Liquidity-Solvency Nexus: A Stress Testing Tool

JOINT IMF-EBA COLLOQUIUM

NEW FRONTIERS ON STRESS TESTING

London, 01 March 2017

Mario Catalan and Maral Shamloo

Monetary and Capital Markets

International Monetary Fund

MOTIVATION

- Unlike stand-alone solvency and liquidity stress test tools, less progress on realistic tools that nest the two.

- The theoretical literature on fundamental-driven bank runs is not new.
  - Morris and Shin (2003), Goldstein and Pauzner (2005)
  - Acharya et. al. (2011)

- It has been much harder to operationalize the links in a realistic setting.

Motivation

- Existing approaches have draw-backs:
  - Linking funding costs to solvency position: delivers little liquidity stress, does not deliver sudden deterioration in liquidity
  - Models with fire sales: fail to distinguish between banks with different fundamentals.
- A realistic tool needs to:
  - Deliver realistic run-off rates during normal times that accelerate in crises
  - Ensure that run-off rates increase gradually (moving away from cliff equilibria)
  - Be able to differentiate between banks according to their fundamentals
- We propose an attempt!

Model

- Imagine a bank with uncertain returns on assets
- Short-term depositors decide to roll-over or withdraw deposits (t=1)
- Based on how many decide to withdraw, the bank may fail due to illiquidity, before the realization of solvency shock (t=2).

t=1

Assets	Liabilities
M1	D_s
L	D_L
	Equity at time 1

t=2

Assets	Liabilities
M1-wD_s	$D_s\,(1+r_s)(1-\mathrm{w})$
$(1+R)\theta L$	$(1+r_L)D_L$
	Equity at time 2

Nash Equilibrium

- $\boldsymbol{\omega}$ denotes the proportion of depositors that withdraw

Table of pay-offs

	$\omega < \frac{M}{D}$	$\omega \geq \frac{M}{D}$
Roll-over	$(1+r)P(\theta > \theta^s)$	0
Withdraw	1	c

- **Multiple equilibria**
  - If $(1+r)P(\theta > \theta^s) > 1$ then all depositors rolling over is an equilibrium.
  - But, everyone withdrawing is also an equilibrium.

- **Global games**: by introducing strategic uncertainty, one can obtain a unique equilibrium (Morris and Shin, 2003).

GLOBAL GAMES: INTRODUCING STRATEGIC UNCERTAINTY

- Assume each depositor receives signal θ_i that is related to the true θ in the following way:

$$\theta_i = \theta + \varepsilon_i$$

where ε_i is uniformly distributed with range $[-\varepsilon, \varepsilon]$

- Then, pay-offs conditional on θ_i are

	$\boldsymbol{\omega < \frac{M}{D}}$	$\boldsymbol{\omega \geq \frac{M}{D}}$
Roll-over	$(1+r)P(\theta > \theta^s \mid \theta_i)$	0
Withdraw	1	c

Equilibrium: Threshold strategy

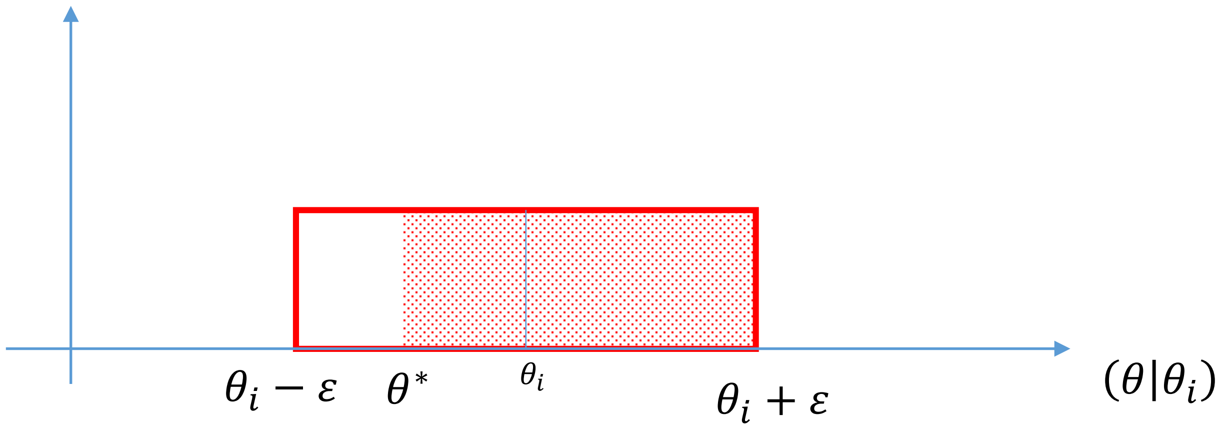
- If all depositors follow a threshold strategy where:

  Withdraw if $\theta_i \leq \theta^*$
  Roll-over if $\theta_i > \theta^*$

- Then it can be shown that there exists a unique θ^* such that:

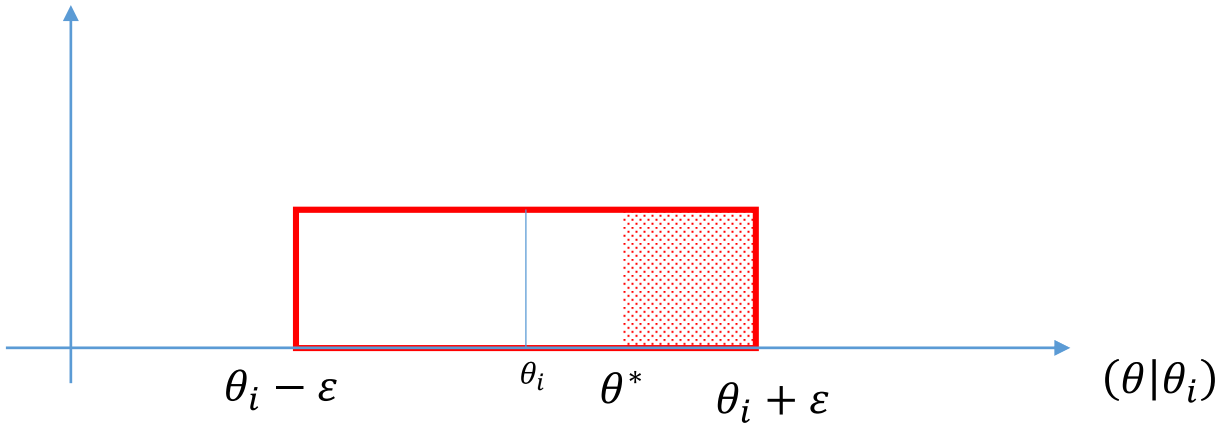
$$\theta^* = f(M, D_S, D_L, \varepsilon, c, r, R)$$

EQUILIBRIUM: THRESHOLD STRATEGY



Case 1:

$\theta_i > \theta^*$ therefore, roll-over

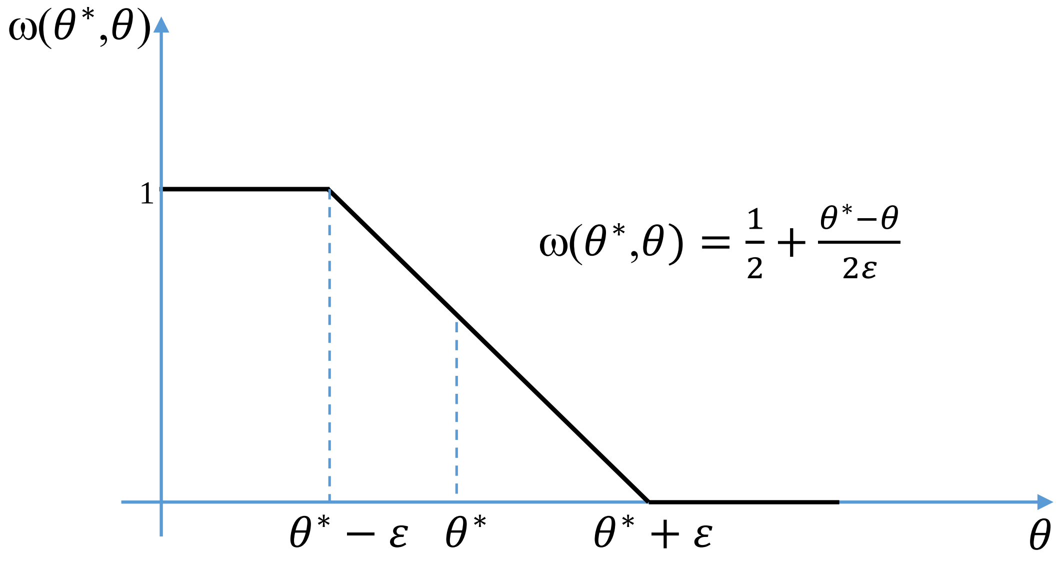


Case 2:

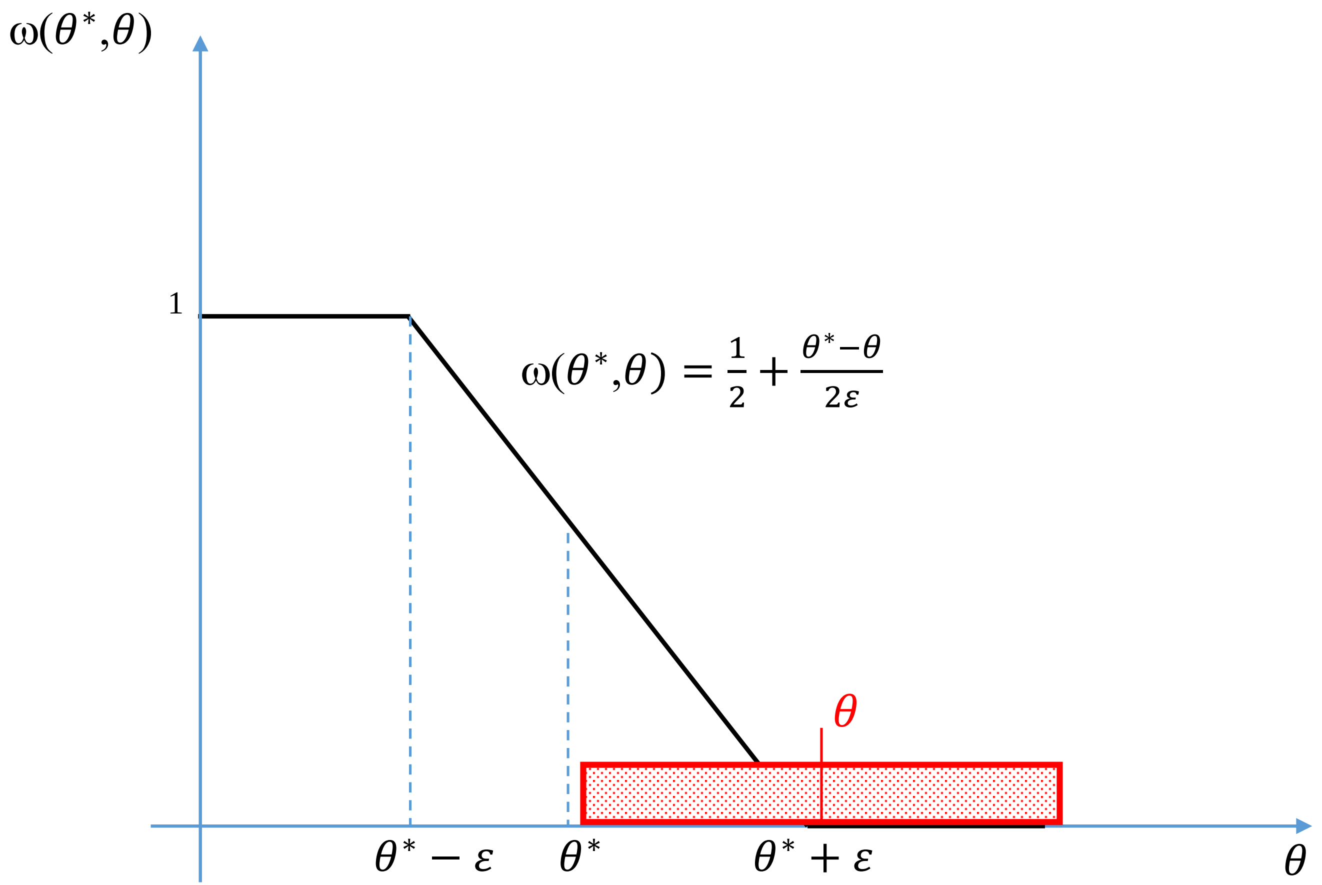
$\theta_i < \theta^*$ therefore, withdraw

Withdrawal rates

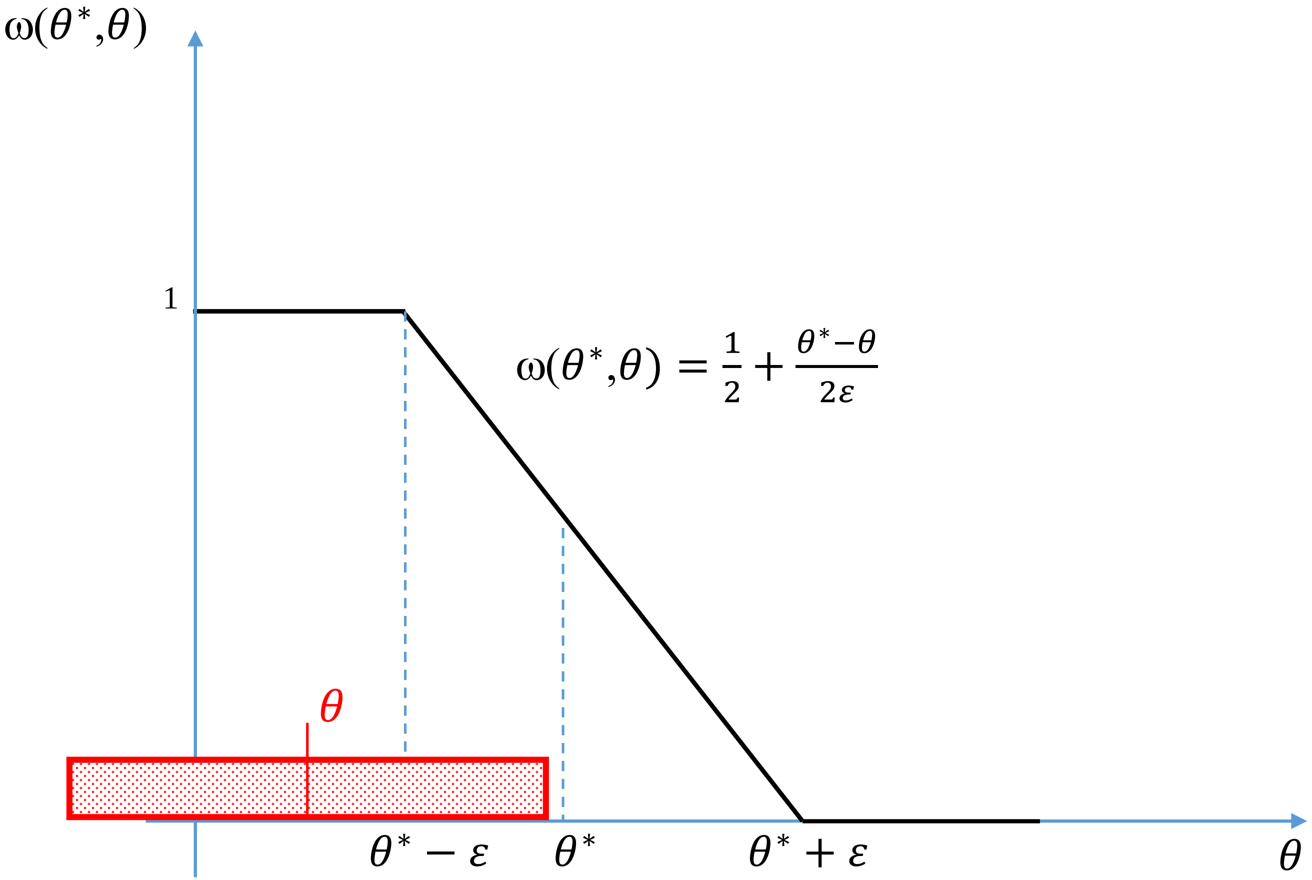
- θ^* is independent of θ, only depends on bank characteristics and the variance of the noise.
- Given a certain θ^*, the realization of θ would lead to the following $\omega(\theta^*, \theta)$ (the proportion of depositors who withdraw)



Withdrawal rates



Withdrawal rates



CASE WITH NO UNCERTAINTY

Balance sheet at t=0 (ex-ante)			
Assets		Liabilities	
M	30	D_S	40
		D_L	40
L	70.0	E	20.0
Total	100.0		100.0

No-run equilibrium

Balance sheet at t=2 (ex-post)			
Assets		Liabilities	
M2	30	$(1+r_S)D_S$	40.4
$(1+R)\theta L$	69.6	$(1+r_L)D_L$	41
		E2	18.2
Total	99.6		99.6

- θ =0.96

Two equilibria:

1) Roll-over equilibrium:
   - Everyone rolls over
   - The bank is solvent in period 2.

2) Withdraw:
   - Everyone withdraws;
   - Bank illiquid in period 1.

- If you could coordinate strategies, roll-over is a dominant strategy for all players.

CASE WITH UNCERTAINTY

Balance sheet at t=0 (ex-ante)

Assets		Liabilities	
M	30	D_s	40
		D_L	40
L	70.0	E	20.0
Total	100.0		100.0

r_s	0.01
r_L	0.025
c	0.0005
ε	0.15
R	0.035
θ	0.96

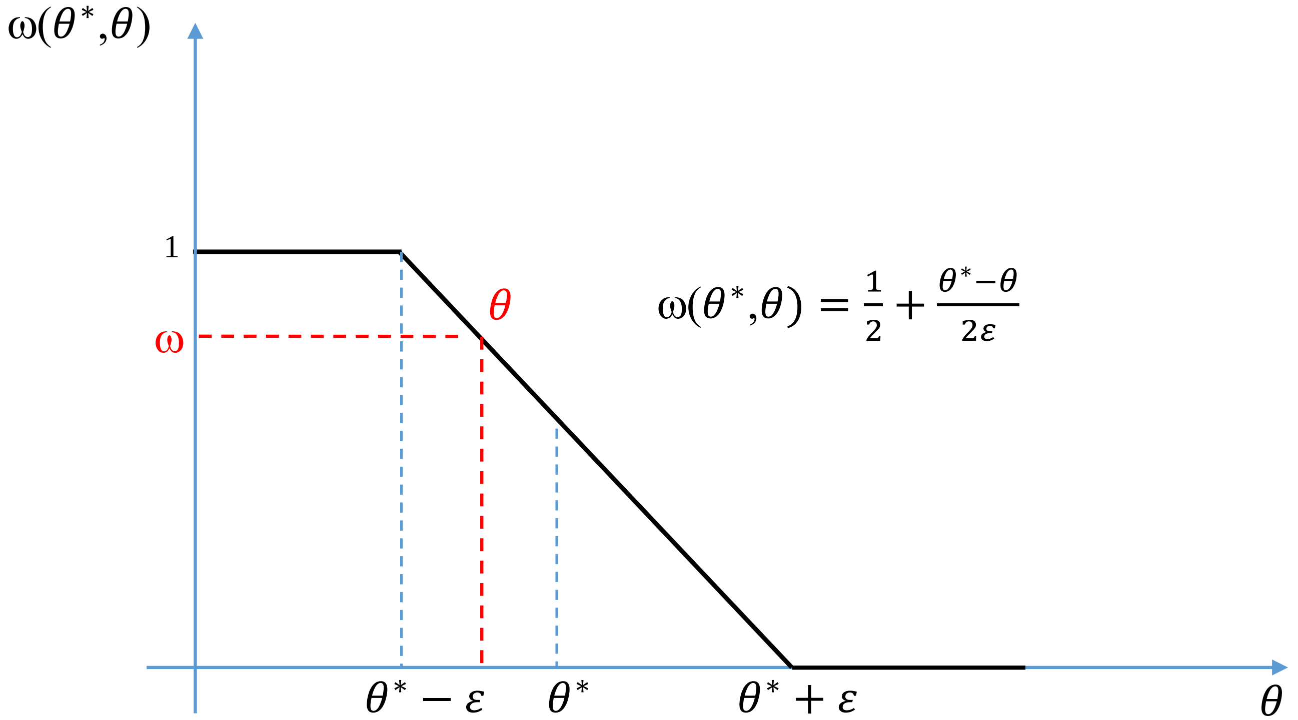
$\boldsymbol{\theta}^*$	**0.85**
w	**0.15**

Balance sheet at t=2 (ex-post)

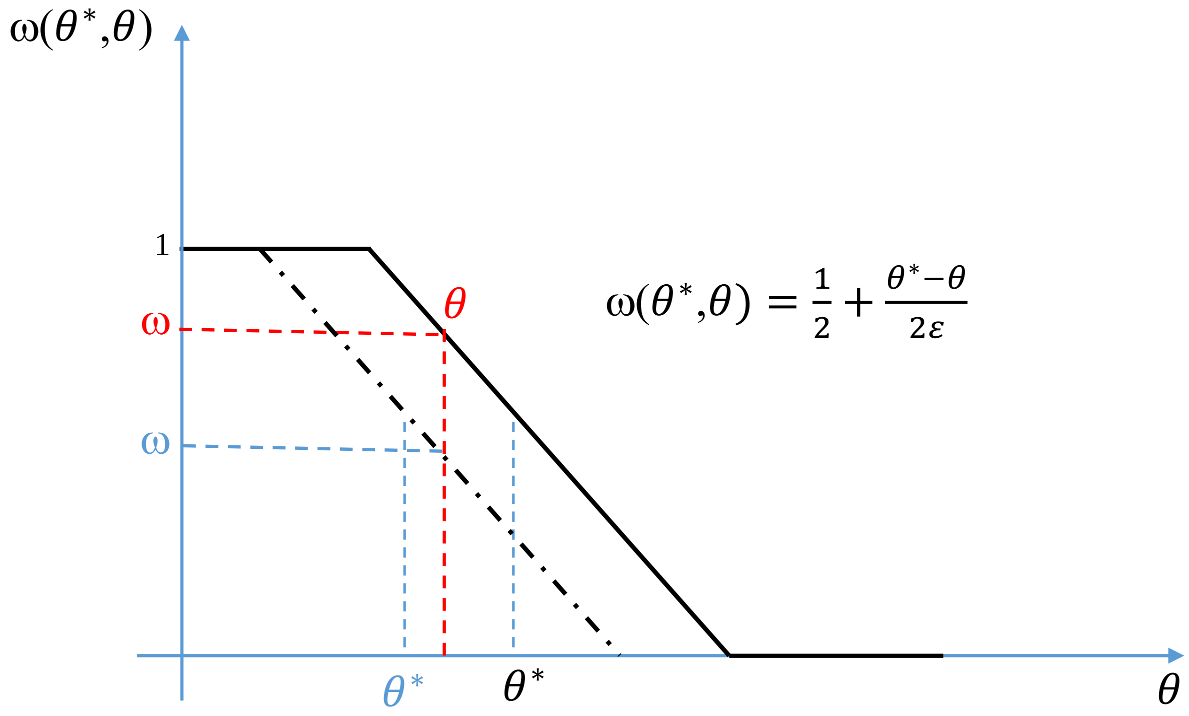
Assets		Liabilities	
M1-wD_s	24.1	$D_s\,(1+r_s)(1-\mathrm{w})$	34.4
$(1+R)\theta L$	69.6	$(1+r_L)D_L$	41
		E2	18.2
Total	93.6		93.6

- Equilibrium features positive run-off rates
- Bank has (slightly) higher capital because pays less interest on short-term debt.

Equilibrium run-off



Comparative statics



What makes the θ^* shift to the left?

- Increase in liquidity (*M1/D1*)
- Increase in rate of return on loans (*R*)

Increase in deposit rate has an ambiguous effect!

- Increases incentive to roll-over
- Decreases bank equity due to higher payments.

Implementation and next steps

1. Realistic calibration to replicate run-off rates in normal times and in crises.
2. Extending to a multiple period model
3. Distinguishing between different types of depositors/liabilities

Thank you!