Monetary-Fiscal Policy Interactions: Basics & Beyond
IMF Institute

Eric M. Leeper
Indiana University

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1. Effects of monetary policy—open-market operations—depend on the sense in which fiscal policy is “held constant”
2. Effects of fiscal policy—bond-financed tax cuts—depend on the sense in which monetary policy is “held constant”
3. MP cannot uniquely determine inflation; FP can
4. MP can uniquely determine bounded inflation—if FP cooperates
5. Cannot use reduced-form correlations or “tests” of equilibrium conditions to infer prevailing monetary-fiscal regime
6. Without credible, enforceable fiscal rules that anchor expectations on appropriate FP behavior, fiscal disturbances always affect output, inflation, and interest rates
Why does fiat currency have value?
Because the government accepts currency—and only currency—in payment of taxes.
Inflation arises when government prints more currency than it eventually absorbs in taxes:
- people try to get rid of currency
- buy things
- pushes up prices & wages

Government can soak up currency by selling bonds:
- does this when it spends more—handing out currency—than it taxes—soaking up currency

Bonds are promises to pay back more currency in future.
If government doesn’t soak up bonds with taxes... inflation
The Theme Generalizes

- Just as money gets its value from taxes...
- Monetary policy gets its power from fiscal backing
- When fiscal backing is assured, MP operates as taught in textbooks
  - MP can control inflation
  - higher interest rates—open-market sale of bonds—reduce consumption & inflation
- But only if future taxes rise to soak up bonds
  - higher taxes eliminate the wealth effects of higher interest payments on government debt
- Otherwise, higher rates...
  - raises wealth
  - reduce value of bonds
  - increase aggregate demand & inflation
- It’s all about fiscal backing
Part I: The Basics

Review of 2011 Course
The Model

- Endowment economy at the cashless limit; complete financial markets, one-period nominal debt
- Representative household maximizes

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(C_t) \right\}$$

subject to sequence of flow budget constraints

$$P_tC_t + P_t\tau_t + E_t[Q_{t,t+1}B_t] = P_tY_t + P_tz_t + B_{t-1}$$

given $B_{-1} > 0$

- $Q_{t,t+1}$: nominal price at $t$ of an asset that pays $1$ at $t + 1$
- $m_{t+1}$: real contingent claims price
- $Q_{t,t+1} = \frac{P_t}{P_{t+1}} m_{t,t+1}$: no-arbitrage condition
- Nominal interest rate, $R_t$: $\frac{1}{R_t} = E_t[Q_{t,t+1}]$
The Model

- Can write HH’s real intertemporal b.c. as

\[ E_t \sum_{j=0}^{\infty} m_{t,t+j} C_{t+j} = \frac{B_{t-1}}{P_t} + E_t \sum_{j=0}^{\infty} m_{t,t+j}(Y_{t+j} - s_{t+j}) \]

- \( s_t \equiv \tau_t - z_t \)
- \( m_{t,t+j} \equiv \prod_{k=0}^{j} m_{t,t+k} \) is real discount factor, \( m_{t,t} = 1 \)
- HH choices also satisfy the transversality condition

\[ \lim_{T \to \infty} E_t \left[ m_{t,T} \frac{B_{T-1}}{P_T} \right] = 0 \]

- It is not optimal for HHs to overaccumulate assets
Impose equilibrium, $C_t = Y$, and TVC to get two eqm conditions

$$\frac{1}{R_t} = \beta E_t \frac{P_t}{P_{t+1}} \equiv \beta E_t \frac{1}{\pi_{t+1}}$$

$$\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t s_{t+j}$$

$s_t \equiv \tau_t - z_t$ (We assume $0 < E_t PV(s) < \infty$)

Price sequence $\{P_t\}$ must satisfy these to be an eqm (markets clear & HH’s optimization problem solved)

Without additional restrictions from policy behavior, there are many possible eqm $\{P_t\}$ sequences
The Model

- Specify policy rules & government budget constraint

\[
\frac{1}{R_t} = \frac{1}{R^*} + \alpha \left( \frac{1}{\pi_t} - \frac{1}{\pi^*} \right)
\]

\[
s_t = s^* + \gamma \left( \frac{B_{t-1}}{P_t} - b^* \right)
\]

\[
\frac{E_t[Q_{t,t+1}B_t]}{P_t} + s_t = \frac{B_{t-1}}{P_t}
\]

- Steady state

\[
\frac{B_{t-1}}{P_t} = b^*, \quad s^* = (1 - \beta)b^*, \quad R^* = \frac{\pi^*}{\beta}, \quad m^* = \beta
\]
The Model

- Combine MP rule w/ Fisher equation
- Combine FP rule w/ government budget constraint
- Dynamical system in inflation, $\pi_t$, and real debt, $b_t$, after imposing asset-pricing relations and market clearing

\[
E_t \left( \frac{1}{\pi_{t+1}} - \frac{1}{\pi^*} \right) = \frac{\alpha}{\beta} \left( \frac{1}{\pi_t} - \frac{1}{\pi^*} \right)
\]

\[
\frac{B_t}{P_{t+1}} - b^* = \frac{1 - \gamma}{\beta} \left( \frac{B_{t-1}}{P_t} - b^* \right)
\]

where $\frac{B_t}{P_{t+1}} \equiv b_t$ and $b^* = \frac{B_t}{P_{t+1}}$ in steady state and in equilibrium

\[
m_{t,t+1} = \beta \frac{U''(C_{t+1})}{U'(C_t)} = \beta \frac{U''(Y)}{U'(Y)} = \beta
\]
Two Tasks of Policy

- Monetary & fiscal policy have two tasks: (1) control inflation; (2) stabilize debt
- Two different policy mixes that can accomplish these tasks

**Regime M:** conventional assignment—MP targets inflation; FP targets real debt (called active MP/passive FP)

**Regime F:** alternative assignment—MP maintains value of debt; FP controls inflation (called passive MP/active FP)

- **Regime M:** normal state of affairs
- **Regime F:** can arise in an era of fiscal stress
Regime M Policy Behavior

- MP behavior completely familiar: target inflation by aggressively adjusting nominal interest rates
- FP adjusts future surpluses to cover interest plus principal on debt
- In terms of policy rules

\[
\text{Regime M: } \alpha/\beta > 1 \land \gamma > 1 - \beta
\]
Regime M Equilibrium

Unique *bounded* equilibrium is

\[ \pi_t = \pi^* \]

And expected evolution of government debt is

\[
E_t \left( \frac{B_t}{P_{t+1}} - b^* \right) = \frac{1 - \gamma}{\beta} \left( \frac{B_{t-1}}{P_t} - b^* \right)
\]

which ensures \( \lim_{T \to \infty} E_t b_T = b^* \)

But... also a continuum of equilibria with

\[ \lim_{T \to \infty} \pi_T = \infty \]

Neither MP nor private behavior rules out equilibria with \( \pi_t = \infty \)

This (minor?) anomaly or embarrassment can be resolved only by fiscal policy
Regime M’s Explosive Solutions

- Examine perfect foresight; generalize policy rule
  \[ R_t = \beta^{-1}\pi_{t+1} \]
  \[ R_t = \tilde{\Phi}(\pi_t) \]

- Solution satisfies non-linear difference equation
  \[ \pi_{t+1} = \Phi(\pi_t) \]

- Two steady states: \( \pi^* \) and \( \pi_L \)
- \( \pi_L \) are zero lower bound for nominal interest rate
Regime M’s Explosive Solutions

Indeterminacy of steady state and dynamic path

Zero nominal rate

\( \Phi(\Pi) \)
Regime M Fiscal Policy

- What is FP doing in Regime M?
  - any shock that changes debt must create the expectation that future surpluses will adjust to stabilize debt’s value
  - people must believe adjustments will occur eventually
  - eliminates wealth effects from government debt
  - for MP to target inflation, fiscal expectations must be anchored on FP adjusting to maintain value of debt

- Can rule out equilibria with \( \pi_t \to \infty \) where \( b_t \to 0 \), so \( s_t \to 0 \)
  - FP commits to a fixed floor value of debt, \( b \)
  - surplus rule becomes \( s = (1 - \beta)b \)
  - this requires a switch in fiscal regime
  - ironically, by “passively” supporting MP, FP permits explosive inflation
An Equilibrium Condition

\[
\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}]
\]

- In Regime M…
  - MP delivers equilibrium inflation process
  - taking inflation as given, FP must choose compatible surplus policy
  - “compatible” means: stabilizes debt
  - imposes restrictions on \( E_t PV(s) \)
Primer on Monetary-Fiscal Interactions

- Monetary & fiscal policy have two tasks: (1) control inflation; (2) stabilize debt
- Beautiful symmetry: two different policy mixes that can accomplish these tasks

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- **Regime M:** normal state of affairs
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- Regime F arises in two ways
  1. Sargent & Wallace’s unpleasant monetarist arithmetic
Primer on Monetary-Fiscal Interactions

- Unpleasant monetarist arithmetic
  - economy hits the fiscal limit
  - surpluses unresponsive to debt
  - seigniorage adjusts to stabilize debt
  - produces high & volatile inflation

- Many countries have guarded against this
  - central bank independence
  - clear mandate to control inflation—e.g., inflation targeting

- Designed to *force* FP to be passive
- Will focus on second way Regime F can arise
Primer on Monetary-Fiscal Interactions

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- Regime M: normal state of affairs
- Regime F: can arise in an era of fiscal stress
- Regime F arises in two ways
  1. Sargent & Wallace’s unpleasant monetarist arithmetic
  2. fiscal theory of the price level
Monetary-Fiscal Interactions: Regime F

- Governments issue mostly nominal (non-indexed, local currency) bonds
  - 90% U.S. debt; 80% U.K. debt; 95% Euro-area debt; most of Australian, Japanese, Korean, New Zealand, & Swedish debt
  - Increasingly important in Latin America: Chile (92%), Brazil (89%), Colombia (77%), Mexico (75%)

- In Regime F:
  - FP sets primary surpluses independently of debt
  - MP prevents interest payments on debt from destabilizing debt

- Nominal debt is revalued to align its value with expected surpluses

- Lower current or expected surpluses reduce value of outstanding debt: raises aggregate demand
Regime F Policy Behavior

- FP responds weakly (or not at all) to state of government indebtedness
- MP prevents nominal interest rate from reacting strongly to inflation
- In terms of policy rules

\[
\text{Regime F: } 0 < \frac{\alpha}{\beta} < 1 \& \gamma < 1 - \beta
\]

- Focus on special case

\[
\alpha = 0 \& \gamma = 0
\]

- MP sets \( \{R_t\} \) exogenously; FP sets \( \{s_t\} \) exogenously
Regime F Equilibrium

- Pegs expected inflation

\[ E_t \left( \frac{1}{\pi_{t+1}} \right) = \frac{1}{\beta R^*} = \frac{1}{\pi^*} \]

- Price level determined by

\[ \frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}] \]

- At \( t \), \( B_{t-1} \) predetermined and \( E_t s_{t+j} \) a number

- \( P_t \) must adjust to equate value of debt to expected cash flows
Regime F Transmission Mechanism

\[
\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}]
\]

- Increase in current or expected transfers
  - no offsetting taxes expected, household wealth rises
  - lower expected path of surpluses reduces “cash flows,” lowers value of debt
  - individuals shed debt in favor of consumption, raising aggregate demand
  - higher current & future inflation and economic activity
  - long bonds shift inflation into future

- Demand for debt ⇔ aggregate demand
Regime F Determinacy

\[ \frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}] \]

- How do we know that no other \( \{P_t\} \) sequence is an equilibrium (especially ones with \( P_t \to \infty \))?

- Suppose \( P_t \) is “too low”: debt over-valued relative to cash flows
  - agents substitute out of debt and into buying goods
  - higher aggregate demand drives up \( P_t \) until value of debt consistent with \( E_t PV(s) \)

- Symmetric argument if \( P_t \) is “too high”
An Equilibrium Condition

\[ \frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}] \]

- In Regime F...
  - FP delivers unique equilibrium price process
  - taking inflation as given, MP must choose compatible interest rate policy
  - “compatible” means: stabilizes debt
  - imposes restrictions on \( P_t \) (& on MP, if price level to remain stable)
More on the Equilibrium Condition

\[
\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}]
\]

- Ubiquitous: holds in any model, in any regime
  - cannot be used to “test” for regime
- It is not an “intertemporal government budget constraint”
  - have imposed market clearing, Euler equations, transversality (from private behavior)
- Government is not restricted to choose \( \{s_t\} \) to satisfy it for any \( \{P_t\} \) (but it is free to do so)
- Cochrane calls it a “debt valuation equation”
  - with only one-period debt, \( B_{t-1}/P_t \) is market value of debt
Equilibrium conditions for nominal and real debt

Nominal: \( B_{t-1} = P_t \sum_{j=0}^{\infty} \beta^j E_t \left[ \tau_{t+j} - z_{t+j} + \frac{M_{t+j} - M_{t+j-1}}{P_{t+j}} \right] \)

Real: \( \nu_{t-1} = \sum_{j=0}^{\infty} \beta^j E_t \left[ \tau_{t+j} - z_{t+j} + \frac{M_{t+j} - M_{t+j-1}}{P_{t+j}} \right] \)

Hypothetical increase in \( P_t \), all else fixed

- raises nominal backing: support more nominal debt with no change in surpluses or seigniorage
- lowers real backing: reduces seigniorage revenues

Fiscal Theory is not about seigniorage: if \( M/P \) tiny, higher \( P_t \) raises backing of nominal debt but not of real debt

Unpleasant Arithmetic is about seigniorage: growing real debt requires growing seigniorage & inflation
Part II: Extensions

Maturity Structure of Debt
Model with Sticky Prices
Observational Equivalence
Monetary Policy Impacts
Role of Debt Maturity Structure

- Simple model:
  - output exogenous
  - real discount rate fixed at $1/\beta$
  - prices flexible
  - cashless economy

- Extend intertemporal equilibrium condition with only one-period nominal debt

\[
\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{t+j}]
\]

$s$: primary surplus
Role of Debt Maturity Structure: I

- Allow one- and two-period zero-coupon nominal bonds: $B_t(t + 1), B_t(t + 2)$; equilibrium condition is

$$\frac{B_{t-1}(t)}{P_t} + \beta B_{t-1}(t + 1) E_t \frac{1}{P_{t+1}} = \sum_{j=0}^{\infty} \beta^j E_t s_{t+j}$$

- MP determines the timing of inflation
  - stabilize expected inflation: forces adjustment in $P_t$
  - lean against current inflation: forces adjustment in $E_t \left(\frac{1}{P_{t+1}}\right)$
  - tradeoff depends on maturity structure, $B_{t-1}(t + 1)/B_{t-1}(t)$
  - shorter average maturity $\Rightarrow$ need larger $\Delta E_t \left(\frac{1}{P_{t+1}}\right)$ to compensate for given $\Delta \left(\frac{1}{P_t}\right)$

- Message: MP not impotent, but it cannot control both actual & expected inflation
Role of Debt Maturity Structure: II

- Zero-coupon bonds
- Write government’s flow constraint as

\[
B_{t-1}(t) - \sum_{j=1}^{\infty} Q_t(t+j)[B_t(t+j) - B_{t-1}(t+j)] = P_t s_t
\]

- Impose equilibrium on asset-pricing relation

\[
Q_t(t+j) = \beta^j E_t \frac{P_t}{P_{t+j}}
\]

- Combine these

\[
\frac{B_{t-1}(t)}{P_t} - \sum_{j=1}^{\infty} \beta^j E_t \frac{1}{P_{t+j}}[B_t(t+j) - B_{t-1}(t+j)] = s_t
\]
Role of Debt Maturity Structure: II

\[
\frac{B_{t-1}(t)}{P_t} - \sum_{j=1}^{\infty} \beta^j E_t \frac{1}{P_{t+j}} [B_t(t + j) - B_{t-1}(t + j)] = s_t
\]

- Suppose govt neither issues new debt nor repurchases outstanding debt, so
  \[B_{t-1}(t + j) = B_t(t + j) = B_{t-1}(t), j > 0\]
  \[P_t = \frac{B_{t-1}(t)}{s_t}\]

- Future deficits don’t matter (constant debt \(\Rightarrow\) no link between value of debt today & future surpluses)
- Inflation occurs only when surplus realized
- But current bond prices reflect \(E_t s_{t+j}\) which changes \(E_t(1/P_{t+j})\)
  \[Q_t(t + j) = \beta^j E_t \frac{P_t}{P_{t+j}}\]
Role of Debt Maturity Structure: III

- Allow a consol: perpetuity that pays $1 each period
- Government budget constraint

\[
\frac{Q_t B_t}{P_t} + s_t = \frac{(1 + Q_t) B_{t-1}}{P_t}
\]

- Asset-pricing relation, in equilibrium

\[
Q_t = \beta E_t \frac{P_t}{P_{t+1}} (1 + Q_{t+1}) = \sum_{j=1}^{\infty} \beta^j E_t \frac{P_t}{P_{t+j}}
\]

- Intertemporal equilibrium condition

\[
\frac{B_{t-1}}{P_{t-1}} \sum_{j=0}^{\infty} \beta^j E_t \left( \frac{1}{\prod_{k=0}^{j} \pi_{t+k}} \right) = \sum_{j=0}^{\infty} \beta^j E_t s_{t+j}
\]

- FP determines the present value of inflation; MP determines the timing of inflation
Following a surplus shock. . .

- fiscal policy determines the *total* change in inflation
- monetary policy determines the *timing* of inflation

- Calibrate maturity structure to U.S. federal debt data

- Illustrate alternative possible paths for inflation
To further bring the postponed-inflation possibility to life, Fig. 8 plots the corresponding time series of inflation and bond yields. The vertical line indicates the date of the surplus shock. First, long-term bond yields rise. As the inflation approaches, shorter term rates rise as well. Finally, 5 years after the surplus shock, the steady inflation actually materializes.

When you think of fiscal inflation, then think at least of this possibility, not a price-level jump. The “news” here is a collective decision by investors that the US is likely not to solve its long-term deficit problems, or a rise in the discount rate applied to U.S. debt, a “flight”. We are likely first to see a puzzling rise in long-term interest rates. Since the “news” that shifts expectations is seldom independently visible, or is of the quantitatively small “straw that broke the camel’s back” variety, politicians and central bankers are likely to decry unstable markets and speculators, as they did in the Greek crisis. Rises in shorter rates will follow, and steady inflation will follow that, on a time scale roughly coincident with the average maturity of

Three reactions to a 10% expected surplus shock. Red triangles: time-$t$ price-level jump followed by no additional inflation; blue circles: steady inflation starting at time $t$; black triangles: steady inflation starting 4 years after the shock. Calibrated to U.S. federal debt maturity structure.
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![Bond yield reaction graph](image)

**Bond yield reaction**

- **s shock**: 
- **Yield** vs **Date**
- **Inflation**
- **Numbers** indicate the maturity of the bond yields. The vertical line indicates the date of the surplus shock.

Bond yields and inflation from a 10% shock to expected surpluses, when the government sells debt to postpone inflation for 5 years. Numbers indicate the maturity of the bond yields. The vertical line indicates the date of the surplus shock.
Nominal Rigidities

- Follows Woodford (1998)
- Sticky prices: fraction $1 - \alpha$ of goods suppliers get to set a new price each period
- Continuum of identical households indexed by $j \in [0, 1]$, each specializes in production of single differentiated good
- Continuum of differentiated goods each period indexed by $z \in [0, 1]$
- Household $j$ maximizes

$$E_0 \left\{ \sum_{j=0}^{\infty} \beta^t \left[ u(C_t^j) + \nu \left( \frac{M_t^j}{P_t} \right) - w(y_t(j)) \right] \right\}$$

where $y_t(j)$: HH $j$'s supply of its product and

$$C_t^j \equiv \left[ \int_0^1 c_t^j(z) \frac{\theta-1}{\theta} \, dz \right]^{\frac{\theta}{\theta-1}}, \quad \theta > 1$$
Nominal Rigidities

- Household $j$’s budget constraint

$$\int_0^1 p_t(z) c^j_t(z) dz + M^j_t + Q_{t,t+1}^j B^j_t \leq W^j_t + p_t(j)y_t(j) - P_t \tau_t$$

with $P_t \equiv \left[ \int_0^1 p_t(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}}$ and $W^j \equiv M_{t-1} + B^j_{t-1}$

- Government’s budget constraint

$$Q_{t,t+1} B_t = B_{t-1} + P_t \Delta_t - (M_t - M_{t-1})$$

with $\Delta_t \equiv z_t - \tau_t$, primary deficit

- Aggregate resource constraint: $C_t = Y$
Nominal Rigidities

Equilibrium conditions

\[ Q_{t,T} = \beta^{T-t} \frac{u'(Y_T)}{u'(Y_t)} \frac{P_t}{P_T} \]

\[ \frac{v'(M_t/P_t)}{u'(Y_t)} = \frac{R_t - 1}{R_t} \]

\[ \frac{1}{R_t} = \beta E_t \left[ \frac{u'(Y_{t+1})}{u'(Y_t)} \frac{P_t}{P_{t+1}} \right] \]

\[ \lim_{T \to \infty} E_t [Q_{t,T} W_T] = 0 \]

Integrating over all households, intertemporal HH bc

\[ \sum_{T=t}^{\infty} E_t \left\{ Q_{t,T} \left[ P_T C_T + \frac{R_T - 1}{R_T} M_T \right] \right\} \]

\[ = \sum_{T=t}^{\infty} E_t \left\{ Q_{t,T} [P_T Y_T - P_T \tau_T] \right\} + M_{t-1} + B_{t-1} \]
Nominal Rigidities

- Price-setting behavior
  - HH chooses new price, $P_t^*$, to satisfy
    
    $$\sum_{k=0}^{\infty} \alpha^k E_t \left\{ Q_{t,t+k} Y_{t+k} \left( \frac{P_t^*}{P_{t+k}} \right)^{-\theta} \left[ P_t^* - \mu S_{t+k,t} \right] \right\} = 0$$

    where $\mu \equiv \theta / (\theta - 1) > 1$: markup
  
  - $S_{T,t}$: marginal cost at $T$ of good whose price was set at $t$
    
    $$S_{T,t} = \frac{w' \left( Y_T \left( \frac{P_t^*}{P_T} \right)^{-\theta} \right)}{u'(Y_T)} P_T$$

  - and price index is
    
    $$P_t = \left[ \alpha P_{t-1}^{1-\theta} + (1 - \alpha) P_t^* (1-\theta) \right]^{\frac{1}{1-\theta}}$$

- Flexible prices: $P_t^* = \mu S_{t,t}$, so $P_t = P^*$, $Y_t = Y^*$ where $Y^*$ solves $u'(Y^*) = \mu w'(Y^*)$
Fiscal Policy as Source of Instability

- Suppose there are no constraints on FP, so \( \{ \Delta_t \} \) is exogenous
- Then fiscal disturbances \emph{must} affect inflation, output, and interest rates, \emph{regardless of MP behavior}
- Proof by Contradiction: Suppose there is a MP that delivers stable prices despite fluctuations in \( \Delta_t \)
  - then \( Y_t = Y^* \) all \( t \)
  - \( R_t \) and \( M_t \) constant and
    \[
    Q_{t,T} = \beta^{T-t}, \quad R^* = \beta^{-1}, \quad C_t = Y^* \\
    \sum_{j=0}^{\infty} \beta^j \frac{R^* - 1}{R^*} m^* = m^* \\
    
    HH's intertemporal budget constraint is
    \[
    \frac{W_t}{P^*} = m^* - \delta_t \\
    \text{where } \delta_t \equiv \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j}
    \]
Fiscal Policy as Source of Instability

\[ \frac{W_t}{P^*} = m^* - \delta_t \quad (IBC) \]

\[ \delta_t \equiv \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j} \]

- But \( W_t \) predetermined at \( t \)
- Equilibrium condition (IBC) \( \Rightarrow \) fiscal shock cannot change \( \delta_t \)
- Conclusion: Random variation in FP necessarily inconsistent with price stability
- Conclusion is independent of MP behavior
  - so nothing MP can do to offset instability
Assume MP rule that doesn’t react to fiscal variables

\[ R_t = \Phi(\pi_t, Y_t) \]

Government issues only 1-period nominal debt

\[ B_t = R_t[B_{t-1} + P_t \Delta_t - (M_t - M_{t-1})] \]

Steady state is

\[ \Delta_t = \Delta^* < 0, \quad \Phi(1, Y^*) = \beta^{-1} - 1, \quad R^* = \beta^{-1} \]

Log-linearize system around steady state
System is \( \hat{x}_t \equiv \ln(x_t) - \ln(x^*) \)

\[
\hat{m}_t = \chi \left[ \sigma^{-1} \hat{Y}_t - \left( \frac{\beta}{1 - \beta} \right) \hat{R}_t \right]
\]

\[
\hat{Y}_t = E_t \hat{Y}_{t+1} - \sigma (\hat{R}_t - E_t \hat{\pi}_{t+1})
\]

\[
\hat{R}_t = \phi_{\pi} \hat{\pi}_t + \phi_Y \hat{Y}_t
\]

\[
\hat{b}_t = \hat{R}_t + \beta^{-1} (\hat{b}_{t-1} + \hat{\pi}_t) + (\beta^{-1} - 1) \hat{\Delta}_t + \gamma (\hat{m}_{t-1} - \hat{m}_t - \hat{\pi}_t)
\]

\[
\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{Y}_t
\]

where \( \hat{\Delta}_t \equiv \frac{\Delta^* - \Delta_t}{\Delta^*} \), \( \sigma \equiv -\frac{u'(Y^*)}{u''(Y^*)Y^*} \), \( \chi \equiv \frac{v'(m^*)}{v''(m^*)m^*} \), \( \gamma \equiv \frac{m^*}{\beta b^*} \)

\[
\kappa \equiv \frac{(1-\alpha)(1-\alpha\beta)}{\alpha} \frac{\omega+\sigma}{\sigma(\omega+\theta)} , \omega \equiv \frac{w'(Y^*)}{w''(Y^*)Y^*}
\]

Solve for \( \{ \hat{Y}_t, \hat{\pi}_t, \hat{R}_t, \hat{b}_t, \hat{m}_t \} \) given \( \hat{\Delta}_t = \rho \hat{\Delta}_{t-1} + \varepsilon_t \)
Dynamic Impacts of Deficit Shocks

- With \( \{ \hat{\Delta}_t \} \) exogenous, unique eqm requires relatively weak reactions to inflation and output

\[
-1 - \frac{1 + \beta}{\kappa} \phi_Y - \frac{2(1 + \beta)}{\kappa \sigma} < \phi_\pi < 1 - \frac{1 - \beta}{\kappa} \phi_Y
\]

- Benchmark calibration

\[
\beta = .95, \kappa = .3, \chi = \sigma = 1, \gamma = .1, \rho = .6, Y^* = 1, b^*/Y^* = .5
\]

- Vary MP choices of \( \phi_\pi \) and \( \phi_Y \)

  - Pegged interest rate: \( \phi_\pi = \phi_Y = 0 \)
  - Weak lean against wind: \( \phi_\pi = \phi_Y = .3 \)
  - Aggressive stance: \( \phi_\pi = .9, \phi_Y = .5 \)
Impacts of Deficit Shocks: Pegged Rate

\[ \phi_\pi = \phi_Y = 0 \]

Output

\[ \phi_\pi = \phi_Y = 0 \]

Inflation

\[ \phi_\pi = \phi_Y = 0 \]

Nominal Rate

\[ \phi_\pi = \phi_Y = 0 \]

Real Rate

\[ \phi_\pi = \phi_Y = 0 \]
Impacts of Deficit Shocks: Pegged Rate

\[ \phi_{\pi} = \phi_{Y} = 0 \]

\[ \phi_{\pi} = \phi_{Y} = 0 \]

\[ \phi_{\pi} = \phi_{Y} = 0 \]
Impacts of Deficit Shocks: More Hawkish
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\[ \phi_{\pi} = \phi_{Y} = 0 \]

\[ \phi_{\pi} = \phi_{Y} = 0.3 \]

\[ \phi_{\pi} = \phi_{Y} = 0 \]

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Impacts of Deficit Shocks: Even More Hawkish

\[ \phi_\pi = .9, \phi_Y = .5 \]

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Sources of Fiscal Financing

- Write government budget constraint as

\[ \hat{b}_t + E_t \hat{\delta}_{t+1} = \hat{R}_t + \beta^{-1}(\hat{b}_{t-1} + \hat{\delta}_t - \hat{\pi}_t) + \gamma(\hat{m}_{t-1} - \hat{m}_t - \hat{\pi}_t) \]

\[ \hat{\delta}_t \equiv (1 - \beta) \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j} \]

- Solving for the present value of deficits

\[ \hat{\delta}_t = - (\hat{b}_{t-1} - \hat{\pi}_t) + \gamma \sum_{j=0}^{\infty} \beta^{j+1} E_t \hat{\mu}_{t+j} - \sum_{j=0}^{\infty} \beta^{j+1} E_t [\hat{R}_{t+j} - \hat{\pi}_{t+j+1}] \]

\[ \hat{\mu}_t \equiv \hat{m}_t - \hat{m}_{t-1} + \hat{\pi}_t \]

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Quantitative Implications

\[ \hat{\delta}_t = -(\hat{b}_{t-1} - \hat{\pi}_t) + \gamma \sum_{j=0}^{\infty} \beta^{j+1} E_t \hat{\mu}_{t+j} - \sum_{j=0}^{\infty} \beta^{j+1} E_t [\hat{R}_{t+j} - \hat{\pi}_{t+j+1}] \]

<table>
<thead>
<tr>
<th>Percentage Due to</th>
<th>(\hat{\pi}_t)</th>
<th>PV(seig)</th>
<th>(-\text{PV}(r))</th>
<th>PV((\pi))</th>
<th>PV((Y))</th>
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<tbody>
<tr>
<td>(\gamma = .1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\phi_\pi = \phi_Y = 0)</td>
<td>39.6</td>
<td>9.4</td>
<td>51.0</td>
<td>2.1</td>
<td>3.1</td>
</tr>
<tr>
<td>(\phi_\pi = \phi_Y = .3)</td>
<td>52.5</td>
<td>9.4</td>
<td>38.1</td>
<td>4.6</td>
<td>4.1</td>
</tr>
<tr>
<td>(\phi_\pi = .9, \phi_Y = .5)</td>
<td>88.4</td>
<td>10.0</td>
<td>1.6</td>
<td>36.9</td>
<td>6.9</td>
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<tr>
<td>(\gamma = 0)</td>
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</tr>
<tr>
<td>(\phi_\pi = \phi_Y = 0)</td>
<td>43.7</td>
<td>0</td>
<td>56.3</td>
<td>2.3</td>
<td>3.4</td>
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<tr>
<td>(\phi_\pi = .9, \phi_Y = .5)</td>
<td>98.1</td>
<td>0</td>
<td>1.9</td>
<td>41.0</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Dynamic Impacts of Exogenous Serially Correlated Deficit Increase

seig: seigniorage; r: real discount rate; PV(X): present-value change in X; \(\gamma \equiv m^*/(\beta b^*)\); \(\phi_\pi, \phi_Y\): MP parameters
Adding Long-Term Debt

- Let debt issued at $t$ pay $\rho^j$ dollars $j + 1$ periods in the future ($0 \leq \rho < \beta^{-1}$)
- $\rho$ gives average maturity of government debt, $1/(1 - \beta\rho)$
- Government budget constraint becomes

$$P_t^S B_t^S + P_t^M B_t^M = B_{t-1}^S + (1 + \rho P_t^M) B_{t-1}^M + P_t \Delta_t - (M_t - M_{t-1})$$

- Focus on eqm with $B_t^S \equiv 0$, varying average maturity $\rho$
- Bond-pricing equation

$$P_t^M = P_t^S (1 + \rho E_t P_{t+1}^M)$$

$$= \sum_{j=0}^{\infty} (\beta \rho)^j E_t \frac{1}{R_{t+j}}$$
Adding Long-Term Debt

- Intertemporal equilibrium condition becomes

\[
\frac{M_{t-1} + (1 + \rho P_t^M)B_{t-1}^M}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t[s_{t+j}]
\]

- News about future surpluses changes $P_t^M$ & $P_t$
- Precise mix of the two depends on MP
Dynamic Impacts of Deficit Shocks

\[ \pi = \phi Y = 0.3 \]; More Active: \[ \phi \pi = \phi Y = 0.5 \]
Empirical Implications

- MP & FP shocks have very different effects in Regimes M & F
- Isn’t it easy to tell which regime generated observed data?
- No. For example, Regime F implies:
  - negative correlation between inflation & debt-GDP
  - positive correlation between inflation & money growth
  - *any* correlation between inflation & nominal debt growth
  - inflation can Granger-cause deficits
- Common misperception that Regime F creates high inflation
- Regime M can generate same pattern of correlations
- Are Regimes M & F *observationally equivalent*?
Observational Equivalence: Example

- Model: endowment economy; cashless; constant real interest rate; log-linearized deviations
- Fisher relation & government budget constraint:
  \[
  \hat{R}_t = E_t \hat{\pi}_{t+1} \\
  \hat{b}_t + (\beta^{-1} - 1)\hat{s}_t = \beta^{-1}\hat{b}_{t-1} + \beta^{-1}(\hat{R}_{t-1} - \hat{\pi}_t)
  \]
- Policy rules:
  \[
  \hat{R}_t = \alpha \hat{\pi}_t \\
  \hat{s}_t = \gamma \hat{b}_{t-1}
  \]
- Regime M: \(\alpha > 1 \& \gamma > 1\)
Observational Equivalence: Example

- Combine equations to yield

\[
\hat{\pi}_{t+1} = \alpha \hat{\pi}_t, \quad t \geq 0 \\
\hat{b}_t + \beta^{-1} \hat{\pi}_t = \gamma^* \hat{b}_{t-1} + \alpha \beta^{-1} \hat{\pi}_{t-1}, \quad t \geq 1 \\
\hat{b}_0 + (\beta^{-1} - 1) \hat{s}_0 = \beta^{-1} (\hat{b}_{-1} + \hat{R}_{-1})
\]

where \( \gamma^* \equiv \beta^{-1} - \gamma (\beta^{-1} - 1) \)

- Consider special case: \( R_{-1} B_{-1} \) at steady state

- Unique bounded rational expectations equilibrium:

\[
\pi_t = R_t = b_t = s_t = 0, \quad \text{for all } t \geq 0
\]

- The active MP/passive FP equilibrium
Observational Equivalence: Example

- Reproduce equilibrium in **Regime F**:
  - $0 \leq \alpha < 1$ & $0 \leq \gamma > 1$
  - Policy rules:
    \[
    R_t = 0, \quad (\alpha = 0) \\
    s_t = 0, \quad (\gamma = 0)
    \]

- Equilibrium
  \[
  R_t = 0 \Rightarrow E_t \pi_{t+j} = 0, \quad j > 0 \\
  b_t = \beta^{-1} b_{t-1} - \beta^{-1} \pi_t = \sum_{j=1}^{\infty} \beta^j E_t \pi_{t+j} = 0
  \]

- But $b_t = 0 \Rightarrow \pi_t = 0$
- Obtain identical equilibrium as in **Regime M**
This illustration is very special
Can generalize this in several directions

1. Adding randomness
   - if driving processes unobserved, then unrestricted
   - different exogenous processes in Regimes M & F deliver same process for observables

2. Complicating the model
   - real & nominal rigidities

Conjecture: Can always generate an observational equivalence between Regime M & F equilibria

Question: Will the implied driving processes be “reasonable”?
Observational Equivalence: Solution

- What observational equivalence implies
  - cannot “test” for regime using only eqm conditions
  - eqm conditions are satisfied in *all* regimes
  - also rules out reduced-form regressions, dynamic correlations, etc.

- What observational equivalence does *not* imply
  - it is impossible to learn underlying policy regimes
  - theories of inflation determination have no bite

- Need to think hard about specifications of policy behavior
  - which variables do and do not belong in policy rules?

- Gain identification through exclusion restrictions
Broader Implications

\[ \frac{M_{t-1} + B_{t-1}}{P_t} = E_t \sum_{j=0}^{\infty} \frac{1}{r_{t,t+j}} s_{t+j} \]

- \( r_{t,t+j} \) is j-step-ahead real discount rate
- Adjustments to eqm need not occur through \( s_{t+j} \)
  - we saw that price rigidities make future r’s important source of financing
- Changes in \( E_t PV(s) \) need not occur through \( s_{t+j} \)
  - variations in expected r’s can have big effects on \( E_t PV(s) \) with no change in s’s
- When policy does not stand ready to passively provide fiscal backing to monetary actions, MP effects change
- Leads to dramatic re-interpretations
Implications: Discount Rates

\[ \frac{M_{t-1} + B_{t-1}}{P_t} = E_t \sum_{j=0}^{\infty} \frac{1}{r_{t,t+j}} s_{t+j} \]

- Flight to quality in financial crises and recessions
- Investors happy to hold debt at lower expected returns
- As demand for debt rises, demand for goods falls
- Lower demand reduces inflation
- Intertemporal equilibrium condition’s role
  - lower \( r \)’s raises \( E_t PV(s) \) if surpluses unresponsive
  - higher \( E_t PV(s) \) raises value of debt
- Low discount rates can be a source of business cycles
- Ultimate source of demand is fiscal news—beyond central bank’s control
The 2008–2009 recession: conventional story doesn’t hold up (Cochrane)

Sharp increase in precautionary demand for money
  - not met by supply
  - ⇒ lower demand & real output

Fed flooded economy with reserves
  - to flight to money, out of bonds
  - no bank runs

Instead, a flight to all quality—\( M \) & \( B \)—out of goods

Similar to convention, but focuses on all government debt, rather than just money

Appropriate policy responses?
  - announce cuts in fiscal surpluses
  - if surpluses fixed and MP can affect real interest rates, then MP should raise rates

Highly irregular
Implications: Monetary Policy Effects

- An open-market sale of $B$ reduces $M$, raises $R$
- If higher nominal $R$ means higher real $r$
  - holding FP fixed, this lowers $E_t PV(s)$
  - induces people to substitute out of government debt, into goods
  - raises aggregate demand
  - highly irregular
- Conventional view implicitly requires FP to generate higher expected surpluses
- If surpluses rise enough to raise $E_t PV(s)$, even with higher real discount rates...
  - tighter MP reduces demand and inflation
  - otherwise, demand and inflation rise
- An unresolved puzzle: how can MP affect real interest rates?
Implications: Monetary Policy Effects

▶ In new Keynesian model

\[ \hat{Y}_t = E_t \hat{Y}_{t+1} - \sigma (\hat{R}_t - E_t \hat{\pi}_{t+1}) \]

\[ \hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{Y}_t \]

\[ \hat{\pi}_t = \left( b_{t-1} - \delta_t \right) \gamma \sum_{j=0}^{\infty} \beta^{j+1} E_t \hat{\mu}_{t+j} + \sum_{j=0}^{\infty} \beta^{j+1} E_t [\hat{R}_{t+j} - \hat{\pi}_{t+j+1}] \]

PV(seigniorage) + PV(real discount rates)

▶ Tighter monetary policy with fixed surpluses
  ▶ raises \( \hat{R}_t - E_t \hat{\pi}_{t+1} \) in short run: lowers output
  ▶ raises entire path of \( \{ E_t \hat{\pi}_{t+j} \} \): raise inflation
  ▶ appears as an adverse shift in the Phillips curve
▶ More hawkish MP—stronger response to inflation—prolongs rise in \( r \)
  ▶ higher real debt service enhances wealth effects
Implications: Monetary Policy Effects

Serially correlated exogenous monetary policy contraction
Implications: Monetary Policy Effects

Serially correlated exogenous monetary policy contraction
In a world where FP cannot be relied on to adjust surpluses as needed to stabilize debt...

1. it is impossible for MP to stabilize the economy
2. fiscal disturbances will always affect output, inflation & interest rates
3. more aggressive MP will exacerbate the instability
4. fluctuations in “confidence” that affect real interest rates will transmit into fluctuations in output & inflation
5. sudden flights to quality or away from junk can have real effects
6. tighter MP raises debt service, wealth, aggregate demand, and inflation

These facts point to the need to find political devices that lead to stable and reliable fiscal policies

Or to reconsideration of the mandates of central banks
Consider a central bank tasked with targeting inflation.

To be successful, fiscal policy must be passive.

- Surpluses respond in whatever manner is needed to stabilize debt.

What if fiscal policy does not so behave?
The Hungarian Case

- Hungarian facts courtesy of personnel at Magyar Nemzeti Bank

- Inflation targeting adopted since 2001 had mixed success

  - average inflation is lower
  - but still consistently above target
  - real interest rates have tended to be high
Hungary: Inflation Experience

Average inflation before IT: 17.8%

Average inflation after introducing IT: 5.3%
Hungary: Real Rates
The Hungarian Case

- Unfair to declare inflation targeting a failure

- Fiscal policy has been highly volatile
  - huge expansion 2002–2006 (6–7% GDP)
  - dramatic reversals: spending cuts & tax hikes
  - but government debt continued to rise as share of GDP
  - government recently converted pensions from stocks to Hungarian government debt

- About 50% of Hungarian government debt is in HUF—it’s nominal

- Even if only a small fraction in HUF, fiscal theory can operate
  - fiscal theory disappears only if all debt is indexed
Hungary: Government Debt–GDP Ratio
Inflation Targeting

- Like many countries, Hungary adopted IT without corresponding fiscal reforms
- Counterexamples include Chile, New Zealand, Norway, Sweden
  - to varying degrees, they imposed fiscal rules
  - in most cases, the rules have been obeyed
- Monetary & fiscal policies must be consistent
  - long-run IT *must* be consistent with long-run surpluses
  - most important: views about long-run surpluses must be *anchored*
- Ultimately, MP derives its power to control inflation from fiscal backing
  - no fiscal backing $\Rightarrow$ MP cannot achieve long-run IT
Hungarian Inflation Targeting

- Suppose Hungarian fiscal surpluses do not credibly adjust to stabilize debt

- What is the best monetary policy for Hungary?

- One response is obvious: not aggressive inflation targeting

  - without necessary fiscal backing, aggressive inflation fighting counterproductive
  - makes inflation & output more volatile
  - permanently aggressive inflation fighting generates explosive inflation

- Depending on maturity structure of debt, MP has power to determine the timing of inflation

  - but not average long-run inflation
Hungarian Inflation Targeting

- Optimal MP under fiscal dominance has not been studied
  - (but see Cochrane’s *Econometrica* 2001 paper for a theory of optimal inflation smoothing in a frictionless model)
- Existing work on optimal monetary-fiscal policy finds that Regime M dominates Regime F
  - given the observational equivalence between the regimes, this finding is puzzling
  - must stem from auxiliary assumptions, rather than policy behavior
- More basic research is needed
Hungarian Inflation Targeting

- What about practical advice?
- Bear in mind effects of real interest rates on \( E_t PV(s) \)
  - keeping real rates high to fight inflation keeps \( E_t PV(s) \) low
  - low \( E_t PV(s) \) depresses value of debt, encourages demand
  - higher demand leads to higher inflation
- High debt need not imply high inflation
  - if the debt is backed by surpluses, there is no inflation
  - if it’s backed by future seigniorage, it might be inflationary
  - effects of higher debt depend on \( E_t PV(s) \)
- Need to think about what anchors fiscal expectations
- Transmission mechanism: \( E_t PV(s) \Rightarrow \pi_{t+j} \)
  - anything that changes \( E_t PV(s) \) can affect inflation before \( s \)’s change