A Monetary-Fiscal Theory of Sudden Inflations

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The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis, Federal Reserve Board, or the Federal Reserve System.
Motivation

Large run-up in debt/deficit while inflation stays low. Inflation usually not sensitive to debt/deficit, until a crisis

- Relationship btwn Deficits and Inflation; Bassetto, Butters (2010)
- Ends of Four Big Inflations; Sargent (1982)

Crises are sudden, unpredictable, feature increased sensitivity of inflation to prospective deficits, and are never deflationary.
How the model works

Explain sudden inflations with endogenous information acquisition

- Taxes respond to deficits, up to a point
- Consumers have prior about future deficits, can acquire info
- Gorton-Ordoñez, Rational Inattention: little incentive to acquire information about future deficits unless there’s a large payoff

<table>
<thead>
<tr>
<th>Low Deficits</th>
<th>High Deficits</th>
<th>Transition in Inf. Sensitivity</th>
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<tbody>
<tr>
<td>Exogenous Information</td>
<td>Endogenous Information</td>
<td></td>
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<tr>
<td>Deficits don’t predict inflation, Low inflation sensitivity</td>
<td>No incentive to acquire info, Low inflation sensitivity</td>
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<tr>
<td>Deficits predict inflation, High inflation sensitivity</td>
<td>Incentive to acquire info, High inflation sensitivity</td>
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<td>Smooth</td>
<td>Abrupt, possibly discontinuous switch when acquire info</td>
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Model of Government Bonds

Holmstrom (2015): Bonds have purposefully opaque backing
- Optimal ignorance of project outcome
- Costly research valuable only if beliefs near/below kink

Safe assets most opaque backing/expensive to research
- Money/Gov’t bonds backed by “full faith and credit”
- Hard, but possible, to forecast government surplus
Plan

1. Preview
2. Model
   2.1 Model Setup
   2.2 Description of the 3 Periods
   2.3 Equilibrium, from Periods 3 to 1
3. Conclusions
Families, Preferences, Technology, and Goods

Families separate setting prices, quantities (Mackowiak and Wiederholt, 2015)

\[ E \left[ \sum_{t=1}^{3} \beta^{t-1} \left( u(c_{it}) - \int_{0}^{1} \ell_{ijt} \right) \right], \quad c_{it} = \left( \int_{0}^{1} \int_{0}^{1} c_{kjt,i}^{\theta-1} djk \right)^{\frac{\theta}{\theta-1}}, \quad \theta > 1 \]

- Continuum of families \( i \in [0, 1] \)
- Each family has a shopper that buys consumption
- Each family has a continuum of producers running firms \( j \in [0, 1] \) producing differentiated variety (Dixit-Stiglitz)
- Set of goods indexed by \( kj \), one unit of \( kj \) time produces one unit of \( kj \) good
Government, Timing

Government

- All gov’t bonds nominal, one period
- Gov’t bonds are numeraire
- Price level target $P^*_3$
- Gov’t spending uses same aggregator as family consumption
- No spending in periods 1, 2, uncertain spending $G_3$ in period 3
- Taxes in period 3, the “long run”
  - Regime $M$: Gov’t sets real taxes $G_3 + B_2/P^*_3$, hence $P_3 = P^*_3$
  - Regime $F$: Gov’t sets real taxes $\hat{T}$, hence $P_3 = \frac{B_2}{\hat{T} - G_3}$

Timing within periods

- Monetary-fiscal policy is set
- Producers may acquire information and set prices
- Shoppers observe prices, choose quantities, allocate residual resources to buying bonds
Model: 3 Periods

Exogenous information: Know probabilities of period 3 surplus
Endogenous information: Know probabilities of period 3 surplus, can acquire actual realization

<table>
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<th>Period 1</th>
<th>Period 2</th>
<th>Period 3: “Long-run”</th>
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<td>Start with $B_0$, Purchase $B_1$</td>
<td>$B_1$ repaid Public signal, Option to learn</td>
<td>${M, F}$, surplus revealed $B_2$ repaid</td>
</tr>
<tr>
<td>$P_1$ determined</td>
<td>Purchase $B_2$</td>
<td>$P_3$ determined</td>
</tr>
<tr>
<td>$P_2$ (hence $P_2/P_1$) determined</td>
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Compare how inflation responds to news about the future surplus

$$\frac{\partial (P_2/P_1)}{\partial \text{(Likelihood fiscal stress)}}$$
Periods 3 and 2

Period 3: Gov’t owes $B_2$; Regime and $G_3$ realized; $P_3$ determined

Period 2

- Gov’t starts with nominal debt $B_1$
- Fixed nominal interest rate $i$ (for simplicity $i = 1/\beta$)
- $P_2 T_2 = \frac{i}{1+i} B_1$ (implies $B_2 = B_1$)
- Families get signal about fiscal regime:
  - Posterior probability of regime $F$: $\pi$
  - Mean of the posterior for $G_3$ conditional on $F$: $\tilde{G}_3$
  - Regime and spending not independent
  - Assume regime $F$ associated with higher prices: $\frac{[\hat{f} - \tilde{G}_3]}{B_2} < \frac{1}{P_3}$
- Producers can pay a utility cost $K$, observe future regime and spending realization
- Producers set prices, shoppers learn from prices, choose quantities
Period 1: Defines $P_1$ so we can talk about inflation $P_2/P_1$

- Gov’t starts with nominal debt $B_0$
- Fixed nominal interest rate $i$  
  \[ P_1T_1 = \frac{i}{1+i}B_0 \]  
  (for simplicity $i = 1/\beta$) \( \text{(implies } B_1 = B_0) \)
- Families’ information
  - Price level target in period 3 $P^*_3$
  - Prior $\pi_0$ on the regime $\{M, F\}$
  - Prior distribution on spending $G_3$
Plan

1. Preview
2. Model
   2.1 Model Setup
   2.2 Description of the 3 Periods
   2.3 Equilibrium, from Periods 3 to 1
      - Period 3
      - Period 2: Exogenous vs. Endogenous Information
      - When do producers acquire/not acquire information?
      - Period 1
3. Conclusions
Equilibrium: Period 3, Regime M

- Gov’t taxes $B_2/P_3^*$, repay $B_2$, hence $P_3 = P_3^*$
- Producer:
  - Marginal revenue (in utility terms):
    \[
    (1 - \theta)u'(c_{i3})(C_3 + G_3) \frac{(p_{ij3})}{P_3}^{\theta} \frac{P_3}{(p_{ij3}P_3)}
    \]
  - Marginal cost (in utility terms):
    \[
    \theta(C_3 + G_3) \frac{(p_{ij3})}{P_3}^{\theta-1}
    \]
- Equilibrium requires (usual Dixit-Stiglitz distortion):
  \[
  u'(c_{i3}) = \frac{\theta}{\theta - 1}, \quad p_{ij3} = P_3
  \]
- Shopper: exhausts budget constraint, with $c_{i3}$ given as above,
  $c_{ij3} = c_{i3} = C_3$
Equilibrium: Period 3, Regime $F$

- Gov’t taxes $\hat{T}$, surplus is $\hat{T} - G_3$, hence $P_3 = B_2 / (\hat{T} - G_3)$
- Other than that, everything the same as in regime $M$:

$$u'(C_3) = \frac{\theta}{\theta - 1}$$,
$$p_{ij3} = P_3$$

- Prices and consumption of all varieties the same
Equilibrium: Period 2, Exogenous Information

- Shopper optimality

\[
\frac{u'(C_2)}{P_2 \beta u'(C_3)(1 + i)} = \frac{1 - \pi}{P_3^*} + \frac{\pi[\hat{T} - E_2(G_3|F)]}{B_2},
\]

- Producers optimality

\[
u'(C_2) = \frac{\theta}{\theta - 1}
\]

Defines a relation between the price level $P_2$ and the signaled probabilities of regimes and spending

\[
\frac{1}{P_2} = \frac{1 - \pi}{P_3^*} + \frac{\pi[\hat{T} - \tilde{G}_3]}{B_2}
\]

- By assumption $\frac{\partial P_2}{\partial \pi} > 0$, then $\frac{\partial P_2}{\partial \pi \partial \tilde{G}_3} > 0$

- Hence the more likely the realization of the $F$ regime $\pi$, the more the price level responds to post-signal $G_3$
Equilibrium: Period 2, Endogenous Information

Shoppers
- Have same info as producers that do not acquire information
- Know optimal price charged by producers without more info
- If they observe different price, can infer information from price
- (Neglect prices charged by measure zero of agents)

Look at pure-strategy equilibria:
- If no producers pay $K$, equilibrium same as exogenous info
- If all producers pay $K$, shoppers are fully informed too

Endogenous Equilibrium vs. Exogenous Equilibrium
- Equilibrium same as exogenous with $\pi \in \{0, 1\}$ and $G_3$ known.
- If $\pi = 1$ (regime $F$), sensitivity to $G_3$ is higher than exogenous

$$
\left( \frac{\partial P_2}{\partial \pi \partial \tilde{G}_3} \mid \pi = 1 \right) > \left( \frac{\partial P_2}{\partial \pi \partial \tilde{G}_3} \mid \pi \in [0, 1) \right)
$$
When do producers not acquire information?

Assume no one acquires information, check unilateral deviation

- Producer \( ij \) pays cost, learns future price \( P_3 \)
- Optimal choice for producer
  - Marginal revenue (in utility terms):
    \[
    (1 - \theta)u'(c_{i2})C_2 \left( \frac{P_{ij2}}{P_2} \right)^{-\theta}
    \]
  - Marginal cost (in utility terms):
    \[
    \frac{\theta C_2}{P_2} \left( \frac{P_{ij2}}{P_2} \right)^{-\theta-1}
    \]
  - Profits (in utility terms):
    \[
    u'^{-1} \left( \frac{\theta}{\theta - 1} \right) \frac{1}{\theta - 1}
    \]
  - Only \( c_{i2} \) (set by shopper) and \( P_2 \) (set by other producers) matter
  - There is always an equilibrium with no information acquisition
When do producers acquire information?

Assume everyone acquires information, check unilateral deviation

- Shoppers fully informed (learn from other prices) so
  \[ u'(c_{i2}) = \theta / (\theta - 1) \]

- \[ P_2 = P_3 \] but uninformed producer does not know \( P_3 \)

- Optimal price for uninformed producer:
  \[ p_{ij2} = \frac{E_{ij2} [P^\theta]}{E_{ij2} [P^{\theta - 1}]} \]

- Profits of uninformed producer in utility terms:
  
  \[ u'^{-1} \left( \frac{\theta}{\theta - 1} \right) \frac{1}{\theta - 1} \left[ E_{ij2} \left( P^\theta \right) \right]^{1-\theta} \left[ E_{ij2} \left( P^{\theta - 1} \right) \right]^{\theta} \]

  - Symmetric profit
  - Cost of ignorance

- If cost of ignorance is large enough (fear of low \( \hat{T} \), high \( P_2 \)), or cost of info small, optimal to acquire information
Equilibrium: Period 1, Main points

Period 1
- Equilibrium in period 1 exists (unique conditional on period 2)
- Get baseline price level $P_1$, which only depends on prior
- Previous discussion of $P_2$ is really discussion of inflation $P_2/P_1$

Sensitivity of inflation to fiscal news is increasing in likelihood of fiscal stress

$$\frac{\partial (P_2/P_1)}{\partial \pi \partial \tilde{G}_3} > 0$$

For small cost or large fear of high inflation, producers will acquire information, hence a jump in inflation’s sensitivity to fiscal stress

$$\left( \frac{\partial (P_2/P_1)}{\partial \pi \partial \tilde{G}_3} \mid \pi = 1 \right) > \left( \frac{\partial (P_2/P_1)}{\partial \pi \partial \tilde{G}_3} \mid \pi \in [0, 1) \right)$$
Conclusions

A Monetary-Fiscal Theory of Sudden Inflations

Crises are sudden, unpredictable...
- Sharp shift uninformed prior to acquiring info, learning state
- Difficulty acquiring information, little benefit; key to safety

...feature increased sensitivity of inflation to prospective deficits...
- Normal times: Not worthwhile to learn about prospective deficits
- Fiscally stressed times: Worthwhile to acquire information about prospective deficits

...and are never deflationary
- Strictly inflationary from asymmetric benefit, not worthwhile to acquire information
Ends of Four Big Inflations

“...government debt is valued according to the same economic considerations that give private debt value...”

Austrian Retail Prices (1/21 = 100)

- Large debt, deficits covered by printing money 1919-1922
- Bailout negotiations begin end of August ’22, signed October
- “...even before the precise details of the protocols were publicly announced... brought relief to the situation.”

“The essential measures that ended hyperinflation... value[d] that debt according to whether it was backed by sufficiently large prospective taxes relative to public expenditures... Once it became widely understood that the government would not rely on the central bank for its finance, the inflation terminated...”