Sudden stop of capital flows and the consequences for the banking sector and the real economy

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The opinions expressed in this paper are those of the authors and not necessarily represent the views of the National Bank of Romania, nor do they engage it in any way.

Outline

I. Motivation

II. The Model

III. Policy options

IV. Conclusions

I. Motivation – the purpose of the exercise

- (i) to test the capacity of the banking sector to withstand an external capital outflow;
  - total and euro positions
  - impact on solvency through loss and cost channels

- (ii) to assess the importance of shock transmissions channels between banking and non-financial companies;
  - impact on credit supply (new credit and rolling over credit lines)

- (iii) to analyze the efficiency of policy measures.

I. Motivation – the purpose of the exercise (2)

Main limitations of stress tests:

- should not be considered as a early warning tool, but rather an instrument for assessing vulnerabilities within the system (Borio et al. 2012):
    - the model used is a rough simplification of the reality. It does not captures all the non-linearities effects of the liquidity shock;
- "paradox of financial instability" - the system looks strongest when it is most vulnerable:
    - the assumptions and the scenario used before the recent crisis were not strong enough.

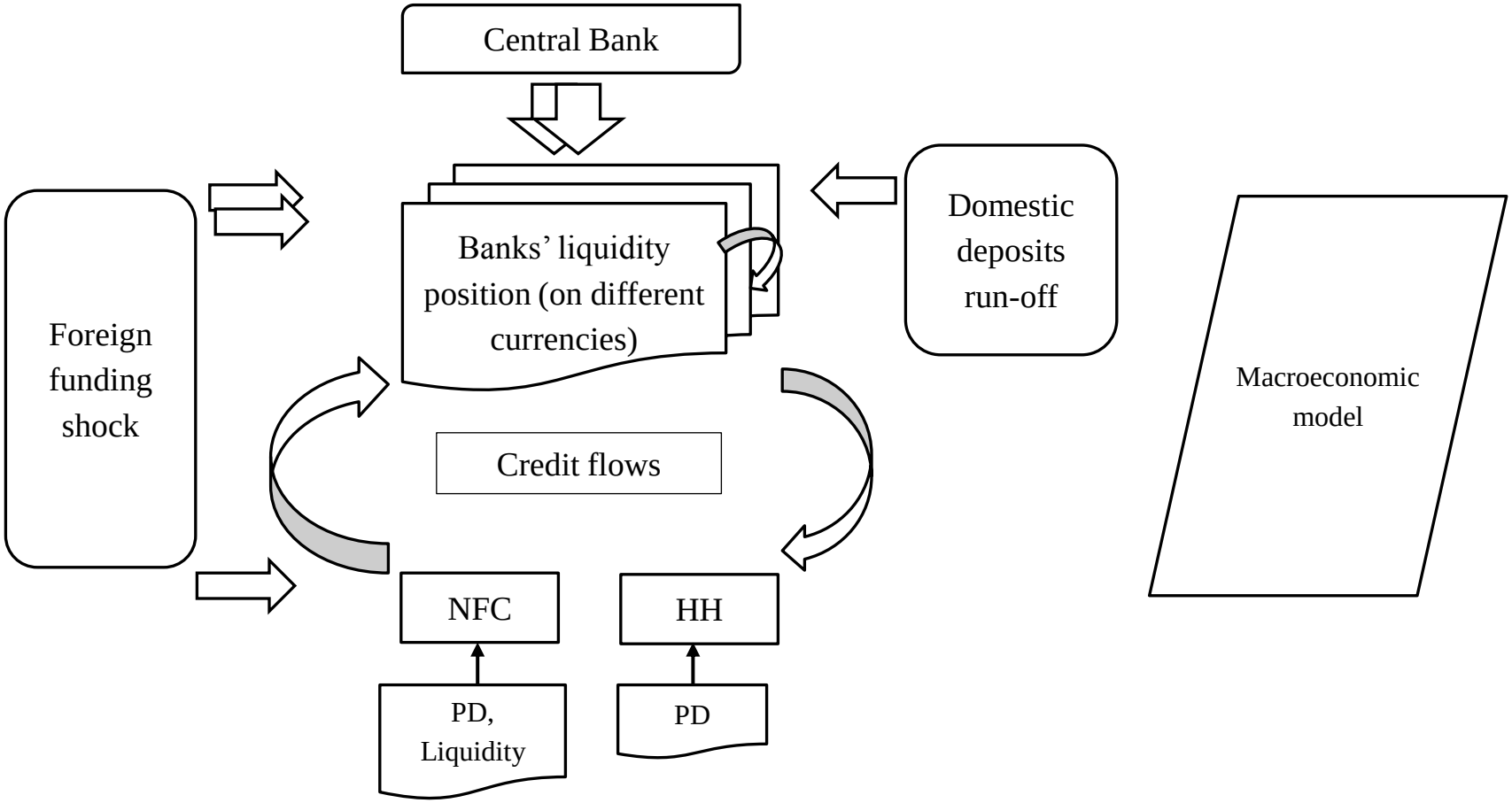
II. The Model – the general framework

- Two sectors:
  - banking sector;
  - real sector (households and non-financial companies).

- Two shock transmission channels:
  - direct: foreign investors decide not to rollover short term credit to either Romanian banks and Romanian non-financial companies;
  - indirect: banks transmits part of the shock to the real sector by deciding to limit/not to grant new credit and/or not to rollover part of the granted credit lines.

- Main features:
  - shock impacts simultaneously both sectors;
  - money market freezes – no new interbank borrowings;
  - takes into account currency and maturity mismatches;
  - proportionality principle.

II. The Model – the general framework (2)



II. The Model – banks: the liquidity position

Liquidity position:

A_q – liquid assets (counterbalancing capacity)

H_q – haircuts applied

CFI_p – cash flows received by the bank from its outstanding loan repayments

CFO_m – cash outflows from new lending or due to run of domestic deposits and parent funding withdrawals, according to the scenario considered

II. The Model – banks: liquid assets

Assets (A_q)	Haircuts (H_q)	Observations
Excess reserves held with the central bank	0%	calculated as total reserves with central bank minus minimum required reserves
Eligible securities for central bank refinancing operations	5% and 8%	5% for domestic-denominated securities and 8% for FX-denominated securities
External assets (deposits)	variable	the percentage of external deposits placed with the parent institution, part of a compensation agreement or a notification special clause
Net money market exposure	100%	there is no new borrowing between banks; the interbank markets collapses due to lack of trust between participants; all the operations will take place only with the central bank

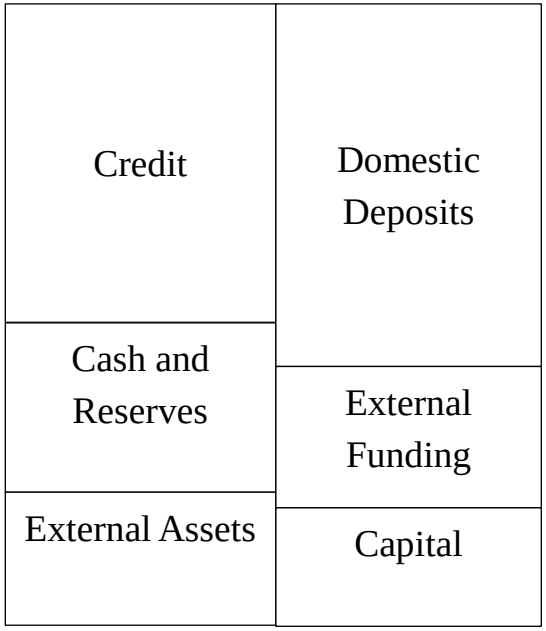
II. The Model – banks: the liquidity shock

The shock of parent funding withdrawals and run of deposits (S) is calculated as:

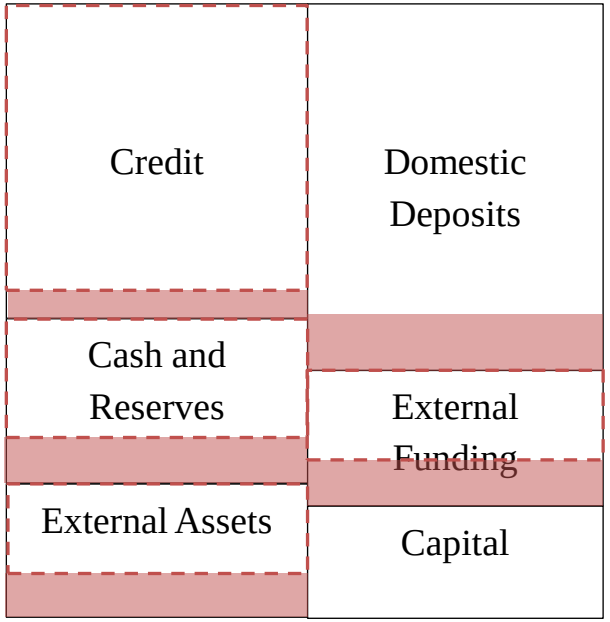
$$S = \alpha(1 - r_{MRR})$$

where α represents the percentage that is withdrew, r_{MRR} is the rate of minimum required reserves.

II. The Model – banks: stress test impact on balance sheet positions



a) initial balance sheet position



b) after liquidity shock and feedback effects from the household and non-financial companies sector

Note: The areas marked in red reflect a decrease in the balance sheet item bordered by the dotted line after the liquidity shock

II. The Model – real sector: liquidity constraint

A company faces the following liquidity constraint:

$$\lambda_{j,t} \geq 0 \qquad \text{for } \forall \text{ j} = \overline{1, \text{M}} \text{ non} - \text{financial companies}$$

where

$$\lambda_{j,t} = Deposits_{j,t} + OCF_{j,t} - STED_{j,t}$$

$$OCF_{j,t} = NetProfit_{j,t} + Amo_{j,t} - NI_{j,t} + dP_{j,t} + dSTD_{j,t} - dCA_{j,t} + dIA_{j,t}$$

II. The Model – real sector: cash inflows and outflows from credit granted to non-financial companies and households

CF inflows from credit: granted to nonfinancial companies:

$$\sum_j \left(1 - \mathrm{PD}_{j,t} * \mathrm{LGD}\right) * \mathrm{DS}^{i}_{j,t} \ ,$$

for $\forall\, j = \overline{1, M}$ companies from bank's portfolio,
and $\forall\, i = \overline{1, N}$ loans granted to company j

CF outflows from credit: new credit granted

$$\begin{cases} \underset{t-12<\theta\leq t}{\mathrm{avg}} \left(dL_{i,\theta}\right), & LTD_{i,t} \leq \overline{LTD_t} \\ 0, & LTD_{i,t} > \overline{LTD_t} \end{cases} \qquad for\ \forall\ bank\ i = \overline{1,n}$$

II. The Model – banks response to the liquidity shock – using liquid assets and/or reducing lending activity

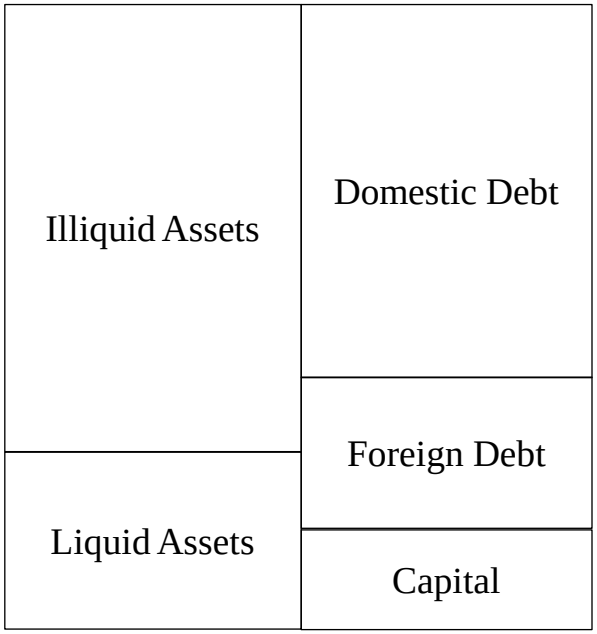
- The matrix of banks' exposures $\langle x_{j,i} \rangle_{j=\overline{1,M},\, i=\overline{1,N}}$ is solved using a maximum relative entropy Mistrulli (2007):

$$\min_x ln \frac{x_{j,i}}{x_{j,i}^0}$$

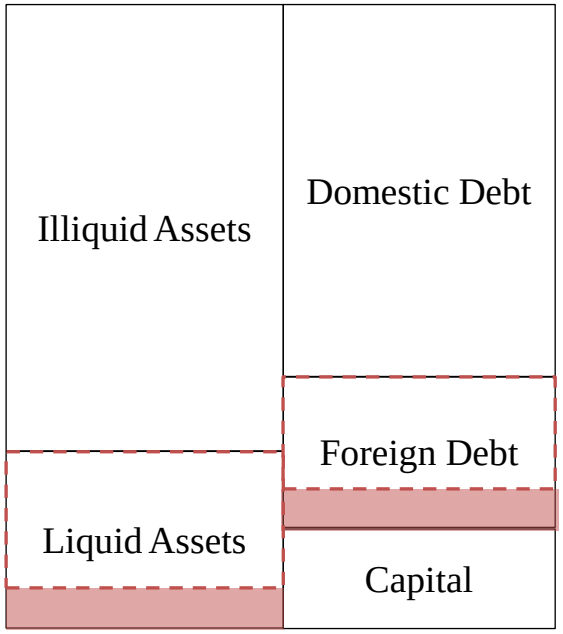
meeting the following restrictions:

$$\begin{cases} \sum_j x_{j,i} = \min\left(|\Lambda_i|, \sum_j CL_{j,i}\right) \text{ where } i = \overline{1,N} \text{ banks for which } \Lambda_i < 0 \\ \sum_i x_{j,i} = \min\left(\lambda_j, \sum_i CL_{j,i}\right) \text{ where } j = \overline{1,M} \text{ non-financial companies} \\ x_{j,i} > 0, \forall i, j \end{cases}$$

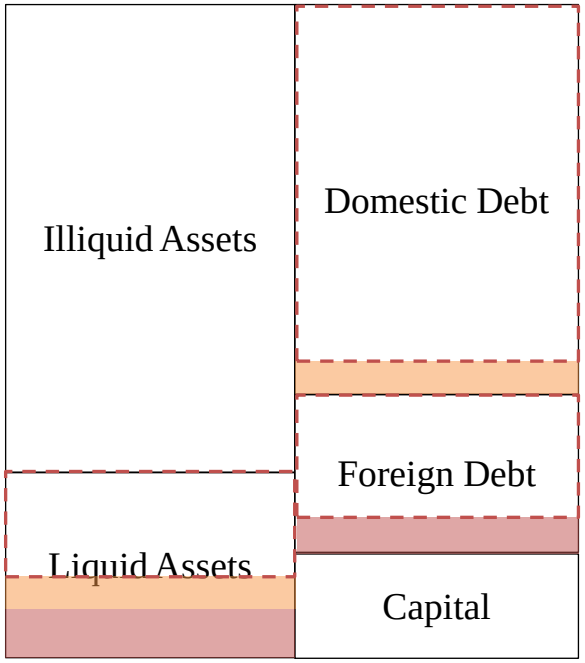
II. The Model – real sector– stress test impact on non-financial companies balance sheet positions



a) initial balance sheet position



b) after the first liquidity shock (from foreign creditors)



c) after the first liquidity shock (from foreign creditors) and the second liquidity shock (from local banks)

Note: The areas marked in red and orange reflect a decrease in the balance sheet item bordered by the dotted line after the first (second) liquidity shock

II. The Model – the solvency link

Liquidity shock is transmitted to solvency through two channels:

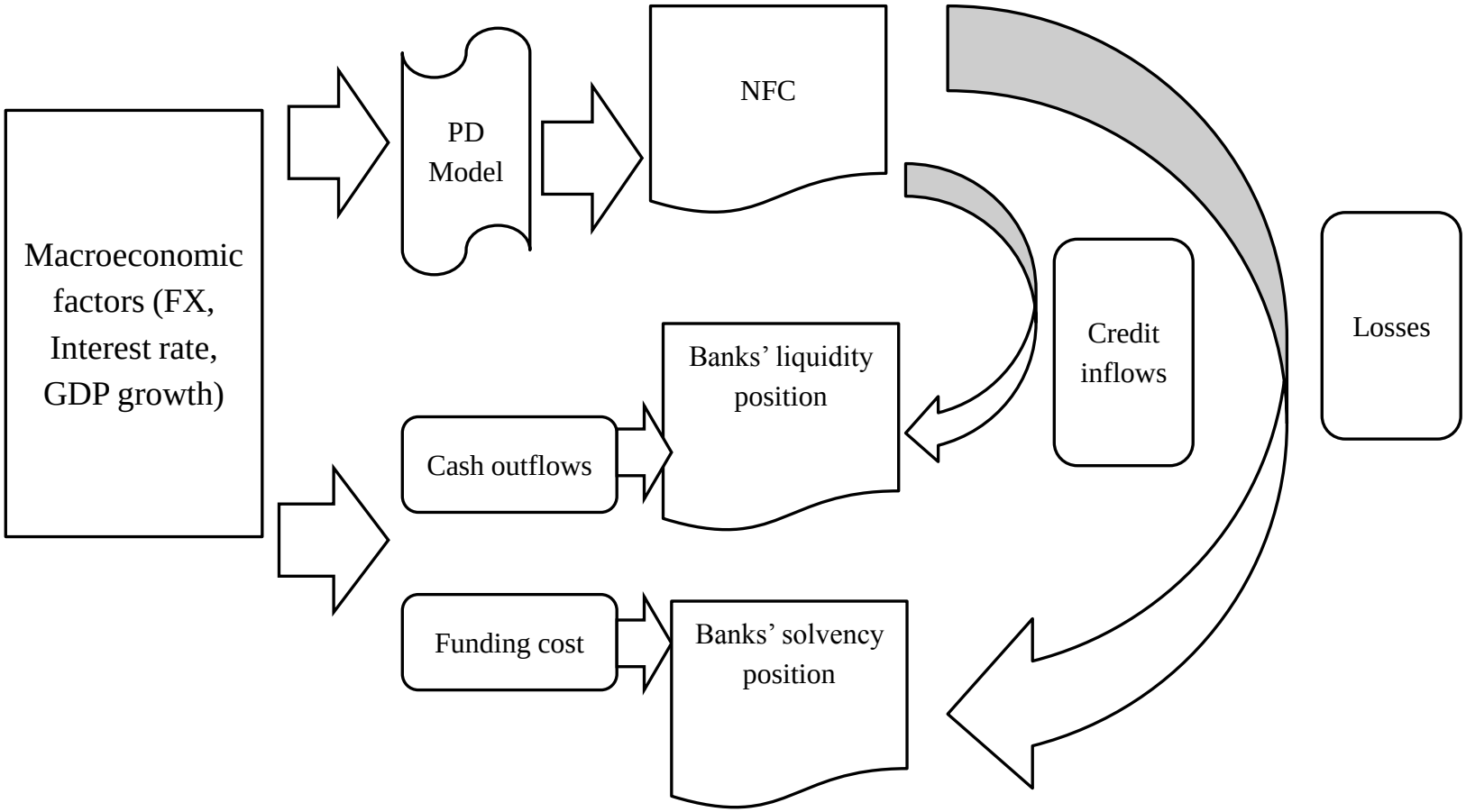
Credit risk channel:

- either due to new macroeconomic environment reflected in new fundamentals (FX rate, interest rate) that determine a shift in PD=> PD*;
- either due to reduced financing reflected in the withdrawals of maturing credit lines. The loss is calculated as the difference between required amount of credit withdrawals and liquidity position of non-financial companies.

Funding cost channel, calculated as the loss given by:

- the cost of new lei denominated finance (Central Bank credit facility and/or open market operation);
- lower interest income from depressed credit activity.

II. The Model – macroeconomic channels



II. The Model – data sources: banking sector

- Banks
  - Minimum required reserves for each observation period;
  - NBR refinancing eligible collateral and outstanding repo transactions (SaFir);
  - Balance sheet information for credit institutions:
    - account with the Central Bank;
    - deposits on main counterparties;
  - External funding (residual maturity);
  - FX swap transactions.

II. The Model – data sources: banking sector (2)

Banks included in the stress test exercise:

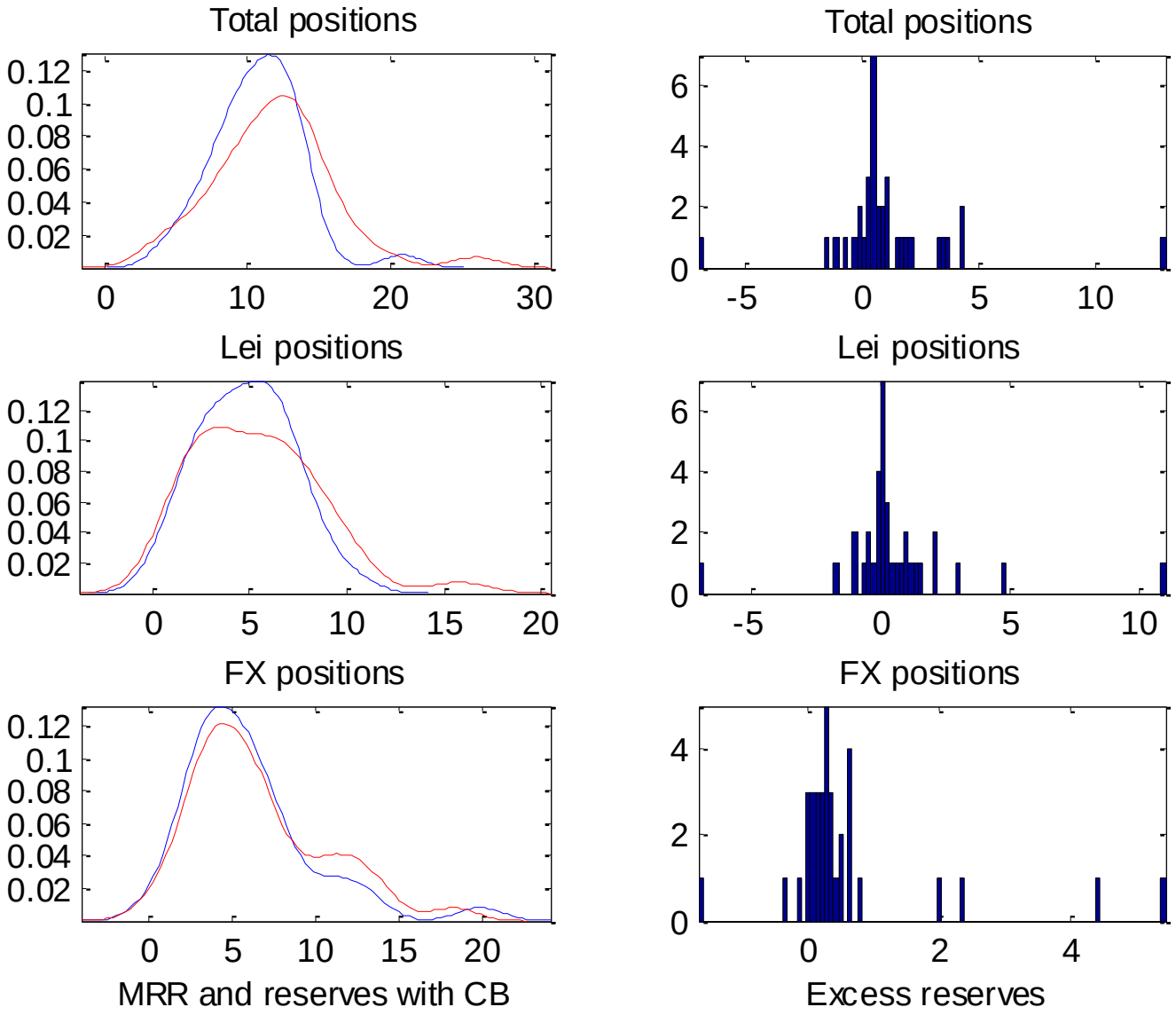
			Number	Assets (% banking system)
Banks, of which			37	99%
	Romanian legal entities, of which		30	92%
		with majority domestic capital	6	16%
		with majority foreign capital	24	75%
	Foreign branches		7	8%

II. The Model – data sources: banking sector (3)

Minimum reserve requirements:

- reserve requirements are the average daily balances held with the NBR during the maintenance period and reserve deficit is subject to a penalty rate, while recurrent deficits are sanctioned by warning, fines or limitation of operations conducted by the credit institutions;

Reserve ratio (%)	
Lei	Foreign currency
15%	20%



MRR, Reserves at Central Bank and excess reserves, December 2011

II. The Model – data sources: banking sector (5)

Banks' balance sheet structure – period 2007-2011:

	Mean	Median	Standard deviation	25 percentile	75 percentile
Assets					
Reserves at central bank	17.6	16.6	7.4	12.0	22.1
Eligible securities	7.5	4.3	9.7	0.6	10.8
External assets	2.5	1.1	3.6	0.4	3.1
Credit to nonfinancial companies	33.4	33.0	13.9	24.5	42.3
Credit to households	22.4	23.0	12.8	11.6	29.8
Liabilities					
Deposits of nonfinancial companies	16.6	14.2	10.9	8.9	22.7
Deposits of households	22.2	18.0	16.6	9.1	31.8
Deposits of other financial institutions	3.8	2.7	3.6	1.5	4.9
External funding	27.5	25.6	20.5	10.3	41.1

II. The Model – data sources: real sector

- Households:

  Credit register bureau – monthly, all credits above 20.000 RON (~5.000 EUR); Credit bureau – monthly, all credits (data since September 2008);

- Companies:
  - Financial statements (all companies, available semiannually) – *650.000 companies;*
  - Credit register bureau – monthly, all credits above 20.000 RON (~5.000 EUR) – *230.000 credits, 95.000 companies;*
  - Long term external debt (DMFAS) – *12.500 credits, 5.500 companies* - information on scheduled inflows and outflows for each long term foreign funding, quarterly frequency;
  - Short term external debt - *10.500 companies* - short term debt transaction are reported by banks as inflows and outflows (transaction by transaction), quarterly frequency;

II. The Model – data sources: real sector (2)

		2007-2011				
		Mean	Median	Standard deviation	25 percentile	75 percentile
Credit lines drawn by non-financial companies (% total credit drawn by non-financial companies)		50.3	49.5	21.4	34.8	61.2
Credit lines maturing in one month drawn by non-financial companies (% total credit lines drawn by non-financial companies), of which		9.7	8.2	7.7	4.6	12.7
	denominated in local currency (% total credit lines granted to non-financial companies maturing in one month)	54.5	53.3	30.6	29.4	81.7
	denominated in euro (% total credit lines granted to non-financial companies maturing in one month)	36.3	35.5	27.9	9.4	57.7
	denominated in other foreign currencies (% total credit lines granted to non-financial companies maturing in one month)	7.7	1.1	15.5	0.0	8.0
Number of non-financial companies with credit lines (% total number of non-fianncial companies with credit)		63.0	67.0	19.7	55.9	85.2
Number of non-financial companies with credit lines maturing in one month (% total number of non-financial companies with credit), of which		10.2	9.3	6.6	6.4	20.2
	denominated in local currency (% total non-financial companies with credit lines maturing in one month)	74.1	80.6	23.3	59.8	100.0
	denominated in euro (% total non-financial companies with credit lines maturing in one month)	23.2	18.8	20.3	5.8	57.5
	denominated in other foreign currencies (% total non-financial companies with credit lines maturing in one month)	4.8	1.2	11.7	0.0	25.0

II. The Model – Scenarios: value used

Description	S1	S2
coverage of the test (no. of banks)	all	all
time horizon	1 month	1 month
domestic deposits (non-financial companies, households) run-off	10%	20%
banks: short term (up to one year) nonresident financial institutions funding withdrawal	25%	50%
banks: FX Swap position maturing in one month not rolled over by nonresident credit institution	25%	50%
non-financial companies: short term external debt for non-financial companies not rolled over	25%	50%

II. The Model – Scenarios: motivation

The design of shocks is motivated by the international and domestic liquidity drain episodes:

- Laeven and Valencia (2008) . According to their findings, the average maximum one-month drop in the ratio of deposits to GDP is over 10% and the largest value is over 25%.
- Under the new Basel III framework (BCBS 2013), recommends a shock of 3% or higher for stable retail deposits and a 10% or higher for less stable retail deposits.
- Comparable results are found in a survey conducted by the European Central Bank (ECB, 2008), most banks reporting a 10% shock, only few banks stated a 30% shock, while on interbank and other investors flows the results were dispersed between 0% and 100% (complete flight of funds).

II. The Model – Scenarios: motivation (2)

Romanian bank deposits - monthly changes for individual banks for different counterparties and currencies, for the period 2007-2011:

		Mean	Median	Standard deviation	25% percentile	5% percentile
non-financial companies	national currency	2.7	1.0	22.4	-5.1	-17.2
	euro	4.8	-0.2	36.2	-7.6	-27.3
	other foreign currencies	28.4	-0.8	715.9	-15.3	-44.0
households	national currency	2.5	1.3	11.5	-1.2	-7.6
	euro	9.0	1.1	276.7	-1.6	-7.6
	other foreign currencies	6.3	-0.3	189.0	-3.8	-13.1
foreign financial institutions	national currency	13.7	0.3	151.1	-9.3	-35.2
	euro	89.7	0.0	1357.1	-14.6	-61.0
	other foreign currencies	73.4	0.3	1031.1	-15.3	-64.8
foreign financial institutions	national currency	23.5	0.3	249.5	-3.1	-33.1
	euro	12.8	0.4	121.3	-3.9	-31.7
	other foreign currencies	47.4	0.1	673.0	-8.3	-56.4

II. The Model – Testing the hypotheses

Hypotheses used:

1. The balance sheet structure remains relative constant with one exception – credit to real sector. Banks grants new credit depending on their funding structure;

II. The Model – Testing the hypotheses (2)

Testing if change in credit depends on their funding structure:

	Banks with high LTD		Banks with low LTD		t-stat	p-value
	Mean	Standard deviation	Mean	Standard deviation		
period 2007-2011	0.00	0.59	0.00	0.80	0.00	0.50
year 2007	0.27	0.77	0.69	0.93	**-6.53**	**0.00**
year 2008	0.07	0.66	0.19	0.78	**-2.16**	**0.02**
year 2009	-0.09	0.48	-0.36	0.56	*6.90*	*1.00*
year 2010	-0.07	0.46	-0.29	0.56	*5.89*	*1.00*
year 2011	-0.15	0.45	-0.17	0.61	*0.44*	*0.67*

II. The Model – Testing the hypotheses (3)

Hypotheses used (cont.):

2. Shock impacts simultaneously both sectors. When a company has to deal with a simultaneous shock from abroad and domestic financial market, we consider the foreign creditor would be paid first;
3. Money market freezes – no new interbank borrowings;
4. Bank uses first the external assets to pay the foreign funding withdrawals;

II. The Model – Testing the hypotheses (4)

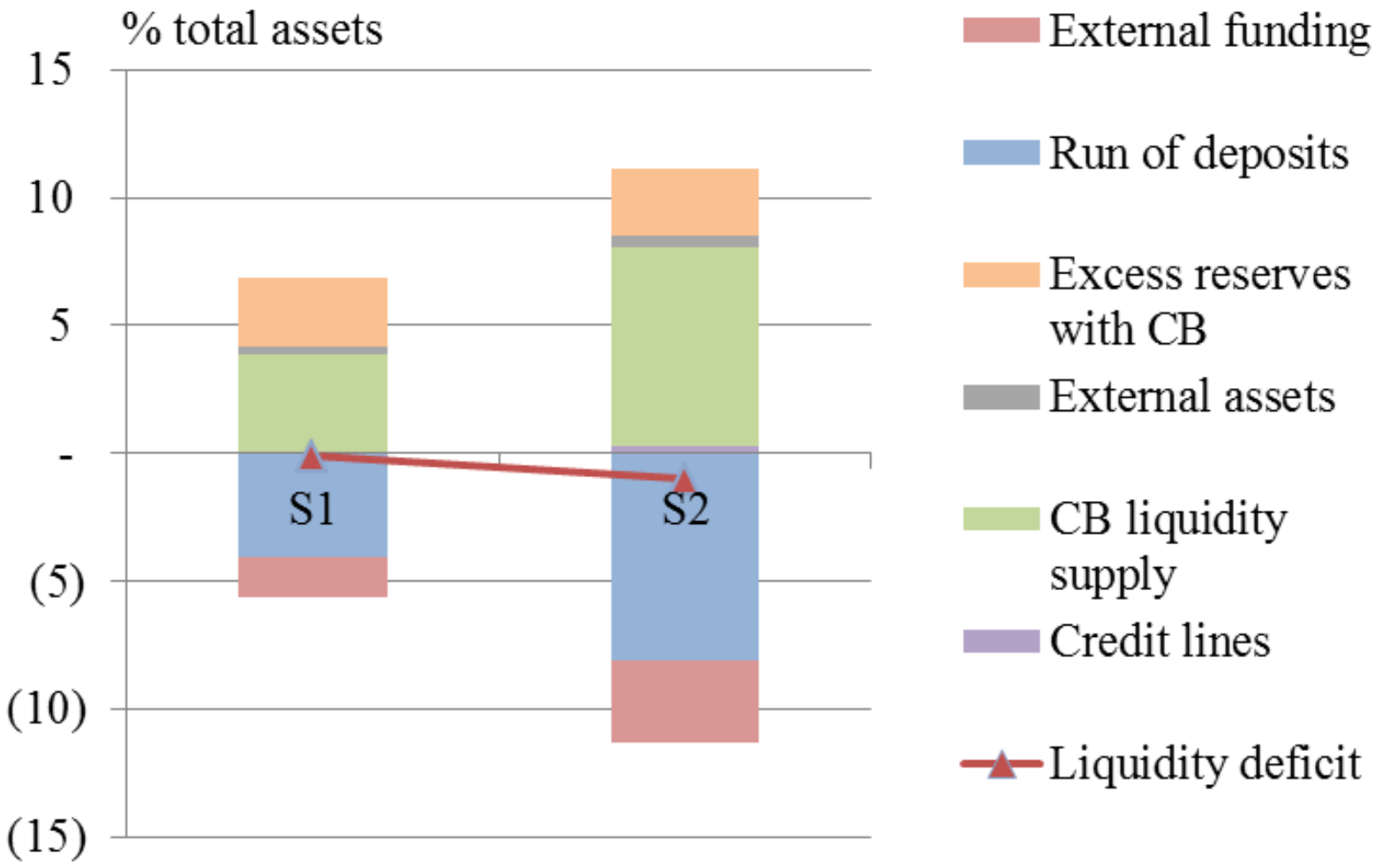
Hypotheses used (cont.):

5. Banks do not roll over credit lines granted to non financial companies.

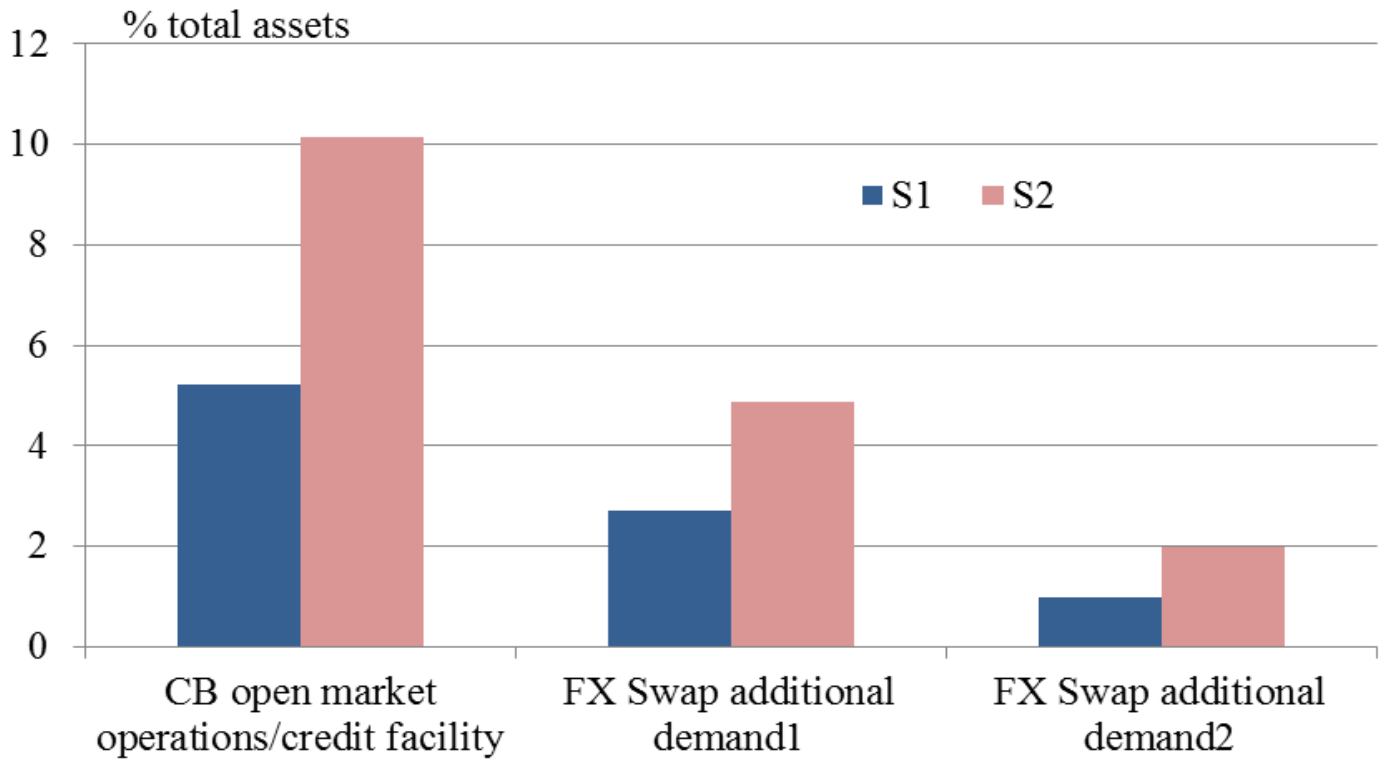
II. The Model – Testing the hypotheses (5)

	period 2007-2011				2009/2007		2009/2008		2009/2010		2009/2011	
	Mean	Median	25 prctl.	5 prctl.	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
Credit lines - volumes drawn by non-financial companies (monthly changes on individual banks)	2.0	0.9	-1.5	-7.3	***-3.8***	***0.0***	***-3.4***	***0.0***	-0.1	0.4	-0.3	0.4
Credit lines - volumes granted to non-financial companies (monthly changes on individual banks)	1.8	0.7	-1.3	-6.9	***-3.7***	***0.0***	***-3.9***	***0.0***	0.0	0.5	-0.2	0.4
Number of non-financial companies with credit lines (monthly changes on individual banks)	1.5	0.0	-1.7	-4.7	***-1.6***	***0.05***	***-6.5***	***0.0***	-0.2	0.4	-1.2	0.1

II. The Model – Results: Liquidity deficit (change in total banking sector assets)



II. The Model – Results: Central bank interventions and banks demand for foreign currency*



*Note: "FX swap additional demand1" refers to banks need for FX as a result of surplus liquidity in domestic currency and deficit liquidity in FX. "FX swap additional demand2" is resulted from the parent banks withdrawals from the FX market (the amount of withdrawals depending on the stress test scenarios)

II. The Model – Results: The impact of the liquidity shock to the new lending activity

II. The Model – Results: The importance of non-financial companies with external liquidity deficit

Arrears generated as of December 2011 are:
(i) between 6.6 and 12.9 bln Lei to foreign investors;
(ii) between 50 and 112 mln Lei to domestic banks.

	Gross value added	Assets
Non-financial companies with domestic bank credit and/or foreign debt (% total non-financial companies), of which	65.7	60.5
with external deficit in scenario 1	7.7	9.1
with external deficit in scenario 2	8.7	10.2

III. Policy options

Two types of policy options:

1. ex-ante solutions (e.g. early call for additional capital, improvement in loan to deposit ratio, increase of the outstanding amount of eligible collateral in banks portfolio)
   - target the banks in need;
   - credit conditions would develop in an orderly way
2. ex-post solutions (e.g. extending eligible collateral, reducing MRR rates)
   - the most efficient seems to be, from our simulations, the unconventional ones.

In both types of policy measures, the cooperation between the central bank and the supervisory authority is essential.

IV. Conclusions

Stress test tools are useful instruments for macroprudential purpose, in order to assess

-how the overall banking sector might withstand a shock;
-how shocks are transmitted between sectors or markets.

However, predicting the outcome of a severe capital outflow remains a challenge

-different triggering events;
-multiple transmission channels (also due to feedback responses).

Capital outflows suddenly appear and liquidity crises develops in very short time span:

-policy measures should be in place and functional;
-banks should hold high-quality assets in an adequate amount and have good solvency ratios.

Thank you!

For questions and comments, please write to
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or to me, Irina.Mihai@bnro.ro.