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NBP stress testing satellite models

15 September 2017
Agenda

- Introduction – definitions and framework
- Scenarios and macro-financial assumptions
- Satellite panel models of credit risk and (net) interest margin
Introduction – definitions and framework
Some definitions

- A macro stress test (MST) is a rough quantitative evaluation of the resilience of a financial system to large but plausible shocks (low probability, high impact events)

- Sensitivity vs. scenario analysis
  - sensitivity – a single indicator (macro variable or FSI) is shocked
  - scenario – coherent changes in multiple variables, for example projection from macro model or historical data

- Top-down (“in-house”) vs. bottom-up (calculations performed by financial institutions based on assumptions provided by supervisory authority)
Constructing a macro stress test

1. Decide on the source of shocks – "story"
2. Build macroeconomic stress scenario
3. Calculate change in banks’ financial result relative to baseline scenario
4. Calculate the changes in capital adequacy, liquidity position, etc. of individual banks

- Expert input
  - Expert analysis
    - Ad-hoc shocks
    - Macro model
    - Historical crisis
- Econometric models
  - e.g. recent macro forecast
Macro stress-testing at the NBP – building blocks

**Liquidity shock**
- Liquidity shock
  - Liabilities outflow
  - Margin calls on FX hedging transactions
  - Change in liquid assets buffer
- Coverage of liquidity outflows
- Contagion effects

**Market shock**
- Capital outflow
  - Interest rate shock
  - FX shock
  - Income buffer forecast
- Fall in sovereign bonds value
- Change in credit risk cost
- Change in risk weighted assets

**Macro shocks**
- Macro scenarios
  - Credit risk cost forecast
  - Net interest income forecast
  - Banks’ BS and P&L
  - Additional assumptions

Change in capital adequacy ratios and estimates of recapitalisation needs
Solvency macro stress testing at the NBP

- Top-down stress test for domestically incorporated commercial banks:
  - 35 commercial banks (BGK excluded) – above 80% of the banking sector by assets
  - Polish banking sector is composed of domestically incorporated commercial banks, 27 branches of credit institutions (2%) and 554 cooperative banks (7%)

- Simulations for individual banks on solo basis

- Usually performed twice a year, aggregate results published in the FSR
  - additional stress tests – for example if requested by the NBP management board

- Since 2013: cooperation with the supervisory authority
  - same scenarios used for top-down tests of the NBP and bottom-up tests of the PFSA or…
  - NBP performs top-down stress tests for PFSA as a reference for bottom-up exercises (like the European stress-test)
  - discussion on results
Scenarios and macro-financial assumptions
**Liquidity shock**
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**Macro shocks**
- Net interest income forecast
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- Fall in sovereign bonds value

**Change in capital adequacy ratios and estimates of recapitalisation needs**
Macroeconomic scenarios in solvency stress tests for FSR

- Reference scenario – central path of the macroeconomic projection from the latest Inflation Report
  - fixed interest rates assumed - should not be treated as the expectation on the future!
- Shock scenario – projection from the multi-equation NECMOD model used for macroeconomic forecasts at the NBP
  - based on assumptions on external GDP growth and "shock story"
  - developed by the experts from the Economic Institute

Reference and shock scenarios

Satellite panel models of credit risk and interest margin
**Liquidity shock**
- Liabilities outflow
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- Net interest income forecast
- Change in capital adequacy ratios and estimates of recapitalisation needs
General specification

- Panel models of credit risk and interest margin as satellites for the macro model
  - variables projected by macro model enter panel models as explanatory variables
  - outputs of the panel models do not feed back to the macro model
- 3 equations for credit risk: housing, consumer and corporate loans
  - dependent variables: coverage of total (impaired and not impaired) loans by stock of impairment provisions
- 1 equation for net interest margin
  - dependent variables: ratio of annualised net interest income to average assets
  - interest income on debt securities excluded
- Dynamic panel model introduced by Arellano–Bover/Blundell–Bond
  - S-GMM estimated in Stata (xtabond2)
Data

- Quarterly data from Q1 1997 to the latest available
  - shorter sample for housing loans – better fit and more reliable forecast
  - data from end-1997 for NIM due to annualisation
- Macroeconomic and bank-specific explanatory variables
  - only lags to alleviate endogeneity problems
  - bank-specific variables (ratios) constant in projection period (unless forecast by other satellite models)
- Bank mergers accounted for by ”backward sum” approach
  - ”artificial” bank – sum of banks that were merged
- Some banks excluded from estimation:
  - history too short
  - insignificant share of a given loan portfolio
## Credit risk models - variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Abbreviation</th>
<th>Sign</th>
<th>Story</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF exchange rate</td>
<td>CHF</td>
<td>+</td>
<td>Influence instalment of mortgages denominated in CHF</td>
<td>Level</td>
</tr>
<tr>
<td>GDP</td>
<td>pkb</td>
<td>-</td>
<td>Proxy for economic activity</td>
<td>Change</td>
</tr>
<tr>
<td>Interest rate</td>
<td>wibor</td>
<td>+</td>
<td>Most of loans in Poland are floating rates loans so it impacts level of instalment</td>
<td>Level</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>unemp</td>
<td>+</td>
<td>Work is the main source of income for creditors</td>
<td>Level</td>
</tr>
<tr>
<td>Employment</td>
<td>emp</td>
<td>-</td>
<td>Proxy for unemployment and companies condition</td>
<td>Change</td>
</tr>
<tr>
<td>Real wage fund</td>
<td>Wage_fund</td>
<td>-</td>
<td>Determines disposable income thus loan repaying capacity</td>
<td>Change</td>
</tr>
</tbody>
</table>
Credit risk – corporate loans

Explanatory variables:

- Lagged dependent variable
- Annual GDP growth
- Annual growth rate in corporate loans at bank level
- Annual change in employment rate
- Dummies:
  - IFRS introduction
  - change in provisioning regulation

| Variable                | Coef.   | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|-------------------------|---------|-----------|-------|-----|---------------------|
| corp_loans_cover        |         |           |       |     |                     |
| L1                      | .903762 | .0080778  | 111.88| 0.00 | .887935             | .9195993            |
| gdp                     |         |           |       |     |                     |
| L2                      | -.0991826 | .016066 | -6.17 | 0.00 | -.1306714           | -.0676938           |
| pracujacy               |         |           |       |     |                     |
| L3                      | -.0427208 | .0119185 | -3.58 | 0.00 | -.0660807           | -.019361            |
| dummy_new_psr           | .000503 | .0022449  | 0.22  | 0.823 | -.0038969           | .0049029            |
| dummy_ifrs              | .0022048 | .0021866 | 1.01  | 0.313 | -.0064905           | .0064905            |
Credit risk – corporate loans
## Credit risk – housing loans

### Explanatory variables:
- Lagged dependent variable
- Annual GDP growth
- Annual change in unemployment rate
- Quarterly average CHF/PLN exchange rate
- Dummies:
  - IFRS introduction – out of sample
  - change in provisioning regulation – out of sample

### Regression Output

|                      | Coef.  | Std. Err. |     z  |   P>|z|  |   [95% Conf. Interval] |
|----------------------|--------|-----------|-------|------|-----------------------|
| hous_loans_cover     |        |           |       |      |                       |
|                      |        |           |       |      |                       |
|                      | L1.    | .7864084  | .0098394 | 79.92| 0.000     | .7671236  | .8056933   |
|                      | gdp    | -.014602  | .0059503 | -2.45| 0.014    | -.0262645 | -.0029396  |
|                      | bezrobocie | .006566  | .0036075 | 1.82 | 0.069    | -.0005047 | .0136366   |
|                      | chf    | .0017151  | .0002836 | 6.05 | 0.000    | .0011593  | .002271    |
|                      | dummy_new_psr | -.0024501 | .0009295 | -2.64| 0.008    | -.0042719 | -.0006283  |
|                      | dummy_ifrs | -.0011464 | .0008415 | -1.36| 0.173    | -.0027957 | .0005028   |
Credit risk – housing loans
Credit risk – consumer loans

Explanatory variables:
- Lagged dependent variable
- Annual GDP growth
- Annual real wage fund growth
- 3m interbank rate (WIBOR)
- Provision ratio from credit risk model
Credit risk – consumer loans

Consumption loans equation - fit xtabond

Consumption loans equation - base vs alt
# NM model - variables

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<td>GDP</td>
<td>GDP</td>
<td>+</td>
<td>Rise in economic activity leads to higher demand on credit that allows banks to use higher margins.</td>
<td>change</td>
</tr>
<tr>
<td>Short term interest rate</td>
<td>wibor</td>
<td>+</td>
<td>Banks tend to charge higher commissions and margins in the times of loose monetary policy.</td>
<td>level</td>
</tr>
<tr>
<td>Credit losses</td>
<td>prov_ratio</td>
<td>-</td>
<td>No interest are paid on non-performing loans.</td>
<td>level</td>
</tr>
</tbody>
</table>
NIM – net interest margin

Explanatory variables:

- Lagged dependent variable
- Annual GDP growth
- 3m interbank rate (WIBOR)
- Provision ratio from credit risk model

|                | Coef.  | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|----------------|--------|-----------|-------|------|----------------------|
| nirm           |        |           |       |      |                      |
| L1             | .9044025 | .0057875  | 156.27 | 0.000 | .8930592 - .9157458  |
| gdp            | .0078667 | .0055527  | 1.42  | 0.157 | -.0030164 - .0187497 |
| wibor          | .0117551 | .0028507  | 4.12  | 0.000 | .0061678 - .0173425  |
| prov_ratio_nf_mgrs | -.0039382 | .0033476 | -1.18 | 0.239 | -.0104994 - .0026231 |
NIM – net interest margin
We protect the value of money