Monetary and Fiscal Policy Interactions
IMF Institute

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Sketch of Course

1. General view of tasks of monetary & fiscal policies
2. Two expositions of the fiscal theory of the price level
3. Observational equivalence of monetary & fiscal determination of inflation
4. Long-term debt and inflation dynamics
5. Applications of the fiscal theory
6. Recurring policy regime change
7. Fiscal limits
8. Wrap up
9. Research agenda
Macroeconomic policies have two tasks to perform:

1. control inflation
2. stabilize government debt

“Control inflation” means ensure inflation process unique:

- eliminate self-fulfilling inflation expectations
- rule out arbitrarily large deviations of inflation from target

“Stabilize government debt” means maintain value of debt:

- prevent debt from growing unsustainably
- line up market value of debt with its expected backing
A Beautiful Symmetry

- Monetary & fiscal policy perfectly symmetric with regard to these two tasks
- Two different policy mixes—or assignments—can accomplish these tasks

**Regime M:** conventional assignment—MP targets inflation; FP targets real debt

**Regime F:** alternative assignment—MP maintains value of debt; FP controls inflation

- **Regime M:** normal state of affairs
- **Regime F:** can arise in crises or states of fiscal stress
- Regime F arises in two ways
  1. Sargent & Wallace’s unpleasant monetarist arithmetic
  2. fiscal theory of the price level
Unpleasant Monetarist Arithmetic

- Best-known case of alternative assignment of tasks
  - FP sets primary surpluses independently of debt & inflation
  - MP passively adjusts money growth so seigniorage revenues service & stabilize debt
- Higher current debt—from fiscal deficits or open-market sales—requires higher future money growth
  - quantity theory $\Rightarrow$ future inflation rises
  - Fisher relation $\Rightarrow$ current nominal interest rates rise
  - lower money demand now $\Rightarrow$ inflation may rise now
- Emphasizes money market equilibrium via
  \[ M_t V_t(\cdot) = P_t Y_t \] (QE)
- Monetary policy loses control of inflation
Fiscal Theory of the Price Level

- FTPL requires nominal government debt
- Most debt issued by advanced economies qualifies:
  - U.S. (90%); U.K. (80%); over 90% in Australia, Canada, New Zealand, Sweden; most EMU-member debt in euro; most Japanese bonds in yen
- FP is as in unpleasant arithmetic; MP different
  - FP sets primary surpluses independently of debt & inflation
  - MP prevents nominal rates from rising strongly with debt & inflation
- Emphasizes debt revaluation effects via

\[
\frac{M_{t-1} + B_{t-1}}{P_t} = \text{Expected PV (Surpluses + Seigniorage)}
\]

(IEC)

- Monetary policy loses control of inflation
The Models

- Endowment economy, MIUF, \( g_t \equiv 0 \)
- Representative household maximizes

\[
E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U \left( c_t, \frac{M_t}{P_t} \right) \right\}
\]

subject to sequence of flow budget constraints

\[
M_t + E_t[R_{t,t+1}(W_{t+1} - M_t)] \leq W_t + P_t y_t - T_t - P_t c_t
\]

- \( W_{t+1} - M_t \): nominal value in \( t + 1 \) of HH’s bond holdings at end of \( t \)
- \( E_t[R_{t,t+1}(W_{t+1} - M_t)] \): nominal market value of state-contingent claims
- \( R_{t,t+1} \): stochastic discount factor
- Note: \( W_t^s = M_{t-1}^s + (1 + i_{t-1}) B_{t-1}^s \)
- So \( 1 + i_t = E_t[R_{t,t+1}]^{-1} \)
The Models

- HH’s flow b.c. & borrowing limit $\Rightarrow$ intertemporal b.c.

$$\sum_{T=t}^{\infty} E_{tR,t,T} \left[ P_{Tc_T} + \frac{i_T}{1+i_T} M_{T} \right] \leq W_t + \sum_{T=t}^{\infty} E_{tR,t,T} [ P_{Ty_T} - T_T ]$$

- HH’s FOCs yield

$$\frac{U_m(c_t, m_t)}{U_c(c_t, m_t)} = \frac{i_t}{1+i_t}$$

$$\frac{U_c(c_t, m_t)}{U_c(c_{t+1}, m_{t+1})} = \frac{\beta}{R_{t,t+1}} \frac{P_t}{P_{t+1}}$$

- And intertemporal b.c. at equality
Models’ Equilibria

- Impose market clearing on liquidity preference

\[
\frac{U_m \left( y_t, \frac{M^s_t}{P_t} \right)}{U_c \left( y_t, \frac{M^s_t}{P_t} \right)} = \frac{i_t}{1 + i_t}
\]

we can write this as

\[
\frac{M^s_t}{P_t} = L(y_t, i_t), \quad L_y > 0, L_i < 0
\]

- Impose market clearing on Fisher relation (assume \( U \) separable in \( c \) and \( m \))

\[
R_{t,t+1} = \beta \frac{U_c(y_{t+1})}{U_c(y_t)} \frac{P_t}{P_{t+1}}
\]

\[
1 + i_t = \beta^{-1} \left\{ E_t \left[ \frac{U_c(y_{t+1})}{U_c(y_t)} \frac{P_t}{P_{t+1}} \right] \right\}^{-1}
\]
Models’ Equilibria

In equilibrium, transversality condition implies

\[
\sum_{T=t}^{\infty} \beta^{T-t} E_t \frac{U_c(y_T)}{U_c(y_t)} \left[ y_T + \frac{i_T}{1 + i_T} \frac{M_T}{P_T} \right] = \sum_{T=t}^{\infty} \beta^{T-t} E_t \frac{U_c(y_T)}{U_c(y_t)} \left[ y_T - \frac{T_T}{P_T} \right]
\]

Simplify to yield the intertemporal equilibrium condition

\[
\frac{W^s_t}{P_t} = \sum_{T=t}^{\infty} \beta^{T-t} E_t \Lambda_{t,T} \left[ s_T + \frac{i_T}{1 + i_T} \frac{M_T}{P_T} \right]
\]

(IEC)

\[s_t \equiv T_t/P_t, \text{ primary surplus}; \quad \Lambda_{t,T} \equiv \beta^{T-t} U_c(y_T)/U_c(y_t), \text{ real discount factor}\]
Policy Behavior in Model 1

- MP: pegs price of one-period bond $\Rightarrow \{i_t\}$ exogenous
- FP: sets $\{s_t\}$ exogenously
- All government debt riskless, one-period, nominal
- Total government liabilities at beginning of $t$:
  \[ W_t^s = M_{t-1}^s + (1 + i_{t-1})B_{t-1}^s \]
- Law of motion for government liabilities

\[
W_{t+1}^s = (1 + i_t) \left[ W_t^s - P_t s_t - \frac{i_t}{1 + i_t} M_t^s \right]
\]

- Need to ensure that hypothesized policies satisfy this law of motion: can solve the model recursively
Equilibrium in Model 1

\[
\frac{W_t^s}{P_t} = \sum_{T=t}^{\infty} E_t \Lambda_{t,T} \left[ s_T + \frac{i_T}{1+i_T} L(y_T, i_T) \right]
\]

- News that \(E_t s_T \downarrow\) implies \(P_t \uparrow\) (anticipated fiscal expansions are inflationary)
- Although \(M_t^s \uparrow\) to clear money market, this is a passive response induced by pegging \(i_t\)—\(M\) is not causing \(P\)
- Both \(P_t\) and \(M_t^s\) rise before fiscal changes are realized
- This is *not* the usual monetization of deficits, as in unpleasant arithmetic
- Anticipated surpluses & seigniorage symmetric: lower \(E_t s_T\) or \(E_t \frac{i_T}{1+i_T} L(y_T, i_T)\) both inflationary (highly irregular)
How can changes in lump-sum taxes affect $P$?

**Answer:** wealth effect

**Suppose** $E_t s_T \downarrow$

- HH feels wealthier (lower expected future taxes)
- able to afford more $c_t$, so demand for goods $\uparrow$ (at initial prices)
- because supply of goods fixed, $P_t \uparrow$
- $P$ reaches new eqm by reducing real value of nominal assets held by HH
- $P$ rises to point where value of nominal assets $= \text{PV}$ expected primary surpluses b/c then HH can afford to buy exactly the quantity of goods produced
- $P$ adjusts until **intertemporal eqm condition** restored
- in eqm, no change in wealth from lower anticipated taxes
Generalize policy behavior with a conventional parametric representation

Allow us to characterize the MP/FP behavior that is consistent with existence & uniqueness of eqm

Cost of generality: focus on local dynamics within a neighborhood of steady state, rather than previous global results

Same model as above
Model 2’s Critical Equations

Fisher: \[ \frac{1}{1 + i_t} = \beta E_t \left[ \frac{1}{\pi_{t+1}} \right] \]

Money demand: \[ m_t = L(i_t) \]

Fiscal Policy: \[ \tau_t = \gamma_0 + \gamma b_{t-1} + \psi_t \quad \text{(AR(1) coeff } \rho_\psi) \]

Monetary Policy: \[ i_t = \alpha_0 + \alpha \pi_t + \theta_t \quad \text{(AR(1) coeff } \rho_\theta) \]

GBC: \[ b_t + m_t + \tau_t = g + \frac{(1 + i_{t-1})b_{t-1} + m_{t-1}}{\pi_t} \]

where: \[ \pi_t = P_t/P_{t-1}, m_t = M_t/P_t, b_t = B_t/P_t \]

- Linearize & reduce to system in \((\pi_t, b_t)\) with exogenous variables \((\theta_t, \psi_t)\)
  - reflects two tasks: control \(\pi_t\); stabilize \(b_t\)
- Policy parameters \((\alpha, \gamma)\) critical to existence & uniqueness of equilibrium
Solving Model 2

- Using Sims’s (2001) notation, let $x_t = (\pi_t, b_t)'$ and $z_t = (\theta_t, b_t)'$ and write system as

$$
\Gamma_0 x_{t+1} = \Gamma_1 x_t + \Phi_0 z_{t+1} + \Phi_1 z_t + \Pi \eta_{t+1}
$$

$$
\eta_{t+1} \equiv \pi_{t+1} - E_t \pi_{t+1}
$$

- Eigensystem analysis focuses on the transition matrix

$$
\Gamma_0^{-1} \Gamma_1 = \begin{bmatrix}
\alpha \beta & 0 \\
-\alpha \beta \varphi_1 + \varphi_2 & \beta^{-1} - \gamma
\end{bmatrix}
$$

- Eigenvalues are $\alpha \beta$ & $\beta^{-1} - \gamma$

- With a single forecast error, $\eta_{t+1}$, need one unstable root for a unique eqm to exist
  - this anchors expectations
Policy Regimes in Model 2

- Four regions of policy parameter space are of interest

1: \(|\alpha \beta| \geq 1 \text{ and } |\beta^{-1} - \gamma| < 1 \Rightarrow \text{Unique Eqm}\)

2: \(|\alpha \beta| < 1 \text{ and } |\beta^{-1} - \gamma| \geq 1 \Rightarrow \text{Unique Eqm}\)

3: \(|\alpha \beta| < 1 \text{ and } |\beta^{-1} - \gamma| < 1 \Rightarrow \text{Multiple Eq/Sunspots}\)

4: \(|\alpha \beta| \geq 1 \text{ and } |\beta^{-1} - \gamma| \geq 1 \Rightarrow \text{No Bounded Eqm}\)

- Nature of eqm very different across regions

  - Region I: monetarist & Ricardian
  - Region II: non-monetarist & FTPL
  - Region III: non-monetarist & FTPL in all eq
  - Region IV: no eqm unless \(\theta_t \text{ & } \psi_t\) correlated perfectly
Active & Passive Policy Behavior

- An *active* policy authority is free to pursue its objectives, unconstrained by the state of government debt
  - decision rule may depend on past, current, or expected future variables
- A *passive* policy authority is constrained by the behavior of the active authority and the private sector and must be consistent with equilibrium
  - decision rule necessarily depends on state of government indebtedness, as summarized by current and past variables
- *Active* forward-looking & *passive* backward-looking consistent with Simon’s “rule vs. discretion” perspective as put forth by Friedman and with Sargent-Wallace’s terminology
Active MP & Passive FP: **Regime M**

- **Equilibrium is**

  \[
  \pi_t = -\frac{\beta}{\alpha \beta - \rho \theta} \theta_t \\
  i_t = -\frac{\rho \theta}{\alpha \beta - \rho \theta} \theta_t \\
  \eta_t = -\frac{\beta}{\alpha \beta - \rho \theta} \varepsilon \theta_t
  \]

- **Inflation entirely a monetary phenomenon**

- **What is FP doing?**
  - adjusts future surpluses to cover interest plus principal on debt
  - any shock that changes debt must create the expectation that eventually future surpluses will adjust to stabilize debt’s value
  - for MP to target inflation, fiscal expectations must be anchored on FP adjusting to maintain value of debt
Active MP & Passive FP: **Regime M**

- Equilibrium sequences of \( \{\tau_t, b_t\} \) are determined by the (stable) difference equation in debt and the tax rule
- Taxes & debt irrelevant for inflation \( \Rightarrow \) equilibrium exhibits Ricardian equivalence
- Tax policy stabilizes debt

\[
E_{t-1} b_t = (\beta^{-1} - \gamma) b_{t-1} - E_{t-1} \psi_t + \text{terms in } \theta_t, \theta_{t-1}
\]

- Higher debt induced by fiscal *or monetary* shocks is expected to bring forth higher taxes that retire debt back to steady state
- Although taxes appear to be irrelevant, tax policy provides essential support to monetary policy
Passive MP & Active FP: Regime F

- Focus on the special case in the FT literature
  - Assume $\alpha = \gamma = \rho_{\theta} = \rho_{\psi} = 0$
  - $\alpha = 0 \Rightarrow$ the nominal interest rate is exogenous
  - $\gamma = 0 \Rightarrow$ the net-of-interest surplus surplus exogenous

- Equilibrium is

\[
\begin{align*}
i_t &= \varepsilon_{\theta t} \\
\pi_t &= \varphi \varepsilon_{\psi t} + \beta \varepsilon_{\theta t-1}, \quad \varphi < 0 \\
b_t &= \delta \varepsilon_{\theta t}, \quad \delta > 0
\end{align*}
\]

- Features of the equilibrium
  - tax cuts raise inflation
  - open-market sales raise future inflation
  - fiscal shocks do not change value of debt
  - open-market sales raise value of debt
Passive MP & Active FP: **Regime F**

- Why don’t tax shocks change the value of debt?
- Surprise tax cut at $t$ financed with new *nominal* debt
- Monetary policy pegs $i_t$ ⇒ no change in expected inflation (and seigniorage)
- FP does not allow future taxes to change ($\gamma = 0$)
- At pre-shock prices, a cut in taxes without an increase in expected taxes, makes households feel wealthier
- Higher wealth leads households to try to raise their consumption paths
- Higher aggregate demand raises goods prices
- Price level rises until the wealth effect disappears ($B_t/P_t$ back to initial value)
- In equilibrium, no change in real wealth and the tax cut raises current inflation
Why does an open-market sale raise future inflation?

\[ \pi_t = \varphi \epsilon_{\psi t} + \beta \epsilon_{\theta t-1} \quad \varphi < 0 \]

Open-market sale:
- raises \( B_t \); contracts \( M_t \)
- but \( \Delta B_t = -\Delta M_t \)
- total nominal liabilities unchanged
- so \( P_t \) cannot change

Monetary contraction: raises \( B_t/P_t \) & \( i_t \)
- Higher value of debt supported by higher expected seigniorage revenues
- Same phenomenon as in unpleasant arithmetic
For Completeness: Other Regimes

- Passive MP & Passive FP
  - Eqm is indeterminate and admits bounded sunspot solutions
  - Both MP & FP are stabilizing debt
  - Neither policy is controlling inflation
  - This is the policy regime in Sargent-Wallace’s result about indeterminacy under an interest rate peg

- Active MP & Active FP
  - No eqm exists with bounded debt
  - Both MP & FP are controlling inflation
  - Neither policy is stabilizing debt
  - An “unsustainable” policy mix
An Observational Equivalence Result

Let $X_t$ denote the vector of observed (endogenous) time series with joint probability distribution $f(X_t)$ and let $\xi_t$ denote the vector of unobserved (exogenous) driving processes with joint probability distribution $g(\xi_t)$.

Proposition

If $g(\xi_t)$ generates the equilibrium $f(X_t)$ under an active monetary/passive fiscal regime (AM/PF), then there exists another distribution function for the driving processes, $h(\xi_t)$, that also generates the equilibrium $f(X_t)$, but under a passive monetary/active fiscal regime (PM/AF).
Observational Equivalence Reasoning

- Any equilibrium satisfies both conditions

\[ M_t V_t(\cdot) = P_t Y_t \]  
\[ \frac{W^s_t}{P_t} = \sum_{T=t}^{\infty} E_t \Lambda_{t,T} \left[ s_T + \frac{i_T}{1 + i_T} L(y_T, i_T) \right] \]

- cannot use these conditions alone to discern regime
- Solution to any structural model can be written as function of only exogenous shocks
  - but PM/AF regime has structural policy equations that are functions of only exogenous shocks
- Classic identification problem **writ large**
- Problems not well understood by the profession
Observational Equivalence Implications

▶ For every new Keynesian/Ricardian interpretation of time series, there is an equivalent fiscal theory/non-Ricardian interpretation

▶ Bohn (1998)-style regressions not identified
  ▶ Regress $s_t = \alpha + \beta b_{t-1} + X_t \Gamma + \varepsilon_t$
  ▶ IEC $\Rightarrow \hat{\beta} > 0$ in every eqm

▶ Canzoneri-Cumby-Diba (2001)-style VARs not identified
  ▶ Bivariate $\{s_t, b_t\}$ VARs reveal dynamics implied also by IEC—not policy behavior alone

▶ “Tests” of intertemporal equilibrium condition (IEC) are meaningless
  ▶ if debt is valued, condition must hold
  ▶ expectations unobserved but critical

▶ Solution: work much harder to identify policy behavior
Long maturity bonds affect inflation dynamics

Bonds sold at $Q_t$, issued in $t$ pay $\phi^j$ dollars $j + 1$ periods later

Bond’s duration is $(1 - \beta \phi)^{-1}$; consol sets $\phi = 1$

Now $W_t^s = M_{t-1}^s + (1 + \phi Q_t)B_{t-1}^s$

$$\frac{W_t^s}{P_t} = \sum_{T=t}^{\infty} E_t \Lambda_{t,T} \left[ s_T + \frac{i_T}{1 + i_T} L(y_T, i_T) \right]$$

$W_t^s$ no longer predetermined at $t$
  - news about future $s_T$ affects both $P_t$ & $Q_t$
Two no-arbitrage conditions

\[ \frac{1}{1 + i_t} = \beta E_t \frac{1}{\pi_{t+1}} \]

\[ Q_t = \frac{1}{1 + i_t} E_t [1 + \phi Q_{t+1}] \]

Combining and linearizing

\[ Q_t = - \sum_{i=0}^{\infty} \phi^i E_t \pi_{t+i+1} \]
Maturity of Debt & Inflation Dynamics

\[
\frac{M^s_{t-1} + (1 + \phi Q_t)B^s_{t-1}}{P_t} = \sum_{T=t}^{\infty} E_t \Lambda_{t,T} \left[ s_T + \frac{i_T}{1 + i_T} L(y_T, i_T) \right]
\]

\[
Q_t = -\sum_{i=0}^{\infty} \phi^i E_t \pi_{t+i+1}
\]

- Adjustments in value of liabilities come through both \( P_t \) & \( Q_t \)
- Lower \( Q_t \) pushes inflation into the future
- Timing: first long-term bond yields move, then short-term, then inflation
To further bring the postponed-inflation possibility to life, Fig. 8 plots the corresponding time series of inflation and bond yields. The vertical line indicates the date of the surplus shock. First, long-term bond yields rise. As the inflation approaches, shorter term rates rise as well. Finally, 5 years after the surplus shock, the steady inflation actually materializes.

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

Three reactions to a 10% expected surplus shock. Red triangles: time-\( t \) price-level jump followed by no additional inflation; blue circles: steady inflation starting at time \( t \); black triangles: steady inflation starting 4 years after the shock. Calibrated to U.S. federal debt maturity structure.
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Bond yields and inflation from a 10% shock to expected surpluses, when the government sells debt to postpone inflation for 5 years. Numbers indicate the maturity of the bond yields. The vertical line indicates the date of the surplus shock.
Application: Fiscal Stimulus

\[
\frac{M_{t-1} + B_{t-1}}{P_t} = \mathrm{E} \ PV(\text{Surpluses from } t \text{ onward})
\]

- News that future surpluses will be smaller
  - state governments cannot meet pension payments, turn to federal government ($3.2 trillion)
  - 2001 & 2003 tax cuts extended
  - Fannie & Freddie costs higher than anticipated
  - increase in willingness to take on risk—flight from quality (raises real discount rates)
  - political clout of tea party rises
- Each of these reduces market value of debt
- Increases aggregate demand & inflation
- Fiscal expansion matched by future fiscal contraction does not stimulate
Application: Flight to Quality

\[
\frac{M_{t-1} + B_{t-1}}{P_t} = E\ PV(\text{Surpluses from } t \text{ onward})
\]

- “Flight to quality”
  - shift from risky assets to government bonds
  - sharp reduction in real discount rates
  - increase in E PV(Surpluses)
  - large & sudden revaluation in debt
  - drop in aggregate demand
  - lower inflation & economic activity now and in future

- Possible source of deflation fears?

- Ultimate source of demand is fiscal news—beyond central bank’s control
Recurring Policy Regime Change

- Regime change: realizations of params in policy rule

\[ i_t = \alpha_0(S_t) + \alpha_\pi(S_t)\pi_t + \alpha_x(S_t)x_t + \sigma^i(S_t)\varepsilon^i_t \]

\[ \tau_t = \gamma_0(S_t) + \gamma_b(S_t)b_{t-1} + \gamma_x(S_t)x_t + \sigma^\tau(S_t)\varepsilon^\tau_t \]

\( S_t \) evolves stochastically by a known process

- Many researchers have estimated policy rules to find parameters changed over time

  - Taylor, Clarida-Galí-Gertler, Auerbach, Lubik-Schorfheide, Sala, Favero-Monacelli, Davig-Leeper

- Fixed-regime theory: problematic interpretation

  - ex-ante agents put probability 0 on change
  - ex-post agents put probability 1 on new regime
  - Cooley-LeRoy-Raymon: this is logically inconsistent
Recurring Regime Change: Analytical Example

- Canzoneri, Cumby, Diba (2001): Ricardian equilibria are more general than non-Ricardian
  - if responses of taxes to liabilities is positive infinitely often—however small and infrequent—then eqm exhibits Ricardian equiv
  - because fiscal response does not stabilize debt, these are potentially equilibria with unbounded debt-output ratios
- Our example satisfies CCD’s assumptions, but delivers a unique eqm in set with bounded debt-output ratios
  - this eqm is non-Ricardian
  - important conclusions hinge on unboundedness assumption of CCD
Recurring Regime Change: The Model

- MIUF, constant endowment, log prefs, constant \( g \)
- Fisher equation
  \[
  \frac{1}{I_t} = \beta E_t \frac{1}{\pi_{t+1}}
  \]
- Money demand
  \[
  m_t = \left[ \frac{I_t - 1}{I_t} \right]^{-1} c
  \]
- Monetary policy
  \[
  I_t = \exp(\alpha_0 + \alpha(S_t)\hat{\pi}_t + \theta_t)
  \]
- Tax policy
  \[
  \tau_t = \gamma_0 + \gamma(S_t)(b_{t-1} + m_{t-1}) + \psi_t
  \]
  \((\theta_t, \psi_t) \text{ exogenous policy shocks}; \hat{\pi} = \ln \pi\)
Recurring Regime Change: The Model

- $S_t$ an $N$-state Markov chain with transition probs
  \[ P[S_t = j | S_{t-1} = i] = p_{ij} \]
- Define expectation error (and use Fisher equation)
  \[
  \eta_{t+1} \equiv \frac{1/\pi_{t+1}}{E_t[1/\pi_{t+1}]} = \beta \frac{I_t}{\pi_{t+1}}
  \]
- Then the inflation process is given by
  \[
  \hat{\pi}_{t+1} = \alpha(S_t)\hat{\pi}_t + \alpha_0 + \theta_t - \hat{\eta}_{t+1} + \ln \beta
  \]
- Let $l_t = b_t + m_t$, real govt liabilities
- Use tax rule & money demand in govt budget constraint
  \[
  l_t = \left[ \frac{I_{t-1}}{\pi_t} - \gamma(S_t) \right] l_{t-1} - \frac{I_{t-1}}{\pi_t} c + D - \psi_t
  \]
  \[
  D = g - \gamma_0
  \]
Recurring Regime Change: Solution

- Assume that
  1. $E_t[\gamma_{t+1}] = \gamma$
  2. $\gamma$ satisfies $|1/\beta - \gamma| > 1$
  3. inflation process is stable in expectation (i.e., there exists a $0 < \xi < \infty$ such that $|E_t\pi_{t+k}| < \xi$ for all $k$

- (i)-(ii): on average FP active; (iii): on average MP passive

- Iterate on $l$ equation, take $E_{t-1}$, apply law of iterated expectations

$$E_{t-1}[l_{t+k}] = (1/\beta - \gamma)^{k+1} \left[ l_{t-1} - c \left( \frac{1/\beta - D/c}{1/\beta - \gamma - 1} \right) \right]$$

$$+ c \left( \frac{1/\beta - D/c}{1/\beta - \gamma - 1} \right)$$

Stability requires that $l_{t-1} = c \left( \frac{1/\beta - D/c}{1/\beta - \gamma - 1} \right)$, which is positive if $D/c < 1/\beta$
Recurring Regime Change: Solution

- The value of $\eta_t$ is obtained from the budget constraint after substituting in the value of $l$

$$
\eta_t = \frac{\beta (1 + \gamma(S_t)) (1/\beta - D/c) - (D/c) (1/\beta - \gamma - 1)}{1 + \gamma - D/c} \\
+ \frac{\beta}{c} \left( \frac{1/\beta - \gamma - 1}{1 + \gamma - D/c} \right) \psi_t
$$

- The unique eqm mapping from $\psi_t$ and $\gamma(S_t)$ to forecast error in inflation

- $\eta_t$ process yields unique solution for inflation

- **Unique bounded eqm is a fiscal theory eqm**
  - tax shocks & parameters affect inflation
  - monetary policy shocks do not affect current inflation
Recurring Regime Change: Example

- Two regimes, $N = 2$, and policy parameters take on the distinct values in each regime.
- Suppose $\alpha(1)$ and $\alpha(2)$ are sufficiently small such that the inflation process is stable in expectation:

$$E[\gamma_{t+j} | S_t = 1, \Omega_t] = \gamma(1)p_{11} + \gamma(2)p_{12}$$

$$= E[\gamma_{t+j} | S_t = 2, \Omega_t] = \gamma(1)p_{21} + \gamma(2)p_{22} \equiv \gamma$$

- If either $\gamma(1)$ or $\gamma(2)$ is positive, then the model satisfies CCD’s premise that taxes adjust to debt infinitely often.
- But negative tax shocks generate wealth effects that raise inflation.
- The only eqm with bounded debt is one in which Ricardian equiv breaks down: counterexample to CCD.
Recurring Regime Change: Fiscal Theory
Always Operative

- Percentage of time in AM/PF regime in a new Keynesian model
Fiscal Limits

- Many advanced economies are heading to an era of fiscal stress
  - populations are aging
  - governments have promised many more benefits... than they have made provisions to finance
- Several European countries—Greece, Ireland, Portugal—are facing sovereign debt crises even before demographic effects hit
- Raises the possibility that countries will run against their fiscal limit—a point beyond which taxes & spending cannot be adjusted to stabilize debt
- **Regime F** becomes relevant at the fiscal limit
- Just the prospect of a fiscal limit can be sufficient for **Regime F** effects to arise in current equilibrium
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook (June 2009)
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook (June 2009)
## Worldwide “Unfunded Liabilities”

<table>
<thead>
<tr>
<th>Country</th>
<th>Aging-Related Spending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>482</td>
</tr>
<tr>
<td>Canada</td>
<td>726</td>
</tr>
<tr>
<td>France</td>
<td>276</td>
</tr>
<tr>
<td>Germany</td>
<td>280</td>
</tr>
<tr>
<td>Italy</td>
<td>169</td>
</tr>
<tr>
<td>Japan</td>
<td>158</td>
</tr>
<tr>
<td>Korea</td>
<td>683</td>
</tr>
<tr>
<td>Spain</td>
<td>652</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>335</td>
</tr>
<tr>
<td>United States</td>
<td>495</td>
</tr>
<tr>
<td>Advanced G-20 Countries</td>
<td>409</td>
</tr>
</tbody>
</table>

Net present value of impact on fiscal deficit of aging-related spending, in percent of GDP. Source: IMF
Rolling Projected Deficits into Debt

Source: CBO Long-Term Budget Outlook (2009 & 2010)
Spending promises without financing plans create unresolved fiscal stress

Raises likelihood that agents will begin to speculate about when and if the economy will hit its fiscal limit

Natural questions to ask:

1. What are the effects of unresolved fiscal stress & the prospect of hitting a fiscal limit?

2. What are the impacts of alternative possible resolutions?

3. Even if we knew long-run policies, what might happen along the transition to the long run?
Analytic Intuition: Simple Model

- Consider a flexible price, cashless, endowment economy (as before)

- The consumption Euler equation reduces to the Fisher equation
  \[
  \frac{1}{I_t} = \beta E_t \left( \frac{P_t}{P_{t+1}} \right)
  \]

- Transfers grow at rate $\mu$ financed by lump-sum taxes and debt
  \[
  z_t = (1 - \mu)z^* + \mu z_{t-1} + \varepsilon_t, \quad \mu < 1/\beta
  \]

- Government’s Budget Constraint:
  \[
  \frac{B_t}{P_t} + \tau_t = z_t + \frac{I_{t-1}B_{t-1}}{P_t}
  \]
At time $T$ economy reaches fiscal limit

<table>
<thead>
<tr>
<th>Regime 1</th>
<th>$t = 0, 1, \ldots, T - 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary Policy</td>
<td>$I_t^{-1} = I_<em>^{-1} + \alpha \left( \frac{P_{t-1}}{P_t} - \frac{1}{\pi^</em>} \right)$</td>
</tr>
<tr>
<td>Tax Policy</td>
<td>$\tau_t = \tau_* + \gamma \left( \frac{B_{t-1}}{P_{t-1}} - b^* \right)$</td>
</tr>
</tbody>
</table>
Analytic Intuition: Policy Specification

At time $T$ economy reaches fiscal limit

<table>
<thead>
<tr>
<th>Regime 1</th>
<th>Regime 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = 0, 1, \ldots, T - 1$</td>
<td>$t = T, T + 1, \ldots$</td>
</tr>
</tbody>
</table>

Monetary Policy

$$I_t^{-1} = I^{*^{-1}} + \alpha \left( \frac{P_{t-1}}{P_t} - \frac{1}{\pi^*} \right)$$

$$I_t^{-1} = I^{*^{-1}}$$

Tax Policy

$$\tau_t = \tau^* + \gamma \left( \frac{B_{t-1}}{P_{t-1}} - b^* \right)$$

$$\tau_t = \tau^{\text{max}}$$

Fiscal limit may be economic (peak of Laffer curve) or political (intolerance of taxation)
Analytic Intuition: Polar Case 1

If Regime 1 were absorbing state (No Fiscal Limit)

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

(Regime 1)

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

\[
\alpha / \beta > 1, \ \beta^{-1} - \gamma < 1 \Rightarrow \text{Equilibrium} \ \pi_t = \pi^*
\]

A Standard Monetary Equilibrium
If Regime 2 were absorbing state

$$E_t \left( \frac{P_t}{P_{t+1}} \right) = \frac{1}{\beta I^*} = \frac{1}{\pi^*} \quad \text{(Regime 2)}$$

$$B_t = \left( \frac{\beta}{1 - \beta} \right) \tau^* - E_t \sum_{j=1}^{\infty} \beta^j z_{t+j}$$

$$\alpha = 0, \gamma = 0 \Rightarrow \text{Actual Inflation}$$

$$P_t = \frac{I_{t-1}B_{t-1}}{\left( \frac{1}{1-\beta} \right) \tau^* - E_t \sum_{j=0}^{\infty} \beta^j z_{t+j}}$$

A Standard Fiscal Equilibrium
## Fiscal Limit: Reneging

<table>
<thead>
<tr>
<th></th>
<th>( t = 0, 1, \ldots, T - 1 )</th>
<th>( t = T, T + 1, \ldots )</th>
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<tbody>
<tr>
<td><strong>Monetary Policy</strong></td>
<td>( I_t^{-1} = I_t^{<em>-1} + \alpha \left( \frac{P_{t-1}}{P_t} - \frac{1}{\pi^</em>} \right) )</td>
<td>same</td>
</tr>
<tr>
<td><strong>Tax Policy</strong></td>
<td>( \tau_t = \tau^* + \gamma \left( \frac{B_{t-1}}{P_{t-1}} - b^* \right) )</td>
<td>( \tau_t = \tau^{\max} )</td>
</tr>
<tr>
<td><strong>Transfer Policy</strong></td>
<td>( z_t )</td>
<td>( \lambda_t z_t )</td>
</tr>
</tbody>
</table>

\[
E_{t-1}[B_t/P_t] + \tau^{\max} = E_{t-1} \lambda_t z_t + (\beta^{-1} - \gamma)(B_{t-1}/P_{t-1})
\]

\( \lambda_t \) adjusts to stabilize debt

\[
\pi_t = \pi^*
\]

**A Standard Monetary Equilibrium**
## Fiscal Limit: No Reneging

<table>
<thead>
<tr>
<th>Policy</th>
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<td>( I_t^{-1} = I^{*-1} )</td>
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<td>Transfer Policy</td>
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<td>same</td>
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</tbody>
</table>

\[
E_t \left( \frac{P_t}{P_{t+1}} - \frac{1}{\pi^*} \right) = \frac{\alpha}{\beta} \left( \frac{P_{t-1}}{P_t} - \frac{1}{\pi^*} \right), \quad \frac{\alpha}{\beta} > 1
\]

\[
P_t = f(z_t; \gamma, \mu, \beta, \pi^*)
\]

**A New Fiscal Equilibrium Before the Limit**
Fiscal Limit: No Reneging Analytics

\[
\frac{B_0}{P_0} = E_0 \sum_{j=1}^{\infty} \beta^j s_j
\]

\[
= E_0 \sum_{j=1}^{T-1} \beta^j s_j + \left( \frac{1}{1 - \beta \gamma} \right)^{T-1} E_0 \sum_{j=T}^{\infty} \beta^j s_j
\]

\[
S_t = \begin{cases} 
\tau^* - \gamma(B_{t-1}/P_{t-1} - b^*) - z_t, & t = 0, 1, \ldots, T - 1 \\
\tau^\text{max} - z_t, & t = T, \ldots, \infty
\end{cases}
\]
Fiscal Limit: No Reneging Analytics

Evaluate sum from 1 to \(T - 1\)

\[
E_0 \sum_{j=1}^{T-1} \beta^j s_j = (\tau^* - \gamma b^* - z^*) \sum_{j=1}^{T-1} \left( \frac{\beta}{1 - \gamma \beta} \right)^j
\]

\[-(z_0 - z^*) \sum_{j=1}^{T-1} \left( \frac{\beta \mu}{1 - \gamma \beta} \right)^j\]

Evaluate sum from \(T\) to \(\infty\), letting \(\tau^{\text{max}} = \tau^*\)

\[
E_0 \sum_{j=T}^{\infty} \beta^j s_j = E_0 \left( \frac{B_{T-1}}{P_{T-1}} \right) = \frac{\beta^T}{1 - \beta} (\tau^* - z^*) - \frac{(\beta \mu)^T}{1 - \beta \mu} (z_0 - z^*)
\]
Pulling it together...

\[
\frac{B_0}{P_0} = \left[ \left( \frac{1}{1 - \beta \gamma} \right)^{T-1} \frac{\beta^T}{1 - \beta} + \sum_{j=1}^{T-1} \left( \frac{\beta}{1 - \gamma \beta} \right)^j \right] (\tau^* - z^*)
\]

\[
- \gamma b^* \sum_{j=1}^{T-1} \left( \frac{\beta}{1 - \gamma \beta} \right)^j
\]

\[
- \left[ \left( \frac{1}{1 - \beta \gamma} \right)^{T-1} \frac{(\beta \mu)^T}{1 - \beta \mu} + \sum_{j=1}^{T-1} \left( \frac{\beta \mu}{1 - \gamma \beta} \right)^j \right] (z_0 - z^*)
\]
Analytic Intuition: Debt

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Debt−GDP Target

Debt in Fixed Regime Passive Monetary/Active Fiscal
Analytic Intuition: Debt

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Debt When Fiscal Limit at $T = 50$

Debt in Fixed Regime Passive Monetary/Active Fiscal

Debt–GDP Target
Analytic Intuition: Inflation

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Inflation Target

Inflation in Fixed Regime Passive Monetary/Active Fiscal
Analytic Intuition: Inflation

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Inflation When Fiscal Limit at $T = 50$

Inflation Target

Inflation in Fixed Regime Passive Monetary/Active Fiscal
Analytic Intuition: Expected Inflation

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Expected Inflation When Fiscal Limit at T = 50

Inflation When Fiscal Limit at T = 50

Inflation Target

Inflation in Fixed Regime Passive Monetary/Active Fiscal
Stronger Response of Taxes to Debt

Fiscal Limit Regime is Passive Monetary/Active Fiscal

Debt When Fiscal Limit at $T = 50$

More Aggressive Response of Taxes to Debt

Debt When Fiscal Limit at $T = 50$

Less Aggressive Response of Taxes to Debt

Debt in Fixed Regime

Passive Monetary/Active Fiscal

Debt–GDP Target
Stronger Response of Taxes to Debt

Inflation When Fiscal Limit at T = 50

More Aggressive Response of Taxes to Debt

Inflation in Fixed Regime Passive Monetary/Active Fiscal

Inflation When Fiscal Limit at T = 50

Less Aggressive Response of Taxes to Debt

Fiscal Limit Regime is Passive Monetary/Active Fiscal
Fiscal Limit: Implications

- Expectations of post-limit policies determine *pre-limit* equilibrium
- Inflation and debt *not* anchored on targets
- Expectations—and equilibrium—time varying as approach limit
- More aggressive inflation or debt targeting pre-limit raises instability
- Monetary policy loses its ability to control inflation and influence economy in usual ways
Wrap Up

- Monetary & fiscal policies always interact to determine equilibrium

- In “normal times,” when FP behaves to stabilize debt, we tend to ignore it and focus on MP alone

- Normal times are over for the foreseeable future

- FP’s effect on inflation are far more subtle than the unpleasant arithmetic story of running the printing press

- FP can undermine MP’s control of inflation
  - even if MP aggressively targets inflation
Research Agenda

1. Identifying policy behavior
   ▶ creative approaches to restricting policy rules

2. Quantifying fiscal limits
   ▶ political economy in detailed stochastic general equilibrium models

3. Integrating heterogeneity & policy uncertainty
   ▶ re-slicing the pie has large welfare consequences

4. Understanding sovereign debt default
   ▶ optimal default models too stylized
   ▶ other models too *ad hoc*

5. Anchoring fiscal expectations
   ▶ MP’s control of inflation hinges on correct anchoring
   ▶ what FP frameworks can ensure this?

6. Learning from the past
   ▶ unprecedented things don’t happen much
   ▶ how can we extrapolate from past data?