

Liquidity stress testing

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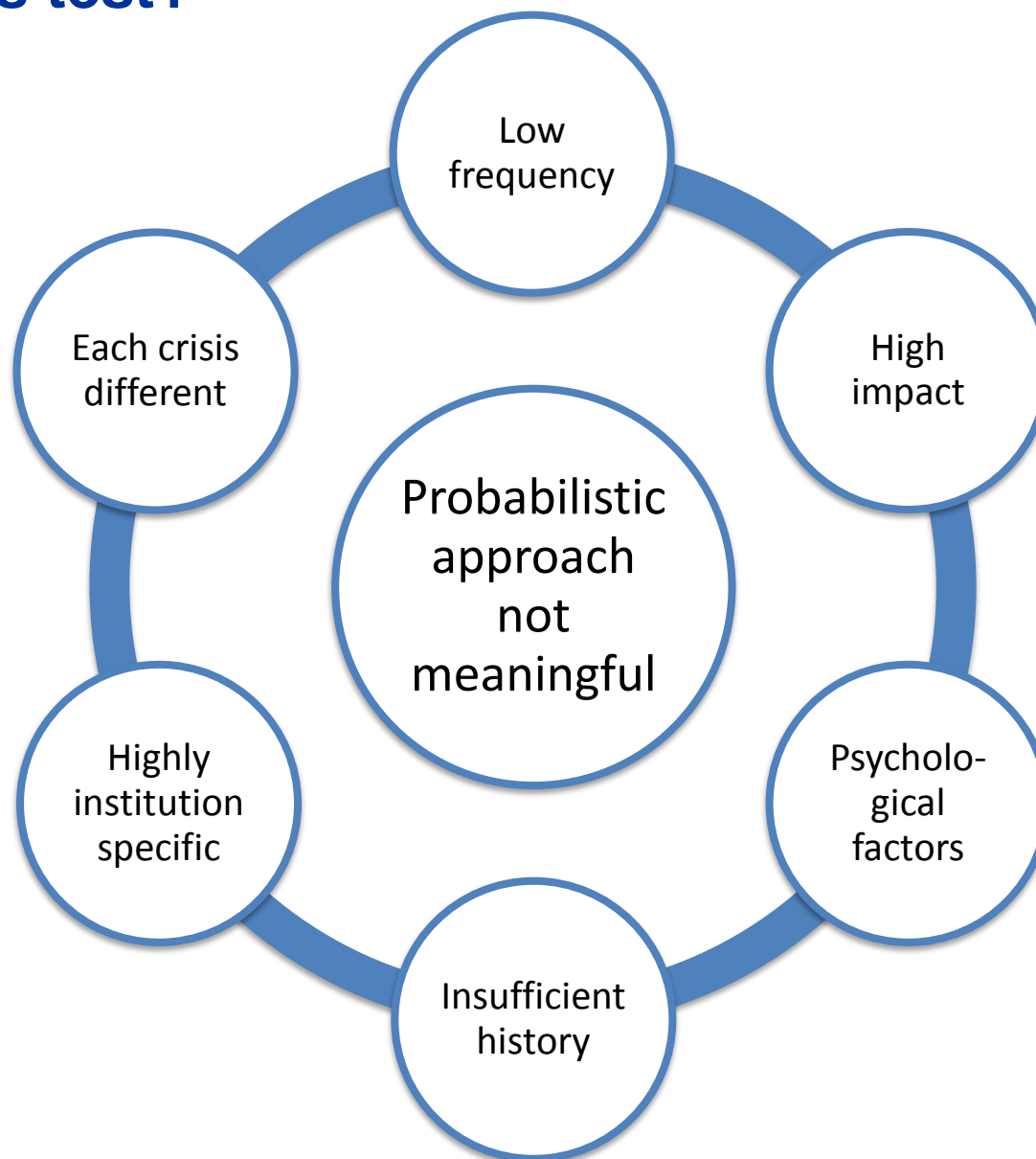
IMF

STI course on Macro Stress Testing,
Singapore 09/29-10/03

The opinions expressed in this presentation are the author's and do not necessarily reflect those of the OeNB.

Session 1

Why stress test?



Main challenges of liquidity stress tests

Data

Scenario design

Scenario calibration

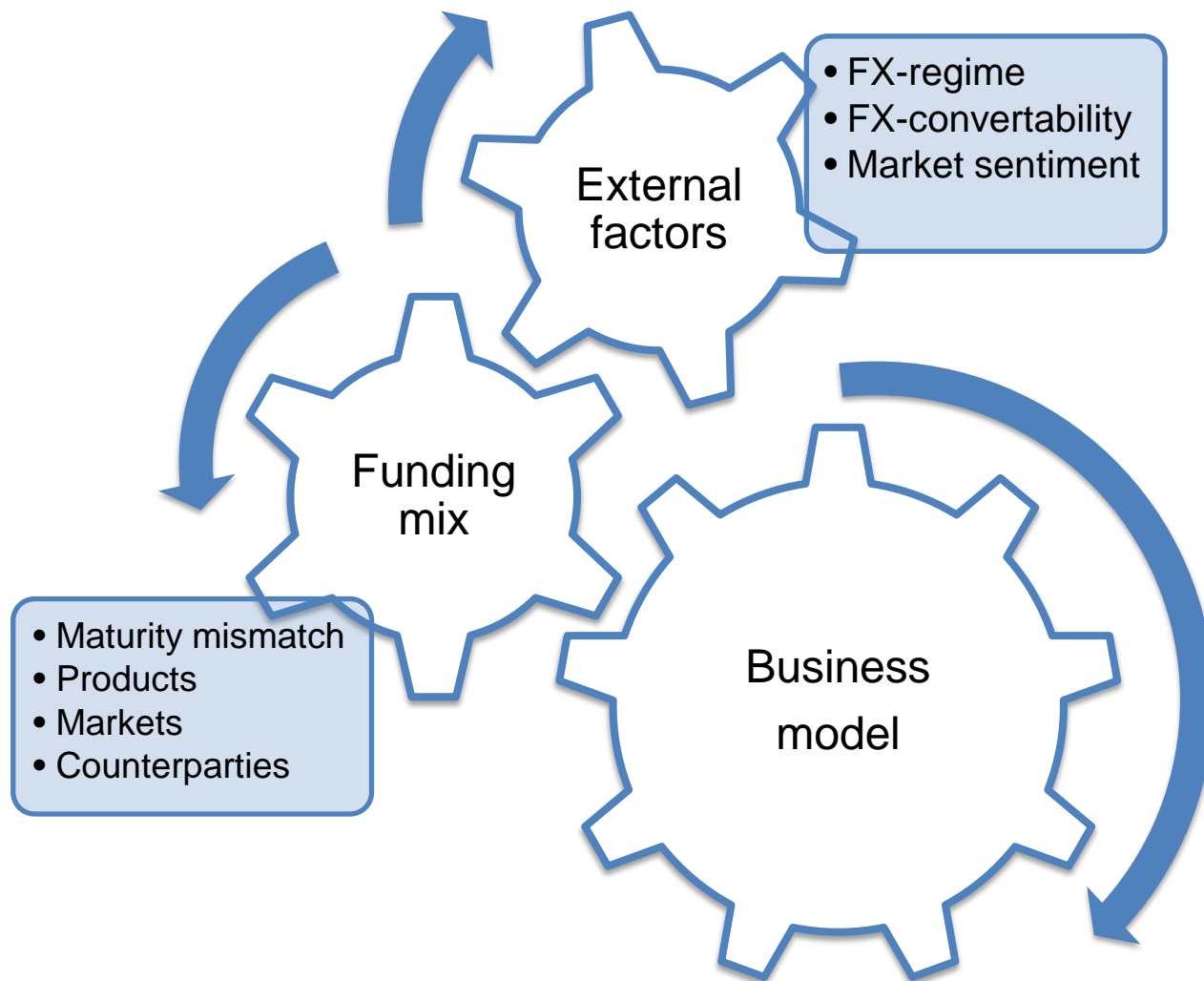
Parameter uncertainty

Treatment of CB

Liquidity/solvency integration

Data

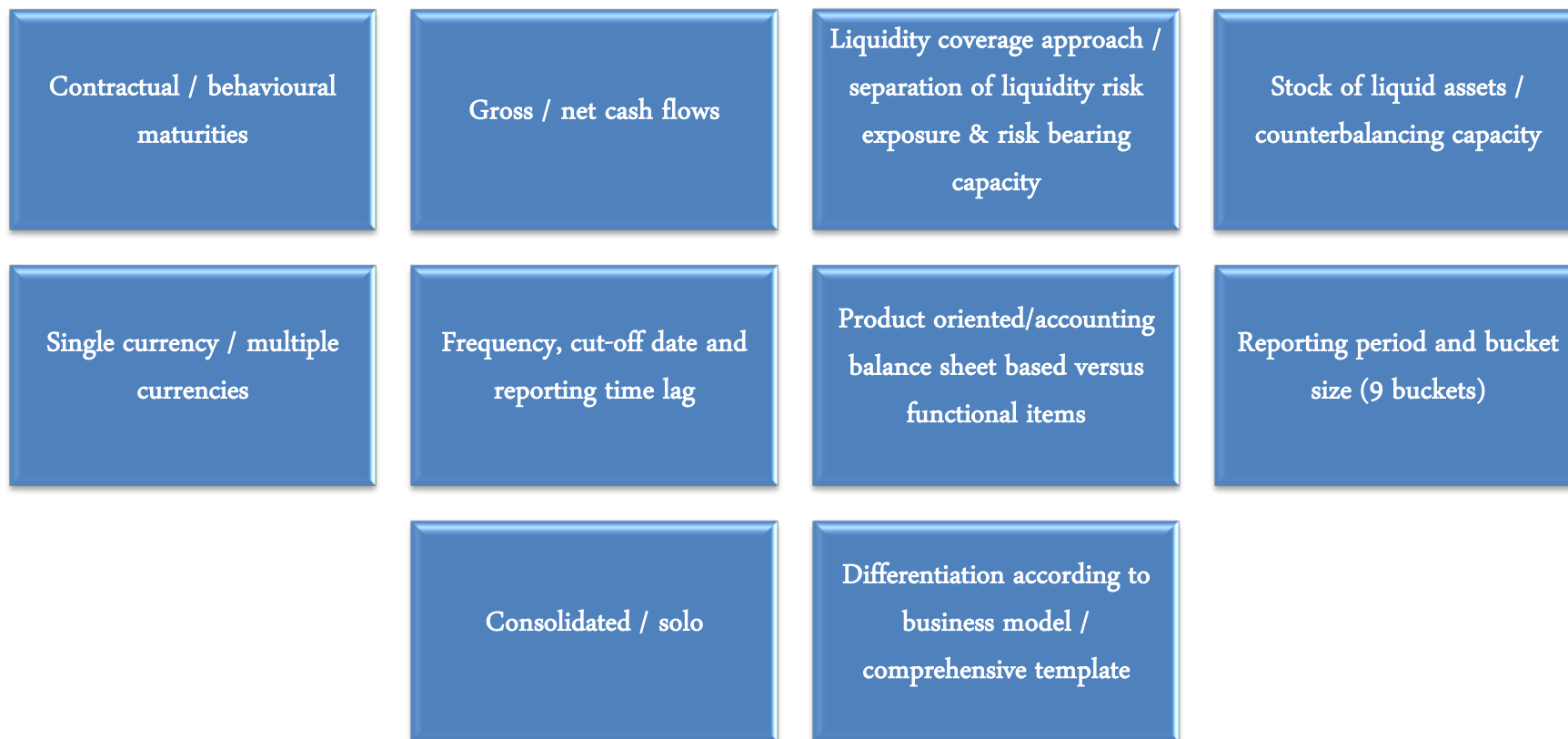
Liquidity risk assessment



Diversity of liquidity risk measurement

- *Projected cash flows*
- *Stock approach - balance sheet maturity mismatch (O/N – 6M)*
- *Balance sheet based ratios*
 - *Customer deposits/total loans ratio*
 - *Rate sensitivity and stability of customer deposits*
 - *Diversification*
 - *(Market funds - liquid assets)/total assets*
 - *Liquid assets/total assets*
 - *Composition and diversification of liquid assets*
 - *Expected liquidity under distress*
 - *Current liability ratio (current liabilities/short-term liabilities or total liabilities)*
 - *Working capital/total assets*
 - *Liquidity coverage ratio (liquid assets/average daily negative cash flow)*

Data requirements



Template design crucial

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

Net cash flows and stock of liquid assets

Investment Bank							
ENTRIES		Time to run till the term					
		1	2	3	4	5	6
1	Net Cash-Flows						
1.1	Net Wholesale Flows	-279	-367	-448	-530	-220	-341
1.2	Net Retail Flows	-21	-55	-44	-10	-14	-19
1.3	Net Securities issued (long-term)	127.5	173.6	227.5	187.5	122.8	210.5
1.4	Net Securities issued (short-term)	234.45	281.4	359.7	252.45	183.75	284.7
1.5	Net Loans to Non-financials	-2.4	-3.74	-3.34	-4.16	-3.8	-3.52
1.6	Net Repos	28	51	1	20	-61	2
1.7	...						
1.8	...						
1.9	Net Own investments	-118	-150	-67	-146	-130	-155
2	Net Funding Gap	-30.45	-69.74	25.86	-230.21	-122.25	-21.32
3	Cumulated Net Funding Gap	-30.45	-100.19	-74.33	-304.54	-426.79	-448.11
	Liquid Assets						
4.1	Central banks reserves (level 1)	350					
4.2	Central banks reserves (level 2)	50					
4.3	Other liquid assets	50					
4.4	...						
5	Sum of liquid assets	450					

Net cash flows and stock of liquid assets

Growing Retail Bank							
ENTRIES		Time to run till the term					
		1	2	3	4	5	6
1	Net Cash-Flows						
1.1	Net Wholesale Flows	0	0	0	0	0	0
1.2	Net Retail Flows	124.7	184.6	235.9	258.9	163.8	238.5
1.3	Net Securities issued (long-term)	127.5	173.6	227.5	187.5	122.8	210.5
1.4	Net Securities issued (short-term)	0	0	0	0	0	0
1.5	Net Loans to Non-financials	-280	-413	-433	-682	-410	-474
1.6	Net Repos	0	0	0	0	0	0
1.7	...						
1.8	...						
1.9	Net Own investments	0	0	0	0	0	0
2	Net Funding Gap	-27.8	-54.8	30.4	-235.6	-123.4	-25
3	Cumulated Net Funding Gap	-27.8	-82.6	-52.2	-287.8	-411.2	-436.2
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4.4	...						
5	Sum of liquid assets	450					

Gross cash flows and stock of liquid assets

Investment Bank							
ENTRIES		Time to run till the term					
		1	2	3	4	5	6
1	Cash-inflows						
1.1	Wholesale inflows	1284	3798	3227	2668	1956	2746
1.2	Retail inflows	247	846	359	589	638	385
1.3	Securities issued (long-term)	1275	1736	2275	1875	1228	2105
1.4	Securities issued (short-term)	1563	1876	2398	1683	1225	1898
	Maturing loans to Non-financials	120	187	187	200	190	176
1.4.1	New repo inflow	124	187	124	118	120	132
1.4.2	Maturing reverse repos	50	37	49	27	34	41
1.4.3	...						
1.4.4	Own investments maturing	125	176	89	200	146	150
	Sum of Cash-Inflows	4788	8843	8688	7368	5537	7633
2	Cash-Outflows						
2.1	Wholesale outflows	1563	4165	3675	3198	2176	3087
2.1.1	Retail outflows	268	901	403	599	652	404
2.1.2	Securities due (long-term)	1147.5	1562.4	2047.5	1687.5	1105.2	1894.5
2.2	Securities due (short-term)	1328.55	1594.6	2038.3	1430.55	1041.25	1613.3
2.2.1	Maturing repos	120	136	148	100	180	147
2.2.2	New reverse repos	26	37	24	25	35	24
2.2.3	New loans granted	122.4	190.74	170.34	212.16	193.8	179.52
2.3	Own investments	243	326	156	346	276	305
2.8	Sum of Cash-Outflows	4818.45	8912.74	8662.14	7598.21	5659.25	7654.32
	Net Funding Gap	-30.45	-69.74	25.86	-230.21	-122.25	-31.32
	Cumulated Net Funding Gap	-30.45	-100.19	-74.33	-304.54	-426.79	-448.11
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3.1.4	...						
3.2	Stock of liquid assets	450					

Gross cash flows and stock of liquid assets

Growing Retail Bank		Time to run till the term					
		ENTRIES					
		1	2	3	4	5	6
1	Cash-Inflows						
1.1	Wholesale inflows						
1.2	Retail inflows	1247	1846	2359	2589	1638	2385
1.3	Securities issued (long-term)	1275	1736	2275	1875	1228	2105
1.4	Securities issued (short-term)						
	Maturing loans to Non-financials	1120	1887	2267	2508	1690	2276
1.4.1	New repo inflow						
1.4.2	Maturing reverse repos						
1.4.3	...						
1.4.4	Own investments maturing						
	Sum of Cash-Inflows	3642	5469	6901	6972	4556	6766
2	Cash-Outflows						
2.1	Wholesale outflows						
2.1.1	Retail outflows	1122.3	1661.4	2123.1	2330.1	1474.2	2146.5
2.1.2	Securities due (long-term)	1147.5	1562.4	2047.5	1687.5	1105.2	1894.5
2.2	Securities due (short-term)						
2.2.1	Maturing repos						
2.2.2	New reverse repos						
2.2.3	New loans granted	1400	2300	2700	3190	2100	2750
2.3	Own investments						
2.8	Sum of Cash-Outflows	3669.8	5523.8	6870.6	7207.6	4679.4	6791
	Net Funding Gap	-27.8	-54.8	30.4	-235.6	-123.4	-25
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Gross cash flows and counterbalancing capacity

Investment Bank							
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3	Counterbalancing Capacity						
	Central banks reserves (level 1)	350					
3.1	Central banks reserves (level 2)	50					
3.1.3	Other liquid assets	50	-25.9	20.7	-96.8	14	1.75
3.1.4	...						
3.2	Sum of Counterbalancing Capacity	450	-25.9	20.7	-96.8	14	1.75
5	Cumulated Counterbalancing Capacity	419.55	323.91	370.47	43.46	-64.79	-84.36

Gross cash flows and counterbalancing capacity

Growing Retail Bank							
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3.1.3	Other liquid assets	50					
3.1.4	...						
3.2	Sum of Counterbalancing Capacity	450	0	0	0	0	0
5	Cumulated Counterbalancing Capacity	422.2	367.4	397.8	162.2	38.8	13.8

Example I: EBA LRA 2011

Cash-Outflows

Own issuances due

Unsecured wholesale funding due

thereof: from non-financial corporates

thereof: from financial corporates

thereof: from financial institutions

thereof: from government/public entities

thereof: from institutional networks

Secured wholesale funding due

thereof: secured by sovereign debt 0% r/w

thereof: secured by sovereign debt 20% r/w, covered bonds up to AA-, non-financial corporates)

thereof: secured by equity

thereof: secured by other instruments

Repos due with central banks

Retail (incl. SME) funding due

thereof: sight deposits

New loans granted

Outflows from derivatives

Undrawn volume of committed credit/liquidity lines to financial institutions and SPV.

Undrawn volume of committed liquidity lines to financial corporates.

Undrawn volume of committed credit/liquidity lines to retail/sme/non-financial corporates and credit lines to financial corporates

Additional outflows due to a two-notch rating downgrade

Others

Sum of Cash-Outflows

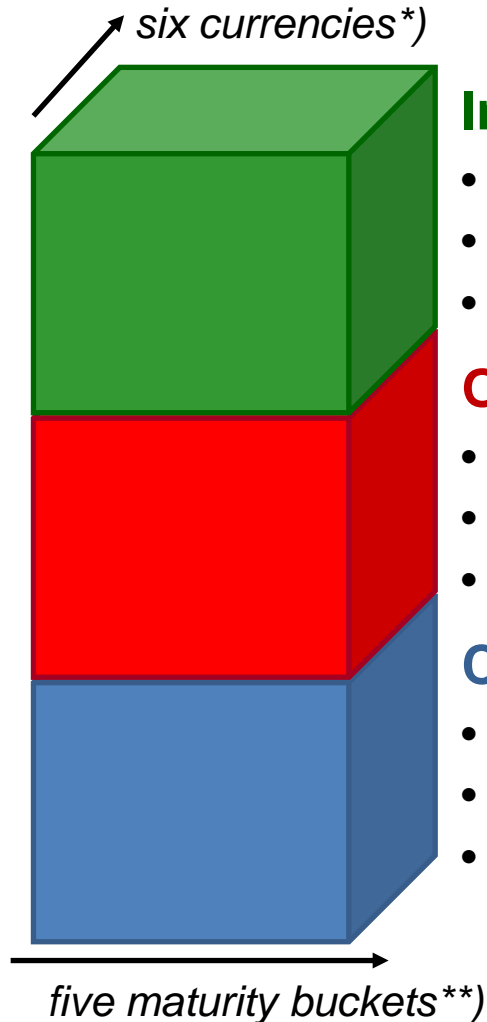
Example (cont'd)

Cash-Inflows	
New own issuances (already contracted)	
Unsecured wholesale funding	
Secured wholesale funding	
Retail funding	
Loans maturing	
thereof: loans to financial institutions	
thereof: other	
Inflows from derivatives	
Paper in own portfolio maturing	
Reverse repos	
thereof: secured by sovereign debt 0% r/w	
thereof: secured by sovereign debt 20% r/w, covered bonds up to AA-, non-financial corporates	
thereof: secured by equity	
thereof: secured by other instruments	
Volume of available credit lines from financial institutions	
Others	
<i>Sum of Cash-Inflows</i>	
<i>Net Funding Gap</i>	
Cumulated Net Funding Gap	

Example (cont'd)

Counterbalancing capacity
Cash and central bank reserves in excess of minimum reserve requirements
Unencumbered CB eligible collateral (deposited at central banks)
Claims on sovereigns (PSEs or government guaranteed) 0% risk-weight under Basel II standardised approach
Claims on sovereigns (PSEs or government guaranteed) 20% risk-weight under Basel II standardised approach
Covered bonds (excl own issues, rating at least AA-)
Non-financial corporate bonds (rating at least AA-)
Other CB eligible assets (incl credit claims)
thereof: own issues
Unencumbered assets (CB eligible, but not deposited at CB)
Claims on sovereigns (PSEs or government guaranteed) 0% risk-weight under Basel II standardised approach
Claims on sovereigns (PSEs or government guaranteed) 20% risk-weight under Basel II standardised approach
Covered bonds (excl. own issues, rating at least AA-)
Non-financial corporate bonds (rating at least AA-)
Other CB eligible assets (incl. credit claims)
thereof: own issues
Other non CB eligible, tradeable assets (incl equity)
<i>Sum of Counterbalancing Capacity (after haircut)</i>
<i>Cumulated Counterbalancing Capacity (after haircut)</i>

Example II: 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.

Session 2

Scenario design

Scenario design

- Issues to consider
 - Internal consistency
 - Idiosyncratic and market scenarios
 - Time horizon(s)
 - Cross-border flow of liquidity and collateral
 - Behavioural (second round) effects
 - Shortening/lengthening of funding terms
 - Linkages between liquidity, credit and market risk

Risk factors – components of liquidity stress tests I

Risk factors - cash inflows
Loans due from credit institutions of which:
unsecured interbank loans
receivables due from repos
Expected loans due from non-banks of which:
from households
from non-financial companies
from non-bank financial companies (i.e. hedge funds, private equity companies)
Expected repayments on bonds in portfolio (coupon and/or principal) of which:
from (local) governments, agencies etc.
from non-financial companies
from banks
from non-bank financial companies (i.e. hedge funds, private equity companies)
Others of which:
unrevocable credit line provided by other banks

Risk factors - cash inflows
Expected net run-off of wholesale deposits of which:
from banks (unsecured interbank deposits)
from banks (secured interbank deposits - repos)
from sophisticated wholesale investors (i.e. non-bank financial intermediaries)
from less sophisticated wholesale investors (i.e. non-financial firms)
Expected net run-off of retail deposits of which:
demand deposits (volume covered by deposit insurance)
demand deposits (volume not covered by deposit insurance)
term deposits (volume covered by deposit insurance)
term deposits (volume not covered by deposit insurance)
Credit lines called of which:
called by households (overdraft)
called by non-financial institutions
called by banks
called by non-bank financial intermediaries
Own issues due (net of potential new issuances) of which:
Long-term debt (senior benchmark issues)
Long-term debt (covered bonds)
Short-term debt (CP)
Net cash outflows from derivatives of which:
outflows due to margin calls
others
Others

Risk factors – components of liquidity stress tests II

Risk factors - counterbalancing capacity	
Tightening of the class of assets accepted as collateral by relevant central banks (i.e. changes to ESCB single list back from AAA-BBB to AAA-A)	
Downgrade of assets in counterbalancing capacity of which:	
AAA rated	
AA rated	
A rated	
BBB rated	
Increase in haircut of assets held in counterbalancing capacity of which:	
AAA rated [increase of average haircut: in %-points]	
AA rated [increase of average haircut: in %-points]	
A rated [increase of average haircut: in %-points]	
BBB rated [increase of average haircut: in %-points]	
Others [[increase of average haircut: in %-points]	
Equity holdings [increase of average haircut: in %-points]	

Risk factors - other risk factors
Exchange rate movements vis-a-vis currencies in which the banks faces material liquidity risk]
FX appreciations
FX depreciations
Barriers to the cross-border flow of liquidity of which:
ring-fencing of liquidity by regulators
operational shock to cross-border payment or settlement system
FX-swap market dry-up
Funding costs
Money market rates spreads (increases in bp)
1MEuribor-1MEurepo
3MEuribor-1MEurepo
6MEuribor-1MEurepo
CP rate spreads (increase in bp)
3MCP rate-treasury (or local equivalent) 1M
6MCP rate - treasury (or local equivalent) 6M
12MCP rate treasury (or local equivalent) 12M
Bond market spreads (increases in bp)
senior benchmark-swap
covered bond-swap
securitisation-swap
Retail deposit spreads (increases in bp)
demand deposit-O/N
term deposit 1 year-treasury (or local equivalent) 1 year
term deposit 3 years-treasury (or local equivalent) 3 years
term deposit 5 years-treasury (or local equivalent) 5 years

Scenario calibration

Fundamentals

- ❑ Never use banks' internal evidence for calibration
 - ❑ Few banks have experienced liquidity shocks
- ❑ Do not focus on bank characteristics alone
 - ❑ Market dynamics can affect also very sound banks
- ❑ Evidence based calibration is most convincing
 - ❑ Extensive literature surveys very helpful (l.e. BCBS 24/25)
- ❑ Parameter uncertainty is intrinsic
 - ❑ Do not over-engineer calibration
- ❑ Coherent economic story key to communication

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

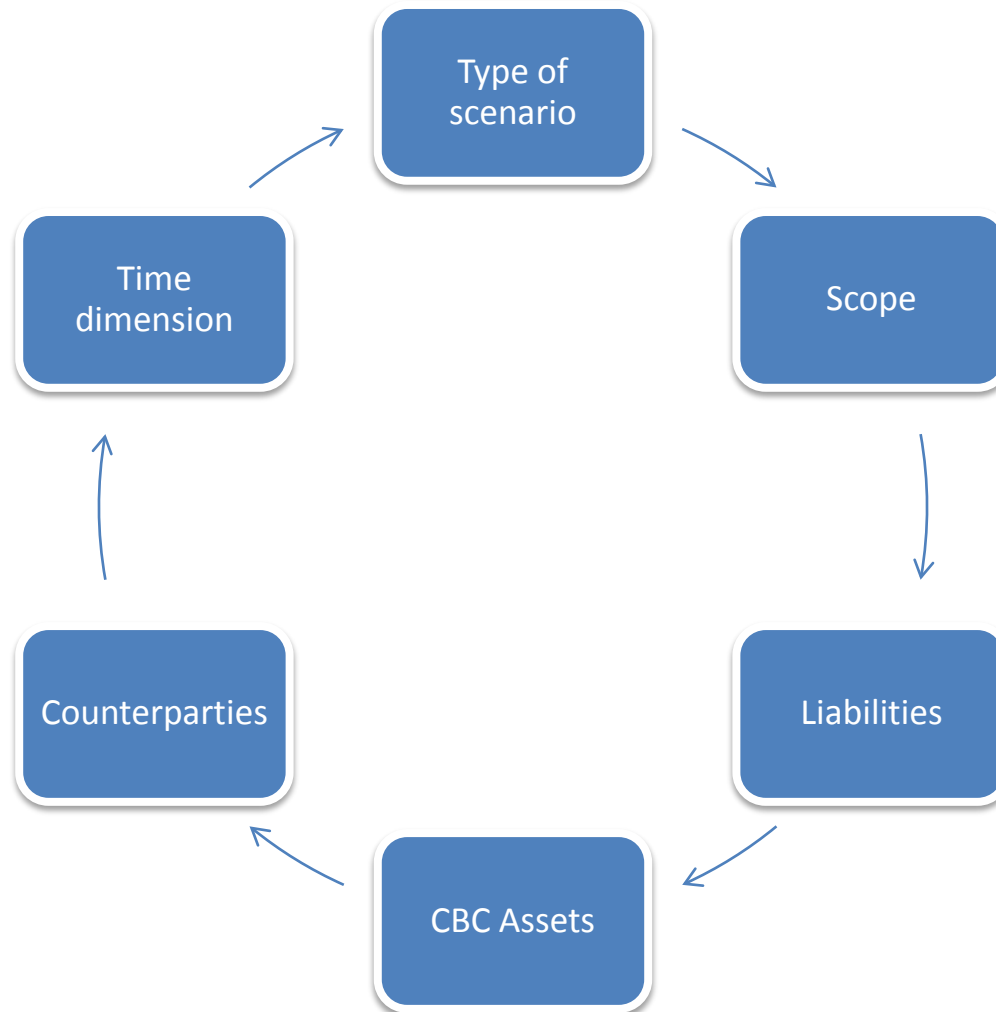
Case studies

- Bank, market & country level

Output of solvency stress test

- See discussion below

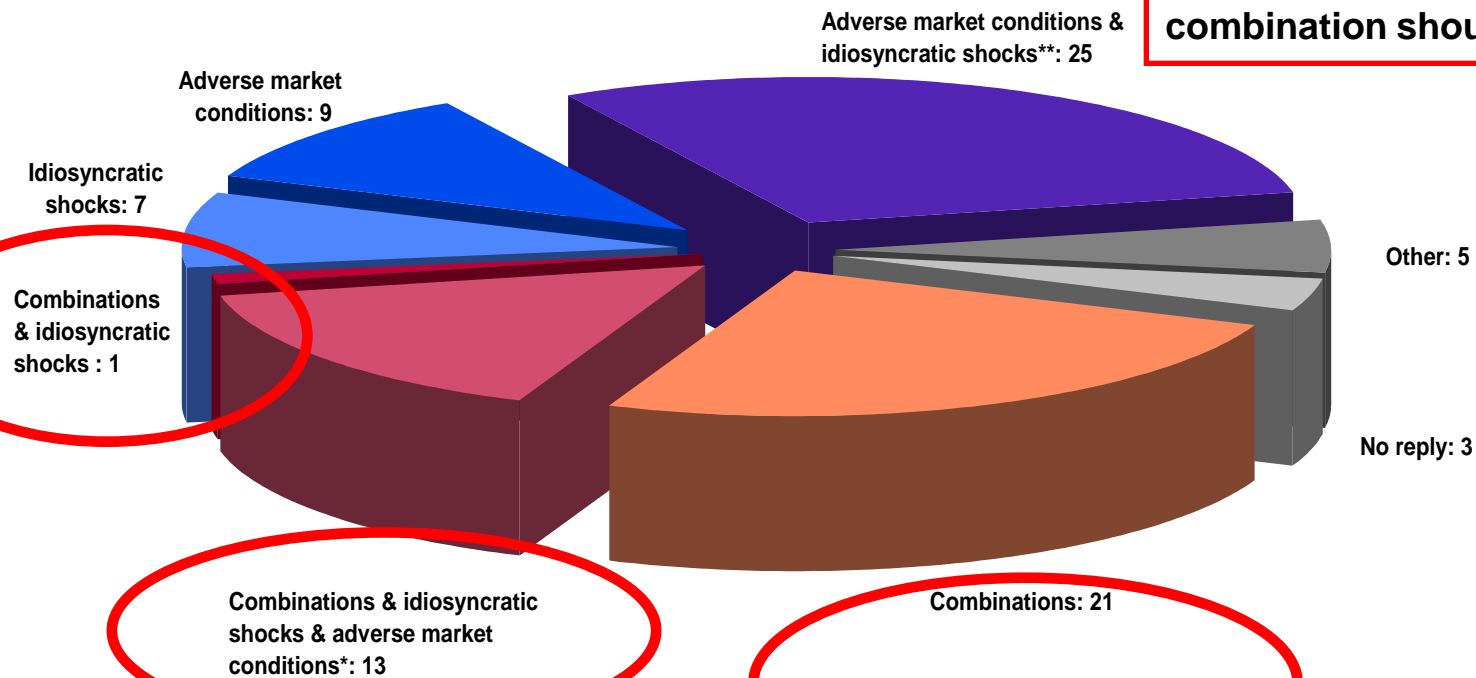
Elements of scenario calibration



Types of scenario

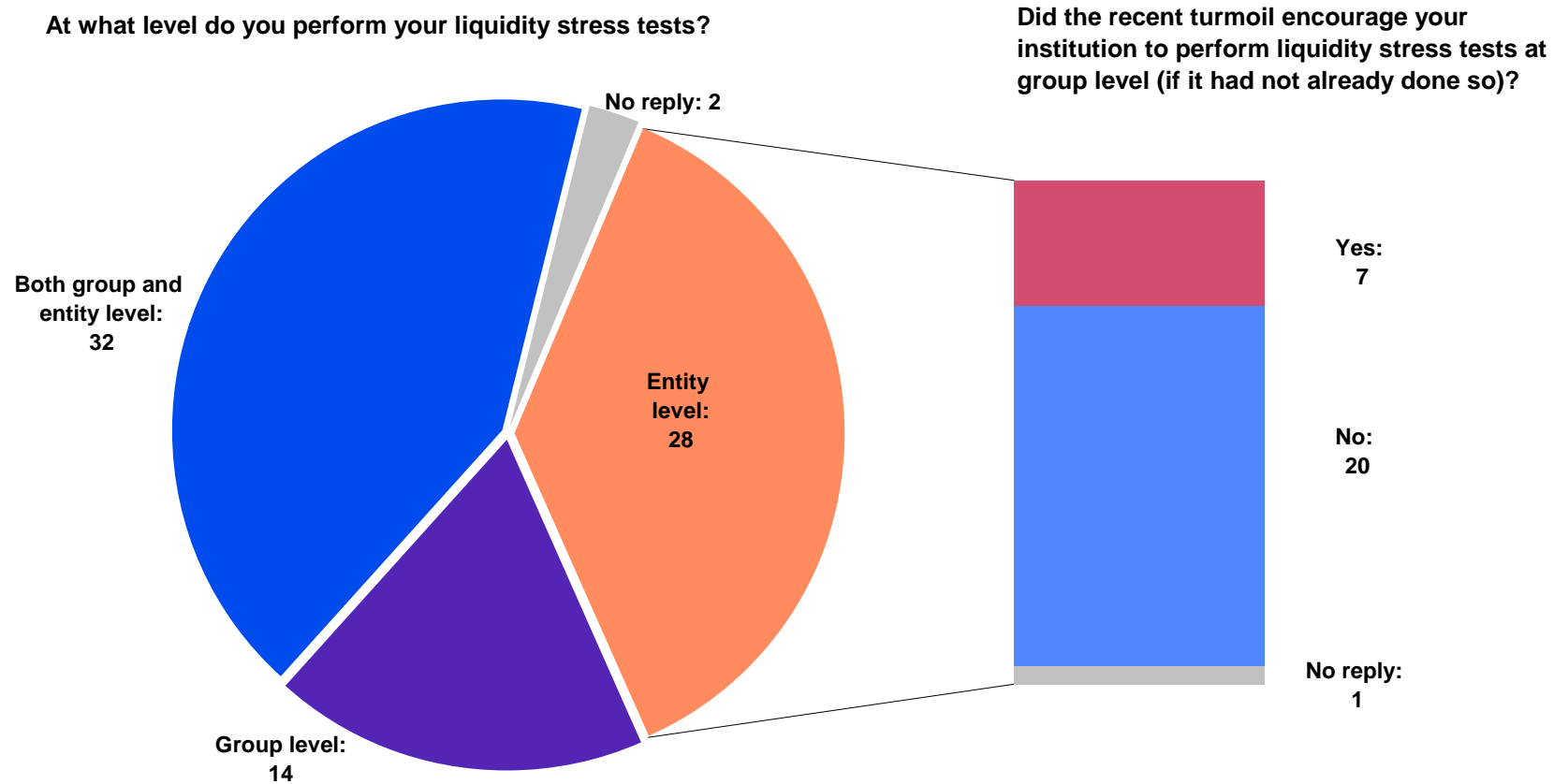
What types of stress test scenario do you consider: adverse market conditions (1), idiosyncratic shocks (2), combinations of (1) and (2), other scenarios?

Both core scenarios & their combination should be tested



* One of the 13 banks also performed other tests
** Three of the 25 banks also performed other tests

Scope



LSTs at group & entity level are recommended

Deposits (Liabilities I)

Insured deposits

- Mixed evidence regarding price & quantity effects
- Example: Northern Rock → set-up of DGS matters (full coverage £2,000; 90% coinsurance up to an additional £33,000 → run-premium= £3,300 net)
- Focus on expected inflows rather than withdrawals

Uninsured deposits

- Clear evidence of price/quantity effects
- Transaction/operational deposits
- Domestic/non-domestic and/or FX deposits
- Volume/pricing/distribution channel deposits

ABCP & CP (Liabilities II)

High stress sensitivity

Very quick evaporation of liquidity under stress & substantial spread increases

Substantial liquidity risk for sponsors → Warehousing & commitments

Distinction across issuers takes time

Intitially run on the market then selective reopening for higher quality issuers

Strong influence of stability of non-banks

Non-bank financials can have substantial impact on market liquidity & pricing

Liquidity risk of MMMF (Primary Reserve Fund)

Issuances (Liabilities III)

Unsecured issuances

- Long-term/short-term → Long-term issuances more information sensitive
- Impact on maturity → spirals of increasing liquidity risk
- Private placement/public issuance → public issuance more information sensitive

Secured issuances

- Underlying assets → lower asset quality/transparency more information sensitive
- Covered bonds versus ABS → ABS more information sensitive
- Domestic currency versus FX → FX more information sensitive
- Private placement/public issuance → public issuance more information sensitive

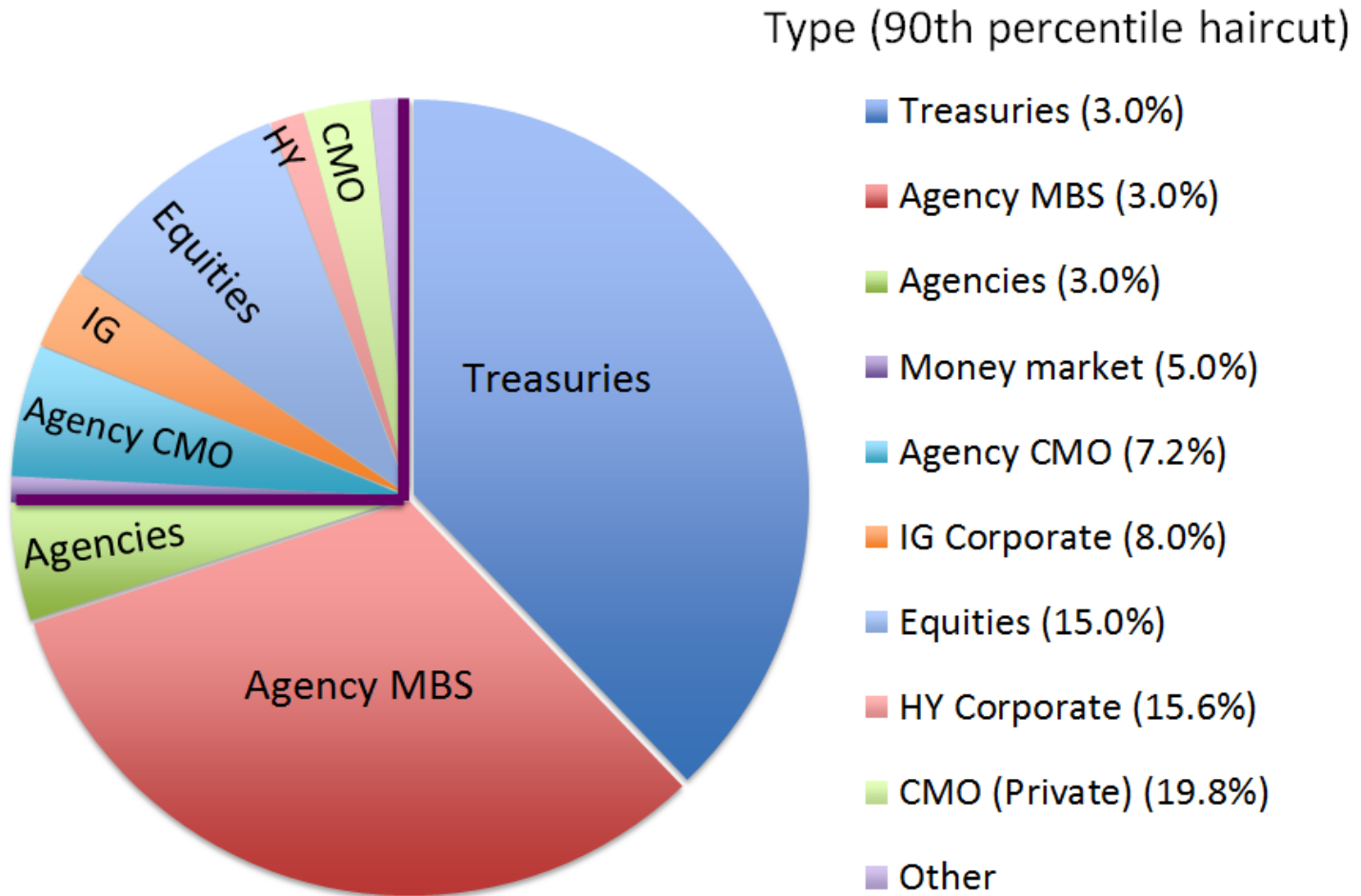
Repo (Liabilities IV)

- ❑ In principle, more stable than unsecured, but strong cyclical due to
 1. Collateral valuation,
 2. Haircuts,
 3. Breadth & depth of the market,
 4. Rehypothecation chains,
 5. Changes in counterparty limits,
 6. Tenors/maturities
 7. Demand shocks (migration from unsecured to secured),
 8. Supply shocks (banks - precautionary self-insurance; non-banks – flight to safety & from maturity)

Secured funding (cont'd)

- ❑ Stress tests haircuts/roll-over assumptions must combine different impacts of the above + bank characteristics/counterparty/collateral/market structure, e.g.
 - ❑ More risky/less liquid collateral → higher haircuts
 - ❑ Repo markets in some collateral can even disappear (subprime/leveraged/opaque ABS)
 - ❑ Others experience collateral shortage → flight to safety
 - ❑ Tri-party repo more stable than bilateral, but riskier/less liquid collateral still subject to shocks
- ❑ Collateral swaps (combination of two repos)
 - ❑ Margining impact on outflows
 - ❑ Non-roll-over impact on CBC

Haircuts in US Tri-party repos for selected collateral classes



Data source: FRBNY, January 10, 2014

Haircuts in bilateral repos for selected collateral classes I

June 2007				June 2009		
	Counterparty			Counterparty		
	Prime ¹	Non-prime ²	Unrated ³	Prime ¹	Non-prime ²	Unrated ³
G7 government bonds						
Short-term	0	0	0.5	0.5	1	2
Medium-term	0	0	0.5	1	2	3
US agencies						
Short-term	1	2	3	1	2	3
Medium-term	1	2	3	2	5	7
Pfandbrief	0	0	1	1	2	8

Haircuts in bilateral repos for selected collateral classes I

Prime MBS						
AAA-rated	4	6	10	10	20	30–100
AA- and A-rated	8	12	25	100	100	100
Asset-backed securities	10	20	20	25	50	100
Structured products (AAA)	10	15	20	100	100	100
Investment grade bonds						
AAA- and AA-rated	1	2	5	8	12	15
A- and BBB-rated	4	7	10	10	15	20
High-yield bonds	8	12	20	15	20	40
Equity						
G7 countries	10	12	20	15	20	25
Emerging economies	15	20	35	20	25	40

Liquidity/credit facilities (Liabilities VI)

ABCP/CP

- Very sensitive to market sentiment & timing
- Northern Rock → double impact (assets remain on-balance & draw down of lines to conduit/SPV)

Banks

- Potentially high demand
- Negative selection
- Asymmetric treatment

HH & NFC

- Draw-downs from HH & NFC less significant
- But negative credit quality selection

Counterbalancing capacity I

- ❑ Only assets that are expected to be liquid on private markets under stress should be eligible for the counterbalancing capacity
- ❑ Market liquidity can decrease very quickly for many asset classes
 - ❑ Measuring market liquidity non-trivial
 - ❑ Lower credit quality → less stable market liquidity
 - ❑ Lower market liquidity → higher decreases during stress
 - ❑ Consistency of haircuts in repo and counterbalancing capacity
- ❑ Diversification
- ❑ Control of liquidity management function
- ❑ Actual usability → regular test sales/repos
- ❑ Encumbrance

Counterbalancing capacity II

Central bank eligibility

- Might have a positive feedback effect on the market liquidity of tradable eligible assets
- But monetary policy implementation/regimes (currency boards) need to be taken into account
- No over-reliance on central bank eligibility

Minimum reserve requirements

- Usually dedicated to monetary policy objectives
- Source of liquidity iff explicitly designed for that purpose
- Averaging period no sufficient condition for inclusion in CBC
- Subordinate other creditors of the bank (i.e. the deposit insurance scheme)?

Unsecured interbank market (Counterparties I)

- ❑ Complete dry-up/loss of access standard assumption even under mild liquidity stress
- ❑ Driven by counterparty risk/precautionary self-insurance
- ❑ Reinforced by second round effects – positive feedback-loops & network effects
- ❑ Volume decreases strongly for longer tenors
- ❑ Overnight sometimes more stable
 - ❑ But combined effect of shorter tenors & loss of market access
 - ❑ Increasing wall of maturity in short tenors → negative dynamics
- ❑ Loss of market access rather than higher rates

Counterparties II

MMMF

- Regulation matters (CNAV?) for MMMF investor behaviour
- MMMF investor base matters → institutional investors more information sensitive
- Shorten maturity, reduce credit risk & tenor
- Run on European banks (2011H1)

Depositor relationship

- Duration: Long-term customers are less information sensitive
- Breadth: Additional products deepen relation & legal framework (netting?)
- Depth: Operational dependence → impact of withdrawal on client operations?

Systemic liquidity

Definition	<p>Integrated view of liquidity across markets, instruments, and counterparties.</p> <hr/> <p>Interaction of market & funding liquidity risk</p> <hr/> <p>Interaction with credit & counterparty risk</p>
Complex dynamics during times of systemic liquidity stress	<p>Correlations between the components of systemic liquidity bifurcates</p> <hr/> <p>Some instruments become safe havens, while others experience strongly reduced market liquidity.</p>
Systemic liquidity can evaporate quickly	<p>High systemic liquidity is high → banks might reduce self-insurance (i.e. they are more willing to lend and supply-side tenors are longer) and rely more heavily on future availability of liquidity.</p> <hr/> <p>Positive feedback-loops and network externalities → exacerbate shocks!</p>

- ❑ Non-bank financial intermediaries play an increasingly important role in systemic liquidity → impact on inflows & outflows & CBC
- ❑ Network models: indirect contagion via systemic liquidity more important than via networks of bilateral exposure
- ❑ Implications for scenarios design
 - ❑ Integration of solvency and liquidity stress tests & feedback-effects and network effects
 - ❑ Intrinsic interaction of banks' capital, leverage, and liquidity dynamics & money and capital market dynamics
 - ❑ Interaction between banks & non-bank financials can be very important
 - ❑ Shocks can originate from outside the banking sector → soundness/capital not sufficient insurance against liquidity shocks
 - ❑ Combination of runs by wholesale creditors, fire sales of assets, and risks of a general credit crunch

Very important concept

Strong implications for macroprudential liquidity supervision

- Instruments are at early stages of development

Concept at early stages of development

- Mostly quantity based
- Maturities & prices receive too little attention

More research on conceptualisation & measurement necessary


Parameter uncertainty

Embedded scenarios

Cumulative severity



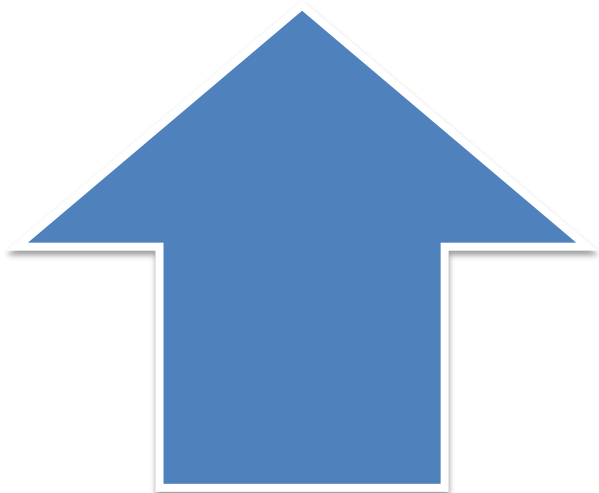
- Scenario 1
 - Closure of unsecured interbank markets
 - Closure of FX Swap markets
- Scenario 2
 - Reduced issuance of short term / long term debt
 - Increase in calling of credit commitments
 - Mild haircuts on unencumbered collateral in CBC
- Scenario 3
 - Dry up of funding markets – no future debt issuance
 - Severe increase in calling of credit commitments
 - Increased Haircuts on CBC according to the asset quality
 - Reduction in planned financial investments (mitigating)
- Scenario 4
 - Combines scenario 3 with idiosyncratic shock
 - Reduction of expected roll-over rates of wholesale and retail deposits



Reveals
liquidity risk
tolerance

Treatment of CBs as lender of last resort

Distinction between LoLR & monetary policy implementation



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

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

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

Conditionality

Automatic sanctions

Replacement of board members

Trigger for early intervention mechanism

Liquidity provision to market rather than illiquid bank

Address asset fire sale externality

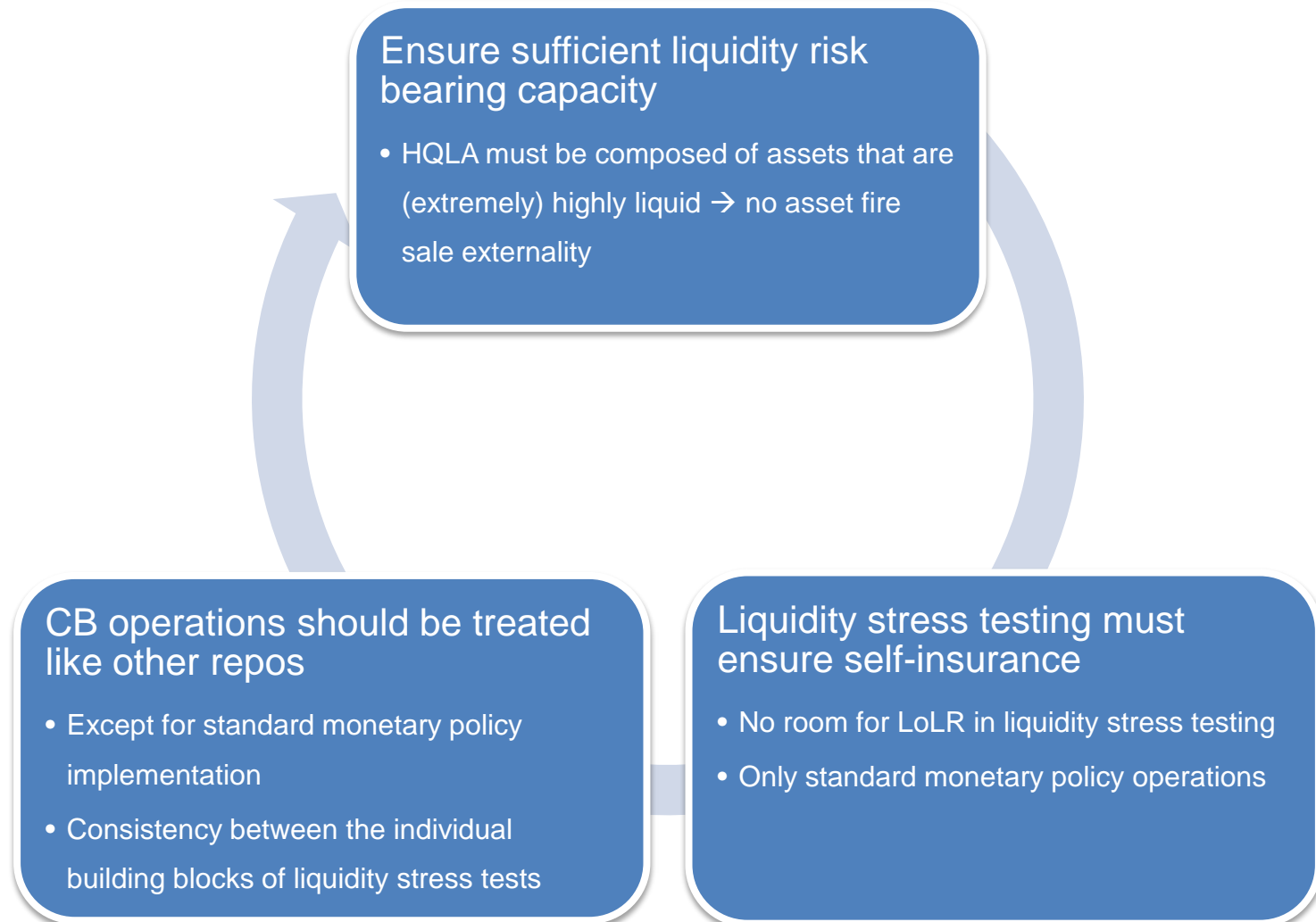
assumes other market participants cannot exploit underpricing due to liquidity constraints

Original concept of the LoLR according to Thornton and Bagehot

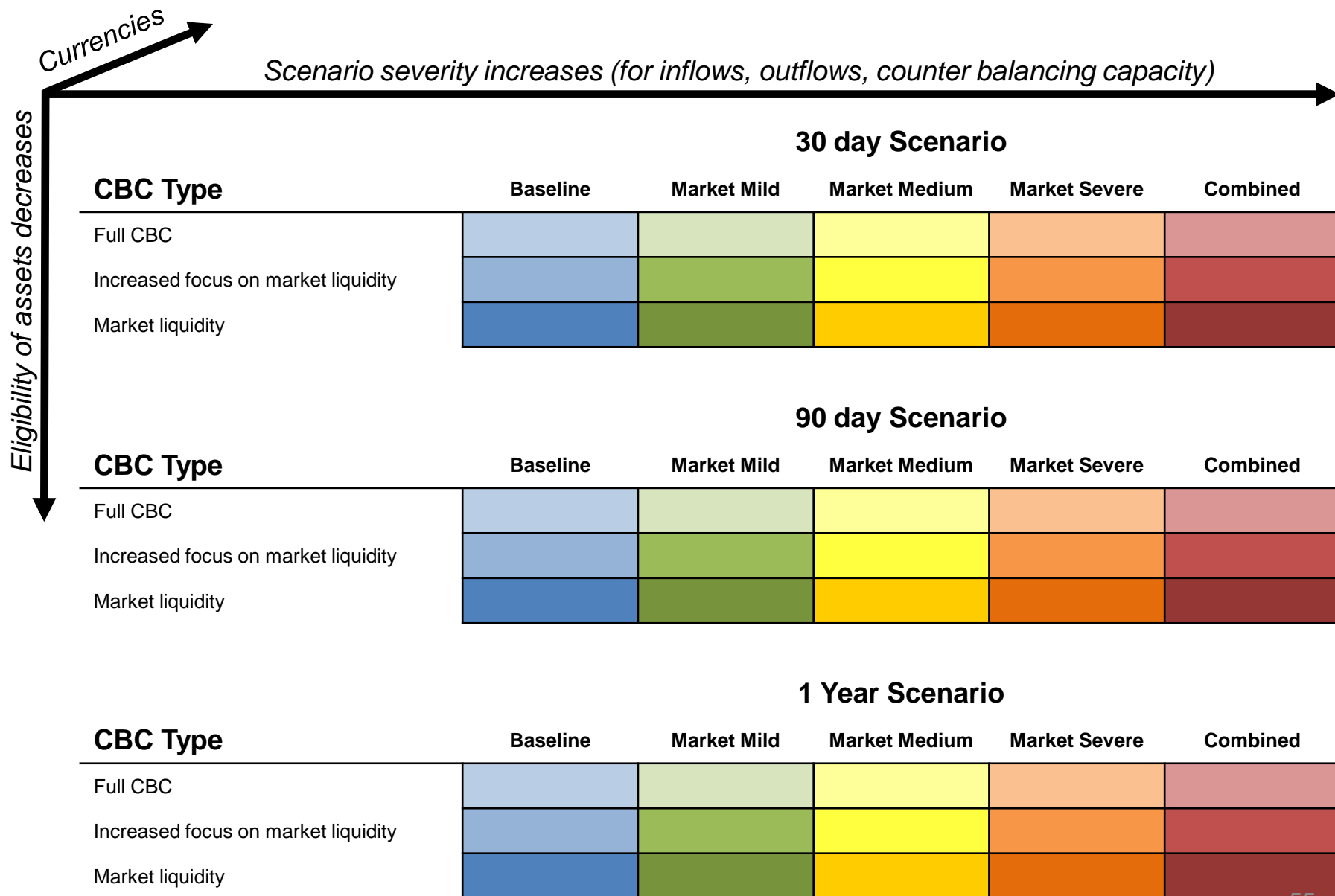
Enables other market participants to profit from underpricing

Limits negative price effect

Conclusions: No LoLR in liquidity stress testing



Scenario & parameter uncertainty



Session 3

Example

Structure

- Mild & severe scenario
- Market & combined scenario (idiosyncratic & market)
- 3 & 6 months horizons
- 3 different approaches to assess counterbalancing capacity
 - Full counterbalancing capacity (with haircuts)
 - CBC without non-liquid assets not deposited at central banks
 - CBC reduced to liquid assets according to LCR

•24 scenarios (all currencies) + 4 scenarios (USD)

Calibration I

Cash-Outflows	Mild Market	Mild Combined	Severe Market	Severe Combined
Own issuances due	1	1	1	1
Unsecured wholesale funding due				
thereof: from non-financial corporates	0	0,06	0,10	0,20
thereof: from financial corporates	0,15	0,25	0,20	0,40
thereof: from financial institutions	1	1	1	1
thereof: from government/public entities	0	0,05	0,00	0,05
thereof: from institutional networks	0	0,06	0,05	0,10
Secured wholesale funding due				
thereof: secured by sovereign debt 0% r/w	0	0	0,20	0,20
thereof: secured by sovereign debt 20% r/w, covered bonds up to AA-, non-financial corporates)	0,05	0,05	0,60	0,60
thereof: secured by equity	0,30	0,30	0,80	1
thereof: secured by other instruments	0,50	0,50	0,80	1
Repos due with central banks	1	1	1	1
Retail (incl. SME) funding due	0	0,06	0,05	0,10
thereof: sight deposits	0	0,06	0,05	0,10
New loans granted	1	1	1	1
Outflows from derivatives	1	1	1	1
Undrawn volume of committed credit/liquidity lines to financial institutions and SPV.	0,30	0,50	0,70	0,70
Undrawn volume of committed liquidity lines to financial corporates.	0,05	0,05	0,10	0,10
Undrawn volume of committed credit/liquidity lines to retail/sme/non-financial corporates and credit lines to financial corporates	0,05	0,05	0,10	0,10
Additional outflows due to a two-notch rating downgrade	0	0	0	1
Others	1	1	1	1
Sum of Cash-Outflows				

Calibration II

Cash-Inflows	Mild Market	Mild Combined	Severe Market	Severe Combined
New own issuances (already contracted)	1	1	1	1
Unsecured wholesale funding	0	0	0	0
Secured wholesale funding	0	0	0	0
Retail funding	0	0	0	0
Loans maturing	0	0	0	0
thereof: loans to financial institutions	1	1	1	1
thereof: other	0	0	0	0
Inflows from derivatives	1	1	1	1
Paper in own portfolio maturing	1	1	1	1
Reverse repos	0	0	0	
thereof: secured by sovereign debt 0% r/w	0	0	0,20	1
thereof: secured by sovereign debt 20% r/w, covered bonds up to AA-, non-financial corporates	0,05	0,05	0,60	1
thereof: secured by equity	0,30	0,30	0,80	1
thereof: secured by other instruments	0,50	0,50	0,80	1
Volume of available credit lines from financial institutions	0	0	0	0
Others	1	1	1	1
Sum of Cash-Inflows				
Net Funding Gap				
Cumulated Net Funding Gap				

Calibration III

Counterbalancing capacity	Mild Market	Mild Combined	Severe Market	Severe Combined
Cash and central bank reserves in excess of minimum reserve requirements				
Unencumbered CB eligible collateral (deposited at central banks)				
Claims on sovereigns (PSEs or government guaranteed) 0% risk-weight under Basel II standardised approach	0,03	0,03	0,05	0,05
Claims on sovereigns (PSEs or government guaranteed) 20% risk-weight under Basel II standardised approach	0,05	0,05	0,10	0,10
Covered bonds (excl own issues, rating at least AA-)	0,05	0,05	0,08	0,08
Non-financial corporate bonds (rating at least AA-)	0,05	0,05	0,10	0,10
Other CB eligible assets (incl credit claims)	0,08	0,08	0,10	0,10
thereof: own issues	0,08	0,08	0,10	0,10
Unencumbered assets (CB eligible, but not deposited at CB)				
Claims on sovereigns (PSEs or government guaranteed) 0% risk-weight under Basel II standardised approach	0,03	0,03	0,07	0,07
Claims on sovereigns (PSEs or government guaranteed) 20% risk-weight under Basel II standardised approach	0,05	0,05	0,15	0,15
Covered bonds (excl. own issues, rating at least AA-)	0,05	0,05	0,10	0,10
Non-financial corporate bonds (rating at least AA-)	0,05	0,05	0,15	0,15
Other CB eligible assets (incl. credit claims)	0,08	0,08	0,25	0,25
thereof: own issues	0,08	0,08	0,25	0,25
Other non CB eligible, tradeable assets (incl equity)	0,60	0,60	0,80	0,80
Sum of Counterbalancing Capacity (after haircut)				
Cumulated Counterbalancing Capacity (after haircut)				

Results (example) – liquidity risk tolerance

	Three months horizon		Six months horizon	
	Mild	Severe	Mild	Severe
Market scenario	X_{11}	X_{12}	X_{13}	X_{14}
CBC without non-liquid assets not deposited at central banks	X_{21}	X_{22}	X_{23}	X_{24}
CBC reduced to liquid assets according to LCR	X_{31}	X_{32}	X_{33}	X_{34}
Combined scenario	X_{41}	X_{42}	X_{43}	X_{44}
CBC without non-liquid assets not deposited at central banks	X_{51}	X_{52}	X_{53}	X_{54}
CBC reduced to liquid assets according to LCR	X_{61}	X_{62}	X_{63}	X_{64}

X_{yz} = # of illiquid banks or US\$ of li-shortfall

**Alternative:
Concerted rounds of common liquidity stress
tests**

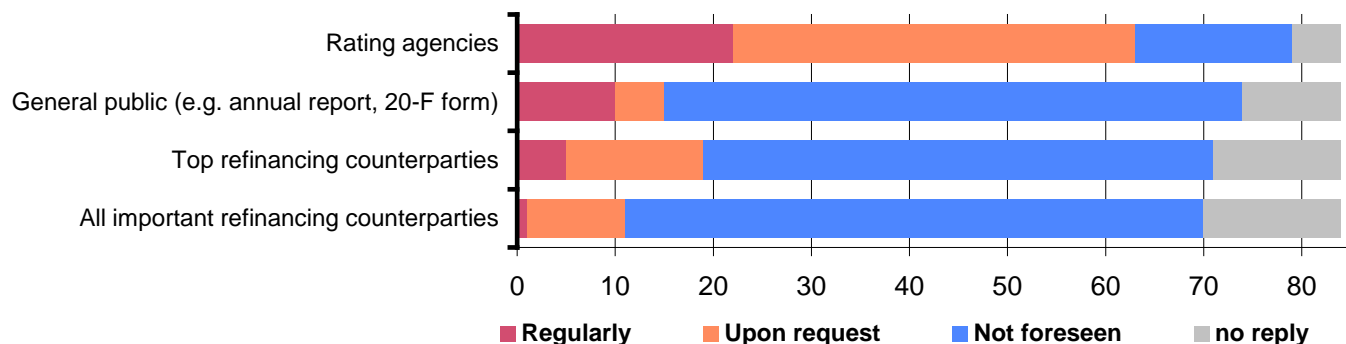
Concerted rounds of common liquidity stress tests

- Combine top-down and bottom-up approaches to macroprudential liquidity stress testing
- Incorporate data on measures taken
- Can incorporate second round effects based on banks' reactions to liquidity stress

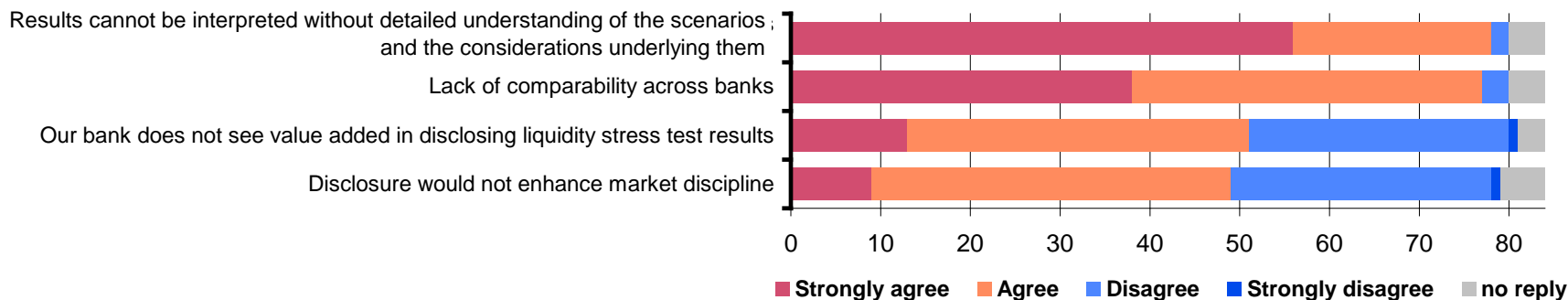
Concerted rounds of common liquidity stress tests

Disclosure policy of stress testing

Does your bank disclose the results of its liquidity stress tests to one of the following audiences?



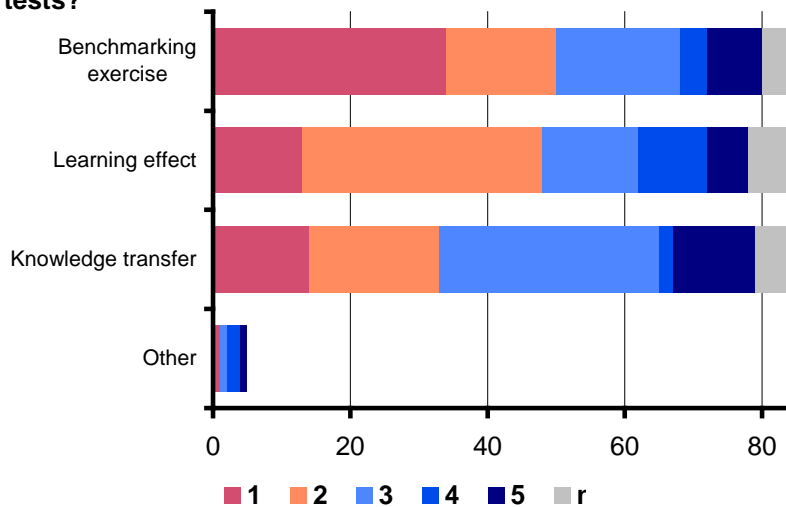
The disclosure of liquidity stress test results is quite rare. What do you consider to be possible reasons for this from your bank's point of view? (multiple answers possible)



Concerted rounds of common liquidity stress tests

Standardisation of liquidity stress tests

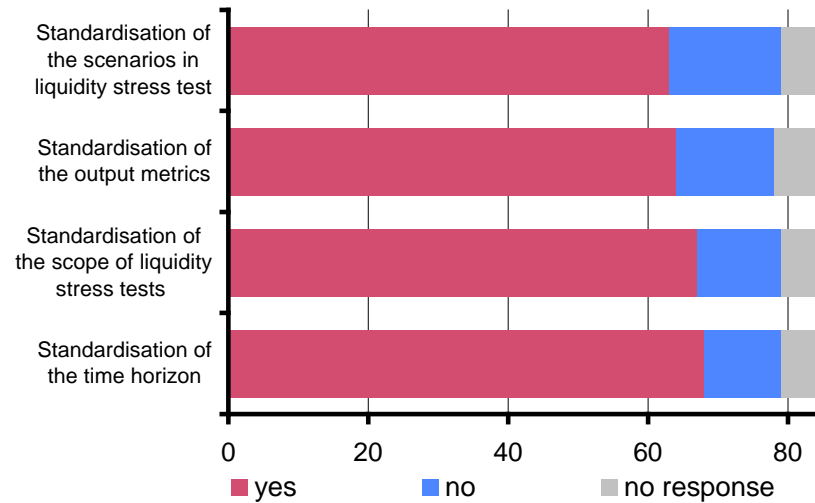
How would you rank (from 1 most important to 5 least important) the benefits for your bank of standardisation of liquidity stress tests?



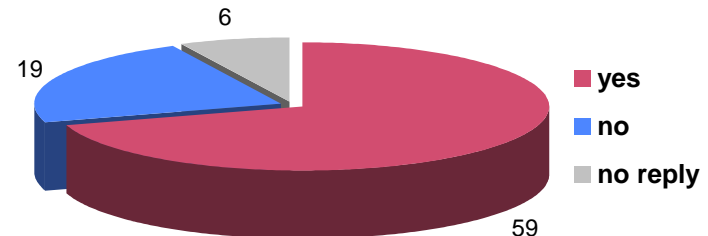
Other

- Worthy as a leader (1)
- Use in risk rating of bank counterparty (3)
- Counterparty risk measurement (4)
- Market discipline (4)
- Comparability across banks (5)

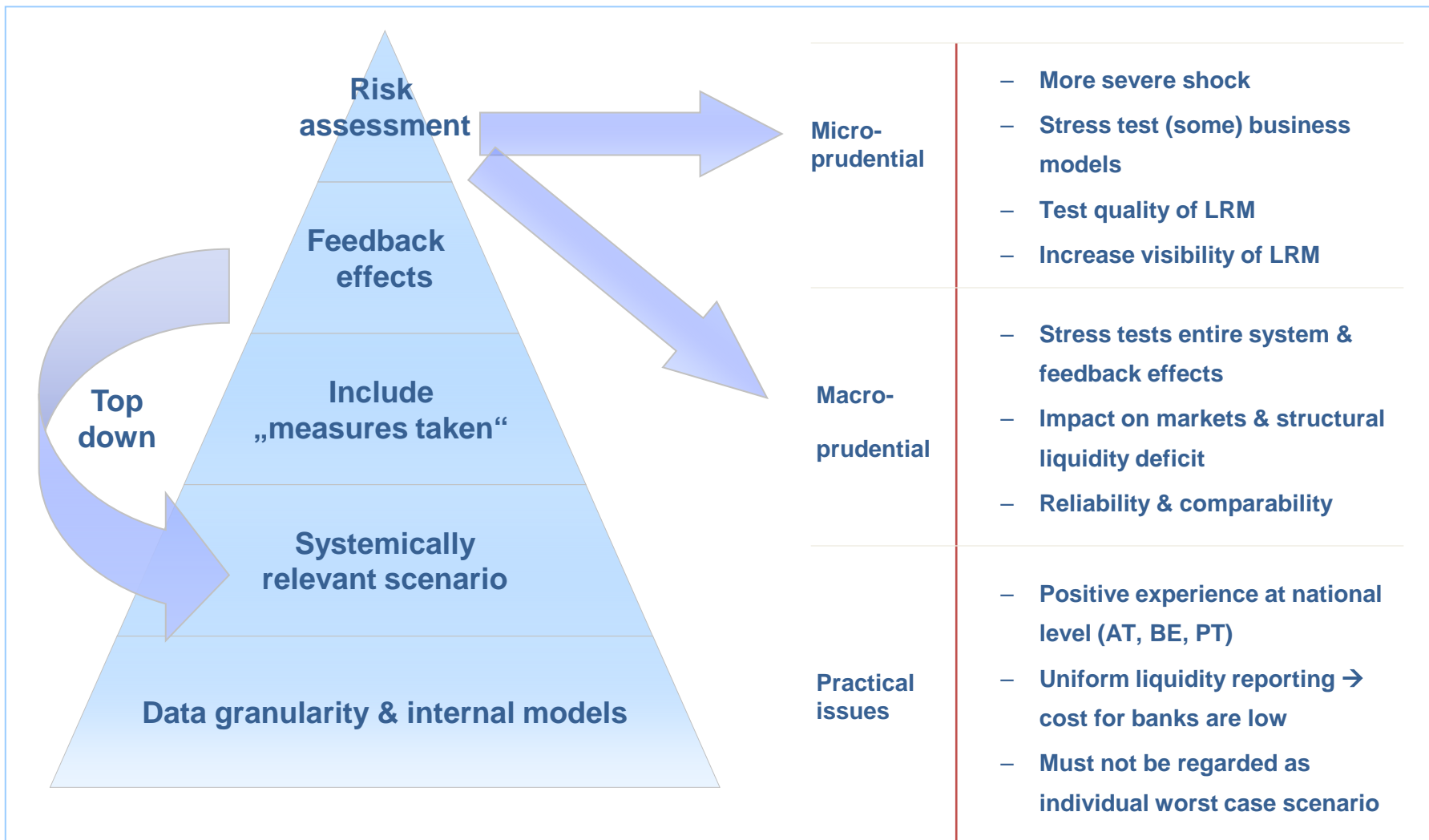
Would standardisation of the following liquidity stress test elements help to improve comparability among banks?



Given standardisation of liquidity stress tests, would disclosure requirements foster market discipline in liquidity risk management?



Concerted rounds of common liquidity stress tests



Measures taken

	<i>amounts in EUR mln</i>						Stress scenario					
	Baseline scenario			Stress scenario			Baseline scenario			Stress scenario		
	1 day	1 week	2 weeks	1 month	3 months	6 months	1 day	1 week	2 weeks	1 month	3 months	6 months
Dedicated portfolio disposal, adjustment trading limits												
o.w. bonds												
o.w. ABS												
o.w. equity												
other												
Adjustment of loans and deposits												
o.w. reduction unsecured interbank loans												
o.w. reduction repos												
o.w. reduction intra-group lines												
o.w. reduction of lending to corporates, households												
o.w. additional savings through increasing retail deposit rate												
Hedging measures												
o.w. interest rate contracts												
o.w. equity contracts												
o.w. CDS contracts												
Restructuring maturity profile												
Drawings on liquidity facilities												
o.w. unsecured interbank credit lines												
o.w. secured interbank credit lines, repos												
o.w. intra-group funding												
o.w. other*												
Debt issuance												
o.w. short-term debt instruments												
o.w. medium, long-term debt instruments												
o.w. ABS												
o.w. government-guaranteed debt**												
Recourse to central bank facilities												
Non-redemption of callable bonds												
Cutting dividends												
* <i>stating counterparties</i>												
** <i>Central bank policy and governmental support facilities are assumed to be left unchanged, save for changes described in the scenario</i>												

Session 4

Practical session

Session 5

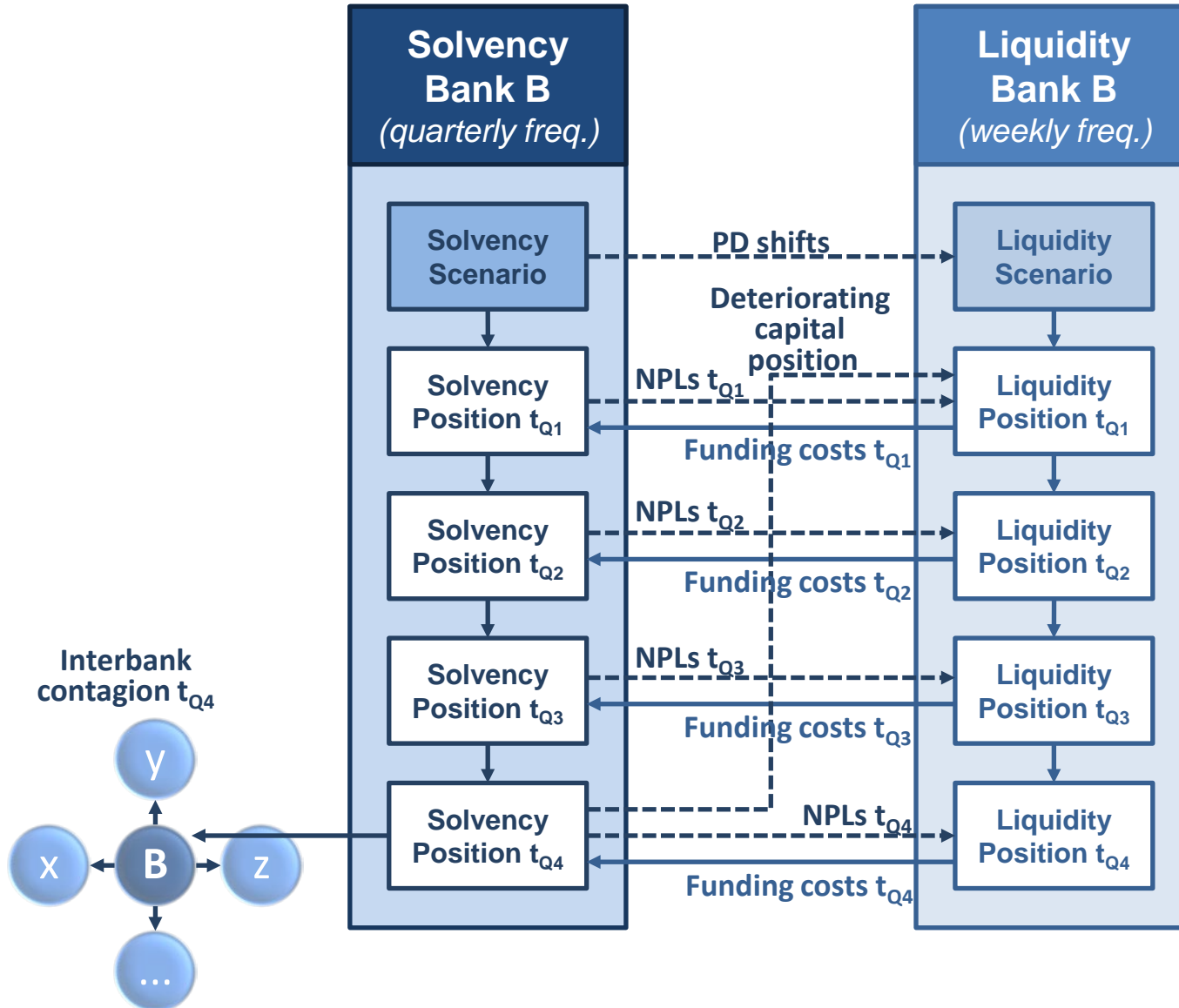
Interaction solvency/liquidity

Interlinkages solvency / liquidity

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

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

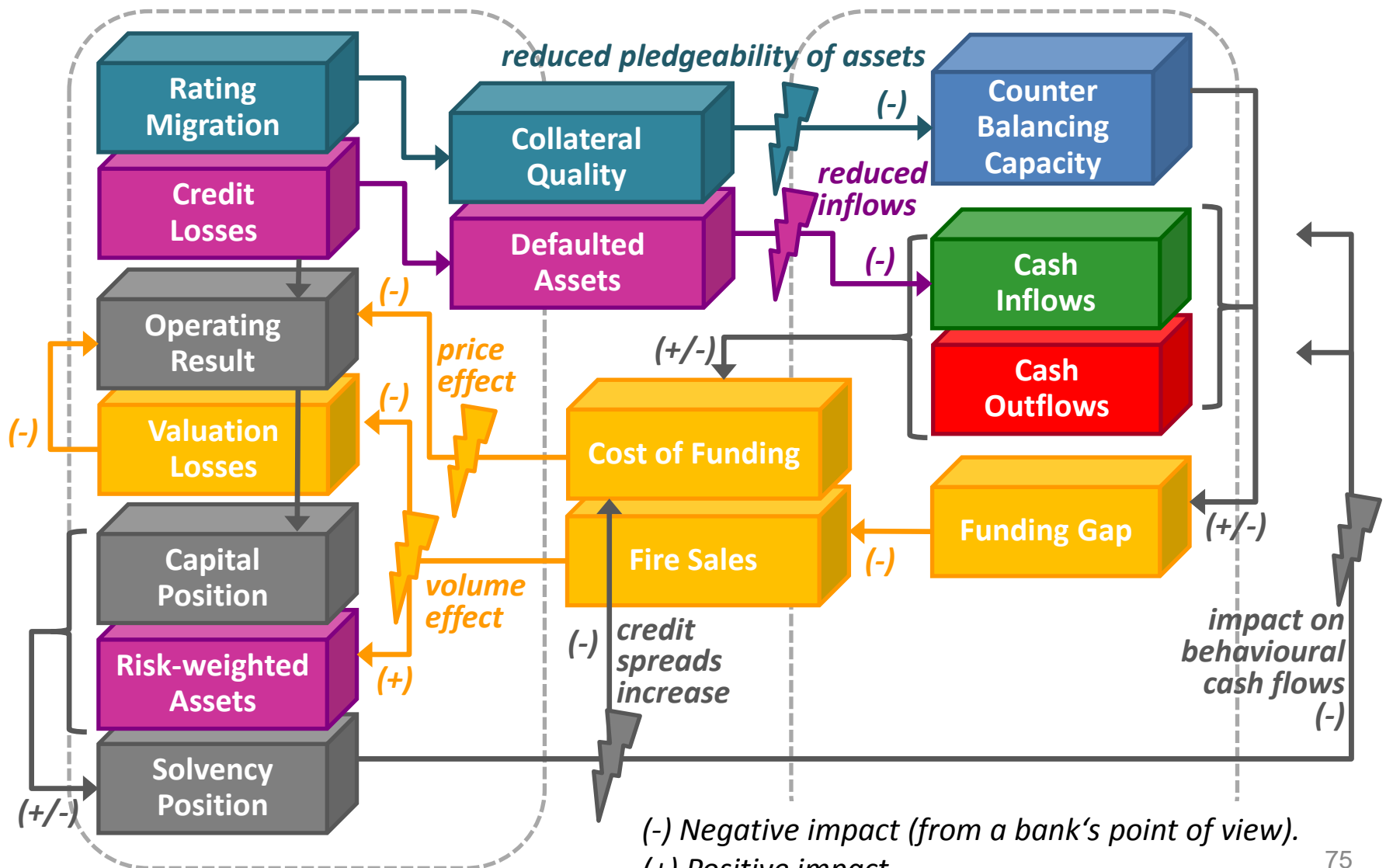
Timing / sequencing of interaction



Complex interaction of solvency and liquidity

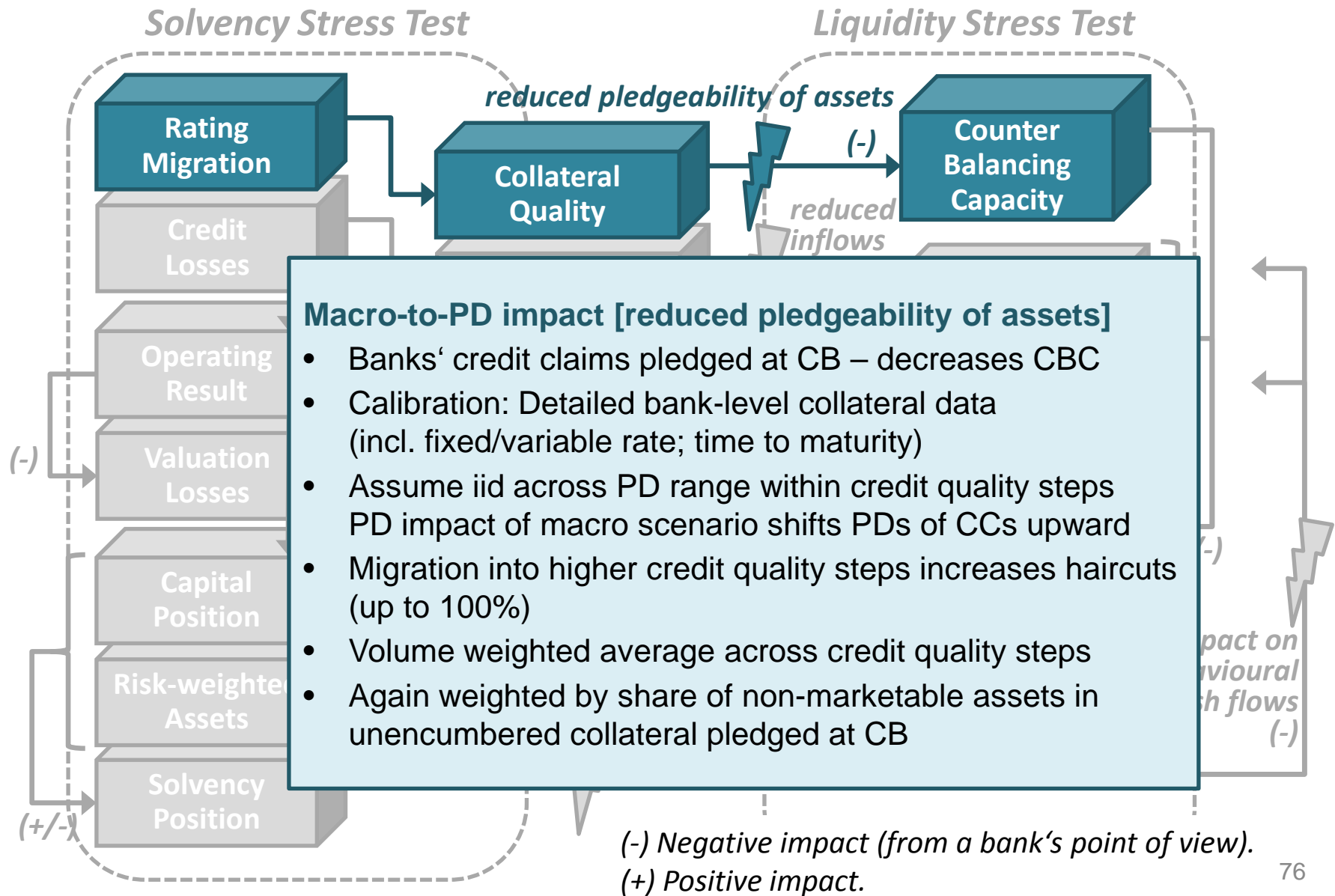
Solvency Stress Test

Liquidity Stress Test

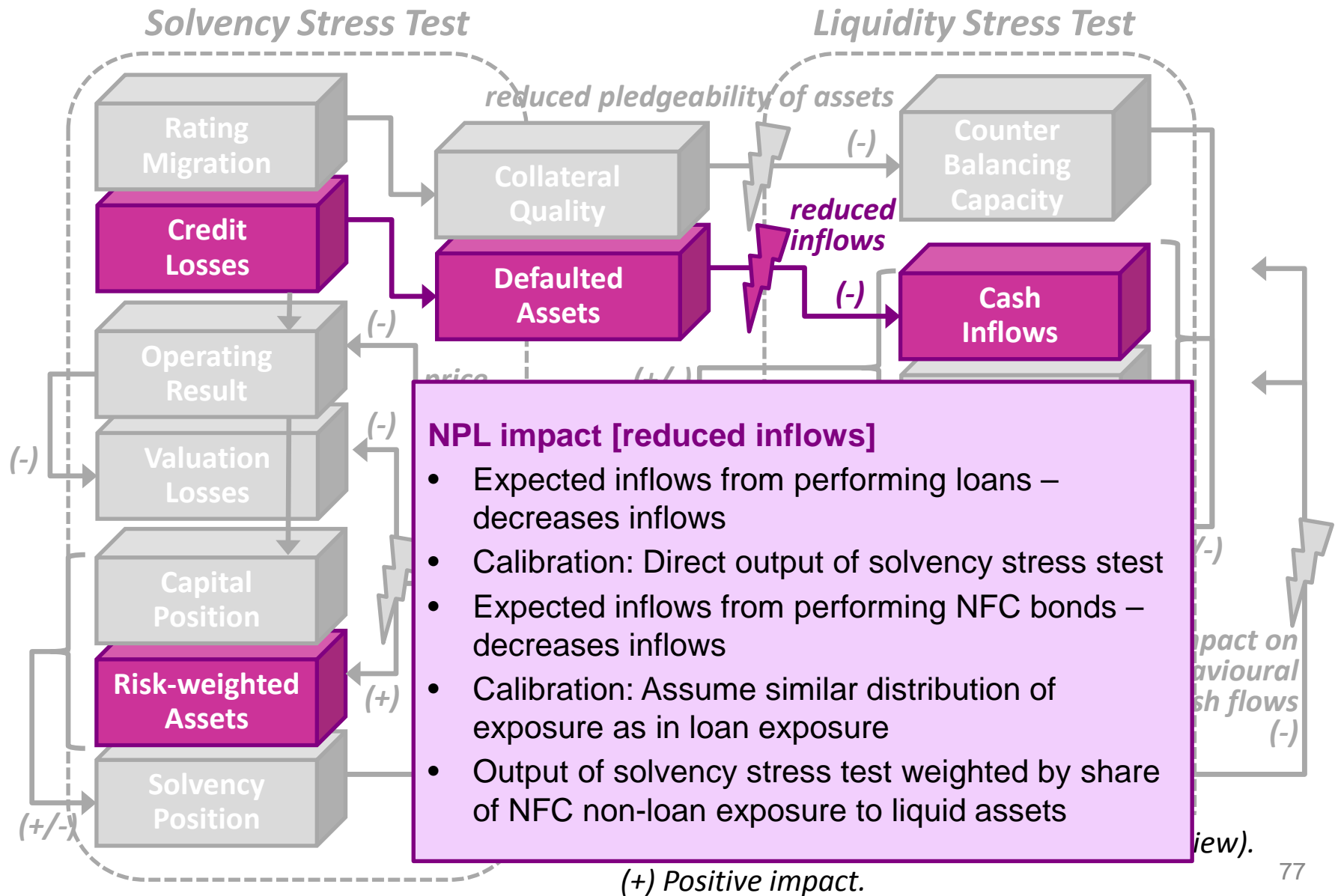


(-) Negative impact (from a bank's point of view).
 (+) Positive impact.

The interaction of solvency and liquidity



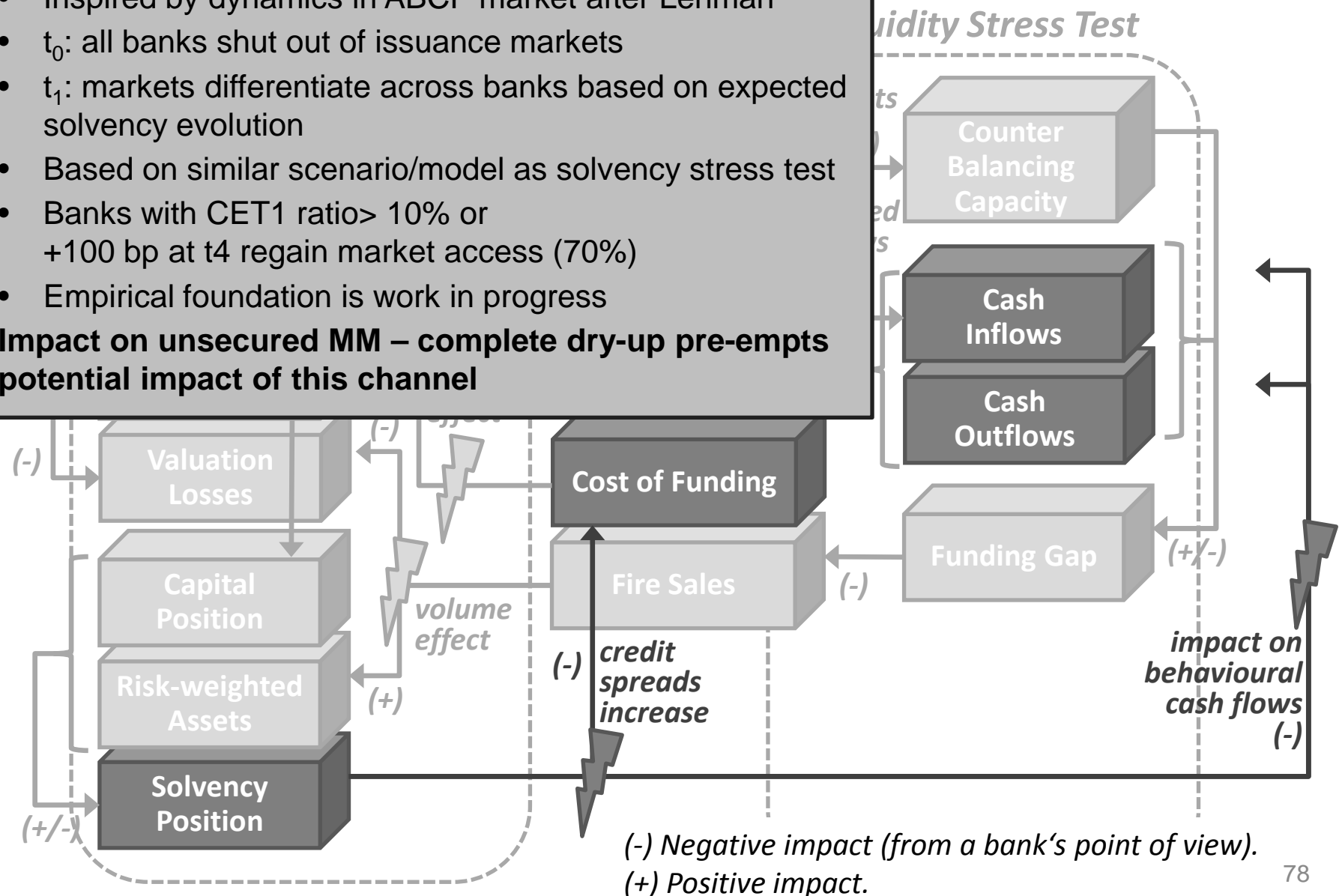
The interaction of solvency and liquidity



Solvency impact on funding [impact on behavioural cash flows]

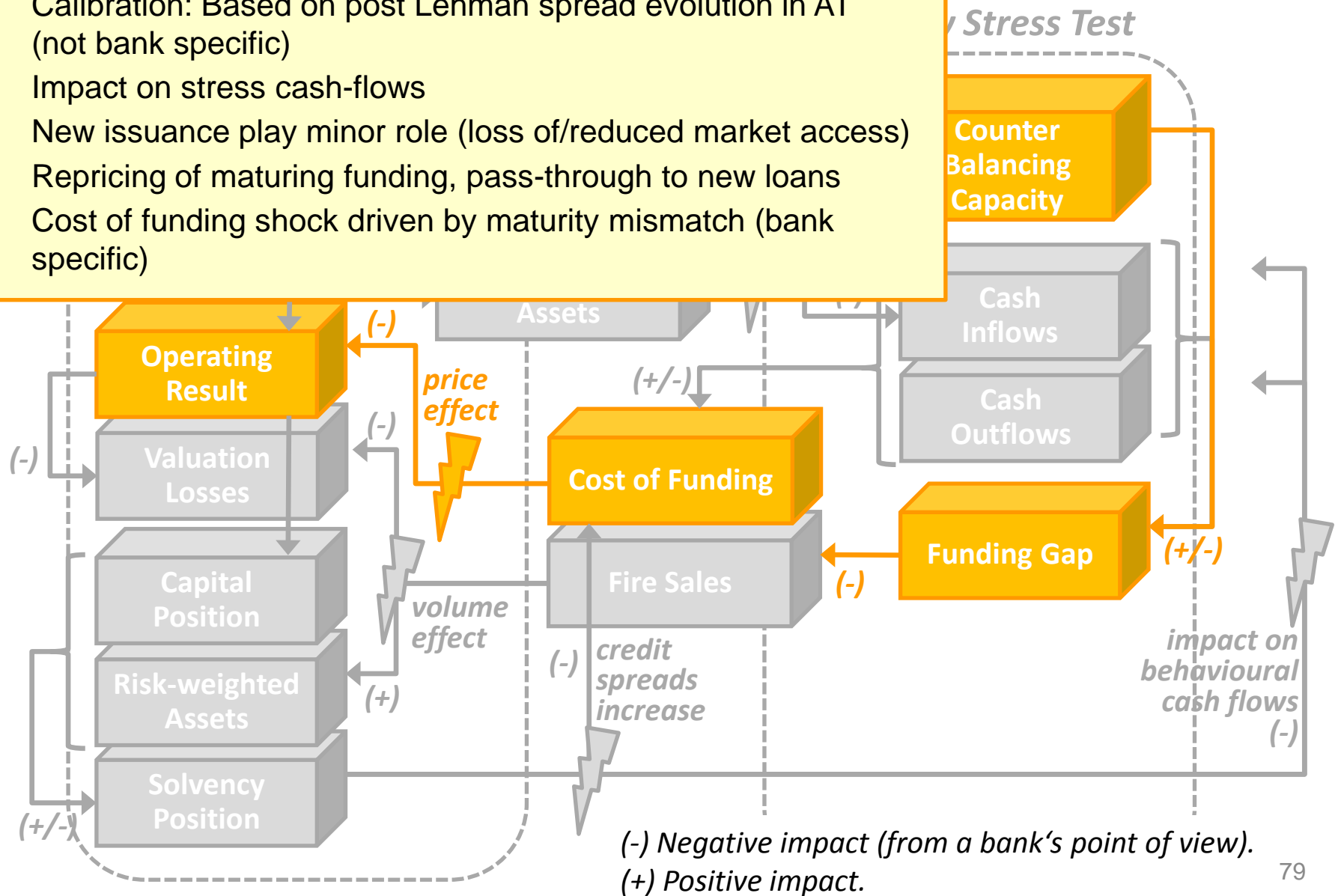
- Inspired by dynamics in ABCP market after Lehman
- t_0 : all banks shut out of issuance markets
- t_1 : markets differentiate across banks based on expected solvency evolution
- Based on similar scenario/model as solvency stress test
- Banks with CET1 ratio > 10% or +100 bp at t_4 regain market access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

Impact on unsecured MM – complete dry-up pre-empts 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)

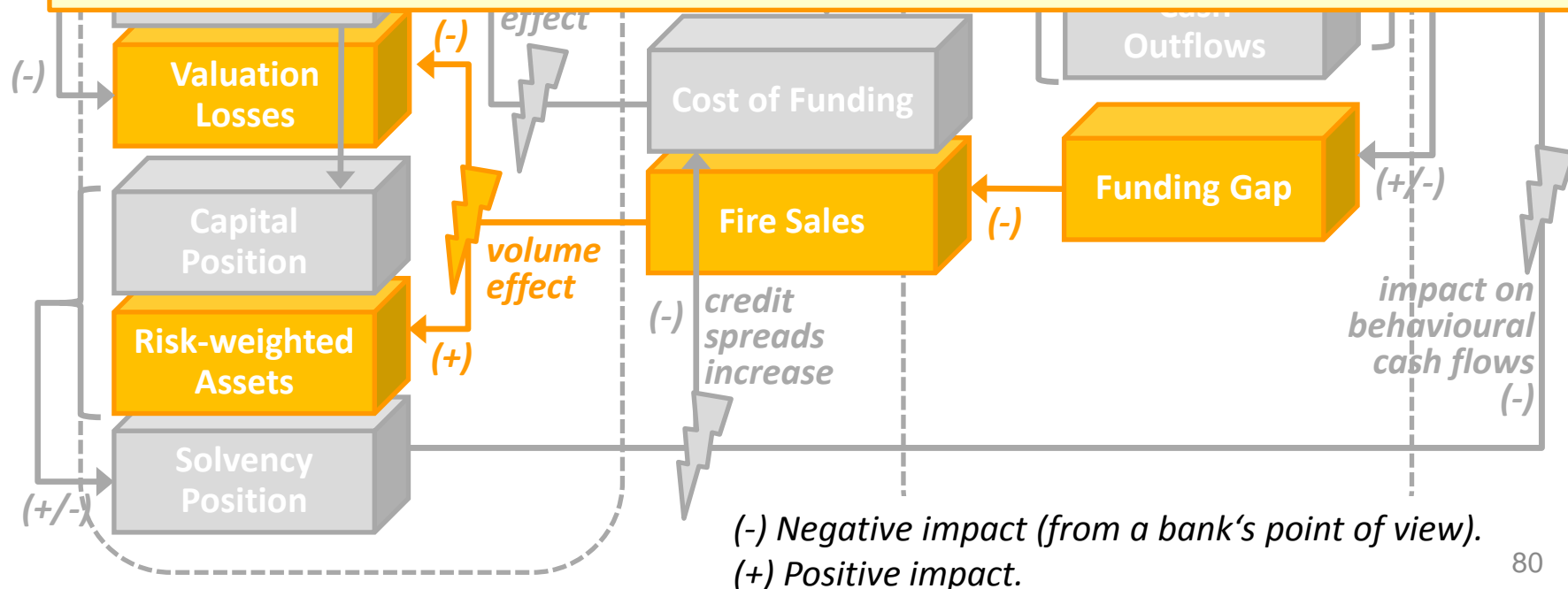


Asset fire sales losses [volume effect]

- 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



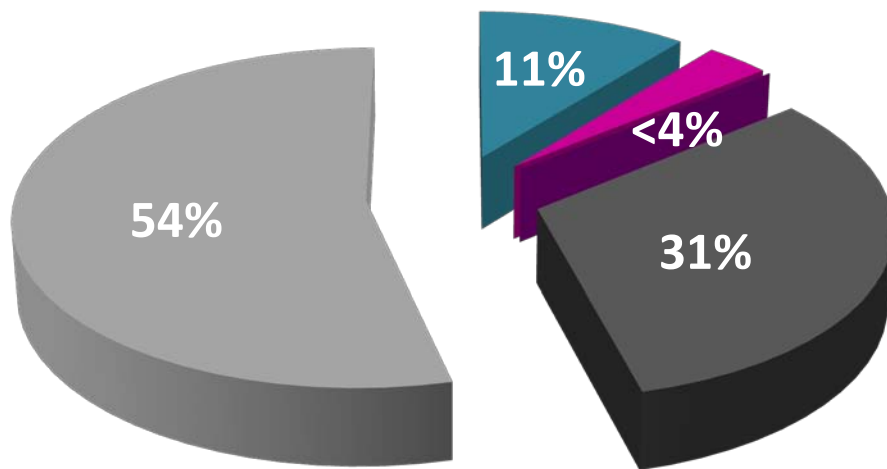
Important channels disregarded

- ❑ 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

Measuring the impact of interaction channels

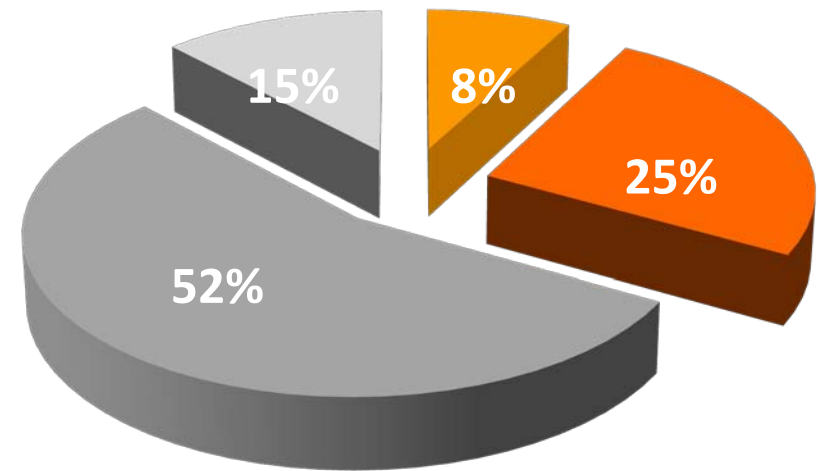
Liquidity Stress Test

(share of total impact on cumulated counter balancing capacity)



Solvency Stress Test

(share of total impact on P&L losses)



- 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

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

Conclusions, policy recommendations & discussion

Policy implications (I)

Liquidity stress tests complement liquidity regulation

- Aggregation of comprehensive & complex information

Data quality key prerequisite

- Behavioural cash flows necessary
- Dynamic consistency across all components (in-/outflows & CBC)

Parameter uncertainty

- Careful & well documented empirical foundations
- Embedded scenarios of increasing severity
- Decision makers have to understand that even the best models and calibrations cannot exonerate them from the burden of subjective judgement in risk assessment

Policy implications (II)

No reliance on LoLR

- Moral hazard, externalities & pricing of liquidity risk

Interaction of liquidity/solvency must not be disregarded in stress tests

- Underestimation of impact in LST – 85%
- Under-estimation of impact on SST – 50%

Parameter uncertainty

- Careful & well documented empirical foundations
- Embedded scenarios of increasing severity

No reliance on LoLR

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.

BCBS (2013 b), '*Literature review of factors relating to liquidity stress – extended version*', Basel Committee on Banking Supervision WP No. 25, Basel.

ECB (2008) Report on EU banks liquidity stress tests and contingency funding plans, Frankfurt

Puhr, C. and S. W. Schmitz (2013), '*A View From The Top – The Interaction Between Solvency And Liquidity Stress*', Journal of Risk Management in Financial Institutions 7(4), 2014, 38-51

Schmieder, C., H. Hesse, B. Neudorfer, C. Puhr and S. W. Schmitz (2012), '*Next generation system-wide liquidity stress testing*', IMF Working Paper, 12/03, Washington D.C.

Schmitz, S. W. (2013), '*The impact of the Liquidity Coverage Ratio (LCR) on the implementation of monetary policy*', Economic Notes, 32/2, 1-36.

Schmitz, S.W., A. Ittner (2007) Why central banks should look at liquidity risk, Quarterly Journal Central Banking Vol. XVII No. 4, 32-40