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## Abstract

This *Note* describes the Central Bank of Ireland’s overall approach and toolkit for assessing systemic risks in Ireland. The aim of systemic risk assessments is to identify and measure the potential for negative macro-financial outcomes (“tail risks”) to occur in the future. Evaluating the nature and magnitude of risks facing the financial system in a forward-looking, systematic manner is an important input to the setting of macroprudential policy. There are four main elements to the risk identification and assessment framework including (i) the monitoring of selected indicators, (ii) the development of analytical tools and modelling approaches, (iii) qualitative tools such as the use of surveys and engagement with stakeholders and (iv) targeted deep dives on specific topics to complement regular analysis. The risk assessment draws on these different elements to inform judgements on key risks facing the financial system in Ireland.

## 1 Introduction

The assessment of key risks and vulnerabilities facing the Irish economy and financial system is a key element of the ongoing work of the Central Bank of Ireland (the ‘Central Bank’). The aim of systemic risk assessments is to identify and measure the potential for negative macro-financial outcomes (“tail risks”) to occur in the future. Evaluating the nature and magnitude of risks facing the financial system in a forward-looking, systematic manner is an important input to the setting of macroprudential policy. Each year the Central Bank publishes two Financial Stability Reviews (FSRs) which documents its assessment of key risks and vulnerabilities over the short to medium term, whether global or domestic in nature. This *Note* briefly describes the toolkit and range of analytical approaches used by the Central Bank to inform the risk assessment of the macro-financial environment in Ireland as presented in the FSR.

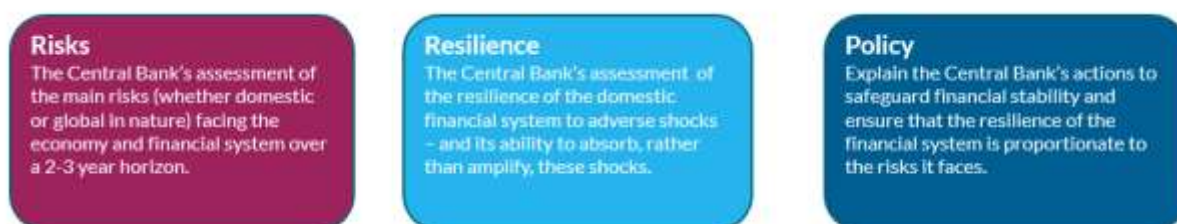
A number of international institutions such as the Financial Stability Board (FSB) and International Monetary Fund (IMF) and other central banks have presented a high-level overview of their respective toolkits and wider conceptual frameworks for monitoring financial stability risks. For

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<sup>1</sup> The views presented in this *Note* are those of the authors alone and do not necessarily represent the official views of the Central Bank of Ireland or the European System of Central Banks. Email: [niamh.hallissey@centralbank.ie](mailto:niamh.hallissey@centralbank.ie) and [neill.killeen@centralbank.ie](mailto:neill.killeen@centralbank.ie). We would like to thank Fergal McCann, Vasileios Madouros and other colleagues for comments in drafting this *Note*. Any remaining errors are our own.

example, FSB (2021) discusses the operational framework employed by the FSB to facilitate comprehensive and forward-looking assessments of vulnerabilities and risks at a global level. Similarly, Blancher et al. (2013) and IMF (2021) document the toolkit available to the IMF as part of its financial stability analysis and assessment, including for Article IV and FSAP consultations as well as the IMF's flagship Global Financial Stability Report. Other central banks, for example, the Federal Reserve in the US (see Adrian, Covitz and Liang, 2015 and Federal Reserve, 2021), have also described the toolkit used to assess risks as presented in their regular financial stability reports.

**Figure 1 Overview of Central Bank of Ireland's Financial Stability Review (FSR)**



The Central Bank has in recent years sought to develop and continuously enhance its toolkit for undertaking systemic risk assessments. As shown in Figure 1, the FSR comprises three elements including the systemic risk assessment, resilience assessment and policy actions. The FSR provides an assessment of the main risks facing the Irish financial system over the short to medium term (2-3 year horizon). The Central Bank is committed to transparency over its judgements around systemic risks facing the Irish financial system and, therefore publicly communicates its latest assessment of the risk environment in the FSR, along with its assessment of the resilience of the financial system to those risks and the policy actions it takes to safeguard financial stability. Against this background, this *Note* aims to briefly describe the toolkit underlying the first element, namely the risk assessment framework used to inform the Central Bank's judgement on key risks. It is important to note that the aim of the systemic risk assessment is not to provide an economic forecast, but instead to focus on the potential for negative outcomes (including tail risks) to materialise.

## 2 Overview of systemic risk identification and assessment framework

This section provides a high-level overview of the systemic risk identification and assessment framework used by the Central Bank. As noted in Grace, Hallissey and Woods (2015), the risk of a

systemic crisis occurring is called a systemic risk.<sup>2</sup> ESRB (2019a) defines systemic risk as “*as a risk of disruption in the financial system with the potential to have serious negative consequences for the real economy of the Union or of one or more of its Member States and for the functioning of the internal market.*” Macroprudential policies seek to reduce systemic risk and promote financial stability so that the financial system is able to absorb – rather than amplify – adverse shocks, providing financial services to households and businesses, both in good times and in bad.

Assessing systemic risk requires a well-developed risk assessment toolkit. The assessment of systemic risks can be broadly categorised according to cyclical (including real estate) and structural risks.

- Cyclical risks relate to developments in credit, asset markets (including real estate), risk-taking behaviour, the broader economic cycle and external imbalances, which are reflective of the gradual build-up of vulnerabilities in the macro-financial environment. The Central Bank monitors the evolution of the cyclical risk environment on an ongoing basis to inform policy decisions such as appropriately calibrating the CCyB rate.
- Structural risks also exist within the financial system and are independent of the financial and economic cycles. These risks stem from slower-moving features of the financial system or economy, such as market or exposure concentration, the degree of financial system interconnectedness and systemic importance, and the scope for structural macroeconomic shocks. The Central Bank assesses the structural risk environment to inform policy decisions such as the setting of buffers for systemically important institutions.

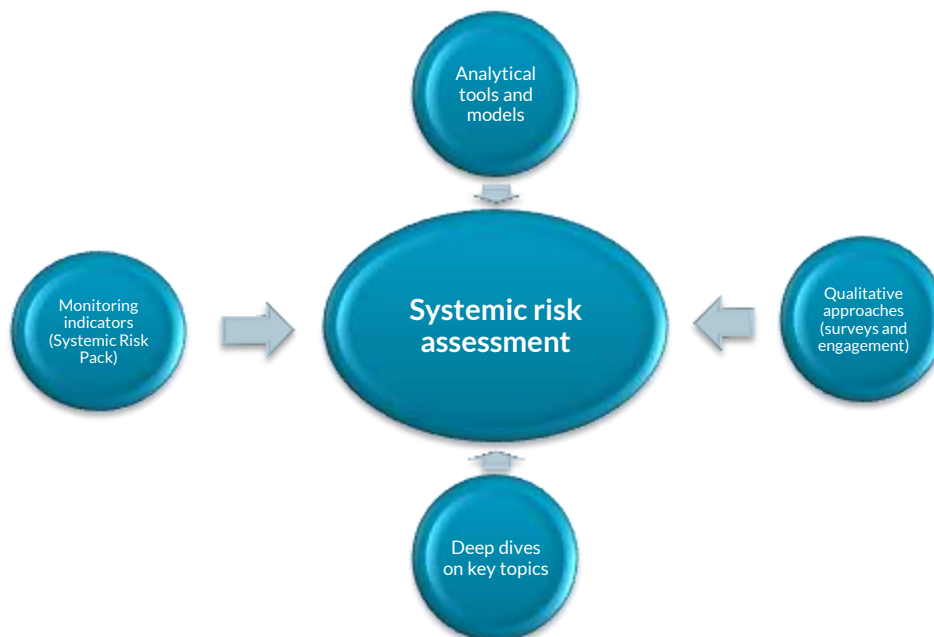
In addition, financial stability risks related to climate change and cyber risks are increasing. Reflecting their increased potential macro-financial impacts, these risks are increasingly examined in the FSR as better data and risk assessment methodologies are developed, both internationally and in Ireland. Trigger events such as the recent global pandemic (e.g. COVID-19 shock) and war (e.g. Russian invasion of Ukraine) illustrate how shocks can prompt the materialisation of risks with material macro-financial impacts.

Against this background, there are **four main** elements to the Central Bank’s toolkit for assessing systemic risks in Ireland as depicted in Figure 2 and discussed in detail in Section 3.

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<sup>2</sup> See also “[A Macroprudential Policy Framework for Ireland](#)”, 2014.

Figure 2 High-level overview of systemic risk identification and assessment toolkit



- The first element of the risk assessment toolkit is the **monitoring of selected indicators** that have historically been good leading indicators of financial system stress in Ireland and globally.
- The second element of the risk assessment toolkit is the continuous **development of analytical frameworks and modelling approaches** that allow the information from risk indicators to be combined into quantitative, forward-looking measures of downside risks.
- The third element of the risk assessment toolkit is the use of **qualitative approaches**, including surveys and discussions with stakeholders to better understand the conditions in the macro-financial environment in Ireland.
- The fourth element of the risk assessment toolkit involves **complementing the regular systemic risk analysis with “deep dives” into specific areas**, especially where structural changes in the economy or financial system might mean that historical data may give imperfect signals around the magnitude of risks.

Taken together, these four elements are used to inform judgements on the nature and magnitude of risks facing the financial system in Ireland. Given the importance of clear and transparent communication in relation to systemic risk assessment, the underlying analyses are published in Central Bank publications such as the FSR as well as Financial Stability Notes, Economic Letters or Research Technical Papers.

## 3 Systemic risk identification and assessment

Having provided an overview of the systemic risk framework employed by the Central Bank, this section describes the different elements of the systemic risk analysis toolkit in more detail.

### 3.1 Monitoring of selected indicators

The monitoring of selected systemic risk indicators that have historically acted as leading indicators of financial system stress in Ireland, as well as globally, forms the first element of the toolkit used by the Central Bank to assess risks. These indicators – which cover developments in credit markets, asset prices, macroeconomic conditions as well as the global macro-financial environment – are typically considered relative to specific thresholds. Some of these indicators are presented in the Central Bank’s Systemic Risk Pack (SRP), which is published annually and is augmented regularly as new indicators are developed and utilised. The monitoring of indicators acts as a starting point for identifying potential macro-financial developments that could point to growing or receding risks, in a consistent, systematic manner. Risk dashboards are a commonly used tool in systemic risk assessment, and are published by many central banks and European authorities.<sup>3</sup> To illustrate some of the indicators that are monitored, a snapshot of recent cyclical systemic risk levels, as reported in the SRP, is outlined in Figure 3 below.

Within the overall category of cyclical risk, there are sub-categories of indicators for each of credit risk, asset price risk, financial market risk and those relating to the wider economy. Each indicator is assigned a description, a currently reported risk level and a threshold value against which the current value for that indicator can be considered. Depending upon this analysis, a colour-coding scheme is adopted and heightened risk is reflected by various shades of amber or red risk levels. The darker the shading, the greater the distance (in a direction associated with increasing risk) between the current value and the threshold. Six month and twelve month changes in each indicator are also depicted, which aid in assessing recent trends in the risk indicator.

The monitoring of selected risk indicators, via a heatmap such as the SRP, acts as a starting point for the regular risk assessment and can be a useful cross-reference to guard against placing too much weight on particular models or analytical approaches. Moreover, the monitoring of risk indicators allows for the continuous assessment of developments over time, in a consistent and systematic manner.

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<sup>3</sup> For example, see the [European Systemic Risk Board \(ESRB\) Risk Dashboard](#) and the [European Banking Authority \(EBA\) Risk Dashboard](#).

Figure 3 Example of cyclical risk heatmap from Central Bank’s Systemic Risk Pack

Systemic Risk Heatmap						
>1.5 SDs below	>1.0 SDs below	>0.5 SDs below	Threshold	>0.5 SDs above	>1.0 SDs above	>1.5 SDs above
<b>Cyclical Risk Heatmap</b>						
Indicators	Threshold	Risk level	Last observation	Latest observation date	6 month change	Annual change
<b>Credit</b>						
Standardised credit gap	Lower threshold for CCyB setting (BCBS 2010)		-95.0pps	Jun-22	2.1 pps	4.4 pps
Private-sector credit growth	Historical average		0.6%	Sep-22	0.6 pps	1.5 pps
National credit-to-GNI* gap	Lower threshold for CCyB setting (BCBS 2010)		-41.8pps	Jun-22	3.5 pps	3.7 pps
Alternative National Specific gap	Lower threshold for CCyB setting (BCBS 2010)		0.7pps	Jun-22	1.9 pps	1.6 pps
Growth in residential mortgage drawdowns	MIP threshold		8.0%	Sep-22	-12.7 pps	-12.4 pps
Mortgage lending to disposable income	Model Benchmark (2003Q1-2018Q1)		7.1%	Mar-22	0.6 pps	0.6 pps
Household credit growth	Historical average		-1.4%	Sep-22	0.0 pps	0.1 pps
Domestic NFC credit growth	Historical average		7.3%	Sep-22	2.4 pps	5.8 pps
Irish Private Sector Enterprises: CRE credit growth	Historical average		2.9%	Jun-22	0.7 pps	-1.3 pps
Ratio of total assets to total equity	Historical average (retail banks)		10.48	Jun-22	0.26	0.15
<b>Asset prices</b>						
Residential property price growth	MIP threshold		10.8%	Sep-22	-4.3 pps	-1.7 pps
Residential property price-to-rent ratio	Historical average		19.19	Sep-22	0.2%	1.4%
Residential property price-to-income ratio	Historical average		4.67	Jun-22	0.02	0.40
Res. real estate misalignment measure	Zero		-4.0%	Jun-22	-0.5 pps	2.0 pps
Residential property price at risk	Historical average		-2.6%	Jun-22	-2.5 pps	5.0 pps
Commercial real estate price growth	Historical average		-1.6%	Sep-22	-1.5 pps	0.8 pps
CRE yields	Historical average		5.3%	Sep-22	0.2 pps	0.1 pps
CRE price misalignment measure	Zero		-17.1%	Jun-22	-2.2 pps	-4.9 pps
Commercial real estate price at risk	Historical average		-10.4%	Jun-22	0.0 pps	0.0 pps
Commercial real estate vacancy rates	Historical average		7.7%	Sep-22	0.0 pps	0.0 pps
<b>Financial markets</b>						
ISEQ 3 month MA QoQ growth	Historical average		1.0%	Nov-22	10.7 pps	-3.8 pps
EURIBOR OIS 3M Spread - 1 quarter average (bps)	Historical average		-0.2 bps	Nov-22	-8.2 bps	6.1 bps
Irish composite stress index	Historical average		17.7%	Mar-22	2.0 pps	4.2 pps
CISS euro area - 1 quarter max	Historical average		47.0%	Sep-22	0.4 pps	4.5 pps
High yield corporate bond spreads	Historical average		0.1 bps	Oct-22	0.3 bps	0.9 bps
Euro NFC spreads - 1 quarter avg (bps)	Historical average		180.5 bps	Nov-22	53.4 bps	99.2 bps
Euro financials spreads - 1 quarter avg (bps)	Historical average		197.7 bps	Aug-22	99.0 bps	118.0 bps
Euro gov spreads - 1 quarter avg (bps)	Historical average		73.0 bps	Nov-22	16.9 bps	32.6 bps
Irish gov bond spreads - monthly avg (bps)	Historical average		58.8 bps	Sep-22	46.0 bps	56.9 bps
Systemic banking crises likelihood	Historical average		2.3%	Mar-22	-25.4 pps	-32.8 pps
Dynamic delta coVaR	Historical average		5.5%	Sep-22	0.0 pps	0.0 pps
<b>Domestic macroeconomy</b>						
Employment rate	Historical average		73.5%	Jun-22	0.5 pps	4.9 pps
Unemployment rate	Historical average		4.4%	Jun-22	-0.8 pps	-2.7 pps
Domestic inflation	Historical average		8.2%	Sep-22	1.4 pps	4.4 pps
Purchasing Managers' Index (PMI)	Index = 50		52.1	Oct-22	1.1	-0.7
GNI* Growth at risk	Historical average		-4.4%	Jun-22	-0.9 pps	-0.4 pps
<b>International macroeconomy</b>						
World GDP growth	Historical average		6.0%	Dec-21		9.0 pps
Growth in global indebtedness	Historical average		9.4%	Dec-20		9.7 pps
World Trade growth	Historical average		5.3%	Aug-22	-0.9 pps	-3.1 pps
Euro area inflation	Historical average		10.6%	Oct-22	3.3 pps	6.6 pps

**Note:** The risk level column is categorised as follows: Orange, red and dark red colours highlight indicators moving in a direction associated with a build-up of systemic risk. Darker green colours will generally be associated with subdued financial system activity or the materialisation of systemic risk. As a result, light green and light yellow shades should be more indicative of benign conditions. Where appropriate the colour spectrum is inverted. Where a build-up of risks are associated with an indicator being below its threshold the heatmap is orange, red and dark red. For example relatively low bond spreads can reflect an under-pricing of risk. A grey fill is used where heatmap colour coding cannot be constructed or data are not available. The latter may be due to the length of a time series or its reporting frequency (e.g., six monthly growth rates cannot be calculated for annual series). The six month and annual change columns are coloured dark blue when an indicator is decreasing and light blue when it is increasing. The list of indicators can vary over time depending on the suitability and availability of data. Note care should be taken when interpreting indicators with a short time series or with a limited number of observations.

The primary focus of the Systemic Risk Pack is to examine the build-up of risks to the Irish financial system and its participants. For banking sector indicators, the sample of banks focuses on those institutions that interact with the Irish economy, unless otherwise specified. However, due to the nature of the indicators and the availability of data, banking samples may vary between indicators. For example, data on credit exposures are drawn from published resident statistics data available on the Central Bank’s website and include branches of foreign institutions active in Ireland. Indicators based on supervisory data reflect banks that are licenced by the Central Bank and are compiled for Irish retail banks i.e., Allied Irish Banks plc, KBC Bank Ireland plc, Permanent TSB plc, the Governor and Company of the Bank of Ireland and Ulster Bank Ireland Designated Activity Company.

The regular monitoring of a heatmap such as the SRP can also usefully inform the choice of risk topics and areas for future in-depth analysis or deep dives. For instance, if some of these risk indicators highlight increasing risks, it would prompt more in-depth analysis to understand the potential drivers and implications of these trends, including the overall judgement around the

direction and magnitude of risks. In addition to the SRP, Central Bank staff maintain an internal Global Risk Matrix for monitoring and assessing global risks which may have implications for financial stability in Ireland. Beyond their inclusion in the SRP, many of these indicators feature regularly in FSRs alongside more in-depth analysis and form part of the Central Bank's broader judgement around the evolution of the overall risk environment facing the Irish financial system.

One analytical challenge is the fact that Ireland is a small, open and highly globalised economy and therefore internationally developed statistics and risk indicators often need to be adapted or augmented to account for the structure of the economy or the financial system. This is reflected in the fact that alternative statistics and indicators are produced for Ireland as well as standard international benchmarks. For example, regarding economic output, GNI\* statistics are calculated by the Central Statistics Office (CSO) as well as standard international GDP statistics.

These analytical challenges are particularly evident in the measurement of cyclical systemic risk in Ireland. As documented in O'Brien et al. (2018), as a result of the influence of the activities of large foreign-owned multinational enterprises (MNEs) in Irish macroeconomic data, both the numerator and the denominator of the standard credit-to-GDP ratio are not reflective of the relevant factors for the domestic macro-financial environment. For these reasons, the Central Bank produces an alternative credit gap as well as the standard credit gap. These alternative data assist in assessing debt levels in the economy relative to economic output (see O'Brien and Velasco (2020)). The importance of credit gap indicators can be seen from the international academic research (see Kaminsky and Reinhart (1999), Schularick and Taylor (2012), Mian and Sufi (2010) and Aikman et al. (2019)), which show that excessive credit growth often precedes a severe economic downturn.

Contemporaneous indicators that highlight the emergence of tightening of financial conditions are also an important element of the toolkit, both as indicators in their own right but also for their signalling properties within some of the analytical models. The Central Bank has developed and refined an indicator of composite financial stress for the Irish financial system, the Irish Composite Stress Indicator or ICSI (see Parla (2021)). This indicator acts as a proxy variable for financial conditions in Ireland. The ICSI is also used as an input to a number of analytical models, including the growth-at-risk framework discussed below. Research has shown that financial conditions are important determinants of near term tail risk, from 1 to 8 quarters ahead, whereas the credit gap indicator is a useful predictor of tail risk in the medium to longer term, i.e. 8 to 16 quarters ahead.

### **3.2 Development of analytical tools and modelling approaches**

The second element is the development of the analytical and modelling toolkit to allow for combining signals from systemic risk indicators into quantitative, forward-looking measures of downside risks. One strand of modelling approaches builds on a growing literature that seeks to use current macro-financial conditions to forecast the tail of the distribution of potential future macro-

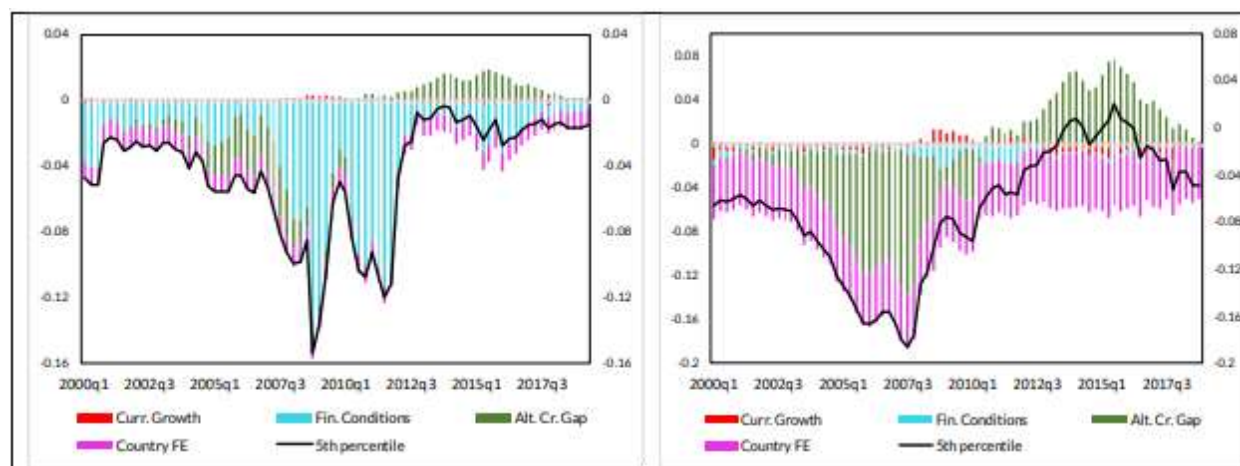


financial outcomes. For example, forward-looking quantitative measures of tail risks can be assessed for a variety of macro-financial series (e.g. GDP-at-risk). Similar toolkits include early warning models of future crises or models that seek to estimate the deviation between current developments in credit and asset prices from their trends in order to assess the magnitude of imbalances. A further approach is that of macroprudential stress testing. Macroprudential stress tests extend the traditional stress testing toolkit to incorporate the modelling of shock amplification mechanisms such as deleveraging and credit crunches. Insights from quantitative models and analytical tools are important inputs to inform judgements around the risk environment.

#### *Growth at risk and other frameworks for assessing tail risks*

The growth at risk framework proposed by Adrian et al. (2019) allows for assessing forward-looking distributions (over a term structure of up to 16 quarters) of any economic or financial system growth variable. The left tail of these distributions correspond to very weak or negative growth rates (e.g. tail risk usually represented by the 5<sup>th</sup> percentile of the growth distribution), as might happen when the economy enters into a recession, or when real estate valuations decline. Such tail events can correspond with periods of financial instability as losses are incurred.

**Figure 4 GNI\* growth-at-risk 5<sup>th</sup> percentile for Ireland – contribution of key systemic risk indicators and other determinants**



Source: O'Brien and Wosser (2021). Notes: The LHS chart shows the contribution of the explanatory variables toward Ireland's 5th percentile GNI\* forecast distributions (t+4Q ahead). The RHS chart shows their impact three years ahead (t+12Q). Y axis is GNI\* growth rate. Illustrative charts depicting tail risks, first published in O'Brien and Wosser (2021).

The Central Bank has, to date, developed three analytical models to assess growth at risk (GaR), covering GNI\* (see O'Brien and Wosser (2021)), house prices (see Central Bank (2020) and O'Brien et al. (2022)) and CRE prices (see Kennedy et al. (2021)). In each case the analytical model employs similar risk variables such as the alternative credit gap as well the ICSI described above and as depicted in Figure 4 for GNI\*.<sup>4</sup> In the case of each of the real estate at risk models, a

<sup>4</sup> An overview of the Central Bank's GNI\* at risk framework is described in O'Brien and Wosser (2021).

misalignment indicator is also included to assess the degree of overvaluation in house prices or CRE prices. One limitation of growth-at-risk models is that they do not account for structural changes occurring in the broader macro-financial environment, as they are calibrated based on the relationships evident in the historical data. This illustrates the need for targeted deep dive analytical projects to assess the impact of broader structural changes within the financial system which may not be fully captured by analytical tools or models.

In addition to the growth-at-risk models, the analytical toolkit also includes early warning models of future crises (see, O'Brien and Wosser (2018)) or models that seek to estimate the deviation between current trends in credit and asset prices from their long-term trends, to assess the magnitude of imbalances (see Kennedy et al. (2016)). Moreover, some models are used to assess the importance of particular financial institutions via delta CoVAR or marginal expected shortfalls (see Wosser (2017)). Annex 1 provides an overview of some selected analytical models used by the Central Bank for financial stability analysis.

#### *Macprudential stress testing*

A recent addition to the suite of models used by the Central Bank in assessing systemic risk is the development of a macroprudential stress testing framework for the banking sector (see FSR 2022:I and Morrell et al. (2022)) as well as the funds sector (see Fiedor and Katsoulis (2019) and Fiedor and Fragkou (2021)). A key lesson from the global financial crisis is the role played by shock amplification mechanisms (such as a sharp deleveraging and credit crunches), in addition to the direct effect of balance sheet losses in the banking sector. For the banking sector, these are important for a more holistic assessment of capital adequacy and also for understanding the real economy effects of bank behaviour in times of stress. The macroprudential stress testing model builds on the forward-looking assessment of banking resilience and acknowledges that banks adjust their balance sheets in response to adverse shocks.

Macroprudential stress tests can be used together with the growth at risk models through the development of countercyclical adverse scenarios to inform policymakers about the potential impact of shocks on the banking sector and the broader economy. The growth at risk models are an important input into the countercyclical adverse scenarios, as these models provide a benchmark for risk sensitivity in a large-scale full-narrative macro scenario. More broadly, these macroprudential stress test models used together with the growth at risk models link the assessments of systemic risk (through the adverse scenarios), with the assessment of resilience (capital adequacy under a stressed scenario) and of policy (appropriate levels of countercyclical capital). These holistic assessments of risks, resilience, and policy are an important area for future development in the analytical toolkit, as discussed further in Section 4.

### 3.3 Qualitative approaches

The third element of the systemic risk analysis toolkit is the use of qualitative approaches, including the use of surveys and engagement with a range of stakeholders so as to understand macro-financial conditions in Ireland. These surveys provide timely information on specific aspects of the economy or financial system including, for example, market participants' expectations around topics such as house prices or housing market conditions. Moreover, engagement with stakeholders through workshops and consultations as well as Central Bank staff's engagement in wider European or Eurosystem committees also provide timely qualitative information on the current risk environment both internationally and in Ireland. Workshops and conferences with public and private authorities are also used to collect information on current conditions in the macro-financial environment and key risks observed by stakeholders. In addition, a key element of the Central Bank's systemic risk toolkit involves broader engagement with supervisors to reach a judgement about the key risks being faced by the financial institutions that are supervised.

An example of how qualitative approaches are used to inform the Central Bank's risk assessment can be seen in the macroprudential mortgage measures framework. The Central Bank carries out regular reviews of the functioning of the measures. These reviews are informed by a range of indicators and data available to the Central Bank through its monitoring of the housing and mortgage markets (as published in the FSR). In addition, a range of analytical models are employed to assess the relationship between housing market variables and the broader economy. The reviews are also informed by more qualitative sources of information. Specific examples of engagement with external stakeholders include property roundtables which are set up to ensure that the Central Bank has as much information as possible on issues in the broader property market to inform macroprudential decisions.<sup>5</sup> The Central Bank, in collaboration with the Society of Chartered Surveyors Ireland (SCSI), also undertakes a regular sentiment survey, carried out amongst the SCSI membership of chartered auctioneers and estate agents. While the principal focus is on participants' house price expectations, the survey also collects information on the factors underlying these views and on their assessment regarding the level of transactional activity in the market. Such qualitative information from market participants adds to existing data and analysis and informs the assessment of developments in the Irish property market.

Qualitative information also provided a large input into the 2021-22 review of the mortgage measures framework. In July 2021, as part of this review, the Central Bank conducted an online survey where the public and other stakeholders were asked to share their views and experiences on the functioning of the mortgage measures, as well as perspectives on what a sustainable

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<sup>5</sup> For a high-level summary of a property market stakeholder engagement see, for example, Central Bank Financial Stability Review 2020:II.

mortgage markets looks like.<sup>6</sup> In addition, the Central Bank held a number of listening events with different stakeholder groups, including the property and mortgage industry, business groups, and civil society. The information gathered through these exercises was important in defining the areas of deeper focus of the framework review, as well as informing policymakers and the broader research agenda for the framework review.<sup>7</sup>

### 3.4 Complementing our regular analysis with deep dives on specific topics

The fourth element of the systemic risk analysis toolkit involves ‘deep dives’ on specific risk topics, which complement the regular risk assessments. Such deep dives occur when structural changes in the economy or financial system might mean that historical data may potentially give imperfect signals around the magnitude or scale of future risks. For example, in 2020, the Central Bank undertook a study into Irish property funds and their role within the broader CRE market in order to understand the magnitude of risks related to leverage, liquidity mismatches and interconnectedness with other parts of the domestic economy and financial system (see Daly et al. (2021)). This deep dive also employed a targeted data collection to deepen the assessment of these risks. The survey requested additional information on a range of dimensions that help inform an assessment of potential vulnerabilities in property funds, including characteristics of asset holdings and investment strategy such as the type of CRE asset, location of CRE assets, liquidity of the assets and the expected remaining life of the fund, characteristics of liability such as the liability structure, location and sector of investors of the property fund, types of covenants in place for different types of borrowing. The survey also requested information about the liquidity management tools available to the fund, the fund’s approach to stress testing and an overview of the different information that fund managers use in assessing and managing risks.

Such deep dives are particularly important in the context of a constantly evolving economy and financial system, where history might not prove a good guide to the future. The results of such deep dives are included as topical analysis in the FSR while the more comprehensive research into such topics are published as Economic Letters, Financial Stability Notes or Research Technical Papers.

## 4 Conclusion

This Note describes the Central Bank’s overall approach and toolkit for assessing systemic risks in Ireland. The aim of systemic risk assessment is to identify and measure the potential for tail risks to occur in the future. It is important to note that while insights from the systemic risks analysis toolkit are important inputs to inform overall judgements around systemic risks in Ireland, there is no mechanical mapping between the results of the suite of tools and the risks assessment. In particular,

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<sup>6</sup> See [Summary Report: Mortgage Measures Framework Review Listening and Engagement Events](#).

<sup>7</sup> See, Central Bank [Consultation Paper 146: Mortgage measures framework review](#).

expert judgement and wider stakeholder engagement are also important inputs to the overall risk assessment process.

Looking ahead, there are a number of areas where further development of the systemic risk assessment framework is anticipated. There is a continuous process underway of enhancing systemic risk indicators and augmenting the suite of modelling and empirical approaches used to assess systemic risks. In particular, the continued development of systemic risk indicators includes regularly reviewing existing indicators as well as their presentation in the SRP. A key area of focus is in the area of CRE, including addressing CRE data gaps and enhancing the understanding of the financing and ownership of CRE assets.

Another area of development over the coming years will be the extension of the macroprudential stress testing framework to sectors beyond the banking and funds sectors, incorporating interlinkages between those sectors. The potential for shocks to be amplified by interconnections between different sectors, in particular between banks and institutions involved in market-based finance, will be an important area of research over the coming years.

A further area of focus, both in Ireland and at a European level, will be the development of analytical approaches to measure whether macroprudential policies are meeting their objectives and sufficiently mitigating systemic risks. This area of research, known as macroprudential stance, aims to assess whether the macroprudential policy stance is neutral, loose, or tight. The development of a macroprudential stance framework will take time, as experience and understanding of the transmission channels and effectiveness of these policies grows, but will enhance the accountability and communication of macroprudential policymakers.<sup>8</sup> More broadly, work is also underway at enhancing the toolkit for assessing risks related to market-based finance, climate and cyber related risks and their impact on financial stability in Ireland.

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<sup>8</sup> See, for example, ESRB (2019b) and ESRB (2021).

## Annex 1: Selected analytical models and tools

Model	Description	Reference
Early warning models of financial crises	Early warning system (EWS) model - A multivariate logit model applied to a quarterly panel of 27 developed economies from the period 1980 incorporating a range of model robustness techniques to derive crisis probabilities. The specific output is the systemic banking crisis likelihood time series for OECD countries.	O'Brien, M. and Wosser, M., 2018. An Early Warning System for Systemic Banking Crises. Central Bank of Ireland - Research Technical Paper, No. 9.
GNI* Growth at Risk model	Used to assess how financial conditions and the level of financial vulnerabilities contribute to the possibility of future episodes of weak economic growth.	O'Brien, M. and Wosser, M., 2021. Growth at Risk and Financial Stability. Central Bank of Ireland, Financial Stability Notes, 2.
'An Lonn Dubh' - a macroprudential stress-testing framework for investment funds	A framework that conducts macroprudential stress testing exercises for investment funds (including money market funds).	Fiedor, P. and Katsoulis., 2019 "An Lonn Dubh: A Framework for Macroprudential Stress Testing of Investment Funds, Central Bank of Ireland, Financial Stability Notes, 2.
A Framework for Macroprudential Stress Testing	A macroprudential stress testing model of the Irish retail banks used for general resilience and macroprudential policy applications.	Morell, J., Rice, J., Shaw, F., 2022 "A Framework for Macroprudential Stress Testing" Research Technical Papers 07/RT/22, Central Bank of Ireland
Single-institution risk models and systemic financial sector risk models	Delta CoVaR methodology to measure relative contribution of Irish retail bank to Euro Stoxx 600 Banking index. Marginal Expected Shortfall to measure systemic vulnerability of Irish Retail banks to large European Banking System shock.	Wosser, M., 2017. What drives systemic bank risk in Europe - The balance sheet effect (No. 8/RT/17). Central Bank of Ireland - Research Technical Paper, No. 8.
Macro-financial linkages models	Bayesian Mixed-Frequency VAR fitted to an in-house built Financial distress index and to proxies of real economic activity and banking aggregates	Parla, F., 2021. Financial Market Turbulence and Macro-Financial Developments in Ireland: a Mixed Data Sampling (MIDAS) Approach, Research Technical Paper, No. 7.
SME Viability in the COVID-19 Recovery	A micro-simulation model of a representative sample of Irish SMEs	McCann, F, McGeever, N and Yao, F, 2021 "SME Viability in the COVID-19 Recovery", Research Technical Papers 09/RT/21, Central Bank of Ireland

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