



OESTERREICHISCHE NATIONALBANK  
EUROSYSTEM

# Modelling solvency and liquidity stress interactions

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Oesterreichische Nationalbank

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## Disclaimer

**The opinions expressed in this presentation are those of the authors and do not necessarily reflect those of the OeNB or the Euro System.**

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# Agenda

## **Austrian stress test models**

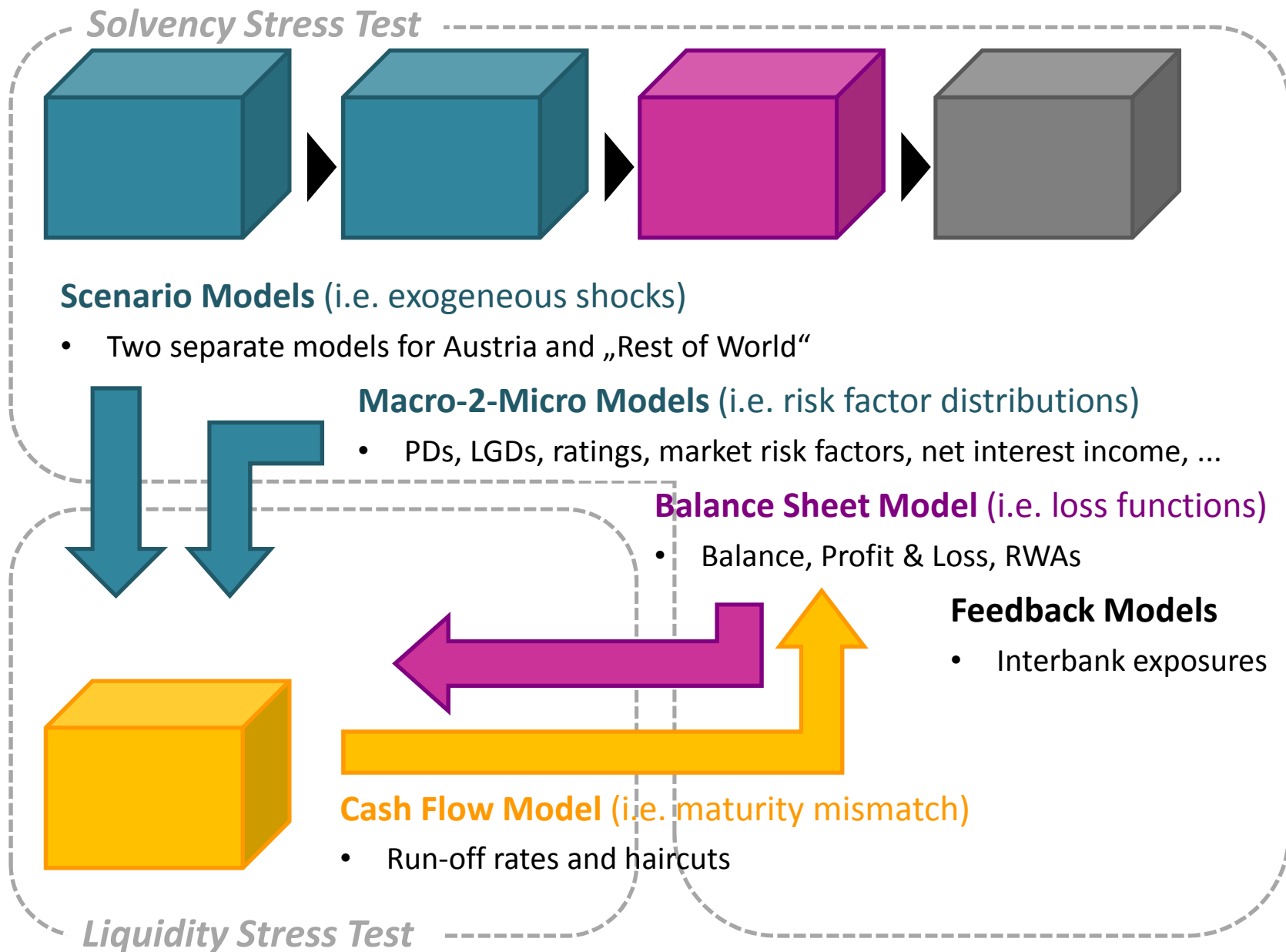
Solvency stress test model

Liquidity stress test model

Interaction solvency/liquidity

Results & conclusions

# Austrian solvency stress test models



## Data sources for stress testing in Austria

Reporting	Solvency	Liquidity
<b>Scope</b>	All Austrian banks (~600 consolidated, ~800+100 unconsolidated)	29 largest Austrian banks on a consolidated / sub-consolidated basis
<b>Frequency</b>	Quarterly	Weekly
<b>Sources</b>	FINREP & COREP (incl. cross-border subs) Central Credit Registry NFC default frequencies Bloomberg data Macroeconomic variables	Weekly liquidity reporting Unencumbered collateral deposited at OeNB Reporting data on NFC bond holdings
<b>Cut-off date</b> (for this example)	2012Q4	2012Q4

# Agenda

Austrian stress test models

**Solvency stress test model**

Liquidity stress test model

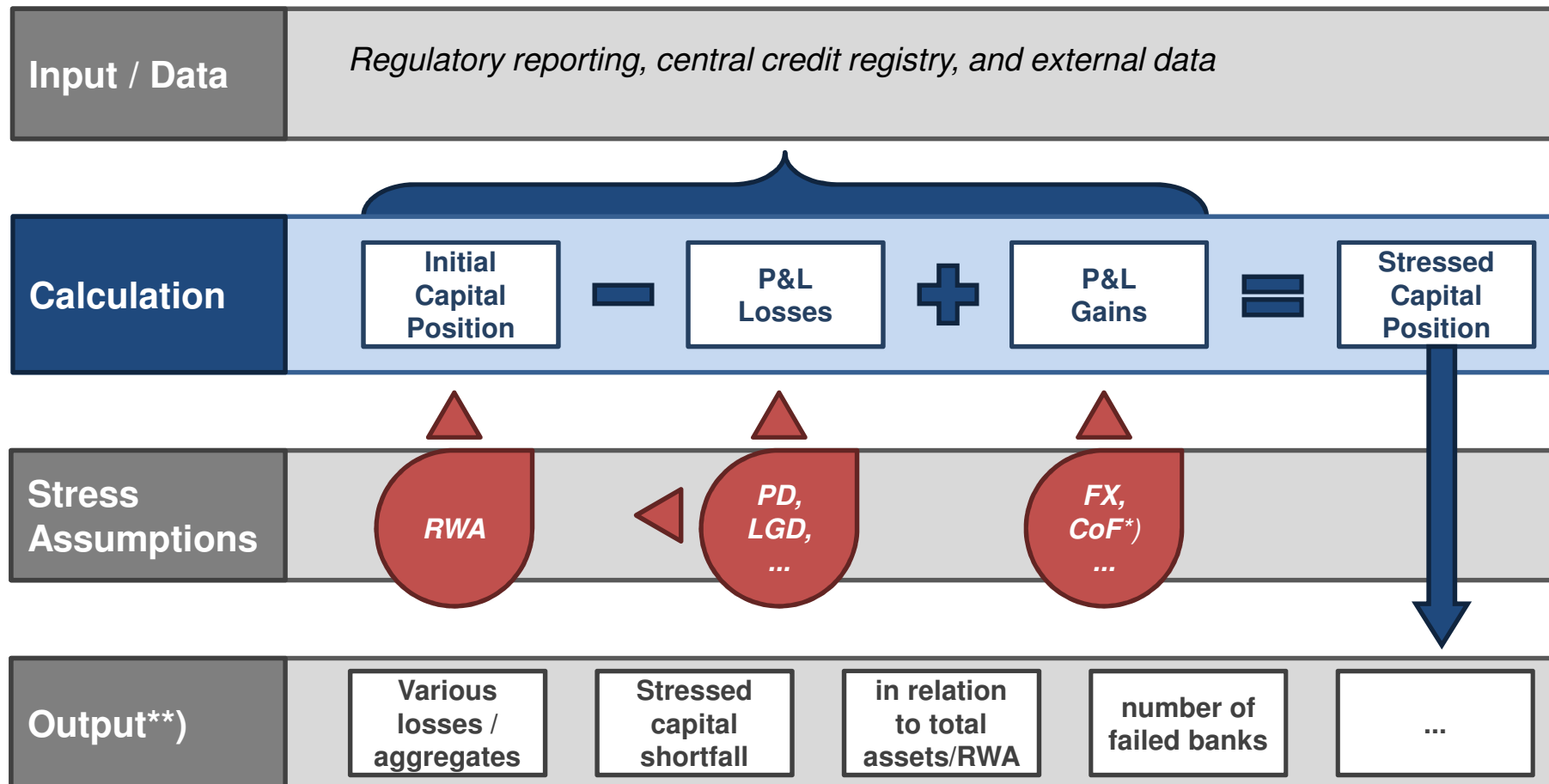
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# Main challenges of solvency stress tests

Main challenges	OeNB solution
Availability of granular data	Central Credit Registry
Robustness of the scenario	Cooperation with Economics Department
Uncertainty of the risk factor distributions	Model averaging for macro-2-micro models
Uncertainty with regard to the loss functions	Bottom-up benchmarks, cross sectional comparisons, extensive back testing
Explicit link to liquidity	Cost of funding, fire sales (preliminary)
Network externalities	Only partially addressed (IB contagion)

# Solvency stress testing model (ARNIE\*\*)



\*) CoF = Cost of Funding

\*\*) ARNIE = Applied Risk, Network and Impact assessment Engine, OeNB's new systemic risk assessment tool, fully implemented in Matlab (see Feldkircher et al., 2013)



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Austrian stress test models

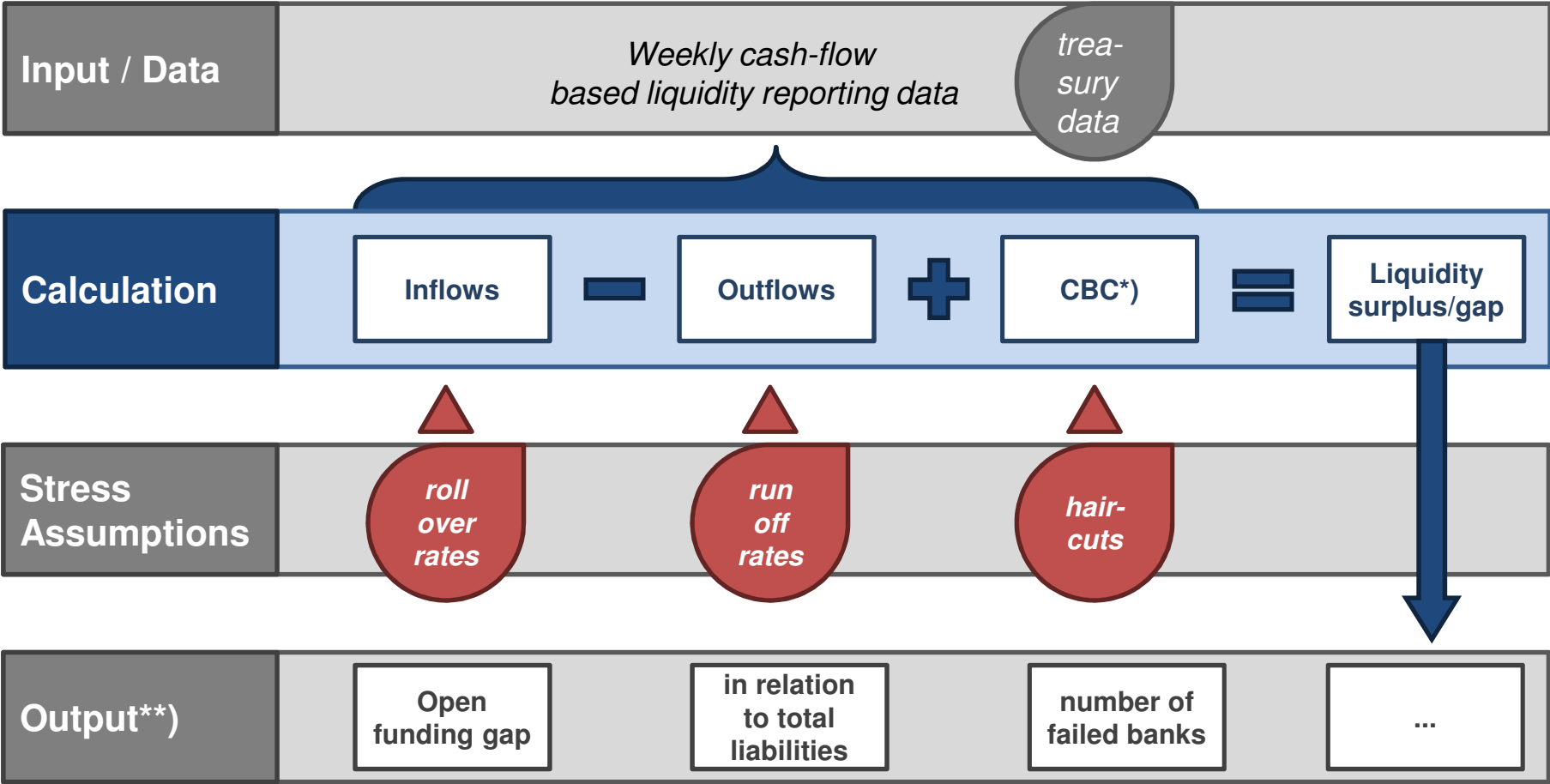
Solvency stress test model

**Liquidity stress test model**

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# Liquidity stress testing model



\*) CBC = Counter Balancing Capacity

\*\*\*) A bank fails the stress test (i.e., has a liquidity gap) if it is not able to cover a possible net funding gap (i.e.,  $Inflows < Outflows$ ) with its counterbalancing capacity

# Main challenges of liquidity stress tests

Main challenges	OeNB solution
Availability of cash flow data	Weekly cash flow report in six currencies
Scenario design	Close link to solvency scenario
Scenario calibration	Extensive empirical foundation
Parameter uncertainty	Three groups of 12 embedded scenarios
Explicit link to solvency	Macro-to-PD shifts feed into CC migration matrix in CBC & CIF (loans)
Treatment of CBs as lender of last resort	Three stage gradual approach

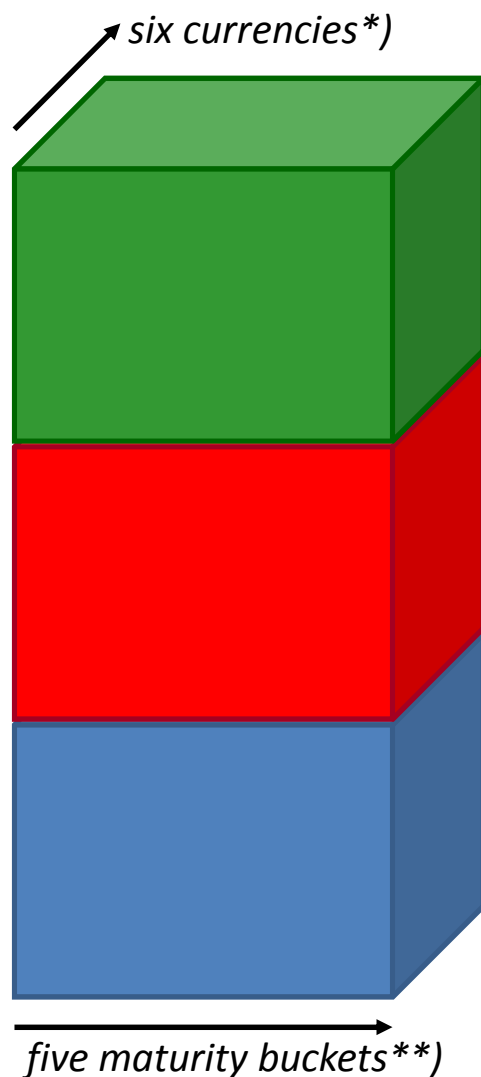
# Data requirements

Contractual / behavioural maturities	Gross / net cash flows	Liquidity coverage approach / separation of li risk exposure & risk bearing capacity	Stock of liquid assets / counterbalancing capacity
Single currency / multiple currencies	Frequency, cut-off date and reporting time lag	Product oriented/accounting balance sheet based versus functional items	Reporting period and bucket size (9 buckets)
	Consolidated / solo	Differentiation according to business model / comprehensive template	

# Template design crucial

Contractual & behavioural	<ul style="list-style-type: none"><li>▪ Without contractual → <b>results biased</b></li><li>▪ Behavioural assumptions explicit → <b>reveal risk tolerance</b></li><li>▪ Allow for <b>institution specificity</b></li></ul>
Gross cash flows	<ul style="list-style-type: none"><li>▪ Allow for differentiated analysis of liquidity risk exposure → <b>more risk sensitive</b></li><li>▪ More granular stress tests possible</li></ul>
Counterbalancing capacity	<ul style="list-style-type: none"><li>▪ <b>Consistency</b> across inflows/outflows counterbalancing capacity</li><li>▪ Makes implicit assumptions of stock explicit → <b>information gain</b></li></ul>
Multiple currencies	<ul style="list-style-type: none"><li>▪ <b>Liquidity risk currency specific</b></li><li>▪ Links across currencies product specific</li></ul>
Functional items	<ul style="list-style-type: none"><li>▪ <b>Common language</b> among li-risk managers &amp; supervisors</li><li>▪ <b>Facilitates</b> scenario design &amp; calibration</li></ul>

# Austrian maturity mismatch template



## Inflows (14 line items)

- Maturing instruments (loans, swaps, ...)
- Fixed / expected issuances (short- and long-term)
- Expected deposit inflows (un/secured, retail / wholesale)

## Outflows (16)

- New loans, advances, calling of lines, ...
- Tender, Repos, Issuances (due)
- Expected deposit outflows (un/secured, retail / wholesale)

## Counterbalancing Capacity (9)

- Cash, excess reserves at the central bank (by rating category)
- Tender / unencumbered collateral
- Liquid and other assets available for collateralisation

\*) Six currencies include: EUR, USD, CHF, GBP, YEN and a basket of other currencies.

\*\*\*) Five maturity buckets cover: up to 5 days, 1 month, 3 months, 6 months and 12 months.

# Scenario calibration

## Consistency with solvency scenario

- Often contain relevant parameters (e.g. bond prices)

## Econometric approach not feasible

- Low frequency/high impact events
- Data hardly available

## Product & market specific

- Reporting data & academic literature (IMF WP03/12, BCBS WP 24/25 2013)

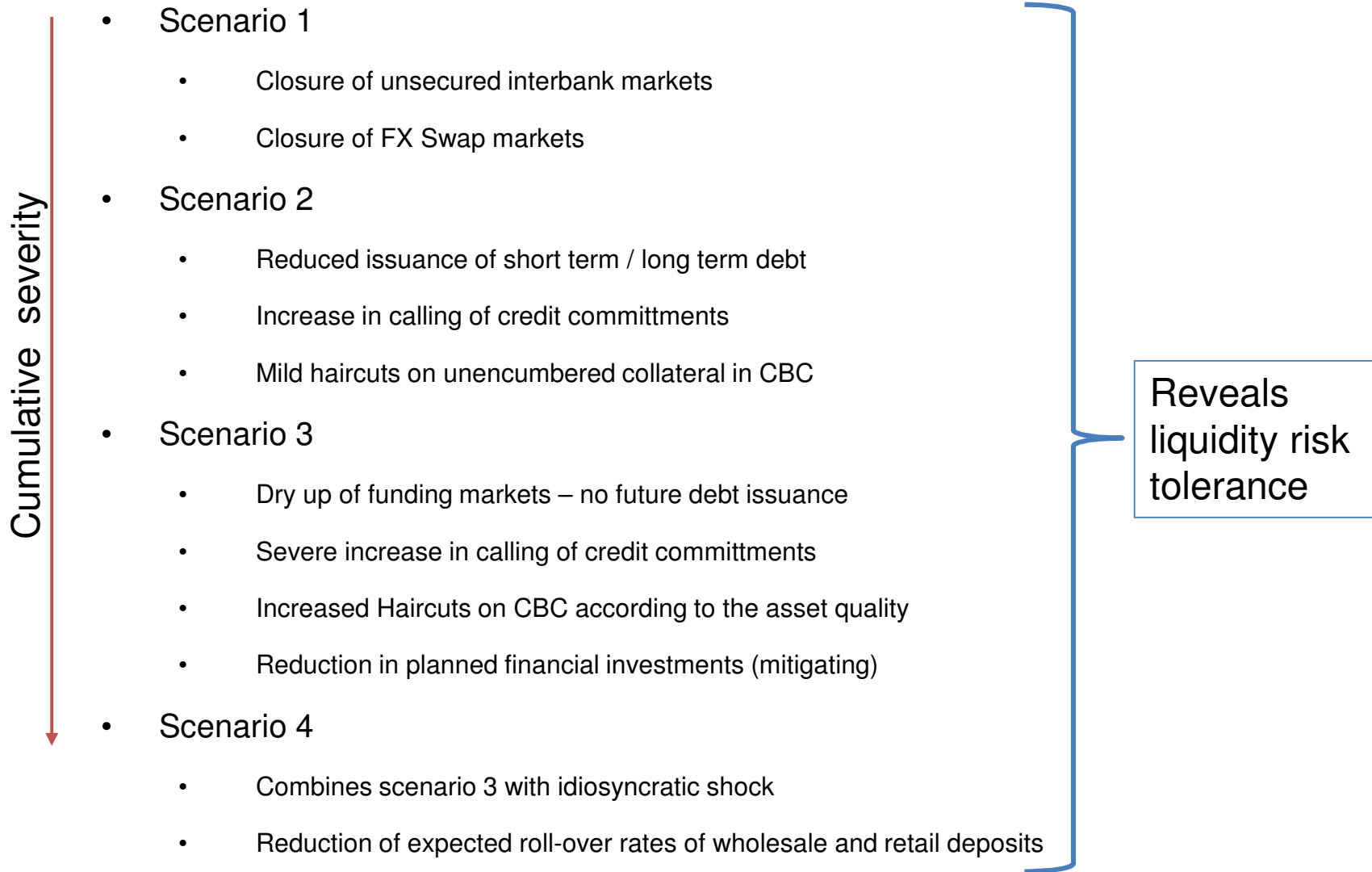
## Case studies

- Bank, market & country level (IMF WP03/12, BCBS WP 24/25 2013)

## Output of solvency stress test

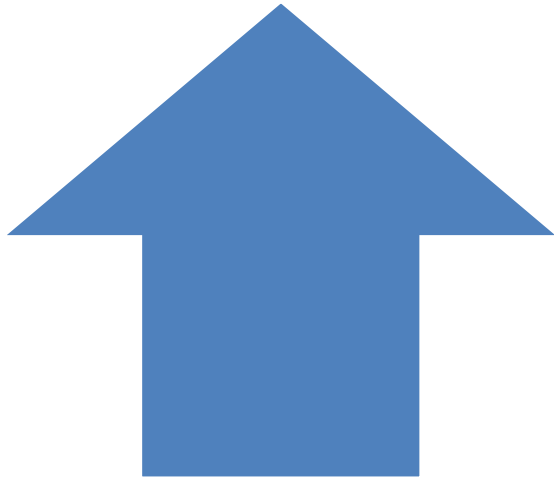
- See discussion below

# parameter uncertainty – embedded scenarios



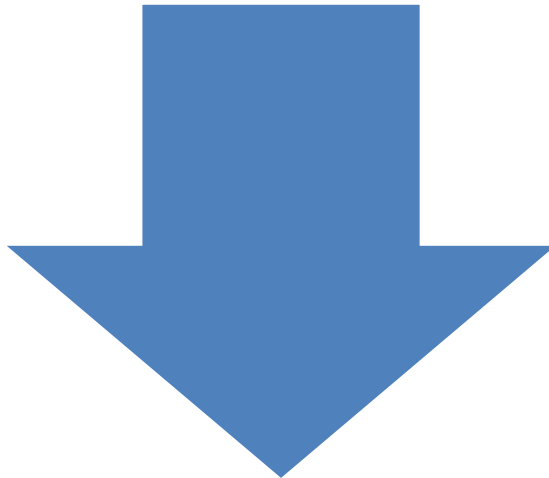


## Treatment of CBs as lender of last resort



### Lender of last resort

- Discretionary/extra-ordinary deviation from the standard framework of monetary policy implementation
- Liquidity provided to individual/subsample of institutions on specific terms that are not available to other market participants



### Monetary policy implementation

- Reaction to expected increase of the structural liquidity deficit at the target rate
- Always market oriented – never individual bank focused
- Can entail deviations from standard monetary policy

# LoLR: focus on markets rather than failing bank

## Arguments for reliance on LoLR

- Historical experience
- Theory
  - Potential efficiency gains under restrictive assumption (e.g. prevent asset fire sale contagion)

## Arguments against reliance on LoLR

- Conflicts with *raison-d'être* for liquidity regulation
  - Internalise externality & moral hazard & efficient allocation of liquidity & risk
  - Qualitative liquidity regulation aims at self-insurance (CEBS 2009, 2010a, BCBS 2010)
- FX liquidity (e.g. Bulgaria)
- LoLR cannot be considered in isolation (subordination, bank resolution)
- Political economy of bail-outs
  - Interference in property rights, fiscal exposure, distributional effects
- CB discretion undermined
  - Delienation of illiquidity from insolvency impossible under time pressure
  - Conflict of interest with monetary policy implementation

Potential efficiency gains can be achieved by less distortionary alternatives

# Less distortionary alternatives to standard LoLR

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## Pricing

Charging a fee according to the liquidity risk exposure and liquidity risk bearing capacity of the bank

Objective: Internalise the externality associated with liquidity risk → banks should be indifferent between effective self-insurance and insurance by the public

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Challenge: unrealistic → fair price difficult to estimate (see pricing of RCLF in AUS)

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## Conditionality

Automatic sanctions

Replacement of board members

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Trigger for early intervention mechanism

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## Liquidity provision to market rather than illiquid bank

Address asset fire sale externality

assumes other market participants cannot exploit underpricing due to liquidity constraints

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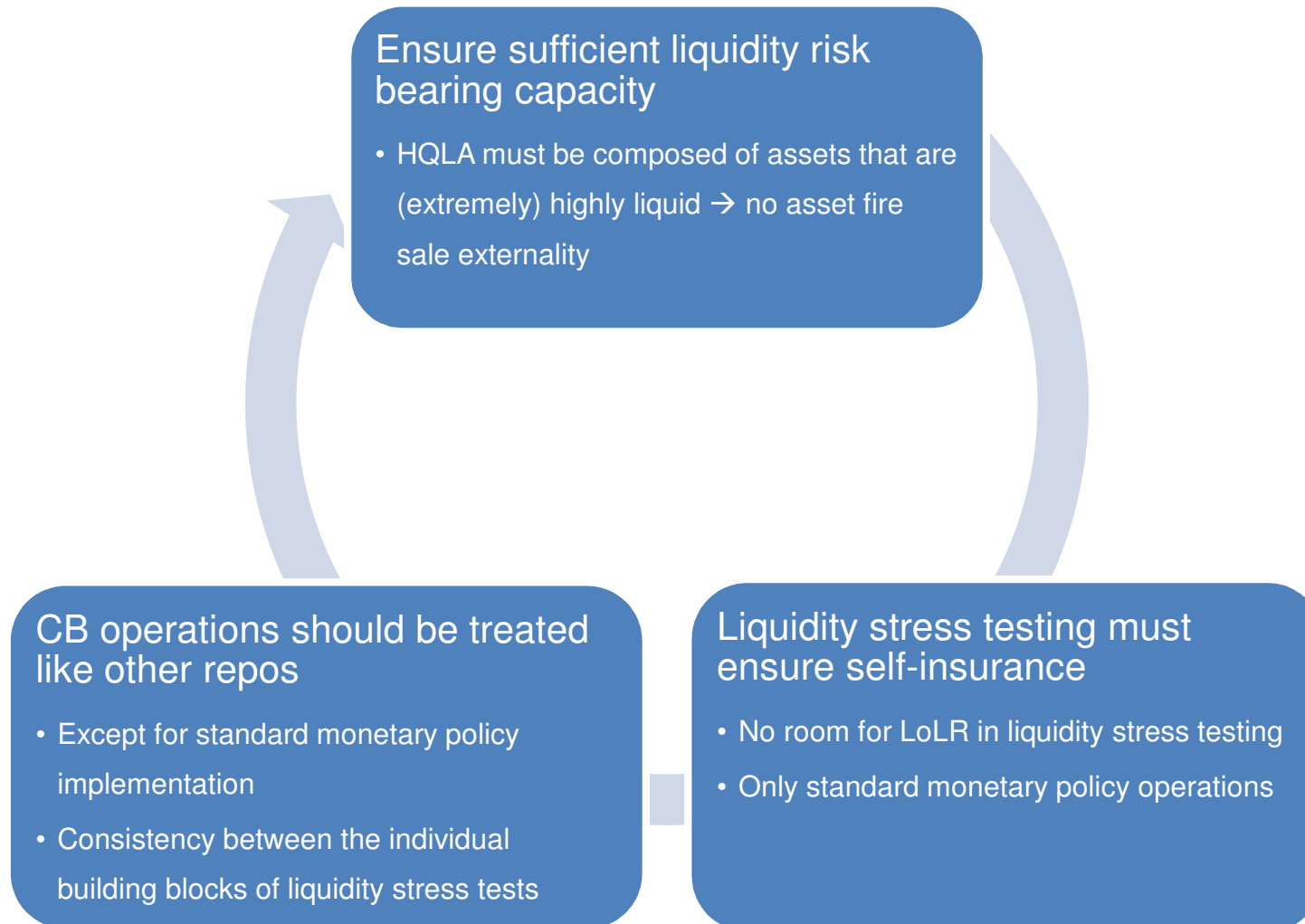
Original concept of the LoLR according to Thornton and Bagehot

Enables other market participants to profit from underpricing

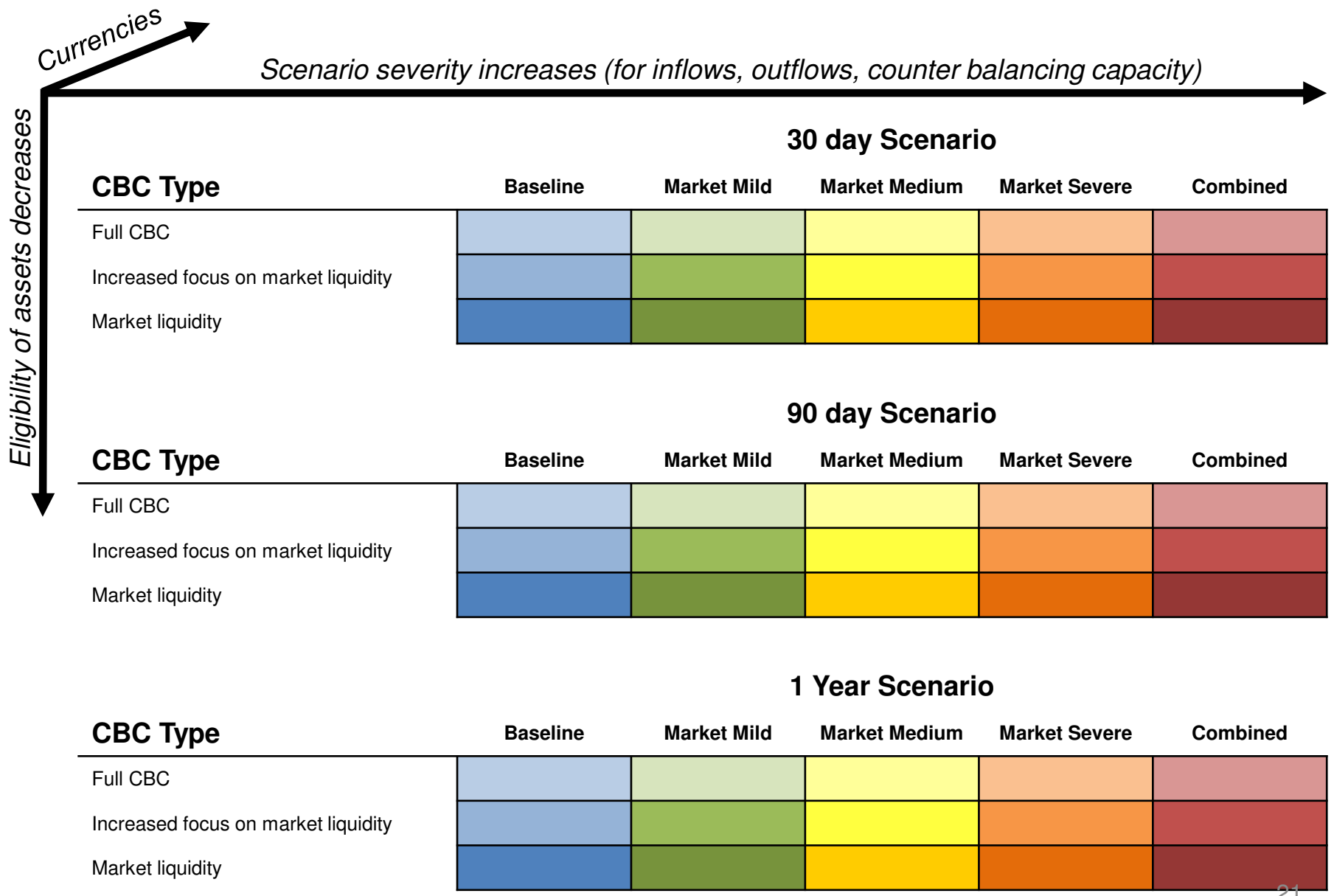
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Limits negative price effect

## Conclusions: No LoLR in liquidity stress testing



# Scenario & parameter uncertainty



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Liquidity stress test model

**Interaction solvency/liquidity**

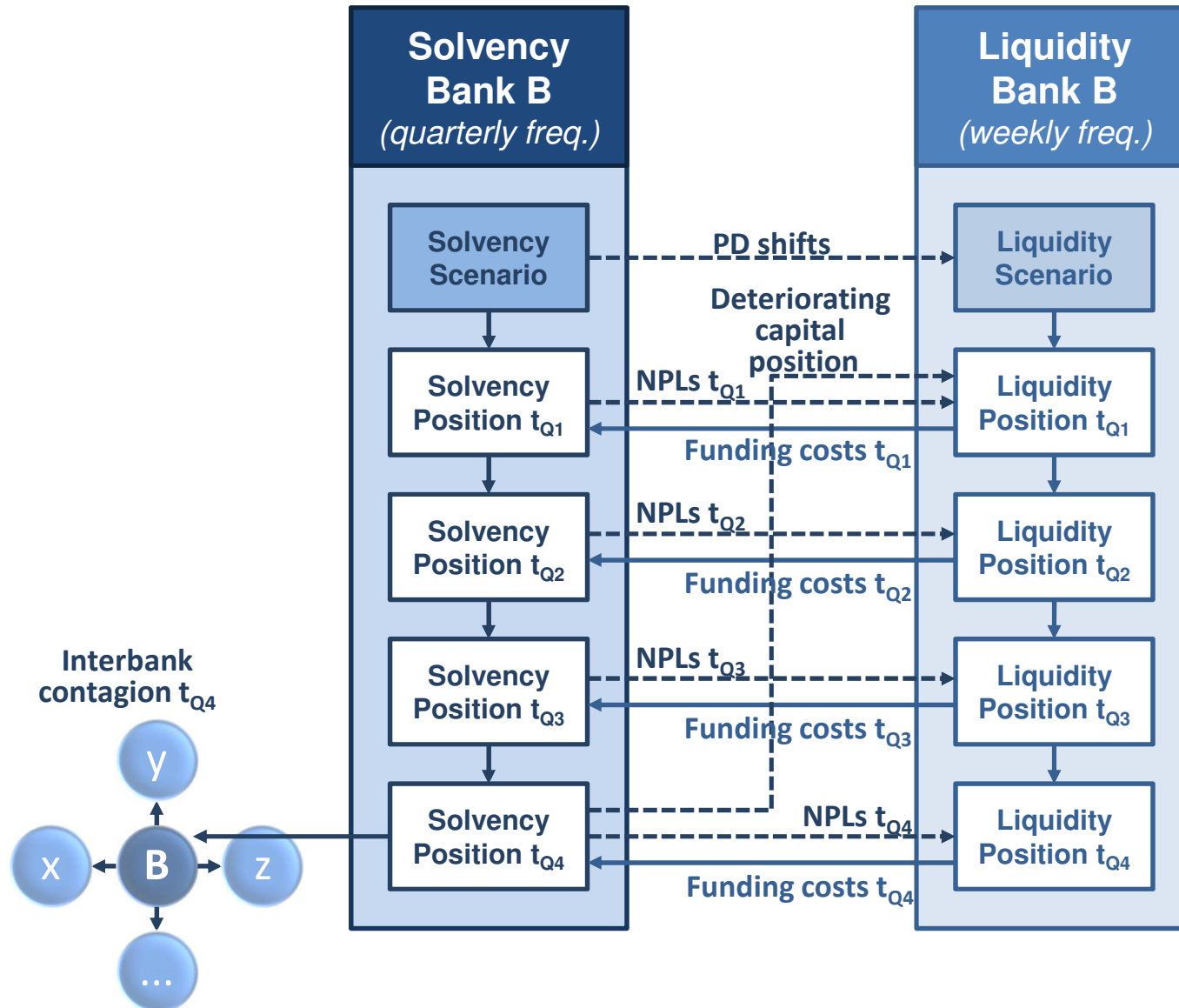
Results & conclusions

# Interlinkages solvency / liquidity

<b>Solvency Stress Test</b>	<b>Mapping to Liquidity Stress Test</b>
<b>Deteriorating Capital Position</b>	Ability to issue new CP & bonds (12M scenario)
<b>Increase in Expected NPLs</b>	Reduction in expected inflows from loan repayments Reduction of expected inflows from NFC bonds
<b>Macro-driven PD Shifts</b>	Implied rating migration of banks unencumbered collateral deposited at CB

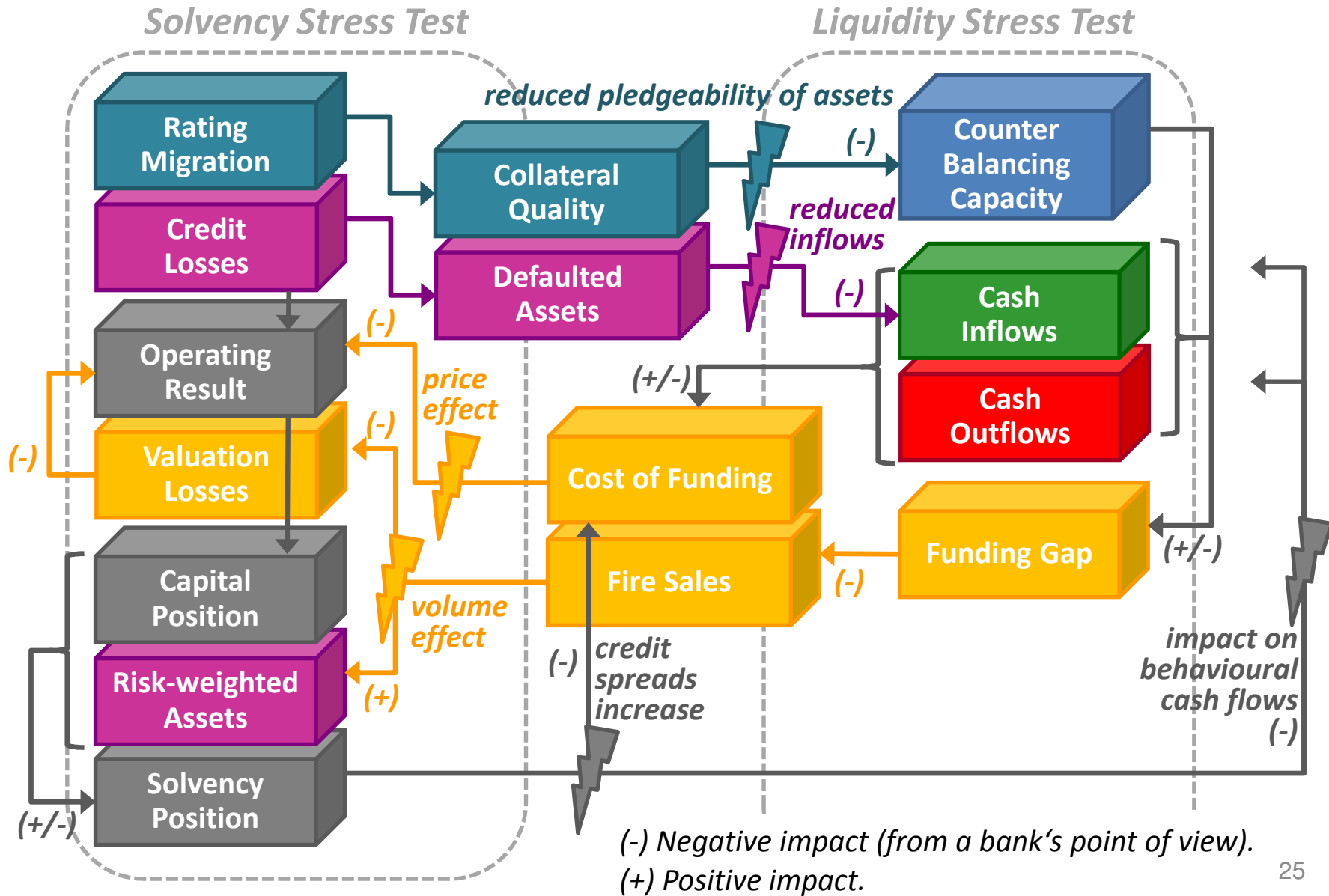
<b>Liquidity Stress Test</b>	<b>Mapping to Solvency Stress Test</b>
<b>Liquidity gap</b>	Asset fire sales
<b>Increase in Funding Costs</b>	P&L effects

# Timing / sequencing of interaction

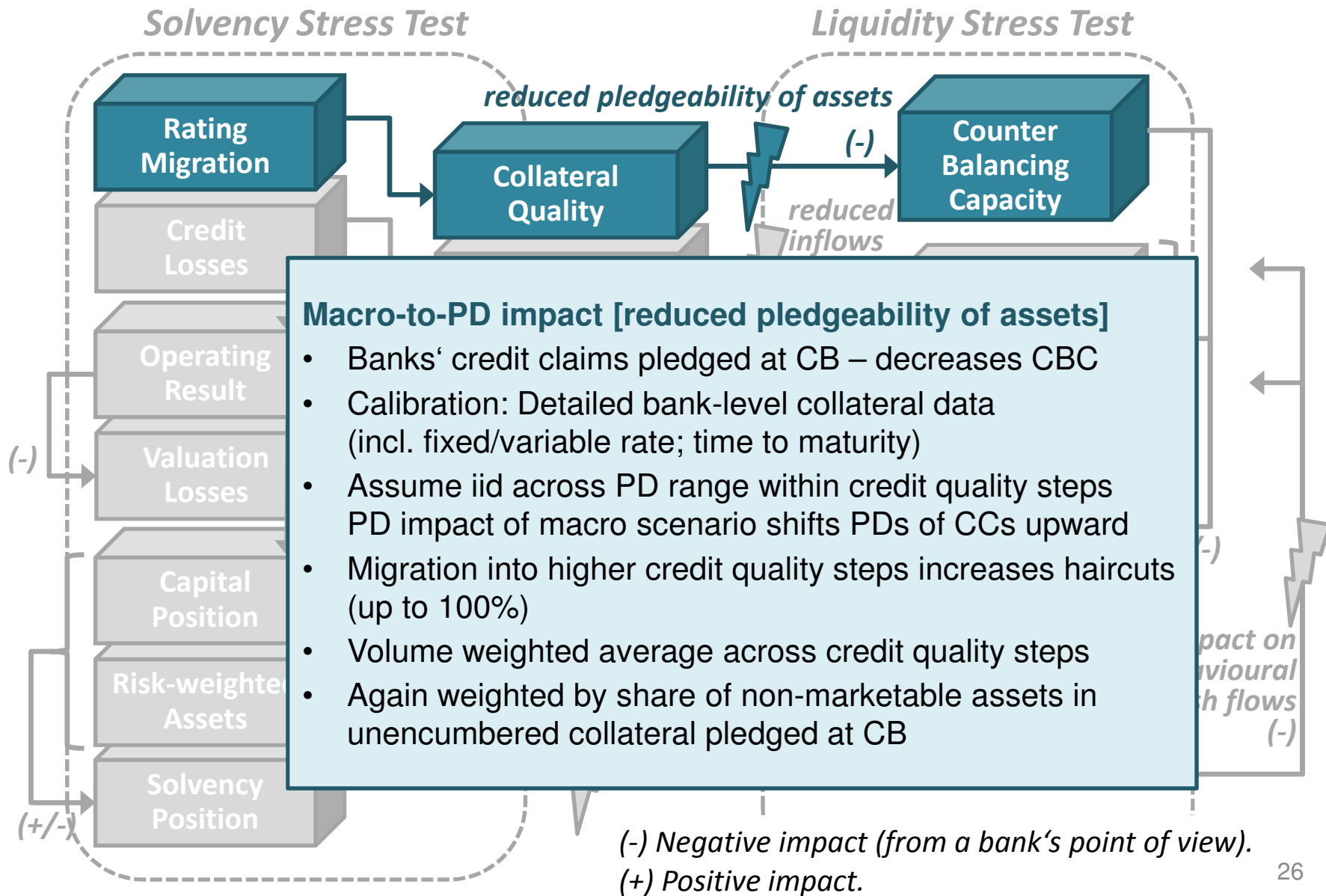




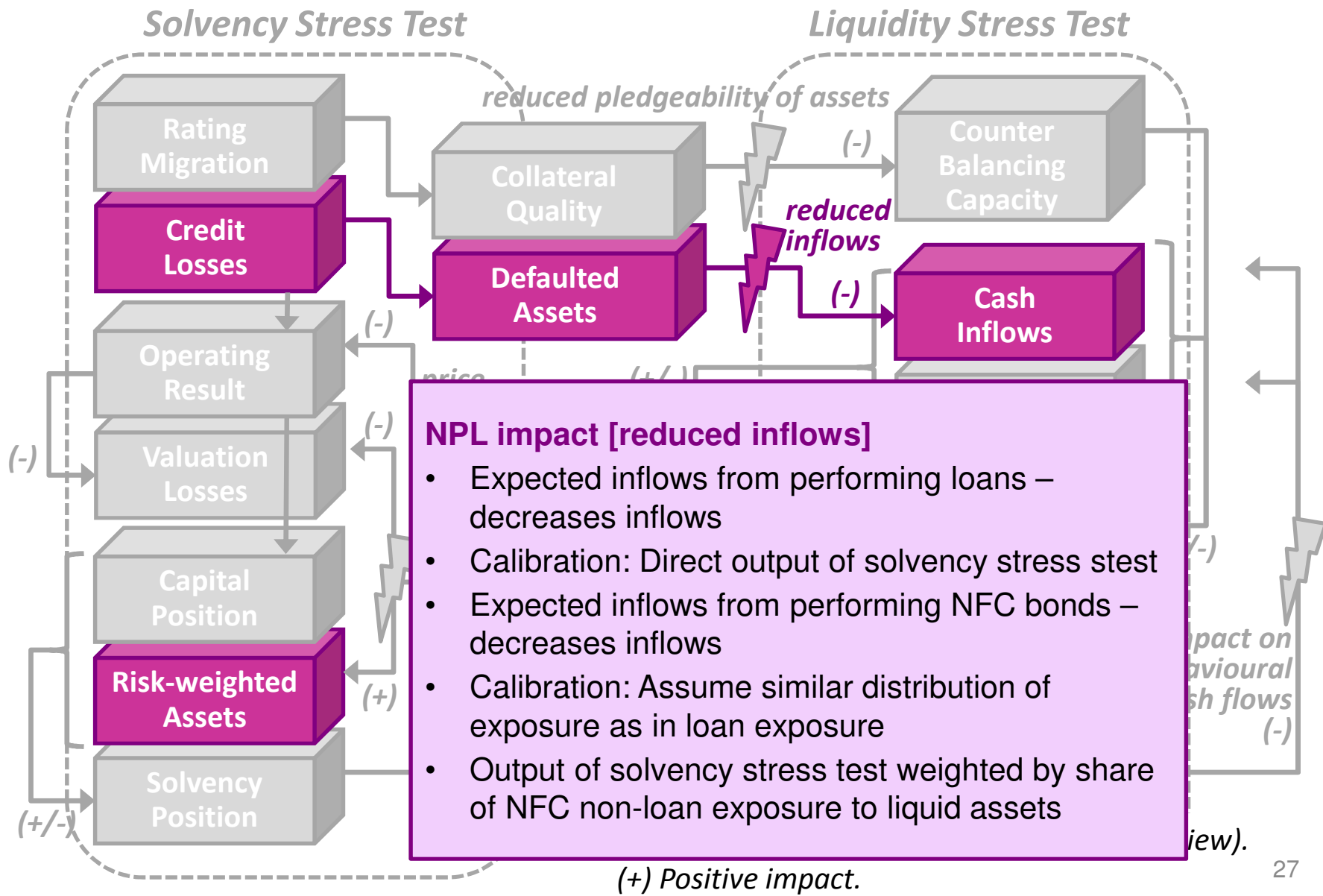
# The interaction of solvency and liquidity



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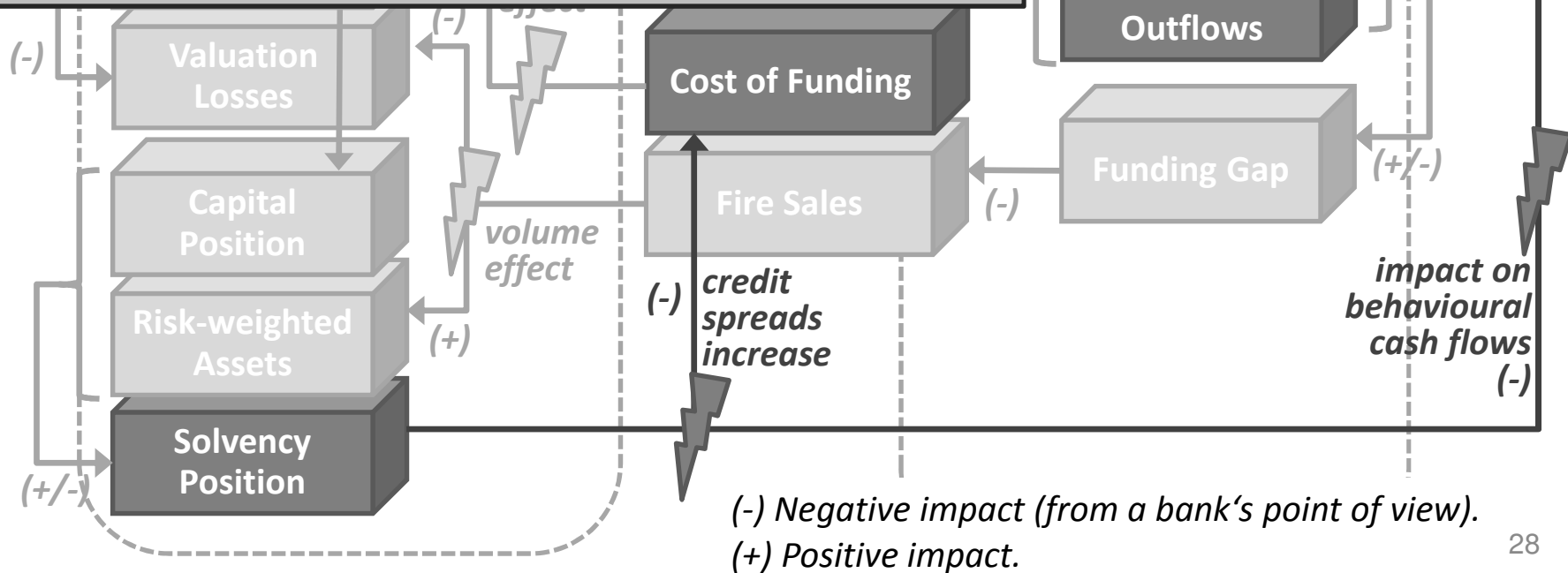
# The interaction of solvency and liquidity



**Solvency impact on funding**  
**[impact on behavioural cash flows]**

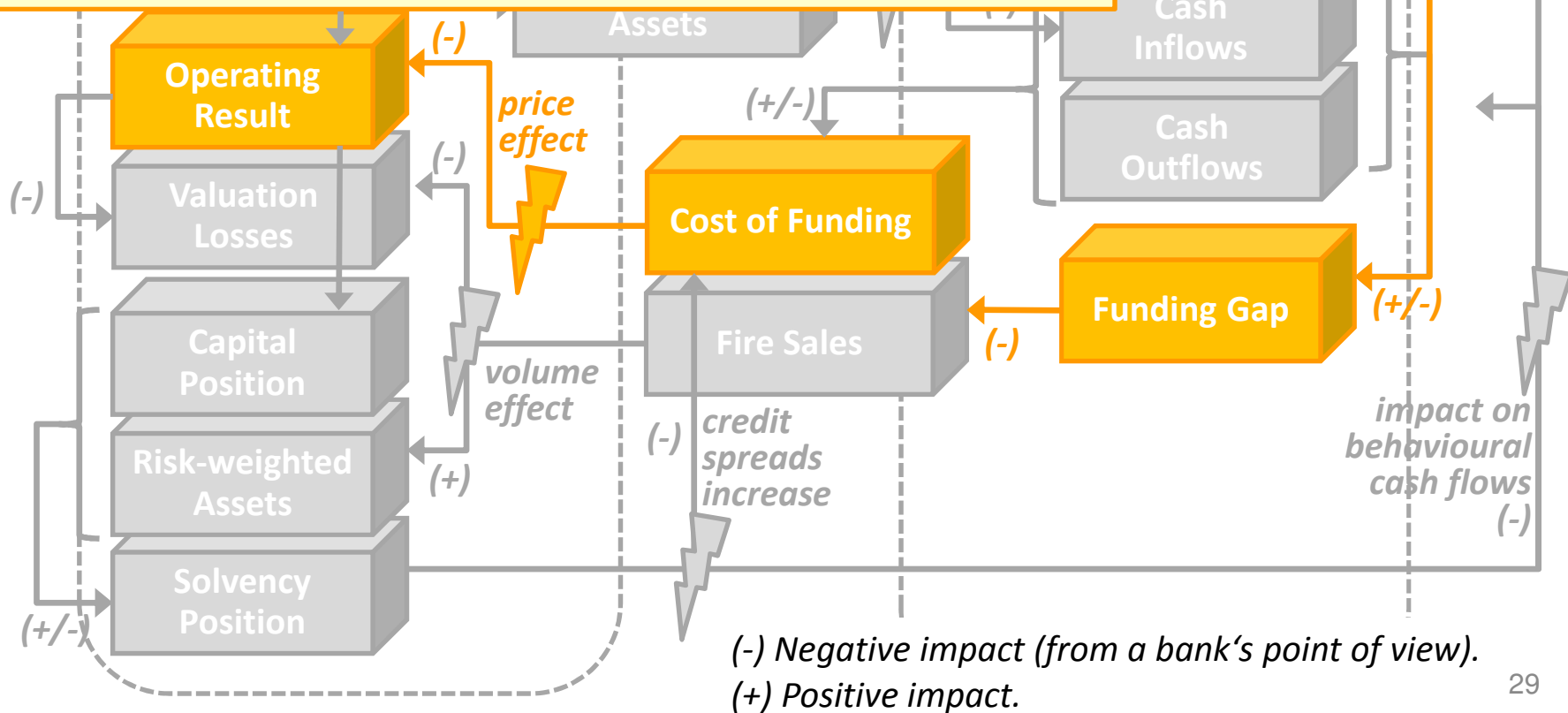
- Inspired by dynamics in ABCP market after Lehman
- $t_0$ : all banks shut out of issuance markets
- $t_1$ : markets differentiate across banks based on expected solvency evolution
- Based on similar scenario/model as solvency stress test
- Banks with CET1 ratio > 10% or +100 bp at  $t_4$  regain market access (70%)
- Empirical foundation is work in progress

**Impact on unsecured MM – complete dry-up pre-empt potential impact of this channel**



## Cost of funding shock [credit spread increase – price effect]

- Increasing funding costs – impact on P&L
- Calibration: Based on post Lehman spread evolution in AT (not bank specific)
- Impact on stress cash-flows
- New issuance play minor role (loss of/reduced market access)
- Repricing of maturing funding, pass-through to new loans
- Cost of funding shock driven by maturity mismatch (bank specific)

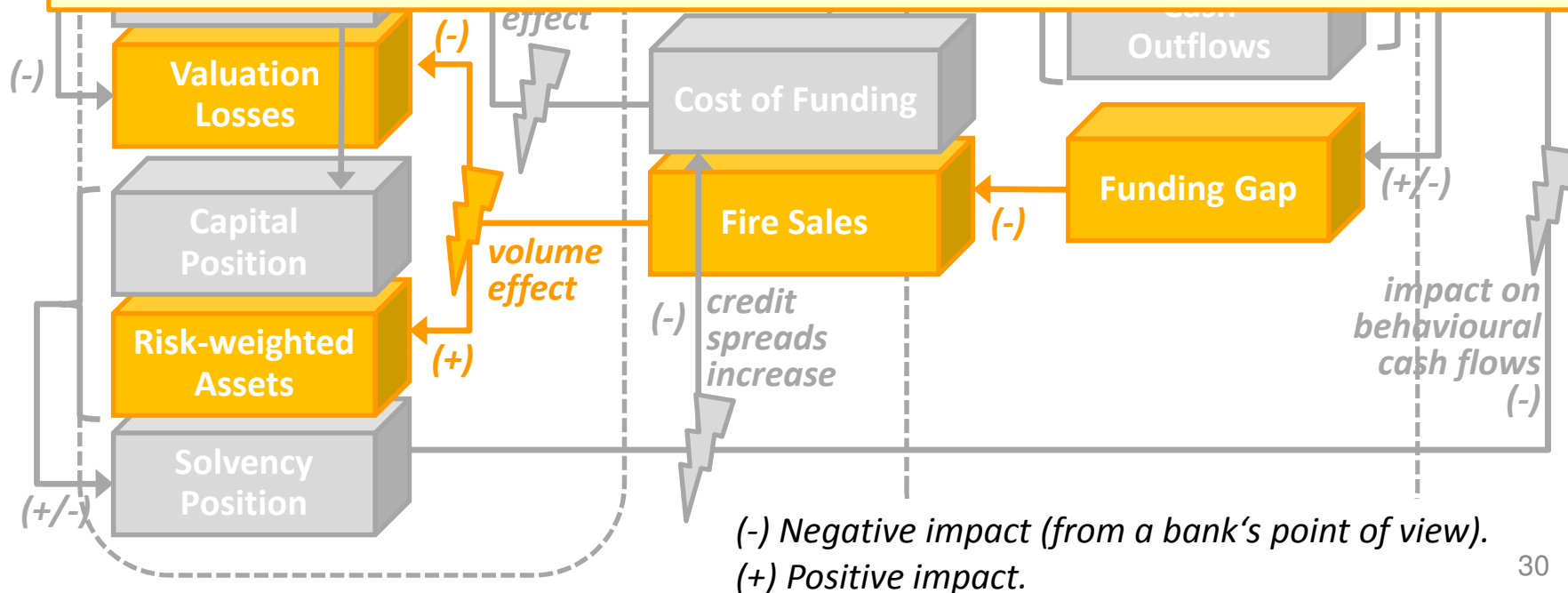


## Asset fire sales losses [volume effect]

- Captures common exposure to market price & market liquidity effects
- Calibration: Based on HC of liquidity stress scenario & CC migration due to solvency
- Assets: Full CBC except callable, committed credit-lines, liquidity support received from holding company (binding commitment)
- Assumption: banks sell assets proportionally to composition of CBC
- Empirical evidence inconclusive

$$ASFL_t = \begin{cases} = 0, & \text{if } CNFG_t \leq (\text{cash} + \text{excess reserves}) \\ = (CBC_{unstressed} - CBC_{stressed}) \times \left\{ \frac{\text{cash} + \text{excess reserves} + CBC_{t,stressed}}{CBC_{t,unstressed}} \right\}, & \text{otherwise} \end{cases}$$

- Effect: Banks with same level of CBC but higher shares of less liquid assets face higher asset fire sale losses
- Caveats: CB treatment; static, non-behavioural; no additional fire sale loss haircuts



## Important channels disregarded

- Impact of solvency on access to unsecured money market
  - Pre-empt by assumption of complete dry-up
- Impact of own liquidity position on supply of funds on unsecured money market & network dynamics
  - Pre-empt by assumption of complete dry-up
- Contagious bank runs
- Margin calls due to rating downgrades
- Deposit outflows due to rating downgrades

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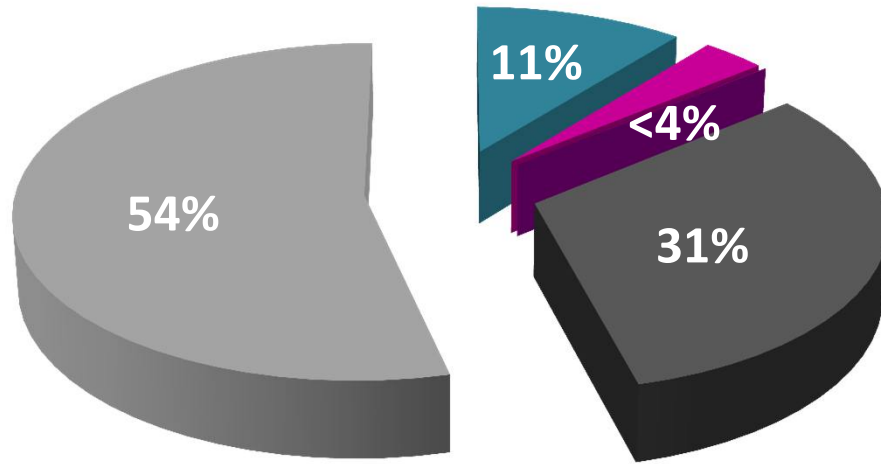
**Results & conclusions**



# Measuring the impact of interaction channels

## Liquidity Stress Test

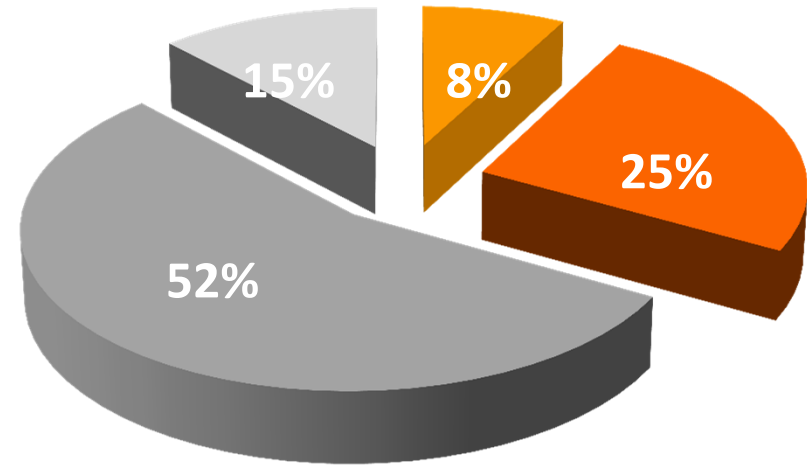
(share of total impact on cumulated counter balancing capacity)



- Rating migration impact on banks' credit claims (i.)
- NPL effect on expected inflows from performing loans to non-banks (ii.)
- Losses on inflows from paper in own portfolio maturing (iii.)
- Market funding due to solvency position (iv.)
- Other liquidity impact not associated with solvency stress

## Solvency Stress Test

(share of total impact on P&L losses)



- Cost of funding
- Fire sale losses
- Credit risk costs
- Other risk costs through P&L

## Conclusions

- Supervisory experience, case studies, and the theoretical literature point at **a number of potential channels** for the interaction between solvency and liquidity stress testing
- Supervisory experience and the example demonstrate that these **interactions are material**
- Failure to integrate leads to substantially underestimation of the risk exposure of individual banks and banking systems
- **Two interesting trade-offs:**
  - Trade-off between the quantitative impact of channels and their respective model risk and/or parameter uncertainty
  - Trade-off between conceptual quality and actionable output

## Policy recommendations

- The main policy recommendation is the **need to integrate** solvency and liquidity stress tests in order not to underestimate risk
  - Complex interactions require adequately complex models
  - Further research required
- Main **objectives for solvency** stress tests
  - Soundly integrate methodologies to cover the cost of funding
  - Move beyond the constant balance sheet assumption
- Main **objectives for liquidity** stress test
  - Consider the solvency impact on funding costs / volumes
  - Invest in the calibration of asset fire sales
- Decision makers have to understand that even the best models and calibrations cannot exonerate them from the burden of subjective judgement in risk assessment

## Further research

- Identify further channels of intercation
- Empirical foundations for calibration
  - Event studies
  - Econometric analysis
- Second round effects
  - Incorporate dynamic balance-sheet
  - Balance-sheet optimisation rather than quantity restrictions
  - Price effects rather than quantity effects in macro-models
- Indirect contagion
  - Empirical evidence
- BCBS RTF TF on Liquidity Stress Testing
  - Studies some of these topics → paper in March 2015

## Literature

BCBS (2013 a), '*Liquidity stress testing: a survey of theory, empirics and current industry and supervisory practice*', Basel Committee on Banking Supervision WP No. 24, Basel.

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