On a Lender of Last Resort with a Central Bank and a Stability Fund

Giovanni Callegari\textsuperscript{1}  Ramon Marimon\textsuperscript{2,3}  Adrien Wicht\textsuperscript{3}  Luca Zavalloni\textsuperscript{1}

\textsuperscript{1}European Stability Mechanism

\textsuperscript{2}Universitat Pompeu Fabra - BSE, CREi, CEPR and NBER

\textsuperscript{3}European University Institute

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Motivation

Last two decades characterized by several crises:

- Multiple programs → Large fraction of debt in euro area institutions.

- No leading sovereign debt policy but heavy intervention of the ECB

  - Direct: PSPP, PEPP
  - Announced: MTO, TPI
Motivation

Eurosystem, ESM/EFSF, European Commission holdings of Member States government liabilities, % of end 2022 total government debt
Motivation

Last two decades characterized by several crises:

- Multiple programs $\rightarrow$ Large fraction of debt in euro area institutions.
- No leading sovereign debt policy but heavy intervention of the ECB
  - Direct: PSPP, PEPP
  - Indirect: MTO, TPI
- TPI is conditional on debt being sustainable:
  
  \[...in\textit{ ascertaining that the trajectory of public debt is sustainable, the Governing Council will take into account, where available, the debt sustainability analyses of the European Commission, ESM [...]}\]

$\Rightarrow$ What is to complement the ECB in its role of lender of last resort?
This Paper

- Role and design of Financial Stability Fund:

- Sovereign debt crises:

- Effective lender of last resort:
  - Sovereign debt stabilization.
Main Results

- **Fund prevents both** fundamental and belief-driven debt crises:
  - Provides securities contingent on state and non-default unlike private lenders.
  - Fills the gap in case of failed debt auction.

- **Fund is essential**

- **Perfect complementarity** between Fund and Central Bank:
  - Fund can stabilize sovereign debt (i.e. makes it safe), but may lack absorption capacity.
  - Central Bank has absorption capacity, but needs instruments to prevent fundamental risk.

- **Optimal** maturity structure as outcome of institutional design:
  - Longer maturities avert self-fulfilling debt crises.
  - Shorter maturities ease the Fund's intervention.
Outline

1  Environment

2  Quantitative Analysis

3  Conclusion
Benevolent government with no commitment acting as a representative agent

Continuum of private competitive lenders:
- Non-contingent long-term debt, $b' \leq 0$, maturity $\delta$ and coupon $\kappa$.
- Coordination on sunspot $\rho \in \{0, 1\}$

Financial Stability Fund:
- Full set of Arrow securities, $\hat{a}'(\theta)$.
- Complements private lenders (*Minimum intervention*)
Fund Contract I

- Two sided limited enforcement constraints
  - Fund should make no permanent losses ex-ante or ex-post:
    **No-Excessive-Lending (or DSA)**
    \[
    \mathbb{E} \left[ \sum_{j=t}^{\infty} \left( \frac{1}{1+r} \right)^{j-t} \tau_f(s^j) s^t \right] \geq \theta_{t-1} Z. \tag{NEL}
    \]
    No permanent loss if \( Z = 0 \)

  - Government should not default
    **No-default**
    \[
    \mathbb{E} \left[ \sum_{j=t}^{\infty} \beta^{j-t} U(c(s^j), n(s^j)) s^t \right] \geq V^D(s^t). \tag{ND}
    \]
    Value under default
\{c(s^t), n(s^t)\}_{t=0}^{\infty} is a solution to the Fund’s contract, given \(b_{l,0}\), if there exist sequences of transfers \(\{\tau_p(s^t), \tau_f(s^t)\}_{t=0}^{\infty}\) with associate \(\{b_{l,t}\}_{t=0}^{\infty}\), such that:

\[
\max_{\{c(s^t), n(s^t)\}_{t=0}^{\infty}} \mathbb{E} \left[ \sum_{t=0}^{\infty} \beta^t U(c(s^t), n(s^t)) + \mu_{l,0} \sum_{t=0}^{\infty} \left( \frac{1}{1+r} \right)^t \tau(s^t) \bigg| s_0 \right]
\]

s.t. (NEL), (ND)

\(\Rightarrow\) Existence and uniqueness: interiority condition and appropriate \(b_{l,0}\).

\(\Rightarrow\) Initial \(\mu_{b,0}\) and \(\mu_{l,0}\) obtained by setting (NEL) to 0 at \(t = 0\).
Two Types of Sudden Stops

1 Fundamental-driven (excessive lending externality):

- When (NEL) binds at $\theta'$, negative spread at $\theta$: $r_f(s, \omega, \bar{\omega}') = r_p(s, \omega, \bar{\omega}') < r$
- Negative spread restricts provision of Fund’s insurance and sustains no-trade in private bond markets
- Private lenders would like to liquidate their holdings to the fund and invest at $r$
  $\Rightarrow$ Fund must be ready to absorb long-term private debt position $\delta b_l$.

2 Belief-driven:

- Borrower is in crisis zone and $\rho = 1$.
- Fund must be able to absorb the Gross Financial Needs (GFN) if needed, i.e. $\bar{a}_l' \geq \bar{\omega}_l - \delta b_l$. 
Recall, two types of sudden stops to take care of:

- **Fundamental-driven:** $\delta b_i$ increasing in $\delta$.
- **Belief-driven:** \( GFN(\delta) = q_f(s, \omega, \bar{\omega}')(\bar{\omega}' - \delta \omega_l) \) decreasing in $\delta$.

The minimal capacity absorption for a Fund contract with maturity $\delta$ is:

$$A^c(\delta) = \max\{ GFN(\delta), \delta b_i \}.$$ 

The optimal maturity structure: $\delta^* = \arg\min_{\delta \in [0,1]} A^c(\delta)$.

The Required Fiscal Capacity (RFC) is $A^c(\delta^*)$. 
Optimal Maturity

\[ \tilde{A}^c(\delta^*) \]

- **Maximum** $\tilde{G}FN$
- **Maximum** $\tilde{\delta}b_l$
Fund’s Intervention

**Minimal Intervention Policy:** For a given state \((\theta, b_l)\), we say that the Fund implements a Minimal Intervention Policy if \(\bar{a}_l' = a(\theta, b_l)\) where

1. If (NEL) binds, \(a(\theta, b_l) \in [\bar{a}, \bar{a} + \delta b_l]\).
2. If (NEL) does not bind, \((s, \omega) \in C(\varphi)\) and \(\rho = 1\), then \(a(\theta, b_l) \in [\bar{\omega}_l - \delta b_l, \bar{\omega}_l]\).
3. Otherwise, \(a(\theta, b_l) = 0\).

**Implications:**

- **No Default:** With the Fund’s intervention, the sovereign does not default.
- **Safe Zone:** With the Fund’s intervention, the sovereign remains in the safe zone.
- **Safe assets:** With the Fund’s intervention, all sovereign debt liabilities become safe assets.

**The First and Second Welfare Theorems are satisfied.**
**Problem:** Fund may not have the necessary absorption capacity → e.g. ESM.

**Solution:** Central Bank (CB) may complement the absorbing capacity of the Fund.

**CB unpleasant arithmetic:**

- Reserves must be safe and transfers cannot be permanent.
- CB intervention conditional on sovereign debt free from fundamental defaults → ECB’s TPI/OMT.

**Fund allows CB to intervene and CB guarantees the success of Fund intervention.**
Outline

1 Environment

2 Quantitative Analysis

3 Conclusion
Calibration

Calibration to Italy 1992 to 2019
## Calibration Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
<th>SFC Without Fund</th>
<th>SFC With Fund</th>
<th>No SFC Without Fund</th>
<th>No SFC With Fund</th>
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<tr>
<td></td>
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<tr>
<td><strong>A. Targeted Moments</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$b'/y%$</td>
<td>117.64</td>
<td>118.00</td>
<td>123.70</td>
<td>119.10</td>
<td>176.8</td>
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<tr>
<td>$n%$</td>
<td>38.64</td>
<td>38.87</td>
<td>39.09</td>
<td>38.80</td>
<td>39.51</td>
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<tr>
<td>spread$%$</td>
<td>2.50</td>
<td>0.48</td>
<td>-0.04</td>
<td>0.13</td>
<td>-0.03</td>
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<tr>
<td>$\sigma(\tau/y)/\sigma(y)$</td>
<td>1.09</td>
<td>1.38</td>
<td>0.91</td>
<td>0.96</td>
<td>0.91</td>
</tr>
<tr>
<td>$\sigma(n)/\sigma(y)$</td>
<td>0.75</td>
<td>0.75</td>
<td>0.74</td>
<td>0.74</td>
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<td>corr(spread, $y$)</td>
<td>-0.16</td>
<td>-0.29</td>
<td>-0.71</td>
<td>-0.37</td>
<td>-0.66</td>
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<tr>
<td>corr($\tau/y$, $y$)</td>
<td>0.29</td>
<td>0.42</td>
<td>0.97</td>
<td>0.54</td>
<td>0.98</td>
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<td><strong>B. Non-Targeted Moments</strong></td>
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<tr>
<td>$\sigma(\text{spread})$</td>
<td>0.96</td>
<td>0.66</td>
<td>0.01</td>
<td>0.08</td>
<td>0.01</td>
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<tr>
<td>$\sigma(c)/\sigma(y)$</td>
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<tr>
<td>corr($c$, $y$)</td>
<td>0.53</td>
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<td>corr($n$, $y$)</td>
<td>0.68</td>
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<td>0.98</td>
<td>0.51</td>
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<td>State</td>
<td>Welfare Gains (%)</td>
<td>Maximal Debt Absorption (% of GDP)</td>
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<td></td>
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<td>-------</td>
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<tr>
<td></td>
<td>With Fund</td>
<td>With Fund</td>
<td>Without Fund</td>
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<td></td>
<td>SFC</td>
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<td>No SFC</td>
<td>SFC</td>
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<tr>
<td>$\rho = 0$ $\gamma = \gamma_{\text{min}}$</td>
<td>0.50</td>
<td>0.80</td>
<td>180</td>
<td>250</td>
<td>159</td>
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<tr>
<td>$\rho = 0$ $\gamma = \gamma_{\text{med}}$</td>
<td>0.16</td>
<td>0.42</td>
<td>144</td>
<td>194</td>
<td>136</td>
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<tr>
<td>$\rho = 0$ $\gamma = \gamma_{\text{max}}$</td>
<td>0.01</td>
<td>0.38</td>
<td>126</td>
<td>168</td>
<td>112</td>
</tr>
<tr>
<td>$\rho = 1$ $\gamma = \gamma_{\text{min}}$</td>
<td>0.50</td>
<td>-</td>
<td>180</td>
<td>-</td>
<td>158</td>
</tr>
<tr>
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<td>-</td>
<td>136</td>
</tr>
<tr>
<td>$\rho = 1$ $\gamma = \gamma_{\text{max}}$</td>
<td>0.01</td>
<td>-</td>
<td>126</td>
<td>-</td>
<td>112</td>
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<tr>
<td>Average</td>
<td>0.11</td>
<td>0.41</td>
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</table>
Average Italian debt maturity: 6.2 years.

Optimal debt maturity: 2.9 years.

Current needed capacity absorption: 105% of GDP.

Capacity absorption under optimal maturity: 90% of GDP.
Outline

1. Environment
2. Quantitative Analysis
3. Conclusion
Conclusion

- Optimal design of a lender of last resort.

- Fund is essential as it provides insurance and prevents excess lending.

- Fund averts debt crises but might lack the required absorption capacity.

- Central Bank can complement the Fund intervention.

- Optimal maturity to minimize the required absorption.
References


Appendix

Euro Area sovereign debt by country and holder I
Appendix

Security Price

- Price is determined by the agent whose constraint is not binding (Krueger et al., 2008)

\[ q_f(\theta', \omega'(\theta')|s, \omega) = \frac{\pi(\theta'|\theta)}{1 + r} \left[ (1 - \delta + \delta \kappa) + \delta \sum_{\theta''|\theta'} q_f(\theta'', \omega''(\theta'')|s', \omega') \right] \max \left\{ \frac{u_c(c')}{u_c(c)} \eta, 1 \right\}. \]

- If (NEL) binds in \( \theta' \), then \( q_f(\theta', \omega'(\theta')|s, \omega) > \frac{1 - \delta + \delta \kappa}{1 + r - \delta} \).

- As private lenders have access to the Fund, no arbitrage is possible so

\[ q_p(s, \omega, \bar{\omega}') = \sum_{\theta'|\theta} q_f(\theta', \omega'(\theta')|s, \omega). \]

\( \Rightarrow \) negative spread passes through private bond market.
Figure: Impulse Response Functions to a Negative $\gamma$ Shock Without SFC
Figure: Impulse Response Functions to a Negative $\gamma$ Shock With SFC and LOLR Absorption
Figure: Simulation of a Steady State Path Without SFC
Appendix

Simulation II

**Figure**: Simulation of a Steady State Path With SFC and LOLR Absorption
Figure: Absorption at Italian $\delta$
Figure: Absorption at optimal $\delta$
Appendix
Economy without the Fund

- Discrete choice with \( s \equiv (\theta, \rho) \):

\[
V(s, b) = \max_{b'} \mathbb{E}\left\{ V^P(s, b, b'), V^D(s) \right\}.
\]

- Value under repayment:

\[
V^P(s, b, b') = \max_{c, n} U(c, n) + \beta \mathbb{E}\left[ V(s', b') \right] \left| \begin{array}{c} \text{Value under default} \\
\text{Value under repayment} \\
\end{array} \right.
\]

\[
s.t. \quad c + q_p(s, b, b')(b' - \delta b) \leq \theta f(n) + (1 - \delta + \delta \kappa) b.
\]

- Value under default:

\[
V^D(s) = \max_n U(\theta^D f(n), n) + \beta \mathbb{E}\left[ (1 - \lambda) V^D(s') + \lambda V(s', 0) \right] \left| \begin{array}{c} \text{New private debt issuance} \\
\text{Maturing debt and coupon payment} \\
\text{Market re-access probability} \\
\end{array} \right.
\]
Private bond price:

\[ q_p(s, b, b') = \frac{1 - d(s, b, b')}{1 + r} \left[ 1 - \delta + \delta \kappa + \delta \mathbb{E} \left( (1 - d(s', b', b'')) q_p(s', b', b'') | s \right) \right]. \]

⇒ Multiple equilibria: in Eaton and Gersovitz, \( d(s, b, b') = 0 \ \forall (s, b, b') \) and \( \mathbb{E} d(s', b', b'') \geq 0. \)

In Eaton and Gersovitz, \( d(s, b, b') = 0 \) for all \( (s, b, b') \) and \( \mathbb{E} d(s', b', b'') \geq 0. \)

Three zones:

1. The safe zone: \( D(s, b) = 0 \) and \( \rho \) is irrelevant.
2. The default zone: \( D(s, b) = 1 \) and \( \rho \) is irrelevant.
3. The crisis zone: \( D(s, b) = 1 \) if \( \rho = 1 \) and \( D(s, b) = 0 \) if \( \rho = 0. \)

⇒ \( D(s, b) = d(s, b, B(s, b)) \) where \( b' = B(s, b). \)