

Illustrative Examples of Stress Tests

As stress testing is an evolving area, a few illustrative examples of typical stress tests are presented below purely with a view to aid in better perception of stress tests among banks. Therefore, it would **not** be appropriate (i) to conclude that the levels of stress or the impacts mentioned in these illustrations are as perceived by the Reserve Bank or are recommended by the Reserve Bank and (ii) for banks to apply the illustrative stress tests as they are. Each bank should ensure that the assumptions and the levels of stress are as determined by them and that the stress tests are suitably modified while designing their respective stress testing frameworks in such a manner that it would be relevant to each bank's requirement. The stress testing framework and methodology in each bank should, however, be tailored to suit the size, complexity, risk philosophy, risk perceptions and skills in each bank. Banks should construct their own stress scenarios; ensure that appropriate risk factors are included; apply the appropriate levels of stress as they perceive to be plausible and ensure that the stress tests are economically meaningful.

Stress test illustration – 1 : Liquidity risk

1. The general sources of stress on liquidity in banks are seen to emerge from
 - a) Over-dependence on more volatile funding sources, such as wholesale funds and inter-bank funds;
 - b) Depositors' ability to switch funds among accounts by electronic means;
 - c) Bank's ratings downgrades or other negative news could cause, among others, reduced market access to unsecured borrowings from call money market; a reduction or cancellation of inter-bank credit lines; a reduction of deposits; and adversely affect a bank's capability of securitising its assets.
 - d) Off-balance sheet products that can give rise to sudden material demands for liquidity at banks include committed lending facilities to customers, committed backstop facilities, and committed back-up lines to special purpose vehicles.
 - e) Sharp and unanticipated market movements or defaults could cause demand for additional collateral calls from exchanges/ settlement platforms in connection with foreign exchange and securities transactions;

2. A primary liquidity risk is deposit run-offs in a bank-specific event. The assumptions that banks may utilise in the stress tests may be based on a combination of bank-specific historical data, industry data from prior stress events, and/or best guess estimates. When using bank-specific historical data, some banks may add an extra cushion to the assumed outflows to factor-in their perception that data largely based on stable historical periods may not adequately reflect depositor behaviour during a future stress event. The severity of deposit outflows in a bank's stress scenario depends upon factors including the strength of the bank's relationships with its customers, the proportion of deposits that is protected by deposit insurance, the composition of its balance sheet, and the duration of the crisis. Banks may reckon securitisation of the eligible assets as a potential source for liquidity after taking all relevant factors into account. While

considering stress scenarios, as a conservative measure, banks should not reckon the Reserve Bank as a contingent source for liquidity.

3. The broad assumptions that may be made on behaviour of liabilities during stress periods may be:
 - a) The percentage of retail deposits that may be withdrawn in a stress scenario is typically in the single digits, while a few banks may assume outflows in the low double digits. This reflects an assumption that retail depositors would be comforted by deposit insurance and so would not withdraw their deposits. Hence, retail for the purpose of stress tests would be those enjoying the protection of deposit insurance.
 - b) Corporate, bank and government deposits or other un-insured deposits may be assumed to reduce between 20 percent and 50 percent, typically over a one-month time span. Outflows may, sometimes, be assumed to be 100 percent for certain deposit types. Some banks may make finer distinction among different types of clients or on the basis of the bank's relationships with them.
 - c) Banks may recognise that disposal of assets to raise liquidity may entail application of haircuts (depending on the scenario) while arriving at their realisable value.
 - d) Banks may recognise that intra-group cash flows might be disrupted.
 - e) Banks may undertake the stress test where the stress scenario is expected to last over different time horizons say one month or less; two or three months; and six months or more.

4. A numerical illustration of a liquidity stress test when on account of an adverse rumour the bank's reputation for meeting its liabilities as and when they mature has been eroded is presented below. The broad assumptions are mentioned below:

(Rs. crore)

	1-7 days	8-14 days	15-28 days	29 days to 3 mths	> 3 to 6 mths	> 6 mths to 1 year	> 1 to 3 yrs	> 3 to 5 yrs	> 5 yrs	TOTAL
Normal										
Assets	50	50	150	200	200	300	350	250	250	1800
Wholesale deposits	12	18	40	50	40	50	10	10	0	230
Retail Deposits	40	50	140	200	310	300	190	140	200	1570
Total Liability	52	68	180	250	350	350	200	150	200	1800
Gap	-2	-18	-30	-50	-150	-50	150	100	50	0
Stress										
Assets	50	50	150	200	200	300	350	250	250	1800
Wholesale deposits	75	55	20	25	20	25	5	5	0	230
Retail Deposits	212	174	112	160	248	240	152	112	160	1570
Total Liability	287	229	132	185	268	265	157	117	160	1800
Gap	-237	-179	18	15	-68	35	193	133	90	0
Assumptions										
The stress scenario is expected to last three months										
1. Wholesale deposits - Fifty percent of these deposits are to be repaid in the first two buckets and the remaining fifty percent is re-deposited with a hike in interest rate by 1%.										
2. The retail deposits are fully covered by deposit insurance. However, 20% of the deposits in the third bucket onwards (i.e., 1570 – 90) are withdrawn in the first two buckets.										
3. Assets maturing beyond the first two buckets are sold at a discount of 10%, to the extent required, to meet the gap in the first two buckets. (i.e. Rs. 416 crore)										
Impact of stress on liquidity										
Loss on sale of assets										
46.22										
Higher Interest on -										
Wholesale deposits										
1.00										
Total cost										
47.22										

Stress test illustration – 2 : Interest rate risk – earnings perspective

Interest rate risk is the risk where changes in market interest rates might adversely affect a bank's financial condition. The immediate impact of changes in interest rates is on bank's earnings through changes in its Net Interest Income (NII). A long-term impact of changes in interest rates is on bank's Market Value of Equity (MVE) or Net worth through changes in the economic value of its assets, liabilities and off-balance sheet positions. The interest rate risk, when viewed from these two perspectives, is known as 'earnings perspective' and 'economic value' perspective, respectively. The present guidelines on asset liability management (BP.BC.8/21.04.098/99 dated February 10, 1999) to banks approach interest rate risk measurement from the 'earnings perspective' using the traditional Gap Analysis (TGA).

The following illustrations indicate a few methods of application of stress tests to assess the impact of interest rate risk from the earnings perspective.

(Rs. crore)

Time buckets ➔	1-14 days	15-28 days	29 days to 3 mths	> 3 to 6 mths	> 6 mths to 1 year	> 1 to 3 yrs	> 3 to 5 yrs	> 5 yrs	TOTAL
Particulars ↓									
RSA**	100	150	200	200	300	350	250	250	1800
RSL**	120	180	250	350	350	200	150	50	1650
Gap (RSA – RSL)	- 20	- 30	-50	-150	- 50	150	100	200	150

Annual Profit = Rs. 18 crore

** RSA – Rate sensitive assets; RSL – Rate sensitive liabilities

Example A : When interest rates increase by one percent across all time buckets both for assets and liabilities

	1-14 days	15-28 days	29 days to 3 mths	> 3 to 6 mths	> 6 mths to 1 year	> 1 to 3 yrs	> 3 to 5 yrs	> 5 yrs	TOTAL
RSA – Value	100	150	200	200	300	350	250	250	1800
RSL – Value	120	180	250	350	350	200	150	50	1650
Gap	-20	-30	-50	-150	-50	150	100	200	150
Intt. On RSA	1	1.5	2	2	3	3.5	2.5	2.5	18
Intt on RSL	-1.2	-1.8	-2.5	-3.5	-3.5	-2	-1.5	-0.5	-16.5
Impact on NII	-0.2	-0.3	-0.5	-1.5	-0.5	1.5	1	2	1.5
Impact on profit									8.33%

Assumptions: Where all assets and liabilities are linked to floating interest rates, any change in the interest rates would normally impact the interest rates pertaining to those assets and liabilities which are due for maturity/ re-pricing within the time horizon over which the stress is envisaged. In the Indian context, when there is a change in the prime lending rates (PLR) of banks, the change will impact the interest rates of all assets which are linked to the PLR, including those that are due for re-pricing/ maturity beyond the time horizon over which the stress is envisaged. Fixed interest rate exposures would be sensitive to interest rate changes with reference to the date of maturity and hence would not be affected by change in interest rates when these exposures are maturing beyond the time horizon over which the stress is envisaged. For the purpose of this illustration, the change in interest rates is assumed to immediately impact the interest rates pertaining to all assets and all liabilities, and, thus the NII.

- Increase in interest income on RSA = $1800 \times 0.01 =$ Rs. 18 crore
- Increase in interest expenditure on RSL = $1650 \times 0.01 =$ Rs. 16.50 crore
- Hence, NII has **increased** by Rs. 1.50 crore and the profits **increase** by 8.33%.
- The impact is equal to one percent of the Net gap between RSA and RSL (150×0.01)

Example B : When interest rates decrease by one percent across all time buckets both for assets and liabilities

	1-14 days	15-28 days	29 days to 3 mths	> 3 to 6 mths	> 6 mths to 1 year	> 1 to 3 yrs	> 3 to 5 yrs	> 5 yrs	TOTAL
RSA – Value	100	150	200	200	300	350	250	250	1800
RSL – Value	120	180	250	350	350	200	150	50	1650
Gap	-20	-30	-50	-150	-50	150	100	200	150
Intt. On RSA	-1	-1.5	-2	-2	-3	-3.5	-2.5	-2.5	-18
Intt on RSL	1.2	1.8	2.5	3.5	3.5	2	1.5	0.5	16.5
Impact on NII	0.2	0.3	0.5	1.5	0.5	-1.5	-1	-2	-1.5
Impact on profit									-8.33%

Assumptions: All assets and liabilities are linked to floating rate interest rates linked to benchmark rates. The change in interest rates immediately impacts the benchmark rates and thus the NII.

- Decrease in interest income on RSA = $1800 \times 0.01 =$ Rs. 18 crore
- Decrease in interest expenditure on RSL = $1650 \times 0.01 =$ Rs. 16.50 crore
- Hence, NII has **decreased** by Rs. 1.50 crore and the profits **decrease** by 8.33%.
- The impact is equal to one percent of the Net gap between RSA and RSL (150×0.01)

Example C : When interest rates increase by one percent for time buckets up to one year and decrease by one percent for time buckets beyond one year both for assets and liabilities

	1-14 days	15-28 days	29 days to 3 mths	> 3 to 6 mths	> 6 mths to 1 year	> 1 to 3 yrs	> 3 to 5 yrs	> 5 yrs	TOTAL
RSA – Value	100	150	200	200	300	350	250	250	1800
RSL – Value	120	180	250	350	350	200	150	50	1650
Gap	-20	-30	-50	-150	-50	150	100	200	150
Intt. On RSA	1	1.5	2	2	3	-3.5	-2.5	-2.5	1
Intt on RSL	-1.2	-1.8	-2.5	-3.5	-3.5	2	1.5	0.5	-8.5
Impact on NII	-0.2	-0.3	-0.5	-1.5	-0.5	-1.5	-1	-2	-7.5
Impact on profit									-41.67%

- RSA – RSL for time buckets up to one year = (-) 300. Hence, impact on NII for time buckets up to one year = $(-) 300 \times 0.01 = (-)$ Rs. 3 crore; i.e., a decrease in NII.

- RSA – RSL for time buckets beyond one year = (+) 450. Hence, impact on NII for time buckets beyond one year = 450 x (-) 0.01= (-) Rs. 4.50 crore; i.e., a decrease in NII.
- The aggregate **decrease** in NII is Rs. 7.50 crore and therefore the profits **decrease** by 41.67%.

Stress test illustration – 3 : Credit risk – Impact on capital adequacy

The stress tests for credit risk may assess the impact of an economic downturn on the bank's capital adequacy position especially under a Basel II scenario. An economic downturn could lead to a downgrade in the credit ratings awarded to a bank's counterparties by rating agencies. This might lead to a consequent increase in the risk weights for these exposures which will have an impact on the bank's capital adequacy position. This is a likely situation under a Basel II scenario where the risk weights will be related to the credit rating enjoyed by the counterparty exposures. A similar stress test may also be undertaken with reference to the internal rating grades awarded to the counterparties. The impact in this situation would be on the economic capital maintained by a bank.

The following two examples illustrate this impact on capital adequacy arising out of an economic downturn, under two assumptions (a) a uniform level of downgrade for all rating grades; and (b) a different level of downgrade for different rating grades.

Example A:

						Rs.crore
		Normal situation		Stress situation		
Rating scale	Risk weight	Exposure	RWA	Extent of down-grade (%)	Exposure	RWA
AAA	20	300	60.00	15	255	51.00
AA	50	200	100.00	15	215	107.50
A	50	100	50.00	15	115	57.50
BBB	100	300	300.00	15	270	270.00
BB & below	150	100	150.00		145	217.50
		1000	660.00		1000	703.50
Minimum Capital			59.40			63.32
Capital funds*	65					
CRAR			9.85			9.24

* Assumed capital funds.

- **Example B :**

						Rs.crore
		Normal situation		Stress situation		
Rating scale	Risk weight	Exposure	RWA	Extent of down-grade (%)	Exposure	RWA
AAA	20	300	60.00	15	255	51.00
AA	50	200	100.00	20	205	102.50
A	50	100	50.00	25	115	57.50
BBB	100	300	300.00	30	235	235.00
BB & below	150	100	150.00		190	285.00
		1000	660.00		1000	731.00
Minimum Capital			59.40			65.79
Capital funds*	65					
CRAR			9.85			8.89

* Assumed capital funds

Stress test illustration – 4 : Credit risk

The stress tests for credit risk may also assess the impact of an increase in the level of non performing loans (NPLs). This could have a two way impact – one on the bank's NPA levels as well as on the additional provisioning requirements which would have a consequent impact on the bank's profits and the CRAR. Banks may also conduct stress tests with reference to the extent of provisioning that may be required by the regulator for various asset categories.

Example A: The regulatory provisioning requirement under a stress situation is assumed as 1% for all Standard (S); 25% for Substandard (SS), and 100% for all Doubtful categories.

					Rs. Crore
		Normal situation		Stress situation *	
Asset Classification	Rate of Provisioning (%)	Exposure	Provision	Revised rate of provisioning (%)	Provision
S	1	900	9.00	1.00	9.00
SS	10	40	4.00	25	10.00
D1	20	10	2.00	100	10.00
D2	30	15	4.50	100	15.00
D3	100	35	35.00	100	35.00
		1000	54.50		79.00
Profit		18		-6.50	
Addl. Provisions					24.50
Impact on profits (%)				-136.11	
ROA		1.80		-0.65	
Capital funds		95		70.50	
RWA		954.50		930.00	
CRAR		9.95		7.58	

* Assumed capital funds – Rs. 95 crore

Note:

1. **Profit** under stress situation = $18 - 24.50 = (-) 6.50$
2. **Capital funds** under stress situation = $95 - 24.50 = 70.50$
3. **RWA** under normal situation = $1000 - (4.00+2.00+4.50+35.00) = 954.50$
4. **RWA** under stress situation = $1000 - (10.00 + 10.00 + 15.00 + 35.00) = 930$

Example B: The downgrade from Standard to NPA (sub standard) is assumed to be 10% (i.e., the extent of present level of gross NPAs) and the provisioning requirements under stress situation are assumed as in example A above:

		Rs. Crore					
		Normal situation			Stress situation *		
Asset Classification	Rate of Provisioning (%)	Exposure	Provision	Extent of downgrade (%)	Exposure	Revised rate of provisioning (%)	Provision
S	1.00	900	9.00	10	810	1	8.10
SS	10	40	4.00		130	25	32.50
D1	20	10	2.00		10	100	10.00
D2	30	15	4.50		15	100	15.00
D3	100	35	35.00		35	100	35.00
		1000	54.50		1000		100.60
Profit		18				-28.10	
Add. Provisions							46.10
Impact on profits						-256.11	
ROA		1.80				-2.81	
Capital funds		95				48.00	
RWA		954.50				907.50	
CRAR		9.95				5.29	

Note:

1. **Profit** under stress situation = $18 - 46.10 = (-) 28.10$
2. **Capital funds** under stress situation = $[95 - (9.00 - 8.10)] - 46.10 = 48.00$
3. **RWA** under stress situation = $1000 - (32.50 + 10.00 + 15.00 + 35.00) = 907.50$

Stress test illustration – 5 : Foreign exchange risk

The stress test for exchange rate may assess the impact of change in exchange rate on the bank's open positions and consequently its capital requirements. To model direct foreign exchange risk only the overall net open position of the bank may be given an adverse shocks (say 5%, 10% and 15%). The overall net open position is measured by aggregating the sum of short positions or the sum of long positions; whichever is greater regardless of sign. Banks may adopt a more conservative method for computing open positions. The impact of the stress event could be measured with reference to

- a) the additional capital that may be required to be maintained; and
- b) the loss on account of change in value

Example A:

Foreign exchange open positions				
Currency		Limits (in millions)	Rupee equivalent (Rs. Crore)	
USD		5	22.50	
EURO		4	23.20	
GBP		3	24.00	
Sw. Franc		7	26.60	
Jap Yen		500	22.50	
Total			118.80	
Stress (%)			Rupee equivalent (Rs. Crore)	Additional capital required (Rs. Crore)
5			1247.4	0.53
10			1306.8	1.07
15			1366.2	1.60
	Normal	5% stress	10% stress	15% stress
Capital funds	65*	65	65	65
Risk weighted assets	660*	665.84	671.78	677.72
CRAR	9.85	9.76	9.68	9.59

* Assumed

Example B :

(Rs. Crore)						
Currency	Rate (in Rs.)	OB/ OS	Position	Rupee equivalent		
USD	45	OS	3	13.50		
EURO	58	OS	4	23.20		
GBP	80	OB	2	16.00		
Sw. Franc	38	OS	5	19.00		
Jap Yen	0.45	OB	450	20.25		
Annual profits				18.00		
Currency	Rupee equivalent 5 % stress	Net impact on P/L account	Rupee equivalent 10% stress	Net impact on P/L account	Rupee equivalent 15% stress	Net impact on P/L account
USD	14.18	-0.68	14.85	-1.35	15.53	-2.03
EURO	24.36	-1.16	25.52	-2.32	26.68	-3.48
GBP	16.80	0.80	17.60	1.60	18.40	2.40
Sw. Franc	19.95	-0.95	20.90	-1.90	21.85	-2.85
Jap Yen	21.26	1.01	22.28	2.03	23.29	3.04
		-0.97		-1.95		-2.92
% of profits		5.4		10.8		16.2

Note:

- a) The Rupee has depreciated against all currencies by 5%, 10% and 15%.
- b) Since Rupee has depreciated, the bank incurs a loss on oversold positions and makes a gain on the overbought positions.