

Systemic risk assessment using interbank markets data

Horatiu Lovin

Financial Stability Department, National Bank of Romania
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BANCA NAȚIONALĂ ROMÂNIEI



1. Interbank markets in Romania

- Money market
 - short term funding for banks
 - short term expectations for liquidity conditions in the banking sector
- Government bonds market
 - funding for government
 - liquidity heaven instruments for banks
- FX market
 - capital flows
 - systemic risk



2. Who are the investors on interbank markets in Romania?

- Romanian banks
- Foreign investors
- Pension funds
- Insurance companies
- Non-financial companies and households (FX market)



3. Interbank market implications for systemic risk

- **Interbank financial markets measure banking system soundness**
 - Participants behavior on interbank markets reflect current status and expectations for financial system conditions
 - Interbank markets can drive lending activity (funding cost, demand)
 - Liquidity risk on financial markets stayed at the roots of current global financial crisis
- **Foreign investors are using interbank markets to take exposure on domestic financial system and economy**
 - Interbank markets may act as contagion channel for external imbalances
 - Foreign entities are not the largest investors on Romanian interbank markets; still they proved to have strong impact on short and medium term developments on interbank markets



4. Interbank markets and lending in Romania

Extensive international literature on relationship between financial markets liquidity and bank lending activity:

- Rixtel and Gasperini (2013)
- Kapan and Minoiu (2013)
- Aiyar (2011)
- Haas and Lelyveld (2010)

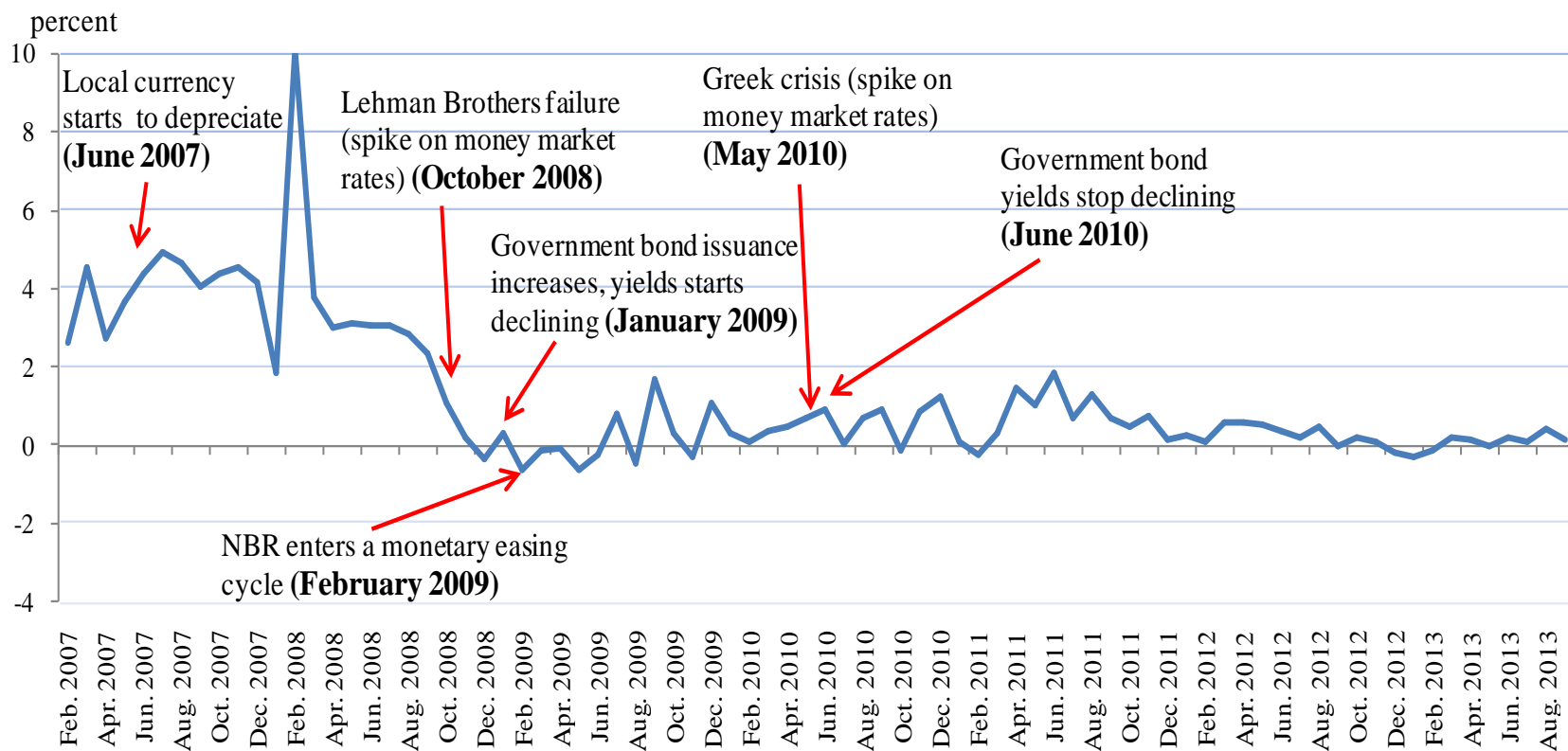
The main papers idea: liquidity conditions on financial markets influence bank lending activity; banks facing difficulties to access funding from financial markets lower their credit activity

In Romania, interbank markets are not a significant funding source for banks; interbank markets are barometer for banking system soundness and provide reliable information ahead of balance sheet reports



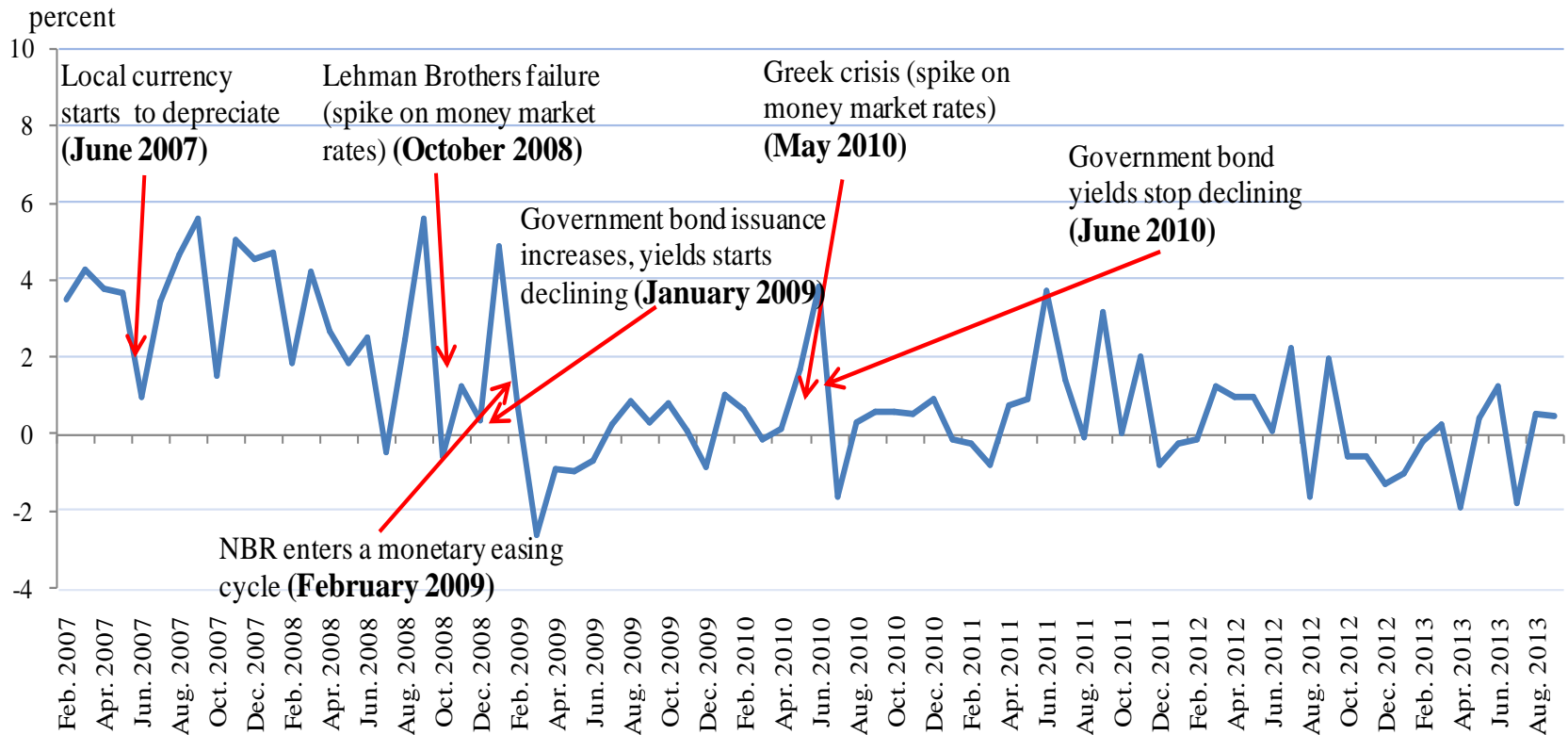
4. Interbank markets and lending in Romania

- Total credit granted by banks (credit stock, monthly change, NBR data)



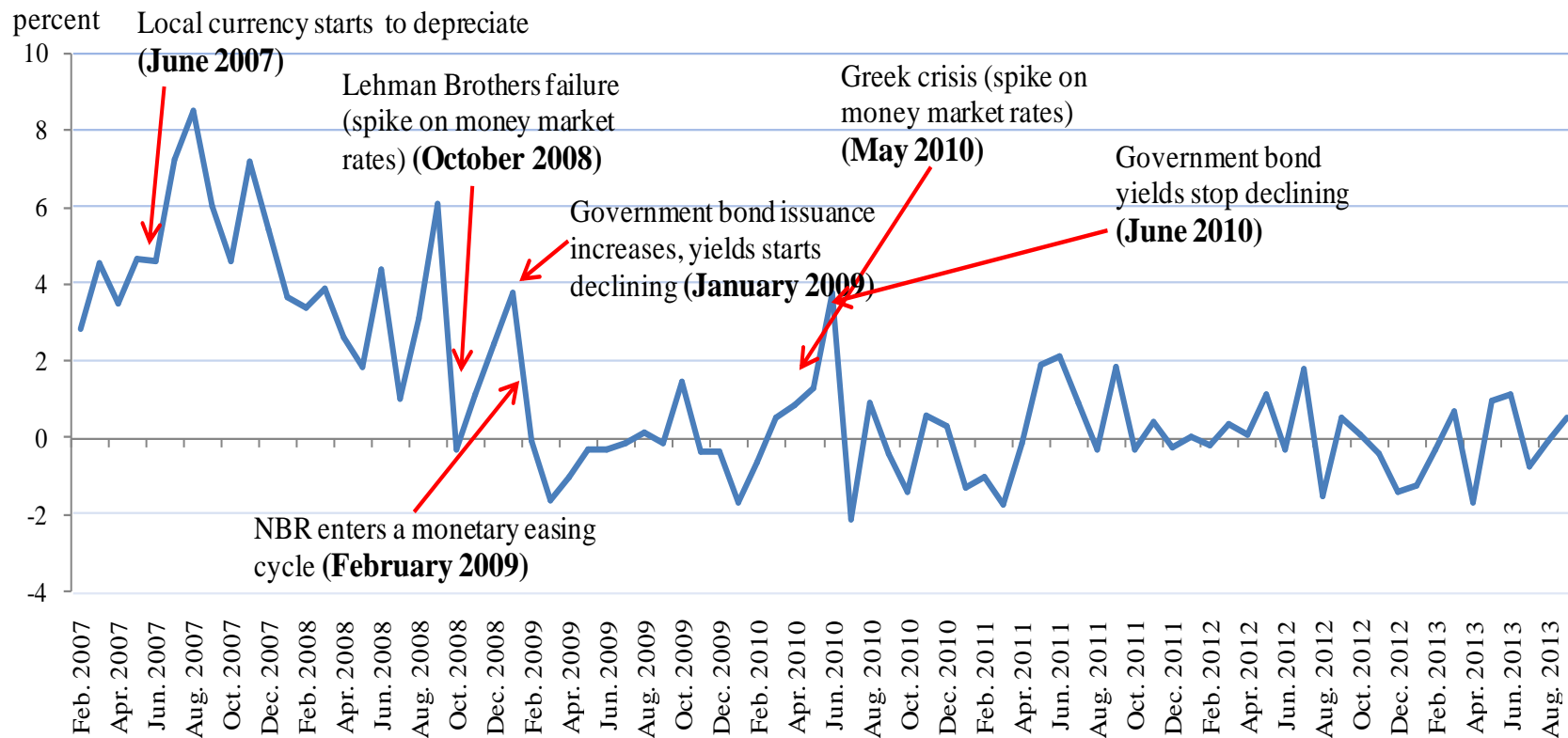
4. Interbank markets and lending in Romania

- Credit granted to non-financial companies (credit stock, monthly change, NBR data)



4. Interbank markets and lending in Romania

- Credit granted to households (credit stock, monthly change, NBR data)



5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

- PCA uses orthogonal transformation to transform a set of possible correlated variables into a smaller number of uncorrelated variables, called *principal components*
- The first principal component accounts for as much of the variability in the dataset as possible, and each succeeding component has the highest variance possible under the constraint that it be orthogonal to the preceding components
- **Objective: to select sub-sets of variables (from a larger data set that contains credit and interbank market indicators) based on how much of the data variability is explained by the principal components**



5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

The first principal component (X_1) is a linear combination of variables V_1, V_2, \dots, V_p

$$X_1 = m_{11} V_1 + m_{12} V_2 + \dots + m_{1p} V_p$$

or in matrix notation $X_1 = m_1^T V$

where $m_{11}^2 + m_{12}^2 + \dots + m_{1p}^2 = 1$

The second principal component (X_2) is estimated in the same way as the first principal component, with the condition that is uncorrelated with the first principal component and accounts for the second highest variability in the dataset

$$X_2 = m_{21} V_1 + m_{22} V_2 + \dots + m_{2p} V_p$$

where $m_{21}^2 + m_{22}^2 + \dots + m_{2p}^2 = 1$



5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

In the end, the relationship between the principal components and the initial dataset becomes:

$$X = M V$$

- where → the rows of matrix M are the **eigenvectors** of variance – covariance matrix of the initial data set;
- the **eigenvalues** are the elements on the diagonal of variance – covariance matrix of the principal components.



5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

Credit variables:

- Total credit granted by banks
- Credit granted to non-financial companies
- Credit granted to households
- Credit granted in local currency (lei) to non-financial companies and households

Interbank market variables:

- EUR/RON exchange rate
- Volatility of EUR/RON exchange rate
- 3-months money market rate in Romania (ROBOR3M)
- Volatility on Romanian money market (volatility of ROBOR3M)
- 1 year government bonds yield
- Volatility on government bonds secondary market (volatility of 1 year yield)
- 3-months money market rate in euro zone (EURIBOR3M)
- Volatility on euro zone money market (volatility of EURIBOR3M)

5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

Spearman Correlation (only the coefficients that are significant at 5% or better)

| | Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|----|---------------------------|------|------|------|------|-------|---|---|------|---|------|----|----|
| 1 | Total credit | | | | | | | | | | | | |
| 2 | Credit to NFC | 0.46 | | | | | | | | | | | |
| 3 | Credit to HH | 0.45 | 0.73 | | | | | | | | | | |
| 4 | Credit in LC | | 0.52 | 0.26 | | | | | | | | | |
| 5 | EUR/RON | 0.28 | 0.54 | 0.58 | 0.25 | | | | | | | | |
| 6 | Volatility of EUR/RON | | | | | | | | | | | | |
| 7 | ROBOR3M | | | | | | | | | | | | |
| 8 | Volatility of ROBOR3M | | | | 0.35 | 0.31 | | | | | | | |
| 9 | 1Y gvt. bonds yield (GBY) | | | | | | | | 0.61 | | | | |
| 10 | Volatility of 1Y GBY | | | | | -0.27 | | | | | | | |
| 11 | EURIBOR3M | | | | | | | | | | | | |
| 12 | Volatility of EURIBOR3M | | | | | | | | | | 0.47 | | |

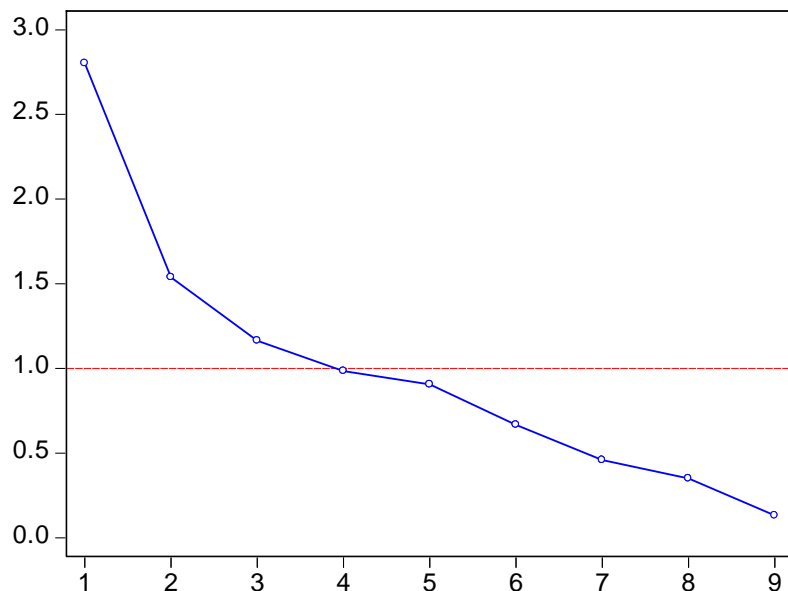
5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

| Number | Eigenvalues | Proportion | Cumulative proportion |
|--------|-------------|------------|-----------------------|
| 1 | 2.802 | 0.311 | 0.311 |
| 2 | 1.538 | 0.171 | 0.482 |
| 3 | 1.163 | 0.129 | 0.611 |
| 4 | 0.984 | 0.109 | 0.721 |
| 5 | 0.906 | 0.101 | 0.821 |
| 6 | 0.666 | 0.074 | 0.895 |
| 7 | 0.459 | 0.051 | 0.946 |
| 8 | 0.350 | 0.039 | 0.985 |
| 9 | 0.132 | 0.015 | 1.000 |

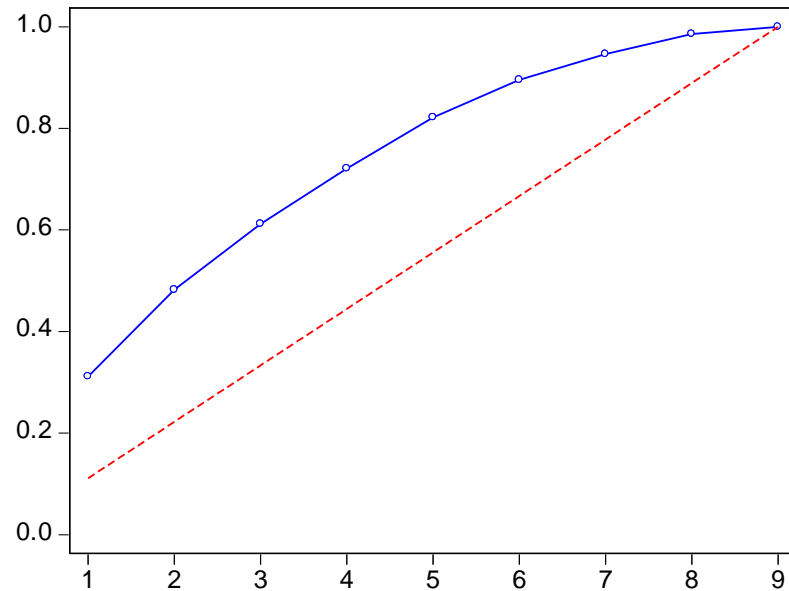
The first 3 principal components with eigenvalues larger than 1 are selected, explaining over 60% of total variability in the dataset (**Kaiser criterion**)

5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

Scree Plot (Ordered Eigenvalues)



Eigenvalue Cumulative Proportion



In the figures is plotted the relationship between the relative magnitude of the eigenvalues and the number of factors. Starting with the 4th principal component, the proportion of variance explained becomes trivial

5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

| Variables | PC1 | PC2 | PC3 |
|-------------------------------------------|--------------|--------------|--------|
| Total credit | 0.325 | 0.409 | -0.290 |
| Credit granted to non-financial companies | 0.537 | 0.077 | -0.086 |
| Credit granted to households | 0.525 | -0.038 | -0.041 |
| Credit granted in local currency (lei) | 0.326 | 0.031 | -0.102 |
| EUR/RON exchange rate | 0.427 | -0.062 | 0.233 |
| Volatility of ROBOR3M | -0.066 | 0.237 | -0.361 |
| 1Y government bonds yield | 0.094 | 0.178 | 0.767 |
| Volatility of 1Y government bonds yield | -0.152 | 0.610 | -0.161 |
| Volatility of EURIBOR3M | -0.078 | 0.601 | 0.314 |

2 sub-set of variables are formed (green and red), following the first two principal components (PC) that explain the highest proportion of data variability

5. A Principal Component Analysis (PCA) to explore the relationship between interbank markets and lending

Results:

- High heterogeneity among interbank market variables
- The variability explained by uncorrelated principal components allows to classify the variables into sub-sets based on discriminative information
- The variability in **credit granted to non-financial companies, credit granted to households, credit granted in local currency (lei) and EUR/RON exchange rate** is mainly explained by the first principal component
- The second principal component summarizes variability in **total credit, volatility of 3M money markets (ROBOR3M and EURIBOR3M) and volatility of 1Y government bonds yield**



6. Lessons

- Developments in interbank markets and lending activity in Romania share common informative features
- Local currency exchange rate against the euro along with credit sub-components (including credit granted in local currency) reveals the highest variance informative subset
- Total credit granted by banks in Romania has similar variance properties with volatility of interbank liquidity conditions (money market rates and government bond yields)
- There is evidence of external influence (euro area money market) on lending activity in Romania



Thank you very much for your attention!

horatiu.lovin@bnro.ro

