WORKING PAPER

CENTRAL BANK OF ICELAND

No. 75

The Central Bank of Iceland's approach to stress testing the Icelandic banking system

By

E. Kaloinen, J.M. Hannesson, Ö.P. Ragnarsson,
H. Jónsdóttir and E.Þ. Þórarinsson

The Central Bank of Iceland's approach to stress testing the Icelandic banking system

By

E. Kaloinen, J.M. Hannesson, Ö.P. Ragnarsson, H. Jónsdóttir and E.Þ. Þórarinsson

Abstract

Stress testing banks is a way of examining the potential impact of hypothetical stress scenarios on the banking system and the institutions within it. Disclosure of stress tests, their results and methodology, can improve public understanding of risks related to the banks. It can also improve prudential policy-making and make policy more effective and credible. The Central Bank of Iceland (CBI) started to develop its current stress testing program in 2013 and the stress test and its results were first published in 2015. The stress scenario is designed with regard to the Bank's assessment of current risks to financial stability in Iceland. In assessing the results of the stress test, the Central Bank uses a stress testing model of its own devising, but the impact of the stress scenario on the commercial banks' balance sheets and profitability are also discussed with each bank. The stress tests are used in assessment of risks to financial stability, and also as a reference when decisions are made in connection with macroprudential tools, such as capital buffers. This report describes the framework and process of the Central Bank's annual stress test, explains how the stress scenario is designed and discusses main aspects of Central Bank´s stress testing model.

Contents

Introduction

Stress testing banks is a way of examining the potential impact of hypothetical stress scenarios on the banking system and the institutions within it. Such stress tests usually begin with the design of a stress scenario by specifying forward-looking time series of macroeconomic and financial variables in a way that will put pressure on the banks' balance sheets and business plans and can lead to losses. In addition to the scenario, a model or set of models is also needed in order to assess the impact of the scenario on the balance sheets and profitability of the banks concerned.

Purpose of stress testing

Stress tests are useful for general risk assessment; they give indications of banks' vulnerability to adverse economic developments and can enable the authorities to respond to potential risks in a timely manner. In addition to helping to assess the impact of hypothetical shocks to individual banks and the whole banking system, stress tests can be used as assistive tools for prudential policy, either microprudential (focused on individual institutions) or macroprudential (focused on the system as a whole).[1] They also create an important foundation for discourse between parties such as banks and financial supervisors, or between various departments within a given bank. The purpose of stress tests, however, is not to unearth the next shock to strike banks but rather to explore issues that could pose problems. Therefore stress tests in general support development and improvement in banks' risk management and capital planning.[2] Banks that have introduced procedures for stress testing into their risk management are better prepared for potential shocks.[3] Furthermore, stress tests and their disclosure can improve public understanding of risk at large banks, and also enhance confidence in the banking system.[4]

Research shows that business cycles are more frequent and more pronounced in Iceland than elsewhere, mainly due to the small size of the economy, fluctuations in domestic demand and net trade. In addition, private consumption tends to fluctuate more than output, not least because of the frequent fluctuations in both the exchange rate and real disposable income.[5] It is therefore important to analyze the resilience of the banking system and develop prudential tools and policies.

Background and evolution of stress tests

Initially, stress tests were isolated exercises for banks' internal risk management to use in order to determine the resilience of their trading books. Market risk stress testing was added to the Basel I rules in 1996, and in 2004, Basel II required that banks carry out stress tests of credit risk.[6] Prior to the onset of the financial crisis in 2008, banks' stress-testing models and practices were still in a developmental stage and the stress tests largely underestimated actual losses that occurred during the crisis.[7]

---

[1] See, for example, Dent *et al.* (2016)
[2] See, for example, Bank of England (2015) and Yellen (2017)
[3] Engelmann, B. (2012)
[4] See, for example, Yellen (2017) and Bank of England (2015)
[5] See, for instance, Central Bank of Iceland (2012)
[6] See, for example, Dent (2016) and Basel Committee of Banking Supervision (2004 and 2009)
[7] See Basel Committee of Banking Supervision (2009)

Supervisory authorities begun to develop their own stress tests by the end of the 1990s with a focus on capturing the impact of severe but plausible shocks to the entire financial system. The International Monetary Fund (IMF) and the World Bank had launched their Financial Sector Assessment Program (FSAP) in 1999. The aim of the program is to assess the stability of a country's financial sector and its potential contribution to growth and development. Stress tests have been a key component of the FSAP, encouraging also national central banks to develop their own independent stress tests. Before the 2008 financial crisis, however, stress tests carried out by supervisory bodies were relatively simple exercises with limited impact on prudential policy.[8]

Since the 2008 crisis, supervisors have stepped up their development and use of stress tests. Supervisors' stress tests have become extensive exercises that are used for policy making. An early example of such a stress test is the Supervisory Capital Assessment Program (SCAP) carried first out by the Federal Reserve Board in 2009. In Europe, the first EU-wide stress test was conducted in late 2009 under the direction of the Committee of European Banking Supervisors (CEBS). The European Banking Authority (EBA) started to conduct stress testing exercises in 2011. The Central Bank of Iceland started developing its current annual stress testing program in 2013 and the stress test and its results were first published in 2015.

At present, however, stress tests are not without limitations, and development is ongoing. A few areas under development are improvements in the evaluation of individual banks' resilience, integration of system-wide feedback and amplification and inclusion of behavioral responses, and expansion of the stress tests beyond the banking system.[9]

About the report

The Central Bank of Iceland's approach to and methods for stress testing the commercial banks in Iceland are described below, beginning with the framework of the Bank's annual stress test, followed by a description of the scenario design and the CBI´s own stress testing model. This is followed by a discussion of the policy on transparency and publication of stress tests and their results. The Bank keeps abreast of developments in stress testing abroad and further develops its approach and methods. This report will be updated as needed in the future.

The framework of the CBI's annual stress test

Each year, the Central Bank of Iceland, in consultation with the Financial Supervisory Authority, carries out a stress test so as to assess the banking system's ability to withstand severely adverse macroeconomic and financial development. The stress test usually extends to the three largest commercial banks, whose total assets constitute some 96.5% of total assets of all deposit institutions in Iceland. The CBI may also carry out other stress tests as needed, with or without involving the banks. This discussion centers mainly on the annual stress test, however.

4

---

[8] See, for instance, Dent *et al.* (2016).
[9] See Dent *et al.* (2016)

The form of the stress test: Scenario analysis

The CBI's stress test takes the form of scenario analysis, in which the impact of macroeconomic scenarios on commercial banks' balance sheets and profitability is assessed. The scenarios include a *baseline scenario* and at least one *stress scenario*, covering a three-year horizon.

The baseline scenario for the stress test is the macroeconomic forecast in the CBI's last *Monetary Bulletin* for the year. The stress scenario, however, is based on analysis and assessments of risks to financial stability that could develop in a way unfavorable to the banks (for further discussion, see the section below entitled Stress scenario design).

Assessments from the participating banks and the Central Bank

The impact of the scenarios on developments in the banks' balance sheets and profit and loss accounts, on the one hand, and the capital base and the risk-weighted assets, on the other, is then assessed. Both the banks and the Central Bank assess the impact of the scenarios.

The banks use their own methodology to carry out the assessment though subject to general guidelines from the Central Bank. The Central Bank also examines the impact of the scenarios on the banks by using its own stress testing model and assessment. The objective is to have a reference for the banks' assessments and to create the foundations for discussions of the impact of the scenarios on various aspects of banks' business plans. An important part of the stress test is the discussions carried out with the banks concerning the impact of the scenarios and the lessons learnt from them.

Guidelines provided to the banks

During the administration of the stress test, the participating banks receive guidelines so as to facilitate comparison between banks. The guidelines give assumptions regarding management actions and potential dividend payments in the stress test. For instance, banks are not allowed to change their current policies, reduce their balance sheets deliberately in order to meet capital ratio requirements or lay off employees in the stress scenario.

Banks are assumed and encouraged to develop and use their own statistical models to assess the impact of scenarios for the stress test, e.g. regarding loan losses. The guidelines, however, provide general assumptions concerning developments in the balance sheet and profit and loss account, risk-weighted assets, and capital to the stress test. For instance, developments in assets (such as loans) must be projected subject to the given macroeconomic scenarios. In addition to developments in demand and prices, banks must account for the funding environment provided for in the scenarios as well as for the debt service capacity of their customers and their potential refinancing needs in such a scenario.[10] Consideration must also be given to regulation regarding liquidity and capital ratios. Importantly, the forecast of developments in the profit and loss account, including loan losses, must be consistent with both the balance sheet forecast and developments in relevant aspects of the scenarios, such as interest rates, exchange rates, or macroeconomic variables.

---

[10] In a stress scenario, when many firms' revenues and debt servicing capacity decline markedly, it is likely that many will need to refinance their loans.

Basis for the stress test

The starting position for the stress test is the banks' consolidated balance sheets as of the end of the year prior to the three-year horizon. The Central Bank is interested in examining the impact of the scenarios on banks´ capital, balance sheets and profitability rather than other changes unrelated to the scenarios. Therefore the year-end figures used as a starting position are sometimes adjusted, e.g. with regard to planned dividend payments due to previous year profit or other planned changes to capital structure and balance sheet.

Data collection

The banks submit information in a template divided into two sections: the baseline scenario and the stress scenario, including the starting point position. There are separate sections for projections of the balance sheet, profit and loss account, risk-weighted assets, and capital base, as well as for estimates of the development of the credit provisioning account, non-performing loans (NPL), particularly new NPLs, and other parameters for both scenarios.

The balance sheet items are divided into classes: assets are divided into cash and deposits, financial assets, and loans; liabilities are divided into deposits, borrowings from the Central Bank and other financial institutions, and debt securities issued. These classes are then subdivided further. For instance, loans are categorized as public sector, financial sector, corporate, and individual, and corporate loans further according to industry and loans to individuals to mortgage loans and other loans. The profit and loss account is divided into income and expense, including interest income, interest expense, loan portfolio valuation adjustments for different classes, and operating expense.

In addition to quantifiable data, information on the banks' stress testing methodology and other data are gathered. The data compilation process is under continuing development; however, it is important to limit the core dataset and changes to it.

The data are used for various purposes. In addition to the assessment of the results of the stress test and to determine a starting position to the central bank´s stress testing model, the data are also used in other in-house analysis of the central bank and in order to collect various data series for further development of the stress test model.

Timing and annual process

The annual stress testing process begins in November with the design of the stress scenario. The stress scenario is presented and the key points concerning the execution of the stress test are discussed at initial meetings held with the banks in January. Thereafter, a request to carry out the stress test is sent out, together with the final version of the stress scenario, guidelines and templates. The banks submit the starting position figures based on the previous year's year-end figures at the end of February. In late March, they submit the first results of the stress test, consisting of projections subject to the scenarios. The Central Bank reviews the banks' results and compares its own assessment to the banks' assessment of the impact of the stress scenario. In May, the impact of the stress scenario on the balance sheet, profit and loss account, loan losses, risk-weighted assets, and capital is discussed with the banks. The Central Bank and the participating banks then revise their assessment if necessary. The final results are presented to the banks by the

end of the summer and published in the CBI's *Financial Stability* report in October.
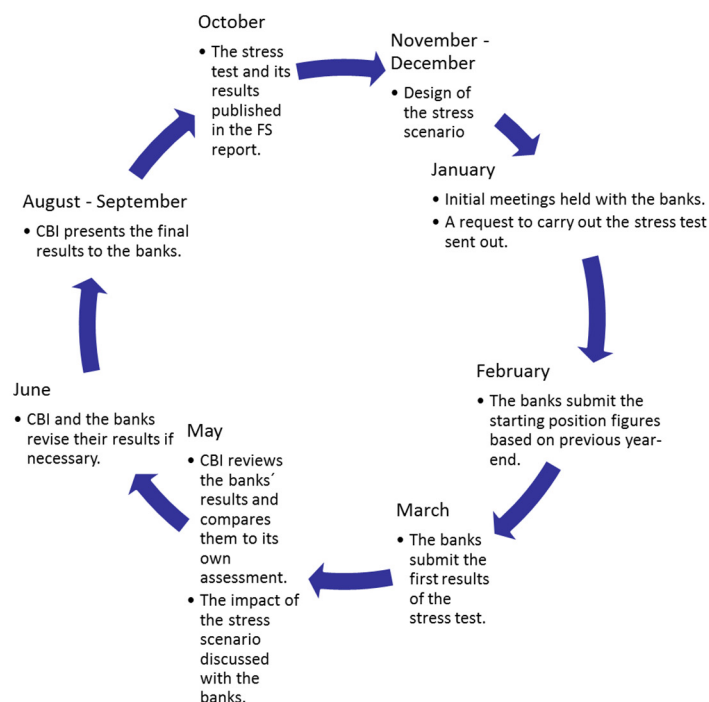

October
• The stress test and its results published in the FS report.

November - December
• Design of the stress scenario

January
• Initial meetings held with the banks.
• A request to carry out the stress test sent out.

February
• The banks submit the starting position figures based on previous year-end.

March
• The banks submit the first results of the stress test.

May
• CBI reviews the banks´ results and compares them to its own assessment.
• The impact of the stress scenario discussed with the banks.

June
• CBI and the banks revise their results if necessary.

August - September
• CBI presents the final results to the banks.

Chart 1. The timing and the annual process of the CBI's stress test.

Use of the stress test and its results

The Central Bank uses stress testing as part of its assessment of risks to financial stability, as the stress tests give indications of the banks' vulnerability to adverse developments in the economy. The stress tests provide information that is useful for the formulation of macroprudential policy and they can therefore be used as a reference when decisions are made in connection with macroprudential tools, such as capital buffers. Macroprudential policy is discussed in the Systemic Risk Committee (SRC), which then submits its analysis and propositions to the Financial Stability Council (FSC), which in turn issues recommendation for policy measures.[11] Furthermore, by the annual stress testing process the commercial banks are encouraged to keep abreast of risks and to develop their risk management tools further.

---

[11] For further information, see https://www.sedlabanki.is/fjarmalastodugleiki/thjodhagsvarud/ for information in Icelandic and https://www.cb.is/financial-stability/macroprudential-policy/ for information in English.

Box 1: The use of stress tests in formulation of macroprudential policy and setting macroprudential tools

The main objectives of macroprudential policy are to contribute to the stability of the financial system as a whole, to strengthen its resilience, and to mitigate systemic risk. In order to enforce the objectives of macroprudential policy, the authorities may apply specific macroprudential tools such as capital buffers, liquidity rules and restrictions on LTV ratios, among others. Applying macroprudential tools requires extensive analysis of the economy and the financial system, the risk that could be building up, and the financial system's resilience towards that risk.

The use of stress testing in the formulation of macroprudential policy and setting macroprudential tools, such as capital buffers, is widely discussed internationally. Stress tests can be used to assess the resilience of the banking system as a whole; they provide insight into the interactions between the banking sector and the real economy, and are useful to the decision process of macro- and microprudential policy instruments. Importantly, the stress scenario must be designed with regard to the planned use.

The European Central Bank (ECB) has endorsed the use of a single stress test that covers both micro- and macroprudential purposes. The stress test scenario should then be designed with a macroprudential focus and the results used in decision process regarding macroprudential measures for the entire system, on the one hand, and microprudential measures focused on individual financial institutions, on the other.[12] The Bank of England's (BoE) approach is to use the results of its stress tests in calibration of system-wide capital buffers, such as the countercyclical capital buffer, and bank-specific capital buffers for individual institutions.[13] The BoE first used this approach for its 2016 stress test: the stress scenario was designed in accordance with it, and capital buffers were set with reference to the impact of the stress scenario on the banking system.[14] The Federal Reserve Board (FED) is considering the use of a "stress capital buffer" which could replace the capital conservation buffer and be recalculated each year based on the results of CCAR stress tests.[15] The European Systemic Risk Board (ESRB) has also recommended that stress tests be used to calibrate macroprudential tools.[16] In Iceland, stress tests have been used in the decision process of the systemic risk buffer, applied to deposit taking institutions since 2016.

8

---

[12] See for instance, Dees et. al. (2017) and Constâncio (2015, 2016 and 2017)
[13] See Bank of England (2015)
[14] See Bank of England (2016)
[15] See Tarullo (2016)
[16] See European Systemic Risk Board (2014)

Stress scenario design

The CBI examines various stress scenarios over time. For the annual stress test, however, the CBI generally uses a single stress scenario, although additional scenarios may be added. The stress scenario is based on the CBI's analysis and assessment of current risks to financial stability in Iceland. In addition, it is generally assumed that GDP will contract substantially and unemployment will rise.[17] After the main drivers and characteristics for the stress scenario are decided, coherent time series for developments of macroeconomic variables for the scenario are obtained by simulation using the CBI's macroeconomic model. The Financial Stability Department therefore collaborates with the Economics and Monetary Policy Department on scenario design. It is to be noted that the stress scenario does not represent the Central Bank's forecast or opinion about upcoming developments, but rather an exploration of the factors that could develop in a way unfavorable to the banks' balance sheets and business plans.

The annual stress scenario is designed so that it adjusts to reflect the assumed position in the financial cycle, its severity will increase during an upward cycle and ease during a downward cycle. Various indicators are considered in the assessment of developments in the financial cycle, including developments in credit, house prices, other asset prices, and the banks' funding costs (e.g., developments in risk premia). Account is also taken of the business cycle and therefore of developments in the output gap. For instance, in a downturn the rise in unemployment would be less in the scenario. Historical developments in economic variables and previous crises as well as the frequency of downturns and their severity in Iceland are considered.

The scenario is designed with an eye to further repercussions of a shock, which could entail, for instance, an increase in the banks' funding costs and even the need to sell assets at fire sale prices. The scenario design is an iterative process where the CBI's stress testing model is used alongside the macroeconomic model while calibrating the stress scenario. Potential amplification stemming from the interaction between liquidity risk and the banks' capital position, assessed with respect to the banks' position at the time, is considered.[18] The Central Bank also keeps abreast of developments in the shadow banking system and takes into consideration the risks that could stem from it in designing the stress scenario. It should be noted, however, that the calibration of the severity of the stress scenario is always subject to assessment by Central Bank staff.

---

[17] For comparison, the scenarios used in the US Federal Reserve Bank's Comprehensive Capital Analysis and Review (CCAR) assume a steep rise in unemployment.
[18] Liquidity squeeze may, for instance, force banks to sell assets at fire sale prices, causing losses.

Box 2: The financial cycle and the severity of the stress scenario

The stress scenario for the stress test is designed so that its severity changes in respect to the assumed position at the financial cycle. As financial system risk accumulates the probability of tail events increases, making it important that the financial system is resilient enough to withstand such shocks.[19] The resilience of the banks is therefore subjected to more stringent testing during an upward phase of the financial cycle, whereas the severity of the stress scenario is eased during a downward phase. The financial cycle position is estimated based on various risk indicators such as credit growth and asset prices, as increases in these can suggest that risk is accumulating in the financial system.

An example of how asset prices may be set to develop in the stress scenario is illustrated in Chart 2: A shock is assumed to cause real house prices to fall below their long-term trend level. The decline is calibrated with reference to the last downturn in the housing market. Thus, real price movements around trend are proportionally the same, in terms of the fall from pre-crisis peak to trend level, and from trend level to trough. The delay from peak to trough is the same as in the last downturn.

Many indicators, however, are examined in the assessment of the financial cycle, and the stress scenario is designed to reflect the perceived overall situation. Indicators such as the development of house prices to wages ratio (Chart 3), house prices to disposable income ratio and household credit to disposable income ratio are considered (Chart 4). Generally, developments in financial variables in the stress scenario are determined with respect to the drivers currently prevailing in the financial cycle.

Estimating the financial cycle position is a complex task and always a matter of both statistical analysis and expert opinion. Although the financial cycle differs from the business cycle they are connected in many ways. When considering the financial cycle position, it can therefore be useful to consider overall economic activity. In Iceland, a sharp decline in exports or capital inflows has typically meant depreciation of the currency, surging inflation and declining purchasing power, followed by a large decline in demand and output. Large house price declines, in turn, tend to coincide with downturns and substantial contraction in demand.[20] However, it is not given that an upward business cycle will be accompanied by either an upward financial cycle or the accumulation of risk in the financial system.[21]

Chart 2
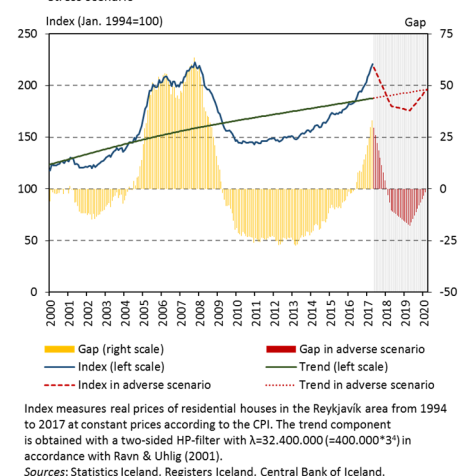Real house prices
Stress scenario

Index measures real prices of residential houses in the Reykjavík area from 1994 to 2017 at constant prices according to the CPI. The trend component is obtained with a two-sided HP-filter with λ=32.400.000 (=400.000*3⁴) in accordance with Ravn & Uhlig (2001).
Sources: Statistics Iceland, Registers Iceland, Central Bank of Iceland.

Chart 3
House prices relative to wages, construction cost and rent prices

Prices of residential housing in the Reykjavík area from 1994 to 2017 in relation to the nominal wage index, the construction cost index and the rent price index.
Sources: Statistics Iceland, Registers Iceland, Central Bank of Iceland.
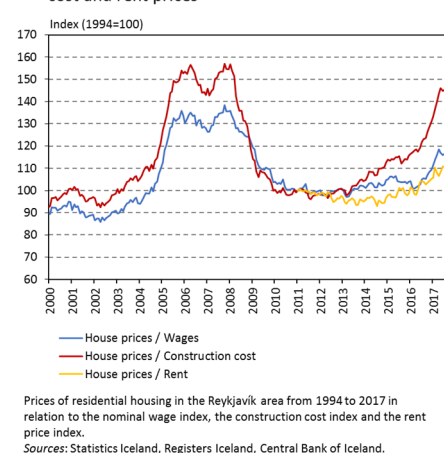
Chart 4
House prices, household debt and disposable income

Prices of residential housing in the Reykjavík area and total household debt in relation to the nominal disposable income index.

10

---
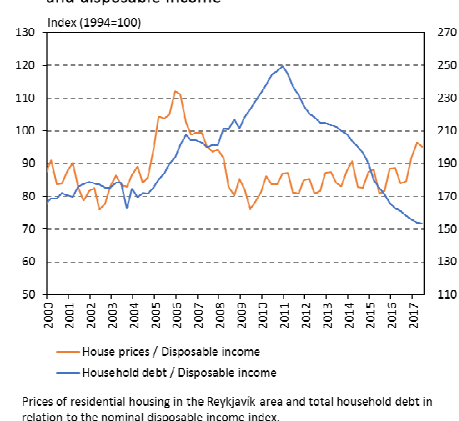
[19] See Bank of England (2015)
[20] See Einarsson *et al.* (2015)
[21] See for instance Borio (2012)

The CBI's stress testing model

In assessing the impact of the scenario, the Central Bank uses a stress testing model, including a set of sub-models, of its own devising. One of the objectives is to have a reference for the banks' assessments and to create the foundations for discussion of the impact of the scenarios on various aspects of banks' business plans. However, the Central Bank can also run independent stress tests without the involvement of the commercial banks if necessary.

Because the models and data used to estimate them are not without limitations, the final assessment of results from a stress test is also based on judgement in addition to the models and discussions with the commercial banks. The models are under continuous development.

Key aspects and assumptions of the model

The stress testing model projects the impact of macroeconomic scenarios on the balance sheet and profit and loss account, as well as risk-weighted assets and capital base, over the next three years. The model relies on sub-models and equations that are estimated for the large commercial banks and for the financial system as a whole, in terms of macroeconomic and financial variables. It also includes accounting identities that show how results from the profit and loss account affect the balance sheet, as well as estimated cash flows.
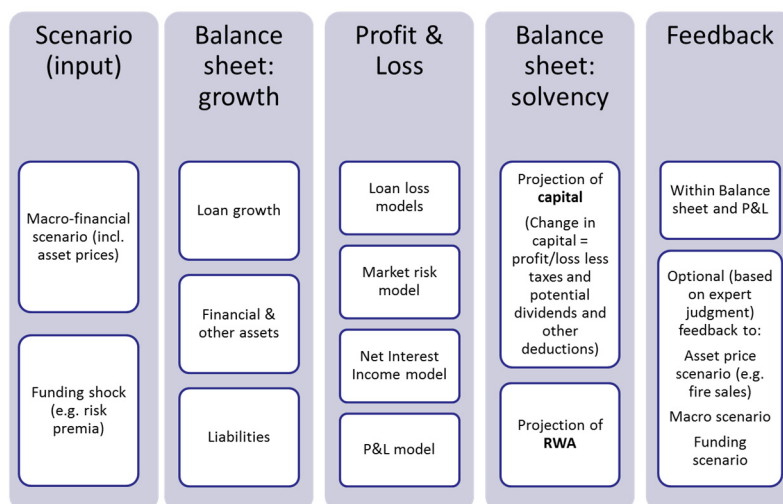
Scenario (input)	Balance sheet: growth	Profit & Loss	Balance sheet: solvency	Feedback
Macro-financial scenario (incl. asset prices)	Loan growth	Loan loss models	Projection of **capital** (Change in capital = profit/loss less taxes and potential dividends and other deductions)	Within Balance sheet and P&L
	Financial & other assets	Market risk model		Optional (based on expert judgment) feedback to:
		Net Interest Income model		Asset price scenario (e.g. fire sales)
Funding shock (e.g. risk premia)	Liabilities	P&L model	Projection of **RWA**	Macro scenario Funding scenario

Chart 5. An overview of the structure of the CBI's stress testing model.

Projections of the balance sheet and risk-weighted assets

The stress testing model forecasts developments in various balance sheet items. In the model, assets and liabilities are divided into various classes similar to the data compilation template the banks submit to the stress test (see section above entitled Data collection).

Forecasts of developments in lending are based on the assumption that the banks will grant loans in line with demand according to the scenarios, but subject to both liquidity and capital requirements. Price and exchange rate movements also affect developments in loan portfolios as well as other assets and liabilities in the model. In Iceland, inflation affects the value of indexed assets and liabilities, and exchange rate movements affect the value of foreign-denominated assets and liabilities. Forecasts concerning other assets are based on developments in economic and financial variables according to the scenarios and feedback from the profit and loss account (share of

profit/loss for the year). Developments in the liabilities side are based on developments in economic and financial variables and the banks' total assets. The balancing item in the model (which balances the total liabilities to equal total assets) is borrowings from the Central Bank. There are also equations for feedback between funding scenario and the balance sheet.

Developments in risk-weighted assets are based on the standardized approach (i.e., standard risk weights) for both credit risk and market risk.[22] Forecasts of the risk-weighted assets are therefore based largely on the projections of loan portfolios and other related assets. Other items included in risk-weighted assets are projected in terms of, for instance, developments in the banks' total assets.

Projections of the profit and loss account and loan losses
Forecasts relating to the profit and loss account are based on the projections concerning the relevant balance sheet items, including those concerning interest income and expense, net income from financial activities, net exchange rate gains, and loan impairment. The main sub-models are modules for net interest income (NII), loan loss impairment, net financial income, net fee income, and operating expense projections. There are also provisions for taxes.

The model for NII includes modules that project interest rates for various classes of assets and liabilities conditional to developments in interest rate and risk premia according to the scenarios. The equations for various interest rates are estimated for the banking system as a whole. The model then uses the projected interest rates on the projections for the relevant classes of assets and liabilities in the balance sheet in order to forecast interest income and expenses for each period.

Developments in loan losses according to the scenarios are assessed separately for corporate loans and loans to individuals. Several different models are used to forecast loan losses. In general, it is assumed that loan losses are the same as expected losses, or PD * LGD * EAD.[23] Because the Central Bank does not have data on the operations and position of each borrower, the estimate of new defaults is based on data concerning bankruptcies, non-performing loans and defaults for given loan categories.[24,25, 26] The forecast of loan losses is therefore based on an estimate of new defaults for the loan category (substitute for probability of default, or PD) and the loss ratio (substitute for loss given default, or LGD), in addition to the projections of the relevant balance sheet items (substitute for exposure at default, or EAD) in each period according to the scenario.

The selection of explanatory variables for models that are used to forecast defaults – i.e., macro-financial variables such as unemployment, GDP, the real exchange rate and disposable income – is based on economic insight,

12

---

historical correlation and significance.[27] In addition, the selected variables are restricted to the availability of forecast from the bank's quarterly macro model (QMM) used in the scenario design. Developments in losses given default, or loss ratios for a loan category, are forecast based on assumed developments in the value of collateral. The value of collateral in turn is projected based on developments of the value of the relevant assets in the given scenario.

Models that directly forecast loan impairment as a ratio of the loan portfolio are also examined, but it should be noted that developments in impairment according to the banks' accounts are always the result of decision-making, and other factors in addition to expected losses may affect how much loans are impaired in any given period.[28] Because of data limitations, it is important to base estimates of loan losses on several models together with expert assessment.

Projections of capital
The change in the banks' capital according to the model is the profit or loss for the year. In addition, any other changes in capital, such as potential dividend payments, can be adjusted if needed.

System-wide feedback, amplification, and limitations of the model
Systemic risk with feedback from one bank to others or, for example, to the securities market can amplify the impact over and above what is assumed in the stress scenario and calculated using the stress testing model. The stress testing model as such does not automatically feed back to the macro-economic model.

Developments in liquidity are estimated roughly in the model, and classification of liquid assets as well as liabilities in the model simulates the classification provided for in the Central Bank liquidity rules (LCR rules, among others).[29] The model entails a link between the funding scenario and the banks' balance sheets. It is possible to approach the potential contagion stemming from a liquidity squeeze by setting rules stipulating what will happen when a given bank's liquidity falls below the regulatory minimum. For example, it is possible to decide whether the bank will sell assets and/or cut back on lending. If one or more banks must sell assets at fire sale prices to cover liquidity shortages, it is also possible to add a further reduction in asset prices to the scenario. A similar approach can be used if the capital position of one or more banks falls close to the regulatory minimum, in which case it is also possible to assume that banks' funding costs will rise.

In general, however, attempts are made to consider potential amplification at the time the stress scenario is designed. In spite of this, the results should be interpreted with caution, as they could be underestimated. The Central Bank keeps abreast of developments in stress testing abroad, and its methods and models are under continuous development.

---

[27] Because there is a strong correlation among many macroeconomic variables, it is important to limit the number of variables in the model and take multicollinearity into account.

[28] Examples of factors that could make an impact are capital ratios, profits for the year, or changes in the management of the bank concerned. Furthermore, historical data on loan impairment during the post-crisis period in Iceland have been affected by upward value adjustments of the old loan portfolio, and there has been a significant difference between book value and claim value of loans.

[29] Liquid assets in the model are divided into categories such as cash and deposits with central banks, debt securities with regard to maturity and issuer, and liquid liabilities into deposits based on the type of holder, borrowings and securities.

Communication and publication of the stress test

Publishing stress tests and their results can enhance financial stability and discipline in the financial markets, and also enhance confidence in the banks. Transparency concerning the stress testing methodology and process can improve public understanding of risks related to the banks, and also improve policy-making, make prudential policy more effective, and enhance policy credibility. On the other hand, excessively detailed publication of financial supervisors' methodology and models could tempt the banks to mimic those models instead of developing their own. Such narrow and homogeneous model development could exacerbate risk in the financial system.[30, 31]

The Central Bank's policy is to publish its stress testing methods and criteria in this publication. The publication and its scope will be reviewed as needed, as the CBI is continuously developing its stress testing models, procedures and administration. In addition, amendments to regulatory provisions, including financial reporting rules (e.g., IFRS 9) or potential changes in the banking system architecture could affect the stress testing methodology.

Each year's stress test, including an explanation of the scenarios and the test results, are published in the autumn edition of *Financial Stability* or in a separate report. The composition and scope of information published are reviewed for each test and could therefore change over time.

---

[30] See for instance Bank of England (2015) or Yellen (2017).
[31] For a more detailed discussion of the advantages and disadvantages of stress test publication, see, for example, Goldstein and Sapra (2013).

References

Basel Committee on Banking Supervision (2004). "International Convergence of Capital Measurement and Capital Standards. A Revised Framework."
http://www.bis.org/publ/bcbs107.pdf

Basel Committee on Banking Supervision (2009). "Principles for sound stress testing practices and supervision".
http://www.bis.org/publ/bcbs155.pdf

Bank of England (2015). "The Bank of England's approach to stress testing the UK banking system".
http://www.bankofengland.co.uk/financialstability/Documents/stresstesting/2015/approach.pdf

Bank of England (2016). "Stress testing the UK banking system: 2016 results".
http://www.bankofengland.co.uk/financialstability/Documents/fpc/results301116.pdf

Board of Governors of the Federal Reserve System (2016). "Dodd-Frank Act Stress Test 2016: Supervisory Stress Test Methodology and Results".
https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20160623a1.pdf

Borio, C. (2012). "The financial cycle and macroeconomics: What have we learnt? Bank for International Settlements, *BIS Working Papers no. 395*.

Central Bank of Iceland (2012). "Iceland's currency and exchange rate policy options", *Special Publication* no. *7*.

Constâncio, V. (2015). Keynote address at the *London School of Economics Conference on "Stress Testing and Macroprudential Regulation: a Trans-Atlantic Assessment"*, London 29 October 2015.
https://www.ecb.europa.eu/press/key/date/2015/html/sp151029.en.html

Constâncio, V. (2016). Speech at the *ECB-IMF Conference on Macroprudential Policy,Frankfurt am Main*, April 26, 2016.
https://www.ecb.europa.eu/press/key/date/2016/html/sp160426.en.html

Constâncio, V. (2017) Remarks at the second *ECB Macroprudential Policy and Research Conference*, Frankfurt am Main, 11 May 2017.
https://www.ecb.europa.eu/press/key/date/2017/html/ecb.sp170511.en.html

Dees, S., Henry, H. and Martin, R. (2017). "STAMP€: Stress-Test Analytics for Macroprudential Purposes in the euro area. European Central Bank.
https://www.ecb.europa.eu/pub/pdf/other/stampe201702.en.pdf

Dent, K., Westwood, B. and Segoviano, M. (2016). "Stress testing of banks: an introduction", Bank of England, *Quarterly Bulletin 2016 Q3.*

Einarsson, B. *et al.* (2015). "The long history of financial boom-bust cycles in Iceland, Part I: Financial crises." Central Bank of Iceland, *Working Paper No. 68.*

Engelmann, B. (2013). "Macroeconomic Stress Testing", presentation at Global Association of Risk Professionals, Sidney, April 24, 2013. http://www.garp.org/media/1153030/macroeconomicstresstesting_bernd engelmann_042413.pdf

European Systemic Risk Board (2014). The ESRB Handbook on Operationalising Macro-prudential Policy in the Banking Sector. https://www.esrb.europa.eu/pub/pdf/other/140303_esrb_handbook_mp. en.pdf

FME Rules on the Capital Requirement and Risk-Weighted Assets of Financial Undertakings, no. 215/2007, with subsequent amendments.

Goldstein, I. and Sapra, H. (2013). "Should Banks' Stress Test Results be Disclosed? An Analysis of the Costs and Benefits", *Foundations and Trends® in Finance, Vol. 8, No. 1.*

Syversten et. al. (2015). "The bank model and the stress test in the 2015 Financial Stability Report", Norges Bank, *Staff Memo, No. 5.*

Tarullo, D. K. (2016). "Next Steps in the Evolution of Stress Testing", remarks at *Yale University School of Management Leaders Forum*, Yale University New Haven, Connecticut, September 26, 2016. https://www.federalreserve.gov/newsevents/speech/tarullo20160926a.ht m

Yellen, J. (2017). "Financial Stability a Decade after the Onset of the Crisis", remarks at *"Fostering a Dynamic Global Recovery,"* a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, August 25, 2017. https://www.federalreserve.gov/newsevents/speech/yellen20170825a.ht m