Additive and Multipliclicative Risk Assessment Models
Early Warning System

Andrzej Banasiak
BGF Board Member
Methods of early detection of banks’ problems
Rationale for early detection of banks’ problems

BCBS and IADI propose the following key points of early detection of banks’ problems

**Responsibility**
- Supervisory institutions
- Certain deposit guarantee institutions which have access to supervisory data

**Goal**
- Adequate preparation for possible insolvency (financial, HR, technical)
- Ability to undertake early preventive actions (liquidity support, M&A support, recapitalisation)
- Improvement of the quality and effectiveness of the financial supervision

**Data sources**
- On-site examinations
- Off-site surveillance
- Banking supervision
- Banks’ management boards
- Auditors
- Market information

### Classification of early detection methods

#### Methods of risk detection according to BCBS/IADI

<table>
<thead>
<tr>
<th>Based on quantitative data</th>
<th>Supervisory assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial statements analysis</td>
<td>Supervisory rating systems (e.g. CAMELS, CAEL)</td>
</tr>
<tr>
<td>Statistical methods</td>
<td>Comprehensive risk assessment systems</td>
</tr>
</tbody>
</table>

- **Construction of financial ratios for a bank on the basis of its reporting data**
- **Comparative analysis of entities and trend analysis**
- **Use of statistical models for estimation of the probability of default, the scale of problems and the scale of losses**
- **Aim: early identification of potential risks**
- **Various data sources can be used, both quantitative and qualitative**
- **Analysis focused on values which stand out of the „normal ones”**
- **Division of banks and banking groups according to business categories and their analysis including all types of risks**
- **A separate assessment is assigned to each criterion, then assessments are aggregated into a final score**

Indices on the micro level can be complemented with macro indicators, which allows to achieve better risk estimation for an entity from the financial sector.

In practice, institutions use a combination of different quantitative and qualitative methods.

---

Financial statements analysis

Method based on data from financial statements of a bank

The most frequently analysed areas

- Capital adequacy
- Asset quality
- Effectiveness indicators
- Liquidity indicators

Exceeding established critical values or obtaining values from a pre-defined range

Signal of risk

Characteristics of the method

Weaknesses of the method

- Effectiveness depending on the quality of data received from banks
- Indicators describe the situation of the entity only for a current moment
- Financial indicators inform on the problems of the entity with a delay, also because of delays in the process of data flow between banks and supervisory institutions
- Qualitative data is not taken into consideration, therefore the picture of the bank’s situation is not complete

### Statistical methods

<table>
<thead>
<tr>
<th>Reasons for their creation</th>
<th>Costly financial crises (in particular, in 90s and at the beginning of the 21st century) and the need of monitoring financial stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Early identification of risks and weaknesses in certain sectors of the economy with the aim of elaborating a proper anti-crisis policy and risk prevention</td>
</tr>
<tr>
<td>First models</td>
<td>The end of the 70s – first generation of models, next ones created under the influence of new crisis events</td>
</tr>
</tbody>
</table>
| Basic elements            | - Definition of a crisis  
- Mechanism of crisis forecasting |
| Use                       | **Macro**  
Forecasting of crises, including systemic ones, in particular:  
- Banking crises  
- Currency crises  
- Fiscal crises  
**Micro**  
Detection and forecasting of risks at the level of an individual entity |
**Most popular statistical methods of early warning systems**

<table>
<thead>
<tr>
<th>Nature</th>
<th>Multi-dimensional logit/probit models</th>
<th>Analysis of the signal extraction in time series</th>
<th>Discrimination analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traits</td>
<td>Estimation of probability of an event on the basis of financial or macro-economic variables</td>
<td>Detection of a signal of a non-standard event in deviation of variables (exceeding a threshold)</td>
<td>Finding a linear combination of characteristics, which classify two or more classes of objects</td>
</tr>
</tbody>
</table>

- **Multi-dimensional logit/probit models**
  - regression parameters hard to interpret, but allow a more accurate fit than thresholds
  - requires an adequate number of observations
  - recommended for global EWS

- **Analysis of the signal extraction in time series**
  - thresholds easy to interpret
  - signal/noise ratio is maximized
  - requires a time series
  - recommended for national EWS

- **Discrimination analysis**
  - thresholds easy to interpret
  - small number of observations is sufficient
  - strong assumptions
  - recommended for classification of entities

The methods can be substitute to some extent, however the choice of a method depends on the number of observations and a compromise between the demand for the accuracy of the forecast and the demand for interpretability of thresholds of the model.
CAMELS as an example of a rating system

### The nature of the model

- CAMELS is a system of scoring (rating) assessment of a bank’s financial standing
- Based on reporting data (financial statements’ analysis) and non-reporting information (expert evaluation)
- Is additive, the final assessment of a bank based on a system of weights

### Genesis

- Created in the US
- Used there since 1979
- Named CAMEL until 1997
- Has become an international standard of supervisory assessment of banks

### Partial assessments in 6 areas

<table>
<thead>
<tr>
<th>C</th>
<th>A</th>
<th>M</th>
<th>E</th>
<th>L</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>A</td>
<td>M</td>
<td>E</td>
<td>L</td>
<td>S</td>
</tr>
<tr>
<td>capital adequacy</td>
<td>assets</td>
<td>management</td>
<td>earnings</td>
<td>liquidity</td>
<td>sensitivity to market risk</td>
</tr>
</tbody>
</table>

### Final assessment: from 1 (good condition of a bank) to 5 (weak condition)

### Advantages of the model:
- Complex combination of quantitative and qualitative assessment
- High effectiveness of risks detection

### Disadvantage of the model:
- Parameters estimated on the basis of data from 90s, do not react to changes in banks’ functioning
BGF Early Warning System
Early Warning System (EWS)

The EWS model created in BGF is a tool for:
- early identification of banks, which generate risk
- detailed analysis of single banks

1) Assessment with the use of rating:
- scoring risk assessment on the basis of bank reporting data
- correction of the scoring assessment on the basis of non-reporting data supplied by the supervisor
- the scoring assessment is additionally complemented with monitoring of the trend

2) Indication of banks for a detailed analysis:
- Selection of banks of potentially high risk (which are subject to further, individual analysis)

The model is not deterministic – low rating assessments resulting from it do not have to mean that the bank will be insolvent
<table>
<thead>
<tr>
<th>Area</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Bank’s capacity to generate income, which excludes risks of banking activity</td>
</tr>
<tr>
<td>Credit risk</td>
<td>Assessment of financial impact of existing risks and ability of a bank to absorb credit risk</td>
</tr>
<tr>
<td>Capital adequacy</td>
<td>Assessment of capital resources in relation to a bank activity profile and ability to mitigate risks correlated with this activity</td>
</tr>
</tbody>
</table>

The model does not use variables that simultaneously reflect two or three areas, for example net profit, which is a broad category covering a combination of operational efficiency and risk mitigation.
### Areas of rating assessment

<table>
<thead>
<tr>
<th>Area</th>
<th>Definition</th>
<th>Criterion</th>
<th>Subject of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficiency</strong></td>
<td>Structural ability of a bank to generate income from business activity</td>
<td>Creation of stable income</td>
<td>Comparison of income positions with costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not take into account factors related to credit risk and factors associated with the loss of required capital</td>
</tr>
<tr>
<td><strong>Credit risk</strong></td>
<td>Loss of the ability to mitigate risk of financial losses arising from the credit portfolio</td>
<td>Absorbtion of credit risk</td>
<td>Quality of bank's assets</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not include factors related to the level of own funds used as a buffer to cover the credit risk</td>
</tr>
<tr>
<td><strong>Capital adequacy</strong></td>
<td>Possession of adequate capital level by a bank</td>
<td>Buffering credit risk and potential losses</td>
<td>Bank’s capital security and accumulation of retained earnings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Assessment of the capital level which can be used to absorb risk and losses</td>
</tr>
</tbody>
</table>
Effectiveness of the EWS model

Calibration of the assessment system

For achieving high quality of the calibration, it is essential to:

• Back the analysis on empirical data
• Have access to long-term data
• Perform numerous tests

Providing the high quality of the calibration requires the use of a limited number of indicators

Complexity of the assessment

For achieving a complex assessment, it is essential to:

• Include in the models all areas of a bank’s activities which can generate risks

The need of the use of complex indicators from the financial and business realm

For achieving high quality of the calibration, it is essential to:
Indicators in the EWS model (1)

In practice, the EWS efficiency depends on a good choice of indicators and a good model calibration.

**Indicators choice**
- Large number of indicators
  - complicates the model,
  - makes model calibration difficult
- Small number of indicators
  - simplifies the model,
  - makes the model easy to manage

**Indicators complexity**
- Simple
  - reduced management information
- Complex
  - business-management perspective
The model used in BGF makes use of both simple and complex indicators

**Simple indicators**
- Assessment of one economic area

**Complex indicators**
Assume individual risk for every bank or relate critical risk levels to other indicators
- Individual benchmarks
  (e.g. credit quality assessment is based on a credit structure in a particular bank)
- Assessment of an indicator change depending on its level
  (indicator level change is assessed depending on the current level of the indicator – the better level, the bigger change of the indicator is acceptable)
- Joint assessment of two indicators
  (assessment of one indicator is modified with the use of another indicator)
The distinguishing feature of the EWS is the combination of multiplicativity and additivity.

**Additivity**
Scores of separate assessment areas are added.

Adding positive traits
If used alone, can lead to a wrong final assessment.

**Multiplicativity**
Scores of indicators within each risk assessment area are multiplied.

Highlights negative traits.

The EWS model serves to parametrize and highlight the weaknesses of assessed banks, not to assess their business attractiveness.
EFFICIENCY ASSESSMENT (EA)
\[ EA = \text{Ind}.1 \times \text{Ind}.2 \times \text{Ind}.3 \times \text{Ind}.4 \]

CREDIT RISK ASSESSMENT (CRA)
\[ CRA = \text{Ind}.1 \times \text{Ind}.2 \times \text{Ind}.3 \times \text{Ind}.4 \]

CAPITAL ADEQUACY ASSESSMENT (CAA)
\[ CAA = \text{Ind}.1 \times \text{Ind}.2 \times \text{Ind}.3 \times \text{Ind}.4 \]

\[ FS = EA \times 0.35 + CRA \times 0.35 + CAA \times 0.30 \] (rating from 0 to 1 point)

Additivity between the assessments
Additivity and multiplicativity in the system

It is more appropriate to use additive-multiplicative system to select banks at risk than using only the additive or multiplicative system
• Additivity leads to a summing of positive traits
• Multiplicativity leads to overassessment of weaknesses
The role of indicators

**Core indicator**
- Discriminating indicator refers to features indicating the most significant risk in a given area

**Supplementary indicators**
- Supplement of the core indicator
  - Extensive information regarding the examined area
- Perspective of change
  - Determination of the direction and scale of changes of a given indicator
- Stress test
  - Determination of the ability to absorb risk by a bank

Presented group of indicators is the same in each assessed area
Score for the area is obtained as a result of multiplication of all indicators within the area.
Final score

Area of efficiency

Area of credit risk

Area of capital adequacy

0.35

0.35

0.30

0.0 p.

MIN

MAX

1.0 p.

Using weights for areas allows to bring the final score to the range 0-1
## EWS - risk categories

### Basic score

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.00 ; 0.20&gt; p.</td>
<td>Minimal</td>
</tr>
<tr>
<td>(0.20 ; 0.50&gt; p.</td>
<td>Low</td>
</tr>
<tr>
<td>(0.50 ; 0.80&gt; p.</td>
<td>Significant</td>
</tr>
<tr>
<td>(0.80 ; 1.00&gt; p.</td>
<td>High</td>
</tr>
</tbody>
</table>

### Corrections of the basic score

#### Quantitative criteria
- Extremely low score in at least two areas
- The buffer on the borders of the ranges – if the score for a bank improves, the bank’s risk category is upgraded only on condition that the upper threshold extended with the buffer is exceeded

#### Qualitative criteria
- Information received from the bank supervisor on including bank under a recovery proceeding or on a danger of non-fulfillment of the recovery program

### The bank's risk assessment
## Final report – rating score given by the system

<table>
<thead>
<tr>
<th>L.p.</th>
<th>Ocena ryzyka</th>
<th>Efektywność (waga 0,35)</th>
<th>Ryzyko kredytowe (waga 0,35)</th>
<th>Adekwatność kapitałowa (waga 0,3)</th>
<th>Ocena punktów a</th>
<th>Postępowanie naprawczego</th>
<th>Ryzyko</th>
<th>Trend 3M</th>
<th>Trend 6M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bank 1</td>
<td>0,07</td>
<td>0,00</td>
<td>0,00</td>
<td>0,07</td>
<td>nie</td>
<td>wysokie</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>2</td>
<td>Bank 2</td>
<td>0,03</td>
<td>0,00</td>
<td>0,25</td>
<td>0,28</td>
<td>realizowane</td>
<td>wysokie</td>
<td>s</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Bank 3</td>
<td>0,04</td>
<td>0,07</td>
<td>0,30</td>
<td>0,41</td>
<td>zagrożone</td>
<td>wysokie</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Bank 11</td>
<td>0,03</td>
<td>0,03</td>
<td>0,23</td>
<td>0,29</td>
<td>nie</td>
<td>istotne</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Bank 12</td>
<td>0,02</td>
<td>0,08</td>
<td>0,30</td>
<td>0,39</td>
<td>nie</td>
<td>istotne</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>13</td>
<td>Bank 13</td>
<td>0,05</td>
<td>0,08</td>
<td>0,27</td>
<td>0,40</td>
<td>nie</td>
<td>istotne</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>14</td>
<td>Bank 14</td>
<td>0,15</td>
<td>0,05</td>
<td>0,30</td>
<td>0,50</td>
<td>nie</td>
<td>istotne</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>15</td>
<td>Bank 15</td>
<td>0,17</td>
<td>0,19</td>
<td>0,16</td>
<td>0,51</td>
<td>realizowane</td>
<td>istotne</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>21</td>
<td>Bank 21</td>
<td>0,17</td>
<td>0,11</td>
<td>0,24</td>
<td>0,52</td>
<td>nie</td>
<td>niskie</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>22</td>
<td>Bank 22</td>
<td>0,18</td>
<td>0,16</td>
<td>0,30</td>
<td>0,63</td>
<td>nie</td>
<td>niskie</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>23</td>
<td>Bank 23</td>
<td>0,11</td>
<td>0,28</td>
<td>0,30</td>
<td>0,68</td>
<td>nie</td>
<td>niskie</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>24</td>
<td>Bank 24</td>
<td>0,18</td>
<td>0,23</td>
<td>0,30</td>
<td>0,71</td>
<td>nie</td>
<td>niskie</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>Bank 25</td>
<td>0,34</td>
<td>0,13</td>
<td>0,30</td>
<td>0,77</td>
<td>nie</td>
<td>niskie</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>Bank 31</td>
<td>0,27</td>
<td>0,24</td>
<td>0,30</td>
<td>0,81</td>
<td>nie</td>
<td>minimalne</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>32</td>
<td>Bank 32</td>
<td>0,31</td>
<td>0,26</td>
<td>0,30</td>
<td>0,88</td>
<td>nie</td>
<td>minimalne</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>33</td>
<td>Bank 33</td>
<td>0,29</td>
<td>0,35</td>
<td>0,30</td>
<td>0,94</td>
<td>nie</td>
<td>minimalne</td>
<td>s</td>
<td>+</td>
</tr>
<tr>
<td>34</td>
<td>Bank 34</td>
<td>0,34</td>
<td>0,34</td>
<td>0,30</td>
<td>0,99</td>
<td>nie</td>
<td>minimalne</td>
<td>s</td>
<td>s</td>
</tr>
</tbody>
</table>

### Final report goals:
- list of banks according to rating score (ordered by score)
- selection of banks for detailed analysis
Auxiliary EWS analyses
## BGF analyses

### Sources of information

<table>
<thead>
<tr>
<th></th>
<th>NBP</th>
<th>KNF</th>
<th>Banks</th>
<th>Credit Unions</th>
<th>Market information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data from the NBP SIS reporting system</td>
<td>Information on banks, Audit and inspection results, Financial recovery plans</td>
<td>Information on covered deposits, the obligatory annual levy</td>
<td>Information on covered deposits, the obligatory annual levy</td>
<td>Reuters (e.g. Datastream), Economic press</td>
<td></td>
</tr>
</tbody>
</table>

### Wide range of BGF analyses

- Monthly and quarterly banking analysis
- Cooperative banks’ analysis
- Individual banks’ analysis
- Early Warning System for banks
- Monthly credit unions’ analysis
- Individual credit unions analysis
- Macro analysis
- Systemic risk analysis
BGF created own analytical tools that enable effective use of multidimensional database. It allows to elaborate:

- wide range of analyses,
- multidimensional analyses,
- problem-oriented analyses.

Dimensions of BGF analyses