

Technical Paper

Including carbon taxation risk in Deutsche Bundesbank's In-house Credit Assessment System (ICAS): An empirical analysis

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Non-technical summary

Research Question

Carbon taxation is currently one of the most salient risks with respect to the transition to a low carbon economy for European enterprises. On 4 July 2022 the Governing Council of the European Central Bank decided amongst other actions to incorporate climate change risks into its internal rating systems by the end of 2024, based on a set of previously developed minimum standards. Although there are ample scientific studies that analyse the economic effect on a macro scale (climate stress tests etc.), there is not much literature to be found at a granular level. The present exercise aims at analysing the potential financial risks for firms resulting from a carbon intensive production conveyed through an increased tax burden. It is based on the idea of scenario analysis and uses the European Union Emissions Trading System (EU ETS) and the Bundesbank's In-house Credit Assessment System (ICAS) as a data source.

Contribution

The developed model delivers a stressed probability of default estimated at the company level on the basis of the individual financial ratios. The model can serve as a tool by updating the rating-relevant balance sheet information to a more current state and is thus helpful in the operative rating business, when political and economic developments are dynamic or include turning-points. The paper contributes to the existing literature by proposing a methodology to account for carbon taxation risk in an ICAS.

Results

This exercise shows the impact of the scenario analysis on the ratings of the companies rated by the Bundesbank's ICAS. The use of the tool in the operational rating process has already shown that it facilitates the consideration of climate related transition risks in a consistent way by the ICAS' analysts. Although the EU ETS data cannot cover all greenhouse gas emitting companies of the rated companies, most major polluters are covered, according to the principle of proportionality. The EU ETS data enable scenario analysis with reliable high quality and a focus on the single materiality. It shows that 15% of entities with national GAAP statements and 4% of IFRS groups would deteriorate their rating if they had to purchase emission allowances at the price of the scenario relevant for the current rating process.

Nichttechnische Zusammenfassung

Fragestellung

Die CO₂-Besteuerung ist derzeit eines der wichtigsten Risiken für den Übergang zu einer kohlenstoffarmen Wirtschaft für europäische Unternehmen. Am 4. Juli 2022 beschloss der EZB-Rat unter anderem, klimabezogene Risiken bis Ende 2024 in seine internen Ratingsysteme einzubeziehen, und zwar auf der Grundlage von zuvor entwickelten Mindeststandards. Zwar gibt es umfangreiche wissenschaftliche Studien, die den ökonomischen Effekt auf Makroebene analysieren (Klimastresstests etc.), auf granularer Ebene gibt es jedoch wenig Literatur. Ziel der vorliegenden Untersuchung ist es, die potenziellen finanziellen Risiken für Unternehmen zu analysieren, die aus einer immer stärker besteuerten kohlenstoffintensiven Produktion resultieren. Sie basiert auf der Idee der Szenarioanalyse und nutzt als Datenquelle das Emissionshandelssystem der Europäischen Union (EU ETS) und das In-house Credit Assessment System (ICAS) der Bundesbank.

Beitrag

Das entwickelte Modell liefert eine gestresste Ausfallwahrscheinlichkeit, die auf Unternehmensebene auf Basis der individuellen Finanzkennzahlen geschätzt wird. Das Modell kann als Tool dienen, indem es die ratingrelevanten bilanziellen Informationen auf einen aktuelleren Stand bringt. Es ist somit im operativen Ratingprozess hilfreich, wenn politische und ökonomische Entwicklungen dynamisch sind, oder Wendepunkte beinhalten. Das Papier trägt zur bestehenden Literatur bei, indem es eine Methodik zur Berücksichtigung des finanziellen Risikos aus der CO₂-Besteuerung in einem ICAS vorstellt.

Ergebnisse

Die vorliegende Untersuchung zeigt den Einfluss der Szenarioanalyse auf die Ratings der von dem ICAS der Bundesbank bewerteten Unternehmen. Der Einsatz des Tools im operativen Ratingprozess hat bereits gezeigt, dass es die konsistente Berücksichtigung klimabezogener Transitionsrisiken durch die Analystinnen und Analysten des ICAS erleichtert. Zwar können die Daten des EU ETS nicht alle Treibhausgas emittierenden Unternehmen der bewerteten Unternehmen abdecken, doch werden die meisten großen Emittenten – gemäß dem Grundsatz der Proportionalität – erfasst. Die EU ETS-Daten ermöglichen eine Szenarioanalyse mit hoher und verlässlicher Qualität und eine Fokussierung auf die single materiality. Es zeigt sich, dass 15 % der Unternehmen mit nationalen GAAP-Abschlüssen und 4 % der IFRS-Konzerne ein schlechteres Rating erhalten, wenn sie Emissionsrechte zum Preis des für den aktuellen Ratingprozess relevanten Szenarios erwerben müssen.

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Including Carbon Taxation Risk in Deutsche Bundesbank's In-house Credit Assessment System (ICAS): An Empirical Analysis

Abstract

Carbon taxation is currently one of the most salient risks with respect to the transition to a low carbon economy for European enterprises. Although there are ample scientific studies that analyse the economic effect on a macro scale (climate stress tests etc.), there is not much literature to be found at a granular level. The present exercise aims at analysing the potential financial risks resulting from a carbon intensive production conveyed through an increased tax burden. It is based on the idea of scenario analysis and uses the European Emissions Trading System (EU ETS) as a data source. The EU ETS also serves in a broader sense as a stance for the institutional framework that is assumed in the exercise.

The developed model delivers a stressed probability of default estimated at the company level on the basis of the individual financial ratios. It can serve as a tool in different ways: It can up-date the rating relevant balance sheet information to a more current state and is thus helpful in the operative rating business, when political and economic developments are dynamic or include turning-points. It can be extended beyond the EU ETS data to explore hypothetical scenarios and long term prospects, too. Carbon intensive production will very likely be in the focus of transition enforcing policy measures in the coming years. The respective enterprises will most likely be required to change their business and/or production model. So the outcome of adverse hypothetical scenarios can be interpreted as measure of the structural pressure to adapt and its impact on the creditworthiness of the company.

The paper will outline the developed methodology and present some results for German enterprises.

Keywords: carbon taxation risk, climate change risk, transition risk, (in-house) credit assessment, scenario analysis, EU ETS

JEL-Classification: E50, E58

1 Introduction

In its press release on 4 July 2022 the European Central Bank (ECB) announced that “the Governing Council of the ECB has decided to take further steps to include climate change considerations in the Eurosystem’s monetary policy framework.”¹ It decided amongst other to adapt its risk management practices; incorporating climate change risks (CCR) into its internal rating systems by the end of 2024, based on a set of previously developed minimum standards². This decision is part of an earlier announcement of the ECB’s climate action plan in July 2021.³ The internal rating systems, called In-house Credit Assessment Systems (ICASs), assess non-financial corporations’ default risk, for the purpose of using their credit claims as collateral for monetary policy operations.⁴ As one of the rating sources within the Eurosystem Collateral Assessment Framework (ECAAF), the ICAS of Deutsche Bundesbank has already started considering climate-change driven transition risks in its rating process. It makes use of an analysis tool, which allows considering the effect of carbon taxation on the default risk of affected enterprises.

Carbon taxation⁵ is currently one of the most salient risks with respect to the transition to a low carbon economy for European enterprises. The present exercise aims at analysing the potential financial risks resulting from a carbon intensive production conveyed through an increased tax burden. It is based on the idea of scenario analysis and uses the European Union Emissions Trading System (EU ETS) as a data source. The EU ETS also serves in a broader sense as a stance for the institutional framework that is assumed in the exercise.

The developed model delivers a stressed probability of default, estimated at company level, on the basis of the individual financial ratios. It can serve as a tool in different ways: It can up-date the rating relevant balance sheet information to a more current state and is thus helpful in the operative rating process. It can be extended beyond the EU ETS data to explore hypothetical scenarios and long term prospects, too. Carbon intensive production will very likely be in the focus of transition enforcing policy measures in the coming years. The respective enterprises will most likely be required to change their business and/or production model. So the outcome of adverse hypothetical scenarios can be interpreted as measure of the structural pressure to adapt, and its impact on the creditworthiness of the company.

¹ ECB. (2022). ECB takes further steps to incorporate climate change into its monetary policy operations. <https://www.ecb.europa.eu/press/pr/date/2022/html/ecb.pr220704~4f48a72462.en.html>.

² For detailed information see: Resch, F., & K rding, J. (2022). Common minimum standards for incorporating climate change risks into in-house credit assessment systems in the Eurosystem. ECB Economic Bulletin, Issue 6/2022.

³ ECB. (2021a). ECB presents action plan to include climate change considerations in its monetary policy strategy. https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1~f104919225.en.html.

⁴ Deutsche Bundesbank. (2015). The Common Credit Assessment System for assessing the eligibility of enterprises. *Monthly Report January, Vol 67*.

⁵ Note that carbon taxation includes not only CO₂ emissions in the European Union Emissions Trading System but also other greenhouse gases. The term “carbon” shall include other greenhouse gases since these are measured by means of CO₂ equivalents.

After a short overview on existing methodological challenges, the paper outlines the methodology used and presents overall results for the German enterprises that are part of the ICAS' portfolio. It also explains how the tool is included in the rating process of the Deutsche Bundesbank ICAS and to what extent it already affects the ratings.

2 Overview on Methodological Challenges

Methodologies for assessing CCR address the realization of it via different risk drivers, their financial impact and the impact on the credit risk of the company. As pointed out by the Task Force on Climate Related Financial Disclosure (2017), CCR can be distinguished in **transition risks and physical risks**. Transition risks originate when a corporation, which is highly polluting its environment, is forced to reduce its emissions⁶ by policy makers (via taxation or by means of legal measures), market participants (who may change preference for the affected products) and investors (who may not want to finance any more polluting enterprises, or who offer worse financing conditions). Enterprises can face these risks by introducing new technologies. Innovative technologies will be adopted by enterprises, at least if their costs are below the ones imposed by policy makers and market in case of inactivity. Transition risks have thus a financial impact on the costs and revenues of enterprises. They will affect their profits, their cash-flows and in the end their credit risk. Physical risks are the effects of physical impairment of assets as property damage, which manifest themselves in the long term, if no mitigation measures to cope with climate change are taken.

A common characteristic of studies on CCR consists in relying on a forward-looking approach, based on a set of assumptions.⁷ Although CCR risk exposure can already be measured by means of carbon emissions, energy or water consumption, the damage of climate change on the environment and subsequently on the economy is just starting to materialise. Traditional models assessing the significance of exposure to certain risk drivers (including high carbon emission) on the default of corporations are thus not reliable for CCR, since carbon emission driven defaults have not materialised yet. This is why current CCR analysis introduces a forward-looking hypothesis on the development of the different climate change risk drivers as policy makers', market or corporations' reactions to climate change. Since the assumptions they make in their scenarios can be very different, so are also the results of these analysis very different. The Network for Greening the Financial System (NGFS) has developed different scenarios, which are often used as a basis for the study of the impact on the financial risk of a corporation.⁸

⁶ Note: With the terms emissions and carbon emissions, we also refer to other greenhouse gas emissions. In the context of the EU ETS, the term includes emissions of the following greenhouse gases: carbon dioxide (CO₂) nitrous oxide (N₂O) and perfluorocarbons (PFCs) from certain sectors and production processes (see: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en).

⁷ See for example ECB. (2021). Climate risk stress test: SSM stress test 2022. https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm_climateriskstresstest2021~a4de107198.en.pdf and ECB. (2021b). ECB economy-wide climate stress. Occasional Paper Series, No 281.

⁸ See for example: Network for Greening the Financial System. (2021). *NGFS Climate Scenarios for central banks and supervisors*.

Moreover, when assessing CCR two aspects are being addressed. **The single and the double –materiality**: these distinguish between the environmental damage of climate change, which is born by the society, and the risk that is born by the corporation polluting its environment. As long as corporations are not forced to internalise the costs they generate, they can act further without bearing direct consequences. The single materiality only tackles the financial risks that are directly born by the assessed corporation, whereas the double materiality also considers the environmental damage for the society.

The choice of data to be used is linked to the question whether a **top-down approach or a bottom-up approach** should be preferred. In a top-down approach sectoral data are assigned to individual corporations by means of imputation and the risk is determined individually, in a bottom-up approach granular data are being used to determine individual risk and the results are then aggregated at portfolio (or macroeconomic sectoral) level. For transition risks a bottom-up approach seems to be more suitable to address a short-time horizon as in the case of ICASs (assuming a stable macroeconomic environment), whereas top-down approaches are mostly used for long-term forecast horizons. As pointed out by UNEP FI (2021), “Bottom-up approaches are generally more granular, but as uncertainties around asset and firm level data increase over the medium to long term, top-down approaches, with their sector overview, may be more credible at these longer timescales.”

Many tools and models are in use by financial market participants for modelling climate-related transition risk. The literature and research on the topic are constantly growing and the UNEP FI reports⁹ a comprehensive overview of the main providers of these tool and models and the key features of their approaches. While many of these approaches allow for **sectoral or portfolio level analysis**, ICASs require firm-level assessments. In recent years, research on climate change on firm credit risk has also been extended considerably (Kabir, Rahman, & Anwar, 2021; Capasso, Gianfrate, & Spinelli, 2020; Faralli & Ruggiero, 2022; Nguyen, Diaz-Rainey, & Kuruppuarachchi, 2023; Carbone, et al., 2021). General findings on relationships between e.g. emissions and credit risk rely in these studies on a **top-down approach**. However, since carbon emissions show a big dispersion within single sectors, such an imputation may result to be too inaccurate to be applied at the individual company level, especially in the case that, as for the Deutsche Bundesbank, corporations are to be informed about their final rating result.

Also the **rating time horizon of an ICAS** is challenging. An ICAS must robustly assess climate change risks for individual companies on a **one-year time horizon**. CCR however mostly manifests in a longer period.

External Credit Assessment Institutions (ECAIs) face similar challenges by rating individual firms and considering climate change risks. But as Ciummo, Walch & Breitenstein (2022) pointed out, it is difficult to track how they overcome these challenges, due to their limited disclosure of methodologies. Moreover, ECAI focus on large listed

⁹ UNEP FI. (2021). The Climate Risk Landscape: A Comprehensive Overview of Climate Risk Assessment Methodologies. UNEP FI. (2022). The Climate Risk Landscape: 2022 Supplement.

companies. The Bundesbank's ICAS portfolio consists also of many small and medium enterprises. Emission data and other climate risk related data is usually not available for these companies.

3 Assumptions and Limitations of the Current Analysis

This paper addresses the transition risks for non-financial corporations, concentrating on the policy risk driver of carbon taxation stemming from the EU ETS. It relies on strong assumptions, in order to reduce complexity and the multiplicity of possible results. It uses a forward-looking approach in the short term, keeping carbon emissions constant as well as other aspects of the financial statement. By means of comparative analysis it only addresses the enterprise risk directly driven by a rise in carbon tax, leaving all other parameters unchanged.

Since ICAS assess the probability of default of corporations, they have no mandate to assign a corporation a worse rating, if there are no mechanisms compelling this corporation to reduce its environmental impact. So this paper relies on the concept of single materiality. Since it chooses EU ETS allowances as an exposure measure to climate change risk, it omits considering other emission data (i.e. from the NFRD), which have not yet been explicitly taxed by policy makers or penalised by market participants. Moreover EU ETS data only address scope 1 emissions, disregarding scope 2 and 3, which may also be relevant for corporations' financial risk. In other words, EU ETS only reports direct emissions from owned or controlled sources (scope 1), thus the tool cannot give any information on risks stemming from acquired electricity, steam, heat and cooling (scope 2), or indirect carbon emissions such as supply chain effects and product emissions (scope 3).

The largest limitation of this methodology is its comparative static approach. We neither consider the reaction of the enterprises nor of the market and investors: no cost pass-through, no investments into new technologies with lower emissions are being tackled.

Also storage of allowances for speculative or inventory purposes is not considered.

Another rather obvious limitation is that the tool can only be used for those companies that operate installations that are required to participate in the EU ETS. Therefore, the EU ETS tool can only be used for a small proportion of the companies in the credit assessment system. However, the companies with EU ETS data are companies with high emissions (see chapter 4.3).

Finally, as the methodology relies on forward looking scenarios, validation of the impact of the results is still pending.

4 Data

4.1 Data Choice Rationale

The Bundesbank's ICAS has decided to use data from the EU ETS rather than Non-Financial Reporting Directive (NFRD)-reported CO₂ data within the new carbon taxation tool. However, also the NFRD-reported data has been

considered in the Bundesbank's rating qualitative process since 2021 and will still be considered under the Corporate Sustainability Reporting Directive (CSRD) when coming into force.

To assess climate change transition risks within the tool, the EU ETS data have a multitude of advantageous features in comparison to NFRD-reported data:

1. **Measurability of financial impact:** A quantitative approach requires the financial impact of a feature or variable to be measurable in Euros. This is exactly true for the EU ETS. Emissions subject to the trading system lead directly to a clear financial impact for the operator of the plant (single materiality), the resulting costs can be calculated without having to make too many assumptions. In contrast to this, emissions reported under the NFRD/CSRD do not necessarily lead to financial consequence in the short run, unless the whole emission volume is being taxed or the corresponding assets strand because of reputational problems. Using NFRD data for stressing the financial statement could imply for Bundesbank's ICAS overestimating the default probability, while mixing financial risk and political preferences. A qualitative assessment relying on analysts' expertise is carried out instead for NFRD emissions exceeding EU ETS.
2. **Data quality:** There are still data quality problems in companies' self-reported data under the NFRD. Especially calculating scope-3-emissions is a big issue for corporations. The EU ETS, on the other hand, reports data that is calculated on the basis of clear rules laid down in the EU ETS regulation and relating to clearly defined units (installations). In addition, the reported values are audited by official authorities where the reporting system has been in place for 18 years now, giving the participants time to develop standards and expertise in the matter.

4.2 European Union Emissions Trading System

In the EU ETS, every company must surrender European Union Allowances (EUA) in the amount of the previous year's measured emissions to the responsible authorities by April of the following year. The certificate is then used up and becomes invalid. One certificate entitles the holder to emit one ton of CO₂ equivalent. A company must therefore have sufficient allowances on its balance sheet to cover the past year's emissions or make appropriate provisions. Some of the allowances are allocated free of charge.¹⁰ For the remaining emissions, the company must purchase certificates on the primary or secondary market. Currently the EU ETS is in its phase 4, which began in 2021 and ends in 2030. Sectors with a high risk of relocating their production outside of the EU (so called carbon leakage risk) receive a high share of free allocated EUA.¹¹

¹⁰ Data on Emissions and Allocations are available at: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en

¹¹ For detailed information see: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/revision-phase-4-2021-2030_en

4.3 Allocation to Company or Group Units

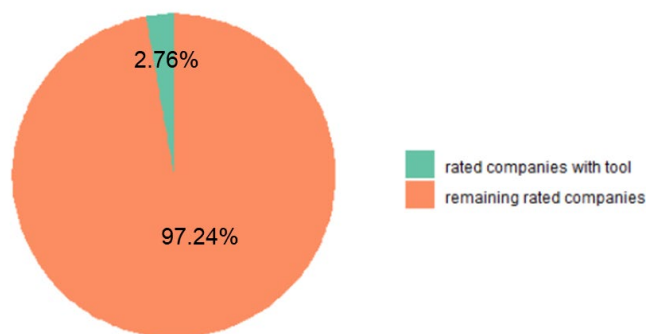
The EU ETS is based on the principle of installation units (plants). These are the objects of taxation and are assigned to the respective operator of the installation - regardless of ownership. In addition, the ICAS also creates ratings for group balance sheets, which do not represent legal entities, but have an influence on the ratings of all group entities within the rating procedure (called group framework). The registered EU ETS installations are therefore assigned to the operating company and subsequently also to the group. Due to data limitations, only plants in Germany can be assigned to the group level, thus German groups' installations that are located in other EU member states are missing in this analysis.

4.4 Coverage of EU ETS of the ICAS' Portfolio

In this chapter the financial statements of 2020 are considered, since this is the most recent year for which all financial statements are already available. For Germany, 1495 operators (i.e. corporations) are registered in the Union Registry¹². For 246 of respective companies (excluding groups), financial statements are available to BBk's ICAS and consequently the tool can be applied.

Although only a small share of corporations rated by the ICAS of BBk is part of EU ETS (Figure 1: 2.76%), their share on German corporate emissions volumina is quite important (Figure 2: 35.13%). Figure 2 illustrates the coverage of ICAS companies, for which the tool can be applied, and the general coverage of the EU ETS of the German corporate sector¹³. 35.13% of the emissions are covered by the installations of the ICAS companies. 65.22% of the emissions of the corporate sector are covered by the EU ETS. 34.78% remain uncovered by focusing on the EU ETS to account for the emissions of companies.

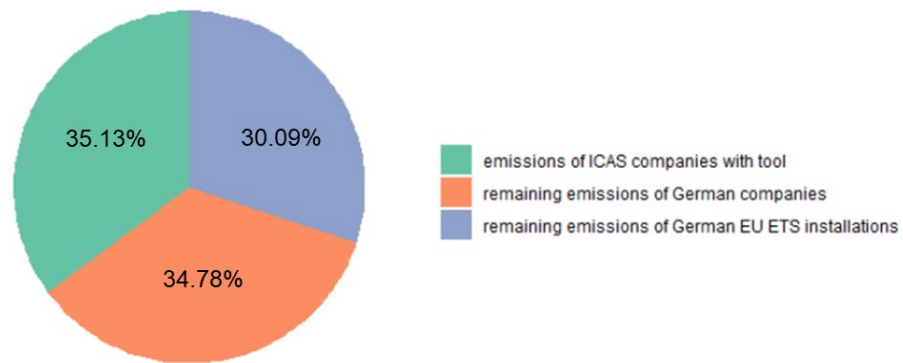
Figure 1: Distribution of Carbon Taxation Tool for ICAS Companies/Groups



¹² See List of Operators 04/2022: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en

¹³ The used estimate for the emissions of German companies is the total estimate of emissions of all NACE activities from Eurostat for 2020.

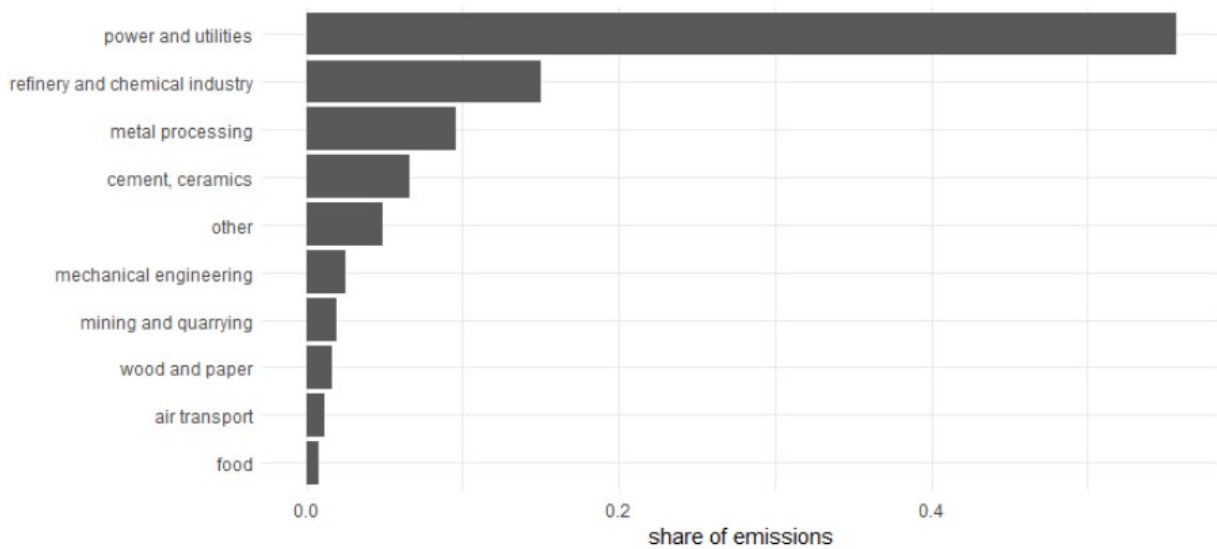
Figure 2 Coverage of Emissions of German Companies



Own representation. Source: eurostat¹⁴ and European Commission¹⁵

The emission distribution of sectors for ICAS companies with the carbon taxation tool is presented in Figure 3. More than half of the emissions stem from the power and utilities sector. Another three sectors contribute perceptibly: refinery and chemical industry, metal processing and cement and ceramics. Other industries are of minor importance.

Figure 3: Emission Distribution of Sectors of ICAS Companies with the Carbon Taxation Tool



¹⁴ https://ec.europa.eu/eurostat/databrowser/product/page/ENV_AC_AINAH_R2__custom_4942752

¹⁵ https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en

To sum-up, although only a small share of corporations rated by the ICAS of BBk is part of EU ETS, their share on German emissions volumina is of major importance. This is in line with the principle of proportionality adopted in the common minimum standards for incorporating climate change risks into in-house credit assessment systems in the Eurosystem. This requires considering at first place all corporations for which carbon emissions are mostly relevant.¹⁶ It should also be noted that, via the group framework, the results of a group's scenario analysis also have an impact on all group entities, thus enlarging the effect of the tool.

5 Methodology

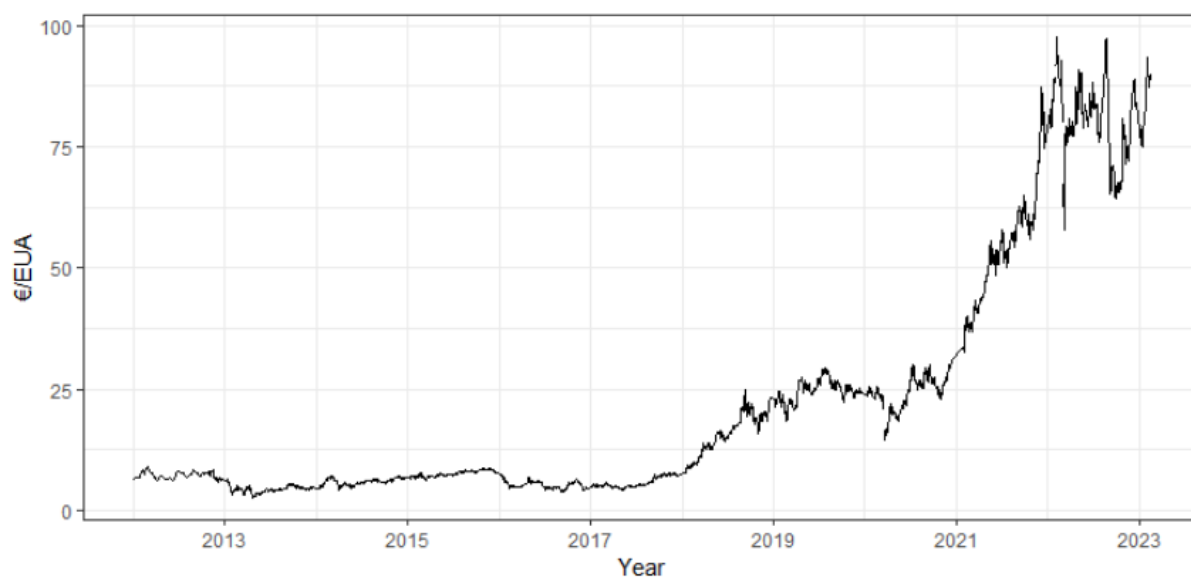
This chapter describes the idea of our methodology for quantifying the impact of carbon taxation risk on Bundesbank's ICAS ratings.

5.1 The Idea of Scenario Analysis

The tool can be understood as an add-on to more accurately capture carbon taxation induced financial stress in the statistical rating. It is based on the data of the EU ETS and reflects the effects of the actual policy measure, being currently the most relevant one at a European level. The tool output is a stressed probability of default, delivered under the assumption of a given carbon price (price for EUA) and a given regime for the allocation of free allowances. While the conventional rating is based on balance sheet data only (thus relying on historical data), the "stressed" PD can reflect more up to date developments, like the marginal impact of an increase of EUA prices (see Figure 4).

¹⁶ See: Resch, F., & Körding, J. (2022). Common minimum standards for incorporating climate change risks into in-house credit assessment systems in the Eurosystem. ECB Economic Bulletin, Issue 6/2022.

Figure 4: Spot Price Development of European Union Allowances (EUA),



Own representation, data source: EEX

In its nature, the tool is also suited to establish a quantitative measure of the financial impact under a hypothetical future scenario, for example a scenario which is aligned with the Paris climate goal of keeping global warming below 2°C from pre-industrial levels. Thinking broader, it can thus be used to give an indication of vulnerability to carbon transition risk and to structural change following from the transition to a low carbon economy. Carbon intensive production will be targeted by policy measures in the medium term with a high probability, if the Paris goals are to be reached. The relevance of carbon emission to the enterprise's business model can thus be a strong indicator for an expected pressure to adapt.

As the existing ICAS rating model is in essence a regression on balance sheet data, the new add-on enhances the rating result with respect to up-to-dateness. This is true especially in a situation of...

- a) ...a balance sheet statement that dates back a relatively long time period; this is a rather realistic assumption, seeing that financial statement data is backward looking by nature and at the time a rating is carried out, the balance sheet date may be older than one year.
- b) ...and the prices of EUA have increased significantly since the reporting period.

The price for EUA is keyed in exogenously, so market reactions on the EU ETS trade are not relevant here. The rationale of the tool is implemented in two scenarios (Table 1).

Table 1: Scenarios

	Scenario	EUA Price[EUR/t]	Share of free EUA allocation
1)	Scenario „current“: average EUA price of year after the balance sheet year (2022)	78.91	As reported

2)	Scenario „extreme“: EUA price represents vulnerability of enterprise with respect to taxation of emissions in a longer time horizon (GCAM5.3_NGFS, orderly transition, price needed 2035 to reach Paris alignment – global warming below 2°C from pre-industrial level –, region: world) ¹⁷	106.51	0%
	Average (volume-weighted) EUA price of 2021	52.92	-

The scenario choices follow from differing questions one aims to answer with the tool. Scenario 1 (“current”) reflects the approximate EUA price that will be used in the rating process. Assuming an enterprise buys the required allowances at this price in 2022, a rating issued in 2022 (which is based on a balance sheet statement of 2021 or even 2020) can thus reflect also the recent price surge in EUA prices, which is relevant for the enterprise, but with all certainty is not reflected in the currently available financial statements. Scenarios 2 tries to link the exercise to the well-known shared social pathways used in climate change modelling in international research, namely the NGFS scenarios, and displays the overall vulnerability of an enterprise with respect to taxation of emissions and to adaptation pressure in the line of business in a longer time horizon.

For these two scenarios the impact on the enterprise’s credit worthiness is simulated. The idea can be summarized in the following steps:

- (1) determine additional cost following from acquiring EUA at a higher EUA price,
- (2) make financial projection on the basis of stressed cost factors (i.e. higher expenses for EUA used as a production input), inserted into the balance sheet in the most realistic way possible,¹⁸
- (3) use stressed balance sheet as a basis for a new rating.
- (4) In calculating the financial projection, it is assumed that other values (for example selling price and demand for the product) stay unchanged.

The calculated stressed rating is provided to rating experts with a downgrade suggestion in the manual part of the rating process, namely the expert analysis.

5.2 Stressing the Financial Statement

This chapter illustrates how the financial statements are stressed using an abstract of the income statement (Table 3) and balance sheet (Table 4 and Table 5).

¹⁷ The scenario was retrieved from: <https://data.ene.iiasa.ac.at/ngfs>

¹⁸ Accounting transactions are recorded, according to the relevant book keeping standards.

The additional costs are calculated as the difference between the expected costs for EUAs at a given price under a selected scenario and the estimated included costs.

$$\begin{aligned} C_{add} &= C_{sc} - C_{est} \\ &= (Q_{rep} - Q_{free_sc}) * P_{sc} - (Q_{rep} - Q_{free_hist}) * P_{hist} \end{aligned}$$

Table 2: Positions for calculating the additional costs

C_{add}	Additional costs due to increased EUA price
C_{sc}	EUA costs under scenario assumptions for the price and for free allocation
C_{est}	Estimate of costs for EUA included in the balance based on the amount of reported emissions in the EU ETS and historical average prices
Q_{rep}	Reported emissions according to EU ETS
Q_{free}	Quantity of allowances allocated free of charge under scenario assumptions (sc) and historically (hist)
P_{sc}	Scenario price assumption
P_{hist}	Historical average price (volume-weighted) based on primary market prices on Leipzig EEX

The additional costs must be financed. Here, it is assumed that the available cash and cash equivalents will be used first (F_{cash}). When these have been used up, a short-term bank liability is taken (F_{bank}). As the interest burden on debt is an important indicator for the rating process, the interest expenses are also adjusted

$$C_{interest} = F_{bank} * \left(\frac{\text{interest expense}}{\text{respective liabilities}} \right).$$

The additional costs reduce the profit. From a reduced profit, we derive a reduced tax burden as follows

$$S_{tax} = (C_{add} + C_{interest}) * t.$$

To calculate the tax rate t , we use the ratio of income tax expense and profit before tax of the reported values. We use several checks to ensure that no implausible values are used.

The profit after tax is lowered (P_{adj}) due to the additional cost for emission allowances and the additional interest expenses. The reduced profit must in turn be taken into account on the liabilities side of the balance sheet under the item retained earnings. The last adjustment that has to be made concerns the provisions:

Since the EUA have to be surrendered to the national emissions trading office only in April of the following year, the emission allowances remain on the balance sheet under the item inventories as of the balance sheet date at the end of the year. However, as greenhouse gases were emitted and obligations to surrender emission allowances arose as a result, a provision is booked for these obligations.

Table 3: Adjustments Income Statement

Income statement (expense of sales method)	adjustment
+ revenue	
- cost of sales	+ C_{add}
= gross profit on sales	
...	
= profit (loss) from operating activities (EBIT)	
...	
- finance costs	
of which interest expense	+ $C_{interest}$
...	
= net financial result	
...	
= profit (loss) before tax	
- income tax expense	- S_{tax}
= profit (loss) after tax from continuing operations	

Table 4: Adjustments Assets

Assets	adjustment
= assets, non-current, total	
...	
= assets, current, total	
of which inventories	+ C_{add}
cash and cash equivalents	- F_{cash}
...	
= assets, total	

Table 5: Adjustments Equity and Liabilities

Equity and Liabilities	adjustments
= equity	
+/- retained earnings	- P_{adj}
...	
= liabilities, total	
= liabilities, non-current, total	
...	
= liabilities, current, total	
other provisions, current	+ C_{add} - S_{tax}
interest-bearing borrowings, current	
of which borrowings from financial institutions	+ F_{bank} + $C_{interest}$
...	
= equity and liabilities, total	

The stressed financial statement is used to calculate a stressed rating. For more information on the rating process of the Bundesbank's ICAS see (Auria, et al., 2021; Deutsche Bundesbank, 2015).

6 Results

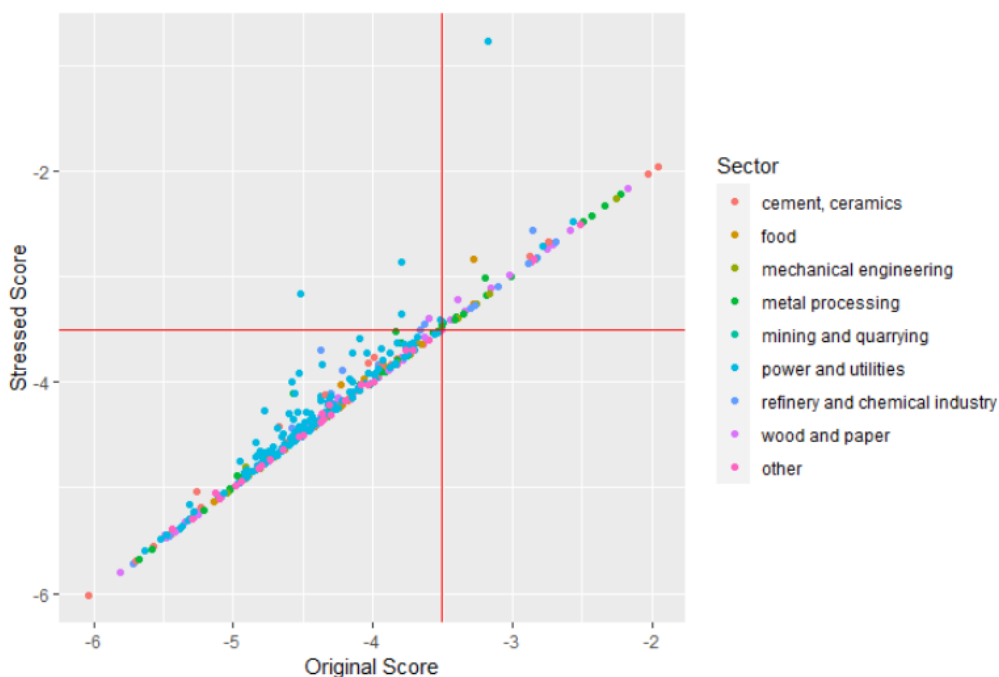
All calculations were made on the basis of the annual financial statements for 2021. Some financial statements have not yet been submitted for that year at the time of the exercise (January 2023). Hence, the number of ICAS companies, which have to participate in the EU ETS, will slightly increase in the next few months. 377 national generally accepted accounting principles (GAAP) statements were examined, of which 27 companies do not belong to a group, 133 are subsidiaries, 67 parent companies and 150 groups (including subgroups). 91 IFRS group statements are considered.

6.1 Rating Migration

Assuming that an enterprise has to buy its allowances in 2022 at an average EUA price of 78.91 EUR, 15% of enterprises with a national GAAP statements would be downgraded by at least one notch (Figure 5). Only a few enterprises' ratings move from the investment grade region to the non-investment grade region (see comment on figures).

Comment on figures: The score is a Probit transformation of the probability of default (PD). The solid red line depicts the threshold to investment grade. Thus, all enterprises located in the upper left quadrant will move from investment grade to non-investment grade within the rating scale.

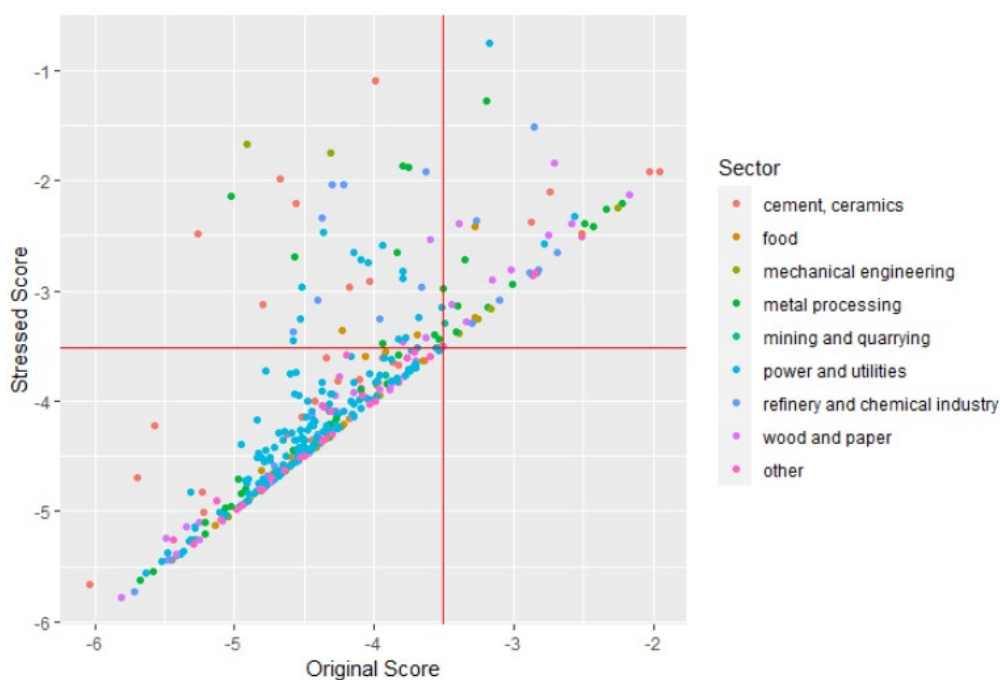
Figure 5: Rating migration for national GAAP statements (current scenario)



No rating migration	Downgrade in notches ≥ 1	Downgrade in notches ≥ 2
85%	15%	2%

Considering the extreme scenario, 40% of companies are downgraded at least one notch (Figure 6). Significantly more enterprises than in the current scenario become non-investment grade in the extreme scenario.

Figure 6: Rating migration for national GAAP statements (extreme scenario)



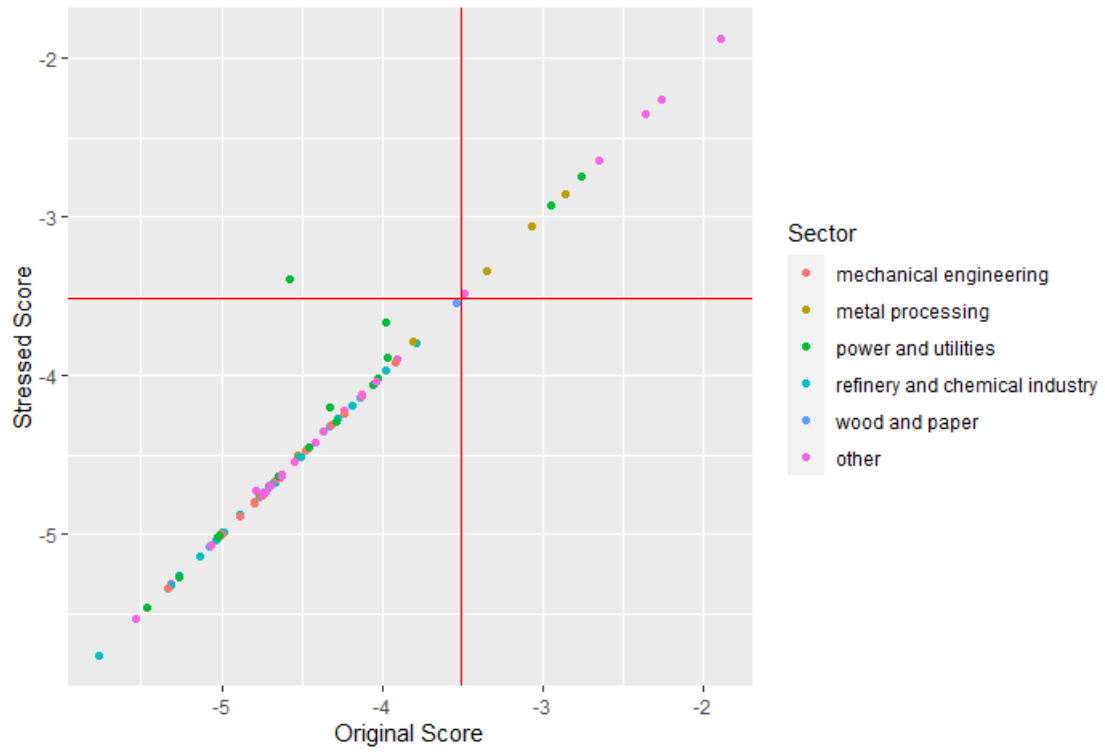
No rating migration	Downgrade in notches ≥ 1	Downgrade in notches ≥ 2
60%	40%	15%

Looking at IFRS group statements results are much less pronounced (Figure 7).

Here, the rating migration is examined on basis of aggregated EU ETS data from all German companies of that group.¹⁹ There are no strong effects of a higher EUA price. A possible explanation is that large groups are highly diversified in their business activities. Even if some enterprises have a carbon intensive production, this is outweighed by a large number of affiliates who do not.

¹⁹ Due limited data on the EU-wide structure of German groups, only German parents and subsidiaries are considered.

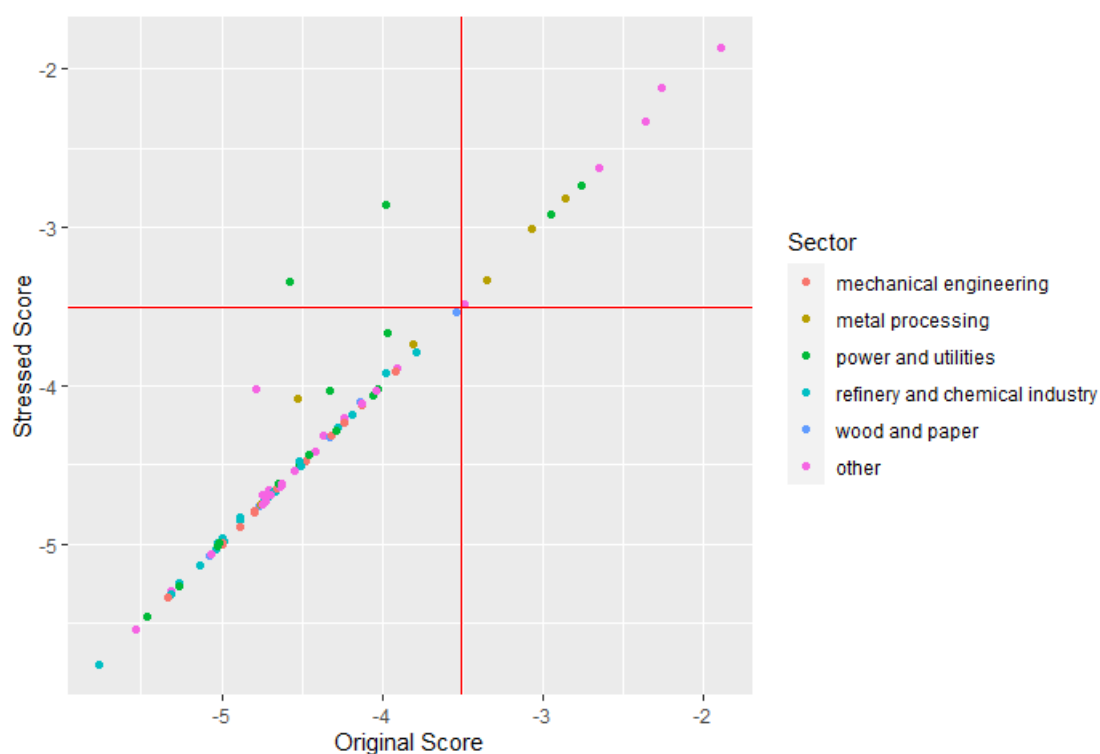
Figure 7: Rating migration for IFRS statements (current scenario)



No rating migration	Downgrade in notches ≥ 1	Downgrade in notches ≥ 2
96%	4%	1%

In the extreme scenario, 9% of IFRS enterprises are downgraded by at least one notch (Figure 8). Two enterprises move from investment grade to non-investment grade.

Figure 8: Rating migration for IFRS statements (extreme scenario)



No rating migration	Downgrade in notches ≥ 1	Downgrade in notches ≥ 2
91%	9%	3%

In summary, it can be concluded that in the extreme scenario, individual companies and smaller groups (national GAAP) have to accept significant downgrades. In the "current" scenario, the effects on the probability of default are only moderate. The ratings of mainly large groups (IFRS), on the other hand, remain largely unchanged in both scenarios. The additional costs incurred for the German plants are too low in relation to the complete group.

6.2 Using Self-Reported Emission Data for IFRS Groups

Since data for installations outside Germany are missing in the approach with the EU ETS data, we repeat the exercise with self-reported data for IFRS groups. The data constraint is especially relevant for IFRS groups, due to their international character; moreover the availability of self-reported data is sufficient. Again, we use financial statements of 2021 and the average EUA price for 2022. We use financial statements of 257 groups. We assume that the cost per ton CO₂ that is already considered in the financial statement, is the average EUA price of 2021. This additional cost stemming from the scenario analysis is thus the difference between the average prices of the two years. The emission data are the ones reported by the groups and collected by the Bundesbank ICAS. In this exercise Scope 1 data was used. The results in Figure 9 demonstrate that a larger share of groups is downgraded. Please take into account that the considered groups are not the same as in the previous exercise.

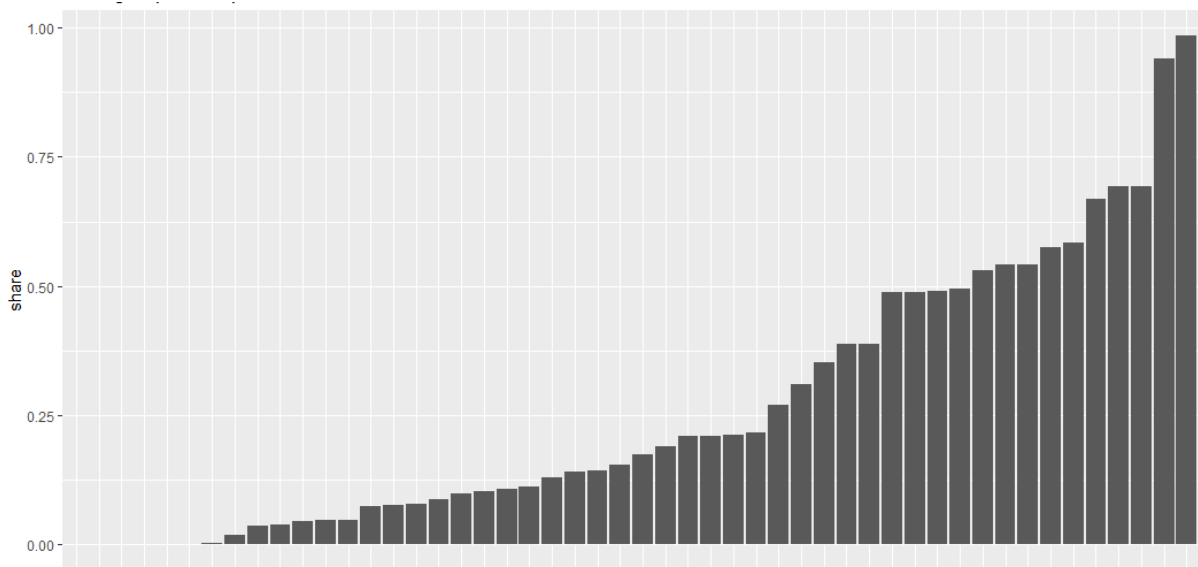
Figure 9: Rating migration for IFRS statements (current scenario) using self-reported data



No rating migration	Downgrade in notches ≥ 1	Downgrade in notches ≥ 2
83%	17%	11%

The intersection of groups for which we have self-reported data and EU ETS data (50 groups) allows us to compare the relation of EU ETS emissions to self-reported emissions. Figure 10 shows that for most of the groups the volume of EU ETS emissions are less than half of the volume of self-reported data. One reasons for the discrepancy is that we only capture EU ETS emissions of installations in Germany. Another reason is that not all emissions of a group are subject to the EU ETS. In the self-reported data there are untaxed emissions in the EU, or there are emissions taxed or untaxed outside the EU. Thus, by choosing this approach we may depart from the principle of the single materiality.

Figure 10: Share EU ETS emissions of self-reported emissions



6.3 Consideration in the Rating Process

The Bundesbank’s ICAS rating process consists of a quantitative and a qualitative stage. First, a statistical model that produces the statistical rating is applied. In a second step, the rating analyst typically confirms or overrules the statistical rating by means of up to 5 notches up- or downgrade and comes to a final rating. The expert analysis takes into account additional quantitative and qualitative information not already considered in the statistical model, because of its qualitative or not standardized nature. Here, the stressed rating resulting from the CCR scenario analysis is displayed to the analyst. In the current version, the tool contribution can only result in a conservative downgrade. The analyst then decides whether the stressed rating finally leads to a downgrade notch in the expert analysis or is disregarded. Information that is not considered in the tool, like cost-pass through, new technologies reducing carbon emissions in the short term-future, or hedging against higher EUA prices, is to be considered heuristically and may lead to disregard a downgrade. The tool has been implemented in the rating process in July 2022. Although the tool has already led to downgrades of affected corporations, validation of the tool performance is still pending in the near future.

7 Outlook

The assumption that costs are not passed through to the customer in the short term makes the model too conservative. In the future, the model could be expanded by considering cost pass-through. Cludius, de Bruyn, Schumacher & Vergeer (2020) did an ex-post investigation of cost pass-through in the EU ETS. However, it is questionable whether their results can be applied to the operational rating process. Another possible improvement is to take the investment in lower-emission technologies and hedging of the companies against rising prices into account. On the other hand, missing an analysis of the effect of high carbon emissions on financing costs as well as of changes in consumers’ preferences, leading to stranded assets, may imply underestimate risk. Integrating these effects into the model is however more complicated, since it requires a macroeconomic model as well as strong assumptions.

8 Summary and Conclusion

The methodology for quantifying the impact of carbon taxation risk on Bundesbank's ICAS ratings enables the analysts to assess financial risks stemming from higher prices for emission allowances. This exercise shows the impact of the scenario analysis on the ratings of the companies rated by the Bundesbank's ICAS. The use of the tool in the operational rating process has already shown that it facilitates the consideration of climate related transition risks in a consistent way by the analysts. Although the EU ETS data cannot cover all greenhouse gas emitting companies of the rated companies, most major polluters are covered, according to the principle of proportionality. The EU ETS data enable scenario analysis with reliable high quality and a focus on the single materiality. It shows that 15% of entities with national GAAP statements and 4% of IFRS groups would deteriorate their rating if they had to purchase EUA at the price of the scenario relevant for the current rating process.

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