et al. (2022).

■ **Monetary-Fiscal Interaction.**

Cagan (1956), Sargent and Wallace (1981), Hall and Sargent (1997), Hall and Sargent (2011), Jiang et al. (2019), Corsetti et al. (2019), Sunder-Plassmann (2020), Du et al. (2020), Akhmadieva (2022)

■ **Empirical Finance** (Decomposition of Returns)

Campbell and Shiller (1988), Cochrane (1992), Campbell and Ammer (1993), Chen and Zhao (2009).

Introduction: A Map of the Road

1. Fiscal Decomposition Derivation

- Simple environment + General decomposition

2. Bayesian-VAR

- Empirical model + Variance decomposition + "Aggregate demand" recession

3. Theory

- Closed economy + Productivity shocks + Policy rules + Open economy

Fiscal Decomposition: The Valuation Equation

- Environment with discrete time + single good (price P_t) + households and government
- One-period nominal public bonds (price Q_t)
- **In the morning**, the government:
 - redeems bonds B_{t-1} for currency
 - announces real taxes s_t (payable in currency)
 - announces sale of B_t new bonds (payable in currency)
- **In the afternoon**, households trade goods, purchase bonds, pay taxes
- Market clearing + No Money Holding $M = 0$:

$$B_{t-1} = P_t s_t + Q_t B_t$$

Fiscal Decomposition: The Valuation Equation

$$B_{t-1} = P_t s_t + Q_t B_t$$

- *Ex-post* real discounting $\beta_t = Q_t(P_{t+1}/P_t)$ $\beta_{t,t+k} = \prod_{\tau=t}^{t+k} \beta_\tau$
- Iterate law of motion forward:

$$\frac{B_{t-1}}{P_t} = \sum_{k=0}^p \beta_{t,t+k-1} s_{t+k} + \beta_{t,t+p} \frac{B_{t+p}}{P_{t+p+1}}$$

- **Key Assumption:** $\lim_{\tau \rightarrow \infty} \beta_{t,\tau} \frac{B_\tau}{P_{\tau+1}} = 0$ almost surely (**No bubbles**)
 - In Macro models: transversality conditions + no Ponzi
- The valuation equation of public debt

$$\frac{B_{t-1}}{P_t} = \sum_{k=0}^{\infty} E_t [\beta_{t,t+k-1} s_{t+k}]$$

Fiscal Decomposition: In the Simplest Environment

- Nominal rate $1 + i_t = 1/Q_t$ and real interest $r_t = i_t - E_t\pi_{t+1}$
- End-of-period real debt v_t

$$\underbrace{\frac{1}{\beta}v_{t-1} + \frac{v}{\beta}(i_{t-1} - \pi_t)}_{B_{t-1}/P_t} = s_t + v_t = \sum_{k=0}^{\infty} \beta^k E_t s_{t+k} - \frac{v}{\beta} \sum_{k=1}^{\infty} \beta^k E_t r_{t+k}$$

Linearized valuation equation (all variable in deviations from their mean)

- Innovations $\Delta E_t = E_t - E_{t-1}$ decomposition:

$$\Delta E_t \pi_t = -\frac{\beta}{v} \sum_{k=0}^{\infty} \beta^k \Delta E_t s_{t+k} + \sum_{k=0}^{\infty} \beta^k \Delta E_t r_{t+k}$$

- Variance decomposition:

$$\text{var} [\Delta E_t \pi_t] = -\text{cov}_{\pi} \left[\frac{\beta}{v} \sum_{k=0}^{\infty} \beta^k \Delta E_t s_{t+k} \right] + \text{cov}_{\pi} \left[\sum_{k=0}^{\infty} \beta^k \Delta E_t r_{t+k} \right]$$

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Fiscal Decomposition: Currency and Term Structures + Growth

- Real **market value** debt-to-GDP v_t , surplus-to-GDP s_t and GDP growth g_t (stationarity!)
- Bonds (j, n) promises one unit of currency j after n periods Currencies
 - Nominal bonds
 - Real bonds (currency denomination = final goods)
 - US Dollar bonds

Constant structure $\{\delta_j\}, \{\omega_j^n\}$

- Bond price $Q_{j,t}^n$, excess return $rx_{j,t}$ $1 + \text{return}_{j,t} = 1 + rx_{j,t} + i_{j,t-1} = \frac{\sum_n Q_{j,t}^{n-1} B_{j,t-1}^n}{\sum_n Q_{j,t-1}^n B_{j,t-1}^n}$
(one-period bonds $\implies rx = 0$)
- Debt law of motion:

$$\frac{v_{t-1}}{\beta} + \frac{v}{\beta} \left[-g_t + \sum_j \delta_j (rx_{j,t} + i_{j,t-1} + \Delta h_{j,t} - \pi_{j,t}) \right] = v_t + s_t$$

Fiscal Decomposition of Unexpected Inflation

- Ex-post real return $r_{j,t} = rx_{j,t} + i_{j,t-1} + \Delta h_{j,t} - \pi_{j,t}$

$$\Delta E_t \pi_t = \underbrace{\left[\Delta E_t rx_t + \sum_{j \neq N} \frac{\delta_j}{\delta} \Delta E_t r_{j,t} \right]}_{\text{Innovation to Bond Prices}} - \frac{\beta}{\delta v} \underbrace{\left[\sum_{k=0}^{\infty} \beta^k \Delta E_t s_{t+k} + \frac{v}{\beta} \sum_{k=0}^{\infty} \beta^k \Delta E_t g_{t+k} - \frac{v}{\beta} \sum_{k=1}^{\infty} \sum_j \delta_j \beta^k \Delta E_t r_{j,t+k} \right]}_{\text{Innovation to the Intrinsic Value of Debt}}$$

$$\equiv d_1(rx) + d_1(r_0) - d_1(s) - d_1(g) + d_1(r)$$

- Variance decomposition.

$$\text{var} [\Delta E_t \pi_t] = \text{cov}_{\pi} [d_1(rx)] + \text{cov}_{\pi} [d_1(r_0)] - \text{cov}_{\pi} [d_1(s)] - \text{cov}_{\pi} [d_1(g)] + \text{cov}_{\pi} [d_1(r)]$$

Bayesian-VAR: Data and Model

- Annual data on **observables** \tilde{x}_t

$$x_t^{OBS} = \begin{bmatrix} i_t & \text{(Nominal Interest)} \\ \pi_t & \text{(CPI Inflation)} \\ v_t^b & \text{(Par-Value Debt-to-GDP)} \\ g_t & \text{(GDP growth)} \\ \Delta h_t & \text{(Chg. Real Exchange Rate)} \end{bmatrix}$$

- 25 countries (samples starting at 1945, 1960, 1975, 1998)
- General VAR

$$X_t = AX_{t-1} + Ke_t$$

- Decompose $X_t' = [x_t^{OBS'} \ x_t^{NOT'}]$

$$X_t = \begin{bmatrix} x_t^{OBS} \\ x_t^{NOT} \end{bmatrix} = \begin{bmatrix} a & 0 \\ b & c \end{bmatrix} \begin{bmatrix} x_{t-1}^{OBS} \\ x_{t-1}^{NOT} \end{bmatrix} + \begin{bmatrix} I \\ k \end{bmatrix} e_t$$

Bayesian-VAR: Empirical Challenges and Solutions

1. Explosive debt dynamics in 1960-2020 implies unstable OLS VARs

$$\tilde{x}_t = \tilde{a} \tilde{x}_{t-1} + \tilde{b} \tilde{u}_{t-1} + \varepsilon_t$$

$$\tilde{u}_t = \tilde{a}_u \tilde{u}_{t-1} + \varepsilon_{u,t}$$

- Estimate US model (\tilde{a}_u) by OLS (stable!)
- Estimate (\tilde{a}, \tilde{b}) with a Bayesian-Regression

$$\tilde{a}^{BAY} = (X'X + \lambda^{-1})^{-1}(X'X \tilde{a}^{OLS} + \lambda^{-1} \tilde{a}^{PRIOR})$$

λ maximizes the marginal distribution $p(\text{data})$ and **ensures stability**

2. Public finance data do not respect law of motion of public debt

- Define surplus from the law of motion: $s_t = \frac{v_{t-1}}{\beta} - v_t + \frac{v}{\beta} \left[-g_t + \sum_j \delta_j (rx_{j,t} + i_{j,t-1} + \Delta h_{j,t} - \pi_{j,t}) \right]$

3. No data on the **market** value of debt, only its **par** value (v_t^b) Public Finances Model

- Model for market vs par value (Cox (1985)): $v_t = v_t^b + \frac{v}{\beta} \sum_j \delta_j (rx_{j,t} + i_{j,t-1} - i_{j,t-1}^b)$

4. No data on bond returns Geometric Term Structure

- Geometric maturity structure: $rx_{j,t} + i_{j,t-1} = (\omega_j \beta) q_{j,t} - q_{j,t-1}$

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4. No data on bond returns Geometric Term Structure

- Geometric maturity structure: $rx_{j,t} + i_{j,t-1} = (\omega_j \beta) q_{j,t} - q_{j,t-1}$

Bayesian-VAR: Variance Decomposition

- **Proposition.** The variance decomposition

$$1 = \frac{\text{cov}_\pi \left[d_1(rx) \right]}{\text{var} [\Delta E_t \pi_t]} + \frac{\text{cov}_\pi \left[d_1(r_0) \right]}{\text{var} [\Delta E_t \pi_t]} - \frac{\text{cov}_\pi \left[d_1(s) \right]}{\text{var} [\Delta E_t \pi_t]} - \frac{\text{cov}_\pi \left[d_1(g) \right]}{\text{var} [\Delta E_t \pi_t]} + \frac{\text{cov}_\pi \left[d_1(r) \right]}{\text{var} [\Delta E_t \pi_t]}$$

is equivalent to the innovations decomposition applied to VAR shock $\text{Proj}(e \mid \Delta E_t \pi_t = 1)$

$$1 = \Delta E_t \pi_t \equiv d_1(rx) + d_1(r_0) - d_1(s) - d_1(g) + d_1(r)$$

- *"Given 1% unexpected inflation, how do we change our nowcast/forecast of the surplus, discounting and bond prices?"*

Bayesian-VAR: Variance Decomposition

Country	$\Delta E_t \pi_t =$	$\Delta E_t(\text{Bond Prices})$		$-\Delta E_t(\text{Intrinsic Value of Debt})$		
		$d_1(r_0)$	$d_1(rx)$	$-d_1(s)$	$-d_1(g)$	$d_1(r)$
United States	1	*0.03	*-0.78	0.57	0.23	0.96
<i>Advanced - 1960 Sample</i>						
Canada	1	*-0.11	*-1.59	0.62	*1.22	0.86
Denmark	1	*-0.29	-0.30	0.42	-0.04	1.21
Japan	1	0	*-0.52	*1.60	-0.38	0.30
Norway	1	*-0.01	*-0.36	0.60	0.47	0.30
Sweden	1	-0.15	*-0.93	-0.34	*0.98	*1.42
United Kingdom	1	*0.52	*-0.73	*2.89	*0.97	*-2.65
<i>Advanced - 1973 Sample</i>						
Australia	1	*0.07	*-0.76	*2.09	0.66	-1.06
New Zealand	1	-0.10	*-0.86	0.40	*0.87	0.68
South Korea	1	-0.01	*-0.45	*1.91	0.17	-0.62
Switzerland	1	0	*-0.69	0.90	*0.91	-0.12

(a) Advanced Economies

Country	$\Delta E_t \pi_t =$	$\Delta E_t(\text{Bond Prices})$		$-\Delta E_t(\text{Intrinsic Value of Debt})$		
		$d_1(r_0)$	$d_1(rx)$	$-d_1(s)$	$-d_1(g)$	$d_1(r)$
<i>Emerging - 1998 Sample</i>						
Brazil	1	-0.26	*-0.22	-1.46	1.05	1.89
Chile	1	-3.80	-1.33	8.95	-5.71	2.88
Colombia	1	1.51	*-0.96	1.39	-1.09	0.15
Czech Republic	1	*-0.16	*-0.37	-2.31	2.42	1.42
Hungary	1	*-0.57	*-0.93	-0.98	1.60	1.88
India	1	*0.17	*-0.46	1.54	0.05	-0.30
Indonesia	1	*-2.59	*-1.07	1.69	*2.61	0.35
Israel	1	-0.06	*-0.78	-0.55	*1.51	0.88
Mexico	1	-0.02	*-0.74	1.41	0.03	0.32
Poland	1	*-0.45	*-1.15	0.87	-0.39	*2.11
Romania	1	-0.40	*-0.96	2.24	0.42	-0.31
South Africa	1	0.36	*-0.51	1.58	0.25	-0.68
Turkey	1	0.37	*-0.37	-1.18	-0.15	*2.33
Ukraine	1	0	*-0.77	0.65	0.41	*0.70

(b) Emerging Economies

Bayesian-VAR: Variance Decomposition - Takeaways

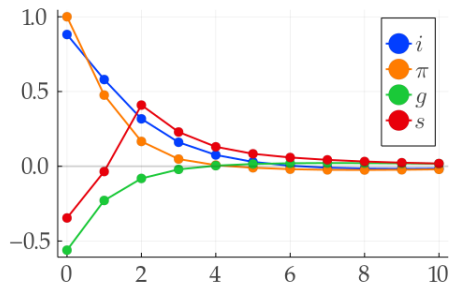


Figure: IRF - Brazil

- Unexpected inflation accounted for by variation in the intrinsic value of debt
- Surplus-to-GDP, GDP growth and real discounting...
 - ...account for unexpected inflation alone in 0/25
 - ...have a positive contribution in 18+/25
- Fiscal roots of inflation do not imply connection between fiscal policy and unexpected inflation
- Nominal bond price dynamics reduce unexpected inflation variance 25/25
 - Effects of monetary policy!

Bayesian-VAR: "Aggregate Demand" Recession

- "Aggregate demand" recessions (Great Recession in 2008) feature:
 - Low inflation
 - Low growth
 - Fiscal deficits (often)
- Does that deny the fiscal sources of inflation?
- Where does unexpected (dis)inflation come from?
- Scenario:

$$\Delta E_t g_t = -1 \quad \Delta E_t \pi_t = -0.5$$

VAR Shock: $\text{Proj}(e \mid \Delta E_t g_t = -1, \Delta E_t \pi_t = -0.5)$

Bayesian-VAR: "Aggregate Demand" Recession

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		$d_1(r_0)$	$d_1(rx)$	$-d_1(s)$	$-d_1(g)$	$d_1(r)$
United States	-0.50	*0.03	*1.00	-0.65	*1.32	*-2.21
<i>Advanced - 1960 Sample</i>						
Canada	-0.50	*0.14	*2.21	-0.45	0.30	*-2.70
Denmark	-0.50	*0.20	*0.86	-2.64	*2.75	-1.67
Japan	-0.50	0	*0.83	*-1.51	*1.64	*-1.46
Norway	-0.50	0	*0.63	-1.36	*1.72	-1.49
Sweden	-0.50	*0.41	*1.22	-0.65	0.87	*-2.35
United Kingdom	-0.50	0.11	*2.54	-2.20	0.73	-1.68
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Australia	-0.50	0.06	*1.54	-1.46	0.66	-1.31
New Zealand	-0.50	*0.26	*0.87	-0.84	0.63	-1.42
South Korea	-0.50	*0.10	*0.70	*-3.17	*1.74	0.14
Switzerland	-0.50	0	*1.18	*-0.93	-0.07	-0.67

(a) Advanced Economies

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Chile	-0.50	*15.78	*2.94	-30.50	30.54	-19.26
Colombia	-0.50	1.86	*0.67	-10.90	*7.57	0.31
Czech Republic	-0.50	*0.37	*0.61	-0.07	0.25	-1.65
Hungary	-0.50	*0.99	*0.60	10.82	-5.29	-7.63
India	-0.50	-0.03	0.13	-1.16	0.71	-0.15
Indonesia	-0.50	*8.23	-0.55	*-11.24	1.42	1.64
Israel	-0.50	*1.79	0.37	-3.18	1.17	-0.65
Mexico	-0.50	*1.69	*0.81	*-4.56	*1.94	-0.38
Poland	-0.50	*0.87	*1.00	-0.14	1.30	*-3.53
Romania	-0.50	*2.08	0.21	*-8.16	2.05	3.31
South Africa	-0.50	-0.10	0.35	*-30.02	*11.15	*18.13
Turkey	-0.50	*0.99	*0.23	0.64	0.52	*-2.88
Ukraine	-0.50	0	-0.68	-3.22	*1.92	1.48

(b) Emerging Economies

Bayesian-VAR: "Aggregate Demand" Recession - Takeaways

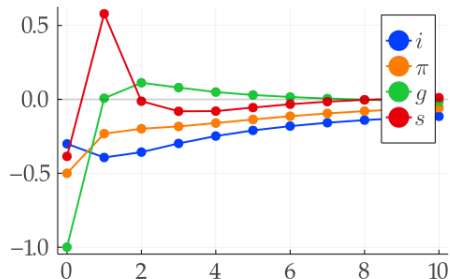


Figure: IRF - United States

- Lower inflation follows from...
 - lower discounting (monetary policy) in 19/25
 - larger surplus-GDP ratios, current or in the future in 22/25
- COVID: what if governments reacted to a recession by credibly reducing $\{s\}$ permanently?
- Direction of causality?

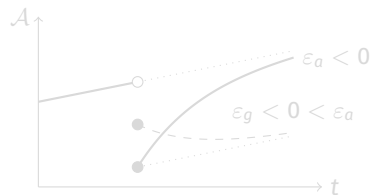
The New-Keynesian Model: Setup

- B-VAR decompositions not structural: all shocks are reduced-form
- Theory: How far do we need to go? **Not much!**
- Two-country NK model:
 - Home economy with $n \rightarrow 0$ households and firms (**small and open**)
 - Foreign economy with $1 - n \rightarrow 1$ households and firms (**large and "closed"**)
- **The Standard.** Intertemporal substitution + Calvo rigidity
- **The New.** Production function $\mathcal{A}_t N = \tau_t A_t N$ (Home), $\mathcal{A}_t^* N = \tau_t^* A_t^* N$ (Foreign)

(Trend component) $\log \tau_t = \log \tau_{t-1} + u_{g,t}$

(AR(1) component) $a_t = \rho_a a_{t-1} + \varepsilon_{a,t}$

$a_t^* = \rho_a a_{t-1}^* + \varepsilon_{a,t}^*$



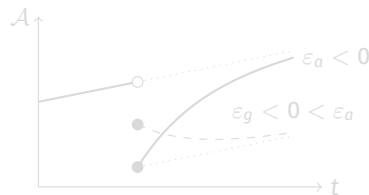
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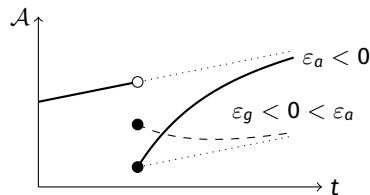
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The New-Keynesian Model: The Foreign, Closed Economy

■ Private Sector

$$y_t^* = E_t y_{t+1}^* - \gamma [i_t^* - E_t \pi_{t+1}^*] + E_t u_{g,t+1}$$

$$\pi_t^* = \beta E_t \pi_{t+1}^* + \kappa y_t^* - \kappa_a a_t^*$$

$$g_t^* = y_t^* - y_{t-1}^* + u_{g,t}$$

Why Trend? Growth

■ Unexpected inflation indeterminacy? FTPL.

■ Monetary and Fiscal Policy

$$i_t^* = \phi_\pi \pi_t^* + \phi_g g_t^* + \varepsilon_{i,t}^*$$

$$s_t^* = \rho_s s_{t-1}^* + \tau_\pi \pi_t^* + \tau_g g_t^* + \varepsilon_{s,t}^*$$

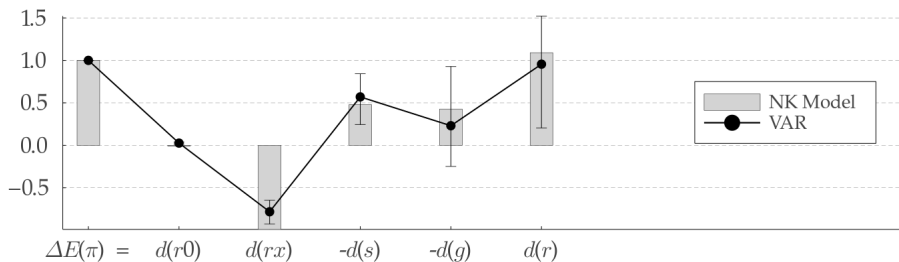
■ GMM for US moments

$$\text{Min}_{\Psi} \quad \alpha_1 \|\mathcal{D}_{VAR} - \mathcal{D}_{NK}(\Psi)\| + \alpha_2 \|\mathcal{M} - \mathcal{M}_{NK}(\Psi)\| \quad \text{s.t. } \Psi \in \Theta$$

Parameters

The New-Keynesian Model: Reproducing the Variance Decomposition

- **Result.** AR(1) productivity shocks $\varepsilon_{a,t}$ **alone** reproduce the **variance decomposition** with positive contributions from surplus-to-output, growth and real interest terms



Target: United States. **Only AR(1) productivity shocks.**

The New-Keynesian Model: Reproducing the Variance Decomposition

$$1 = \Delta E_t \pi_t = d(rx) - d(s) - d(g) + d(r)$$

■ Key Ingredients

- Persistent shock: $\rho_a = 0.98$
- Countercyclical deficits: $\tau_g = 0.7$
- Strong Taylor: $\phi_\pi = 0.8$

■ What is the story?

- Low productivity leads to a recession

$$d(g) < 0$$

- Government raises deficit to fight recession

$$d(s) < 0$$

- Monetary policy raises nominal interest

$$d(rx) < 0$$

$$d(r) > 0$$

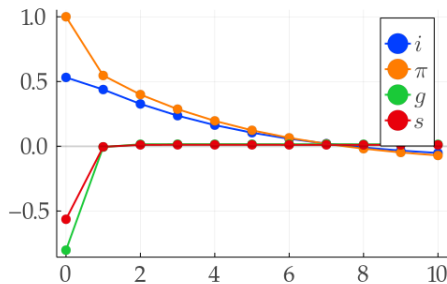


Figure: IRF to $\Delta E_t \pi_t = 1$ ($\varepsilon_{a,t} = -1.15$)

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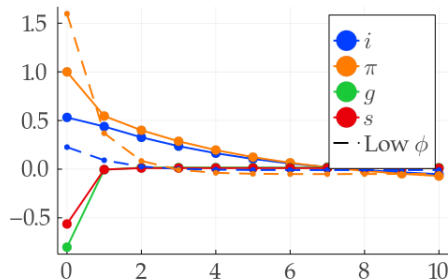
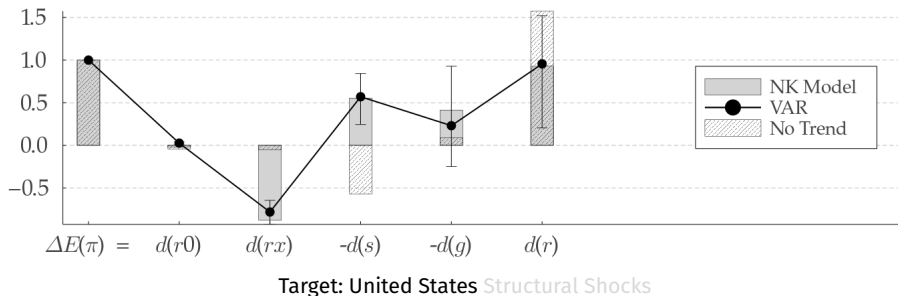


Figure: IRF to $\Delta E_t \pi_t = 1$ ($\varepsilon_{a,t} = -1.15$)

The New-Keynesian Model: Reproducing the Recession Decomposition

$$\Delta E_t g_t = -1 \quad \Delta E_t \pi_t = -0.5$$

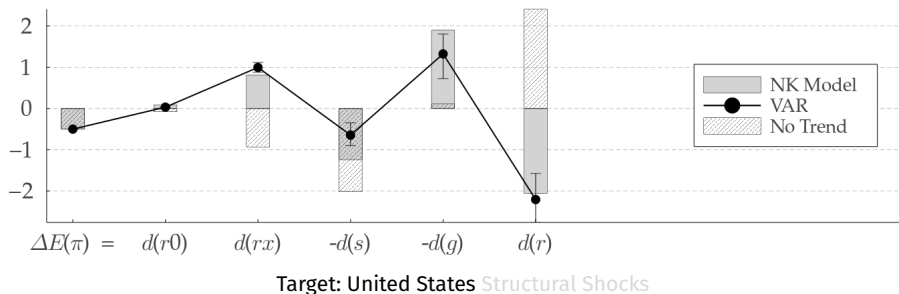
- **Result.** In the absence of trend shocks, NK model fails to replicate the variance and recession decompositions. Policy shocks do not help.
- **Result.** The model with trend shocks reproduces the **recession decomposition** without policy shocks.



The New-Keynesian Model: Reproducing the Recession Decomposition

$$\Delta E_t g_t = -1 \quad \Delta E_t \pi_t = -0.5$$

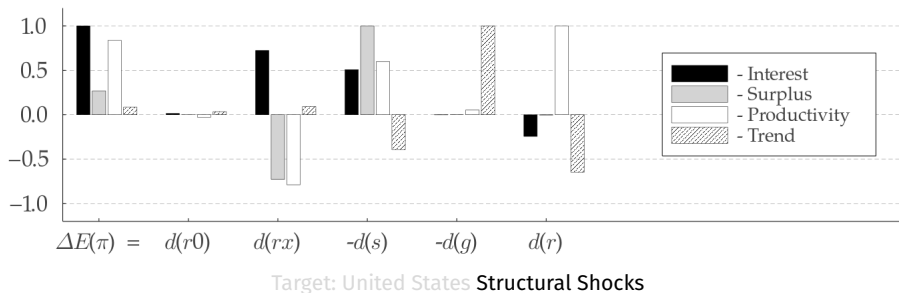
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The New-Keynesian Model: Reproducing the Recession Decomposition

$$\Delta E_t g_t = -1 \quad \Delta E_t \pi_t = -0.5$$

- **Result.** In the absence of trend shocks, NK model fails to replicate the variance and recession decompositions. Policy shocks do not help.
- **Result.** The model with trend shocks reproduces the **recession decomposition** without policy shocks.



The New-Keynesian Model: Reproducing the Recession Decomposition

$$-0.5 = \Delta E_t \pi_t = d(rx) - d(s) - d(g) + d(r)$$

■ Key Ingredients

- Quiet monetary shocks: $\sigma_i = 0.05$
- Trend + AR(1) shocks: $\sigma_g = 2.6$, $\sigma_a = 1.4$
- Strong Taylor: $\phi_\pi = 0.93$

■ Intuition

- AR(1) shocks reproduce variance decomposition
- Monetary policy shocks generate wrong $d(rx)$

■ Recession ($\varepsilon_a = 0.5$, $\varepsilon_g = -1.3$)

- Recession and lower interest

$$d(g) > 0 \quad d(rx) > 0$$

- Low **detrended** marginal costs: $\pi_t < E_t \pi_{t+1}$
- Low/increasing inflation + Taylor guarantee low real interest

$$r_t = i_t - E_t \pi_{t+1} \approx \pi_t - E_t \pi_{t+1} < 0$$

Marginal Costs

vs B-VAR IRF

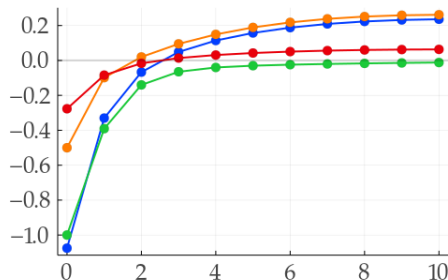


Figure: IRF to $\Delta E_t g_t = -1$, $\Delta E_t \pi_t = -0.5$

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Appendix: Public Debt Currency Denomination

Return

Symbol	Description	Nominal Debt	Real Debt	Dollar Debt
j	Index Symbol Notation	N δ, ω	R δ_R, ω_R	D δ_D, ω_D
P_j	Price per Good	P	1	P_t^{US}
\mathcal{E}_j	Nominal Exchange Rate	1	P	Dollar NER
H_j	Real Exchange Rate	1	1	Dollar RER
π_j	Log Variation in Price	π	0	π_t^{US}
Δh_j	Log Real Depreciation	0	0	Δh_t

Table: Public Debt Denomination

Appendix: Public Finances Model

[Return](#)

Appendix: Geometric Term Structure

Return

- To each currency portfolio j , fixed geometric maturity structure:

$$B_{j,t}^n = \omega_j B_{j,t}^{n-1}$$

- Total return on currency- j portfolio:

$$1 + rx_{j,t} + i_{j,t-1} = \frac{1 + \omega_j Q_{j,t}}{Q_{j,t-1}} \implies \boxed{rx_{j,t} + i_{j,t-1} = (\omega_j \beta) q_{j,t} - q_{j,t-1}}$$

- Assume **constant risk premia** $E_t rx_{j,t+1} = 0$

$$\boxed{q_{j,t} = (\omega_j \beta) E_t q_{j,t+1} - i_{j,t}} = - \sum_{k=0}^{\infty} (\omega_j \beta)^k E_t i_{j,t+k}$$

Appendix: NK Model Parameters

[Return](#)

Appendix: Why Trend Shocks? The Growth Component

[Return](#)

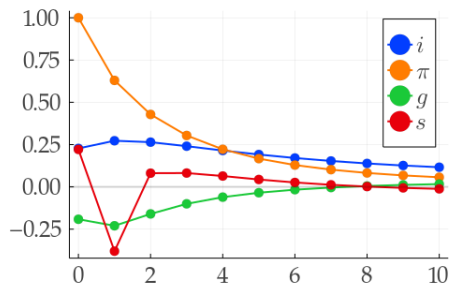
Appendix: Estimated Moments

NK Simple

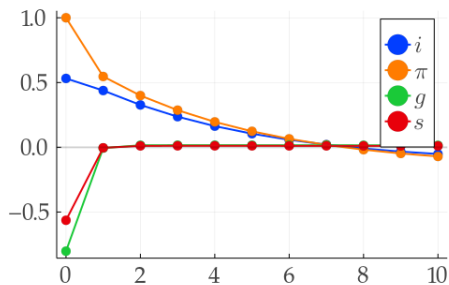
NK Full

Appendix: Simple Model - US Data vs Model

NK Simple



(a) B-VAR



(b) NK Model (Only Prod. Shocks)

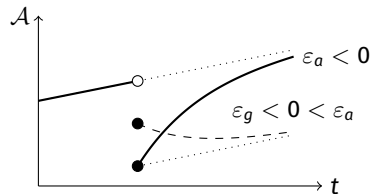
Appendix: Marginal Costs

NK Simple

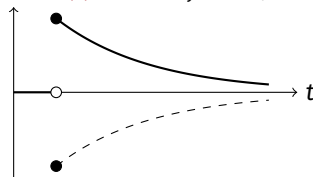
■ AR(1) Productivity Shock

- High marginal costs + strong Taylor rule ($\phi_\pi \approx 1$):

$$i_t \approx \underbrace{\pi_t > E_t \pi_{t+1}}_{mc_t > 0} \implies r_t = i_t - E_t \pi_{t+1} > 0$$



(a) Productivity Path \mathcal{A}_t



(b) $-a_t$ or Mg. Cost at fixed wages