Monetary & Fiscal Policy Interactions

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Coverage of Lecture

1. What is price-level determination?
   - introduction to the basic logic of policy interactions
2. A simple formal model
   - regimes M & F: determine P & stabilize debt
   - details about nature of equilibrium & policy interactions
   - introducing maturity structure for government debt
3. A provocative proposal
   - an alternative fiscal consolidation
4. Bergin's model of monetary union
5. A simple new Keynesian model
   - some analytics
   - including money
6. Exchange-rate & price-level determination
   - merges intertemporal approach to current account with fiscal policy

Monetary & Fiscal Interactions: Big Picture

- 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

Price-Level Determination: Big Picture

- Many macroeconomists have only a narrow understanding of how the aggregate price level—and inflation—get determined
  - supply & demand in the “money market” or
  - the Taylor principle for interest-rate setting
  - both are equivalent to $MV = PY$
- This narrow perspective misses important things
  - role of nominal government debt
  - payment of interest on reserves
  - deeper understanding of “determinacy of equilibrium”
- Why focus on price-level determination?
  - monetary & fiscal policies have many other effects
- Price-level determination is first step
  - study price-level determination *before* studying more complicated things
- We are *not* interested only in inflationary effects of monetary & fiscal policies

Monetary & Fiscal Interactions: Big Picture

- The "money-only" modeling convention a stretch since 2008
  - What have policies actually been doing?
  1. MP at or near lower bound—policy rates < 0 in Europe & Japan
  2. FP bouncing between stimulus & austerity
  1. Central banks aggressively pursuing growth
     - thrown Taylor principle out the window
     - undertaking variety of large-scale asset purchases
  2. Fiscal policies
     - 2008–2009: significant, explicitly temporary, stimulus
     - 2010–2011: declare victory & consolidate
     - since 2012: varies, but generally little to help recovery
- How can such policies anchor monetary expectations on inflation target?
- How can such policies anchor fiscal expectations on debt stabilization?

Monetary & Fiscal Interactions: Big Picture

- Need to understand implications of policy interactions that deviate from convention
- Short-run reasons:
  - European countries & Japan mired in “low-flation”; many advanced & emerging economies have high government debt
  - Ubiquitous tradeoff between macroeconomic stabilization & fiscal sustainability
  - What are effect of fiscal policy when MP pegs rate?
  - What are the fiscal implications of exploding CB balance sheets?
- Long-run reasons:
  - Aging populations & unfunded old-age benefits
  - Huge uncertainty about future fiscal policies
- Conventional modeling cannot address these issues
  - assumes away the problems

Messages

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

Perspectives on the Price Level

An Accounting Perspective

- Nominal government bonds
  - asset to private sector
  - liability to government
- Real primary surpluses (think of as taxes)
  - liability to private sector
  - asset to government
- Real assets must equal real liabilities
- Price level must adjust to equalize
  - real value of debt outstanding &
  - expected present value of surplus stream
- Price-level determination arises from the margin between nominal asset & real backing for the asset

Perspectives on the Price Level

An Economic Perspective

- Nominal government bond holdings a source of wealth to private sector
- Expected stream of taxes is an obligation of private sector
- If bonds rise, but PV taxes does not...
  - households feel wealthier
  - try to convert higher nominal wealth into higher consumption path
  - increases demand for goods—"aggregate demand"
  - raises price level
- Wealth effects lie at the heart of price-level determination

Perspectives on the Price Level

An Asset-Pricing Perspective

- Value of any asset equals expected PV of cash flows
- Primary surpluses—exclusive of interest payments—are cash flows underlying government debt
- Higher primary surpluses raise value of debt
  - induces households to substitute out of buying goods & into holding bonds
  - raises price of bonds in terms of goods
  - reduces price level
- Higher real backing for bonds increases their value & drives down price level

Two Kinds of Government Debt

- Distinction between real & nominal debt is critical

1. Real debt: denominated in "goods"
    - arises whenever debt is in units whose quantity the government *cannot* control
        - indexed to inflation; foreign currency; gold
        - in most countries today only small fraction of debt is real
        - indexed debt is like debt under the Gold Standard, where governments did not control the price level
    - a claim to goods in the future
    - government must acquire those goods to honor obligations
    - can acquire goods through taxes or money creation (seigniorage)
    - if it cannot acquire the goods, default only option

Two Kinds of Government Debt

2. Nominal debt: denominated in home currency ("dollars")
    - arises whenever debt is in units whose supply the government *can* control
        - vast majority of government debt is of this kind
    - a claim to "dollars" in the future
    - government need not be able to acquire goods
    - it can print new "dollars" to reduce market value of debt ("dollars" can be new debt instruments—not necessarily currency)
    - default less likely

- This distinction carries important policy implications

Two Kinds of Government Debt

- E.A. countries don't control their monetary policy
  - to each country, debt in euros is *real debt*
- Default on real debt more likely: euro rates embed default premium

	Debt/GDP	10-year yield
Real		
Greece	159	22.5
Italy	123	5.5
Spain	85	5.9
Germany	80	1.5
Nominal		
Japan	237	0.8
U.K.	86	1.9
U.S.	102	1.8

General government debt as percentage of GDP & 10-year government bond yield in 2012. Sources: ECB, Eurostat, IMF

The Model

- Endowment economy at the cashless limit; incomplete financial markets, only 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

$$P_t C_t + P_t \tau_t + Q_{t,t+1} B_t = P_t Y_t + P_t z_t + B_{t-1}$$

given $B_{-1} > 0$

  - $Q_{t,t+1}$: nominal price at t of a bond that pays \$1 at $t+1$
  - $m_{t,t+1}$: one-period stochastic discount factor
  - $Q_{t,t+1} = E_t[\frac{P_t}{P_{t+1}} m_{t,t+1}]$: no-arbitrage condition
  - Nominal interest rate, R_t: $\frac{1}{R_t} = Q_{t,t+1}$

The Model

- HH choices satisfy transversality & no-Ponzi conditions

$$\lim_{T\to\infty} E_t \left[m_{t,T} \frac{B_T}{P_T} \right] = 0$$

  - it is not optimal for HHs to over- or under-accumulate assets
- These imply the HH's real intertemporal b.c.

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

$s_t \equiv \tau_t - z_t$

- $m_{t,t+j} \equiv \prod_{k=0}^{j} m_{t,t+k}$ is real discount factor, $m_{t,t} = 1$
- Constant endowment: $m_{t,t+j} \equiv \beta^j$

The Model

- Impose equilibrium, $C_t = Y$, and TVC to get two eqm conditions

$$\frac{1}{R_t} = \beta E_t \frac{P_t}{P_{t+1}} \equiv \beta E_t \frac{1}{\pi_{t+1}} \qquad \text{(Fisher relation)}$$

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

$s_t \equiv \tau_t - z_t$ (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

- Cashless economy: $1/P_t$ is goods price of nominal bond; $1/R_t$ is dollar price of bond
- Ad hoc policy rules

$$\text{MP:} \quad \frac{1}{R_t} = \frac{1}{R^*} + \alpha \left(\frac{1}{\pi_t} - \frac{1}{\pi^*} \right) + \varepsilon_t^M$$

$$\text{FP:} \quad s_t = s^* + \gamma \left(\frac{1}{R_{t-1}} \frac{B_{t-1}}{P_{t-1}} - \frac{b^*}{R^*} \right) + \varepsilon_t^F$$

- Combine rules with Euler equation & government budget constraint to yield dynamic equations in $\nu_t \equiv 1/\pi_t$ and $b_t \equiv B_t/P_t$

Separate Dynamics?

$$E_t(\nu_{t+1} - \nu^*) = \frac{\alpha}{\beta}(\nu_t - \nu^*) + \frac{1}{\beta}\varepsilon_t^M$$

$$E_t\left(\frac{b_{t+1}}{R_{t+1}} - \frac{b^*}{R^*}\right) = (\beta^{-1} - \gamma)\left(\frac{b_t}{R_t} - \frac{b^*}{R^*}\right) - E_t\varepsilon_{t+1}^F$$

- Appears as if
  - inflation dynamics driven only by MP through $(\alpha, \varepsilon_t^M)$
  - debt dynamics driven only by FP through $(\gamma, \varepsilon_t^F)$
- **Regime M:** $|\alpha/\beta| > 1$ & $|\beta^{-1} - \gamma| < 1$
- **Regime F:** $|\alpha/\beta| < 1$ & $|\beta^{-1} - \gamma| > 1$
- In either regime, *in equilibrium* policies interact to determine inflation & stabilize debt

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:** conventional "monetarist/new Keynesian"
- **Regime F:** alternative "fiscal theory"

Regime M

- Bounded solution: only MP shocks cause $\pi_t \neq \pi^*$

$$\nu_t = \nu^* - \frac{1}{\alpha} \sum_{j=0}^{\infty} \left(\frac{\beta}{\alpha}\right)^j E_t \varepsilon_{t+j}^M$$

$$\frac{1}{R_t} = \frac{1}{R^*} - \sum_{j=1}^{\infty} \left(\frac{\beta}{\alpha}\right)^j E_t \varepsilon_{t+j}^M$$

- Equilibrium inflation appears to depend only on monetary policy
  - policy parameter: α
  - policy shock: ε_t^M
- Fiscal policy does not seem to matter
- Delivers Friedman: “inflation is always and everywhere a monetary phenomenon”

Regime M

- What is the fiscal backing for monetary policy?
  - passive FP: $\gamma > \beta^{-1} - 1$ (net real interest rate) covers debt service & retires debt
  - assume $\varepsilon_t^M \sim i.i.d.$ and $\varepsilon_t^M > 0$
  - raises P_t, reduces real value of outstanding bonds, B_{t-1}/P_t, & market value of debt, B_t/R_tP_t
  - if s_{t+j} unchanged, reduced real debt gets passed into lower nominal debt growth
  - eventually, people will realize their wealth has declined and reduce their demand for goods
  - lower demand will reduce price level, counteracting MP
  - if lower real debt is backed by lower s_{t+j}, fiscal policy eliminates the negative wealth effect
  - this fiscal backing permits monetary policy to control inflation in the usual way
  - this is the definition of *passive fiscal policy*

Regime M

- Friedman's adage requires an addendum: "inflation is always and everywhere a monetary phenomenon, so long as FP eliminates wealth effects of policy"
- As Tobin put it: "Ricardian equivalence is fundamental, perhaps indispensable, to monetarism"
- Consider an $i.i.d.$ tax cut: $\varepsilon_t^F < 0$
  - has no effect on inflation or nominal interest rate
  - financed by higher $B_t \Rightarrow$ higher b_t
  - passive FP: higher future $\{s_{t+j}\}$
  - $b_t \to b^*$
  - delivers neutrality of tax-debt swaps
- Passive FP achieves two things:
  1. Stabilizes real debt
  2. Provides appropriate fiscal backing to MP

Skip to Regime F

Regime M Equilibrium

- Unique *bounded* equilibrium inflation rate
- Stable process for government debt
- 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

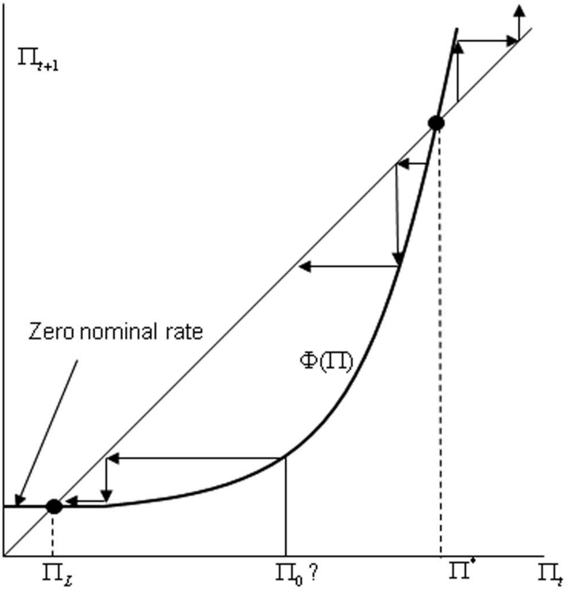
$$R_t = \beta^{-1}\pi_{t+1}$$
$$R_t = \tilde{\Phi}(\pi_t)$$

- Solution satisfies non-linear difference equation

$$\pi_{t+1} = \Phi(\pi_t)$$

- Two steady states: π^* and π_L
- π_L are zero lower bound for nominal interest rate

Regime M's Explosive Solutions



Indeterminacy of steady state and dynamic path

Regime F

- Take case of exogenous surpluses, $\gamma = 0$
- Solve for market value of debt, b_t/R_t, & use GBC

$$P_t = \frac{B_{t-1}}{(1-\beta)^{-1}s^* + \sum_{j=0}^{\infty} \beta^j E_t \varepsilon_{t+j}^F}$$

  - only FP—including B_{t-1}—appears to matter
- 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 $\Leftrightarrow$ aggregate demand

Regime F

- How does monetary policy stabilize debt?

$$E_t \left(\frac{b_{t+1}}{R_{t+1}} - \frac{b^*}{R^*} \right) = \frac{1}{\beta} \left(\frac{b_t}{R_t} - \frac{b^*}{R^*} \right)$$

  - debt dynamics: b_t/R_t *expected* to grow at β^{-1}
  - this appears to violate the transversality condition, which implies cannot be an equilibrium
  - MP stabilizes b_t/R_t by preventing interest payments from exploding
  - appears as surprises in P_t that revalue debt
  - MP accomplishes this through its interest-rate policy
- Show this for $i.i.d.\ \varepsilon^F \Rightarrow b_{t+j}/R_{t+j}$ constant

Regime F

- Use expression for ν_t in MP rule

$$\frac{1}{R_t} - \frac{1}{R^*} = \frac{\alpha}{\beta}\left(\frac{\beta(1-\beta)^{-1}s^* + \beta\varepsilon_t^F}{b_{t-1}} - \frac{1}{R^*}\right) + \varepsilon_t^M$$

- Fiscal expansion: $\varepsilon_t^F < 0$
  - MP reduces $1/R_t$ by $(\alpha/b_{t-1})\varepsilon_t^F$ to fight inflation
  - $i.i.d.$ shock $\Rightarrow b_t/R_t = b^*/R^*$
  - at $t+1$, interest rate obeys

$$\frac{1}{R_{t+1}} - \frac{1}{R^*} = \frac{\alpha}{\beta}\left(\frac{1}{R_t} - \frac{1}{R^*}\right)$$

  - if MP were active, $\alpha/\beta > 1$, $1/R_t$ diverges
  - exploding paths due to wealth effects from ever-growing interest payments to bond holders
  - higher wealth $\Rightarrow$ higher $\pi_{t+1} \Rightarrow$ higher R_{t+1} etc.
  - active MP converts stable fiscal inflation into explosive inflation

Regime F

- Monetary policy rule implies

$$\frac{1}{R_t} - \frac{1}{R^*} = \frac{\alpha}{\beta}\left(\frac{\beta(1-\beta)^{-1}s^* + \beta\varepsilon_t^F}{b_{t-1}} - \frac{1}{R^*}\right) + \varepsilon_t^M$$

  - fiscal expansion, $\varepsilon_t^F < 0$, financed with higher B_t
  - if MP pegs $R_t = R^*$, it fixes future inflation by fixing interest payments that fiscal expansion would raise
- MP contraction, $\varepsilon_t^M < 0$, lowers $1/R_t$, raises interest payments
  - FP does not raise surpluses to eliminate this wealth effect
  - if future inflation were *not* to rise, nominal debt would grow
  - raises wealth still more, so eventually inflation must increase
  - these different MP impacts arise from the different “fiscal backing” of MP

An Equilibrium Condition

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

- In Regime M (active monetary/passive fiscal)...
  - MP delivers equilibrium inflation process
  - taking inflation as given, FP must choose compatible surplus policy
  - "compatible" means: stabilizes debt & passively provides appropriate fiscal backing
  - imposes restrictions on $E_t PV(s)$

An Equilibrium Condition

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

- In Regime F (passive monetary/active fiscal)...
  - 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

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

- 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

Skip to Maturity

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

- 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. fiscal theory of the price level
  2. Sargent & Wallace's unpleasant monetarist arithmetic

Why Fiscal Theory $\neq$ 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: 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 $E_t(1/P_{t+1})$
  - 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—$\dagger$ & $*$—with $R^\dagger > R^* \Rightarrow Q^\dagger < Q^*$
    - $\pi_t^\dagger < \pi_t^*$ but *future* $\pi^\dagger >$ *future* π^*
    - 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
- Bond prices reflect $E_t s_{t+j}$ which changes $E_t(1/P_{t+j})$

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

Skip to Take Aways

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

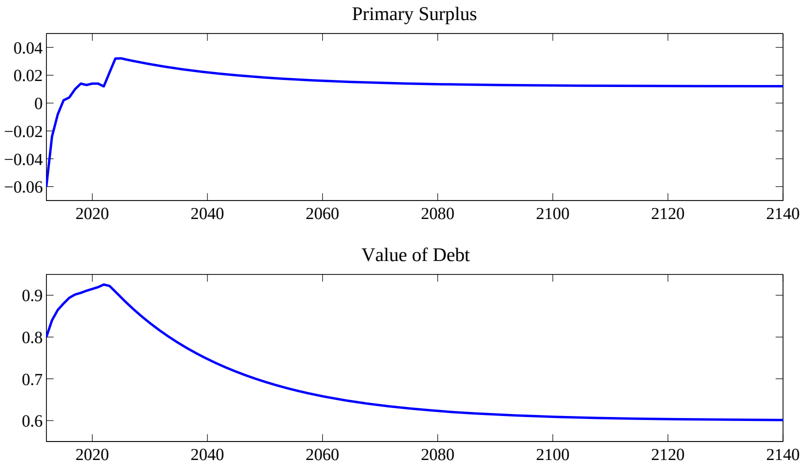
A Provocative Proposal

- 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

Hypothetical Conventional Consolidation

- 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

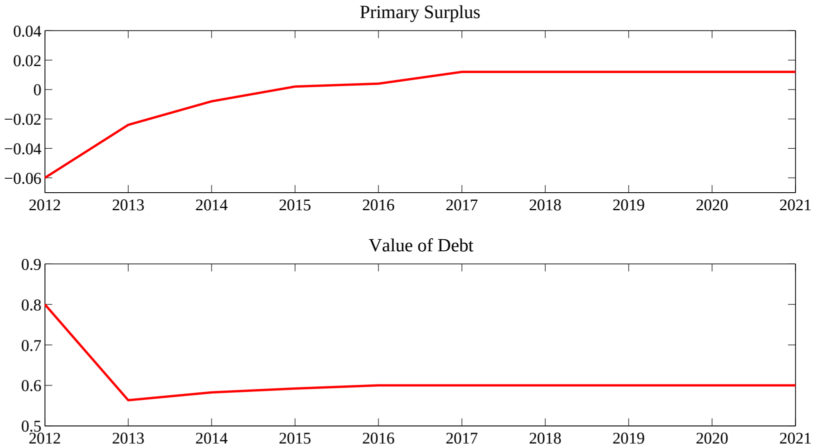


Paths of Primary Surplus & Debt: Debt-GDP from 80% to 60%
Surpluses Must *Overshoot* Long-Run Target

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 ρ^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, ρ
- Equilibrium: $c_t = y$ for all t

Government Behavior

- Government's choices of $\{R_t, s_t, B_{Mt}\}$ and ρ 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

$$\begin{aligned} P_{Mt} &= \beta \sum_{j=0}^{\infty} (\beta\rho)^j E_t \left(\prod_{i=0}^{j} \frac{1}{\pi_{t+i+1}} \right) \\ &= \sum_{j=0}^{\infty} \rho^j E_t \left(\prod_{i=0}^{j} \frac{1}{R_{t+i}} \right) \end{aligned}$$

An Equilibrium Condition

- Imposing equilibrium, asset-pricing relations, transversality

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

- 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

$$s_t = s^* + \gamma(P_{Mt-1}b_{Mt-1} - P_M^* b_M^*)$$

- 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

$$E_t\left(\frac{P_{Mt+1}b_{Mt+1} - P_M^* b_M^*}{P_{t+1}}\right) = (\beta^{-1} - \gamma)\left(\frac{P_{Mt}b_{Mt} - P_M^* b_M^*}{P_t}\right)$$

- $\gamma > \beta^{-1} - 1$ stabilizes debt, ensuring (IEC) holds
- Overshooting: $P_{Mt-1}b_{Mt-1} > P_M^* b_M^* \Rightarrow s_t > s^*$

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 γ determines speed of adjustment
    - higher γ amplifies overshooting, exacerbating economic downturn
    - lower γ prolongs adjustment period, keeping output persistently weak
- Should we take inflation off the table?

Alternative Consolidations

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

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

- 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

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

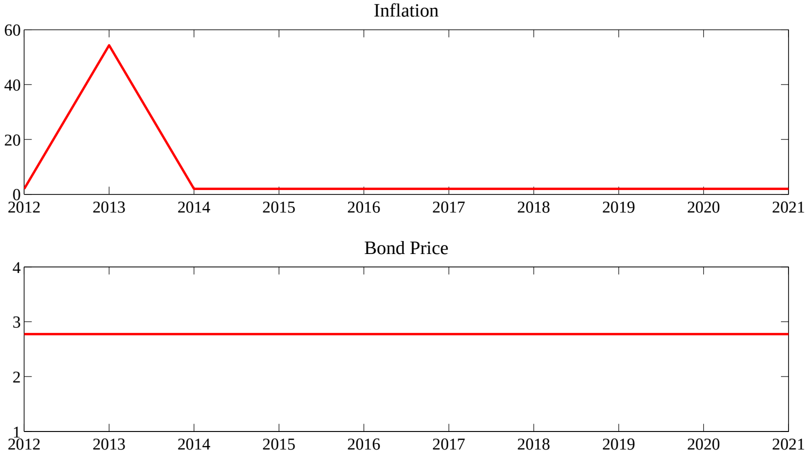
  The expected present value of inflation
- Longer maturity—higher ρ—permits inflation to be postponed

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)

Alternative Consolidation #1



Paths of Inflation & Bond Prices: Debt-GDP from 80% to 60%

Alternative Consolidation #2

- Examine tradeoff between current & (fixed) future inflation

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

- With fixed future inflation, π^F

$$P_{Mt} = \frac{\beta}{\pi^F - \rho\beta}$$

$$\frac{\pi^F}{\pi_t(\pi^F - \rho\beta)} = \frac{E_t PV(s)}{b_{Mt-1}}$$

- Consolidation changes $E_t PV(s)$, given initial b_{Mt-1} at 80%
- Note $\rho = 0 \Rightarrow$ future inflation off the table

Alternative Consolidations

Average Maturity	Current Inflation (π_t) 2%	4%	6%
	Future Inflation (π^F)		
5-year	16.4	13.1	10.0
7-year	10.8	8.0	5.4
10-year	7.4	4.8	2.5
20-year	3.9	1.7	-0.4
30-year	2.9	0.8	-1.3
50-year	2.1	0.1	-2.0

Feasible Current Inflation (π_t) and Future Inflation (π^F) Combinations & Average Debt 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 seriously 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

Take Aways

- 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

Skip to Generalizing the Model

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

$$\frac{D_{j,t}}{P_t} + \tau_{j,t} + v_{j,t} = z_{j,t} + \frac{R_{t-1} D_{j,t-1}}{P_t}$$

$v_{j,t}$: lump-sum transfers from central bank

  - central bank's budget constraint

$$\frac{B_{m,t}}{P_t} + v_{1,t} + v_{2,t} = \frac{R_{t-1} B_{m,t-1}}{P_t}$$

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 $D_{2,t} \to -\infty$

A Monetary Union

- 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
$$C_{1,t} = E_t C_{1,t+1}, \qquad C_{2,t} = E_t C_{2,t+1}$$
- Imposing eqm, get conditions
$$\frac{R_{t-1}D_{1,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t \left[s_{1,t+j} + v_{1,t+j}\right]$$
$$\frac{R_{t-1}D_{2,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t \left[s_{2,t+j} + v_{2,t+j}\right]$$
$$\frac{R_{t-1}B_{m,t-1}}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t \left[v_{1,t+j} + v_{2,t+j}\right]$$

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

A Monetary Union: Needed Extensions

- This model has a single union-wide price level
- Need a model that can account for persistent differences in inflation rates across member nations
- Need heterogeneity across member nations
- Need size of economy to matter
- These are open modeling issues of great importance in Eurozone
- How are European inflation rates determined?

Generalizing the Model

- Up to now, have focused on endowment economies
  - exogenous real interest rate convenient for analytics
  - but can be misleading
- Now introduce nominal rigidities
  - track MP & FP impacts on real rates and output
- Employ textbook new Keynesian model
- Focus on Regime F since Regime M well covered by textbooks

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

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

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

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

with $P_t \equiv \left[\int_0^1 p_t(z)^{1-\theta}dz\right]^{\frac{1}{1-\theta}}$ 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 $\Delta_t \equiv -\tau_t$, primary deficit

- Aggregate resource constraint: $C_t = Y_t$

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 Δ_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

$$\frac{W_t}{P^*} = m^* - \delta_t \qquad \text{(IBC)}$$

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

- But W_t predetermined at t
- Equilibrium condition (IBC) $\Rightarrow$ fiscal shock cannot change δ_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

Analytics for Cashless Limit Version

- Four-equation system

$$
\begin{aligned}
y_t &= E_t y_{t+1} - \sigma(i_t - E_t \pi_{t+1}) \\
\pi_t &= \beta E_t \pi_{t+1} + \kappa y_t \\
b_t &= i_t + \beta^{-1}(b_{t-1} - \pi_t) + (\beta^{-1} - 1)\Delta_t \\
i_t &= \alpha \pi_t + \varphi_t
\end{aligned}
$$

- 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 α—*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 π_t from (†)

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

  1. higher inflation from higher PV deficits or interest rates
  2. effect of deficits on π_t not affected by MP
  3. more hawkish MP increases effect of deficits on *expected* π

- Note: $E_t \pi_{t+1}$ from (‡) consistent

Analytics for Cashless Limit Version

- 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 π_t from (†)
    2. π_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 ($\hat{x}_t \equiv \ln(x_t) - \ln(x^*)$)

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

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 $\hat{\Delta}_t = \rho \hat{\Delta}_{t-1} + \varepsilon_t$

Impacts of Deficit

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

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

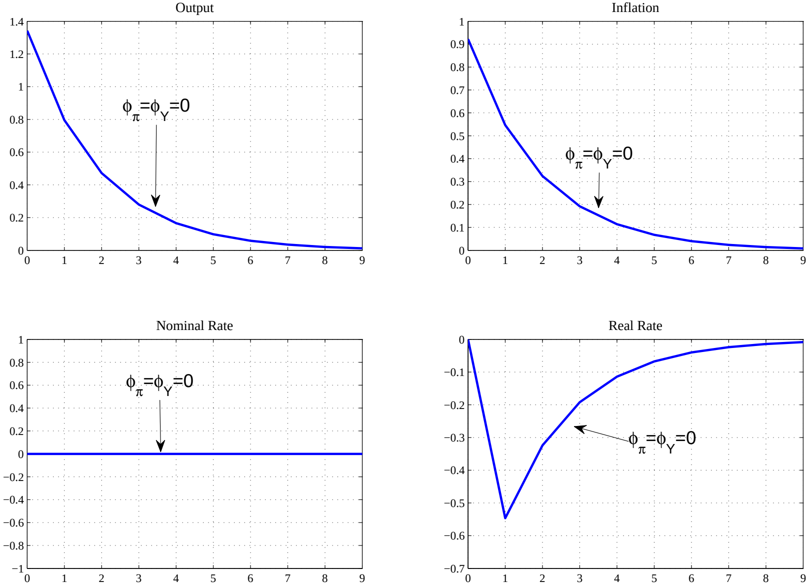
- Benchmark calibration

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

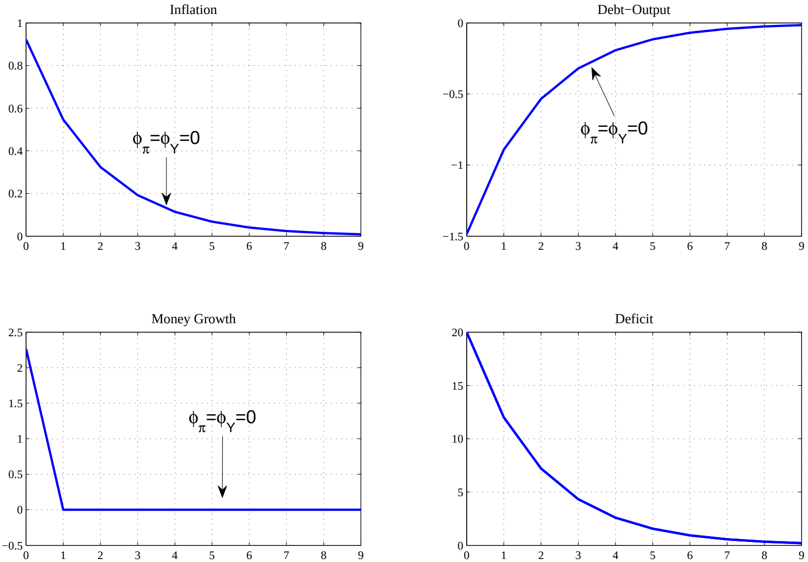
- Vary MP choices of ϕ_π and ϕ_Y

Pegged interest rate: $\phi_\pi = \phi_Y = 0$
Weak lean against wind: $\phi_\pi = \phi_Y = .3$
Aggressive stance: $\phi_\pi = .9, \phi_Y = .5$

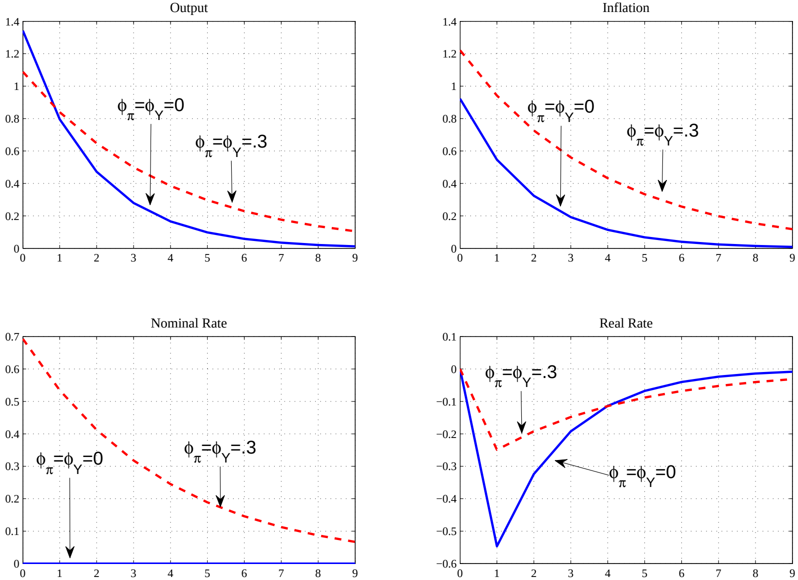
Impacts of Deficit: Pegged Rate



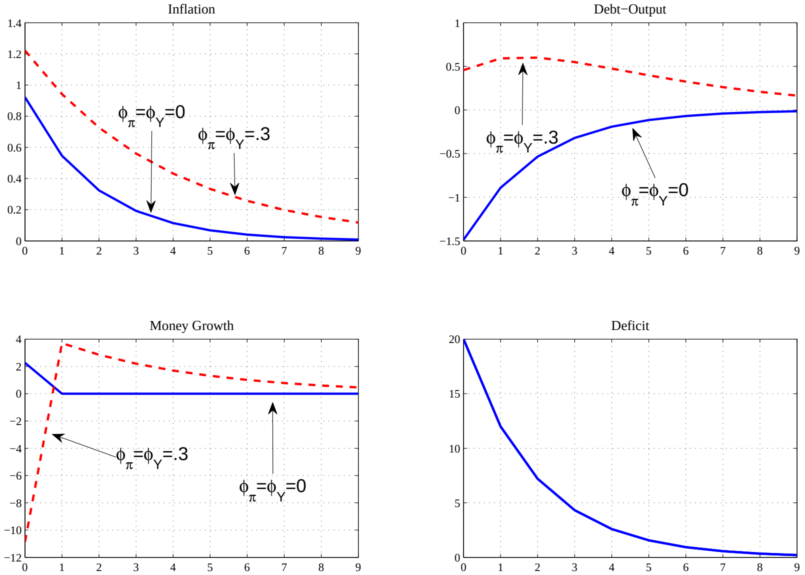
Impacts of Deficit: Pegged Rate



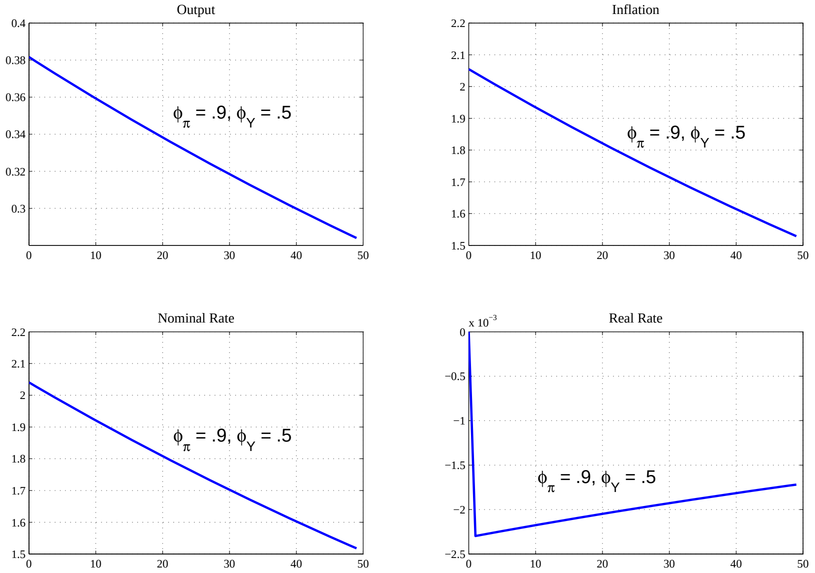
Impacts of Deficit: More Hawkish



Impacts of Deficit: More Hawkish



Impacts of Deficit: Even More Hawkish



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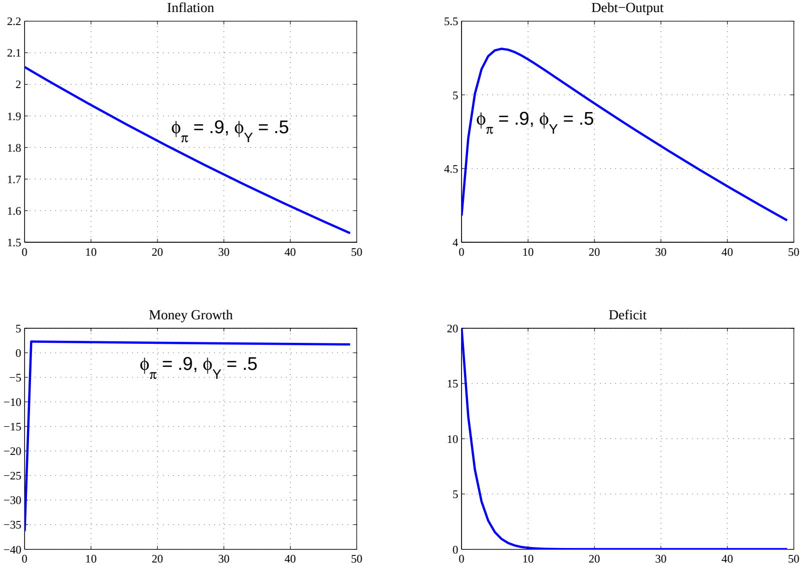


Sources of Fiscal Financing

- Write government budget constraint as

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

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

- Solving for the present value of deficits

$$\hat{\delta}_t = \underbrace{-(\hat{b}_{t-1} - \hat{\pi}_t)}_{\text{surprise revaluation}} \underbrace{+\gamma\sum_{j=0}^{\infty}\beta^{j+1}E_t\hat{\mu}_{t+j}}_{\text{PV(seigniorage)}} \underbrace{-\sum_{j=0}^{\infty}\beta^{j+1}E_t[\hat{R}_{t+j} - \hat{\pi}_{t+j+1}]}_{\text{PV(real discount rates)}}$$

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

Quantitative Implications

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

	Percentage Due to			% Change in	
	$\hat{\pi}_t$	PV(seig)	$-$PV(r)	PV(π)	PV(Y)
$\gamma = .1$					
$\phi_\pi = \phi_Y = 0$	39.6	9.4	51.0	2.1	3.1
$\phi_\pi = \phi_Y = .3$	52.5	9.4	38.1	4.6	4.1
$\phi_\pi = .9, \phi_Y = .5$	88.4	10.0	1.6	36.9	6.9
$\gamma = 0$					
$\phi_\pi = \phi_Y = 0$	43.7	0	56.3	2.3	3.4
$\phi_\pi = .9, \phi_Y = .5$	98.1	0	1.9	41.0	7.6

Dynamic Impacts of Exogenous Serially Correlated Deficit Increase
seig: seigniorage; r: real discount rate; PV(X): present-value change in X; $\gamma \equiv m^*/(\beta b^*)$; ϕ_π, ϕ_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 $E_t PV(s)$
  - 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

Implications: Monetary Policy Effects

- In new Keynesian model

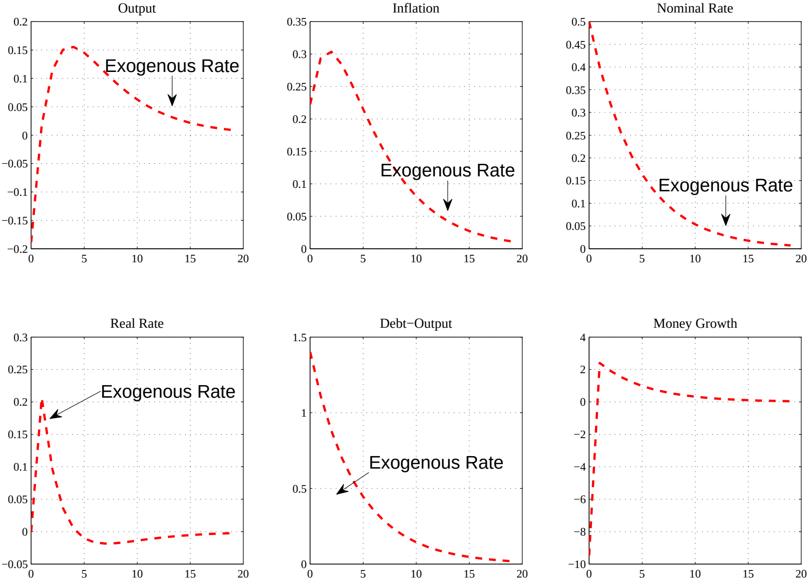
$$\hat{Y}_t = E_t\hat{Y}_{t+1} - \sigma(\hat{R}_t - E_t\hat{\pi}_{t+1})$$

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

$$\hat{\pi}_t = \underbrace{(\hat{b}_{t-1} - \hat{\delta}_t)}_{=0} \underbrace{-\gamma\sum_{j=0}^{\infty}\beta^{j+1}E_t\hat{\mu}_{t+j}}_{\text{PV(seigniorage)}} + \underbrace{\sum_{j=0}^{\infty}\beta^{j+1}E_t[\hat{R}_{t+j} - \hat{\pi}_{t+j+1}]}_{\text{PV(real discount rates)}}$$

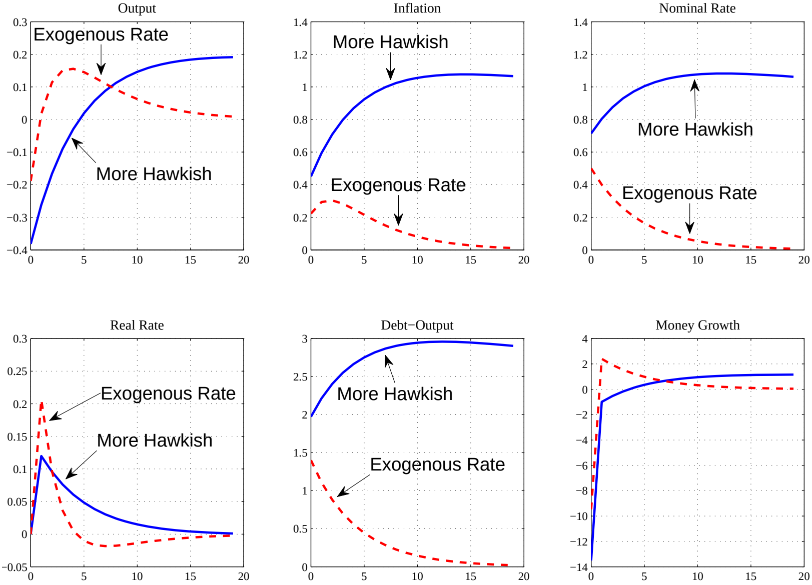
- Tighter monetary policy with fixed surpluses
  - raises $\hat{R}_t - E_t\hat{\pi}_{t+1}$ in short run: lowers output
  - raises entire path of $\{E_t\hat{\pi}_{t+j}\}$: raise inflation
  - appears as an adverse shift in the Phillips curve
- More hawkish MP—stronger response to inflation—prolongs rise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

Implications: Monetary Policy Effects



Serially correlated exogenous monetary policy contraction

Implications: Monetary Policy Effects



Serially correlated exogenous monetary policy contraction

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

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

- 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
  - $\Rightarrow$ lower demand & real output
- Fed flooded economy with reserves
  - no 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

Exchange-Rate & Price-Level Determination

- Merge intertemporal approaches to current account & fiscal policy to determine price level & nominal exchange rate
- Combine two intertemporal equilibrium conditions to create a consolidated present-value condition relevant for open economies
- Simultaneously determine
  - equilibrium price level (P)
  - equilibrium nominal exchange rate (e)
- Price level & exchange rate reflect interactions between expected present values of budget surpluses & trade balances ($EPV(S)$ & $EPV(NX)$)
  - generalizes fiscal theory of price level
- Draws on work-in-progress with Tack Yun

World Economic Developments

- Recent years have seen in advanced economies
  - persistently high levels of public debt
  - large holdings by some governments of international reserves
  - prolonged period of passive—zero lower bound—monetary policies
- Provide a rationale for accumulation of international reserves to achieve price-level & exchange-rate targets
  - more reserves $\Rightarrow$ lower price level
  - because government has more assets to support outstanding public debt
- If reserves exceed public debt, fiscal policy can be sustainable
  - even if expected present value of surpluses is *negative*

Overview

- Derive these implications using a general economic structure
  - budget constraints
  - asset-pricing relations
  - market-clearing conditions
  - transversality & other limiting conditions
  - economy at cashless limit
- Because we do not specify complete model, we are deriving *equilibrium* relationships
  - may or may not have causal interpretations
  - in spirit of "intertemporal approach to current account" literature

Overview

- Introduce *composition* effects from asset demands
  - α_t: share of foreign assets held by households (rest held by government)
  - γ_t: fraction of government debt held by financial sector (rest held by households)
  - for now, take these asset demands as given (unmodeled)
- $\alpha_t \equiv 1$ (govt owns no foreign assets) & $\gamma_t \equiv 0$ (all govt debt held by HHs)
  - obtain usual bond-valuation equation in fiscal theory
  - no role for trade balances in price determination

Overview

- $\alpha_t < 1$ (govt owns foreign assets)
  - α_t can be negative
  - trade balances & budget surpluses affect P & e determination
  - composition effects matter
  - alters how to think about fiscal sustainability...depends on
    - govt holdings of foreign assets
    - $EPV(S)$ & $EPV(NX)$
    - relative asset demands
- How important it is to integrate intertemporal approaches to CA & FP...
  - depends on country characteristics
  - asset demands
  - relative sizes of $EPV(S)$ & $EPV(NX)$

Benchmark Model

- Representative household's budget constraint

$$\frac{q_t B^H_{t+1} + e_t q^*_t B^*_{t+1}}{P_t} = \frac{B^H_t + e_t B^*_t}{P_t} + W_t H_t + R_t K_t - C_t - T_t - I_t \quad (1)$$

B^H_{t+1} : nominal ¥ value of government bonds issued by home country
B^*_{t+1} : nominal \$ value of government bonds issued by foreign country
e_t : nominal exchange rate in ¥/\$
q_t : ¥ price of home country bonds
q^*_t : \$ price of foreign country bonds
W_t : real wage rate; R_t : real rental rate of capital
H_t : number of hours worked; K_t : capital stock at beginning of t
C_t : consumption; I_t : investment; T_t : real taxes

- Note that B_t is bonds outstanding at the *beginning* of period t

Model Setup

Assumption (1)

There is an international financial market in which risk-neutral international investors trade bonds issued by different governments. In this market, uncovered interest parity holds

$$q_t^* e_t = q_t E_t[e_{t+1}] \tag{2}$$

Assumption (2)

Markets for factors of production and goods are perfectly competitive. Production exhibits constant returns to scale, so

$$Y_t = W_t H_t + R_t K_t \tag{3}$$

Y_t *is aggregate output in period* t

Model Setup

- Aggregate resource constraint is

$$Y_t = C_t + I_t + G_t + NX_t \tag{4}$$

  G_t is real government consumption; NX_t is real net exports
- Substitute (2) & (4) into (1) to yield difference equation in household's real asset holdings, d_t

$$E_t[q_{t,t+1}d_{t+1}] = d_t + G_t - T_t + NX_t \tag{5}$$

  where

$$d_t \equiv \frac{B_t^H + e_t B_t^*}{P_t}, \qquad q_{t,t+1} \equiv q_t \frac{P_{t+1}}{P_t}$$

- Use one-period real discount rate, $q_{t,t+1}$ to define

$$q_{t,t+k} = \prod_{j=1}^{k} q_{t+j-1,t+j}, \quad k \geq 1, \quad q_{t,t} = 1$$

Model Setup

- Iterate forward on (5) & impose transversality $\lim_{T\to\infty} E_t[q_{t,t+T} d_{t+T}] = 0$ to get

$$\frac{B_t^H + e_t B_t^*}{P_t} = \sum_{k=0}^{\infty} E_t \left[q_{t,t+k} \left(T_{t+k} - G_{t+k} - NX_{t+k} \right) \right] \qquad (6)$$

  - assume $EPV(S) > EPV(NX)$
- Budget & trade surpluses back $B_t^H + e_t B_t^*$
  - household's total holdings of nominal govt bonds
- If $EPV(S) \uparrow$ or $EPV(NX) \downarrow \ldots$
  - expected higher "cash flows"
  - demand for $B_t^H + e_t B_t^*$ rises
  - mix of $P_t \downarrow$ & $e_t \uparrow$
- From *only* the HH's side, P_t & e_t move in opposite directions

Model Setup

Assumption (3)

The government holds dollar-denominated foreign assets, J_t, at the beginning of each $t \geq 0$. J_t is determined in period $t-1$ and assume that the government does not adjust the exchange rate in response to changes in J_t

- Government's flow budget constraint is

$$q_t B^G_{t+1} - e_t q^*_t J_{t+1} + P_t T_t = B^G_t - e_t J_t + P_t G_t \qquad (7)$$

B^G_t is ¥ value of outstanding government debt at beginning of t; J_{t+1} is the \$ value of foreign assets held by home country; $e_t J_{t+1}$ is ¥ value of foreign assets held by govt

Model Setup

- Applying uncovered interest parity, (7) is

$$E_t[q_{t,t+1}b_{t+1}] = b_t - (T_t - G_t) \tag{8}$$

where $b_t \equiv \frac{B_t^G - e_t J_t}{P_t}$

Assumption (4)

Total outstanding public debt—net of the government's holdings—consists of the household's holdings, B_t^H, and the financial sector's holdings, B_t^F

$$B_t^G = B_t^H + B_t^F$$

- We do not model how B_t^F is determined
  - think of it as foreign lending to domestic govt

Model Setup

- Iterate forward on (8) and impose limiting condition $\lim_{T\to\infty} E_t[q_{t,t+T} b_{t+T}] = 0$ to yield

$$\frac{B_t^G - e_t J_t}{P_t} = \sum_{k=0}^{\infty} E_t \left[q_{t,t+k} \left(T_{t+k} - G_{t+k} \right) \right] \tag{9}$$

- Budget surpluses alone back $B_t^G - e_t J_t$
  - government's net nominal liabilities
- Two interpretations of (9)
  1. $B_t^G - e_t J_t$: "net debt" of govt backed by $EPV(S)$
  2. $B_t^G / P_t = EPV(S) + (e_t/P_t) J_t$
     - $(e_t/P_t)J_t$: income source at t (capital inflows) that supplement $EPV(S)$ as backing for govt bonds
- By (9), $EPV(S) \uparrow \Rightarrow$ mix of $P_t \downarrow$ & $e_t \downarrow$
- From *only* the govt's side, P_t & e_t move in same direction

Model Setup

- Can instead combine HH's and govt's budget constraints, impose marketing clearing

$$\frac{e_t q_t^*(J_{t+1}+B_{t+1}^*) - q_t B_{t+1}^F}{P_t} = \frac{e_t(J_t+B_t^*) - B_t^F}{P_t} + NX_t$$

  - applying uncovered interest parity

$$E_t[q_{t,t+1} f_{t+1}] = f_t + NX_t$$

    where $f_t \equiv \frac{e_t(J_t+B_t^*)-B_t^F}{P_t}$
  - iterate forward & impose $\lim_{T\to\infty} E_t[q_{t,t+T} f_{t+T}] = 0$

$$\frac{e_t(J_t+B_t^*) - B_t^F}{P_t} = \sum_{k=0}^{\infty} E_t q_{t,t+k} NX_{t+k} \tag{10}$$

- (10) equates the value of *net* lending to foreigners to $EPV(NX)$
  - conventional intertemporal approach to current account expression

Equilibrium

- Two intertemporal equilibrium conditions—(6) & (9)—imply different movements between P_t & e_t
- Need to bring both conditions together
  - (6): value of HH asset holdings equals expected present value of govt surpluses net of trade surpluses
  - (9): value of net govt liabilities equals expected present value of primary govt surpluses
  - in closed economy ($NX_t = B_t^* = J_t \equiv 0$), these are identical
  - in open economy, both must hold simultaneously, imposing additional restrictions on equilibrium price level

Price-Level Determination

- Combining (6) & (9) to eliminate e_t yields

$$\frac{B_t^H + \alpha_t B_t^F}{P_t} = \sum_{k=0}^{\infty} E_t \left[q_{t,t+k} \left(T_{t+k} - G_{t+k} \right) \right] - (1 - \alpha_t) \sum_{k=0}^{\infty} E_t \left[q_{t,t+k} NX_{t+k} \right] \quad (11)$$

$$\alpha_t \equiv \frac{B_t^*}{B_t^* + J_t} = \begin{cases} \text{share of foreign assets} \\ \text{held by households} \end{cases}$$

- **Price-level determination**: Two results when assumptions 1–4 hold:
    1. If govt holds foreign assets, equilibrium price level reflects both primary budget surpluses & trade surpluses
    2. When the financial sector holds govt bonds, there are composition effects of debt on the price level

Price-Level Determination

- Denote by γ_t the fraction of govt debt held by financial sector

$$\gamma_t \equiv B_t^F / B_t^G$$

- Solving for the price level from (11) yields

$$P_t = \frac{[(1-\gamma_t) + \gamma_t \alpha_t] B_t^G}{\sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k} - G_{t+k})] - (1-\alpha_t) \sum_{k=0}^{\infty} E_t[q_{t,t+k} NX_{t+k}]} \qquad (12)$$

- Treat (12) as determining the equilibrium price level at t
  - requires assuming $\{T_t - G_t, NX_t\}$ unrelated to govt debt & price level (e.g., exogenous)
  - at t, $B_t^G, \alpha_t, \gamma_t$ predetermined
  - with $B_t^G > 0$, also assume that for all $t \geq 0$

Price-Level Determination

$$P_t = \frac{[(1-\gamma_t) + \gamma_t \alpha_t] B_t^G}{E_t PV(S) - (1-\alpha_t) E_t PV(NX)} \tag{12}$$

$$EPV(S) > EPV(NX) \Rightarrow EPV(S) > (1-\alpha)EPV(NX)$$

1. α_t & γ_t yield composition effects
   - both α_t & γ_t are predetermined
   - $\alpha_t = 1, \gamma_t = 0$ yields fiscal theory P determination
2. When $0 < \alpha_t < 1 \ldots$
   - higher $EPV(NX)$ raises P_t
3. When $0 < \gamma_t < 1$, higher $\gamma_t \ldots$
   - raises P_t because $EPV(S) > (1-\alpha)EPV(NX)$
4. Higher $\alpha_t \ldots$
   - raises P_t if $\gamma EPV(S) > EPV(NX)$
   - lowers P_t if $\gamma EPV(S) < EPV(NX)$
5. When $\gamma_t = 0$, higher α_t decreases P_t as long as $EPV(NX) > 0$

Exchange-Rate Determination

- **Exchange-rate determination**: Two results when assumptions 1–4 hold:
    1. If the govt holds foreign assets ($J_t > 0$), nominal exchange rate reflects both primary budget surpluses & trade surpluses
    2. When the financial sector holds govt bonds ($B_t^F > 0$), there are composition effects on of debt on the exchange rate
- Substitute (12) into (9) & solve for exchange rate

$$e_t = (1-\alpha_t)\frac{B_t^G}{J_t}\frac{\gamma_t \sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k}-G_{t+k})] - \sum_{k=0}^{\infty} E_t[q_{t,t+k}NX_{t+k}]}{\sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k}-G_{t+k})] - (1-\alpha_t)\sum_{k=0}^{\infty} E_t[q_{t,t+k}NX_{t+k}]} \tag{13}$$

- Treat (13) as determining the equilibrium exchange rate
    - requires same assumptions as for price-level

Exchange-Rate Determination

$$e_t = (1-\alpha_t)\frac{B_t^G}{J_t}\left[\frac{\gamma_t E_t PV(S) - E_t PV(NX)}{E_t PV(S) - (1-\alpha_t)E_t PV(NX)}\right] \tag{13}$$

1. The nominal exchange rate also reflects two composition effects, α_t & γ_t
2. If $0 < \alpha_t < 1$, exchange rate directly affected by $EPV(S)$ and $EPV(NX)$
3. If $0 < \gamma_t < 1$ & $EPV(S) > 0$, e_t depreciates as γ_t rises
4. If $EPV(S) > 0$, higher $EPV(NX)$ appreciates home currency
5. If $\gamma_t = 0$, higher α_t appreciates home currency
    - so long as $EPV(NX) > 0$

Case Study: Norway

- North Sea oil & natural gas generating massive revenues
  - petroleum sector 50% of exports & over 20% of GDP
  - petroleum tax payments by companies 30% of govt revenues
- Norway's fiscal rule
  - all govt revenues from oil transferred to Government Pension Fund Global (GPFG)
  - government spending limited to expected real return—4%—from fund
  - all the fund's capital invested abroad

Norway & This Framework

1. $B^G > 0$ gross debt $\approx$ 20% GDP & shrinking
2. J large: GPFG $\approx$ 130% GDP & growing
3. $B_t^G - e_t J_t < 0$ & growing
4. Share of foreign assets held by HHs, $\alpha_t < 1$, maybe negative & shrinking(?)
5. Share of govt debt held by HHs, $1 - \gamma_t > 0$
6. $\frac{B_t^G - e_t J_t}{P_t} = EPV(S) < 0$: expect primary budget deficits!
7. Need $EPV(NX)$ to be negative

$$P_t = \frac{[(1-\gamma_t) - \gamma_t \alpha_t] B_t^G}{EPV(S) - (1-\alpha_t) EPV(NX)} > 0$$
$$\Rightarrow (1-\alpha_t) EPV(NX) < EPV(S) < 0$$

8. $J \uparrow$ & $B^G \downarrow \Rightarrow$ appreciates currency
9. $EPV(S) < 0$ & $EPV(NX) < 0$ changes comparative statics
   - higher $EPV(S) \Rightarrow$ appreciates currency
   - higher $EPV(NX) \Rightarrow$ depreciates currency

Norway & This Framework

- Growing govt holdings of foreign assets exerts *deflationary* pressures
- If fiscal policy is passive, Norges Bank can retain control of price level
  - are oil revenues directly controlled by government?
  - are non-oil surpluses adjusted to stabilize debt?
- Perhaps need to rethink meaning of "passive fiscal policy" when $B_t^G - e_t J_t < 0$
- Norway presents some interesting challenges to conventional thinking

Case Study: Japan

- Gross government debt in Japan over 200% GDP
  - much of JGB held by government & "quasi-government" entities $\Rightarrow B^G$ may be much smaller
  - little of JGB held by Japanese households & foreigners
    - γ_t may be quite large
  - BoJ owns over $1 trillion in foreign reserves
    - J large, so α_t small
- Every study concludes Japanese FP "unsustainable"
  - yet interest rates extremely low & JGBs riskless
- Until recently...
  - ¥ strong & steady
  - chronic trade surpluses
  - inflation extremely low (deflation)
- Many puzzles

Wrap Up

- A great many good research questions remain about policy interactions
- Theory:
  - central bank balance sheet operations require fiscal backing
  - price-level determination in a monetary union
  - open-economy dimensions
- Empirics:
  - can the observational equivalence be broken?
  - are there historical episodes that look like Regime F?
  - need new data sets: market value of debt, maturity structure, real discount rates, primary surpluses