Fiscal Risk in a Monetary Union

Betty C Daniel       Christos Shiamptanis
UAlbany - SUNY       Ryerson University

May 2012
Recent Turmoil in European Financial Markets

- Highlights fiscal risk in EMU
  - Monetary union eliminates a country’s ability to use inflation to reduce the value of government debt
  - Raises possibility of fiscal insolvency

- No country can commit unconditionally to intertemporal government budget balance (Sims 1997)

- Dynamic and quantitative model of a fiscal solvency crisis
Model in Which Government Debt Has Risks

- Initial fiscal policy is passive
  - Government promises to raise present-value surpluses to equal government debt
  - Active monetary policy pegs the price level
- Stochastic shocks to fiscal policies
  - Financial crisis
  - Politics or war
- Fiscal limits
  - Upper bound on the present value of government surpluses
    - Distortionary taxation limits tax revenue
    - Political will limits tax increases and spending decreases
    - Unrelated to limits in Stability and Growth pact
  - Governments do not acquire unlimited quantity of another’s debt
  - Together, implies upper bound on debt/GDP
Stochastic shocks send debt and the surplus toward a path which violates fiscal limit on debt.

Near such a path, agents lend at interest rates reflecting risk on government debt.

If additional shocks send desired debt onto a path with insolvency:
- Agents refuse to lend.
- Fiscal solvency crisis.

Crisis timing is market determined:
- Sudden stop in lending defines crisis.
- Replaces speculative attack in Generation One currency crisis model.

Dynamics and post-crisis equilibrium depend on the policy response:
- Default.
- Fiscal policy switching.
Sovereign Default Model

- Policy response to sudden stop in lending is default
- Insolvency, not unwillingness to pay, as in standard sovereign default models
- Major results
  - Magnitude of default is determined to restore fiscal solvency and is never 100 percent
  - Avoids post-crisis price-level instability (Sims 1997, 1999)
  - Monetary policy can be designed to avoid price level instability in the run-up to the crisis (in contrast to Bi, Leeper, Leith 2010)
  - Post-crisis markets are turbulent with additional defaults and high interest rates
Policy-Switching Model

- Policy response to a sudden stop in lending is policy switching
  - Fiscal policy switches to active
  - Monetary policy switches to passive

- Timing of policy-switching
  - Policy-switching is the response to a lending crisis
  - In the literature, the timing of the switch is either exogenous or becomes more likely as a variable crosses a threshold or grows

- Major results
  - Crisis in one country creates post-crisis price instability for all monetary union countries (Bergin 2000)
  - Policy crisis and post-crisis price instability is the response to a solvency crisis
  - Monetary policy can be designed to avoid price level instability when there is crisis risk (in contrast to Davig, Leeper, Walker (2010, 2011), Davig and Leeper (2011))
Simulations for five EMU countries

- Estimate risk for individual countries from 2009
  - Predict Greek crisis
  - Warn of Italian one

- Additional results
  - Crises develop suddenly
  - Probability of a crisis is lower under default
Credit markets: Interest rate parity

\[
\frac{1}{1 + i_{jt}} = \left( \frac{1}{1 + i} \right) E_t \left[ \frac{P_t}{P_{t+1}} \delta_{jt+1} \right], \quad j = 1, 2, \ldots, N
\]

Interest on asset free of risk of capital loss

\[
(1 + i_t) = (1 + i_{jt}) E_t \left[ \frac{P_t}{P_{t+1}} \delta_{jt+1} \right].
\]

Active monetary policy: Taylor rule

\[
\frac{1}{1 + i_t} = \frac{1}{1 + i} + \kappa \left( \frac{P_{t-1}}{P_t} - 1 \right), \quad \kappa > 1,
\]
Model: Fiscal Policy

- Upper bound on present value of future surpluses

\[ E_t \sum_{k=0}^{\infty} s_{t+k} \left( \frac{1}{1+r} \right)^k \leq \frac{(1+r) \bar{\varphi}}{r} \]

- Government budget constraint

\[ b_t = (1+r)b_{t-1} - s_t - (\gamma_t - E_{t-1}\gamma_t) \]

where

\[ \gamma_t = \left(1 - \frac{\delta_t}{1+\pi_t}\right) \left(\frac{1+i_{t-1}}{1+g}\right) b_{t-1} \quad r = \left(\frac{i-g}{1+g}\right) \]

- Upper bound + country-by-country government intertemporal budget constraint

\[ b_t \leq \bar{\varphi}/r \]

- Political will implies actual fiscal limit could be lower

\[ b_t \leq \rho \bar{\varphi}/r = \hat{\varphi}/r \]
Model: Fiscal Rule

- Passive fiscal rule with stochastic shocks ($\nu_t$)

$$s_t = (1 - \alpha) s_{t-1} + \alpha [(1 - \lambda) \varphi + \lambda r b_{t-1}] + \nu_t$$

where

$$\frac{r}{1 + r} < \alpha < 1, \quad \lambda > 1, \quad 0 < \varphi \leq \bar{\varphi}$$

- Dynamic surplus and debt equations

$$s_t = (1 - \alpha) s_{t-1} + \alpha (1 - \lambda) \varphi + \alpha \lambda r b_{t-1} + \nu_t$$

$$b_t = (1 + r - \alpha \lambda r) b_{t-1} - (1 - \alpha) s_{t-1} - \alpha (1 - \lambda) \varphi - \nu_t$$

$$- \gamma_t + E_{t-1} \gamma_t.$$
Model: Equilibrium

Given constant values for the world interest rate and world price level, a monetary policy, a surplus rule, a fiscal limit on debt, and a policy-response in the event of a fiscal crisis for each country, an equilibrium is a set of time series processes for each country’s primary surplus, debt, and capital loss on debt, \(\{b_t, s_t, \gamma_t\}_{t=0}^\infty\), such that each government’s flow and intertemporal budget constraints hold, expectations are rational, the debt for each country does not exceed its fiscal limit, and world agents expect to receive the return on assets determined by interest rate parity.
When unable to borrow, the government reduces debt through default

- Default is minimum necessary to assure that debt is not expected to travel above the fiscal limit
- Agents know this policy response

**Boundary locus** for debt service \((rb)\) is the piecewise continuous path, given by the adjustment path leading to \(\hat{\phi}\) for \(s \leq \hat{\phi}\) and by \(rb = \hat{\phi}\) for \(s > \hat{\phi}\). (BLM)
Distance and Shadow Value

- Distance between the boundary locus debt and actual debt \((s_{t-1} \leq s_L)\)
  \[ \Omega_t = \hat{b}_t - b_t = x_t = \mu_{t-1}x_{t-1} + \beta_{t-1}\nu_t + \gamma_t - E_{t-1}\gamma_t, \]
  where
  \[ x_{t-1} = \hat{b}_{t-1} - b_{t-1} \quad \mu_{t-1} > 0 \quad \beta_{t-1} > 0 \]

- The shadow value of capital loss on debt, \(\tilde{\gamma}_t\), sets distance to zero \((\Omega_t = 0)\).
  \[ \tilde{\gamma}_t = E_{t-1}\gamma_t - (\mu_{t-1}x_{t-1} + \beta_{t-1}\nu_t). \]

- A positive shadow value is equivalent to a negative value for \(x_t\)
Expectations and crisis timing

- Assume that agents believe default will occur with $\gamma_t = \tilde{\gamma}_t$ if $\tilde{\gamma}_t > 0$.

$$
\gamma_t = \max \{ \tilde{\gamma}_t, 0 \} = \max \{ E_t \gamma_t - (\mu_{t-1} x_{t-1} + \beta_{t-1} \nu_t), 0 \},
$$

- Proposition 1: Expectations exist only if $x_{t-1} \geq 0$.

- Corollary 1: The probability of a crisis in period $t$ is less than one if $x_{t-1} > 0$ and is one if $x_{t-1} = 0$.

- Crisis timing must assure $x_{t-1} \geq 0$.

- Proposition 2: There is no equilibrium without debt devaluation if $\tilde{\gamma}_t > 0$ (because would imply $x_{t-1} < 0$). Debt devaluation with $\gamma_t = \tilde{\gamma}_t$ restores equilibrium.

- Corollary 2: Since $x_t = 0$ after default, there will be expectations and realizations of additional defaults.
Characteristics of Crisis

- Implications for price stability
  - Monetary authority retains control of price pre and post crisis
  - German insistence in October 2010 for an orderly mechanism for sovereign debt restructuring
    - Commitment to default
    - Allows monetary authority to retain price control
  - Magnitude of default determined to restore fiscal solvency and is never 100%
- Markets remain turbulent after default
  - High interest rates
  - Additional default
Switching: Post-crisis policy

- Passive monetary policy pegs the interest rate
- Active fiscal policy
  - No reaction to debt
  - Revised target surplus: if the post-crisis policy mix, conditional on values for debt and the surplus, yields a long-run equilibrium for debt equal to $\tilde{\phi}/r < \hat{\phi}/r$, then the revised surplus target is $\tilde{\phi}$.
  - If not, the surplus target is $\hat{\phi}$
- Dynamic equations with $\hat{\phi}$ target

\[
\begin{align*}
  s_t &= (1 - \alpha) s_{t-1} + \alpha \hat{\phi} + \nu_t. \\
  b_t &= (1 + r) b_{t-1} - (1 - \alpha) s_{t-1} - \alpha \hat{\phi} - \nu_t - \gamma_t + E_{t-1} \gamma_t.
\end{align*}
\]
Active Fiscal Policy
Switching Policy Switching

Policy Switching
Switching Crisis

- When unable to borrow
  - the fiscal authority switches to active fiscal policy with a fiscal target of $\tilde{\phi} \leq \hat{\phi}$
  - the monetary authority accommodates to minimize systematic inflation
- The **boundary locus** for debt service ($rb$) is the piecewise continuous path, given by the saddlepath leading to $\hat{\phi}$ for $s \leq \hat{\phi}$ and by $rb = \hat{\phi}$ for $s > \hat{\phi}$. 
Distance and Shadow Value

- Distance between boundary locus debt and its actual value \((s_t \leq \hat{\phi})\)

\[
\Omega_t = \hat{b}_t^{sp} - b_t = \frac{\alpha (1 + r)}{\alpha + r} \left( x_{t-1} + \frac{\nu_t}{\alpha} \right) + \gamma_t - E_{t-1} \gamma_t,
\]

\[
x_{t-1} = \frac{(1 - \alpha)}{\alpha} s_{t-1} - \frac{(r + \alpha - \alpha \lambda r)}{\alpha} b_{t-1} + \frac{\hat{\phi}}{r} + (1 - \lambda) \phi.
\]

- Shadow value sets \(\Omega_t = 0\)

\[
\tilde{\gamma}_t = E_{t-1} \gamma_t - \frac{\alpha (1 + r)}{\alpha + r} \left( x_{t-1} + \frac{\nu_t}{\alpha} \right).
\]

- A positive shadow value contributes to a negative value for \(x_t\)
Expectations and crisis timing

- Assume that agents believe policy switching will occur with $\gamma_t = \tilde{\gamma}_t$ if $\tilde{\gamma}_t > 0$.

$$\gamma_t = \max \{\tilde{\gamma}_t, 0\} = \max \left\{E_{t-1} \gamma_t - \frac{\alpha (1 + r)}{\alpha + r} \left(x_{t-1} + \frac{v_t}{\alpha}\right), 0\right\}.$$  

- Proposition 1: Expectations exist only if $x_{t-1} > 0$.
- Corollary 1: The probability of a crisis in period $t$ is less than one if $x_{t-1} > 0$ and is one if $x_{t-1} = 0$.
- Crisis timing must assure $x_t \geq 0$.
- Proposition 2: There is no equilibrium without policy switching in period $t$ if $x_t < 0$ or if $\tilde{\gamma}_t > 0$.
  - Policy switching yields $\gamma_t = \tilde{\gamma}_t$ when $\tilde{\gamma}_t > 0$, restoring equilibrium.
  - When $x_t < 0$ but $\tilde{\gamma}_t < 0$, debt devaluation is not necessary to restore equilibrium.
  - New policy rule implies an increase in present-value surpluses.
Implications for price stability

- **Crisis date**
  - Prices most likely jump upwards to restore fiscal solvency
  - Prices do not jump if increased present value surpluses are sufficient to restore solvency

- **Post-crisis**
  - When monetary authority pegs interest rate
    - Monetary authority controls expected and average inflation
    - Actual prices are determined by fiscal shocks
  - If monetary authority maintains active Taylor Rule
    - Hyperinflation is possible

- **Pre-crisis**
  - If interest rate is allowed to rise with expectations of inflation
    - Pre-crisis prices fixed
    - Policy of defending fixed exchange rate with increase in interest rate
  - If monetary authority maintains active Taylor Rule
    - Expected inflation determined by anticipations of capital loss
    - Actual inflation must rise according to Taylor Rule
Simulations

- **Parameter values**
  - EMU panel data estimates (Daniel and Shiamptanis 2011)
  - Fiscal limit on debt of 141%, larger than any country experienced 1970-2006

- **Estimates of crisis risk**
  - Countries adhering to SGP limits - no risk in ten years
  - Countries with small deviations in 2009, Belgium, France, and Germany
    - No risk under baseline parameter values
    - Some risk under sensitivity analyses designed to increase risk
  - Countries with large deviations by the end of 2009, Italy and Greece
    - Risk under baseline parameter values
    - Risk becomes large under OECD projections for future debt

- **Other simulation results**
  - Once risk becomes positive, it rises at an increasing rate in determinants of risk, especially debt
Probability of a Crisis as a Function of Debt/GDP

- Belgium (surplus -2.5%)
- France (surplus -3.3%)
- Germany (surplus -0.8%)
- Greece (surplus -10.5%)
- Italy (surplus -1.3%)
The probability of a crisis as a function of real interest rate

Daniel and Shiamptanis (2012)
Implications

- Crises develop suddenly
  - Even positive surplus shocks can lead to a crisis if not large enough
  - However, with very large positive shocks, can avoid crisis
- Crisis risk is higher with switching than with default
Fiscal Policy Rule and Crisis Probability

The probability of crisis as a function of \( \alpha, \lambda \), and \( \phi \).
Implications

- Small (one-standard deviation) changes in $\lambda$ (responsiveness of the surplus to debt) $\varphi$ (surplus target under passive fiscal policy) could not have reduced the crisis probability for Greece by a large amount.
- A small increase in $\alpha$, which reduces surplus persistence, could have
Fiscal limits and stochastic surplus shocks imply that strongly passive fiscal policy is not sufficient to avoid a lending crisis

- Countries with high debt and deficits are at risk
- Risk is increasing at an increasing rate in its determinants

Dynamics and post-crisis equilibrium depend on policy response

- Default
- Policy switching
Crisis characteristics

- Crisis timing is determined by the market
  - Sudden stop in lending replaces speculative attack of generation one model
- A crisis occurs prior to debt reaching its upper bound
- Magnitude of capital loss in crisis determined to restore fiscal solvency
  - Default magnitude always less than 100%
- Probability of a crisis is increasing at an increasing rate in the world interest rate and in debt
  - Crises develop suddenly
  - When debt is in a critical range a small increase in debt creates a large increase in crisis probability
- Probability of a crisis is higher with a policy response of policy switching
  - Commitment to resolve solvency crises with default would reduce their probability
Summary and Contributions to the Literature (cont)

- Post-crisis price stability
  - Lose with policy switching (Bergin 2000)
  - Retain with default (Sims 1997, 1999)

- Price stability when there is risk of default
  - Can design monetary policy such that price is stable