On the Mechanics of Fiscal Inflations

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Two Big Themes

- Relationship among:
  - Quantity theory of money
  - Unpleasant monetarist arithmetic
  - Fiscal theory of the price level (FTPL)
- Did financial markets see inflation coming?
  - No.
  - I **really** mean no.

- Identical households
- A fiscal/monetary authority (the "government")
- Household preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + v(x_t) - \ell_t]$$

  - c_t: "credit good"
  - x_t "cash good"
  - ℓ_t: labor supply
- Technology: 1 unit of time $\Longrightarrow$ 1 unit of either good

Assets

- Private state-contingent B_{t+1} (buy at t, redeem at $t+1$)
  - Zero net supply, not traded by the government
- Nominal Long-term government debt D_t (buy at t)
  - perpetuity with coupons decaying at rate δ
- Money (used for cash goods)

Household constraints

- Budget constraint:

$$\begin{aligned} &B_t + P_t \ell_t + D_{t-1}(1 + \delta Q_t) + M_{t-1} \\ \geq &M_t + P_t(c_t + x_t) + E_t[z_{t+1} B_{t+1}] + D_t Q_t + T_t \end{aligned}$$

  - z_{t+1}: one-period stochastic discount factor
  - Q_t price of government debt
  - P_t: price of goods
- (no-Ponzi, limits debt)
- Cash-in-advance

$$M_{t-1} \geq P_t x_t$$

Government flow budget constraint

$$D^g_{t-1}(1+\delta Q_t) + M^g_{t-1} = M^g_t + D^g_t Q_t + T_t - P_t G_t$$

G_t: government spending

Competitive Equilibrium Conditions Part 1

- Credit good optimality: $u'(c_t) = 1$
- State-contingent bond optimality: $z_{t+1} = \beta/\pi_{t+1}$, $\pi_{t+1} := P_t/P_{t+1}$
- One-period risk-free rate (no arbitrage):

$$R_t := \frac{1}{E_t z_{t+1}} = \frac{1}{\beta E_t[1/\pi_{t+1}]}$$

- Long-term bond price:

$$Q_t = \beta P_t \sum_{s=0}^{\infty} \frac{(\beta\delta)^s}{P_{t+s+1}}.$$

- Cash-good optimality (Friedman distortion):

$$1 = \beta E_t \left[\frac{1}{\pi_{t+1}} v'(x_{t+1}) \right],$$

Competitive Equilibrium Condition Part 2: Government balance equation

Get it from:

- Household present-value budget constraint
- Part 1 optimality (substitute out asset prices)
- Market clearing

$$D_{t-1} E_t \sum_{s=0}^{\infty} \frac{(\beta\delta)^s}{P_{t+s}} + \frac{M_{t-1}}{P_t} = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{T_s}{P_s} - G_s + \frac{M_s}{P_s} \left(1 - \frac{1}{R_s} \right) \right]$$

Start Point: Steady State

- Fisher equation: $\bar{R} = \bar{\pi}/\bar{\beta}$
- Bond price: $\bar{Q} = \beta/(\bar{\pi} - \beta\delta)$
- Cash good consumption: $\bar{x} = \bar{m} = (v')^{-1}(\bar{R})$
- Define

$$L(\pi) := v'^{-1}\left(\frac{\pi}{\beta}\right)(\pi - \beta)$$

- Government balance equation:

$$\frac{\bar{d}}{\bar{\pi} - \beta\delta} + \frac{\bar{m}}{\bar{\pi}} = \frac{1}{1-\beta}\left[\bar{T} - \bar{G} + \bar{m}\left(1 - \frac{1}{\bar{R}}\right)\right]$$
$$\equiv \frac{1}{1-\beta}\left[\bar{T} - \bar{G} + L(\bar{\pi})\right]$$

d, m: real debt, money balances

Experiment: steady state + 1-time shock to G_S

- Steady state (assume that parameters, policy such that it holds):
- In period S, $G_S = \bar{G} + \hat{G}$, $E_{S-1}\hat{G} = 0$

Shock to G_S+ no response of real taxes

$$\bar{d} P_{S-1} \sum_{s=0}^{\infty} \frac{(\beta\delta)^s}{P_{S+s}} + \bar{m} \frac{P_{S-1}}{P_S} = \frac{1}{1-\beta} \left[\bar{T} - \bar{G} \right] - \hat{G} + \sum_{s=S}^{\infty} \beta^{s-S} L(\pi_{s+1})$$

Need prices to go up sooner or later

Example: one-time immediate response of inflation (up/down by factor ψ)

$$\frac{1}{\psi}\left[\frac{\bar{d}}{\bar{\pi}-\beta\delta}+\frac{\bar{m}}{\bar{\pi}}\right]=\frac{1}{1-\beta}\left[\bar{T}-\bar{G}+\bar{m}\left(1-\frac{1}{\bar{R}}\right)\right]+\hat{G}.$$

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- Bottom line: they are all at work, emphasize different aspects

Example: permanent response of inflation (up/down by factor ψ^L)

$$\frac{\bar{d}}{\psi^L \bar{\pi} - \beta\delta} + \frac{\bar{m}}{\psi^L \bar{\pi}} = \frac{1}{1-\beta}\left[\bar{T} - \bar{G} + L(\psi^L \bar{\pi})\right] - \hat{G}$$

- Same conclusion as before:
- Nominal balances grow at $\psi^L \bar{\pi}$ after first period
- The government monetizes debt, both in period S and all subsequent periods
- ψ^L up/down to meet budget balance

Did the Markets See Inflation Coming?

Hilscher, Raviv, and Reis (2021):

- Use inflation options, data as of end 2017
- Expected inflation over 3 years (under risk-neutral measure): 2.2%
- Probability of annualized inflation over 4% at any point over the next 10 years: 1.7%
- Realized annualized inflation 12/20-12/23: 5.6%

Table: Maturity structure of U.S. government securities as of December 2020

Maturity	Private Holdings of Public Debt
Less than 1 Year	6,356,589
1-5 Years	5,716,708
5-10 Years	2,454,885
10 Years or More	1,751,078
Inflation Protected	1,721,420

Redistribution between gov't and bondholders

- Approximate formula:

$$\Delta V = F \times \kappa \left[\frac{1}{(\pi_E)^H} - \frac{1}{(\pi_A)^H} \right]$$

with:

- ΔV: unexpected transfer from bondholders to gov't
- F: face value of debt
- κ : fraction exposed to inflation
- π_E^H: expected inflation
- π_A^H: actual inflation

Using Hilscher-Raviv-Reis Estimates

- Superconservative estimate: throw away all bonds with mat up to 1 yr and 90% of bonds with mat 1-5yrs
- Get $\Delta V = 1.2\%$ of GDP

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- If remaining debt of mat 1-5 yrs is exposed to inflation for 2 yrs...
- Get $\Delta V = 3.2\%$ of GDP

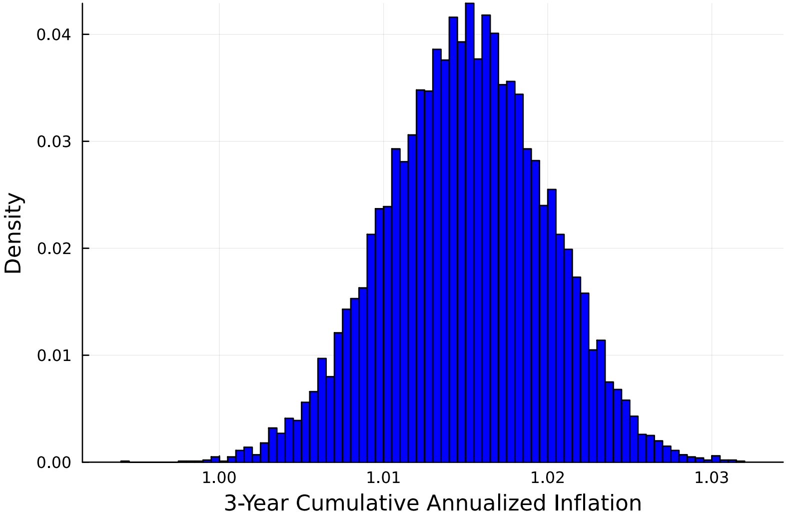
More Data on Inflation Expectations

- Want to update estimates to 12/2020
- Want richer data by maturity
- Market for options has dried up
- Use statistical model in Ajello, Benzoni, and Chyruk (2020)

Ajello-Benzoni-Chyruk Model

- Dynamic term-structure model
- Combines:
  - Latent factors related to the yield curve
  - Macroeconomic factors accounting for core, food, and energy inflation
- Does very well in inflation forecasts
- Predictions under physical measure, not risk-neutral measure
- Limitation: do not push too far in the tails (driven by functional forms)

Distribution of Inflation Expectations (3yr annualized)



Inflation Predictions as of Dec 2020

Table: Annualized cumulative inflation at different horizons

Horizon	Mean Forecast	95% Forecast	Realized Inflation
6 months	1.65%	3.41%	8.8%
1 year	1.57%	2.85%	7.0%
1.5 years	1.54%	2.6%	8.97%
2 years	1.52%	2.45%	6.75%
3 years	1.50%	2.29%	5.6%

Table: Dilution as a percentage of 2020 GDP under different assumptions: Tail forecast

κ, H_s	1 year	1.5 years	2 years
0.1	2.1%	3.2%	3.0%
0.3	2.4%	3.2%	3.1%
0.5	2.6%	3.2%	3.1%

- κ : fraction of 1-5 yr maturity debt diluted for the entire 3 years
- H_s : period over which the balance of 1-5yr debt is exposed to inflation

Table: Dilution as a percentage of exposed holdings under different assumptions: Tail forecast

κ, H_s	1 year	1.5 years	2 years
0.1	5.6%	8.4%	7.9%
0.3	6.2%	8.4%	8.0%
0.5	6.9%	8.4%	8.2%

Table: Dilution as a percentage of 2020 GDP under different assumptions: Mean forecast

κ, H_s	1 year	1.5 years	2 years
0.1	2.7%	3.9%	3.8%
0.3	3.1%	4.0%	3.8%
0.5	3.4%	4.0%	3.9%

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