On the optimal design of a
Financial Stability Fund

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Will the Euro Zone Go Up In Smoke?
(Newsweek Magazine, May 21, 2012)
Long-term spreads over German bond
Primary deficit & surplus /GDP
(MA 2000Q2 – 2011Q2 source ECB)
Not just a RBC recession?
GDP Growth rates (2000Q3 - 2011Q2)
The Euro policy responses

• Maintain ECB mandate of price stability

• The indebted Euro countries keep using debt-financing (with very costly roll-overs)

• In spite of the ”no-bailout clause” in the EU Treaty (Art. 125), a country’s default is perceived catastrophic (bail-out, or partial-bailout expectations)

• Rescue packages with IMF: Greece, Ireland and Portugal
  IMF style: conditional (austerity) financial support (with Greece reschedule)
Long-term spreads over German bond
The Euro policy responses

- In spite of the "monetary financing prohibition" (Art. 123), large ECB debt purchase interventions (Italy and Spain, not Greece 2011-12, Spain again?)

- The European Fiscal Compact (2 March, 2012) setting deficit constraints in State constitutions (similar to US States)

- The creation of the European Stability Mechanism as a Financial Stability Fund; starts July 2012!
The Euro policy responses

• Could have we done better?

• Can we do better?

• Will we learn?
A Financial Stability Fund as a Dynamic Mechanism Design problem

- The finance theories on the 'optimality of the debt contract' do not apply to the long-term relationship of countries in an Economic Union.

- Long-term contracts can provide risk-sharing and enhance investment opportunities.

- A FSF can either use only its own financial resources, or act as a maturity transformation facility, transforming non-contingent loans (from international markets, Central Banks, or households) into contingent loans to participants in the FSF.
A Financial Stability Fund as a Dynamic Mechanism Design problem

• However, a well designed FSF must take into account:

  The redistribution, or Hayek’s, problem: the participation constraints of all the FSF members (and the FSF as lender)

  The moral hazard problem: the incentive compatibility constraints (not accounted for in this version)
The environment

- One risk-averse government-borrower & one risk-neutral fund-lender

- Lender: at the risk-free rate \(r\)

- Borrower’s technology: leisure, \(l = 1 - n\) & output, \(y = \theta f(n)\)

- Borrower’s preferences: \(u(c) + U(1 - n)\) & \(\beta\), \(1/(1 + r) \geq \beta\)

- Markovian shocks: productivity, \(\theta\) & government expenditure, \(G\); i.e. an exogenous state \(s = (\theta, G)\), with transition probability \(\pi(s'|s)\).
Alternative borrowing & lending mechanisms

- *Complete markets* with full commitment ($FB$)
- *Incomplete markets* with & without default, ($IMD$) & ($IM$)
- *Financial Stability Fund* ($FSF$) with one-sided ($1S$) & two-sided limited commitment ($2S$)

- How would an *IMD* look if, with the same shocks, had a $2S – FSF$? (Greece with a proper *ESM*?)
- How much would it gain?
Incomplete markets without default

$b = \text{asset holdings}$ at the beginning of the period (if $b < 0$ we call it debt)

$$V^{bi}(b, \theta, G) = \max_{c, n, b'} \left\{ u(c) + U(1 - n) + \beta \mathbb{E} \left[ V^{bi}(b', \theta', G') \mid \theta, G \right] \right\}$$

s.t. $c + G + qb' \leq \theta f(n) + b$

- Resulting in policies: $c^i(b, \theta, G)$, $n^i(b, \theta, G)$ and $b'^i(b, \theta, G)$

- Since the lender is risk neutral: $q = \frac{1}{1+r}$

- Notice there is an implicit no default technology.
Incomplete markets with default.

Following Arellano (2008), if the country does not default on its debt, the value of $b$ at $(\theta, G')$ is

\[
V^{bid}(b, \theta, G') = \max_{c, n, b'} \left\{ u(c) + U(1 - n) + \beta E \left[ V^{bia}(b', \theta', G') \mid \theta, G \right] \right\}
\]

s.t. \[c + G + q(\theta, G, b')b' \leq \theta f(n),\]

where, taking into account that default can occur next period,

\[
V^{bia}(b, \theta, G) = \max \{V^{bid}(b, \theta, G'), V^{ai}(b, \theta, G)\}
\]
Incomplete markets with default.

- The value in autarky is given by

\[ V^{ai}(\theta, G) = \max_n \{ u((\theta f(n) - G) + U(1 - n) \]

\[ + \beta \mathbb{E} [(1 - \lambda) V^{ai}(\theta', G') + \lambda V^{bid}(0, \theta', G') \mid \theta, G] \} \]

- After default a government is in autarky, but can be re-enter the financial (incomplete) market with probability \( \lambda; \) \( \lambda \) small.
Incomplete markets with default

- The choice of default:
  \[ D(\theta, G, b) = 1 \text{ if } V^{ai}(\theta, G) > V^{bid}(b, \theta, G) \text{ and } 0 \text{ otherwise}, \]

- The price of new debt: \( q(\theta, G, b') = \frac{1-d(\theta, G, b')}{1+r} \)

- The expected default rate: \( d(\theta, G, b') = E[D(\theta, G, b') | \theta, G] \)

- The debt interest rate: \( r^i(\theta, G, b') = 1/q(\theta, G, b') - 1 \)

- The spread: \( r^i(\theta, G, b') - r \geq 0 \)
Incomplete markets accounting

- **Primary surplus** (we also call it transfers, $\tau$, and primary deficit if negative)

\[
qb' - b = \theta f(n) - (c + G) \quad \text{and, with default,}
q(\theta, G, b')b' - b = \theta f(n) - (c + G)
\]

- **Surplus** = primary surplus + interest repayment (end of the period)

\[
b' - b = (qb' - b) + qb'(1/q - 1)
= qb'(1 + r) - b \quad \text{and, with default,}
b' - b = q(\theta, G, b')b'(1 + r^i(\theta, G, b')) - b
\]
The Financial Stability Fund as a long-term contract

\[
\max \{c(s^t), n(s^t)\} \\
\quad \mathbb{E} \left[ \mu_{b,0} \sum_{t=0}^{\infty} \beta^t \left[ u(c(s^t)) + U(1 - n(s^t)) \right] \right] \\
\quad + \mu_{l,0} \sum_{t=0}^{\infty} \left( \frac{1}{1 + r} \right)^t \tau(s^t) | s_0 \\
\text{s.t.} \quad \mathbb{E} \left[ \sum_{r=t}^{\infty} \beta^{r-t} \left[ u(c(s^r)) + U(1 - n(s^r)) \right] | s^t \right] \geq V^{af}(s_t) \\
\mathbb{E} \left[ \sum_{r=t}^{\infty} \left( \frac{1}{1 + r} \right)^{r-t} \tau(s^t) | s^t \right] \geq Z, \\
\text{and} \quad \tau(s^t) = \theta(s^t)f\left( n(s^t) \right) - c(s^t) - G(s^t), \quad t \geq 0.
\]
The Financial Stability Fund as a long-term contract

- $V^{af}(s_t)$, is defined as $V^{ai}(s_t)$, except that $\lambda$ is, in this case, the probability of returning to the fund with $b = 0$.

- $Z \leq 0$ is the outside value of the lender.

- The solution to the FSF maximization problem is:
  - **FB** A first best contract, when $V^{af}(s_t)$ and $Z$ are never binding, for $t > 0$.
  - **1S** A one-sided limited enforcement contract, when only $Z$ is never binding, for $t > 0$.
  - **2S** A two-sided limited enforcement contract, when both participation constraints may bind, for $t > 0$. 
The Financial Stability Fund as a long-term contract

Following Marcet & Marimon (1999, 2011), we can write the FSF contracting problem as:

\[
\min_{\{\gamma_{b,t}, \gamma_{l,t}\}} \max_{\{c_t, n_t\}} \mathbb{E} \left[ \sum_{t=0}^{\infty} \beta_t \left( \mu_{b,t+1} [u(c_t) + U(1 - n_t)] - \gamma_{b,t} V^A(s_t) \right) \right. \\
+ \sum_{t=0}^{\infty} \left( \frac{1}{1 + r} \right)^t \left( \mu_{l,t+1} \tau_t - \gamma_{l,t} Z \right) | s_0 \right]
\]

\[
\mu_{i,t+1}(s_{t+1}) = \mu_{i,t}(s^t) + \gamma_{i,t}(s^t), \quad \mu_{i,0}(s_0) \text{ is given}, \quad i = b, l,
\]

\[
\gamma_{i,t}(s^t) \text{ is the Lagrange multiplier of the participation constraint of agent } i \text{ in period } t, \text{ state } s^t,
\]

\[
\mu_{i,0}(s_0), \quad i = b, l, \text{ is determined by the lender’s zero profit condition.}
\]
The Financial Stability Fund as a long-term contract

Following Kehoe and Perri (2002), we can use as co-state variable $x_t = \frac{\mu_{l,t}}{\mu_{b,t} \eta}$, where $\eta \equiv \beta(1 + r) \leq 1$, and $v_i(x, s) = \gamma_i(x, s) / \mu_i(x, s)$, $i = b, l$.

Resulting in policy functions $c(x, s), n(x, s), \tau(x, s)$ and $v_b(x, s), v_l(x, s)$, satisfying

$$u'(c(x, s)) = x' = \frac{1 + v_l(x, s) x}{1 + v_b(x, s) \eta},$$

and

$$U'(1 - n(x, s)) \quad \frac{u'(c(x, s))}{u'(c(x, s))} = \theta f'(n(x, s)).$$
The Financial Stability Fund as a long-term contract

The value function of the FSF contracting problem takes the form:

$$FV(x, s) = xV^{lf}(x, s) + V^{bf}(x, s);$$
where,

$$V^{bf}(x, s) = u(c(x, s)) + U(1 - n(x, s)) + \beta E[V^{bf}(x', s') | s]$$

and

$$V^{lf}(x, s) = \tau(x, s) + \frac{1}{1 + r} E[V^{lf}(x', s') | s]$$

Furthermore, $V^{bf}(x, s) \geq V^{af}(s)$, with equality if $v_b(x, s) > 0$ and, similarly, $V^{lf}(x, s) \geq Z$ if $v_l(x, s) > 0$. 
Decentralizing the *FSF contract*

Following Alvarez and Jermann (2000), we can find competitive prices to value *FSF* contracts and compare them with the *IM* and *IMD* contracts.
The dual competitive economy

Let the borrower have access to a complete set of one-period Arrow securities...

\[
\max \{c_b(s^t), n(s^t), a_b(s^{t+1})\} \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi \left( s^t \right) \left[ u(c_b(s^t)) + U(1 - n(s^t)) \right]
\]

s.t. \( c_b(s^t) + \sum_{s^{t+1}|s^t} q \left( s^{t+1}|s^t \right) a_b \left( s^{t+1} \right) = \theta(s^t)f \left( n(s^t) \right) - G(s^t) + a_b(s^t) \)

\[
a_b \left( s^{t+1} \right) \geq A_b \left( s^{t+1} \right)
\]

- \( q \left( s^{t+1}|s^t \right) \) is the price of the one-period state contingent
- \( a_b \left( s^{t+1} \right) \) are the asset (contingent claims) holdings
- \( A_b \left( s^{t+1} \right) \) is an endogenous borrowing limit
The dual competitive economy

The borrower’s choice satisfies

\[ q(s^{t+1}|s^t) \geq \beta^t \pi(s^{t+1}|s^t) \frac{u'(c_b(s^{t+1}))}{u'(c_b(s^t))} \]

with equality if \( a_b(s^{t+1}) > A_b(s^{t+1}) \), as well as the present-value budget constraint.
The dual competitive economy

Similarly, let the lender have access to a complete set of Arrow securities...

\[
\max \left\{ c_l(s^t), a_l(s^{t+1}) \right\} \sum_{t=0}^{\infty} \sum_{s^t} \left( \frac{1}{1 + r} \right)^t \pi(s^t) c_l(s^t)
\]

s.t. \( c_l(s^t) + \sum_{s^{t+1}|s^t} q(s^{t+1}|s^t) a_l(s^{t+1}) = a_l(s^t) \)

\( a_l(s^{t+1}) \geq A_l(s^{t+1}) \)

The lender’s choice satisfies, with equality if \( a_l(s^{t+1}) > A_l(s^{t+1}) \),

\[
q(s^{t+1}|s^t) \geq \left( \frac{1}{1 + r} \right)^t \pi(s^{t+1}|s^t)
\]
The dual competitive economy

The values for the borrower and the lender have a recursive form

\[ W^b(a_b(s^t), s^t) = u(c_b(s^t)) + U(1 - n(s^t)) + \]

\[ \beta \sum_{s^{t+1}|s^t} \pi(s_{t+1}|s_t) W^b(a_b(s^{t+1}), s^{t+1}) \]

\[ W^l(a_l(s^t), s^t) = c_l(s^t) + \]

\[ \frac{1}{1 + r} \sum_{s^{t+1}|s^t} \pi(s_{t+1}|s_t) W^l(a_l(s^{t+1}), s^{t+1}) \]
The decentralized FSF contract

Let \( \{ c^* (s^t), n^* (s^t), \tau^* (s^t) \} \) be the allocation of a FSF contract...

\[
q^* (s^{t+1}|s^t) = \max \left\{ \beta \pi (s_{t+1}|s_t) \frac{u'(c^* (s^{t+1}))}{u'(c^* (s^t))}, \left( \frac{1}{1 + r} \right) \pi (s^{t+1}|s^t) \right\}
\]

\[
= \max \left\{ \beta \pi (s_{t+1}|s_t) \frac{1 + v_l(x_{t+1}, s_{t+1})}{(1 + v_b(x_{t+1}, s_{t+1})\eta)}, \left( \frac{1}{1 + r} \right) \pi (s_{t+1}|s_t) \right\}
\]

\[
= \left( \frac{1}{1 + r} \right) \pi (s_{t+1}|s_t) \max \left\{ \frac{1 + v_l(x_{t+1}, s_{t+1})}{1 + v_b(x_{t+1}, s_{t+1})}, 1 \right\}
\]

If the lender’s participation constraint is not binding: \( \frac{1 + v_l(x_{t+1}, s_{t+1})}{1 + v_b(x_{t+1}, s_{t+1})} \leq 1 \).

The price of a one-period bond: \( q^f(s^t) = \sum_{s^{t+1}|s^t} q^* (s^{t+1}|s^t) \).

When the lender’s participation constraint is binding, for some \( s^{t+1} \), the spread is negative.
The decentralized FSF contract

asset holdings = present value of transfers

\[ Q^* \left( s^t | s_0 \right) = q^* \left( s^1 | s_0 \right) q^* \left( s^2 | s^1 \right) \cdots q^* \left( s^t | s^{t-1} \right) \]

\[ a_b \left( s^t \right) = \sum_{n=0}^{\infty} \sum_{s_{t+n} | s^t} Q^* \left( s^t+n | s^t \right) \left[ c^* \left( s^{t+n} \right) - \left( \theta(s^{t+n}) f \left( n^* \left( s^{t+n} \right) \right) - G \left( s^{t+n} \right) \right) \right] \]

\[ a_l \left( s^t \right) = \sum_{n=0}^{\infty} \sum_{s_{t+n} | s^t} Q^* \left( s^t+n | s^t \right) c_l \left( s^{t+n} \right) = \sum_{n=0}^{\infty} \sum_{s_{t+n} | s^t} Q^* \left( s^t+n | s^t \right) \tau^* \left( s^{t+n} \right) \]

\[ a_l \left( s^t \right) = -a_b \left( s^t \right). \]
The decentralized FSF contract

Limited enforcement means, here, that the borrowing limits

\[
A_b(s^{t+1}) = - \sum_{n=0}^{\infty} \sum_{s^{t+n}|s^t} Q(s^{t+n}|s^t) \left[ \theta(s^{t+n}) f \left( n^*(s^{t+n}) \right) - G(s^{t+n}) \right]
\]

\[
A_l(s^{t+1}) \geq Z = \sum_{s^{t+n}|s^t} \left( \frac{1}{1+r} \right)^n n^*(s^{t+n}),
\]

satisfy

\[
W^b(A_b(s^t), s^t) = V^{af}(s^t)
\]

\[
W^l(A_l(s^t), s^t) = Z
\]

\[\Rightarrow\] expected transfers to the lender at the states where his participation constraint are binding can not be negative.
The duality between the FSF contract and the competitive equilibrium

\[ V^{bf}(x, s) = u(c(x, s)) + U(1 - n(x, s)) + \beta \sum_{s'} \pi(s'|s)V^{bf}(x', s') \]

\[ V^{lf}(x, s) = \tau(x, s) + \frac{1}{1 + r} \sum_{s'} \pi(s'|s)V^{lf}(x', s'). \]

\[ W^{bf}(a_b, s) = u(c_b(a_b, s)) + U(1 - n(a_b, s)) + \beta \sum_{s'} \pi(s'|s)W^{bf}(a'_b, s') \]

\[ W^{lf}(a_l, s) = c_l(a_l, s) + \frac{1}{1 + r} \sum_{s'} \pi(s'|s)W^{lf}(a'_l, s'), \]
FSF accounting

• **Primary surplus** (we also call it transfers, $\tau$, and primary deficit if negative)

\[
\sum_{s'|s} q(s'|s) a_b(s') - a_b(s) = c_l(a_l, s) = \tau(x, s)
\]

• **Surplus** = primary surplus + interest repayment (end of the period)

\[
a_b(s') - a_b(s) = \left[ \sum_{s'|s} q(s'|s) a_b(s') - a_b(s) \right] \\
+ \left[ a_b(s') - \sum_{s'|s} q(s'|s) a_b(s') \right]
\]
Contrasting debt contracts and FSF contracts

\[ \log(c) + \frac{\gamma(1 - n)^{1-\sigma}}{1 - \sigma}, \]

with \( \sigma = 2, \gamma = 1 \)

\[ f(n) = n^\alpha, \text{ with } \alpha = 0.67. \]

- Borrower’s discount factor \( \beta = 0.96 \), while \( r = 0.01 \);
  i.e. \( 1/(1 + r) = 0.9901 \) and \( \eta = 0.9696 \)

- The probability of returning to the market, or fund, after default is \( \lambda = 0.0 \)

- In the two-sided limited enforcement contract (2S), \( Z = -0.8 \)
Contrasting debt contracts and FSF contracts: POLICIES
Contrasting *debt contracts* and *FSF contracts*: PATHS
Contrasting debt contracts and FSF contracts: PERSISTENT (-) SHOCK
Contrasting debt contracts and FSF contracts: REACTION TO (-) SHOCK (impulse responses)
Contrasting *debt contracts* and *FSF contracts*:

**SUMMARY**

- Efficiency, FB, calls for consumption decay (impatience) & smoothing, and labour responding to productivity. 1S and 2S achieve these to the extent that *limited enforcement constraints* allow them (e.g. no decay).

- IM and IMD much less; in particular, when borrowers are close to their borrowing/default constraints.

- With *FSF contracts*, if participation constraints are very low, borrowers may need to work more when productivity is low.

- *FSF contracts* are able to exploit more (implicit) asset trading possibilities (e.g. more borrowing with 2S than with IM or IMD)
Contrasting debt contracts and FSF contracts:

SUMMARY

- Persistent crisis and bad shocks exacerbate the differences between:
  - debt contracts and FSF contracts,
  - IM and IMD,
  - 1S and 2S.

- With the same underlying shocks, recessions are likely to be more severe with incomplete markets.

- With the same underlying shocks, there may be frequent episodes of positive spreads in IMD, but few – and harmless – negative spreads with 2S.
Contrasting *debt contracts* and *FSF contracts*: WELFARE
**Debt contracts vs. FSF contracts: WELFARE**

A simple measure, $\chi$, of *consumption equivalence*. FSF with *two-sided limited commitment* vs. *incomplete markets* with and without *default*.

Taking advantage of the decomposition of the welfare functions

$$V_{c}^{bj} = \log (c_j) + \beta EV_{c}^{bj'} = E_0 \sum_{t=0}^{\infty} \beta^t \log(c_{j,t})$$

$$V_{n}^{bj} = \gamma \frac{(1 - n)^{1-\sigma}}{1 - \sigma} + \beta EV_{n}^{bj'}$$

where $j = f, i$ for FSF and *incomplete markets*, respectively. Total welfare is then equal to

$$V^{bj} = V_{c}^{bj} + V_{n}^{bj}$$
Debt contracts vs. FSF contracts: WELFARE

\[ V^{bf} = E_0 \sum_{t=0}^{\infty} \beta^t \log((1 + \chi)c_t^i) + V_n^{bi} = \]

\[ = \frac{\log(1 + \chi)}{1 - \beta} + E_0 \sum_{t=0}^{\infty} \beta^t \log(c_t^i) + V_n^{bi} = \]

\[ = \frac{\log(1 + \chi)}{1 - \beta} + V_c^{bi} + V_n^{bi} \]

\[ = \frac{\log(1 + \chi))}{1 - \beta} + V^{bi} \]

\[ \rightarrow (1 + \chi) = \exp \left( (V^{bf} - V^{bi}) (1 - \beta) \right) \]
Debt contracts vs. FSF contracts: WELFARE

The welfare gains of a FSF contract can be very substantial!

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Conclusions

• This is preliminary work, but it is already very telling...

• Even accounting for limited redistribution (2S) a FSF can substantially improve efficiency, with respect to debt financing.

• Dynamic mechanism design provides a theoretical basis for FSF design.

• Furthermore, costly default events may be prevented or mitigated, even if the economy is subject to the same shocks.

• Similarly, the recession following a negative shock is substantially less severe with a FSF.
Conclusions

- While we have extensively borrowed from the existing theory, our analysis helps to better understand how different lending and borrowing mechanism work and compare.

- For example, how positive and negative spreads can be associated with IMD and 2S, respectively.

- In the end, the application revalues the theory...
Conclusions

• Yet, there is still work ahead:
  
• To better calibrate the model to the Eurozone, or other economies.
  
• To analyze the capacity of the FSF for absorbing existing debts (we always initialize asset holdings to zero).
  
• Mostly, to account for moral hazard; e.g. changing $G$ for $G(e), G'(e) < 0$, where $e$ is costly, unverifiable, effort.
There is no future for the EMU, it will involve too much redistribution!

Using dynamic mechanism design, there should be a future for the EMU!
Thanks!