Generalized stability of monetary unions under regime switching in monetary and fiscal policies

Dennis Bonam\textsuperscript{1} and Bart Hobijn\textsuperscript{2}

\textsuperscript{1}De Nederlandsche Bank
\textsuperscript{2}W.P. Carey School of Business, Arizona State University

20th Central Bank Macroeconomic Modeling Workshop
Banque de France, 16 November 2017

The views expressed do not necessarily reflect the official position of De Nederlandsche Bank or the Eurosystem.
Macro stability: a joint monetary-fiscal effort

- Leeper (1991): to ensure a unique and stable equilibrium...
  - ...monetary policy must “actively” target inflation...
  - ...and fiscal policy must “passively” target debt

- Bergin (2000): Leeper/FTPL result applies to monetary union
  - Single CB ensures determinacy by targeting union-wide inflation
  - Fiscal authorities of all member states must ensure fiscal solvency
  - Failure to do so by one fiscal authority already leads to instability
  - Under FTPL, only one budget constraint determines price level
Macro stability: a joint monetary-fiscal effort

- Leeper (1991): to ensure a unique and stable equilibrium...
  - ...monetary policy must “actively” target inflation...
  - ...and fiscal policy must “passively” target debt
  - If fiscal policy active, monetary policy must be passive
    (Fiscal Theory of the Price Level, FTPL; Sims, 1994; Woodford, 1998)

- Bergin (2000): Leeper/FTPL result applies to monetary union
  - Single CB ensures determinacy by targeting union-wide inflation
  - Fiscal authorities of all member states must ensure fiscal solvency
  - Failure to do so by one fiscal authority already leads to instability
  - Under FTPL, only one budget constraint determines price level
Macro stability: a joint monetary-fiscal effort

- **Leeper (1991):** to ensure a unique and stable equilibrium...
  - ...monetary policy must “actively” target inflation...
  - ...and fiscal policy must “passively” target debt
  - If fiscal policy active, monetary policy must be passive
    (Fiscal Theory of the Price Level, FTPL; Sims, 1994; Woodford, 1998)

- **Bergin (2000):** Leeper/FTPL result applies to monetary union
  - Single CB ensures determinacy by targeting union-wide inflation
  - Fiscal authorities of *all* member states must ensure fiscal solvency
  - Failure to do so by *one* fiscal authority already leads to instability
  - Under FTPL, only *one* budget constraint determines price level
These stability requirements have some issues

- **Policy-mix assumed to be time invariant**
  - But, broad empirical support for changes in policy regimes
    (Favero and Monacelli, 2005; Davig and Leeper, 2006, 2011; Chen et al., 2015; Bianchi and Ilut, 2017)
  - Also, regime switching may expand feasible set of policies
    (Davig and Leeper, 2007; Ascari et al., 2017)

- If member states abandon debt target, monetary union unstable
  - But, under monetary union, no national control over monetary policy
  - Must rely on national fiscal policy to absorb country-specific shocks
  - May require shifts from debt stabilization towards macro stabilization
These stability requirements have some issues

- Policy-mix assumed to be time invariant
  - But, broad empirical support for changes in policy regimes
    (Favero and Monacelli, 2005; Davig and Leeper, 2006, 2011; Chen et al., 2015; Bianchi and Illut, 2017)
  - Also, regime switching may expand feasible set of policies
    (Davig and Leeper, 2007; Ascari et al., 2017)

- If member states abandon debt target, monetary union unstable
  - But, under monetary union, no national control over monetary policy
  - Must rely on national fiscal policy to absorb country-specific shocks
  - May require shifts from debt stabilization towards macro stabilization
What we do in this paper

- Consider simple model for two-country monetary union
- Allow for regime switching in monetary and fiscal policies
- Focus particularly on temporary visits to ‘unstable’ regime
- How to allow for such visits, without threatening stability?
What we do in this paper

- Consider simple model for two-country monetary union
- Allow for regime switching in monetary and fiscal policies
- Focus particularly on temporary visits to ‘unstable’ regime
- How to allow for such visits, without threatening stability?
What we do in this paper

- Consider simple model for two-country monetary union
- Allow for regime switching in monetary and fiscal policies
- Focus particularly on temporary visits to ‘unstable’ regime
- How to allow for such visits, without threatening stability?
What we do in this paper

- Consider simple model for two-country monetary union
- Allow for regime switching in monetary and fiscal policies
- Focus particularly on temporary visits to ‘unstable’ regime
- How to allow for such visits, without threatening stability?
Temporary visits to ‘unstable’ regime possible

- **Future austerity** allows for occasional loosening of debt target
  - More (frequent) binge spending today requires more austerity tomorrow

- Bailouts by partner states also support such visits
  - Necessarily entail transfer of wealth across member states
Temporary visits to ‘unstable’ regime possible

- **Future austerity** allows for occasional loosening of debt target
  - More (frequent) binge spending today requires more austerity tomorrow
- **Temporary visits also supported by debt devaluation**
  - Requires monetary policy to temporarily abandon inflation target
  - Similar to results from Fiscal Theory of the Price Level
  - Dynamically, entail greater bouts of union-wide inflation
Temporary visits to ‘unstable’ regime possible

- **Future austerity** allows for occasional loosening of debt target
  - More (frequent) binge spending today requires more austerity tomorrow

- **Temporary visits also supported by debt devaluation**
  - Requires monetary policy to temporarily abandon inflation target
  - Similar to results from Fiscal Theory of the Price Level
  - Dynamically, entail greater bouts of union-wide inflation

- **Bailouts by partner states** also support such visits
  - Necessarily entail transfer of wealth across member states
The model
Overview of the model

- Two-country monetary union
- Endowment economy
- Supranational central bank (inflation target)
- Each country:
  - Fiscal authority (debt target)
  - Households (maximize utility)
- Regime switching in monetary and fiscal policy
Characterizing monetary policy

- Monetary policy rule:

\[
\frac{R_t}{R} = \left( \frac{\pi_t}{\pi} \right)^{\phi_{\pi,t}}
\]

with \( R_t \) gross nominal interest rate, \( \pi_t \) union-wide gross inflation

Active monetary policy:

- \( \phi_{\pi,t} > 1 \)

Passive monetary policy:

- \( \phi_{\pi,t} \leq 1 \)

Policy parameters may vary across regimes, indexed by \( s_t \)
Characterizing monetary policy

- Monetary policy rule:
  \[
  \frac{R_t}{R} = \left( \frac{\pi_t}{\pi} \right)^{\phi_{\pi,s_t}} \tag{1}
  \]
  with \( R_t \) gross nominal interest rate, \( \pi_t \) union-wide gross inflation

- Active monetary policy: \( \phi_{\pi,s_t} > 1 \)

- Passive monetary policy: \( \phi_{\pi,s_t} \leq 1 \)
Characterizing monetary policy

- Monetary policy rule:
  \[
  \frac{R_t}{R} = \left( \frac{\pi_t}{\pi} \right)^{\phi_{\pi,s_t}}
  \]
  \hspace{1cm} (1)

  with \( R_t \) gross nominal interest rate, \( \pi_t \) union-wide gross inflation

- **Active monetary policy**: \( \phi_{\pi,s_t} > 1 \)

- **Passive monetary policy**: \( \phi_{\pi,s_t} \leq 1 \)

- Policy parameters may vary across regimes, indexed by \( s_t \)
Characterizing fiscal policy

Fiscal policy rule in country $i \in \{1, 2\}$:

$$\tau_{i,t} = \phi_{b_{i,s}} (b_{i,t-1} - b_i) + z_{\tau_{i,t}}$$  \hspace{1cm} (2)

with $\tau_{i,t}$ lump-sum taxes, $b_{i,t}$ real debt, $z_{\tau_{i,t}}$ fiscal policy shock.
Characterizing fiscal policy

- Fiscal policy rule in country $i \in \{1, 2\}$:
  \[
  \tau_{i,t} = \phi_{b_i,s_t} (b_{i,t-1} - b_i) + z_{\tau_{i,t}}
  \]  
  \[ (2) \]
  with $\tau_{i,t}$ lump-sum taxes, $b_{i,t}$ real debt, $z_{\tau_{i,t}}$ fiscal policy shock

- Passive fiscal policy: $\phi_{b_i,s_t} > r$, with $r$ real interest rate

- Active fiscal policy: $\phi_{b_i,s_t} \leq r$
Characterizing fiscal policy

- Fiscal policy rule in country $i \in \{1, 2\}$:

$$\tau_{i,t} = \phi_{b_{i,t},s_t} (b_{i,t-1} - b_i) + z_{\tau_{i,t}}$$  \hspace{1cm} (2)

with $\tau_{i,t}$ lump-sum taxes, $b_{i,t}$ real debt, $z_{\tau_{i,t}}$ fiscal policy shock

- Passive fiscal policy: $\phi_{b_{i,t},s_t} > r$, with $r$ real interest rate

- Active fiscal policy: $\phi_{b_{i,t},s_t} \leq r$

- Fiscal policy in country 2 always passive ($\phi_{b_{2,t},s_t} > r$, $\forall s_t$)
Government budget constraints and bailouts

- Evolution of government debt in country 1:

\[ b_{1,t} = (1 - \gamma_{st}) \frac{R_{t-1}}{\pi_t} b_{1,t-1} - (\tau_{1,t} - g_{1,t}) \]  

(3)

with \( g_{1,t} \) real government consumption
Government budget constraints and bailouts

- Evolution of government debt in country 1:

\[ b_{1,t} = (1 - \gamma_{st}) \frac{R_{t-1}}{\pi_t} b_{1,t-1} - (\tau_{1,t} - g_{1,t}) \]  

(3)

with \( g_{1,t} \) real government consumption

- State-dependent bailout fraction, \( \gamma_{st} \), determined by

\[ \gamma_{st} = \left( \frac{b_{1,t-1}}{b_1} \right)^{\phi_{\gamma, st}} - 1 \]  

(4)

with \( \phi_{\gamma, st} \) bailout elasticity
Government budget constraints and bailouts

- Evolution of government debt in country 1:

\[ b_{1,t} = (1 - \gamma_{st}) \frac{R_{t-1}}{\pi_t} b_{1,t-1} - (\tau_{1,t} - g_{1,t}) \]  

with \( g_{1,t} \) real government consumption

- State-dependent bailout fraction, \( \gamma_{st} \), determined by

\[ \gamma_{st} = \left( \frac{b_{1,t-1}}{b_1} \right)^{\phi_{\gamma, st}} - 1 \]  

with \( \phi_{\gamma, st} \) bailout elasticity

- Evolution of government debt in country 2:

\[ b_{2,t} = \frac{R_{t-1}}{\pi_t} b_{2,t-1} - \left( \tau_{2,t} - g_{2,t} - \gamma_{st} \frac{R_{t-1}}{\pi_t} B_{1,t-1} \right) \]
Households

- Infinitely-lived households choose consumption, $c_{i,t}$, to maximize

$$E_t \sum_{t=0}^{\infty} \beta^t \log c_{i,t}$$

with $\beta \in (0, 1)$ discount factor, subject to

$$c_{i,t} + b_{i,t} + \tau_{i,t} = \frac{R_{t-1}}{\pi_t} b_{i,t-1} + y_i$$

with $y_i$ constant endowment

- Consumption Euler equation:

$$\frac{1}{c_{i,t}} = \beta R_t E_t \left[ \frac{1}{\pi_{t+1}} - \frac{1}{c_{i,t+1}} \right]$$
Resource constraint

- For simplicity, assume $g_{i,t} = g_i$ for all $t$
- Perfect substitutability and tradability of $y_i$ then implies

$$c_{1,t} + c_{2,t} + g_1 + g_2 = y_1 + y_2$$

(9)

- Aggregate consumption constant: increase in consumption in one country comes at cost of lower consumption in other country
Policy regimes and regime switches
The four regimes we consider

1. **Unstable:**
   - Active monetary policy ($\phi_{\pi}, u > 1$), active fiscal policy ($\phi_{b_1}, u \leq r$)

2. **Ricardian:**
   - Active monetary policy ($\phi_{\pi}, R > 1$), passive fiscal policy ($\phi_{b_1}, R > r$)

3. **Fiscal Theory of the Price Level:**
   - Passive monetary policy ($\phi_{\pi}, F \leq 1$), active fiscal policy ($\phi_{b_1}, F \leq r$)

4. **Bailout:**
   - Active monetary policy ($\phi_{\pi}, B > 1$), active fiscal policy ($\phi_{b_1}, B \leq r$), positive bailouts ($\phi_{\gamma}, B > 0$)
The four regimes we consider

1. **Unstable:**
   - Active monetary policy \( \phi_{\pi,U} > 1 \), active fiscal policy \( \phi_{b_1,U} \leq r \)

2. **Ricardian:**
   - Active monetary policy \( \phi_{\pi,R} > 1 \), passive fiscal policy \( \phi_{b_1,R} > r \)

3. **Fiscal Theory of the Price Level:**
   - Passive monetary policy \( \phi_{\pi,F} \leq 1 \), active fiscal policy \( \phi_{b_1,F} \leq r \)

4. **Bailout:**
   - Active monetary policy \( \phi_{\pi,B} > 1 \), active fiscal policy \( \phi_{b_1,B} \leq r \), positive bailouts \( \phi_{\gamma,B} > 0 \)
The four regimes we consider

1. **Unstable:**
   - Active monetary policy \((\phi_{\pi, U} > 1)\), active fiscal policy \((\phi_{b1, U} \leq r)\)

2. **Ricardian:**
   - Active monetary policy \((\phi_{\pi, R} > 1)\), passive fiscal policy \((\phi_{b1, R} > r)\)

3. **Fiscal Theory of the Price Level:**
   - Passive monetary policy \((\phi_{\pi, F} \leq 1)\), active fiscal policy \((\phi_{b1, F} \leq r)\)

4. **Bailout:**
   - Active monetary policy \((\phi_{\pi, B} > 1)\), active fiscal policy \((\phi_{b1, B} \leq r)\), positive bailouts \((\phi_{\gamma, B} > 0)\)
The four regimes we consider

1. **Unstable:**
   - Active monetary policy \( (\phi_{\pi,U} > 1) \), active fiscal policy \( (\phi_{b_1,U} \leq r) \)

2. **Ricardian:**
   - Active monetary policy \( (\phi_{\pi,R} > 1) \), passive fiscal policy \( (\phi_{b_1,R} > r) \)

3. **Fiscal Theory of the Price Level:**
   - Passive monetary policy \( (\phi_{\pi,F} \leq 1) \), active fiscal policy \( (\phi_{b_1,F} \leq r) \)

4. **Bailout:**
   - Active monetary policy \( (\phi_{\pi,B} > 1) \), active fiscal policy \( (\phi_{b_1,B} \leq r) \), positive bailouts \( (\phi_{\gamma,B} > 0) \)
The four regimes we consider

1. **Unstable ***our baseline***:**
   - Active monetary policy ($\phi_{\pi, U} > 1$), active fiscal policy ($\phi_{b_1, U} \leq r$)

2. **Ricardian:**
   - Active monetary policy ($\phi_{\pi, R} > 1$), passive fiscal policy ($\phi_{b_1, R} > r$)

3. **Fiscal Theory of the Price Level:**
   - Passive monetary policy ($\phi_{\pi, F} \leq 1$), active fiscal policy ($\phi_{b_1, F} \leq r$)

4. **Bailout:**
   - Active monetary policy ($\phi_{\pi, B} > 1$), active fiscal policy ($\phi_{b_1, B} \leq r$), positive bailouts ($\phi_{\gamma, B} > 0$)

- Switching occurs only between **U** and one other regime
Regime transitions

- Switching occurs only between $\mathbf{U}$ and one other regime
- Transition matrix given by

$$
P = \begin{bmatrix}
    p_{UU} & p_{Us} \\
p_{s_{t-1}U} & p_{s_{t-1}s_t}
\end{bmatrix}, \quad s_t \in \{R, F, B\}
$$

with $p_{UU} + p_{Us} = p_{s_{t-1}U} + p_{s_{t-1}s_t} = 1$

- We consider various fractions of time spent at $\mathbf{U}$, denoted by

$$
f_U = \frac{1}{1 + \frac{p_{Us}}{p_{s_{t-1}U}}}
$$
Three illustrative examples

Fiscal policy in country 1

<table>
<thead>
<tr>
<th>Monetary policy</th>
<th>Fiscal policy</th>
<th>Gets bailed out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive</td>
<td>Active</td>
<td>Unstable</td>
</tr>
<tr>
<td>Active</td>
<td>Passive</td>
<td>Indeterminate</td>
</tr>
</tbody>
</table>

Examples:
I. Fiscal austerity
II. Debt devaluation
III. Fiscal transfers through bailouts

Note:
- Denotes immediate return.

Ricardian Fiscal Theory of P
Results
Strategy

- Keep unstable regime as our baseline, for different $\phi_{b_1,U} \in [0, r]$.
- Consider various fractions of time spent at $U$, $f_U$.
- What policies in other regimes ($R$, $F$, $B$) can support visits to $U$?
Strategy

- Keep Unstable regime as our baseline, for different $\phi_{b_1, U} \in [0, r]$
- Consider various fractions of time spent at $U, f_U$
- What policies in other regimes ($R, F, B$) can support visits to $U$?
Strategy

- Keep $\mathbf{U}$nstable regime as our baseline, for different $\phi_{b_1,u} \in [0, r]$
- Consider various fractions of time spent at $\mathbf{U}$, $f_U$
- What policies in other regimes ($\mathbf{R}$, $\mathbf{F}$, $\mathbf{B}$) can support visits to $\mathbf{U}$?
Strategy

- Keep unstable regime as our baseline, for different $\phi_{b_1, U} \in [0, r]$
- Consider various fractions of time spent at $U$, $f_U$
- What policies in other regimes ($R$, $F$, $B$) can support visits to $U$?

▶ See benchmark calibration
Example 1: regime-switching fiscal policy

Note: white = no stable equilibrium; gray: stable equilibrium.
Ricardian Equivalence holds

Responses to tax cut in country 1

Notes: Shock occurs in regime $U$; switching between regimes $U$ and $R$; IRFs show log-deviations from steady state.
Example 2: regime-switching monetary policy

Note: white = no stable equilibrium; gray: stable equilibrium.
Debt devaluation in country 1

Responses to tax cut in country 1

Notes: Shock occurs in regime U; switching between regimes U and F; IRFs show log-deviations from steady state.
Example 3: regime-switching fiscal bailouts

Note: white = no stable equilibrium; gray: stable equilibrium.
Fiscal transfers to country 1

Responses to tax cut in country 1

Notes: Shock occurs in regime \( U \); switching between regimes \( U \) and \( B \); IRFs show log-deviations from steady state.
Conclusions

- Monetary unions with active monetary and fiscal policies can be stable.
- Two fiscal relieve valves: pay off debt of country 1 by...
  - ...taxpayers in country 1 through fiscal austerity
  - ...taxpayers in other member states through fiscal bailout
- Monetary relieve valve:
  - Required monetary passiveness independent of fiscal activeness
  - Only regime transition probability matters
- Results allow for dynamic analysis when shocks occur in $U$
  - Dynamic responses of economy sensitive to expected future regimes
Conclusions

- Monetary unions with active monetary and fiscal policies can be stable
- **Two fiscal relieve valves:** pay off debt of country 1 by...
  - ...taxpayers in country 1 through fiscal austerity
  - ...taxpayers in other member states through fiscal bailout
- **Monetary relieve valve:**
  - Required monetary passiveness independent of fiscal activeness
  - Only regime transition probability matters
- **Results allow for dynamic analysis when shocks occur in** $U$
  - Dynamic responses of economy sensitive to expected future regimes
Conclusions

- Monetary unions with active monetary and fiscal policies can be stable
- Two fiscal relieve valves: pay off debt of country 1 by...
  - ...taxpayers in country 1 through fiscal austerity
  - ...taxpayers in other member states through fiscal bailout
- Monetary relieve valve:
  - Required monetary passiveness independent of fiscal activeness
  - Only regime transition probability matters
- Results allow for dynamic analysis when shocks occur in $U$
  - Dynamic responses of economy sensitive to expected future regimes
Conclusions

- Monetary unions with active monetary and fiscal policies can be stable

- Two fiscal relieve valves: pay off debt of country 1 by...
  - ...taxpayers in country 1 through fiscal austerity
  - ...taxpayers in other member states through fiscal bailout

- Monetary relieve valve:
  - Required monetary passiveness independent of fiscal activeness
  - Only regime transition probability matters

- Results allow for dynamic analysis when shocks occur in U
  - Dynamic responses of economy sensitive to expected future regimes
Reference slides
## Benchmark calibration

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$ Discount factor</td>
<td>0.99</td>
<td>4 percent annual real interest rate</td>
</tr>
<tr>
<td>$\rho_{\tau}$ Tax-smoothing parameter</td>
<td>0.9</td>
<td>High persistence of tax shocks</td>
</tr>
<tr>
<td>$b_i$ Steady-state debt ratio</td>
<td>2.4</td>
<td>60 percent annualized debt ratio</td>
</tr>
<tr>
<td>$y_i$ Output levels</td>
<td>0.5</td>
<td>Monetary union of “equals”</td>
</tr>
<tr>
<td>$g_i$ Steady-state public spending ratio</td>
<td>0.2</td>
<td>Long-run OECD average</td>
</tr>
<tr>
<td>$\phi_{\pi,s_t}$ Monetary policy stance ($s_t \neq F$)</td>
<td>1.5</td>
<td>Ensures active monetary policy</td>
</tr>
<tr>
<td>$\phi_{b_2}$ Fiscal policy stance country 2</td>
<td>0.02</td>
<td>Ensures passive fiscal policy</td>
</tr>
</tbody>
</table>