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

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Introduction

- What drives innovations to the price level?
- Sources of inflation variation
- Focus on unexpected inflation $\Delta E_t \pi_t$
  - Campbell and Ammer (1993)
  - Internal consistency of expectations
- Breakdown of valuation equation of public debt

Fiscal Connection?

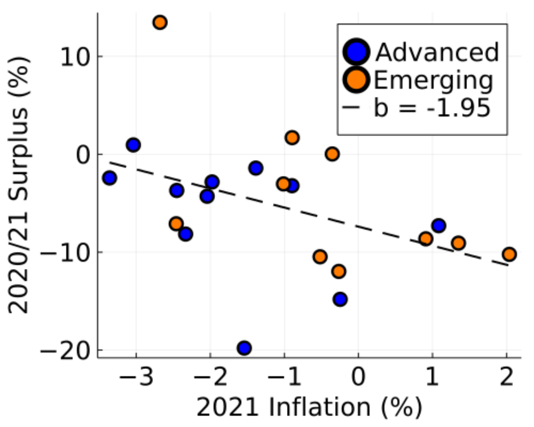

Figure: COVID Inflation - 21 countries in sample

Valuation Equation of Public Debt

- Stock market - Campbell and Ammer (1993)

$$\text{Stock price} = \text{Discounted Dividends}$$

$$\Delta E_t\,[\text{Stock price}] = \Delta E_t\,[\text{Dividends}] - \Delta E_t\,[\text{Disc Rates}]$$

- Micro-founded monetary models

$$\frac{\textbf{Bond Prices} \times \text{Bonds}}{\textbf{Price Level}} = \sum_t \frac{\textbf{Surpluses}_t}{\textbf{Discount}_t}$$

$$\Delta E_t\,[\text{Bond Price}] - \Delta E_t\,[\text{Price}] = \Delta E_t\,[\text{Surplus}] - \Delta E_t\,[\text{Disc}]$$

Exercises

- Generaline Cochrane (2022a)'s decompositions
  - Add real debt
- Public finances model
  - Estimates of bond prices
  - Surpluses consistent with flow equation of debt
  - Par value → Market value of debt
- Bayesian estimation of vector autoregressions
  - 21 countries (advanced, emerging)

Exercises

- Fiscal decompositions
  - Inflation shock: $\Delta E_t \pi_t = 1$
  - Discounted surpluses shock: ΔE_t [Disc Surplus] $= -1$
- New-Keynesian Model
  - Empirically consistent surplus policy rule
  - Persistent output shocks

Motivation + Results

- Measures not structural
- Stylized facts to be matched by theory
- In most countries:
  - Main source of inflation variation: discount rates
  - Main source of disc surplus variation: discount rates
  - GDP growth more important than surplus/GDP ratio

Inflation has fiscal roots, even if fiscal policy is disconnected from the price level.

Motivation + Results

- Surpluses are volatile
- How come no associated inflation?
- Model with partial debt repayment

Why unexpected inflation, not just inflation?

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Literature

- **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)
- **Fiscal Theory of the Price Level.** Leeper (1991), Sims (1994), Woodford (1995), Cochrane (1998), Cochrane (2005), Sims (2011), Leeper and Leith (2016), Bassetto and Cui (2018), Cochrane (2022c), Brunnermeier et al. (2022), Cochrane (2022a), Cochrane (2022b)
- **Empirical Finance.** Campbell and Shiller (1988), Cochrane (1992), Campbell and Ammer (1993), Chen and Zhao (2009), Cochrane (2008), Jiang et al. (2019)

Environment

- 1 period = 1 year
- Consumption good price P_t
- Total output Y_t
- Nominal bonds $B^n_{N,t}$, price $Q^n_{N,t}$
  - Pay one unit of currency after *n* years
- Real bonds $B^n_{R,t}$, price $P_t Q^n_{R,t}$
  - Pay one unit of consumption good after *n* years
- Primary Surplus $P_t S_t$

Evolution of Public Debt

$$\overbrace{\left[B^1_{N,t-1} + P_t B^1_{R,t-1}\right]}^{\text{Issued Currency}} = \Delta M_t$$

$$\underbrace{+ \left[P_t S_t + \sum_{n=1}^{\infty} Q^n_{N,t}\left(B^n_{N,t} - B^{n+1}_{N,t-1}\right) + P_t \sum_{n=1}^{\infty} Q^n_{R,t}\left(B^n_{R,t} - B^{n+1}_{R,t-1}\right)\right]}_{\text{Retired Currency}}$$

- This is a budget constraint
- Assumption 1: households do not value currency $M_t = 0$

Evolution of Public Debt

- Assumption 1: households do not value currency $M_t = 0$
- End-of-period debt $V_{N,t}$ and $V_{R,t}$

$$(1 + r_t^N)V_{N,t-1} + (1 + r_t^R)(1 + \pi_t)V_{R,t-1} = P_t S_t + V_{N,t} + V_{R,t}$$

- This is an equilibrium condition
- Price level adjusts so that

$$\text{currency issued} = \text{currency retired}$$

Evolution of Public Debt

- Constant structure of public debt: $\delta = V_{N,t}/V_t$

$$1 + r_t^n = \delta \left[(1 + r_{N,t})\right] + (1 - \delta) \left[(1 + r_{R,t})(1 + \pi_t)\right]$$

- Debt-to-GDP = $v_t = V_t/P_tY_t$
- Surplus-to-GDP = $s_t = S_t/Y_t$

$$\frac{1 + r_t^n}{(1 + \pi_t)(1 + g_t)} v_{t-1} = s_t + v_t$$

Evolution of Public Debt

Linearized equations

$$v_t + \frac{s_t}{V} = \frac{1}{\beta}\left[v_{t-1} + r_t^n - \pi_t - g_t\right]$$

$$r_t^n = \delta\left[r_t^N\right] + (1-\delta)\left[r_t^R + \pi_t\right]$$

- v_t is log debt-to-GDP
- r_t^n is the nominal return on public debt

Valuation Equation of Public Debt

- Assumption 2: debt does not spiral $\lim_{j \to \infty} \beta^j v_{t+j} = 0$
- Solve flow equation forward:

$$\overbrace{v_{t-1} + r_t^n - \pi_t}^{\text{Real market value of debt}} = \underbrace{\frac{\beta}{V} \sum_{j=0}^{\infty} \beta^j \left[E_t s_{t+j} + E_t g_{t+j} \right] - \sum_{j=1}^{\infty} \beta^j \left[E_t r_{t+j}^n - E_t \pi_{t+j} \right]}_{\text{Discounted Surpluses}}$$

Marked-to-Market Decomposition

Take innovation on the valuation equation:

$$\boxed{\epsilon_{r^n,t} - \epsilon_{\pi,t} = \epsilon_{s,t} + \epsilon_{g,t} - \epsilon_{r,t}}$$

Terms:

$\epsilon_{r^n,t} = \Delta E_t r_t^n$

$\epsilon_{\pi,t} = \Delta E_t \pi_t$ (current inflation)

$\epsilon_{s,t} = (\beta / V) \sum_{j=0}^{\infty} \beta^j \Delta E_t s_{t+j}$

$\epsilon_{g,t} = \sum_{j=0}^{\infty} \beta^j \Delta E_t g_{t+j}$

$\epsilon_{r,t} = \sum_{j=1}^{\infty} \beta^j (\Delta E_t r_{t+j}^n - \Delta E_t \pi_{t+j})$

Public Finances Model

Why a public finances model?

1. We can do better: bond prices forecast future inflation
2. No historical data for bond price/return r_t^n
3. No data on market value of debt (only book value)

Public Finances Model

Key Assumptions

- Assumption: constant maturity structure
- Decays geometrically at rate ω:

$$B^n_{N,t} = \omega_N \, B^{n-1}_{N,t}$$
$$B^n_{R,t} = \omega_R \, B^{n-1}_{R,t}$$

- Assumption: constant (or no) risk premium

$$E_t r_{N,t} = E_t r_{R,t} + E_t \pi_t = i_t$$

Break down of bond price variation

Proposition: let $r_t = i_t - E_t\pi_{t+1}$ be the real interest. Then

$$\epsilon_{r^n,t} - \epsilon_{\pi,t} = -\delta \sum_{j=0}^{\infty} (\omega_N \beta)^j \Delta E_t \pi_t - \sum_{j=1}^{\infty} \beta^j [\delta \omega_N^j + (1-\delta)\omega_R^j] \Delta E_t r_t$$

- Higher real discount lowers real and nominal bond prices
- Higher inflation lowers nominal bond prices
- No long-term debt $\omega = 0$:

$$\epsilon_{r^n,t} - \epsilon_{\pi,t} = -\delta \Delta E_t \pi_t$$

Total Inflation Decomposition

Replace bond return decomp on marked-to-market decomp:

$$\boxed{-\varepsilon_{\pi,t} = \varepsilon_{s,t} + \varepsilon_{g,t} - \varepsilon_{r,t}}$$

Terms:

$\varepsilon_{\pi,t} = \delta \sum_{j=0}^{\infty} (\omega_N \beta)^j \Delta E_t \pi_t$ (current and future inflation)

$\varepsilon_{s,t} = \epsilon_{s,t} = (\beta / V) \sum_{j=0}^{\infty} \beta^j \Delta E_t s_{t+j}$

$\varepsilon_{g,t} = \epsilon_{g,t} = \sum_{j=0}^{\infty} \beta^j \Delta E_t g_{t+j}$

$\varepsilon_{r,t} = \sum_{j=1}^{\infty} \beta^j \left[1 - (\delta \omega_N^j + (1-\delta) \omega_R^j) \right] \Delta E_t r_{t+j}$

Comparison of Decompositions

- **Marked-to-market**: $\boxed{\epsilon_{r^n,t} - \epsilon_{\pi,t} = \epsilon_{s,t} + \epsilon_{g,t} - \epsilon_{r,t}}$
  - Current inflation given current bond prices
  - Highlights effect of monetary policy
- **Total inflation**: $\boxed{-\varepsilon_{\pi,t} = \varepsilon_{s,t} + \varepsilon_{g,t} - \varepsilon_{r,t}}$
  - Path of inflation given path of discount rates
  - Sensitive to future inflation
  - Nets out effect of discount rates on bond prices

Build Market Value of Debt

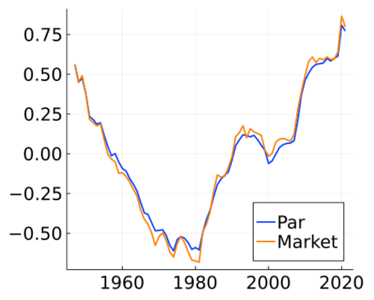
- Converting par to market value of debt
- Dallas Fed, Cox and Hirschhorn (1983) and Cox (1985)

$$V_{j,t} = V_{j,t}^{b} \times \frac{\text{market value of bonds}}{\text{book value of bonds}} = V_{j,t}^{b} \frac{Q_{j,t}}{Q_{j,t}^{b}} \quad \text{for } j = N, R$$

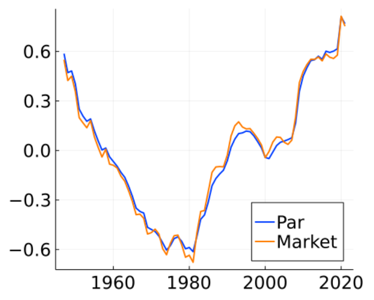
- Book price of bonds evolve according to average interest:

$$i_{N,t}^{b} = (1 - \omega_N) i_t + \omega_N i_{N,t-1}^{b}$$
$$i_{R,t}^{b} = (1 - \omega_R)(i_t - E_t \pi_{t+1}) + \omega_R i_{R,t-1}^{b}$$

Comparison with Dallas Fed



(a) Dallas Fed



(b) Model

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References I

Akhmadieva, V. (2022). Fiscal adjustment in a panel of countries 1870–2016. *Journal of Comparative Economics*, 50(2):555–568.

Bassetto, M. and Cui, W. (2018). The fiscal theory of the price level in a world of low interest rates. *Journal of Economic Dynamics and Control*, 89:5–22.

Brunnermeier, M. K., Merkel, S., and Sannikov, Y. (2022). The Fiscal Theory of the Price Level With a Bubble.

Cagan, P. (1956). The Monetary Dynamics of Hyperinflation. In *Studies in the Quantity Theory of Money*, pages 25–117. University of Chicago Press, milton friedman edition.

Campbell, J. Y. and Ammer, J. (1993). What Moves the Stock and Bond Markets? A Variance Decomposition for Long-Term Asset Returns. *The Journal of Finance*, 48(1):3–37.

References II

Campbell, J. Y. and Shiller, R. J. (1988). The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors. *The Review of Financial Studies*, 1(3):195–228.

Chen, L. and Zhao, X. (2009). Return Decomposition. *Review of Financial Studies*, 22(12):5213–5249.

Cochrane, J. H. (1992). Explaining the Variance of Price–Dividend Ratios. *The Review of Financial Studies*, 5(2):243–280.

Cochrane, J. H. (1998). A Frictionless View of U.S. Inflation. *NBER Macroeconomics Annual*, 13:323–384.

Cochrane, J. H. (2005). Money as stock. *Journal of Monetary Economics*, 52(3):501–528.

Cochrane, J. H. (2008). The Dog That Did Not Bark: A Defense of Return Predictability. *The Review of Financial Studies*, 21(4):1533–1575.

References III

Cochrane, J. H. (2022a). The fiscal roots of inflation. *Review of Economic Dynamics*, 45:22–40.

Cochrane, J. H. (2022b). A fiscal theory of monetary policy with partially-repaid long-term debt. *Review of Economic Dynamics*, 45:1–21.

Cochrane, J. H. (2022c). The Fiscal Theory of the Price Level.

Corsetti, G., Dedola, L., Jarociński, M., Maćkowiak, B., and Schmidt, S. (2019). Macroeconomic stabilization, monetary-fiscal interactions, and Europe's monetary union. *European Journal of Political Economy*, 57:22–33.

Cox, W. M. (1985). The behavior of treasury securities monthly, 1942–1984. *Journal of Monetary Economics*, 16(2):227–250.

Cox, W. M. and Hirschhorn, E. (1983). The market value of U.S. government debt; Monthly, 1942–1980. *Journal of Monetary Economics*, 11(2):261–272.

References IV

Du, W., Plueger, C. E., and Schreger, J. (2020). Sovereign Debt Portfolios, Bond Risks, and the Credibility of Monetary Policy. *The Journal of Finance*, 75(6):3097–3138.

Hall, G. J. and Sargent, T. J. (1997). Accounting for the federal government's cost of funds. *Economic Perspectives*, 21(4).

Hall, G. J. and Sargent, T. J. (2011). Interest Rate Risk and Other Determinants of Post-WWII US Government Debt/GDP Dynamics. *American Economic Journal: Macroeconomics*, 3(3):192–214.

Jiang, Z., Lustig, H., Van Nieuwerburgh, S., and Xiaolan, M. (2019). The U.S. Public Debt Valuation Puzzle. Technical Report w26583, National Bureau of Economic Research, Cambridge, MA.

Leeper, E. and Leith, C. (2016). Chapter 30 - Understanding Inflation as a Joint Monetary–Fiscal Phenomenon. In *Handbook of Macroeconomics*, volume 2, pages 2305–2415. Elsevier.

References V

Leeper, E. M. (1991). Equilibria under 'active' and 'passive' monetary and fiscal policies. *Journal of Monetary Economics*, 27(1):129–147.

Sargent, T. J. and Wallace, N. (1981). Some Unpleasant Monetarist Arithmetic. *Quarterly Review*, 5.

Sims, C. A. (1994). A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory*, 4(3):381–399.

Sims, C. A. (2011). Stepping on a rake: The role of fiscal policy in the inflation of the 1970s. *European Economic Review*, 55(1):48–56.

Sunder-Plassmann, L. (2020). Inflation, default and sovereign debt: The role of denomination and ownership. *Journal of International Economics*, 127:103393.

Woodford, M. (1995). Price-level determinacy without control of a monetary aggregate. *Carnegie-Rochester Conference Series on Public Policy*, 43:1–46.