Monash Mini-Course:
Monetary-Fiscal Policy
Interactions—Part I

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Modeling convention

- Canonical macro models assume
  1. MP can and does control inflation
  2. FP can and does ensure solvency

1. MP optimal or obeys Taylor-type rule
   - unconstrained or “active”
2. FP takes MP & private behavior as given and stabilizes debt
   - constrained or “passive”

- This modeling convention makes sense in normal times
  - embedded in textbooks (Walsh, Woodford, Galí)

- It also makes MP omnipotent & FP trivial
Monetary & Fiscal Interactions: Big Picture

- Modeling convention a stretch since 2008
  - What have policies actually been doing?
  1. MP at or near zero lower bound
  2. FP bouncing between stimulus & austerity

1. Central banks aggressively pursuing growth
   - thrown Taylor principle out the window

2. Recent fiscal advice from IMF:
   - 2008–2009: urgent need to stimulate
   - 2010–2011: urgent need to consolidate
   - 2012: urgent need for stimulative consolidation (“growsterity”)

- How can such policies anchor monetary expectations on inflation target?
- How can such policies anchor fiscal expectations on debt stabilization?
Need to understand implications of policy interactions that deviate from convention

Short-run reasons:
- Europe enters second recession, emerging economies slowing down, U.S. on brink of new recession, Japan still stuck
- Ubiquitous tradeoff between stabilization & sustainability
- What are effect of fiscal policy when MP pegs rate?

Long-run reasons:
- Aging populations & unfunded old-age benefits
- Huge uncertainty about future fiscal policies
- What are impacts of unresolved long-run fiscal stress?

Conventional modeling cannot address these issues
- assumes away the problems
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. If FP does not cooperate, MP cannot affect economy in usual ways

6. Without credible, enforceable fiscal rules that anchor expectations on appropriate FP behavior, fiscal disturbances *always* affect economy
General Points About Inflation

- 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
- Nominal bonds—like fiat currency—are promises to pay back more currency in future
- If government doesn’t soak up bonds with taxes... inflation
General Points About Inflation

- 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
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
- \(Q_{t,t+1} = \frac{P_t}{P_{t+1}} m_{t+1}\): 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
The Model

- 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

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

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

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

▸ 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 $m_{t,t+1} = \frac{\beta U'(C_{t+1})}{U'(C_t)} = \frac{\beta U'(Y)}{U'(Y)} = \beta$
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

**Regime M:** \( \frac{\alpha}{\beta} > 1 \) & \( \gamma > 1 - \beta \)
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 \( E_t b_T \to b^* \) as \( T \to \infty \)

- 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, $\underline{b}$
  - surplus rule becomes $s = (1 - \beta)\underline{b}$
  - 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 \( E_t PV(s) \)
Monetary & fiscal policy have two tasks: (1) control inflation; (2) stabilize debt

Beautiful symmetry: 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 F arises in two ways

1. Sargent & Wallace’s unpleasant monetarist arithmetic
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

- Monetary & fiscal policy have two tasks: (1) control inflation; (2) stabilize debt

- Beautiful symmetry: 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)

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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
  - increasing 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
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

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

- Focus on special case

\[
\alpha = 0 \text{ and } \gamma = 0
\]

- 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 \( E_tPV(s) \)
- 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
Why Fiscal Theory ≠ Unpleasant Arithmetic

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

- 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
Role of Debt Maturity Structure: 1

- 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 $E_t(1/P_{t+1})$
  - tradeoff depends on maturity structure, $B_{t-1}(t + 1)/B_{t-1}(t)$
  - shorter average maturity $\Rightarrow$ need larger $\Delta E_t(1/P_{t+1})$ to compensate for given $\Delta(1/P_t)$

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

- 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
  \[ Q_t = \beta E_t \frac{P_t}{P_{t+1}} (1 + Q_{t+1}) = \sum_{j=1}^{\infty} \beta^j E_t \frac{P_t}{P_{t+j}} \]
- Central bank controls \( R_t \): \( 1/R_t = P_{St} = \beta E_t (P_t/P_{t+1}) \)
- Intertemporal equilibrium condition
  \[ \frac{(1 + Q_t) B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t s_{t+j} \]
- FP determines the present value of inflation; MP determines the timing of inflation
Role of Debt Maturity Structure: II

\[ Q_t = E_t \sum_{j=0}^{\infty} \left( \frac{1}{\prod_{i=0}^{j} R_{t+i}} \right) = E_t \sum_{j=1}^{\infty} \beta^j \left( \frac{1}{\prod_{i=1}^{j} \pi_{t+i}} \right) \]

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

- Any path of \( \{P_t\} \) consistent with these conditions is an equilibrium
- By choosing a (constrained) path for \( \{R_t\} \), MP determines when inflation occurs
- Consider two pegged paths for \( R_t \)--\( \uparrow \) & \( \ast \)--with \( R_{\uparrow} > R^{\ast} \Rightarrow Q_{\uparrow} < Q^{\ast} \)
  - \( \pi_t^{\uparrow} < \pi_t^{\ast} \) but future \( \pi_{t}^{\uparrow} > \) future \( \pi_{t}^{\ast} \)
  - a higher nominal rate lowers current inflation, but raises future inflation
Role of Debt Maturity Structure: III

- 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: III

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

- 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 \(E_t(1/P_{t+j})\)

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

- Two-country union (Sims, Bergin)
  - world endowment: $Y_t = Y_{1,t} + Y_{2,t} = Y$
  - household in country $j$ maximizes
    $$E_0 \sum_{t=0}^{\infty} \beta^t u(C_{j,t})$$
    subject to
    $$C_{j,t} + \frac{B_{j,t}}{P_t} + \tau_{j,t} = Y_{j,t} + z_{j,t} + \frac{R_{t-1}B_{j,t-1}}{P_t}$$
  - country $j$’s government budget constraint
    $$\frac{D_{j,t}}{P_t} + \tau_{j,t} + \nu_{j,t} = z_{j,t} + \frac{R_{t-1}D_{j,t-1}}{P_t}$$
    $\nu_{j,t}$: lump-sum transfers from central bank
  - central bank’s budget constraint
    $$\frac{B_{m,t}}{P_t} + \nu_{1,t} + \nu_{2,t} = \frac{R_{t-1}B_{m,t-1}}{P_t}$$
A Monetary Union

- Equilibrium conditions
  - Euler equation for household $j$
    \[ u'(C_{j,t}) = \beta R_t E_t \frac{P_t}{P_{t+1}} u'(C_{j,t+1}) \]
  - Transversality condition for household $j$
    \[ \lim_{T \to \infty} \beta^T E_t u'(C_{j,t+T}) \frac{B_{j,t+T}}{P_{t+T}} = 0 \]
  - Market clearing conditions
    \[
    C_{1,t} + C_{2,t} = Y_{1,t} + Y_{2,t} = Y \\
    B_{1,t} + B_{2,t} + B_{m,t} = D_{1,t} + D_{2,t}
    \]

- Note: TVC applies to household’s holdings of $B_{j,t}$, not to individual government issues, $D_{j,t}$
  - Can have eqm with $D_{1,t} \to +\infty$ and $D_{2,t} \to -\infty$
If \( D_{1,t} \to +\infty \) and \( D_{2,t} \to -\infty \), then govt 2 is completely financing govt 1, with no expectation of repayment.

- Not a stable political economy equilibrium
- Govt 2 can improve well-being of its citizens by refusing to do this
- Same argument applies to central bank
- We will impose individual govt and CB solvency

\[
\lim_{T \to \infty} \beta^T E_t u'(C_{j,t+T}) \frac{D_{j,t+T}}{P_{t+T}} = 0
\]

\[
\lim_{T \to \infty} \beta^T E_t u'(C_{j,t+T}) \frac{B_{m,t+T}}{P_{t+T}} = 0
\]
A Monetary Union

▶ Assume $u(C_{j,t}) = C_{j,t} - \frac{a}{2}C_{j,t}^2$; adding Euler equations yields

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

▶ Applying this, country-specific consumptions are

$$C_{1,t} = E_tC_{1,t+1}, \quad C_{2,t} = E_tC_{2,t+1}$$

▶ Imposing eqm, get conditions

$$\frac{R_{t-1}D_{1,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{1,t+j} + v_{1,t+j}]$$

$$\frac{R_{t-1}D_{2,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [s_{2,t+j} + v_{2,t+j}]$$

$$\frac{R_{t-1}B_{m,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t [v_{1,t+j} + v_{2,t+j}]$$
A Monetary Union

- **Policy assumptions**
  - CB pegs nominal rate: $R_t = R^*$
  - Country 1 raises surpluses passively with debt
  - Country 2 sets surpluses independent of debt
  - CB rebates portfolio earnings to countries, independent of their debt

- **Results**
  1. Union-wide inflation determined by country 2 (one with profligate FP)
  2. News about country 2 surpluses affects inflation & value of debt in both countries
  3. Requires adjustments in country 1’s surpluses
A Monetary Union

- How can CB retain control of inflation?
  - rebates to countries depend on each nation’s debt in the right way
  - make MP active (ECB in normal times)
- Efforts by the CB to reduce inflation
  - raise value of debt in both countries
  - requires higher rebates from CB to country 2 (backs debt of profligate country)
  - rebates to country 1 may need to be negative (taxes)
  - gives CB power to tax and transfer

- Message: A fiscal union can support monetary union’s efforts to control inflation
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

$$E_0 \left\{ \sum_{j=0}^{\infty} \beta^t \left[ u(C^j_t) + v \left( \frac{M^j_t}{P_t} \right) - w(y^j_t(j)) \right] \right\}$$

where $y^j_t(j)$: HH $j$’s supply of its product and

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

- Household $j$’s budget constraint

\[
\int_0^1 p_t(z) c_t^j(z) dz + M_t^j + Q_{t,t+1} B_t^j \leq W_t^j + p_t(j) y_t(j) - P_t \tau_t
\]

with $P_t \equiv \left[ \int_0^1 p_t(z)^{1-\theta} dz \right]^{1/\theta}$ and $W_t^j \equiv M_{t-1} + B_{t-1}^j$

- 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

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

\[ = \sum_{T=t}^{\infty} E_t \left\{ Q_{t,T} \left[ P_T Y_T - P_T \tau_T \right] \right\} + M_{t-1} + B_{t-1} \]
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 must affect inflation, output, and interest rates, 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
    \[
    \frac{W_t}{P^*} = m^* - \delta_t
    \]
    where \( \delta_t \equiv \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j} \)
Fiscal Policy as Source of Instability

\[
\frac{W_t}{P^*} = m^* - \delta_t
\]  

(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
Four-equation system

\[ y_t = E_t y_{t+1} - \sigma (i_t - E_t \pi_{t+1}) \]
\[ \pi_t = \beta E_t \pi_{t+1} + \kappa y_t \]
\[ b_t = i_t + \beta^{-1} (b_{t-1} - \pi_t) + (\beta^{-1} - 1) \Delta_t \]
\[ i_t = \alpha \pi_t + \varphi_t \]

Can show that

\[ (1 - \alpha \beta) \sum_{j=0}^{\infty} \beta^j E_t \pi_{t+j} = b_{t-1} + \beta \sum_{j=0}^{\infty} \beta^j E_t \varphi_{t+j} + (1 - \beta) \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j} \quad (\dagger) \]

1. present value of inflation determined by policy shocks
2. more hawkish MP—higher \( \alpha \)—amplifies positive impacts of deficits & interest rates
Analytics for Cashless Limit Version

- **Flexible-price case:** $\kappa = \infty \Rightarrow y_t \equiv 0$
- **Constant real rate:** $i_t = E_t \pi_{t+1}$
- **Note that**

$$E_t \pi_{t+j} = \alpha^j \pi_t + \alpha^{j-1} \varphi_t + \alpha^{j-2} E_t \varphi_{t+1} + \ldots + \alpha E_t \varphi_{t+j-2} + E_t \varphi_{t+j-1}$$

- **Solve for** $\pi_t$ **from** ($\dagger$)

$$\pi_t = b_{t-1} + \beta (1 - \alpha \beta) \sum_{j=0}^{\infty} \beta^j E_t \varphi_{t+j} + (1 - \beta) \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j} \quad (\ddagger)$$

1. higher inflation from higher PV deficits or interest rates
2. effect of deficits on $\pi_t$ not affected by MP
3. more hawkish MP increases effect of deficits on expected $\pi$

- **Note:** $E_t \pi_{t+1}$ from ($\ddagger$) consistent
Return to sticky-price model: $0 < \kappa < \infty$
- output and real interest rate endogenous

Real rate: $r_{t+j} \equiv i_{t+j-1} - \pi_{t+j}$

Rewrite (†) as

$$\pi_t - \sum_{j=1}^{\infty} \beta^j E_t r_{t+j} = b_{t-1} + (1 - \beta) \sum_{j=0}^{\infty} \beta^j E_t \Delta_{t+j}$$

News about higher deficits shows up as a mix of
1. higher current inflation
2. lower path of real interest rates
3. transmits to higher output
4. MP behavior determines split between inflation & real activity
analytics for cashless limit version

- combine euler equation, phillips curve, mp rule

\[ E_t \pi_{t+2} - \beta^{-1}(1 + \beta + \sigma \kappa)E_t \pi_{t+1} + \beta^{-1}(1 + \alpha \sigma \kappa)\pi_t = -\beta^{-1}\sigma \kappa \varphi_t \]

- can show two real roots: \( |\lambda_1| < 1, |\lambda_2| > 1 \)

- solution for expected inflation

\[ E_t \pi_{t+1} = \lambda_1 \pi_t + (\beta \lambda_2)^{-1} \sigma \kappa \sum_{j=0}^{\infty} \lambda_2^{-j} E_t \varphi_{t+j} \]

- solve recursively given exogenous \( \{\Delta_t, \varphi_t\} \), predetermined \( b_{t-1} \)
  1. solve for \( \pi_t \) from (†)
  2. \( \pi_t \) & \( E_t \pi_{t+1} \) yield \( y_t \)
  3. \( i_t \) from mp rule
  4. \( b_t \) from government budget constraint
  5. repeat
Return to Cash Version with Exogenous FP

- 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
Equilibrium Consistent with Exogenous FP

System is \( \hat{x}_t \equiv \ln(x_t) - \ln(x^*) \)

\[
\begin{align*}
\hat{m}_t &= \chi \left[ \sigma^{-1} \hat{Y}_t - \left( \frac{\beta}{1 - \beta} \right) \hat{R}_t \right] \\
\hat{Y}_t &= E_t \hat{Y}_{t+1} - \sigma (\hat{R}_t - E_t \hat{\pi}_{t+1}) \\
\hat{R}_t &= \phi_{\pi} \hat{\pi}_t + \phi_Y \hat{Y}_t \\
\hat{b}_t &= \hat{R}_t + \beta^{-1} (\hat{b}_{t-1} + \hat{\pi}_t) + (\beta^{-1} - 1) \hat{\Delta}_t + \gamma (\hat{m}_{t-1} - \hat{m}_t - \hat{\pi}_t) \\
\hat{\pi}_t &= \beta E_t \hat{\pi}_{t+1} + \kappa \hat{Y}_t
\end{align*}
\]

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

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

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

- With \( \{ \Delta_t \} \) 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: 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
Impacts of Deficit: Pegged Rate

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

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

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

\[ \phi = \phi_y = 0 \]
\[ \phi = \phi_y = 0.3 \]

Output

Inflation

Nominal Rate

Real Rate
Impacts of Deficit: More Hawkish

Inflation

Debt–Output

Money Growth

Deficit

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

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

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

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

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

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

\[
\phi_{\pi} = .9, \phi_Y = .5
\]
Impacts of Deficit: Even More Hawkish

φ_π = .9, φ_Y = .5

φ_π = .9, φ_Y = .5

φ_π = .9, φ_Y = .5
Sources of Fiscal Financing

Write government budget constraint as

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

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

Solving for the present value of deficits

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

\[ \hat{\mu}_t \equiv \hat{m}_t - \hat{m}_{t-1} + \hat{\pi}_t \]
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>
</tr>
</thead>
<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>
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<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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<td></td>
</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>
</tr>
<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
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 $E_tPV(s)$
  - 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 $E_tPV(s)$, even with higher real discount rates...
  - tighter MP reduces demand and inflation
  - otherwise, demand and inflation rise
Implications: Monetary Policy Effects

▶ In new Keynesian model

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

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

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

\[=0\]

PV(seigniorage) \hspace{2cm} 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
   ▶ raises inflation still more
Implications: Monetary Policy Effects

**Output**

**Inflation**

**Nominal Rate**

**Real Rate**

**Debt–Output**

**Money Growth**

Serially correlated exogenous monetary policy contraction
Implications: Monetary Policy Effects

Serially correlated exogenous monetary policy contraction
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?
Real Discount Rates

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

- \( r_{t,t+j} \) is \( j \)-step-ahead real discount rate
- Adjustments to eqm need not occur through \( s_{t+j} \)
  - 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
- Leads to dramatic re-interpretations
Flight to Quality

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

- Flight to quality in financial crises and recessions
- Investors 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
- Fluctuating discount rates can be a source of business cycles in Regime F—not in Regime M
- MP response: *raise* rates to increase aggregate demand
Implications: Discount Rates

- 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
The Hungarian Case

- Hungarian facts courtesy of 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: Inflation Experience

[Graph showing the inflation experience in Hungary from 2001 to 2011. The graph includes a line representing the consumer price index and vertical red bars indicating year-end targets. A horizontal red line at the 3% level represents the medium-term inflation target.]
Hungary: Real Rates

![Graph showing Hungary's real rates over time from 2005Q1 to 2013Q3. The graph indicates fluctuations in real rates with peaks and troughs at various quarters.](image-url)
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

- 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
Europe: Government Debt–GDP Ratio

- Estonia
- Bulgaria
- Romania
- Croatia
- Slovenia
- Lithuania
- Czech Republic
- Sweden
- Slovakia
- Denmark
- Latvia
- Finland
- Poland
- Spain
- Cyprus
- Netherlands
- Malta
- Austria
- EU 27
- United Kingdom
- Hungary
- France
- Germany
- Euro area
- Portugal
- Ireland
- Belgium
- Italy
- Greece
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 ⇒ MP cannot achieve long-run IT
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
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 $E_tPV(s)$
  - keeping real rates high to fight inflation keeps $E_tPV(s)$ low
  - low $E_tPV(s)$ 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 $E_tPV(s)$
- Need to think about what anchors fiscal expectations
- **Transmission mechanism:** $E_tPV(s) \Rightarrow \pi_{t+j}$
  - anything that changes $E_tPV(s)$ can affect inflation before $s$’s change
A Provocative Proposal

Many countries face substantial fiscal consolidation

U.K. and U.S. in 2012
  - U.K. net national debt about 70% GDP
  - U.S. federal debt about 80% of GDP

If debt is “risk-free” then bondholders must expect primary surpluses with present value consistent with current debt-GDP ratio

Suppose consolidation aims to reduce ratio from 80% to 60%

Two steps involved
  1. put current primary deficits on path to primary surpluses
  2. converge to long-run primary surpluses consistent with 60% ratio
A Provocative Proposal

- Regime M & Regime F consolidations look very different

- **Regime M Consolidation**
  1. raise taxes & cut spending to convert deficit to surplus
  2. continue to raise surplus to retire current debt toward 60%
  3. reduce surplus to level consistent with long-run debt target

- **Regime F Consolidation**
  1. raise taxes & cut spending to convert deficit to surplus
  2. reduce surplus to level consistent with long-run debt target

- Regime F does not require higher surpluses to retire debt
To achieve the long-run reduction in debt, must substantially cut spending or raise taxes to *overshoot* surplus target. Can overshoot for decades, then can gradually reduce primary surpluses. These short-run adjustments will certainly slow economic growth. Slower growth will automatically reduce revenues & increase expenditures. These impacts are not reflected in the graph. This is what many European countries have been doing, bringing new recessions. What are the welfare costs of conventional consolidation?
Hypothetical Conventional Consolidation

Paths of Primary Surplus & Debt: Debt-GDP from 80% to 60%
Surpluses Must *Overshoot* Long-Run Target
Alternative Fiscal Consolidations

- Conventional consolidation takes inflation off table
- What can inflation do?
  - government debt is nominal & long-term
  - current or future inflation devalues debt
  - can avoid overshooting surplus target
  - requires less fiscal adjustment
- But wait... there's more
  - if monetary policy prevents nominal rates from rising with inflation—as it has the past 4 years
  - then real interest rates fall
  - stimulates consumption & aggregate demand
- Alternative consolidation can avoid retarding growth
- What are the welfare costs of alternative consolidation?
Hypothetical Alternative Consolidation

Paths of Primary Surplus & Debt: Debt-GDP from 80% to 60%
Illustrative Model of Inflation Determination

- Endowment economy with infinitely-lived agents, at cashless limit
- Long-term *nominal* bonds, $B_{Mt}$, sell at price $P_{Mt}$
  - bond issued at $t$ pays $\rho^j$ dollars at $t + j + 1$
  - average duration of bond: $(1 - \beta \rho)^{-1}$
  - $\rho = 0$: all bonds 1 period
- FP: chooses primary surplus, $s_t$
- MP: chooses 1-period nominal interest rate, $R_t$
- Debt Management: chooses average maturity, $\rho$
- Equilibrium: $c_t = y$ for all $t$
Government Behavior

- Government’s choices of \( \{R_t, s_t, B_{Mt}\} \) and \( \rho \) satisfy

\[
\frac{P_{Mt}B_{Mt}}{P_t} + s_t = \frac{(1 + \rho P_{Mt})B_{Mt-1}}{P_t}
\]

- For now, government not optimizing
  - posit \( ad \; hoc \)—but typical—rule
  - on agenda: compute welfare consequences of alternative consolidation schemes
- Government’s choices constrained by conditions for equilibrium
  - market clearing
  - household’s first-order conditions
  - household’s transversality condition: optimal behavior limits growth rate of government debt
Asset-Pricing Relations

\[ \frac{1}{R_t} = \beta E_t \left( \frac{1}{\pi_{t+1}} \right) \]

\[ P_{Mt} = \frac{1}{R_t} E_t (1 + \rho P_{Mt+1}) \]

These imply

\[ P_{Mt} = \beta \sum_{j=0}^{\infty} (\beta \rho)^j E_t \left( \prod_{i=0}^{j} \frac{1}{\pi_{t+i+1}} \right) \]

\[ = \sum_{j=0}^{\infty} \rho^j E_t \left( \prod_{i=0}^{j} \frac{1}{R_{t+i}} \right) \]
An Equilibrium Condition

- Imposing equilibrium, asset-pricing relations, transversality

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

(IEC)

- In conventional consolidation...
  - MP unconstrained: determines equilibrium \( \{P_t\} \Rightarrow \{P_{Mt}\} \)
  - FP constrained: chooses \( \{s_t\} \) to satisfy (IEC)

- In the alternative consolidation...
  - FP unconstrained: determines equilibrium \( \{P_t, P_{Mt}\} \)
  - MP constrained: determines *timing* of inflation
Thought Experiment

- Take path of \( \{s_t\} \) for 2012–2022 from Congressional Budget Office “Budget Projections,” March 2012
  - conventional consolidation: \( s_t \) for 2023 & 2024 increases by 1% each year
  - alternative consolidation: \( s_t \) reaches long-run target early

- Debt-output, \( P_{Mt}B_{Mt}/P_t \)
  - initial: 80%
  - target: 60%

- Model calibration
  1. real interest rate 2%
  2. initial inflation 2%
  3. vary average maturity
Conventional Consolidation

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

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

- Unique bounded solution when \( \alpha > \beta \) is
  \[ \pi_t = \pi^* \text{ for all } t \]
Conventional Consolidation

- After CBO projection period, \( s_t \) obeys

\[
s_t = s^* + \gamma(P_{Mt-1}b_{Mt-1} - P^*_Mb^*_M)
\]

- Impose the Euler equation

\[
E_{t-1} \left( \frac{1 + \rho P_{Mt}}{\pi_t} \right) = \frac{1}{\beta} P_{Mt-1}
\]

on government’s flow constraint and substitute \( s \) rule

\[
E_t \left( \frac{P_{Mt+1}b_{Mt+1} - P^*_Mb^*_M}{P_{t+1}} \right) = (\beta^{-1} - \gamma) \left( \frac{P_{Mt}b_{Mt} - P^*_Mb^*_M}{P_t} \right)
\]

- \( \gamma > \beta^{-1} - 1 \) stabilizes debt, ensuring (IEC) holds

- Overshooting: \( P_{Mt-1}b_{Mt-1} > P^*_Mb^*_M \Rightarrow s_t > s^* \)
Conventional Consolidation

- With MP aggressively targeting inflation...
  - inflation cannot be used to reduce value of debt
  - consolidation requires surplus to overshoot long-run target
  - higher surpluses retire debt to achieve 60% target

- In reasonable model, where taxes distort & government spending affects demand...
  - during overshooting, output will fall
  - choice of $\gamma$ determines speed of adjustment
    - higher $\gamma$ amplifies overshooting, exacerbating economic downturn
    - lower $\gamma$ prolongs adjustment period, keeping output persistently weak

- Should we take inflation off the table?
Alternative Consolidations

- FP sets $\{s_t\}$ exogenously—indeedently of debt
- MP sets $\{R_t\}$ to react weakly to inflation

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

- In (IEC): right-side given, $B_{Mt-1}$ predetermined
- (IEC) determines continuum of $(P_t, P_{Mt})$ combinations
- Can think of this as $E_t PV(s)$ determining

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

The expected present value of inflation

- Longer maturity—higher $\rho$—permits inflation to be postponed
Alternative Consolidation #1

- MP pegs $R_t = R^* \Rightarrow \pi_{t+j} = \pi^*$ \quad j \geq 1
  - all inflation occurs at $t$
  - future inflation at $\pi^* = 2\%$
  - $P_{Mt} = P^*_M$ all $t \geq 0$

- (Not a realistic scenario, as it requires flexible prices)
Paths of Inflation & Bond Prices: Debt-GDP from 80% to 60%
Alternative Consolidation #2

- Examine tradeoff between current & (fixed) future inflation

\[
\frac{(1 + \rho P_{Mt})B_{Mt-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t s_{t+j} \quad \text{(IEC)}
\]

- With fixed future inflation

\[
P_{Mt} = \frac{\beta}{\tilde{\pi} - \rho \beta}
\]

\[
\frac{\tilde{\pi}}{\pi_t(\tilde{\pi} - \rho \beta)} = \frac{E_t PV(s)}{b_{Mt-1}}
\]

- Consolidation changes \(E_t PV(s)\), given initial \(b_{Mt-1}\) at 80%

- Note \(\rho = 0 \Rightarrow\) future inflation off the table
<table>
<thead>
<tr>
<th>Maturity</th>
<th>2%</th>
<th>4%</th>
<th>6%</th>
<th>8%</th>
<th>10%</th>
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<tr>
<td>2-year</td>
<td>114.5</td>
<td>97.5</td>
<td>83.1</td>
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<td>3-year</td>
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<td>5-year</td>
<td>16.4</td>
<td>13.1</td>
<td>10.0</td>
<td>7.1</td>
<td>4.3</td>
</tr>
<tr>
<td>7-year</td>
<td>10.8</td>
<td>8.0</td>
<td>5.4</td>
<td>2.8</td>
<td>0.4</td>
</tr>
<tr>
<td>10-year</td>
<td>7.4</td>
<td>4.8</td>
<td>2.5</td>
<td>0.2</td>
<td>-2.0</td>
</tr>
<tr>
<td>20-year</td>
<td>3.9</td>
<td>1.7</td>
<td>-0.4</td>
<td>-2.5</td>
<td>-4.4</td>
</tr>
</tbody>
</table>

$\tilde{\pi}$: Future Inflation as Function of Current Inflation & Average Maturity (Annual %)
Alternative Consolidation #2

- Longer average maturity, more can spread inflation over time
- Requires a particular monetary policy
- Long maturities imply small inflation cost to consolidation
- Some realities
  1. in U.S., Fed has been shortening outstanding maturity via QE II & III
     - efforts to reduce long rates to stimulate growth
  2. irony: with fears of deflation, this is precisely the policy to pursue
  3. further irony: no policy makers are considering this option
Where To Go From Here

1. Employ new Keynesian model
   ▶ sticky prices: higher inflation lowers real interest rates
   ▶ lower real rates raise output, consumption, investment
   ▶ get an economic expansion from alternative consolidation

2. Introduce distorting taxes & government spending

3. Compare welfare costs of conventional & alternative consolidation

4. Brings back into the picture an old topic: optimal maturity structure of government debt
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
Take Aways

1. Conventional perceptions of inflation miss a channel for fiscal inflation
   - channel may be important in times of fiscal stress
2. Perception that MP can always stop an inflation that breaks out *assumes* the necessary fiscal backing will always be forthcoming
   - when fiscal limit possible, the assumption breaks down
3. If inflation has fiscal roots, MP cannot offset it
4. Two policy options:
   i. impose enforceable rules on fiscal behavior
   ii. give different mandates to central banks