MONETARY AND FISCAL INTERACTIONS: THE IMPORTANCE OF NONLINEARITIES

Todd B. Walker

Indiana University

July 2012

Monash Mini-course: Monetary-Fiscal Policy Interactions
MONETARY AND FISCAL INTERACTIONS

Lecture 1: Regime Switching in policy
  1. Markov Switching in Regime \( M \)
  2. Empirical Relevance

Lecture 2: Monetary-Fiscal Interactions and Government Spending
  1. Multiplier Morass
  2. Modeling the Zero-Lower Bound

Lecture 3: Fiscal Limits in Advanced Economies
  1. Monetary and Fiscal interaction in era of fiscal stress
  2. Modeling Policy Uncertainty
Lecture 1: Regime Switching in Policy


Lecture 2: Monetary-Fiscal Interactions and Government Spending


Lecture 3: Fiscal Limits in Advanced Economies


Forecasting


Solution Methods

Lecture 1: Regime Switching in Policy

Todd B. Walker

Indiana University

July 2012

Monash Mini-course: Monetary-Fiscal Policy Interactions
THE MESSAGE

I will focus on expectation effects of regime switching

- Determinacy conditions in monetary policy [Davig and Leeper (2007), Farmer, Waggoner and Zha (2009)]

- Importance of expectation effects in monetary policy from estimated model [Bianchi (2011)]
Example 1: Determinacy conditions

- Before studying monetary-fiscal interactions when policy regimes can change, need some preliminary analysis when only MP can switch

- This allows simple analytical derivations that build intuition and understanding

- Will not discuss (in detail) technical issues [see Farmer, Waggoner and Zha (2010)]
Simplifying Policy

- Monetary policy is complex
- For descriptive & prescriptive reasons, seek to simplify
- Most successful simplification due to Taylor

\[ i_t = i^* + \alpha(\pi_t - \pi^*) + \gamma x_t + \varepsilon_t \]

- **Taylor principle**: \( \alpha > 1 \)
  - necessary & sufficient for unique bounded (cov stationarity) eqm
- Unique & stable eqm necessary for good policy
  - rules out sunspots
THE TAYLOR RULE & PRINCIPLE

- Central banks can stabilize economy by adjusting nominal interest rate more than one-for-one with inflation
  - approximates Federal Reserve behavior since 1982
  - nearly optimal in workhorse class of monetary models
  - used by central banks as a benchmark
- Maintains two key assumptions
  - fiscal policy is perpetually passive
  - policy rule permanent & agents believe change impossible
- DL relax this second assumption
  - rule evolves according to a Markov chain
  - consider two conventional monetary models
Generalizing the Taylor Rule & Principle

- $\alpha(s_t), \gamma(s_t)$ $s_t \sim$ Markov chain
- $s_t$: “rule,” “regime,” “state”
- $s_t$ exogenous
- Can believe actual policy rule time invariant
  - but Taylor rule is a gross simplification of reality
  - paper shows that a particular form of non-linearity can change predictions of models
In the Fisherian Model . . .

- Derive long-run Taylor principle
  - imposes much weaker conditions on MP for uniqueness
  - departures from short-run Taylor principle can be substantial—but brief—or modest—and prolonged
  - the more “hawkish” one regime is, the more “dovish” the other can be and still deliver uniqueness
  - “expectations formation effects”—beliefs about possible future regimes affect current eqm, increasing volatility even in a regime that satisfies TP
In the New-Keynesian Model . . .

- Derive *long-run Taylor principle*: dramatically expands region of determinacy
- Inference that inflation of the 70’s due to failure to obey TP does not hold up when expectations embed possibility of regime change
- Occasional large departures from TP—due to worries about financial instability or economic weakness—can have quantitatively important impacts even in a regime that satisfies TP
- Misleading inferences can arise from dividing data into regime-specific periods to interpret estimates as arising from distinct fixed regimes
MODEL OF INFLATION DETERMINATION

- A simple Fisherian economy

\[ i_t = E_t \pi_{t+1} + r_t \]
\[ r_t = \rho r_{t-1} + \nu_t, \quad \nu \sim \text{Guassian} \]
\[ i_t = \alpha(s_t)\pi_t, \quad s_t \text{ Markov}; \quad s_t = 1, 2 \]

\[ p_{ij} = P[s_t = j \mid s_{t-1} = i] \]

\[ \alpha(s_t) = \begin{cases} 
\alpha_1 & \text{for } s_t = 1 \\
\alpha_2 & \text{for } s_t = 2 
\end{cases} \]

- a monetary policy regime: realization of \( \alpha(s_t) \)
- a monetary policy process: collection \((\alpha_1, \alpha_2, p_{11}, p_{22})\)
- policy is active if \( \alpha_i > 1 \); passive if \( \alpha_i < 1 \)
DETERMINACY: DEFINITION

- Seek generalization of Taylor principle
  - necessary & sufficient condition for existence of unique bounded (cov stationary) eqm
- Why boundedness?
  - consistent w/ standard definition under fixed regime
  - corresponds to locally unique eqm
    - can analyze small perturbations
  - considering log-linearized models
    - boundedness ensures approximations are good
**Determinacy: Formalism**

Model: \( \alpha(s_t)\pi_t = E_t\pi_{t+1} + r_t \)

- Let \( \Omega_t^{-s} = \{r_t, r_{t-1}, \ldots, s_{t-1}, s_{t-2}, \ldots\} \) and \( \Omega_t = \Omega_t^{-s} \cup \{s_t\} \)
- Integrating over \( s_t \), for \( s_t = 1 \) and \( s_t = 2 \)

\[
E_t\pi_{t+1} = E[\pi_{t+1} \mid s_t = i, \Omega_t^{-s}]
\]

\[
= p_{i1} E[\pi_{1t+1} \mid \Omega_t^{-s}] + p_{i2} E[\pi_{2t+1} \mid \Omega_t^{-s}]
\]

where \( \pi_{it} = \pi_t(s_t = i, r_t) \), the solution when \( s_t = i \)

- The system is

\[
\begin{bmatrix}
\alpha_1 & 0 \\
0 & \alpha_2
\end{bmatrix}
\begin{bmatrix}
\pi_{1t} \\
\pi_{2t}
\end{bmatrix}
= \begin{bmatrix}
p_{11} & p_{12} \\
p_{21} & p_{22}
\end{bmatrix}
\begin{bmatrix}
E_t\pi_{1t+1} \\
E_t\pi_{2t+1}
\end{bmatrix}
+ \begin{bmatrix}
r_t \\
r_t
\end{bmatrix}
\]

where \( E_t\pi_{it+1} \) denotes \( E[\pi_{it+1} \mid \Omega_t^{-s}] \)
Determinacy: Formalism (con’t)

• Write system as

\[ \pi_t = ME_t \pi_{t+1} + \alpha^{-1} r_t \]

• MSV solution: \( \pi_t \) function only of \((r_t, s_t)\)
• Define \( x_t = \pi_t - \pi_t^{MSV}(r_t, s_t) \)
• Bounded soln for \( \{x_t\} \iff \text{bounded soln for} \ \{\pi_t\} \)
• We study: \( x_t = ME_t x_{t+1} \)
**Prop. 1** When $\alpha_i > 0$, a unique bounded solution exists iff all the eigenvalues of $M$ lie inside the unit circle

**Sufficiency:** the usual proof in linear RE models

- intuition: boundedness requires that $\lim_{n \to \infty} M^n = 0$, so $x_t = 0$ the only solution
- delivered by eigenvalue condition
Long-Run Taylor Principle

- Prop. 2 Given $\alpha_i > p_{ii}$ for $i = 1, 2$, the following statements are equivalent:

  (A) All the eigenvalues of $M$ lie inside the unit circle.

  (B) $\alpha_i > 1$, for some $i = 1, 2$, and the long-run Taylor principle (LRTP)

  $$(1 - \alpha_2) p_{11} + (1 - \alpha_1) p_{22} + \alpha_1 \alpha_2 > 1$$

  is satisfied.

- Premise $\alpha_i > p_{ii}$ all $i$ unfamiliar
  - fixed regime: MP always obeys TP
  - LRTP is hyperbola w/ asymptotes $\alpha_1 = p_{11}$ & $\alpha_2 = p_{22}$
  - restricts $\alpha$’s to economically interesting portion of hyperbola

Walker: Regime Switching
A Range of Policies Deliver Uniqueness

\[ \alpha_1 > 1: p_{11}(1 - \alpha_2) + p_{22}(1 - \alpha_1) + \alpha_1\alpha_2 > 1 \]

- Some policy processes that deliver unique equilibria
  \[ \alpha_1 \to \infty \Rightarrow \alpha_2 > p_{22} \]
  or
  \[ p_{11} = 1 \Rightarrow \text{need } \alpha_1 > 1 \text{ and } \alpha_2 > p_{22} \]

- more active is one regime, more passive the other can be
  \[ p_{22} \to 1 \text{ OK if } \alpha_2 \approx 1 \text{ (but } < 1) \]

- ergodic prob of passive regime can be \( \approx 1 \) (but \( < 1 \))
  \[ p_{11} = p_{22} = 0 \text{ need } \alpha_2 > 1/\alpha_1 \]

- more active in one regime, less active in the other

- Figure illustrates these points
Determinacy Region: Fisherian Model

- $p_{11} = 0.95 ; p_{22} = 0.95$
- $p_{11} = 0.8 ; p_{22} = 0.95$
- $p_{11} = 0.95 ; p_{22} = 0$
- $p_{11} = 0 ; p_{22} = 0$
**FISHERIAN MODEL: SOLUTION**

- Define state as \((r_t, s_t)\) & find MSV solutions
  - posit regime-dependent rules:
    \[
    \pi_t = a(s_t = i) r_t
    \]
    \[
    a(s_t) = \begin{cases} 
    a_1 & \text{for } s_t = 1 \\
    a_2 & \text{for } s_t = 2 
    \end{cases}
    \]
  - expectations functions:
    \[
    E[\pi_{t+1} | s_t = 1, r_t] = [p_{11}a_1 + (1 - p_{11})a_2] \rho r_t
    \]
    \[
    E[\pi_{t+1} | s_t = 2, r_t] = [(1 - p_{22})a_1 + p_{22}a_2] \rho r_t
    \]
  - solve simple \(2 \times 2\) system to get \(a_1\) and \(a_2\)
**SOLUTION**

- Solutions are:

\[ a_1 = a_1^F \left( \frac{1 + \rho p_{12} a_2^F}{1 - \rho^2 p_{12} a_2^F p_{21} a_1^F} \right) \]

and

\[ a_2 = a_2^F \left( \frac{1 + \rho p_{21} a_1^F}{1 - \rho^2 p_{12} a_2^F p_{21} a_1^F} \right) \]

\[ p_{12} = 1 - p_{11}, \quad p_{21} = 1 - p_{22} \] & “fixed-regime” coefficients

\[ a_i^F = \frac{1}{\alpha_i - \rho p_{ii}}, \quad i = 1, 2 \]

- \( \alpha_1 > \alpha_2 \iff a_1 < a_2 \)
Expectations-Formation Effects

- Solutions are:

\[
a_1 = a_1^F \left( \frac{1 + \rho p_{12} a_2^F}{1 - \rho^2 p_{12} a_2^F p_{21} a_1^F} \right)
\]

and

\[
a_2 = a_2^F \left( \frac{1 + \rho p_{21} a_1^F}{1 - \rho^2 p_{12} a_2^F p_{21} a_1^F} \right)
\]

- Expectations-formation effects from regime 2 to regime 1
  - through \( p_{12} a_2^F \)
  - large if \( p_{12} \) large, \( p_{22} \) large, \( \alpha_2 \) small
A New-Keynesian Model

- Bare-bones model with nominal rigidities
  - from class in wide use for monetary policy analysis
  - general insights extend to more complex models now confronting data

- With recurring regime change and rational expectations:
  - How does the Taylor principle change?
  - How do impacts of demand and supply shocks change?

- Expectations-formation effects can be large
A New-Keynesian Model

- Consumption-Euler equation and AS relations

\[ x_t = E_t x_{t+1} - \sigma^{-1}(i_t - E_t \pi_{t+1}) + u^D_t \]
\[ \pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u^S_t \]

- Disturbances: bounded, autoregressive, mutually uncorrelated

\[ u^D_t = \rho_D u^D_{t-1} + \varepsilon^D_t \]
\[ u^S_t = \rho_S u^S_{t-1} + \varepsilon^S_t \]

- A Taylor rule for \( s_t = 1, 2 \)

\[ i_t = \alpha(s_t) \pi_t + \gamma(s_t) x_t \]
NEW-KEYNESIAN MODEL: DETERMINACY

- Let $\pi_{it} = \pi_t(s_t = i)$ & $x_{it} = x_t(s_t = i), i = 1, 2$
- Define forecast errors

$$
\eta_{1t+1}^\pi = \pi_{1t+1} - E_t \pi_{1t+1} \\
\eta_{1t+1}^x = x_{1t+1} - E_t x_{1t+1} \\
\eta_{2t+1}^\pi = \pi_{2t+1} - E_t \pi_{2t+1} \\
\eta_{2t+1}^x = x_{2t+1} - E_t x_{2t+1}
$$

- Model is

$$AY_t = BY_{t-1} + A\eta_t + Cu_t$$

- Unique bounded eqm requires the 4 generalized eigenvalues of $(B, A)$ to lie inside unit circle
- Derive long-run Taylor principle
New-Keynesian Model: Determinacy

- Set $\gamma(s_t) = 0$
- Intertemporal margins interact with expected policy to affect determinacy
- Determinacy regions expand with parameters that reduce ability to substitute away from future policy
  - Increase degree of stickiness ($\kappa$)
  - Reduce intertemporal elasticity of substitution ($\sigma$)
**Determinacy Regions Expand**

- $p_{11} = 0.95, p_{22} = 0.95$
- $p_{11} = 0.8, p_{22} = 0.95$
- $p_{11} = 0.95, p_{22} = 0$
- $p_{11} = 0, p_{22} = 0$
DET. REGIONS & PRIVATE PARAMETERS

\[ p_{11} = 0.9 , p_{22} = 0.9 , \omega = 0.01 \]

\[ p_{11} = 0.9 , p_{22} = 0.9 , \omega = 0.99 \]

\[ p_{11} = 0.9 , p_{22} = 0.9 , \sigma = 0.01 \]

\[ p_{11} = 0.9 , p_{22} = 0.9 , \sigma = 10 \]

Walker: Regime Switching
Empirical Relevance

Bianchi (2011): Regime Switches, Agents Beliefs...

- Estimates NK model with regime switches in policy and stochastic volatility
- Improvement over splitting data in two regimes
- Switching in beliefs crucial aspect of policy story (Hawk vs. Dove Regime)
- Performs “beliefs” counterfactuals
- Technical contribution: estimation
Empirical Relevance

Bianchi (2011): Standard NK Model except

- introduces two unobserved state variables that identify policy regime and stoch volatility regime

\[
\log(\xi_{I,t}) = \rho_{\xi} \log(\xi_{I,t-1}) + \sigma_{\xi}(\varsigma_t)\varepsilon_{\xi,t}
\]
\[
\log(R_t) = \rho_R \log(R_{t-1}) + \phi(\omega_t)\tilde{\pi}_t)
\]

- States are unobserved
- Uses MSV solution of Farmer, Waggoner and Zha
- Solution takes form of Regime Switching VAR
- Estimates using Bayesian methods
\textbf{Prob } \alpha_1 > 1 \text{ & High Stoch Vol}

\begin{itemize}
  \item \textbf{Structural parameters - Prob Hawk regime}
  \item \textbf{Stochastic volatilities - Prob High Volatility regime}
\end{itemize}
BELIEFS COUNTERFACTUAL: HAWK REGIME
THREAT OF EAGLE REGIME
Because model has both regime switching in policy parameters and stochastic volatility, can address Great Moderation was good luck or good policy

- Data do not support models that assume one-time, permanent regime change with Volker
- Data suggest that policy beliefs evolve stochastically
- Paper concludes good luck more plausible than good policy
LECTURE 2: MONETARY-FISCAL INTERACTIONS AND GOVERNMENT SPENDING

Todd B. Walker

Indiana University

July 2012
Monash Mini-course: Monetary-Fiscal Policy Interactions
Monetary-Fiscal interactions crucial for government spending multipliers

- Use Bayesian prior predictive to show the extent to which this is true in linear models [Leeper, Traum and Walker (2011)]
- Show that introducing regime switching can mitigate this effect somewhat [Christiano, Eichenbaum and Rebelo (2011)]
**Fiscal Multiplier(s): Definition**

1. **Present Value Multiplier:**

   \[
   \text{Present Value Multiplier}(Q) = \frac{\sum_{t=1}^{Q} \left( \prod_{i=1}^{t} R_i^{-1} \right) Y_t}{\sum_{t=1}^{Q} \left( \prod_{i=1}^{t} R_i^{-1} \right) G_t}
   \]

2. **Impact Multiplier:** \( Y_0/G_0 \)

3. \( G \) is unproductive spending
The Morass

IMF Working Paper 10/73 March 2010

1. 17 coauthors: model builders for policy institutions

2. Seven Structural Models: QUEST, GIMF, FRB-US, SIGMA, BoC-GEM, OECD Fiscal, NAWM.

3. Conclude: “Robust finding across all models that fiscal policy can have sizeable output multipliers.”
THE MORASS

• A robust finding?

• Cogan, Cwik, Taylor and Wieland (2010), Cwik and Wieland (2010)
  • Multipliers less than 1

• Uhlig (2010)
  • Distorting taxes produce negative long-run multipliers

• Drautzb burg and Uhlig (2011)
  • short-run multipliers 0.52; long-run multipliers -0.42;
Motivation

Why do DSGE models yield very different conclusions for multipliers even when conditioning on same data set?

Answer: Multipliers are conditional statistics, so different specifications $\rightarrow$ different multipliers
Open Question: To what extent does a DSGE model force a particular multiplier on the data?

- “black box” problem of DSGE models
- use Bayesian methodology to address issue
WHAT WE DO

- Use five nested models
- Employ prior predictive analysis to understand the *a priori* restrictions a DSGE model imposes
  - sheds light on complication object of interest—the multiplier
- Compute wealth & substitution effects produced by higher government spending
WHAT WE FIND

- Model restrictions impose tight ranges on multipliers
- Important model features that produce large multipliers:
  1. wage rigidities can flip sign of substitution effect (negative to positive)
  2. rule-of-thumb consumers ignore future tax liabilities to reduce negative wealth effect, boosts consumption
  3. higher persistence amplifies negative wealth effects, induces more work effort
  4. greater interest rate smoothing alters discount rates
- Monetary-fiscal regime
  1. active MP/passive FP: hard to get large multipliers
  2. passive MP/active FP: hard to get small multipliers
- All these results are largely independent of data
Prior Predictive Analysis

- Standard Exercise [Lancaster (2004), Geweke (2010)]: used to evaluate model’s adequacy for given feature of data before estimation stage (model evaluation)

- $A_j$ DSGE model, $\theta$ parameters of DSGE, $\omega = \text{multipliers}$
  1. Draw from priors: $\theta^{(m)} \sim p(\theta|A_j)$
  2. Solve DSGE Model
  3. Calculate $\omega^{(m)}|\theta^{(m)}, A_j$
  4. Draw $m = 1, \ldots, M$ to generate prior distribution $p(\omega|A_j)$

- Prior Predictive gives entire range of possible multipliers
- Computationally inexpensive
 Nested Specifications

- Model 1: Basic RBC
- Model 2: RBC with real frictions
- Model 3: NK model with sticky prices and wages
- Model 4: NK model with hand-to-mouth agents
- Model 5: NK model with open economy features
**Model 1: Basic RBC**

- CRRA, time-separable utility

\[
E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-\gamma}}{1-\gamma} - \frac{L_t^{1+\xi}}{1+\xi} \right]
\]

- Cobb-Douglas production

\[
Y_t = A_t K_t^\alpha L_t^{1-\alpha}
\]

- Law of motion for capital:

\[
K_t = I_t + (1 - \delta)K_{t-1}
\]
Model 1: Basic RBC

- GBC:

\[ B_t + \tau_t^K R_t^K K_{t-1} + \tau_t^L W_t L_t + \tau_t^C C_t = R_{t-1} B_{t-1} + G_t + Z_t \]

- Policy rules: capital tax, labor tax, government consumption, transfers obey

\[ \hat{X}_t = \rho_x \hat{X}_{t-1} + (1 - \rho_x) \gamma_x \hat{s}^b_{t-1} + \epsilon^x_t \]

where \( s^b_{t-1} = B_{t-1} / Y_{t-1}, \hat{X} = \hat{r}^K, \hat{r}^L, \hat{G} \)
MODEL 1: BASIC RBC

- 5,000 draws from priors: $\gamma \sim N^+(2, 0.6)$, $\xi \sim N^+(2, 0.6)$, $\rho_x \sim B(0.7, 0.2)$, $\gamma_{K,L} \sim N^+(0.2, 0.05)$, $\gamma_G \sim N^-(0.2, 0.05)$

- Priors similar to Smets and Wouters (2003) and others

- Other parameters fixed at well-established values (e.g., $\beta = 0.99$, $\alpha = 0.36$, $\delta = 0.025$)

- Prior imposes active MP/passive FP
  - discard draws inconsistent with existence of determinate equilibrium
**Model 1: Basic RBC**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>∞</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob($PV \frac{\Delta Y}{\Delta G} &gt; 1$)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prob($PV \frac{\Delta C}{\Delta G} &gt; 0$)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prob($PV \frac{\Delta I}{\Delta G} &gt; 0$)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Just can’t produce big multipliers
MODEL 1: BASIC RBC

Intuition straightforward:


• $\uparrow G \Rightarrow$ negative wealth and substitution effects, crowding out

• Consumption and investment fall

• Increase in public demand cannot offset decrease in private demand
Add to Model 1

- Habit formation in utility

\[
E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{(c_t - \theta C_{t-1})^{1-\gamma}}{1 - \gamma} - \frac{L_t^{1+\xi}}{1 + \xi} \right]
\]

\[\theta \sim B(0.5, 0.2)\]

- Capacity utilization: \(\psi(v_t)\) cost per unit of \(K\)

\[v = 1, \; \psi(1) = 0, \; \frac{\psi''(1)}{\psi'(1)} = \frac{\psi}{1-\psi}, \; \psi \sim B(0.6, 0.15)\]
Model 2: RBC with Real Frictions

- Investment adjustment costs

\[ K_t = (1 - \delta)K_{t-1} + \left[ 1 - s \left( \frac{I_t}{I_{t-1}} \right) \right] I_t \]

where \( s(1) = s'(1) = 0 \), and \( s''(1) = s > 0 \), \( s \sim N(6, 1.5) \).
# Model 2: RBC with Real Frictions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>∞</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Prob}(PV \frac{\Delta Y}{\Delta G} &gt; 1) )</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>( \text{Prob}(PV \frac{\Delta C}{\Delta G} &gt; 0) )</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>( \text{Prob}(PV \frac{\Delta I}{\Delta G} &gt; 0) )</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Just can’t produce big multipliers
MODEL 2: RBC WITH REAL FRICTIONS

Range of *a priori* possible outcomes
Model 2: RBC with Real Frictions

- Frictions affect very short-run multipliers
- More dispersed range of multipliers
- Agents and firms want to smooth consumption and investment
- Smaller wealth effects (agents care about $c_t, c_{t-1}$), larger substitution effects (more sensitive to price changes)
- Same policy implications
**Model 3: Sticky Price & Wage**

Add to Model 2

- Monopolistically competitive intermediate goods & labor services

\[
Y_t = \left[ \int_0^1 y_t(i) \frac{1}{1+\eta_p} di \right]^{1+\eta_p}
\]

- Price & wage stickiness à la Calvo (1983)
  
  - prob. \( 1 - \omega_p \) re-optimize
  
  - prob. \( \omega_p \) partial indexation: \( p_t = \pi_{t-1}^{\chi_p} p_{t-1} \)

- Respecify preferences appropriately
Model 3: Sticky Price & Wage

- Monetary policy via Taylor rule

\[
\hat{R}_t = \rho_r \hat{R}_{t-1} + (1 - \rho_r) \left[ \phi_\pi \hat{\pi}_t + \phi_y \hat{Y}_t \right] + \epsilon_t^r
\]
**Model 3: Sticky Price & Wage**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>$\infty$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Prob}(PV \frac{\Delta Y}{\Delta G} &gt; 1)$</td>
<td>0.35</td>
<td>0.01</td>
<td>$&lt;0.01$</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta C}{\Delta G} &gt; 0)$</td>
<td>$&lt;0.01$</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta I}{\Delta G} &gt; 0)$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Can produce modest multipliers, but consumption crowded out.
**Model 3: Sticky Price & Wage**

1. PV Multiplier: Output
2. PV Multiplier: Consumption
3. PV Multiplier: Consumption (Wealth Effect)
4. PV Multiplier: Consumption (Substitution Effect)

Blue: RBC w/ rigidities
Model 3: Sticky Price & Wage

1. PV Multiplier: Output

2. PV Multiplier: Consumption

3. PV Multiplier: Consumption (Wealth Effect)

4. PV Multiplier: Consumption (Substitution Effect)

Blue: RBC w/ rigidities; Red: Nominal rigidities
Model 3: Sticky Price & Wage

- Much larger multipliers

- Sticky prices $\Rightarrow$ firms respond to a government spending increase by increasing production rather than prices

- Positive Substitution Effect: sticky wages $\Rightarrow$ real wages often rise

- CB doesn’t raise nominal rate enough initially to keep real rate from falling

- Smaller Wealth Effect: initial real value of debt higher (than flexible-price case), requires larger fiscal adjustment
MODEL 4: NON-SAVERS

Add to Model 3

- Non-savers consume entire per period disposable income

\[ c_t^N = (1 - \tau_t^L)w_tL_t^N + Z_t^N \]

- Set wage to average of savers

- Crucial parameter: percentage of non-savers
  \[ \mu \sim B(0.3, 0.1) \]
## Model 4: Non-Savers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>$\infty$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Prob}(PV \frac{\Delta Y}{\Delta G} &gt; 1)$</td>
<td>0.88</td>
<td>0.32</td>
<td>0.07</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta C}{\Delta G} &gt; 0)$</td>
<td>0.84</td>
<td>0.46</td>
<td>0.18</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta I}{\Delta G} &gt; 0)$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>$&lt;0.01$</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Unlikely to produce small multipliers, except for investment
MODEL 4: NON-SAVERS

1. PV Multiplier: Output

2. PV Multiplier: Consumption

3. PV Multiplier: Consumption (Wealth Effect)

4. PV Multiplier: Consumption (Substitution Effect)

Blue: RBC w/ rigidities; Red: Nominal rigidities
MODEL 4: NON-SAVERS

1. PV Multiplier: Output

2. PV Multiplier: Consumption

3. PV Multiplier: Consumption (Wealth Effect)

4. PV Multiplier: Consumption (Substitution Effect)

Blue: RBC w/ rigidities; Red: Nominal rigidities; Black: Non-savers
Model 4: Non-Savers

- Much, much larger impact multipliers, similar long-run multipliers
- Intuition: nonsavers don’t save—they consume
  - reduces negative wealth effect
- The most critical parameter value
Model 5: Open Economy

Add to Model 4

- Two large symmetric countries
- $C$ and $I$ consist of domestic and imported goods
- $G$ non-traded
- Local currency pricing
# Model 5: Open Economy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>$\infty$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Prob}(PV \frac{\Delta Y}{\Delta G} &gt; 1)$</td>
<td>0.81</td>
<td>0.27</td>
<td>0.05</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta C}{\Delta G} &gt; 0)$</td>
<td>0.82</td>
<td>0.48</td>
<td>0.23</td>
<td>0.02</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta I}{\Delta G} &gt; 0)$</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Moderates large multipliers created by rule-of-thumbers
How much do multipliers vary on average due to particular parameter?

- Draw $\tilde{\theta} = [\tilde{\theta}_1 \ldots \tilde{\theta}_n]'$ from $p(\theta)$. Calculate $\tilde{\omega}|\tilde{\theta}_n$
- Let $\tilde{\theta}^i = [\tilde{\theta}_1 \ldots E[\theta_i] \ldots \tilde{\theta}_n]'$. Calculate $\tilde{\omega}^i|\tilde{\theta}^i$
- Calculate $\sqrt{\frac{\sum_{j=1}^{M} (\tilde{\omega}_j - \tilde{\omega}^i_j)^2}{M}}$
## RMSDs for NK Open Economy Model

### Impact $\frac{\Delta Y}{\Delta G}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Impact</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$, fraction of non-savers</td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>$\rho_G$, persistence of govt cons</td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>$\psi$, capital utilization</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>$\rho_r$, lagged interest rate resp.</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>$\theta_c$, habit formation</td>
<td></td>
<td>0.08</td>
</tr>
</tbody>
</table>

### $PV_\infty \frac{\Delta Y}{\Delta G}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Impact</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_G$, persistence of govt cons</td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>$\rho_r$, lagged interest rate resp.</td>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>$\omega_w$, wage stickiness</td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>$\xi$, inverse Frisch labor elast.</td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>$\phi_{\pi}$, interest rate resp. to inflation</td>
<td></td>
<td>0.05</td>
</tr>
</tbody>
</table>

Wealth effect dominates in long run
### RMSDs for NK Open Economy Model

<table>
<thead>
<tr>
<th>Impact $\frac{\Delta C}{\Delta G}$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$, fraction of non-savers</td>
<td>0.28</td>
</tr>
<tr>
<td>$\rho_G$, persistence of govt cons</td>
<td>0.16</td>
</tr>
<tr>
<td>$\theta_c$, habit formation</td>
<td>0.12</td>
</tr>
<tr>
<td>$\rho_r$, lagged interest rate resp.</td>
<td>0.12</td>
</tr>
<tr>
<td>$\gamma$, risk aversion</td>
<td>0.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$PV_\infty \frac{\Delta C}{\Delta G}$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_G$, persistence of govt cons</td>
<td>0.28</td>
</tr>
<tr>
<td>$\gamma$, risk aversion</td>
<td>0.08</td>
</tr>
<tr>
<td>$\rho_r$, lagged interest rate resp.</td>
<td>0.06</td>
</tr>
<tr>
<td>$\omega_w$, wage stickiness</td>
<td>0.06</td>
</tr>
<tr>
<td>$\xi$, inverse Frisch labor elast.</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Wealth effect dominates in long run
**Alternative MP-FP Regime**

- Multipliers depend on monetary/fiscal policy regime
  - Davig & Leeper, Christiano, Eichenbaum, & Rebelo

- Calculate multipliers for passive monetary and active fiscal policy regime
  - FP unconstrained: doesn’t control $B$ growth
  - MP stabilizes debt: $R$ adjusts less than 1-1 with $\pi$
    - MP: $\phi_\pi \sim U[0, 1]$
    - FP: $\gamma_{K,L,G,Z} \sim N(0, 0.03)$

- Higher government spending *lowers* real interest rates
## Model 5: Open Economy PM/AF

<table>
<thead>
<tr>
<th>Variable</th>
<th>Impact</th>
<th>4 qtr.</th>
<th>10 qtr.</th>
<th>25 qtr.</th>
<th>$\infty$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Prob}(PV \frac{\Delta Y}{\Delta G} &gt; 1)$</td>
<td>1.00</td>
<td>1.00</td>
<td>0.97</td>
<td>0.93</td>
<td>0.91</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta C}{\Delta G} &gt; 0)$</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
<td>0.93</td>
</tr>
<tr>
<td>$\text{Prob}(PV \frac{\Delta I}{\Delta G} &gt; 0)$</td>
<td>0.73</td>
<td>0.53</td>
<td>0.45</td>
<td>0.44</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Guarantees big multipliers across the board
MODEL 5: OPEN ECONOMY PM/AF

Total Output PV

Total Consumption PV

Wealth Consumption PV

Subst. Consumption PV

Black: AM/PF
Model 5: Open Economy PM/AF

Total Output PV

Total Consumption PV

Wealth Consumption PV

Subst. Consumption PV

Black: AM/PF; Blue: PM/AF
CONCLUSION FROM FIXED REGIME

• Many model & prior specification impose tight range on multiplier even before the models are taken to data

• Most important model features for multiplier variation:
  • persistence of government spending process
  • fraction of hand-to-mouth agents
  • monetary-fiscal policy regime

• Broader message: Prior Predictive Analysis shines light inside the DSGE black box
  • reveals joint prior distribution over objects of interest
How will results change if we allow switching between Regime $M$ and Regime $F$?
Abstract: When the zero bound on nominal interest rates is binding.
Thought Experiment

1. Standard NK model without $K$
2. Economy begins at $t = 0$ at ZLB
3. Government spending shock hits economy (for $T$ periods)
4. Economy stays at ZLB for $T$ periods
5. from 0 to $T$ economy in regime $F$ from $T$ on in regime $M$

Intuition: $\uparrow$ in $G_t \rightarrow \uparrow t$ Total Demand $\rightarrow \downarrow$ Markup$_t$ $\rightarrow \uparrow N_t$ $\rightarrow \uparrow C_t$
Two Comments

1. Government spending process and expectations

2. Existence and uniqueness of equilibria
## ARRA (2009)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimated Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorization</td>
<td>379.0</td>
<td>114.7</td>
<td>53.6</td>
<td>11.2</td>
<td>9.8</td>
<td>16.2</td>
<td>580.7</td>
</tr>
<tr>
<td>Outlays</td>
<td>120.1</td>
<td>219.3</td>
<td>126.2</td>
<td>46.2</td>
<td>30.3</td>
<td>27.9</td>
<td>575.3</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorization</td>
<td>27.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Outlays</td>
<td>2.75</td>
<td>6.875</td>
<td>5.5</td>
<td>4.125</td>
<td>3.025</td>
<td>2.75</td>
<td>27.5</td>
</tr>
</tbody>
</table>

*Billions of Dollars*

Source: CBO
Government Spending Process

Typically assume

\[ g_t = \rho g_{t-1} + \varepsilon_t \]  \hspace{1cm} (1)

Slight change

\[ g_t = \rho g_{t-1} + \varepsilon_{t-1} \]  \hspace{1cm} (2)

If agents observe \( \{\varepsilon_{t-j}\}_{j=0}^{\infty} \) then agents have foresight about future \( g \) [Ramey (2008), Leeper, Walker, Yang (2009)]

Important Expectational Effects: knowledge of \( \varepsilon_t \) is equivalent to knowledge of \( g_{t+1} \)
EXPECTATIONS

Simple Model

\[ \pi_t = \beta E_t \pi_{t+1} + \Gamma_1 Y_t - \Gamma_2 G_t \]
\[ Y_t = \Theta_1 (G_t - E_t G_{t+1}) + E_t Y_{t+1} + \Theta_2 E_t \pi_{t+1} - \Theta_2 \{\phi_1 \pi_t + \phi_2 Y_t\} \]

\[ \uparrow \text{in } G_t \rightarrow \uparrow t \text{ Total Demand} \rightarrow \downarrow \text{Markup}_t \rightarrow \uparrow N_t \rightarrow \uparrow C_t \]

\[ \frac{dY_t}{dG_t} = \frac{1}{g} \frac{\hat{Y}_t}{\hat{G}_t} = 1 + \frac{1 - g}{g} \frac{\hat{C}_t}{\hat{G}_t} \] (3)

Anticipated \[ \uparrow \text{in } G_{t+1} \rightarrow \uparrow t + 1 \text{ Total Demand} \rightarrow \downarrow \text{Markup}_{t+1} \]
\[ \rightarrow \uparrow N_{t+1} \rightarrow \uparrow C_{t+1} \]
Impulse Response I
Impulse Response II

Walker: Government Spending
IMPULSE RESPONSE III
**Present Value Multiplier**

\[
PVMultiplier(Q) = \frac{E_t \sum_{j=0}^{Q} \prod_{i=0}^{j}(1 + r_{t+i})^{-j} \Delta Y_{t+Q}}{E_t \sum_{j=0}^{Q} \prod_{i=0}^{j}(1 + r_{t+i})^{-j} \Delta G_{t+Q}}
\]

<table>
<thead>
<tr>
<th>Q</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>12</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Gov Foresight* (AR(1))</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
</tr>
<tr>
<td>Gov Foresight (ARMA)</td>
<td>0.09</td>
<td>0.78</td>
<td>1.02</td>
<td>1.05</td>
<td>1.06</td>
</tr>
</tbody>
</table>

* Differs from CER (1.05) because \( \beta = \theta_1^{-1} = 0.99 \)
Zero Bound

Experiment

\[ \pi_t = \beta(s_t) E_t \pi_{t+1} + \Gamma_1 Y_t - \Gamma_2 G_t \]

\[ Y_t = \Theta_1 (G_t - E_t G_{t+1}) + E_t Y_{t+1} + \Theta_2 E_t \pi_{t+1} - \Theta_2 \{ \phi_1(s_t) \pi_t + \phi_2 Y_t \} \]

Two states: Normal Model (NM), Zero Bound (ZB)

\[ \rightarrow \{ \beta^l > 1, \phi^l_1 = 0 \} \]

Markov Switching Determines State

\[ Pr(ZB_{t+1}|ZB_t) = p_{11}, \quad Pr(NM_{t+1}|ZB_t) = 1 - p_{11}, \]

\[ Pr(NM_{t+1}|NM_t) = p_{22}, \quad Pr(ZB_{t+1}|NM_t) = 1 - p_{22} \]
**Zero Bound**

Markov Switching Determines State (Assumptions)

\[ \Pr(ZB_{t+1}|ZB_t) = 0.8, \quad \Pr(NM_{t+1}|ZB_t) = 0.2, \]
\[ \Pr(NM_{t+1}|NM_t) = 1, \quad \Pr(ZB_{t+1}|NM_t) = 0 \]

Initial Probability \([ZB_0 = 1, NM_0 = 0]\)

To solve model, CER assume equilibrium characterized by two values for each variable and solve two separate systems.

Existence and uniqueness of equilibrium
Figure 3: Now that’s a multiplier!
Determinacy with a zero bound

\[ \pi_t = \beta(s_t) E_t \pi_{t+1} + \Gamma_1 Y_t - \Gamma_2 G_t \]

\[ Y_t = \Theta_1 (G_t - E_t G_{t+1}) + E_t Y_{t+1} + \Theta_2 E_t \pi_{t+1} - \Theta_2 \{ \phi_1(s_t) \pi_t + \phi_2 Y_t \} \]

Davig & Leeper (2007) like CER posit two processes for each variable

\[ E[\pi_{t+1} | s_t = ZB] = p_{11} E[\pi_{1t}] + p_{12} E[\pi_{2t}] \]

Cannot stay in zero bound state too long.
"Stacked System"

\[
\begin{bmatrix}
1 & 0 & -\Gamma_1 & 0 \\
0 & 1 & 0 & -\Gamma_1 \\
\Theta_2 \phi_1 & 0 & (1 + \Theta_2 \phi_2) & 0 \\
0 & \Theta_2 \phi_1 & 0 & (1 + \Theta_2 \phi_2)
\end{bmatrix}
\begin{bmatrix}
\pi_{1t} \\
\pi_{2t} \\
Y_{1t} \\
Y_{2t}
\end{bmatrix}
= \\
\begin{bmatrix}
\beta_1 p_{11} & \beta_1 p_{12} & 0 & 0 \\
0 & 0 & \beta_{p12} & \beta_{p22} \\
\Theta_2 p_{11} & \Theta_2 p_{21} & p_{11} & p_{21} \\
\Theta_2 p_{21} & \Theta_2 p_{22} & p_{21} & p_{22}
\end{bmatrix}
\begin{bmatrix}
\pi_{1t+1} \\
\pi_{2t+1} \\
Y_{1t+1} \\
Y_{2t+1}
\end{bmatrix}
+ \\
\begin{bmatrix}
-\Gamma_2 & 0 & 0 & 0 \\
0 & -\Gamma_2 & 0 & 0 \\
\Theta_1 & 0 & -\Theta_1 p_{11} & -\Theta_1 p_{12} \\
0 & \Theta_1 & -\Theta_1 p_{21} & -\Theta_1 p_{22}
\end{bmatrix}
\begin{bmatrix}
G_{1t+1} \\
G_{2t+1} \\
E_t G_{1t+1} \\
E_t G_{2t+1}
\end{bmatrix}
\]

\[
AX_t = BE_t X_{t+1} + CG_t
\]

Existence and Uniqueness = Generalized Eigenvalues of \((A, B)\)
Determinacy Regions

Benchmark Calibration

Indeterminacy

$p_{11}$
\( \kappa \) output multiplier with binding zero bound
Determinacy with a Zero Bound

LECTURE 3: FISCAL LIMITS IN ADVANCED ECONOMIES

Todd B. Walker
Indiana University

July 2012
Monash Mini-course: Monetary-Fiscal Policy Interactions
Era of Fiscal Stress

- Short-run imbalances
SHORT-RUN FISCAL STRESS

Fiscal Balance

- Emerging and developing economies
- Advanced economies
- World

Public Debt

- Advanced economies
- G7
- World
- Emerging and developing economies

 Shares of GDP. Source: IMF
ERA OF FISCAL STRESS

- Short-run imbalances
- Long-run imbalances
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook

Walker: Forecasting
# Spending Commitments to the Aged

<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>

Worldwide “Unfunded Liabilities.” Net present value of impact on fiscal deficit of aging-related spending, in percent of GDP. Source: IMF.
U.S. Fiscal Stress: Longer Run

Percentage of GDP

Baseline Scenario

Alternative Scenario

2009

2010


Walker: Forecasting
MESSAGE IN LONG-RUN PROJECTIONS

- These projections cannot happen
- Some assumptions underlying projections
  1. economies will grow out of projected deficits
  2. governments will default outright on debt
  3. fiscal policies will adjust surpluses to stabilize debt
  4. paths of inflation will turn out different from assumed
  5. some combination of the four

- 1 is too optimistic
- Europe makes clear how onerous is 2
- Most central bankers hope for 3
Prospects for Entitlements Reform

The level of public fiscal discourse in Greece

Walker: Forecasting
Prospects for Entitlements Reform

Keep Govt Out of My Medicare

Dawn Teo
Old and New Ideas: Is Fiscal Stress Unprecedented?

- Short-run problems nothing new
- The fiscal iceberg is long-run entitlements
- Aging populations imply a fresh political economy issue
  - old people vote & this is a very long-run problem
  - an “obvious” solution may be politically infeasible
  - tax resistance in U.S. at all-time high since the original Tea Party
  - early signs of trouble: Ryan’s Plan and National Commission’s plan seem D.O.A.
- At a minimum, political economy factors create great policy uncertainty
WHAT WE DO IN SERIES OF PAPERS

- Spending promises without financing plans create unresolved fiscal stress

- Raises possibility economy will hit its fiscal limit—point at which, for economic or political reasons, surpluses can no longer adjust to stabilize debt

- Many questions to address

- In the paper we use simple framework to focus narrowly on

1. How might unresolved fiscal stress affect inflation?

2. Can central banks retain control of inflation?

In talk I will extend results to more realistic framework
Recall: Monetary-Fiscal Interactions

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

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

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

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

- MP behavior completely familiar: target inflation by aggressively adjusting nominal interest rates
- FP adjusts future surpluses to cover interest plus principal on debt
- What is FP doing?
  - any shock that changes debt must create the *expectation* that future surpluses will adjust to stabilize debt’s value
  - people must believe adjustments will occur eventually
  - eliminates wealth effects from government debt
  - for MP to target inflation, fiscal expectations must be *anchored* on FP adjusting to maintain value of debt
- How firmly are expectations so anchored?
An Equilibrium Condition

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

= Expected present value primary surpluses + seigniorage

- In Regime M . . .
  - MP delivers equilibrium inflation process
  - taking inflation as given, FP must choose compatible surplus policy
  - “compatible” means: stabilizes debt
  - imposes restrictions on \( E_t PV \)
MONETARY-FISCAL INTERACTIONS

- Monetary & fiscal policy have two tasks: (1) control inflation; (2) stabilize debt
- Two different policy mixes that can accomplish these tasks
  1. Regime M: conventional assignment—MP targets inflation; FP targets real debt (called active MP/passive FP)
  2. Regime F: alternative assignment—MP maintains value of debt; FP controls inflation (called passive MP/active FP)
- Regime M: normal state of affairs
- Regime F: can arise in an era of fiscal stress
- Regime F arises in two ways
  1. Sargent & Wallace’s unpleasant monetarist arithmetic
COMMON PERCEPTION OF FISCAL INFLATION

- Arises from unpleasant arithmetic mechanism
  - hit fiscal limit; surpluses unresponsive to debt
  - seigniorage adjusts to stabilize debt

- A central banker’s take on this:

  “...the proposition is of little current relevance to the major industrial countries. This is for two reasons. First, seigniorage—financing the deficit by issuing currency rather than bonds—is very small relative to other sources of revenues. Second, over the past decade or so, governments have become increasingly committed to price stability... This sea change in the conventional wisdom about price stability leaves no room for inflation to bail out fiscal policy.”

  —Mervyn King (1995)

We agree
**Policy Separation Principle**

- A deeply ingrained misperception: CB independence & inflation targeting insulate inflation from FP

- Policies are conducted by separate institutions

- Principle underlies monetary reforms without corresponding fiscal reforms
  - assumes MP reform can force FP reform
  - we’re seeing how well that works

- System may work in normal times, but creates uncertainty or worse during fiscal stress

- Central bank models build in separation principle
  - inflation & government debt dynamics decoupled
Separation in CB Model Schematic

- Fisher relation
  \[ R_t = r_t + E_t \pi_{t+1} \]

- Government budget
  \[ \frac{B_t + M_t}{P_t} + s_t = \frac{R_{t-1}B_{t-1} + M_{t-1}}{P_t} \]

- Monetary policy
  \[ R_t - R^* = \alpha (\pi_t - \pi^*) \]

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

- MP feeds directly into inflation, but debt does not feed directly into inflation
- Yet as we see... fiscal policy can determine inflation
Misperception of Fiscal Inflation

• King reflects the common perception of fiscal inflation that is embedded in the separation principle
  • arises if and only if monetary policy monetizes deficits

• But it is a misperception that monetizing deficits is the only channel for fiscal inflation

• Let’s take direct monetization off the table and equate Regime F to the fiscal theory
UNDERMINING MONETARY CONTROL OF INFLATION

- Policy starts in Regime M: active MP/passive FP
- Agents begin to doubt necessary fiscal adjustments will be forthcoming
  - consolidation progresses in fits & starts
  - domestic politics grow more polarized
- Simplest case: people believe at future date $T$ economy hits the fiscal limit and Regime F adopted
- From $T$ on, inflation determined by fiscal expectations
  - value of debt & price level at date $T - 1$ pinned down
- Forward-looking agents bring those effects into period before the fiscal limit
**Undermining Monetary Control of Inflation**

At a known date $T$ 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>$R_t^{-1} = R^<em><em>{t-1} + \alpha \left( \frac{P</em>{t-1}}{P_t} - \frac{1}{\pi^</em>} \right)$</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>
**Undermining Monetary Control of Inflation**

At a known date $T$ economy reaches fiscal limit

<table>
<thead>
<tr>
<th>Regime 1 $t = 0, 1, \ldots, T - 1$</th>
<th>Regime 2 $t = T, T + 1, \ldots$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monetary Policy</strong></td>
<td><strong>Tax Policy</strong></td>
</tr>
<tr>
<td>$R_t^{-1} = R^<em>^{-1} + \alpha \left( \frac{P_{t-1}}{P_t} - \frac{1}{\pi^</em>} \right)$</td>
<td>$\tau_t = \tau^* + \gamma \left( \frac{B_{t-1}}{P_{t-1}} - b^* \right)$</td>
</tr>
<tr>
<td>$R_t^{-1} = R^*^{-1}$</td>
<td>$\tau_t = \tau^{\text{max}}$</td>
</tr>
</tbody>
</table>

Walker: Forecasting
UNDERMINING MONETARY CONTROL OF INFLATION

• What happens before the fiscal limit?
  • Regime M policies do not determine inflation
  • Ricardian equivalence breaks down
  • Lower expected surpluses reduce debt-output
  • Regime M MP destabilizes expected inflation
    • leaning against inflation raises interest on debt, wealth, future inflation

• Messages:
  1. Price level determined by beliefs about policy in the long run
  2. Inappropriate or uncertain FP makes MP unable to anchor inflation expectations

• All this generalizes to more plausible scenarios
FULL-BLOWN MODEL

• Standard DSGE model: capital accumulation, sticky prices, distorting taxation

• Government announces path of *promised* transfers

• Government debt and taxes grow until the economy hits fiscal limit

• Specify a set of policies that stabilize debt after fiscal limit

• Multiple layers of policy uncertainty
Households and Firms

- An infinitely lived representative household chooses \( \{C_t, N_t, M_t, B_t, K_t\} \) to maximize

\[
E_t \sum_{i=0}^{\infty} \beta^i \left[ \frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\eta}}{1+\eta} + \nu \frac{(M_t+i/P_{t+i})^{1-\kappa}}{1-\kappa} \right]
\]

- Household’s budget constraint is

\[
C_t + K_t + \frac{B_t}{P_t} + \frac{M_t}{P_t} \leq (1 - \tau_t) \left( \frac{W_t}{P_t} N_t + R_t^k K_{t-1} \right)
\]

\[
\quad \quad + (1 - \delta) K_{t-1} + \frac{R_{t-1} B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} + \lambda_t z_t + \frac{D_t}{P_t}
\]

- Firms set prices as a markup over marginal costs (Rotemberg costly adjustment)
Uncertainty Over Future Financing

- \( \lambda_t \) denotes the fraction of promised transfers paid to the household
- \( \lambda_t \in (0, 1) \) denotes reneging by the government
- Households know the process for promised transfers and possible future financing options
  1. Renege on transfers
  2. Distorting taxation, subject to the fiscal limit
  3. Sacrifice inflation target
- Households know probability distribution over policies
- Household choose the amount of nominal bonds and capital such that their expected real returns are equal
Firms

- Intermediate goods producing firms rent labor and non-firm specific capital from households
  - Firms set prices as a markup over marginal costs, subject to a Rotemberg cost of adjustment
- A perfectly competitive final goods producing firm bundles the intermediate goods using a CRS technology
**Initial Period: Stationary Transfers**

**MP:** \[ R_t = R^* + \alpha (\pi_t - \pi^*), \quad \alpha > 1/\beta \]

**FP:** \[ \tau_t = \tau^* + \gamma (b_{t-1}/Y_{t-1} - b^*), \quad \gamma > r \]

**Transfers:** \[ z_t = (1 - \rho_z)z^* + \rho_z z_{t-1} + \varepsilon_t \]
Non-Stationary *Promised Transfers*

**MP:** $R_t = R^* + \alpha(\pi_t - \pi^*), \quad \alpha > 1/\beta$

**FP:** $\tau_t = \tau^* + \gamma(b_{t-1}/Y_{t-1} - b^*), \quad \gamma > r$

**Transfers:** $z_t = \mu z_{t-1} + \varepsilon_t, \quad \mu > 1$
U.S. “Unfunded Liabilities”

Source: CBO Long-Term Budget Outlook

Walker: Forecasting
**NON-STATIONARY Promised TRANSFERS**

**MP:**
\[ R_t = R^* + \alpha(\pi_t - \pi^*), \quad \alpha > 1/\beta \]

**FP:**
\[ \tau_t = \tau^* + \gamma\left(\frac{b_{t-1}}{Y_{t-1}} - b^*\right), \quad \gamma > r \]

**Transfers:**
\[ z_t = \mu z_{t-1} + \varepsilon_t, \quad \mu > 1 \]
FP: \( \tau_t = \tau^{\text{max}} \)

\[
P_{L,t} = \frac{\exp(\eta_0 + \eta_1 (\tau_{t-1} - \tau^*))}{1 + \exp(\eta_0 + \eta_1 (\tau_{t-1} - \tau^*))}
\]
FISCAL LIMIT: REGIME 1 AM/AF/PT

MP: $R_t = R^* + \alpha (\pi_t - \pi^*), \quad \alpha > 1/\beta$

FP: $\tau_t = \tau^{max}$

Transfers: $\lambda_t z_t = \lambda_t \mu z_{t-1} + \lambda_t \varepsilon_t$

$q = 0.5$

Regime 1
**Fiscal Limit: Regime 2 PM/AF/AT**

**MP:** $R_t = R^*$

**FP:** $\tau_t = \tau^{max}$

**Transfers:** $z_t = \mu z_{t-1} + \varepsilon_t$

$1 - q = 0.5$

Regime 2

Regime 1
Fiscal Limit: Switch Between Regimes

MP: \[ R_t = \begin{cases} R^* + \alpha (\pi_t - \pi^*), & \alpha > 1/\beta \\ R^* \end{cases} \]

FP: \[ \tau_t = \tau^{max} \]

Transfers: \[ z_t = \begin{cases} \lambda_t \mu z_{t-1} + \lambda_t \epsilon_t \\ \mu z_{t-1} + \epsilon_t \end{cases} \]

Regime 2

Regime 1

1 \(-p_{11} \)

1 \(-p_{22} \)
Pre-Limit as Transfers Grow

- Dominant forces are rising debt and taxes
- Rising tax rates discourage labor effort and reduce consumption
- Inflection point in dynamics arises at limit, $\tau_{max}$
- Capital falls when $\tau_t < \tau_{max}$, then rises when $\tau_t > \tau_{max}$, in expectation of a future reduction in tax rates.
Conditional on *not* triggering fiscal limit
**Post-Limit Reneging** ($\lambda_t \in (0, 1)$)

- Monetary policy is active, but can’t stabilize inflation
- Agents believe can return to regime without reneging, but with passive monetary policy $\Rightarrow E_t \pi_{t+k}$ rises while $R_t$ falls in response to drop in $\pi_t$
**Post-Limit Reneging** ($\lambda_t \in (0, 1)$)

- Low real rates reduce savings & increase consumption
- Capital stock declines

![Graph showing capital stock and ex-ante real rate over time](image)
Range of possible outcomes for macro variables due to uncertainty about future policy. Dashed blue lines are 25th and 75th percentile bands; solid red lines are 10th and 90th percentile bands.
LONG-TERM INFLATION EXPECTATIONS

• Survey-based measures of long-term inflation expectations are typically reported as the average rate of annual inflation over the next 10 years (e.g. SPF)

• Such measures have remained stable in the U.S. despite dire fiscal consequences

• Can we rationalize the stability of these expectations within our framework?
INFLATION HAS A FAT TAIL

Left scale: average paths of inflation (solid red line) and 10-year-ahead expected inflation (dashed red line); Right scale: average paths of inflation (solid black line) and 10-year-ahead expected inflation from 0.5 percent tail of distribution (dashed black line)
LONG-TERM INFLATION EXPECTATIONS

- We run 10,000 model simulations and compute the average inflation rate over a 10-year horizon

- Differences in simulations rest with when the fiscal limit is hit and which policy regime is realized at the fiscal limit
LONG-TERM INFLATION EXPECTATIONS

- The upward drift in expectations is not dramatic and in a real-time policy setting, it would be hard to attribute such drift to fiscal policy

- Policymakers are likely to down weight the probability of a tail outcome...

  ...self-fulfilling prophesy?

- The worst-case scenarios are very low-probability events, but still influence trend inflation (i.e. a ‘peso’ problem)
The Right-Tail of Inflation Outcomes

- The average of the highest .005 percent of outcomes for each time period

![Graph showing inflation and debt-output ratio over time with fiscal limit indicated.]

**Fiscal Limit = 2037**
The Right-Tail of Inflation Outcomes

- The average of the highest .005 percent of outcomes for each time period
THE RIGHT-TAIL OF INFLATION OUTCOMES

- The average of the highest .005 percent of outcomes for each time period

![Graphs showing inflation and debt-output ratio from 2010 to 2060. The fiscal limit is marked as 2047.](image-url)
The Right-Tail of Inflation Outcomes

- The average of the highest .005 percent of outcomes for each time period

![Graph of inflation and debt-output ratio over time with fiscal limit marked as 2052.](image-url)
The Left-Tail of Transfer Outcomes

- Looking at the left tail (i.e., the lowest) of the transfer distribution shows reneging could begin as soon as 2013
  - Transfers are fully reneged on in 2054

- Large-scale reneging allows the monetary authority to target inflation
  - This is essentially the standard world with lump-sum taxation and active monetary policy

- Policymakers face a tradeoff between reneging and tail inflation
THE LEFT-TAIL OF TRANSFER OUTCOMES

- The average of the lowest .005 percent of outcomes for each time period
CALIBRATING YOUR OWN $\lambda_t$
**Take Aways**

1. Conventional perceptions of inflation miss a channel for fiscal inflation
   - channel may be important in times of fiscal stress
2. Separation of M & FP maintains assumption that fiscal surpluses stabilize debt
   - when fiscal limit possible, assumption breaks down
3. Tenuously anchored fiscal expectations threaten ability of MP to control inflation
   - tenuous anchoring exposes economy to fluctuations caused by fiscal news
4. Existing monetary-fiscal frameworks largely silent on how tensions get resolved
   - policy uncertainty needs resolution before the big fiscal stress hits