A GUIDE TO CLIMATE TRANSITION RISK SCENARIO ANALYSIS OF MORTGAGE PORTFOLIOS

A hands-on guide for how banks and financial institutions can assess climate-related risks for the mortgage portfolio entailed in a transition to a low-carbon economy.

Copenhagen Economics
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Introduction

Scope and limitations

This document describes a straightforward approach to transition risk scenario analysis for credit risk in mortgage portfolios. The aim of the presentation is to give a set of concrete tools that can be used on an institutional level, to clearly identify the direct transition risks for mortgages.

In addition, we hope to guide the general discussion around climate risks by given a concrete example of how to analyse transition risk for a specific portfolio.

As the focus is on individual banks and institutions, we only consider direct effects from transition-induced policy action. Indirect effects with economy-wide impact, which in turn can affect financial institutions (e.g. labour market composition), are left to transition risk scenarios by supervising entities.

Analytical foundation for the study

The outlined approach is developed as part of the Energy Efficient Mortgage Initiative. The analytical foundation of the guide is the forthcoming study within that initiative: "Appropriate prudential framework for energy efficient mortgages".

Furthermore, we build on top of recent work by the Bank of International Settlements, the Task-Force on Climate-related financial Disclosures, and the Network for Greening the Financial System, but with a focus on how these risk assessment tools concretely can be applied in an institutional setting and on actual portfolios.

To make this document even more hands-on, throughout the paper, we take the average EU mortgage portfolio as an example and demonstrate how the estimations can be carried out – and what the results may look like.
EXECUTIVE SUMMARY
CLIMATE RISK ASSESSMENT USING SCENARIO ANALYSIS

Our research shows that transition risks for mortgage primarily affects collateral value, i.e. Loan-To-Value (LTV), and is less likely to be the direct root cause of credit losses. Therefore, this guide focuses on assessing impact on risk-weights.

Our starting point is a risk scenario of increasing CO2 prices, which can represent a range of transition risks.

This can then be transformed into an increase in energy costs, based on the energy composition, which leads to user costs of owning the building based on the energy efficiency. These higher costs will in turn affect collateral value, which eventually increases risk weights.

The approach can be collapsed into four steps, outlined on the right. As a fifth step, we recommend to consider the robustness of the analysis, as assumptions made along the way will have large impacts on the obtained result.

This document has two tracks. First, we describe the methodology, followed immediately by a hands-on illustration which takes the average EU mortgage portfolio as an example.

5 steps to climate transition mortgage risk assessment

1 Choose your scenario
• Consider the objectives of your analysis and define a scenario accordingly
• Estimate transition implied effects on future energy prices

2 Estimate energy costs
• Discount future incremental user costs over the entire investment horizon
• Ideally mortgage specific, alternatively portfolio-wide

3 Estimate collateral values
• Estimate the impact on collateral values from the increased energy costs
• But, if energy renovations are profitable, base the new collateral value on this instead

4 Estimate risk weights
• Update risk weights based on the collateral effect on Loss Given Default and Probability of Default
• If using the standardised method, recalculate LTV-ratio and assign to new risk buckets

5 Consider robustness
• Check sensitivity and ensure that assumptions are sound
<table>
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<tr>
<th>Scenario</th>
<th>Energy price</th>
<th>Collateral value</th>
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Climate transition risk assessment for mortgage portfolios.
METHODOLOGY
1 CHOOSE YOUR SCENARIO

Define the objectives of your analysis

Decide on the scenario for transitioning to a carbon-free economy

Estimate the impact on energy prices across the relevant energy sources

To obtain meaningful insights, the initial step to any scenario analysis is to define the objectives. What do you want to learn?

The transition to a low-carbon economy can take many paths, resulting in many types of transition risks. Do you want to assess the impact of a universal carbon tax that aligns the cost of emissions at a given level? Or is it the impact of raising costs of emissions by a fixed amount, regardless of current implicit taxation?

Decisions like this can completely alter the outcome of the scenario analysis. For instance if you take into account that in some countries, current implicit carbon taxes on e.g. heating is already so high that they are not required to increase as part of the transition.

Once your analysis objectives are in place, design a scenario for the climate transition around them.

If you simply what to analyse impact of higher costs of CO2 emissions, benchmark scenarios, such as those proposed by NGFS, may be relevant.

If you want to analyse the impact of a universal CO2 price, you would need to identify existing and implicit local or domestic carbon prices, and estimate how large the required increase would be.

Finally – as an alternative – you could construct specific risk scenarios to test for particular risks, e.g. the impact on certain sectors, or similar.

For mortgages, the relevant credit risk driver under the climate transition is energy costs. To operationalize your scenario, it should thus be converted into impact on energy prices.

This can be done at different levels of sophistication.

The minimum viable approach considers heterogeneous carbon intensities across energy sources, implying a price increase proportional to the amount of carbon emissions. To obtain more precise results, formal energy market price modelling that capture general equilibrium effects (or other indirect effects) may be called for.

1 See Copenhagen Economics (2021): Appropriate Regulatory Capital Framework for Energy Efficient Mortgages
Gather asset specific data for the portfolio, or make sensible assumptions

Forecast increase in energy costs for property owners and discount to present value

As increases in energy costs is the key driver of the portfolio impact, this step is essential to achieve a precise impact.

The first-best approach is to use building specific data on energy consumption and the sourced energy mix.

If this data is unavailable, use a sensible proxy that brings you as close to the underlying assets as possible, e.g., energy labels, heating technology and local average electricity mix.

Calculate future energy costs on a mortgage specific level by combining the energy price increases defined in your model scenario with actual energy type and usage. Then sum and discount to obtain the present value.

The forecast should be carried out over the full modelling period, which should resemble a typical mortgage investment horizon.

The calculated net present value of future energy costs would be the theoretical decrease of the collateral value in a perfect market (with complete rationality, perfect information, etc.). However, as we demonstrate in step 3, the collateral value is likely to decrease less.
We use average EU energy consumption and the “orderly transition” benchmark scenario by NGFS, which implies a linearly increasing carbon price, shown below. In other words, in this estimation, we do not consider current explicit and implicit carbon prices.

The induced impact on energy prices are calculated on the right. Other scenarios will impact energy prices differently, and you may have to estimate energy prices independently across different sources, using the energy mix from the specific region you analyse.

NGFS Scenario: Effective Carbon tax 2020-2050
EUR / ton CO2e

The above scenario is relevant for the EU average. In your organisation you might want to consider a scenario relevant for your jurisdiction. Consult step 5 on robustness checks for details.
EXAMPLE: AVERAGE EU MORTGAGE PORTFOLIO
2 ESTIMATE INCREASED ENERGY COSTS

In our case, we collapse the data to average European values across energy labels and assume an average size of 100 square meters. Then, we use a 30-year investment horizon and a discount rate of 2.6% to calculate the energy price increase. Assumptions are necessary at this stage, but they should portfolio-relevant, as well as questioned in the robustness analysis.

Since our objective was to estimate the effect on a representative European household, we reduce our model to average values across energy labels without losing nuance, as this is enough to capture heterogenous effects in our case. This is generally not possible if the objective is to assess portfolio-specific risk assessment. Aim at keeping your data as granular as possible at this stage, e.g. by doing asset specific estimations, in order to properly capture asset or asset group specific impacts in the subsequent steps.

1 See Copenhagen Economics (2021): Appropriate Regulatory Capital Framework for Energy Efficient Mortgages for justification of these assumptions under this scenario
3 ESTIMATE IMPACT ON COLLATERAL VALUES

Adjust for the fact that households do not fully price energy costs into house prices

Theoretically, the increase in user costs should decrease property values one-to-one. However, studies have found that this effect is not factored fully into the price of a property. This is, among other, due to financial myopia and illusory discounting at the time of purchase.

To combat these imperfections, adjust impact on collateral values by an appropriate “irrationality factor”. This can be region/customer type specific.

Calculate new collateral value by deducting the lowest of future energy costs or renovation costs

The impact on collateral value cannot go lower than the cost of renovating the building to a higher energy standard.

Thus, the impact is the lowest of either 1) all future, rationality-adjusted and discounted energy bill increases, or 2) the net costs of energy renovations plus the new (lower) increase in user costs. The lowest of the two is then subtracted from the current collateral value.

The renovation can both decrease energy demand (higher efficiency) or lead to lower co2 price from a new (greener) energy source.

The new, and most likely lower, collateral value represents a negative wealth effect on credit risks, which is the main risk driver for mortgage portfolios in the context of climate transition. The realized impact is considered in step 4.

Estimate the net costs of performing an energy renovation to escape energy price increases

As an alternative to bearing the increased energy costs, consider – preferably on a consumer level – whether it is profitable to perform an energy renovation that brings energy costs down permanently.

If the net costs of performing an energy renovation is smaller than the future energy costs, it is a profitable deviation to renovate the property, and the collateral value should be devalued by the net costs of the renovation, plus a now smaller increase in energy costs.

The reduction in energy costs from an energy renovation should be discounted and adjusted for irrationality in the same manner as future energy costs.
Scale the price impact from increased user costs through the energy bill by an irrationality factor to account for the fact that future costs are not fully priced into the current price. In a previous study, we estimated an average rationality factor of 58%, though heterogeneous across geography and energy labels. Deduct the irrationality-scaled price impact, or the cost of a relevant energy renovation – whichever gives the highest collateral value.

What about energy renovations in this example?

In our European average case, and for the specific scenario, the cost of relevant energy renovations exceeded the increase in energy costs for all energy labels. In other settings and scenarios, this may not be the case, in particular when looking at asset specific estimations. If the option of performing an energy renovation is not taken into account, the risk weights assessment may be upward biased.

1 See our forthcoming EeMMIP project
METHODOLOGY

4 ESTIMATE RISK WEIGHTS

Use new collateral value to update the LTV, which in turn increases the PD and LGD

The increase in Loan-to-Value ratio implies larger Loss Given Default and Probability of Default, which increases risk weights.

As the collateral values decreases, the Loan-to-Value ratio of each mortgage increases, leaving financial institutions exposed to greater credit risk on the mortgage portfolio.

The increased credit risk can be decomposed into two effects. The Loss Given Default, LGD, decreases as the collateral value decreases. Additionally, the Probability of Default, PD, increases, as the smaller equity stake leaves the debtor with less skin in the game, and thus less of an incentive to avoid defaulting on the mortgage.

Recalculate risk weights

If using the IRB approach, recalculate risk weights based on increased PD and LGD, or place mortgages into new risk buckets based on LTV, if using the Standardised Approach.

This final step to credit risk assessment should follow the approach used for the original risk assessment to ensure comparability.

Ultimately, capital ratio can be recalculated based on the updated risk weights, to arrive at the capital shortfall, i.e. impact of the scenario.
EXAMPLE: AVERAGE EU MORTGAGE PORTFOLIO

4 ESTIMATE RISK WEIGHTS

Use the current value of the loan and the new, lower collateral value, to recalculate the Loan-to-Value ratio. Then, use the new LTV-ratio to recalculate risk weights, keeping all other values constant, if using internal calculation methods. If using the Standardised Approach, recategorize assets into the appropriate risk weight bucket. Note that this approach may mute the effect, on a customer level, as only LTV-ratios relatively close to a cut-off point will be affected.

90,000
Current loan, EUR

124,800
Collateral value post-scenario, EUR

72%
Loan-to-Value ratio post-scenario

Average EU mortgage risk weight increase in our scenario

Initial risk weight: 17.3%

Higher LGD: 70 bp.
Higher LTV-ratio implies a higher LGD by definition.

Higher PD: 60 bp.
Higher LTV-ratio implies a higher PD through incentives.

New risk weight: 18.6%

90,000
Current loan, EUR

124,800
Collateral value post-scenario, EUR

72%
Loan-to-Value ratio post-scenario
When considering robustness, it is relevant to gauge both the effect of the chosen scenario, as well as the assumed asset characteristics, if non-granular data is used. In our case – as shown on the right – we found that the chosen scenario has a large effect on risk weights, as does the heating source in the household. The effect across energy label was less significant, however. These are only examples – robustness check could also consider irrationality, discount factors, etc.

Additionally, it is critical to keep geographical and political heterogeneity in mind when choosing a scenario and estimating price impact. As shown below, the chosen scenario – e.g. an increase to explicit carbon taxes – will hit very differently across EU countries due to diverse country characteristics, why analysis should be done on a carefully selected domestic level.
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