Reverse Stress Testing

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* Any views expressed are those of the author and do not necessarily reflect those of the ECB
## Overview

1. **Overview**
2. **General Remarks**
3. **Minor Comments**
Contribution

Development of a algorithmic and systematic methodology to design stress test scenarios, assuming banks’ react optimally by minimising losses from forced liquidations.

Policy relevance from …

… a Microprudential perspective
  – Which banks are most vulnerable to worst-case stress test scenarios?
  – How important is the selection of “the most appropriate scenario”?

… a Macroprudential perspective
  – Which worst-case economic scenarios maximize contagion in the financial system?
  – How do shocks spill over from one institution to another?
Three step approach

1. **Economic model**: banks react optimally to minimise fire-sale losses in light of an adverse exogenous shock to the value of their non-tradable assets.

2. **Simulation approach**: Identify worst-case scenarios leading to maximal contagion from fire-sale losses.

3. **Empirical Analysis**: For the identified worst-case scenarios, investigate what characterises these scenarios: which banks / asset classes are most affected?

Data

- **EBA 2016 EU-wide ST**: notional exposures for 51 European banks, across hundreds of asset classes (marketable: corp & sov).
- **BIS**: residual and commercial property prices to ensure stress scenarios are consistency with historical asset price co-movement.
### Banks’ balance sheets

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-tradable</td>
<td>CET1</td>
</tr>
<tr>
<td>Tradable</td>
<td>Other liabilities</td>
</tr>
</tbody>
</table>

### Regulatory constraint can be

1. **Leverage constraint**
   \[
   \frac{\text{Non tradable} + \text{tradable}}{\text{CET1 capital}} \leq \lambda_{\text{max}}
   \]

2. **RWA constraint**
   \[
   \frac{\text{Non tradable} \times RW + \text{tradable} \times RW}{\text{Capital}} \leq \phi_{\text{max}}
   \]

### Stress scenario

Exogenous adverse shock to non-tradable assets results in an immediate loss for a bank

### Deleveraging

To comply with the regulatory constraint, a bank deleverages by selling tradable assets

### Price impact

Selling tradable assets triggers ↓ their value, depending on total sales in the system and their market depth

### Fire sale losses

Marking-to-market ↓ value of tradable assets in portfolio; Realised losses on tradable assets sold with ↓ value

### Contagion

Fire sales by one institution spill over to another, initiating potential feedback loops
Main findings

1. **Worst-case scenarios**
   Those scenarios leading to maximal contagion from fire-sale losses can be **heterogeneous in terms of the underlying factor shocks**.

2. **Macroprudential perspective**
   In the identified worst-case scenarios, banks with the largest initial loss from the shocks to non-tradable assets differ from those with the largest fire-sale losses, suggestive of a predominantly **non-overlapping contagion channel**.

3. **Microprudential perspective**: 
   Despite heterogeneity in the identified worst-case **scenarios**, all **target a small subset of banks**, which drive contagion within the financial system.
1. Definition of worst-case scenarios

• **Evaluate 22 500 shock scenarios**, which are
  1. Historically consistent (i.e. capture the co-movement of historical asset prices);
  2. The initial shock can not be too severe (i.e. maximum initial monetary loss in the system < 10%).

• Subsequently, **400 worst-case scenarios are selected for further analysis** (i.e. those where fire-sale losses >40 EURbn*).

• **This severity threshold warrants further motivation**, as it determines the sample/results.

• **Potential suggestions**:
  – Could we miss a relevant part of the loss distribution by looking only at the 400 scenarios of highest losses?
  – Consistency with historical narratives?**

* What is the metric being used as a cut-off: solely initial losses or including feedback effects?
** Nevertheless, designing stress test scenarios independently from historical data provides the advantage of quantifying known-unknown scenarios.

![Distribution of fire sales losses for worst case scenarios](chart.png)
GENERAL REMARKS

2. Plausibility of worst-case scenario

• “…the Basel Committee on Banking Supervision's requirement that stress tests be (i) plausible, (ii) severe and (iii) suggestive of risk-reducing actions.” [Baes and Schaaning (2019, p. 3)]

• The paper focusses primarily on severity, yet from a policy perspective, one should consider as relevant also the (different) plausibility of the identified worst-case scenarios.

• Already take into account that the initial shock
  – is not so severe that all institutions default immediately
    However, further motivation necessary for the chosen maximum
    • percentage shock (i.e. $\bar{\epsilon}_k = 20\%$);
    • initial monetary loss across the system (i.e. $L_{\text{max}} \in [0.1\%, 10\%]$)
  – makes economic sense (i.e. be historically consistent)
    However, this consistency only pertains to the historical correlation structure between shocks, and not to the plausibility of the identified worst-case scenario.
3. Distributional statistics empirical results

- **Key results** describe **averages across identified worst-case scenarios** (e.g. mean fire-sale losses for a bank), and conditional means for different scenario clusters.

- However, **other moments of the distribution** (e.g. standard deviation, skewness) would prove useful to **understand whether results are consistent across worst-case scenarios or driven by outlier scenarios**.
4. Risk-weighted assets constraint

- How do the empirical results change when considering a risk-weighted asset constraint to determine banks’ optimal behaviour, as opposed to the leverage constraint?
- In Section 3.4.3, results show a predominance of sovereign assets being sold.
Minor Comments

1. **Section 2.2:** Further motivation warranted for the chosen
   – form of the market depth equation?
   – liquidation horizon?

2. **Section 2.3:** To improve readability, further details could be provided for the
   transition from equation (5) to the optimization problem in (6) - (9).*

3. **Section 3.2:**
   – For the benefit of the reader, the paper could elaborate in further detail the
     characteristics of the empirical datasets being used.
   – Corporate exposures are identified as marketable assets, but this will
     depend on their respective ratings.

4. **Section 3.3:** Which banks are ultimately most vulnerable to the worst-case
   scenarios? Figures on the joint impact from initial losses (Figure 5) and fire-sale
   losses (Figure 6) could help in this area.

5. **Section 3.3 onwards:** Existing empirical methods could be motivated more to
   clarify how these methods best allow to answer the questions being set forth.

* For instance, no definition provided for variable $l_i$ in equation (7) and (9).