Commission modelling inventory and knowledge management system (MIDAS)
Report generation date 15/05/23

MIDAS includes the descriptions of models in use by the Commission in support to the policy cycle. MIDAS is developed and managed by the **Competence Centre on Modelling** of the European Commission.

Find out more at https://ec.europa.eu/knowledge4policy/modelling_en
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Factsheet

SWD/2023/225 final

Impact Assessment Accompanying the Proposals for a Directive of the European Parliament and Council amending Directive 2014/59/EU as regards early intervention measures, conditions for resolution and financing of resolution action Regulation of the European Parliament and Council amending Regulation (EU) 806/2014 as regards early intervention measures, conditions for resolution and financing of resolution action Directive of the European Parliament and Council amending Directive 2014/49/EU as regards the scope of deposit protection, use of deposit guarantee schemes funds, cross-border cooperation, and transparency

Supporting model

SYMBOL

Impact assessment
SWD/2023/225 final

Fact sheet on model contributions

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Overview of model contributions to the impact assessment SWD/2023/225 final

Title
Impact Assessment Accompanying the Proposals for a Directive of the European Parliament and Council amending Directive 2014/59/EU as regards early intervention measures, conditions for resolution and financing of resolution action Regulation of the European Parliament and Council amending Regulation (EU) 806/2014 as regards early intervention measures, conditions for resolution and financing of resolution action Directive of the European Parliament and Council amending Directive 2014/49/EU as regards the scope of deposit protection, use of deposit guarantee schemes funds, cross-border cooperation, and transparency

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2023

Led by
FISMA

Model(s) used
SYMBOL

SYMBOL

Full title
SYstemic Model of Banking Originated Losses

Run for this impact assessment by
European Commission

Contributed to
Baseline and assessment of policy options

Description of Model Contribution
The SYMBOL model was used to support two assessments. First, to evaluate the potential use of funding sources in resolution and insolvency (e.g. internal loss-absorbing capacity, deposit guarantee schemes, resolution funds) depending on each bank's characteristics and various policy scenarios, on the basis of simulated losses applied to the banks' liabilities by respecting the waterfall in the hierarchy of claims. Second, to evaluate the effectiveness of various forms of pan-European deposit guarantee scheme under different crisis scenarios and assess the impact of mutualisation on the financial situation of national deposit guarantee schemes as well as the potential synergies that could be achieved via a pooling of resources for depositor protection at EU level.

Overview of models

SYMBOL

Overview

Acronym SYMBOL
Full title SYstemic Model of Banking Originated Losses

Main purpose
SYMBOL estimates the probability and magnitude of important economic losses and liquidity shortfalls occurring in the banking sector.

Summary
SYMBOL, the SYstemic Model of Banking Originated Losses, is a simulation model developed by the JRC and DG MARKT (now DG FISMA) together with experts of banking regulation that analyzes the probability and the magnitude of financial crisis hitting the banking system.

SYMBOL is implemented in full coherence with Basel banking regulations, and includes correlation and contagion effects. In a first step, SYMBOL analyses the riskiness of each bank. Then a number of scenarios are generated in which one or more banks fail, and a probability distribution of the possible evolutions of the banking system is obtained. The model uses micro information about each bank profile as well as aggregate information about the banking sector. Results can be liquidity shortfalls or losses of a single bank, cumulated losses for the whole system, and estimates of the individual contributions to the systemic risk.

SYMBOL is suitable for policy preparation and implementation. It can assess the impact of various regulatory/policy initiatives in the realm of banking. In The model has been used in this way by the European Commission as a tool for the assessment of contingent liabilities linked to public support to the EU banking sector and for ex-ante quantitative impact assessment of a number of legislative proposals such as the stability effect of regulatory tools of the banking safety net. It makes up a framework for evaluating dimension, role, risk-based contributions and integration between Deposits Guarantee Schemes, Resolution Funds, impact of capitalization parameters as required by Basel III and the Capital Requirement Directive IV, and for evaluating the residual risk supported by public finances.

Keywords
Financial Market, Risk Assessment, Financial Stability, Public Finances

Model home page
None provided

Ownership & licence

Ownership

EU ownership (European Commission)

Ownership details

The model has been developed by JRC and DG-Markt (now DG FISMA) in collaboration with colleagues form academia. We plan to start the procedure to license it.

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

SYMBOL structure and approach

SYMBOL is a simulation model to estimate aggregate losses in the banking sector of a country (or group of countries) in case of a financial crisis. SYMBOL is a Monte Carlo micro-simulation model based on balance sheet and regulatory capital data at individual bank level.

The SYMBOL model is built around the Fundamental Internal Risk Based formula from the Basel III regulatory framework. The riskiness of each bank's pool of assets is obtained by inverting the FIRB formula*. Individual banks' losses are then generated via Monte Carlo simulation using the Basel FIRB loss distribution function and a correlation matrix representing the common risk factors across European banks. Losses generated in the simulation can then be compared with actual bank capital to check which banks default of remain severely under-capitalized. As the simulation is conducted at individual bank level, any other loss-absorbing or recapitalization tool (e.g. MREL, bail-in, funds) operating at individual bank level can also be modelled. Individual losses remaining after interventions are then aggregated for each simulation run. Given a sufficient number of simulations runs, the aggregate distribution of losses can be estimated. SYMBOL can thus be used to assess the amount of losses that remain uncovered after the intervention of any given set of policy tools, and that could potentially hit public finances. This assessment can be run under various policy scenarios depending on the tools implemented.

The probability distributions obtained from the model cannot be interpreted in terms of "real world" probabilities. This is because the regulatory assumption is that if a bank holds the level of capital prescribed by the formula it should have a probability of default lower than 0.1%, while markets regularly assess the real probability to be higher. As SYMBOL makes use of the regulatory model, its estimates suffer from the same kind of distortion.

This limitation can be overcome by focusing on parts of the distribution of aggregate outcomes which reproduce banking crisis events observed in the real world and by looking at how these outcomes vary under different policy scenarios.

SYMBOL estimations are based on the following assumptions: (1) all risks can be approximated as if they were credit risk; (2) banks report their own risks accurately and in line with the underlying regulatory approach; (3) all events happen at the same time, i.e. there is no sequencing in the simulated events.

Simulation can be run at country level, EU (or EA) level or for any sample of banks. The SYMBOL model is going under continuous revision.

Inputs

The model uses as input data coming from Bankscope/OrbisBankFocus database. Data needed for the SYMBOL model are unconsolidated banks' balance sheet data for a sample of roughly 3,000 EU banks for the period 2006 – 2016 (RWA, total assets, total capital, interbank deposits and loans used only in case contagion is modeled).

Data are processed in order to obtain a reliable dataset. Data quality checks are performed and missing data on capital and risk weighted assets are imputed via robust statistics techniques (FSDA toolbox in Matlab) and by ECS statistics on solvency ratios. Data from the EBA Basel III monitoring exercise (Quantitative Impact Study) are used to adjust for the definition of Basel III capital and RWA.

In case of specific analysis additional data are required. As an example, information on covered deposits is needed to assess the performance of safety net tools. These data are obtained combining data from national Deposits Guarantee Schemes with ECB, Eurostat, or EBA sources. For liquidity analysis also liquidity buffer, loans, total deposits are needed. For a market risk evaluation data on bonds, shares and other financial assets are needed. Recently, the effect of non-performing loans on losses hitting the banking sector has been introduced.

Results are always rescaled from sample to population via country aggregated ECB statistics on total assets.

Steps of the SYMBOL model:

1. **Estimation of the Implied Obligor Probability of Default of the portfolio of each individual bank.**
   The main ingredient of the model is the average implied obligor probability of default of a bank. It is a single parameter describing its entire loss distribution. It is obtained by numerical inversion of the Basel IRB formula for credit risk, based on total minimum capital requirements declared in the balance sheet. Individual bank data needed to estimate the implied obligor probability of default are banks' risk-weighted assets and total assets, which can be derived from the balance sheet data.

2. **Simulation of correlated losses for the banks in the system.**
   Given the estimated IOPD, SYMBOL simulates correlated losses hitting banks via Monte Carlo, using the same IRB formula and imposing a correlation structure among banks. The correlation exists either as a consequence of the banks' exposure to common borrowers or, more generally, to a particular common factor (for example, the business cycle). Each simulation ends when 100,000 runs with at least one default are simulated. This implies to let the model run for few millions of iterations in the case of small size countries and hundreds of thousands iterations for medium-large countries.
3. **Determination of bank failure.**
   Given the matrix of correlated losses, SYMBOL determines which banks fail. A bank failure happens when simulated obligor portfolio losses (*L*) exceed the sum of the expected losses and the total actual capital given by the sum of its minimum capital requirements plus the bank's excess capital, if any.
4. **Output of SYMBOL**.
   The output of SYMBOL are matrices with 100,000 rows (number of iterations) and nbanks columns (number of banks in the sample). The value of nbanks varies from few units to more than 1,000 (e.g. Germany). Recapitalization needs to keep the banks viable are set to be equal to 8% of Basel III RWA and summed up to losses in excess of capital.
5. **Aggregate distribution of losses for the whole system.**
   Aggregate losses are obtained by summing losses in excess of capital plus potential recapi-

talization needs of all distressed banks in the system (i.e. both failed and undercapitalized banks) in each simulation run.

** This function is based on the Vasicek model, which in broad terms extends the Merton model to a portfolio of borrowers. See Vasicek O. A., 2002, Loan portfolio value, Risk http://www.risk.net/data/Pay_per_view/risk/technical/2002/1202_loan.pdf and Merton R.C., 1974, On the pricing of corporate debt: the risk structure of interest rates, Journal of Finance, 29, 449-470*

Input and parametrization

Main inputs of the SYMBOL model are:

- Total assets
- Total regulatory capital
- Risk weighted assets
- Implied obligors' probability of default (IOPD): representing the riskiness of the bank's assets portfolio
- Correlation structure among banks.

Main output

Main outputs of the SYMBOL model are:

- Losses of a single bank,
- Aggregated losses in excess of capital plus recapitalization needs of all distressed banks in the system for the whole system
- Effect on public finances of the bail in, resolution funds, deposit guarantee schemes
- Liquidity shortfalls
- Contribution to the systemic risk

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU Member states 27
(Spatial) resolution	National
Temporal extent	Short-term (period of 5 years or less), Medium-term (5-15 years)
Temporal resolution	Years

Quality & Transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	Yes	We make use of Montecarlo simulations. Experiments with bootstrapping have been made.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	Yes	Sensitivity analysis has been applied on the correlation factor, to different levels of capital and RWA.
Have model results been published in peer-reviewed articles?	Yes	
Has the model formally undergone scientific review by a panel of external experts? (Please note that this does not refer to the cases when model results were validated by stakeholders)	Yes	In 2018 the model was reviewed by an external panel of experts, organised by the European Commission's Competence Centre on Modelling (CC-MOD), descrived in Hordijk et al: Review of the SYMBOL model, Publications Office of the European Union, doi:10.2760/607271
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	No	Not possible as it refers to historical data and the model is calibrated on historical events

Transparency

Question	Answer	Details
To what extent do input data come from publicly available sources? (Note: this may include sources accessible upon subscription and/or payment)	Not Provided	
Is the full model database as such available to external users? (The answer 'yes' comprises the cases when access to the database implies a specific procedure or a fee)	No	Not possible as coming from a commercial database.

Have model results been presented in publicly available reports (in addition to IA reports and journal articles)?	Not Provided	
Have output datasets been made publicly available? (Note: this could also imply a specific procedure or a fee)	Yes	Several scientific papers and policy reports have been published with SYMBOL results aggregated per MS.
Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public?	Not Provided	
Has the model been documented in a publicly available report or a manual?	Yes	Documentation is available to the general public.
Is there a dedicated public website where information about the model is provided?	Not Provided	
Is the model code open source?	No	
Can the code be accessed upon request?	No	The Matlab code is not provided.

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Miscellaneous

The model is designed to contribute to the following phases of the policy cycle

- Formulation
- Implementation
- Evaluation

The model's potential

The SYMBOL model has proven to be flexible enough to assess the impact of various regulatory/policy initiatives in the realm of banking. In fact, once the model is run one can use the losses distributions (output of the standard model) to evaluate different what-if scenarios and different policy initiatives.

SYMBOL has been used in this way by the European Commission as a tool for ex-ante quantitative impact assessment of a number of legislative proposals and for the assessment of contingent liabilities linked to public support to the EU banking sector.

One typical case is the analysis on the effects on public finances of the bail-in Directive (Bank Recovery Resolution Directive, BBRD). This Directive (European Parliament and Council, 2014) introduces and defines the order of intervention of different safety-net tools which include (i) improved standards on minimum capital requirements and capital conservation buffer set up in the CRR/CRD IV package (ii) bail-in, (iii) Resolution Funds (RF), (iv) Deposit Guarantee Schemes (DGS).

In the latest years Symbol has been used in collaboration with Economic and Financial Affairs Directorate to analyse the stability of the EU 27 banking sector.