Coordination and Crisis in Monetary Unions

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Introduction

Currency union

- Common monetary policy
- Decentralized fiscal policy

Much studied
- Stabilization policy, potential for conflict

Under studied
- Heterogenous debt levels
- Lack of commitment

Question
- Implications for debt dynamics and self-fulfilling debt crises?
- Potential for conflict, optimal currency area
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- Potential for conflict, optimal currency area
Results

Fiscal externality in a monetary union
- Excessive debt and inflation
- Case for debt ceilings
- Lack of coordination and lack of commitment
Results

Decision to join monetary union for high-debt country

- Classic argument: Join union with greatest credibility to keep inflation low
  - Union with low average debt
    - Roll-over debt at low interest rates
    - Low inflation.
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Decision to join monetary union for high-debt country

- Classic argument: Join union with greatest credibility to keeping inflation low
  - Union with low average debt
    - Roll-over debt at low interest rates
    - Low inflation.

- With Roll-over risk: Join union with intermediate credibility to keeping inflation low
  - Union with intermediate average debt
    - Deliver low inflation in good times
    - Act as lender of last resort in crises
    - Reduce vulnerability to self-fulfilling crises.
Results

Institutional design of monetary policy

- Limited commitment
  - Appoint a conservative central banker (Rogoff QJE 1985)
Results

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- Limited commitment
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  - Here, preference of central banker endogenously impacted . . .
Institutional design of monetary policy

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  - Appoint a conservative central banker (Rogoff QJE 1985)
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    - through debt composition of union
Literature Review

- Optimal currency areas

- Debt ceilings
  - Chari and Kehoe (2007)
  - Cooper, Kempf and Peled (2009, 2010): monetary bailout in the presence of regional debt

- Fiscal and monetary policy in a MU
  - Gali and Monacelli (2008) (stabilization on a peg)
  - Farhi and Werning (2012) (Fiscal Unions)
Road Map

- No roll-over risk
  - Fiscal externality
Road Map

- No roll-over risk
  - Fiscal externality

- Roll-over risk
  - Conflicts in presence of roll-over risk
Environment

- Continuum of SOE
- Time is continuous
- Fiscal policy determined at the country level
- Constant endowment economy, \( y_i = y \)
- Monetary policy chosen by single monetary authority

\[
P_t = P(t) = P(0)e^{\int_0^t \pi(t) dt}
\]

- Risk neutral lenders, outside option \( r^* \)
No Roll-over Risk

Fiscal Authority’s Problem

\[ V(b, b) = \max_{c(t)} \int_0^\infty e^{-\rho t} \left( u(c(t)) - \psi_0 \pi(b(t)) \right) dt \]

\[ \dot{b}(t) = c(t) - y + (r(b(t)) - \pi(b(t))) b(t) \]

\[ V(b, b) \geq \underline{V} \]

- Choose \( c(t) \) given schedules \( \{\pi(b(t)), r(b(t)), \tilde{C}(b(t))\} \)
- \( \pi \in [0, \bar{\pi}] \)
No Roll-over Risk

Fiscal Authority’s Problem

\[
V(b, \dot{b}) = \max_{c(t)} \int_{0}^{\infty} e^{-\rho t} (u(c(t)) - \psi_0 \pi(b(t))) \, dt
\]

\[
\dot{b}(t) = c(t) - y + (r(b(t)) - \pi(b(t))) b(t)
\]

\[
V(b, \dot{b}) \geq V
\]

- Choose \(c(t)\) given schedules \(\{\pi(b(t)), r(b(t)), \tilde{C}(b(t))\}\)
- \(\pi \in [0, \bar{\pi}]\)
- Default payoff

\[
\bar{V} = \frac{u((1 - \chi)y)}{\rho} - \int_{0}^{\infty} e^{-\rho t} \psi(\pi(t)) \, dt.
\]
No Roll-over Risk

Monetary Authority’s Problem

\[ J(b) = \int_{0}^{\infty} e^{-\rho t} \left( \int_{i} u(C_i(b_i(t), b(t))) \, di - \psi_0 \pi(t) \right) \, dt \]

\[ \dot{b}(t) = C(b_i(t), b(t)) + (r(b(t)) - \pi(t))b_i(t) - y \]

- Choose \( \pi(t) \), given schedules \( \{ r(b(t)), C(b_i(t), b(t)) \} \)
No Roll-over Risk

Monetary Authority’s Problem

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- Choose \( \pi(t) \), given schedules \( \{r(b(t)), C(b_i(t), b(t))\} \)

Risk Neutral Lenders

\[ r(b) - \Pi(b) = r^* = \rho \]

Solve for symmetric recursive competitive equilibrium
No Roll-over Risk: Fiscal Authority

- Simple consumption-saving problem

\[
\max_{c(t)} \int_0^\infty e^{-\rho t} u(c(t)) dt,
\]

subject to \( \dot{b}(t) = c(t) - y + \rho b(t). \)

- \( C(b, b) = y - \rho b, \dot{b}(t) = 0. \)
No Roll-over Risk: Fiscal Authority

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subject to \( \dot{b}(t) = c(t) - y + \rho b(t). \)

- \( C(b, b) = y - \rho b, \dot{b}(t) = 0. \)

- Max sustainable debt

\[ V(b, b) \geq V \]

\[ \Rightarrow \]

\[ b \leq \frac{\chi y}{\rho}. \]
No Roll-over Risk: Monetary Authority

\[ \rho J(b) = \max_{\pi \in [0, \bar{\pi}]} u(y - \rho b) - \psi_0 \pi + (r(b) - \pi - \rho)J'(b) \cdot b', \]

\[ \Pi(b) = \begin{cases} 
0 & \text{if } \psi_0 > -J'(b) \cdot b', \\
\in [0, \bar{\pi}] & \text{if } \psi_0 = -J'(b) \cdot b', \\
\bar{\pi} & \text{if } \psi_0 < -J'(b) \cdot b'.
\end{cases} \]

\[ -J'(b) = u'(y - \rho b) - \psi_0 \Pi'(b)/\rho \]
No Roll-over Risk: Monetary Authority

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- Best Monotone Equilibrium
- Bang-Bang solution for inflation
No Roll-over Risk: Monetary Authority

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\[-J'(b) = u'(y - \rho b) - \psi_0 \Pi'(b)/\rho\]

- **Best Monotone Equilibrium**
- **Bang-Bang solution for inflation**
- **Assume symmetric initial debt positions, } b = b
Monetary Union with No Crisis

(a) Consumption Policy

(b) Inflation Policy

(c) Value Function

(d) Interest Rates

\[ C(b) \]

\[ \Pi(b) \]

\[ V(b) \]

\[ r(b) \]
Fiscal Externality: MU

\[ V(b) \]

\[ V \]

\[ b_{\pi} \]

\[ b \]
Fiscal Externality: Value of Coordination

$V(b)$

$\pi$

$\pi$

$\mu$

$\mu$

$\pi$

$\mu$

$\mu$

$\pi$

Aguiar et al (2012)

Higher LR debt and inflation in MU relative to SOE.

Debt Ceiling: $b(t) \leq b_{SOE}$

SOE

MU

$b_\pi$

$b^*$

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Fiscal Externality: Role of Coordination

- Aguiar et al (2012)
- Higher LR debt and inflation in MU relative to SOE.
- Debt Ceiling: $b(t) \leq b^t_{SOE}$
Aguiar et al (2012)
- Higher LR debt and inflation in MU relative to SOE.
- Debt Ceiling: $b(t) \leq b_{t}^{SOE}$
Fiscal Externality: Role of Commitment

- Consumption: \( c_{\text{Ramsey}} = c^{\text{MU}} = y - \rho b \)
- Higher inflation in a MU
- Chari, Kehoe (07)
Heterogeneity Absent Crises

- Suppose fraction $\eta$ have debt $b > 0$ and $(1 - \eta)$ have $b = 0$
- Do members disagree about the debt choices of other members (or potential new members)?
Heterogeneity Absent Crises

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- Do members disagree about the debt choices of other members (or potential new members)?

- Without roll-over risk: NO

\[ \psi_0 = \eta \cdot u'(y - \rho b_\pi)b_\pi \]

- All members benefit from a decrease in $\eta$

- As $\eta \to 0$, $MU \to Ramsey$. 
Suppose fraction $\eta$ have debt $b > 0$ and $(1 - \eta)$ have $b = 0$

Do members disagree about the debt choices of other members (or potential new members)?

Without roll-over risk: NO

$$\psi_0 = \eta \cdot u'(y - \rho b_{\pi})b_{\pi}$$

All members benefit from a decrease in $\eta$

As $\eta \to 0$, $MU \to Ramsey$.

No longer true when have roll-over crises.
Roll-over Crises

- Builds on Cole and Kehoe (00), Aguiar et al (12)
- Equilibrium interest rate schedule of lenders

\[ r(b) = r^* + \pi(b) + \lambda(b) \]

- where \( \pi(b) \) is the inflation strategy of the government
- and \( \lambda(b) \) is the default probability (including sunspots)
Roll-over Crises

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Coordination problem of the lenders

For high values of debt:

- if each lender thinks all other lenders will roll-over, no crises
- if each lender thinks all other lenders will not roll-over, then debt run
Roll-over Crises

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Coordination problem of the lenders

For high values of debt:
- if each lender thinks all other lenders will roll-over, no crises
- if each lender thinks all other lenders will not roll-over, then debt run
- Run is a common shock for all positive debtors.
Regions of Multiplicity

Constructing debt runs

- Suppose the government cannot roll over
Regions of Multiplicity

Constructing debt runs

- Suppose the government cannot roll over
- To avoid default, needs to repay within a grace period
  - value of repayment depends on debt and interest rate
  - value of repayment depends on inflation
Regions of Multiplicity

Constructing debt runs

- Suppose the government cannot roll over
- To avoid default, needs to repay within a grace period
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  - value of repayment depends on inflation
- If the value of repayment is below the default value, ✓
  - roll-over crisis is self-fulfilling: vulnerable to crisis
Regions of Multiplicity

Constructing debt runs

- Suppose the government cannot roll over
- To avoid default, needs to repay within a grace period
  - value of repayment depends on debt and interest rate
  - value of repayment depends on inflation
- If the value of repayment is below the default value, \( V \)
  - roll-over crisis is self-fulfilling: vulnerable to crisis
- Monetary Authority: More likely to inflate the higher is \( \eta \)
Threshold Equilibria:

- Vulnerability cutoff level $b_\lambda$: Safe for $b \leq b_\lambda$, vulnerable $b > b_\lambda$
Regions of Multiplicity

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- Equilibrium Selection: Best equilibrium in grace period
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Question

- How does the vulnerability cutoff ($b_\lambda$) depend on the fraction of members, $\eta$, with high debt?
Regions of Multiplicity

\[ b \lambda \eta^{-1} \]

Debt → less debtors

Reduce ECB incentive to inflate in run → More costly to repay
Reduce ECB incentive to inflate in normal → Reduce equilibrium interest rate → Reduce cost of repaying in case of run.

→ less debtors
Regions of Multiplicity

Debt

Vulnerable

Safe

→ less debtors
Reduce ECB incentive to inflate in run → More costly to repay
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Regions of Multiplicity

- **Debt**
- **Vulnerable**
- **Safe**
- **Mostly Germany**
- **Some Greece**
- ** Mostly Greece**

$\lambda$
Regions of Multiplicity

Debt

Vulnerable

Some Greece

Mostly Germany

Safe
Regions of Multiplicity

- Debt
- Vulnerable
- Safe
- Mostly Greece
- Some Greece
- Mostly Germany

Parameter $\lambda$ and $\eta^{-1}$
In vulnerable region have probability $\lambda$ of default (sunspot)
Full Solution for Crisis Equilibria

- In vulnerable region have probability $\lambda$ of default (sunspot)
- Fiscal authority may desire to save out of the crisis zone.
Full Solution for Crisis Equilibria

- HJB for fiscal authority in the crisis zone:

\[(\rho + \lambda)\hat{V}(b) = \max_c u(c) + \hat{V}'(b)[(\rho + \lambda)b + c - y] + \lambda\hat{V}.\]

- FOC

\[u'(c) = -\hat{V}'(b),\]

\[\hat{V}''(b)[(\rho + \lambda)b + c - y] = 0.\]
Full Solution for Crisis Equilibria

- HJB for fiscal authority in the crisis zone:
  \[(\rho + \lambda) \hat{V}(b) = \max_{c} u(c) + \hat{V}'(b)[(\rho + \lambda)b + c - y] + \lambda \hat{V}.\]

- FOC
  \[u'(c) = -\hat{V}'(b),\]
  \[\hat{V}''(b)[(\rho + \lambda)b + c - y] = 0.\]

- Unique Viscosity Solution
\[ \hat{V}(\mathbf{b}) = \frac{u(y - \rho \mathbf{b})}{\rho} + \frac{u(y - (\rho + \lambda) \mathbf{b}) + \lambda \hat{V}(\mathbf{b})}{\rho + \lambda} \]
\[ \hat{V}(b) = \frac{u(y - \rho b)}{\rho} \]

\[ \frac{u(y - (\rho + \lambda) b) + \lambda \hat{V}(b)}{\rho + \lambda} \]
Figure: Consumption policy

- Consumption policy depends indirectly on $\eta$ through its impact on equilibrium $b_\lambda$. 
Full Solution for Crisis Equilibria

- HJB for the monetary authority in the crisis zone:

\[
(\rho + \lambda)J(b) = \max_{\pi} \eta u(c(b)) + (1 - \eta)u(y) - \psi_0\pi + J'(b)[(r(b) - \pi)b + c(b) - y] + \lambda \Pi.
\]

\[
\Pi(b) = \begin{cases} 
0 & \text{if } \frac{\psi_0}{\eta} \geq -J'(b)b, \\
\bar{\pi} & \text{if } \frac{\psi_0}{\eta} < -J'(b)b.
\end{cases}
\]

\[
J'(b)\Pi'(b)b + J''(b)\left((\rho + \lambda)b + c - y\right) = 0.
\]

- \(\eta\) determines whether jump in inflation takes place in the safe zone or the vulnerability zone.
Welfare and Debt Composition

$V(b, b)$

- Mostly Germany
- Some Greece
Conclusions

Fiscal Externality

- Limits countries incentives to reduce debt
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Fiscal Externality

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Conflicts in a monetary union that arise in presence of roll-over risk

- “Greece” may have higher welfare in a monetary union with some “Germany” but not all “Germany”
Conclusions

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Conflicts in a monetary union that arise in presence of roll-over risk

- “Greece” may have higher welfare in a monetary union with some “Germany” but not all “Germany”
- If inflation done “off equilibrium”, no loss of welfare to “Germany”.
- Different from conflicts arising from asynchronous fundamentals and output stabilization.
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Conflicts in a monetary union that arise in presence of roll-over risk

- “Greece” may have higher welfare in a monetary union with some “Germany” but not all “Germany”
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- Different from conflicts arising from asynchronous fundamentals and output stabilization.

Institutional design in a monetary union

- Debt composition of members
Grace period problem: Fiscal Authority

\[ V^G(b_0, b_0, r_0, r_0) = \max_{c(t)} \int_0^\delta e^{-\rho t} \left( u(c(t)) - \psi_0 \pi^G(b, r_0, t) \right) dt + e^{-\rho \delta} V(0, 0), \]

\[ \dot{b}(t) = c(t) - y + (r_0 - \pi^G(b, r_0, t)) b(t), \]

\[ b(0) = b, \quad b(\delta) = 0, \quad \text{and} \quad \dot{b}(t) \leq -\pi^G(b, r_0, t) b(t), \]

\[ \dot{b}(t) = c^G(b, r_0, t) - y + (r - \pi^G(b, r_0, t)) b(t) \]

\[ b(0) = b, \quad b(\delta) = 0. \]

- Value net of inflation costs,

\[ \hat{V}^G(b_0, b_0, r_0, r_0) = V^G(b_0, b_0, r_0, r_0) + \int_0^\delta e^{-\rho t} \psi_0 \pi^G(b, r_0, t) dt. \]

- Repay instead of defaulting if and only if

\[ \hat{V}^G(b_0, b_0, r_0, r_0) \geq \hat{\nu}, \]

\[ \hat{\nu} = u(\chi y)/\rho \]
Grace period problem: Fiscal Authority

- $\hat{V}^G(b_0, b_0, r_0, r_0)$ is decreasing in $b_0$ and $r_0$.

- Assume that the rollover crisis is an equilibrium possibility only if $\hat{V}^G(b_0, b_0, r_0, r_0) < \hat{V}$.

- Indicator function $I(b_0, b_0, r_0, r_0)$ which takes the value of one if a rollover crisis leads to a default, and zero otherwise.

- Assume that, as long as $\hat{V}^G(b_0, b_0, r_0, r_0) < \hat{V}$, a rollover crisis occurs with a Poisson arrival probability equal to $\lambda$. 
Grace period problem: Monetary Authority

\[ J^G(b_0, r_0) = \max_{\pi(t)} \int_0^\delta e^{-\rho t} \left( \eta u(C^G(b_0, r_0, t)) + (1 - \eta)u(y) - \psi_0 \pi(t) \right) dt + \frac{e^{-\rho \delta}}{\rho} \]

subject to
\[ \dot{b}(t) = C^G(b_0, r_0, t) - y + (r_0 - \pi(t))b(t) \quad \text{and} \quad b(0) = b. \]

- \( J^G(b_0, r_0) \) is decreasing in \( b_0 \) and \( r_0 \).
- For a given \((b_0, r_0)\), the monetary authority is more likely to inflate the larger the fraction of countries with positive debt, i.e. the higher is \( \eta \). There is no fiscal externality in the grace period problem.