Terra Methodology Refinement: A Proposal of New Methodologies to Measure the Performance of Cement, and Automotive Sectors

Halyn Cho (s2026481)

Faculty of Behavioural, Management, and Social Sciences

University of Twente

First supervisor: Dr. Marcos Machado

Second supervisor: Dr. Patricia Rogetzer

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Management Summary

Introduction

As a member of the Net-Zero Banking Alliance (NZBA), ING is adopting the so-called Terra approach towards net-zero goals in the most carbon intensive parts of its portfolio. The measurement methodology of the Terra approach is currently based on outstanding. Hence, it makes difficult for ING to steer its portfolio towards the net-zero goals since it fluctuates from year to year. Therefore, the aim of the research is to analyse alternative metrics such as EAD and lending limit for stability and feasibility.

Analysis

Portfolio emission intensity analysis, consisting of the portfolio size, year-to-year composition, and breakdown of the portfolio analyses, showed different results in each sector. In the cement sector, the portfolio emission intensity measured in outstanding is the highest and lending limit is the lowest. Also, the portfolio composition in outstanding is more stable than lending limit and EAD. On the one hand, in the automotive sector, portfolio emission intensity measured is the highest, and generally lending limit is lower than EAD except for 2019. In addition, the portfolio compositions are similar in terms of outstanding, EAD, and lending limit.

Conclusions and Recommendations

Based on the analysis, it is recommended to use lending limit as a measurement metric. Unlike outstanding, it is not influenced by changes in clients' funding requirements. Also, it makes ING to effectively control and take actions by showing concrete steps by ING to meet the target.

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1 Introduction

As a bank, one of the ways ING can make a positive impact on climate action is through its financing. ING is aiming to steer the most carbon-intensive parts of its portfolio towards reaching net zero by 2050 and this is called the Terra approach. To accomplish that, the company is focusing on parts of the sectors in its loan book that are responsible for most greenhouse gas emissions so-called Terra sectors: power generation, fossil fuels, automotive, shipping, aviation, steel, cement, residential mortgages, and commercial real estate. Hence, ING is measuring whether its lending in scope in each sector is adding up to contribute to achieving net-zero greenhouse gas emissions by 2050. For these measurements, ING uses sector-specific metrics, mostly emission intensity such as CO_2 per ton of steel produced and CO_2 per driven kilometres. The performance of ING clients in the Terra sectors is measured and then aggregated at portfolio level via an outstanding weighted average. However, using outstanding is a problem for the company in terms of stability and volatility to measure the progress. Hence, Exposure at Default (EAD) and lending limits are other parameters that can be tested to substitute outstanding on measuring Terra sectors including the cement and automotive sectors, while the bank can better control the emission intensities of companies in different sectors. Therefore, the aim of this research is to compare stability among outstanding, exposure at default (EAD) and lending limit to check which method is better to check the progress of the Terra approach and suggest implementation based on the analysis.

1.1 Problem Description and Problem Cluster

To measure the progress of the Terra approach, ING is using outstanding. Outstanding is the money that the company is drawing from ING, so it depends on the needs of the company and clients. Hence, it can lead to rapid fluctuations and large swings in the portfolio emission intensity because it is volatile, which makes it difficult to accurately measure the progress over time. Hence, the measurement of the norm and reality of the problem is described in Table 1.

Table 1. The Norm and the Reality of the Current Measurement Methodology (Kahneman & Miller, 1986)

Problem	Norm	Reality
Outstanding is volatile and unstable.	The measurement method should be not dependent on other factors that ING cannot control.	The measurement method can be selected based on comparative analysis of different metrics to find the most stable and predictable metric.
The current measurement method makes it difficult to accurately measure progress over time.	The measurement method should provide accurate emission intensity over time so that the changes of the emission intensity can be explained clearly.	The current measurement uses the simplest calculation method, so it is convenient. Due to this, the current methodology can be adapted.

Based on the identified gap between the norm and the reality, it is possible to see that the gap is mainly caused by instability and fluctuations. Figure 1, which is the problem cluster, shows that the arrow goes from the cause to the effect. The use of outstanding was identified to be the core problem because it forms the basis of the potential impact to the company and individuals. In addition, the difficulty of accurately measuring the progress over time was chosen as an action problem because it is approached through the core problem.

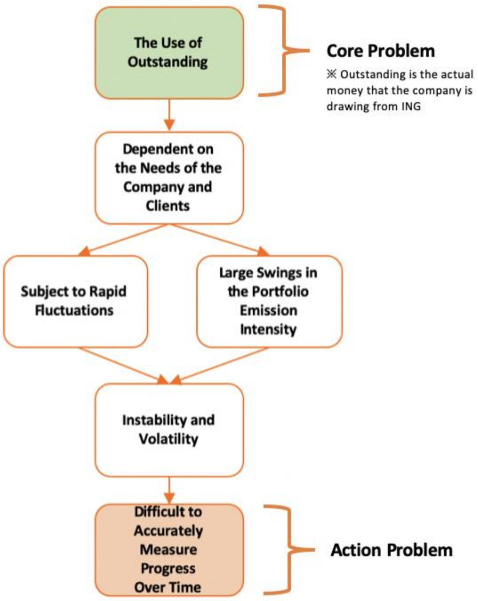

Figure 1. The Problem Cluster

1.2 Knowledge Problems and Research Question

On the one hand, Thalén (2023) claimed that knowledge problems are formulated to explore and obtain knowledges related to the research context. On the other hand, Suarez and Setoguchi (2021) argued that the research question is made to solve the real-world problem by applying the knowledge gained from the knowledge problems. Based on the problem cluster in Figure 1, the aim of this research, which derives from the action problem, is to analyse the current measurement method for the Terra approach, analyse other measurement metrics, and suggest recommendations with the method that is suitable for checking the progress of the Terra approach based on the analysis. Thus, the knowledge problems based on the aim of the research are presented below.

i. How can banks manage climate risks?
ii. How can banks make a positive impact on the environment through green financing?

Based on the knowledge problems, the main research question can be formulated to highlight the importance on the analysis of the current situation and other metrics. The main research question of this thesis is **'What are the impacts of keep tracking of the Terra approach using emission intensity based on outstanding, exposure at default (EAD), and lending limit?'**.

1.3 Problem Solving Approach

In order to tackle the problem presented in Section 1.1, we first analyse the current situation. We explain why measuring the progress using outstanding can be a problem for the company. Second, we will study why EAD and lending limit as candidates to be used as alternative metrics. Third, we extract the historical data of companies in each sector including the name of companies and their outstanding, exposure at default (EAD), and lending limit over the years from the wholesale banking data and loan book data files, which are internal data of ING. Fourth, we calculate the emission intensity of the portfolio using outstanding, EAD, and lending limits. In addition, we analyse the volatility and changes in the portfolio based on the portfolio emission intensity that is calculated by each method. We will use different types of the graphs to analyse the breakdown of the portfolio based on outstanding, EAD, and lending limit. In this step, volatility refers to stability[1]. Thus, we will check if the emission intensity is

[1] See Prioritising stability in a volatile market (2021), especially page 1, for more information on this theory.

consistent over the years and the portfolio is stable. Fifth, we will compare results and analyse what financial number can estimate the portfolio emission intensity the best. Based on the five steps of analysis, a conclusion will be formulated regarding whether to keep using outstanding or switch the approach to the alternative method should be considered and suggestions will be made to improve the measurement method of the Terra approach.

Based on the approaches to solve the problem, some of the deliverables of this study are, but are not limited to, below.

i. Data analysis of portfolio emission intensity using outstanding, EAD, and lending limit from 2018 to 2021.
ii. Comparative analysis of outstanding, EAD, and lending limit by checking changes in portfolios of each year.
iii. Analysis of volatility and changes in the lines in the portfolio if exposure at default (EAD) and lending limits are used.
iv. Decision and suggestions on what method should be used to measure progress of Terra approach.

The remainder of this thesis is organised as follows: Chapter 2 contains a literature review, Chapter 3 presents research and statistical methods that will be used for the thesis, Chapter 4 discusses results based on the analysis of each sector, and finally Chapter 5 concludes the study, presenting its limitations and suggesting future research.

1.4 Summary

In summary, ING is using outstanding for tracking the emission intensities of its portfolios. However, outstanding is volatile and unstable so it makes difficult for ING to steer its portfolios towards the net zero goal since it fluctuates. Therefore, the alternative metrics such as EAD and lending limit will be analysed to check whether they can be used instead of outstanding. We will analyse the portfolio emission intensities using outstanding, EAD, and lending limit and conduct comparative analysis of outstanding, EAD, and lending limit by checking changes in portfolios. The decisions and suggestions will be made based on the analysis and literature review.

2 Literature Review

The knowledge questions are formulated in the way that there is a clear link between the areas of knowledge and real-life situations. Thus, by applying the knowledges to the real-life situation, it is possible to have a foundation for the research question to understand better about the current measurement methodology and potential problem of the Terra approach. Through the systematic literature, we will analyse how banks can manage climate risk and how banks can make a positive impact on the environment based on green financing. The knowledge questions aim to explore the relationship between financing to achieve green development and emission intensity and what it means for the bank to analyse the emission intensity in terms of going towards the achievement of the Paris Agreement[2], which aims to cut the greenhouse gas emissions to limit the global temperature increase. In addition, we will analyse the impacts of using different metrics, which are outstanding, EAD, and lending limit for the calculation of the emission intensity. The findings that have significant risk of bias and outdated sources will be excluded to have accuracy and high quality. Thus, academic databases such as Web of Science[3] are used to avoid biased information and sources that are published in the last five years are used to increase accuracy and current relevance.

In terms of the search phase, Web of Science is known for having depth of scientific citations, research and analysis tools to provide relevant and up to date data. Thus, Web of Science will be used to analyse the latest research. Also, Web of Science covers the wide range of fields including financial industry and provides search operators. Therefore, for this systematic literature review, Web of Science is used to explore relevant literature using advanced search.

2.1 How Banks can Manage Climate Risks

The keywords that are included in the review can be defined as climate risks in banks and managing climate risks. For the search terms, “Climate risk”, “Bank”, “Manage” will be used. The search terms will be combined with the Boolean “AND” operator in the search field. Based on the search terms, the structure of the search query was formulated as “Climate risk” ANG “Bank” AND “Manage”.

[2] See The Paris Agreement (2021) for more information on its definition.
[3] https://www.webofscience.com/

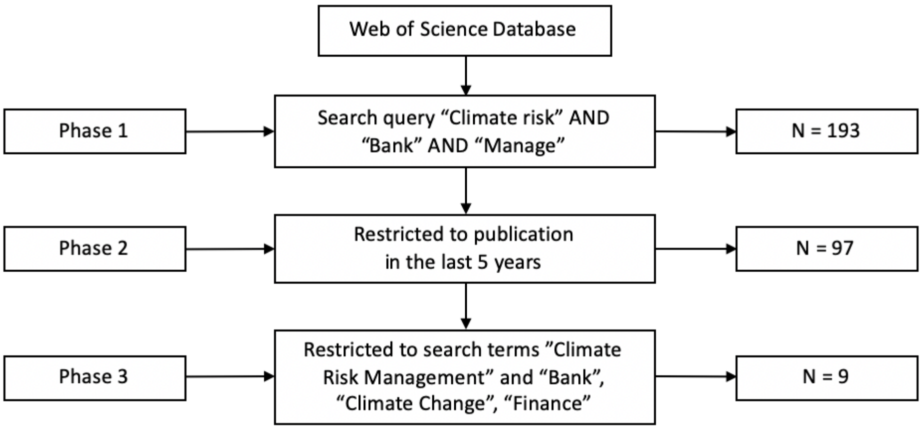

Figure 2. Stages of the Selection Process for the Literature review

Figure 2 shows the selection process for the literature review and the number of search results from Web of Science. The search query with Boolean operators were used in the first phase. In the second phase, the publication year was limited to the last five years to reduce the number of findings and obtain recent papers. In the third and final phase, the findings were restricted to key words "Climate Risk Management", "Bank", "Climate Change", and "Finance" to identify the role of the bank as a financial institution in the climate management, which is the aim of ING towards decarbonisation.

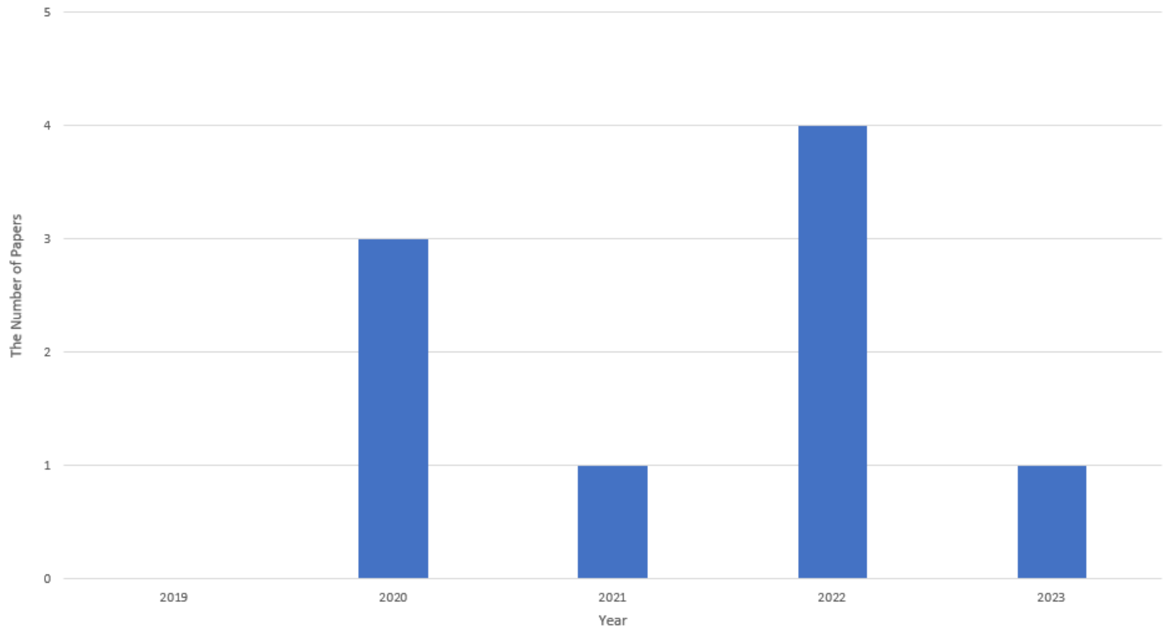

Figure 3. The Number of Articles Published Per Year

Figure 3 shows the distribution of papers based on each year from 2019 to 2023. Eight out of nine papers were released prior to 2023, which means the remaining papers were published between 2020 and 2022. There was no published paper in 2019. Based on the keywords and titles of the papers, word clouds were made in Figure 4 and Figure 5 to analyse the top five words that appear the most frequently. In Figure 4, the most popular keywords are “risk” and“climate”, but “energy”, “banks”, “financial”, “green”, “change”, and “managing” are appeared with similar frequency. On the other hand, the most popular keywords in Figure 5 are “climate”, “change”, “risk”, “protection”, and “resilience”.

Figure 4. Word Cloud Based on the Titles

Figure 5. Word Cloud Based on the Key Words

In order to organise connections between available papers and specific aspects of the knowledge question to be answered, we will analyse key topics of each paper. Table A-1 in Appendix A presents the summary of the studies that are found after the selection process. There are some studies that are not closely related to all four concepts: climate risk management, climate change, bank, and finance. Rana et al. (2022) explored topics confined within the prediction of wind and storm surge risk and the allocation of assets rather than explaining the role of the bank in terms of climate risk management. In addition, Adnan et al. (2021) discussed a topic about different risk management strategies made by farmers related to farming and agricultural credit and Liao and Ren (2020) examined the influence of energy-biased technological progress and measures the relationship between energy-biased technological progress and energy efficiency. Also, Doeffinger and Rubinyi (2023) suggested an economic model about various secondary benefits to the economy, society, and the environment in terms of flood protection. On the one hand, Reguero et al. (2020) explored the use of ecosystems for adaptation and risk reduction and applications of economic models to the projects related to reef restoration project and Ardia et al. (2022) discussed cash flow and discount rate of brown and green firms. Hence, the papers by Toma and Stefanelli (2022b), Kedward et al. (2022), and Fu and Ng (2021) are further explained for the literature review.

Toma and Stefanelli (2022) analysed strategies that economy can employ to effectively utilise the financial system in terms of climate change, and actions that banks are taking to mitigate climate risks while safeguarding stakeholder interests. The paper highlights the importance of banks developing a stronger awareness, beginning with their governance, regarding the need to adopt strategic measures that promote financial sustainability in the context of increasing climate risks. It urges bank executives to understand the environmental effects on financial operations and develop strategies to mitigate them. Furthermore, it emphasises the significance of banks implementing internal governance models that accurately evaluate their vulnerability to climate-related risks. In addition, the analysis shows that there is potential to enhance climate change management strategies by effectively utilising the financial operations of banks to promote responsible behaviour, leading to advancements in both the country's quality of life and economic development.

On the one hand, Kedward et al. (2022) examined approaches taken by central banks and financial supervisors on the BRFR (Banking and Financial Regulation on Climate Risk) issue and its link to climate-related financial risk. They argue that policymakers should adopt a comprehensive approach to address systemic environmental-financial risks, considering the interplay between biodiversity and climate change. Kedward et al. (2020) also suggested that policymakers should focus on understanding how the financial system contributes to environmental damage rather than waiting for financial materiality evidence. Hence, by assessing potential risks based on current information, policymakers can intervene to reduce harmful financial flows that could push ecological systems beyond critical tipping points.

Fu and Ng (2021) argued that green bonds have become widely popular worldwide as a financing mechanism for renewable energy initiatives. These bonds are structured with specific compliance standards and provide tangible financial benefits to investors, making them a valuable tool in the fight against climate change. However, there is a lack of comprehensive exploration into the extent to which green bonds effectively support renewable energy projects in emerging economies and how they address the associated risks involved. Based on the analysis, Fu and Ng (2021) suggested that the findings demonstrate the potential to scale up the growth of renewable energy through effective risk management and significant risk sharing.

Toma and Stefanelli (2022) explored strategies for utilising the financial system to address climate change while safeguarding stakeholder interests.They emphasised the importance of banks developing awareness and implementing strategic measures for financial sustainability amidst climate risks. In addition, Kedward et al. (2022) focused on the approaches taken by central banks and financial supervisors regarding the link between BRFR and climate-related financial risks. They argue for a comprehensive approach that considers the interplay of biodiversity and climate change, urging policymakers to understand the financial system's contribution to environmental damage. Also, Fu and Ng (2021) emphasised the need for further exploration into the effectiveness of green bonds in supporting renewable energy in emerging economies and managing associated risks.

The studies suggest the potential for scaling up sustainable business such as renewable energy development through effective risk management and risk sharing based on comprehensive understanding of stakeholders, biodiversity, and policymakers. Therefore, banks can use effective risk management such as tracking emission intensities of their portfolio and risk sharing strategies through financing to help scale sustainable businesses such as renewable energy. This can be achieved by taking stakeholder perspectives into account, understanding biodiversity, and aligning with policy makers' comprehensive understanding of the topic.

2.2 Green Financing

The keywords that are included in the review can be defined as green financing and portfolio emission intensity. For the search terms, "Green financing", "Portfolio emission intensity", "Bank" are used. The search terms are combined with the Boolean "AND" and "OR" operators in the search field. Based on the search terms, the structure of the search query was formulated as "Green financing" OR "Portfolio emission intensity" AND "Bank".

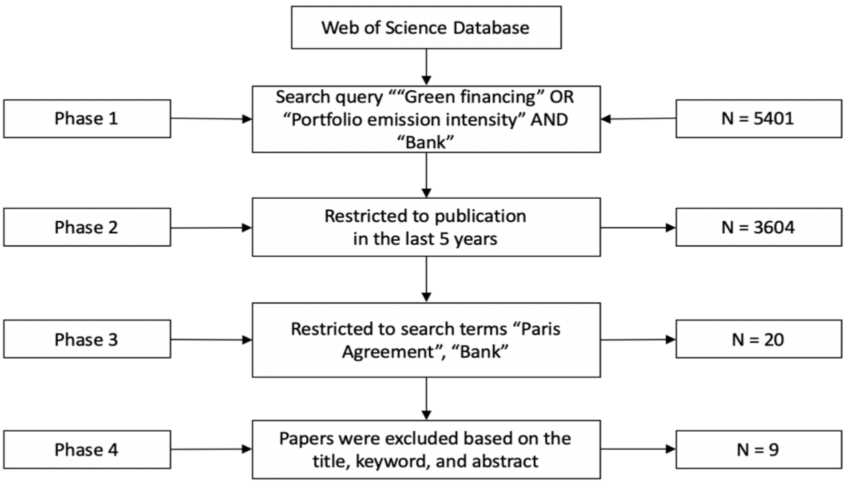

Figure 6. Stages of the Selection Process for the Literature review

Figure 6 shows the selection process for the literature review and the number of search results from Web of Science. The search query with Boolean operators were used in the first phase. In the second phase, the publication year was limited to the last five years to reduce the number of findings and obtain recent data. In the third phase, the findings were restricted to key words "Paris Agreement and "Bank" to identify the role of the bank in the Paris Agreement, which is the goal of ING that aims to achieve green development. In the third place, some irrelevant papers to this thesis were excluded based on the title, keyword, and abstract that involved "Island developing states", "Taxation and subsidies", "Structural equation model", and "Nationally Determined Contribution (NDC)".

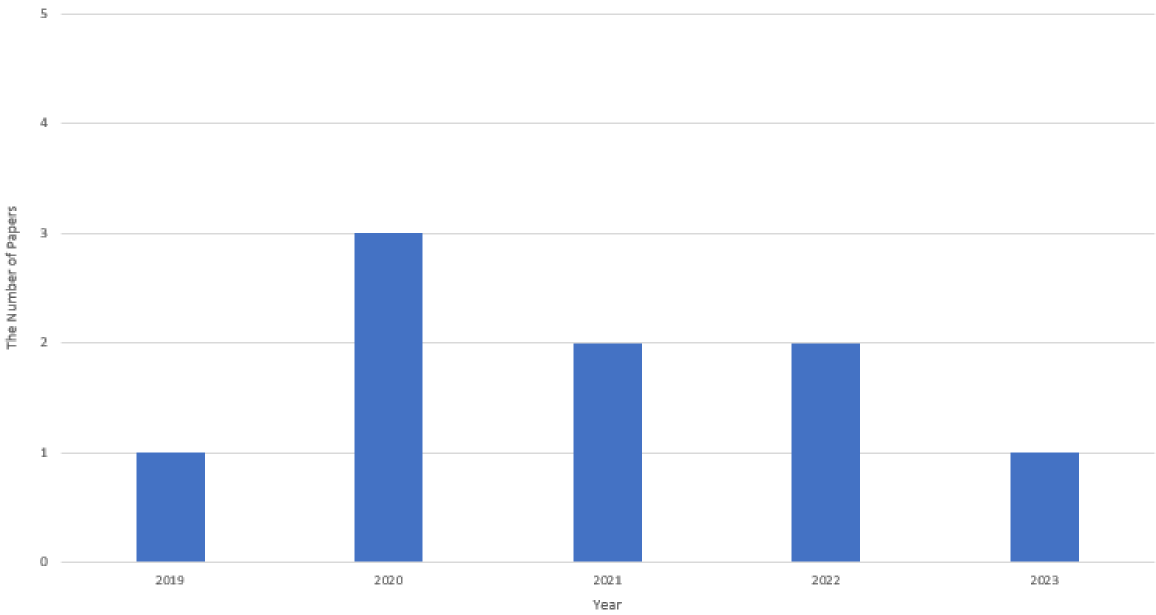

Figure 7. The Number of Articles Obtained Each Year

Figure 7 presents the distribution of papers based on their year of publication from 2019 to 2023. Eight out of nine papers were released prior to 2023 (i.e., 2019-2022). Based on the keywords and titles of the papers, word clouds were made in Figure 8 and Figure 9 to analyse the top five words that appear the most frequently. In Figure 8, the most popular words in the keywords of the selected papers based on the titles are "green", "banks", "policy", "energy", and "finance". On the one hand, the most popular words are described in Figure 9 as "green", "finance", "energy", "sustainable", "climate", "emissions", and "financial".

Figure 8. Word Cloud Based on the Titles

Figure 9. Word Cloud Based on the Key Words

In order to organise connections between available papers and specific aspects of the knowledge question to be answered, we will analyse key aspects of each paper. Appendix B presents a summary of the studies. There are some studies that are not closely related to all four concepts: green financing, sustainability, emission, and environmental impacts. Geddes et al. (2019) cover topics related to emission and environmental impacts, but it focuses on political aspects related to environmental impacts rather than green financing and sustainability. Toliver et al. (2019; 2020) cover topics associated with sustainability, emission, and environmental impacts, but it is too focused on green bonds rather than green financing. D'Orazio (2021) explores sustainability, emission, environmental impacts, but it is focused on the framework of managing post-pandemic policy against climate risks rather than green financing. In addition, Aleluia (2022) covers the scope of clean energy transition in a specific region by emphasizing the role of government and public policy rather than green financing. Also, the paper by Zhou et al. (2020) is focused on investigating mid-century decarbonization strategies for developing Asia to 2050. Therefore, the papers by Pyka & Nocon (2021), Khan et al. (2022), and Birindeli & Palea (2023) will be further explained for the literature review.

Pyka & Nocon (2021) mainly analysed the extrapolation of risks that arise within the volatile environment of credit institutions that are increasingly displaying a bold approach by incorporating their expectations into the implementation of the sustainable finance concept. Pyka & Nocon (2021) argued that investment strategies that align portfolio composition with the principles of sustainable finance and prioritise long-term high returns will alter the resilience of banks concerning key risks in the context of sustainable development.

Khan et al. (2022) measured green finance as climate mitigation finance and examines its impact on the ecological footprint of 26 economies in Asia. Based on the analysis, Khan et al. (2022) argued that green finance effectively lowers ecological footprints and exhibits environmentally friendly characteristics, and this is particularly evident in the Asian context, where green finance performs as expected. As a result, Khan et al. (2022) insisted that policymakers should be encouraged by these findings to maintain their investments in climate finance.

On the one hand, Birindeli & Palea (2023) analysed the correlation between banks' governance-level corporate social responsibility (CSR) mechanisms and their inclination to adopt green product strategies. Also, they investigated the evolution of CSR characteristics and green product strategies over time and across different regions. Based on the analysis, Birindeli &

Palea (2023) argued that ESG-related compensation mechanisms require comprehensive re-evaluation since they are effectively discouraging green financing, so it is required to modify remuneration policies by focusing on long-term goals and ESG-related objectives.

Pyka & Nocon (2021) analysed the risks encountered by credit institutions and their integration of sustainable finance practices. They argued that investment strategies aligned with sustainable finance principles and long-term profitability can enhance the resilience of banks against risks in sustainable development. On the one hand, Khan et al. (2022) examined the impact of green finance and the findings showed that green finance effectively reduces ecological footprints and promotes environmental sustainability, particularly in the Asian region. The authors emphasise the importance of policymakers continuing to invest in climate finance based on these positive outcomes. Birindeli & Palea (2023) investigated the correlation between corporate social responsibility (CSR) mechanisms at the governance level of banks and their adoption of green product strategies and suggested modifying remuneration policies to prioritise long-term goals and ESG objectives. Therefore, green financing helps to improve banks' resilience to risks in sustainable development and it is possible to decrease the impact on the environment and encourage environmental sustainability based on long-term goals and ESG objectives. This justifies that it is necessary to accurately and fairly measure the portfolio towards the target of the Terra approach

2.3 Summary

Based on the literature review, we can say that it is possible for banks to support sustainable businesses by effectively managing risks and strategies such as tracking emission intensities of their portfolio. Also, banks can contribute to the decrease the impact on the environment through green financing based on long-term goals and ESG objectives. Hence, by tracking the emission intensity of the portfolio, banks are able to check the comprehensive overview of their activities and take appropriate actions based on the performance of their clients such as increasing the lending criteria for clients that have significant emission intensity.

3 Methods

The key constructs of the research questions are impacts and emission intensity. In order to operationalise the key constructs, the impacts are measured by using graphs that represents breakdown of a portfolio based on portfolio emission intensities that are calculated using outstanding, EAD, and lending limit from 2018 to 2021. In addition, the emission intensity will be operationalised by using outstanding, EAD, and lending limit from 2018 to 2021.

On the one hand, the variables of the research question can be identified as the amount of outstanding, EAD, and lending limit of different companies and the emission intensities of the different companies. For the operationalisation of the variables, we will extract the data of the amount of outstanding, exposure of default (EAD), and lending limit for each company from 2018 to 2021. Also, we will calculate the emission intensities for each company based on the extracted data from the database.

4 Experimental Study

This chapter analyses the research method to answer the research question. A combination of qualitative and quantitative methods are used to analyse the impact of tracking the portfolio emission intensity using outstanding, EAD, and lending limit. In order to conduct the analysis, a data extraction step is performed to obtain the data of clients in each sector. After that, statistical tests are conducted for data validation and graphs are created to check the portfolio composition every year.

4.1 Research Design

For this thesis, qualitative and quantitative methods are used. The overview of the research design is described in Figure 10.

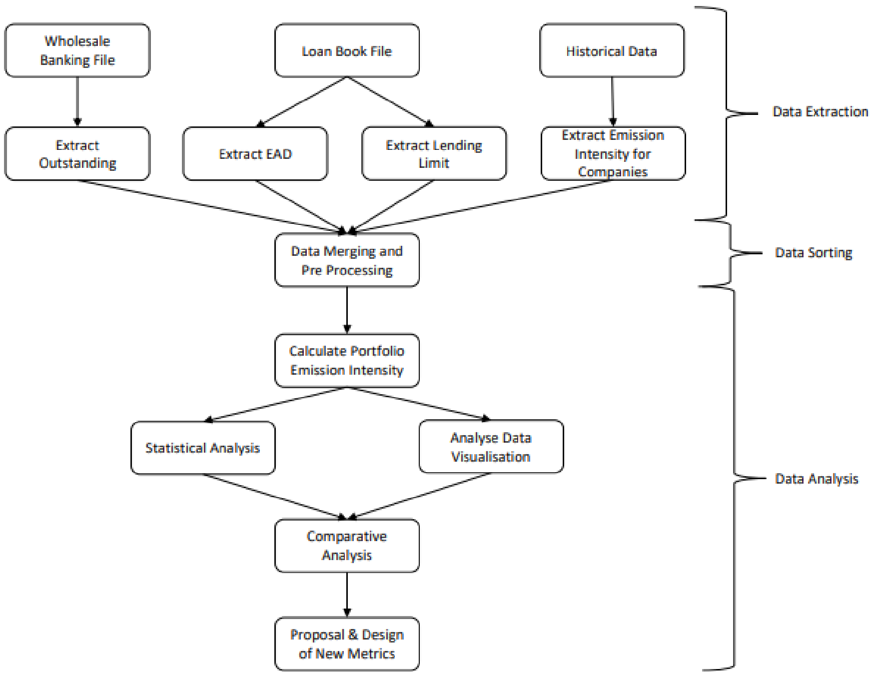

Figure 10. The Research Design

In order to answer the research question, Figure 10 can be classified into two steps: data extraction and data analysis. First, we extract the data from the internal database of ING. The wholesale banking file and the loan book file are used to obtain the information about outstanding, EAD, and lending limit. Second, we sort the data to match the extracted data with each company. Third, we calculate the portfolio emission intensity using outstanding, EAD, and lending limit. Fourth, based on the portfolio emission intensity using the three methods, we create graphs such as bubble charts and scatter plots to analyse their impacts.

In addition, the research can be classified into two types of research strategy, which are deep qualitative and deep quantitative. For the deep qualitative strategy, descriptive research is conducted through systematic literature review and informal conversations with the Terra team. We do analysis and statistical tests with datasets to analyse the portfolio emission intensity using different metrics, which are outstanding, EAD, and lending limit. Also, we do descriptive research for the deep quantitative strategy. We extract datasets of the Global Sustainability Department and analyse them using graphs. The data are extracted from the internal database of Terra team, and they include company names, emissions intensities, and the amount of outstanding, EAD, and lending limit. Based on the analysis, we conduct a comparative analysis and propose the most appropriate metric for the measurement method of the Terra approach.

4.2 Modelling Emission Intensity

It is widely known that the emission intensity[4] is a measure of carbon dioxide and other greenhouse gases per unit of activity. In order to analyse the portfolio emission intensity, data extraction steps are performed. The loan book file and the wholesale banking file are used to extract the data of outstanding, EAD, and lending limit of each company in each sector. Both files are the internal data of the company and the wholesale banking file contains all transaction data of ING's clients and outstanding, EAD, and lending limit. On the one hand, the loan book file is a subset of the wholesale banking file, which means all companies in the loan book file should exist in the wholesale banking file. However, the loan book file does not contain any information about outstanding, EAD, and lending limit. Therefore, the companies of the loan book file are matched to the companies in the wholesale banking file to obtain the information about outstanding, EAD, and lending limit. For each sector, the basic methodology for data extraction begins with matching the loan book file with wholesale banking file to extract the data about outstanding, EAD, and lending limit. After that, emission intensity for each company will be matched with corresponding companies. Based on the extracted data, emission intensities of the portfolios will be calculated using weighted average. The equation 1 will be used for calculation. In the formula, x_i represents outstanding or EAD or lending limit of company i and y_i represents the emission intensity of company i.

$$\frac{\sum_{i=1}^{N}(x_i * y_i)}{\sum_{i=1}^{N}(x_i)} \tag{1}$$

[4] See What is carbon intensity? (n.d.) for more information on its definition.

4.3 Statistical Methods for Validation

Statistical methods are used to predict emission intensity based on variables which are emission intensities and independent variables which are outstanding, EAD, and lending limit. In particular, we look at the values derived from the regression test, which are R-squared values[5] that describe how much of the variance can be explained by each model and p-values[6] that measure the consistency between the data and the hypothesis being tested. Also, we use a paired t-test[7] to analyse whether metrics are showing the same or different pattern.

Furthermore, bar and line graphs are used for comparative analysis. They are used to compare different trends over the years based on different metrics and proportions based on different sectors and metrics. Also, scatter plots are used to analyse the portfolio composition.

4.4 Summary

In order to analyse the suitable metric for measuring the Terra approach, data extraction, data sorting, and data analysis steps are performed with a combination of qualitative and quantitative methods. In addition, for the calculation of the portfolio emission intensity, the weighted average is used based on outstanding, EAD, and lending limit. Also, comparative analysis and statistical tests are conducted to examine the portfolio emission intensity of outstanding, EAD, and lending limit. For the analysis, various graphs are used to analyse the composition of the portfolios.

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[5] See The Coefficient of Determination: Understanding r squared and R squared (2000) for more information on its definition.

[6] See The p value: what is it and what does it tell you? (2010) for more information on its definition.

[7] See The t-test: An Influential Inferential Tool in Chaplaincy and Other Healthcare Research (2017) for more information on its definition.

5 Results and Discussions

The emission intensities of the portfolios are analysed in two ways based on the existence of data, i.e., with and without filters. The filters are revolvers and term loans. In this case, revolvers stand for the general situation that the company pays back less than a year and term loans refer include a specific payback period in the contract. In the past, ING only performed analysis using these two filters. However, it might be possible that ING could have filtered out some clients that could have impact on the portfolio because of the fact that they do not have term loans and revolvers. Therefore, the emission intensities of each portfolio are analysed first applying and then not applying the product filters, respectively. The data for the analysis are selected based on data availability and data quality of each sector, namely cement and automotive sector.

5.1 Discussions of Each Sector Cement, and Automotive Sectors[8]

The emission intensities of portfolios in the cement sector are currently calculated using weighted average (see Section 3.3 for the explanations of the method). The overview of the total amount of outstanding, EAD, lending limit, and emission intensities are described in Table 2 and represented in Figure 11. The emission intensity from the official climate report of ING [9] in 2018 and 2019 are slightly different compared to our analysis due to the data quality issue in 2018 and the data availability issue in 2019. Particularly, in 2018, the data was not granular enough in 2018 so it was not possible to restate the 2018 market figure. In addition, the higher emission intensity the company has, the worse performance that the company has.

[8] The analysis will be mainly conducted with product filters, but the similar findings for the datasets without filters are displayed in Appendix C, Appendix D, and Appendix E.

[9] See ING (2021), page 106, for a more detailed explanation

Table 2. Cement Portfolio Emission Intensity Overview

Reporting Year	2018	2019	2020	2021
Emission intensity from the climate report (in tonnes of CO_2 per tonne of cement)	-	0.7045	0.7042	0.7092
Emission intensity (Outstanding, in tonnes of CO_2 per tonne of cement)	0.6942	0.7045	0.7046	0.7092
Emission intensity (EAD, in tonnes of CO_2 per tonne of cement)	0.6917	0.7020	0.7035	0.7047
Emission intensity (Lending limit, in in tonnes of CO_2 per tonne of cement)	0.6896	0.7014	0.7021	0.7028
Total Outstanding	800X	625X	510X	337X
Total EAD	1178Y	865Y	761Y	518Y
Total Lending Limit	1585Z	1051Z	1084Z	773Z

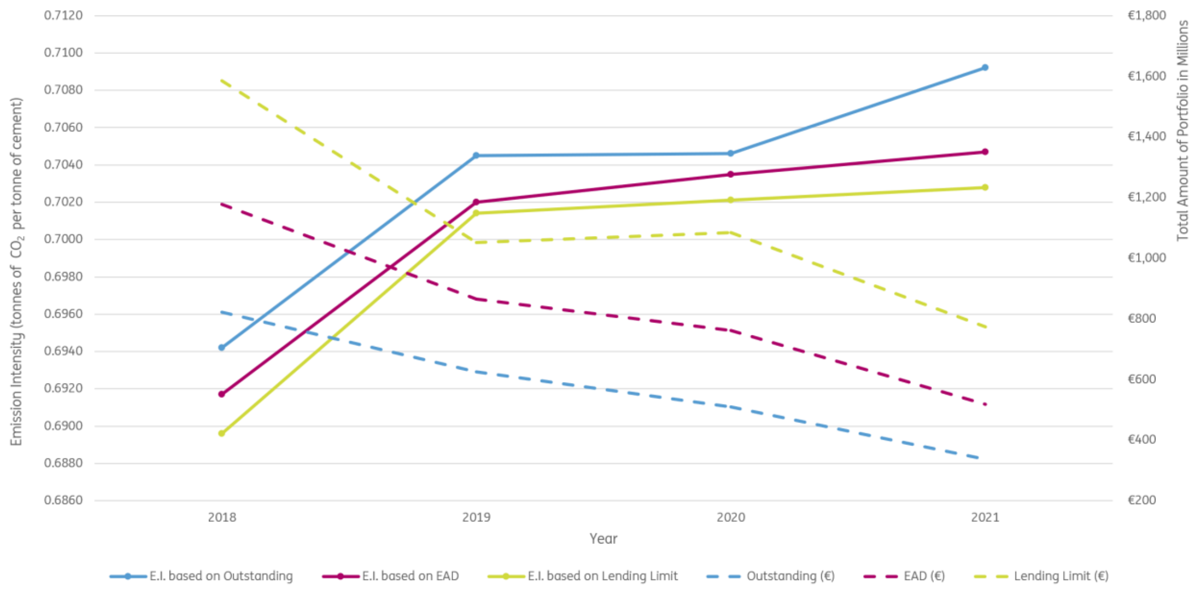

Figure 11. The Size of the Portfolio with Portfolio Emission Intensities

If we look at the graph except 2018, outstanding has the biggest leap between 2020 and 2021 and lending limit is the most stable metric. Generally, the size of the portfolio decreases over the years for each metric and the amount of outstanding and EAD shows the similar pattern over the years. Also, the emission intensity based on lending limit showed the steadiest pattern between 2019 and 2021. In order to support the argument in terms of stability of metrics, statistical analysis was conducted.

In order to statistically analyse to if the metrics are considered as the same measurement metric or not, a statistical analysis was conducted. We perform a pairwise T-test to see if they are statistically equal or different for a given certainty and regression test to support the claim about why we should use a specific variable when predicting emission intensities based on outstanding, EAD, and lending limit. Table 3 shows the number of observations, mean, variance, and p-value for the pair of variables. The confidence level of 95% was taken for the analysis. In Table 3, the average of outstanding is different compared to the average of EAD. Therefore, we are 95% confident about the claim that they are different, so they are different metrics on average with 95% confidence. Also, the p-values for outstanding and EAD, and outstanding and lending limit are lower than 0.05. Hence, we can say that the p-values are lower than the significance level, so it is possible to reject the null hypothesis[10], which represents that there is no significant difference between the variables. This implies that the two samples are different.

[10] See Travers et al (2017), page 209, for a more detailed explanation

Table 3. Equality T-test for Yearly Analysis for Amount of Outstanding, EAD, and Lending Limit

Pair Composition	# Observations	Mean	Variance	P-Value
Outstanding and EAD	3	49,082,719	21,024,106,844,946	0.00460491
Outstanding and Lending Limit	3	49,082,719	21,024,106,844,946	0.00491874
EAD and Lending Limit	3	71,456,367	11,135,400,000,000	0.01104414

In addition, we perform a T-test to see if metrics are different in terms of emission intensity. Table 4 shows the number of observations, mean, variance, and P-Value for each metric in terms of the emission intensities calculated using outstanding, EAD, and lending limit. Based on Table 4, we can see that the p-values of outstanding and lending limit, and EAD and lending limit are lower than 0.05. Hence, we can say that they are statistically different metrics. However, the p-value of outstanding and EAD is higher than 0.05 so we can accept the null hypothesis. Thus, we can statistically say that they are equal so they do not have significant differences.

Table 4. T-test for Yearly Analysis for Emission Intensity Based on Outstanding, EAD, and Lending Limit

Pair Composition	# Observations	Mean	Variance	P-Value
Outstanding and EAD	3	0.7061	0.00000721	0.05580
Outstanding and Lending Limit	3	0.7061	0.00000721	0.04044
EAD and Lending Limit	3	0.7034	0.00000183	0.03768

In addition, we implement a linear regression test to see how much the variances can be explained using a specific metric and identify the most useful metric for predicting emission intensity. Hence, by doing a regression test, we check how much of the volatility and variances can be explained using a specific metric. Table 5 shows the results of the regression test including R-squared values and p-values based on each variable. Based on Table 5, we can say that outstanding can explain 94% of the variance, EAD can explain 96% of the variance, and lending limit can explain 98% of the variance. Hence, we can say that outstanding has the lowest R^2 value and lending limit has the highest R^2 value, which implies that it is statistically more important when predicting emission intensity compared to outstanding and EAD. However, the p-values of outstanding, EAD, and lending limit are higher than 0.05. This implies that the regression models of each metric are not statistically significant. On the one hand, the regression test for the pair compositions was conducted to check if variances can be explained better when metrics are combined. Based on Table 5, we can say that outstanding and EAD can explain 39% of variances, outstanding and lending limit can explain 40% of variances, and EAD and lending limit can explain 39% of variances. Despite the fact that low variances can be explained using the paired metrics, they showed p-values of lower than 0.05. This means that the regression model is statistically significant.

Table 5. Regression Test for Yearly Analysis

Independent Variables	R^2	Significance F (p-value)
All Metrics	0.85315	0.00003
Outstanding	0.94370	0.10888
EAD	0.95968	0.09163
Lending Limit	0.97950	0.06489
Outstanding and EAD	0.39433	0.00016
Outstanding and Lending Limit	0.40184	0.00013
EAD and Lending Limit	0.38784	0.00020

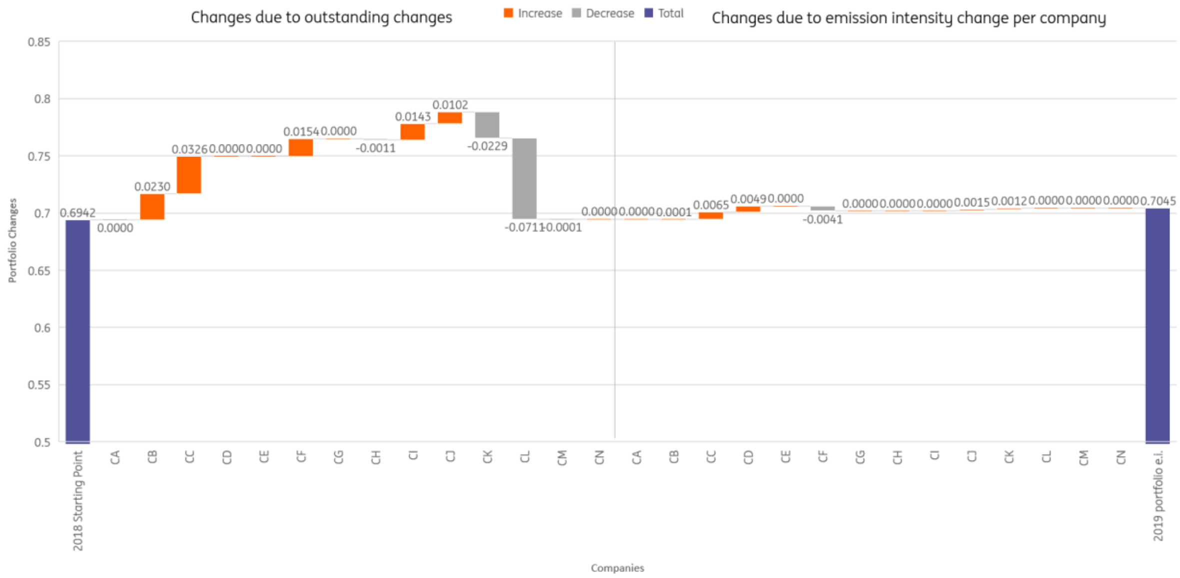

Figure 12. Changes of Emission Intensity Based on Outstanding from 2018 to 2019

In order to see the cause of the changes in the portfolio for each metric, the changes due to changes of the portfolio change in terms of outstanding, EAD, and lending limit, and the changes due to emission intensity changes are calculated. When calculating the changes caused by the portfolio change, it was assumed that the weight of each company stays the same. Figure 12 shows the changes of emission intensity for outstanding from 2018 to 2019. We split the graph into two drivers. The left side of Figure 12 is a driver caused by outstanding changes and the right side is a driver caused by the emission intensity of the company. We can see that company CL has significant changes and it is volatile and company CC also has quite significant changes. On the one hand, there are no significant changes caused by the portfolio size, but there are some changes caused by emission intensity changes (see the left side of Figure 12). We can observe that company CL contributed the most to the change caused by outstanding changes.

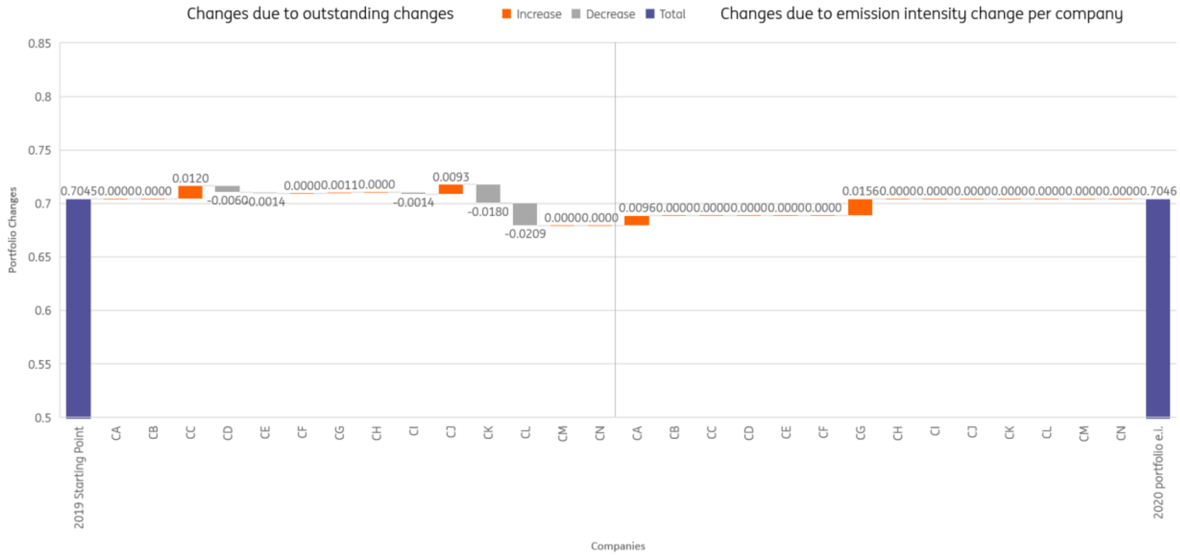

Figure 13. Changes of Emission Intensity Based on Outstanding from 2019 to 2020

Figure 13 shows the changes of emission intensity for outstanding from 2019 to 2020. We can see that it is generally stable and involatile. Although there are a few changes caused by emission intensity change per company, we can say that it relatively shows a stable trend.

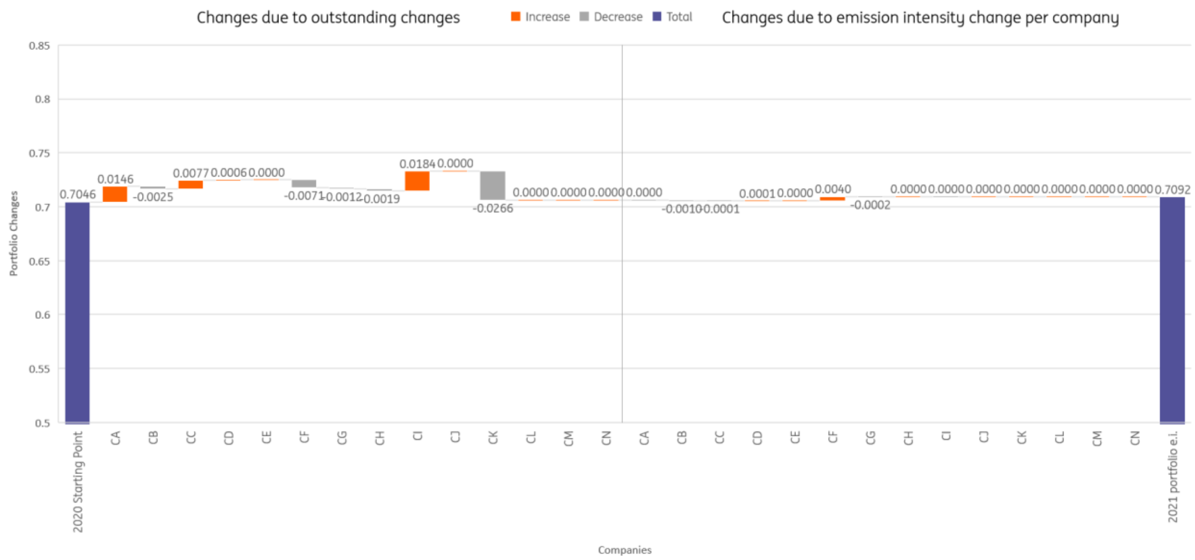

Figure 14. Changes of Emission Intensity Based on Outstanding from 2020 to 2021

Also, Figure 14 shows the changes of emission intensity for outstanding from 2020 to 2021. We can observe that it is generally stable, but most of the changes are caused by the changes due to emission intensity change of each company. We can observe that company CK contributed the most to the changes caused by the portfolio size and the change of portfolio emission intensity based on outstanding.

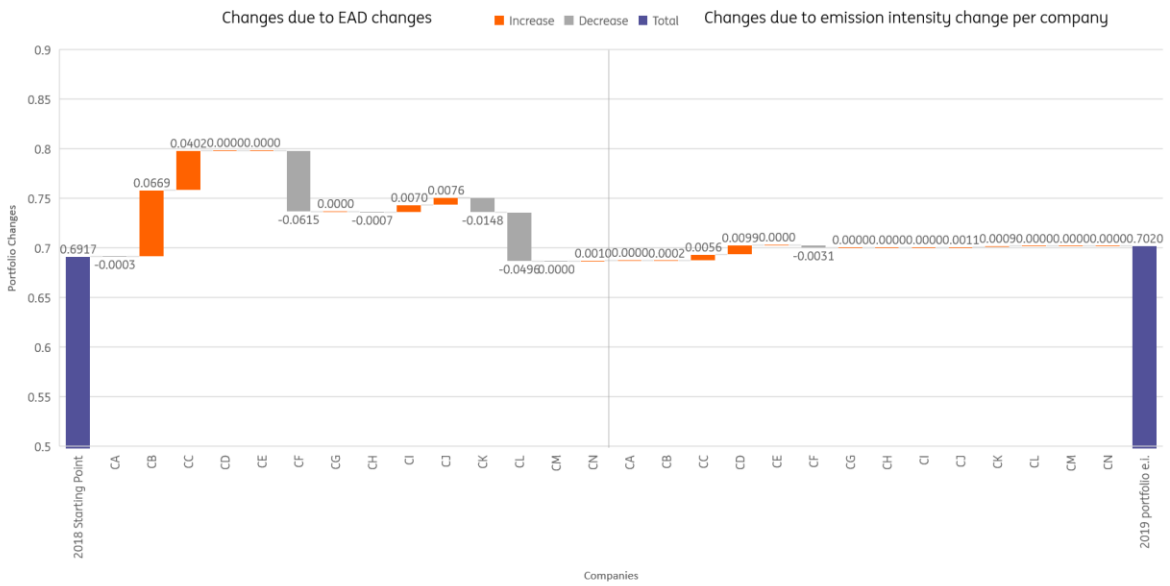

Figure 15. Changes of Emission Intensity Based on EAD from 2018 to 2019

On the one hand, Figure 15 shows the changes of emission intensity for EAD from 2018 to 2019. Unlike outstanding, we can see that company CB contributed the most to the changes caused by EAD changes, so it is volatile. Also, company CF has significant changes due to EAD changes so it is fluctuating. In addition, we can observe that company CF contributed the most to the changes caused by the portfolio size.

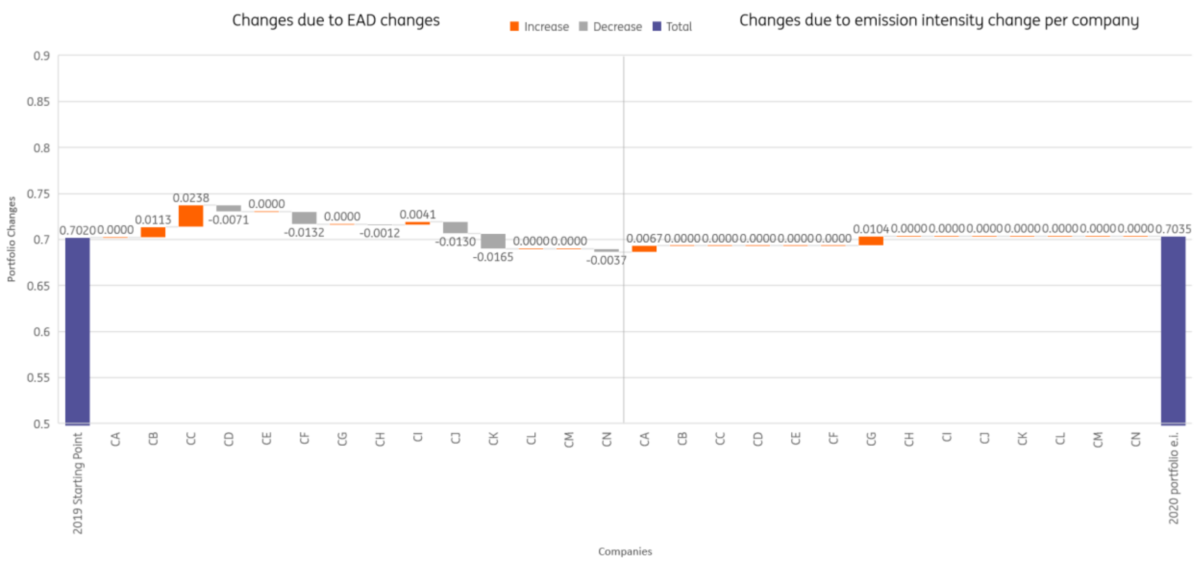

Figure 16. Changes of Emission Intensity Based on EAD from 2019 to 2020

Figure 16 shows the changes of emission intensity for EAD from 2019 to 2020. We can observe that the significant changes are caused by the changes due to emission intensity change of each company. We can see that company CC contributed the most to the changes caused by the portfolio size and company CA contributed the most to the change of portfolio emission intensity based on EAD.

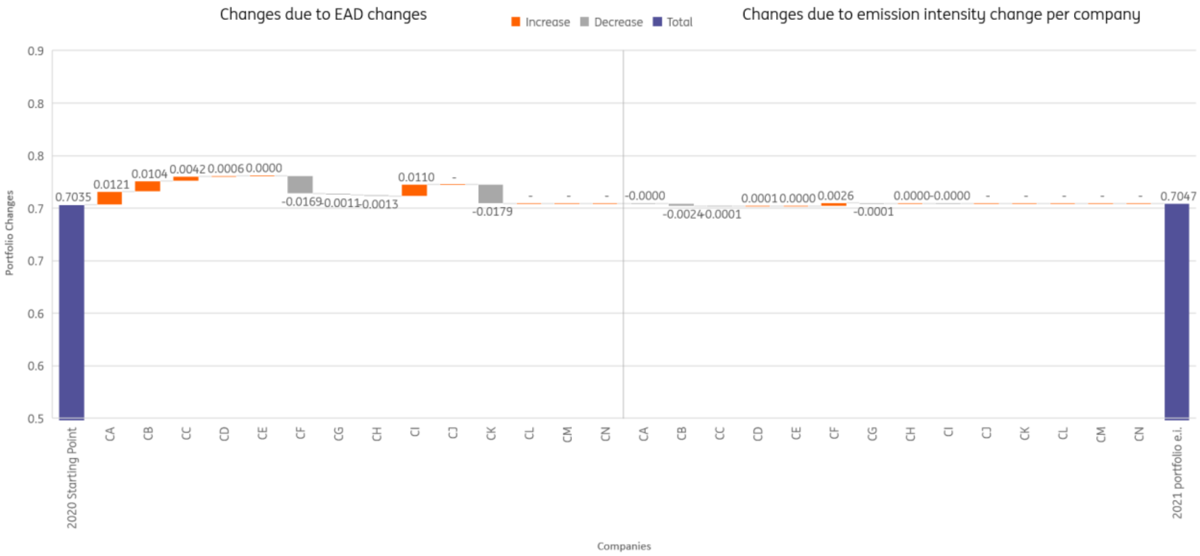

Figure 17. Changes of Emission Intensity Based on EAD from 2020 to 2021

Also, Figure 17 shows the changes of emission intensity for EAD from 2020 to 2021. We can observe that it is quite stable, but most of the changes are caused by the changes due to emission intensity change of each company. We can see that company CF contributed the most to the changes caused by the portfolio size and company CK contributed the most to the change of portfolio emission intensity based on EAD.

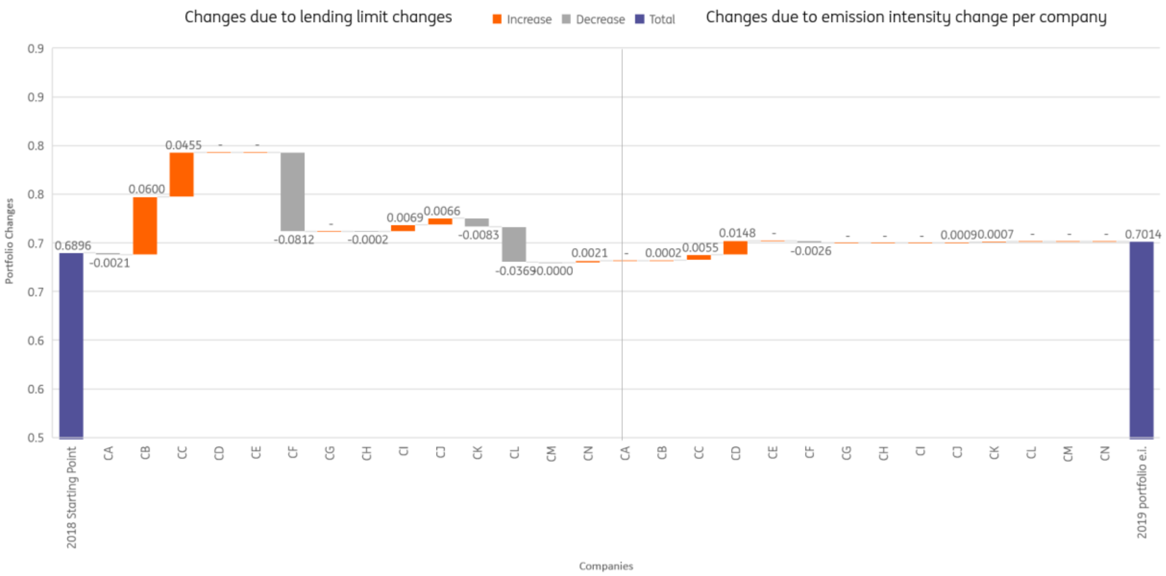

Figure 18. Changes of Emission Intensity Based on Lending Limit from 2018 to 2019

On the one hand, Figure 18 shows the changes of emission intensity for lending limit from 2018 to 2019. We can see that company CF has significant changes caused by the changes due to lending limit changes. Also, company CB, company CC, and company CL fluctuate. Based on the observation of each metric from 2018 to 2019, outstanding showed the most stable trend and lending limit and EAD followed the similar pattern of changes.

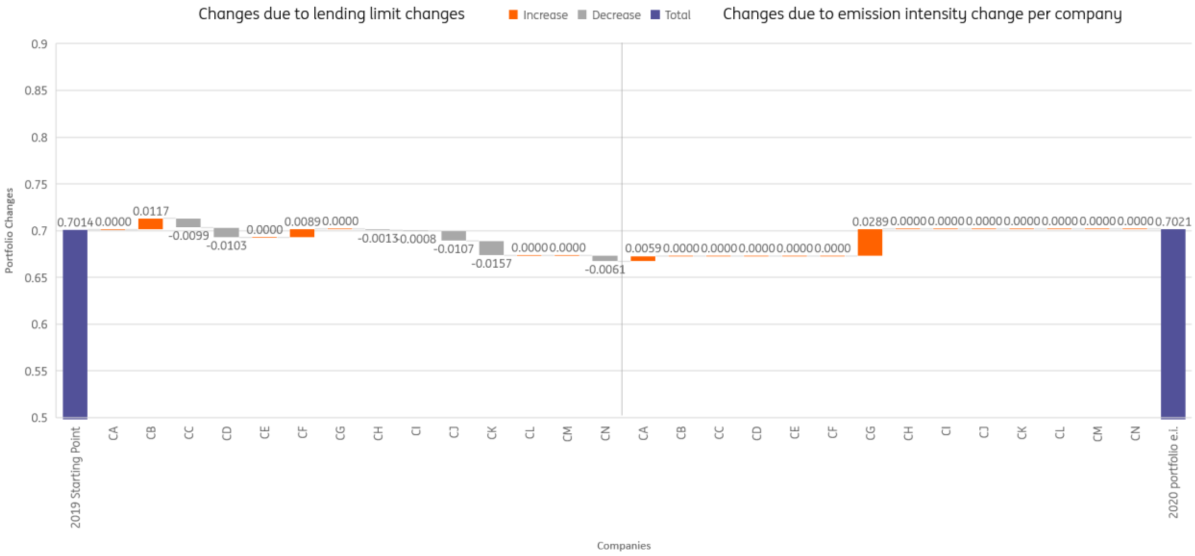

Figure 19. Changes of Emission Intensity Based on Lending Limit from 2019 to 2020

Figure 19 shows the changes of emission intensity for lending limit from 2019 to 2020. We can observe that it is generally stable, but most of the changes are caused by the changes due to emission intensity change of each company. We can observe that company CK contributed the most to the changes caused by the portfolio size and a company CG contributed the most to the change of portfolio emission intensity based on lending limit.

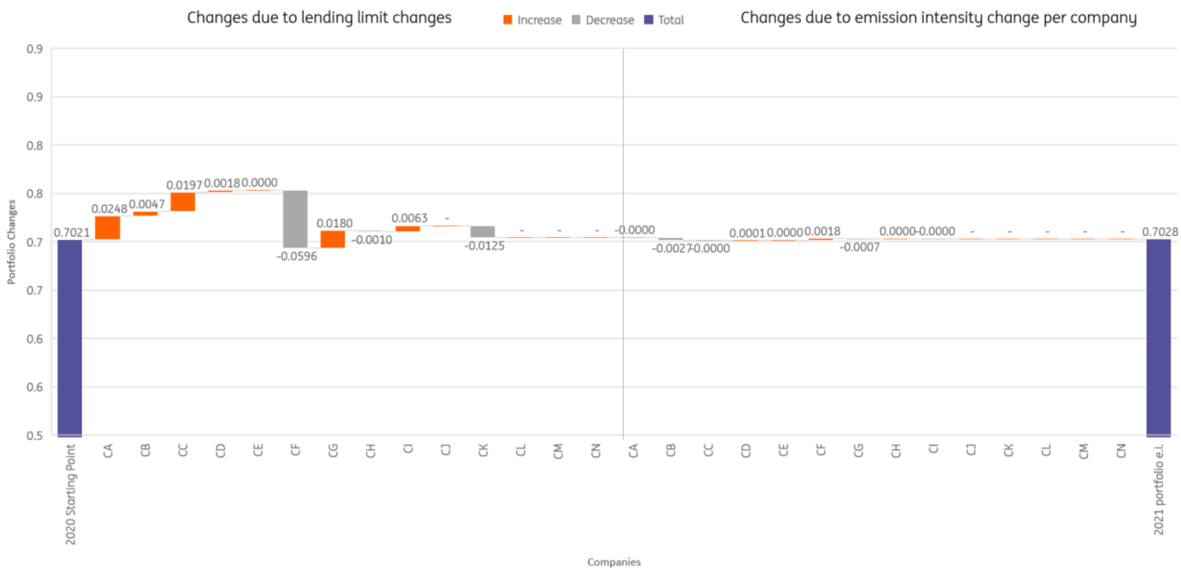

Figure 20. Changes of Emission Intensity Based on Lending Limit from 2020 to 2021

In addition, Figure 20 shows the changes of emission intensity for lending limit from 2020 to 2021. We can observe that it is generally stable, but most of the changes are caused by the changes due to emission intensity change of each company. We can observe that company CF contributed the most to the changes caused by the portfolio size and a company CB contributed the most to the change of portfolio emission intensity based on lending limit.

Based on the observation of year-to-year composition changes, outstanding showed the most stable and involatile pattern in terms of changes of the portfolio size and emission intensity change for each company. Lending limit is a metric that ING can control whereas outstanding is dependent on the needs of companies to draw money. For example, based on Figure 19, we see that company CF has significant changes due to portfolio changes driven by the changes of the portfolio of lending limit. This implies the performance of company CF is not superior. Hence, by taking suitable actions based on the changes of emission intensities, it might be possible that ING can control the lending limit for stability. Therefore, despite the fact that outstanding showed the most stable pattern, lending limit can be used as a metric for ING to access the information for evaluating its performance in terms of emission intensity.

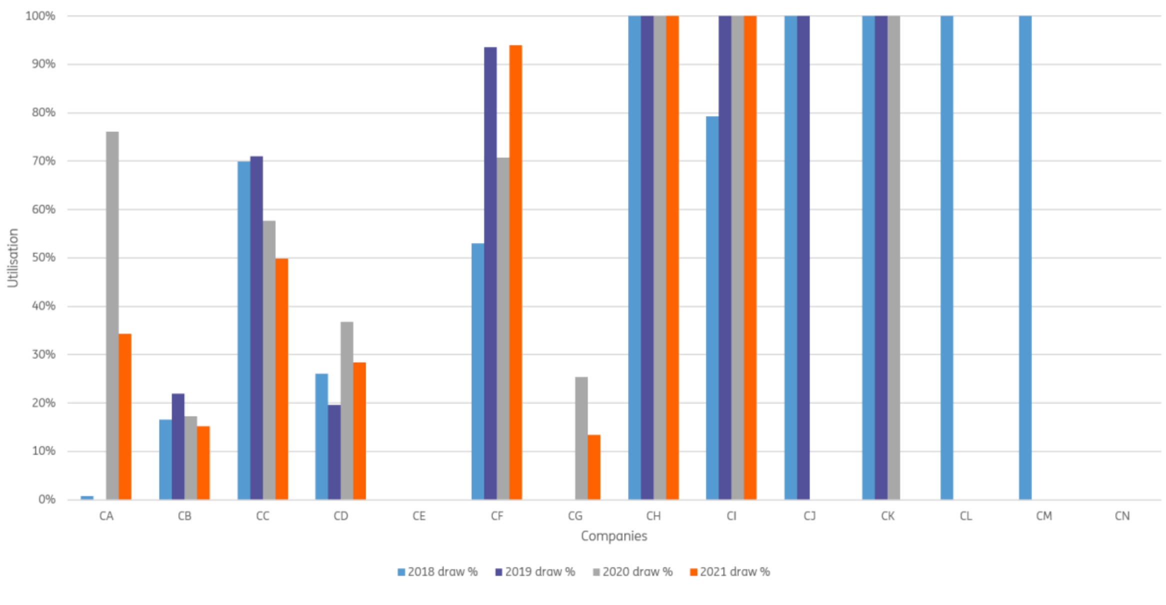

Figure 21. Lending Limit Year-to-Year Utilisation Comparison

Figure 21 shows the withdrawal percentage in terms of lending limit and utilisation, which represents how much a company drew compared to its lending limit. Although there is no direct correlation with emission intensity, utilisation is used to show the company is utilising the limit and it changes in terms of utilisation year-to-year. From Figure 21, we see that company CH utilises its full amount of limit and company CI almost utilises the full amount of limit over the years. Also, company CB and company CD utilise relatively stable amount of money over the years. In order to analyse the relative share of each company, we look at the breakdown of the portfolio based on each metric (Figure 22, 23, 24).

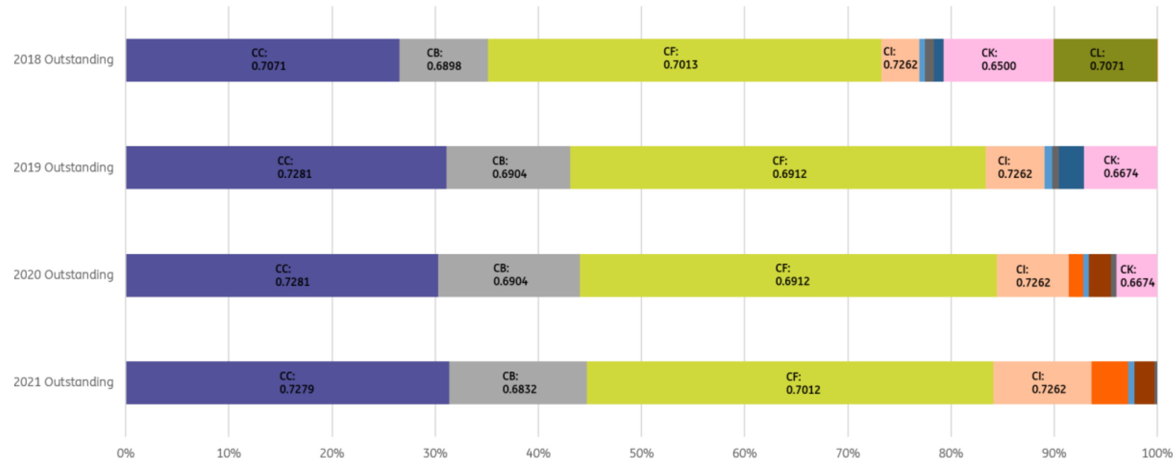

Figure 22. Breakdown of the Portfolio Based on Outstanding

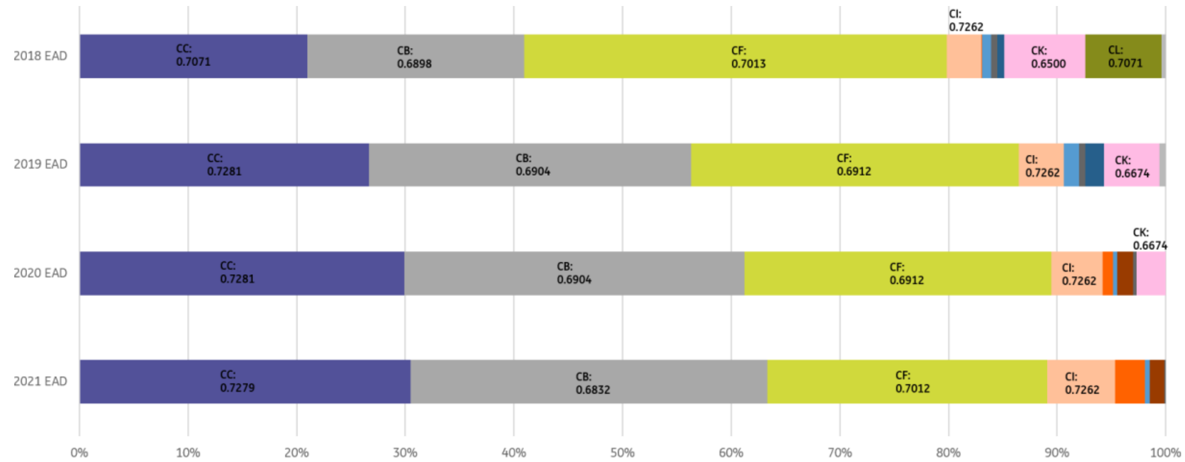

Figure 23. Breakdown of the Portfolio Based on EAD

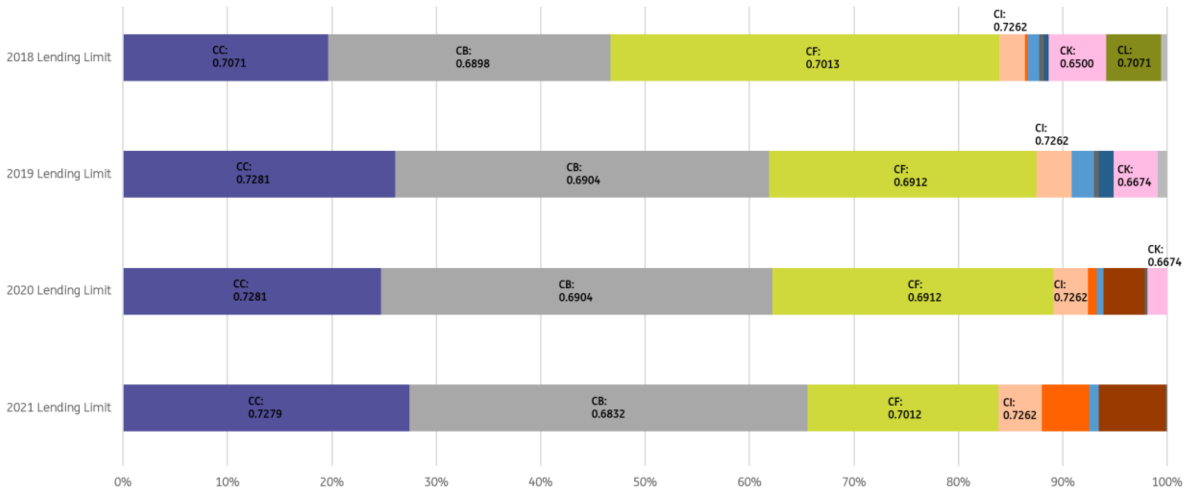

Figure 24. Breakdown of the Portfolio Based on Lending Limit

Figure 22, Figure 23, and Figure 24 explain details about the relative percentages over the years. If we look at company CF based on Figure 24, which is based on the lending limit, it shows that the limit of company CF is significantly reduced in terms of relative share. In addition, the relative share of company CB is relatively high. However, if we look at Figure 22 that is based on outstanding, the relative share is different. The relative share of company CF looks stable from 2020 to 2021, but there is a decrease in the relative share in the limit based on Figure 24. In addition, based on Figure 22, the relative share of company CB decreases over the years compared to limit.

Also, based on Figure 21, we can see that the pattern of company CF. It increased drastically in 2019, decreased in 2020, and increased again in 2021. Based on Figure 22, it follows the similar pattern in terms of outstanding. In addition, based on Figure 21, it shows that the utilisation of company CB and CC were slightly increased in 2019 and continuously decreased from 2020 to 2021. In this case, we can say that Figure 21 that is based on outstanding and Figure 24 based on lending limit follow the similar pattern.

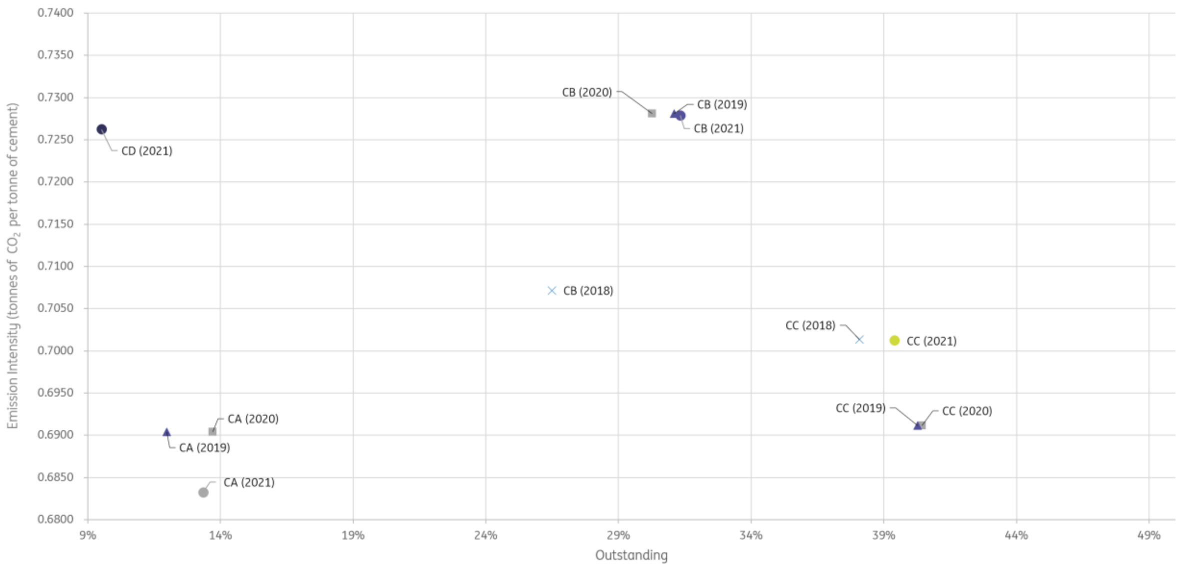

Figure 25. Year-to-Year Portfolio Composition Change based on Outstanding

In order to check the weight of each company based on its emission intensity, scatter plots are made. For the x-axis, the minimum scale was set to 9% to see companies that have weights more than 10% of the portfolio to ignore companies that have minor weights. Figure 25 shows portfolio composition change based on outstanding from 2018 to 2021. Based on Figure 25, we can see that the clusters of company CB and CF. This implies positions of company CB and CC are relatively stable over the years.

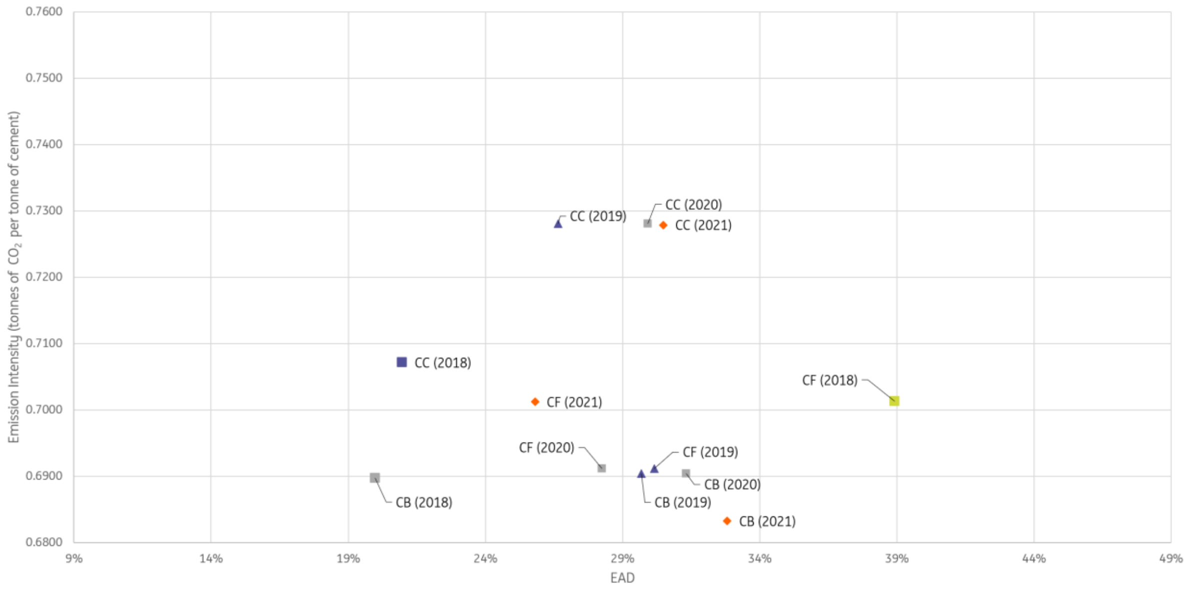

Figure 26. Year-to-Year Portfolio Composition Change based on EAD

On the other hand, Figure 26 shows the portfolio composition change based on EAD from 2018 to 2021. Based on Figure 26, we can see that most of the companies are dispersed over the years. Although company CB showed a relatively clustered pattern, there is still a significant gap caused in 2018.

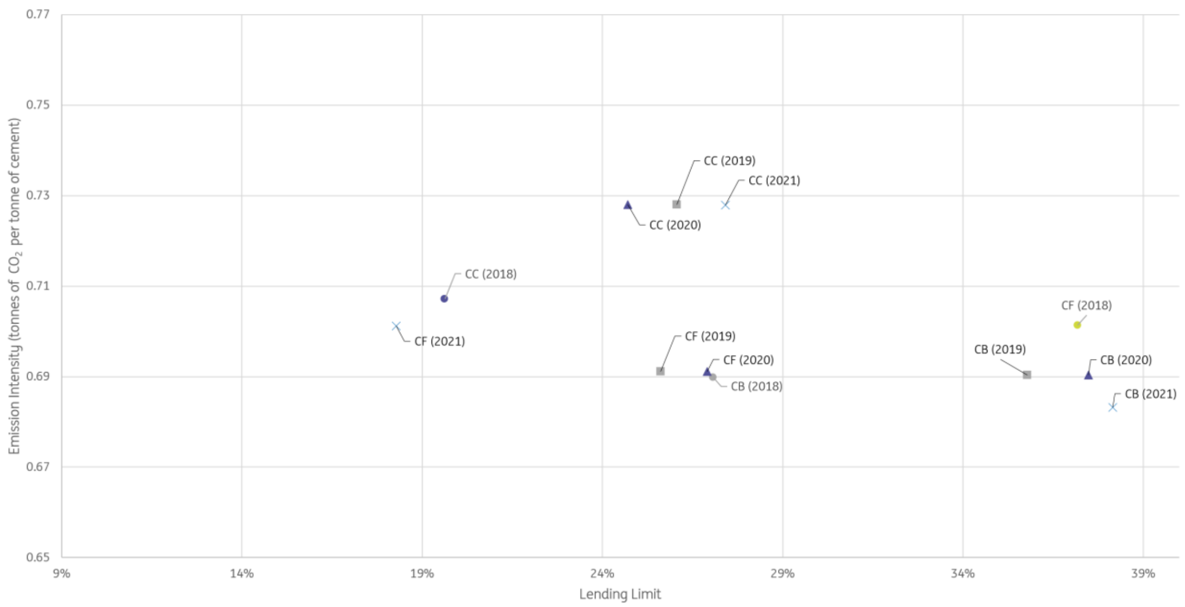

Figure 27. Year-to-Year Portfolio Composition Change based on Lending Limit

Figure 27 shows the portfolio composition change based on the lending limit from 2018 to 2021. Based on Figure 27, we can observe that most of the companies are dispersed. There are some clusters of company CB and CC, but a company CC in 2018 and a company CF in 2021 caused a significant gap.

Based on the year-to-year composition changes, it is possible to see that outstanding showed the most stable pattern since most of the companies are clustered. However, EAD and lending limit have dispersed pattern over the years. For the further discussion, it would be interesting to discuss the use of the lending limit since it is the metric that ING can control so it might be possible to control stability by making changes based on the performance of the portfolio.

A similar analysis was conducted for the portfolio without applying product filters for better understanding (see Appendix C). The analysis without the product filters shows a similar trend in terms of emission intensity. Outstanding and lending limit has a similar pattern in terms of the emission intensity between 2019 and 2021 and EAD continuously increases over the years. Nevertheless, compared to the graph based on product filter, it is relatively unstable in terms of the portfolio size. In addition, the breakdown of the portfolio shows similar results as the analysis with the product filters. In conclusion, there are no significant differences between with and without product filters.

The emission intensities of portfolios in the automotive sector were analysed using weighted average as we did for the cement sector. The overview of total amount of outstanding, EAD, and lending limit, and emission intensities are shown in Table 6. Due to data availability, data from 2019 to 2021 are selected for the analysis. Also, the emission intensities from 2019 to 2021 are not explicitly mentioned in the climate report of ING so they are not described in Table 6. Based on this analysis, the values are visualised in Figure 28.

Table 6. Automotive Portfolio Emission Intensity Overview

Reporting Year	2019	2020	2021
Emission intensity (Outstanding, in kg CO_2/km)	0.2150	0.1935	0.1875
Emission intensity (EAD, in kg CO_2/km)	0.2147	0.1901	0.1859
Emission intensity (Lending Limit, in kg CO_2/km)	0.2148	0.1880	0.1853
Total Outstanding	2591X	2719X	2440X
Total EAD	3698Y	3850Y	3712Y
Total Lending Limit	5579Z	5741Z	5843Z

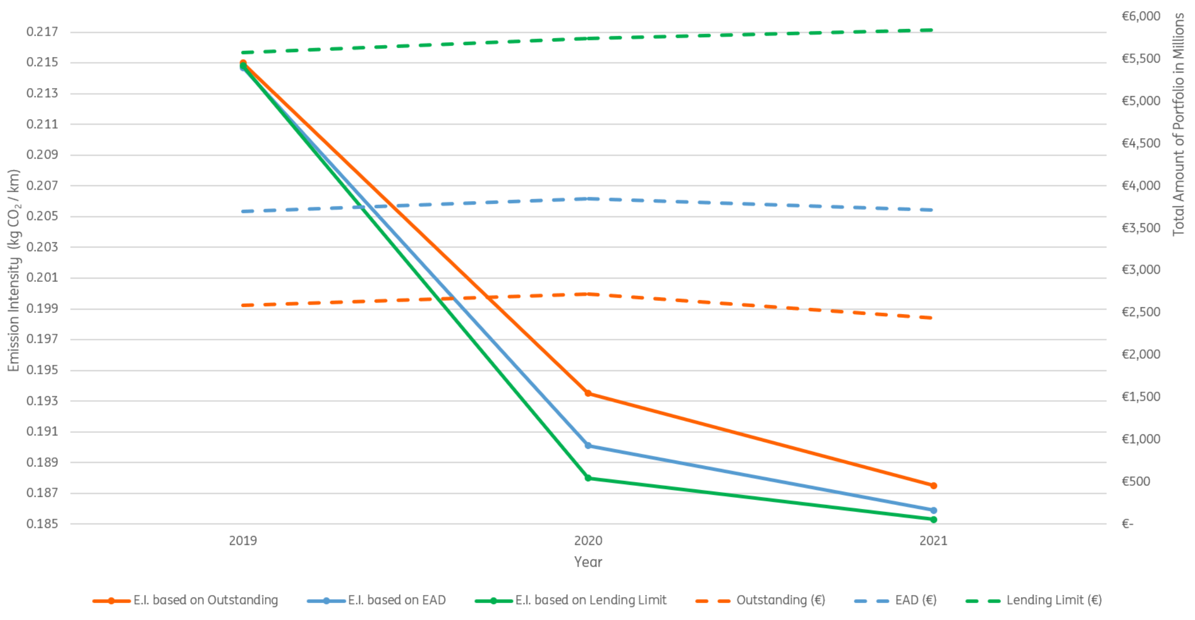

Figure 28. The Size of the Portfolio with Portfolio Emission Intensities

Based on Figure 28, all three metrics follow the similar trend in terms of emission intensity and portfolio size and quite stable. However, the portfolio size of lending limit slightly increases from 2020 to 2021 and the portfolio size of outstanding slightly decreases from 2021 to 2021.

In order to analyse whether they are significantly different or not, a statistical analysis was conducted. We do a pairwise T-test to see if they are statistically equal or different for a given certainty and regression test to support the claim about why we should use a specific variable when predicting emission intensities based on outstanding, EAD, and lending limit.

Table 7 shows the number of observations, mean, variance, and p-value for each pair of metric based on the amount of outstanding, EAD, and lending limit. The p-values for outstanding and EAD, and outstanding and lending limit are higher than 0.05. Therefore, we can say that the p-values are higher than the significance level, so it is possible to accept the null hypothesis. This means that the two samples are statistically equal so there are no significant differences between the samples.

Table 7. T-test for Yearly Analysis for Amount of Outstanding, EAD, and Lending Limit

Pair Composition	# Observations	Mean	Variance	P-Value
Outstanding and EAD	3	2,579,608,222	38,839,156,293,486,900	0.01856387
Outstanding and Lending Limit	3	2,579,608,222	38,839,156,293,486,900	0.01886542
EAD and Lending Limit	3	3,781,251,466	9,575,792,257,781,250	0.01904562

Also, we perform a t-test to see if metrics are different in terms of emission intensity. Table 8 shows the number of observations, mean, variance, and p-value for each metric based on the emission intensities calculated using outstanding, EAD, and lending limit. We can see that the p-values of outstanding and lending limit, and outstanding and lending limit are lower than 0.05. Hence, we can say that they are statistically different metrics. Nevertheless, the p-value of EAD and lending limit is higher than 0.05 so we can accept the null hypothesis, which means they have no significant differences.

Table 8. T-test for Yearly Analysis for Emission Intensity Based on Outstanding, EAD, and Lending Limit

Pair Composition	# Observations	Mean	Variance	P-Value
Outstanding and EAD	2	0.1905	0.000018	0.18536870
Outstanding and Lending Limit	2	0.1905	0.000018	0.12888106
EAD and Lending Limit	2	0.1885	0.000005	0.05256846

Table 9 shows results of regression test including R^2 values and p-values. In terms of emission intensities, we can say that outstanding can explain 42.6% of the variance, EAD can explain 46.5% of the variance, and lending limit can explain 47.2% of the variance. Hence, we can say that outstanding has the lowest R^2 value and lending limit has the highest R^2 value. Thus, we can say that lending limit, which has the highest R^2, implies it is statistically more crucial to predict emission intensity than outstanding. Considering that the annual data analysis result in a limited number of observations, we do a monthly analysis, following a similar scheme: paired wise t-test, and regression analysis to verify if the metrics are statistically different. The results are shown in the Appendix D, and it demonstrates the same result as yearly analysis.

Table 9. Regression Test for Yearly Analysis

Independent Variables	R^2	Significance F (P-Value)
All Metrics	0.48122447	0.000072
Outstanding	0.42601033	0.000013
EAD	0.46522664	0.000004
Lending Limit	0.47234725	0.000003
Outstanding and EAD	0.46630425	0.000025
Outstanding and Lending Limit	0.47777516	0.000017
EAD and Lending Limit	0.47480250	0.000019

In order to analyse the cause of the changes in the portfolio for all metrics, the changes due to changes of the portfolio change based on outstanding, EAD, and lending limit, and the changes caused by emission intensity changes are calculated. It was assumed that the weight of each company stays the same when calculating the changes caused by the portfolio change.

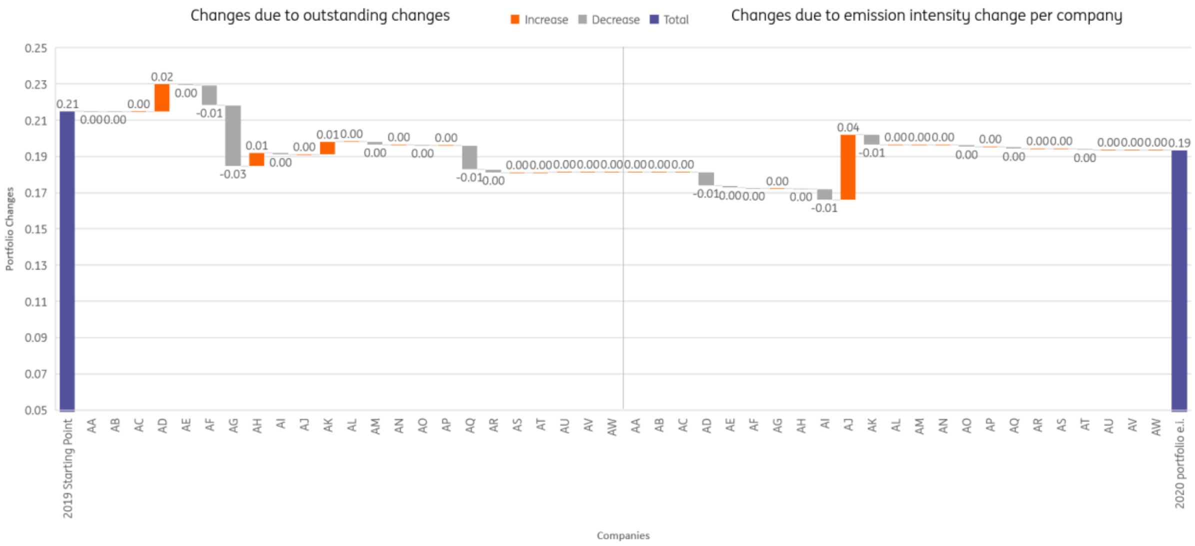

Figure 29. Changes of Emission Intensity Based on Outstanding from 2019 to 2020

Figure 29 shows changes of emission intensity for outstanding from 2019 to 2020. We split the graph into two drivers. The left side of Figure 29 represents a driver caused by outstanding changes and the right side represents a driver caused by the emission intensity of the company. We see that the there are some changes caused by the portfolio size, but there are no significant changes caused by emission intensity changes. However, company AJ contributed to the significant emission intensity change while not drawing any money. In addition, company AG contributed the most to changes caused by outstanding changes and significantly decreased so it fluctuates, and it is volatile.

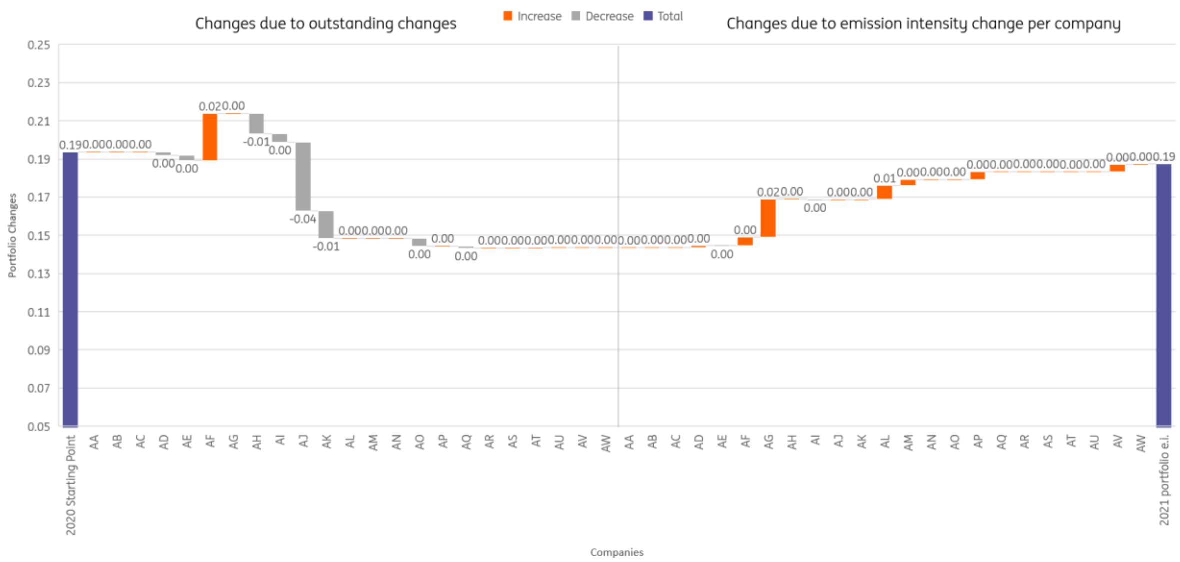

Figure 30. Changes of Emission Intensity Based on Outstanding from 2020 to 2021

Figure 30 shows changes of emission intensity for outstanding from 2020 and 2021. Unlike the previous year changes, company AG does not fluctuate, but company AF and AJ fluctuate. In addition, we see that company AJ has the most significant change caused by outstanding changes and slight increase in its emission intensity.

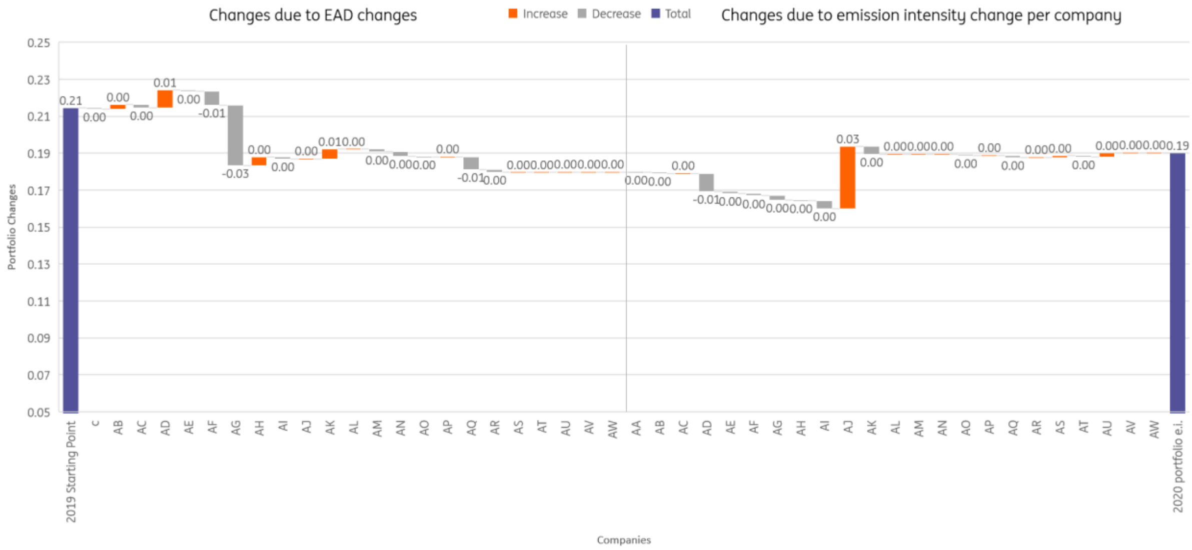

Figure 31. Changes of Emission Intensity Based on EAD from 2019 to 2020

On the one hand, Figure 31 shows changes of emission intensity based on EAD from 2019 to 2020. As outstanding, we see that company AJ contributed the most to the changes caused by emission intensity while not having any changes in the portfolio size. As outstanding, company AG contributed the most to changes caused by EAD changes and it has decrease in its portfolio size, so it is volatile.

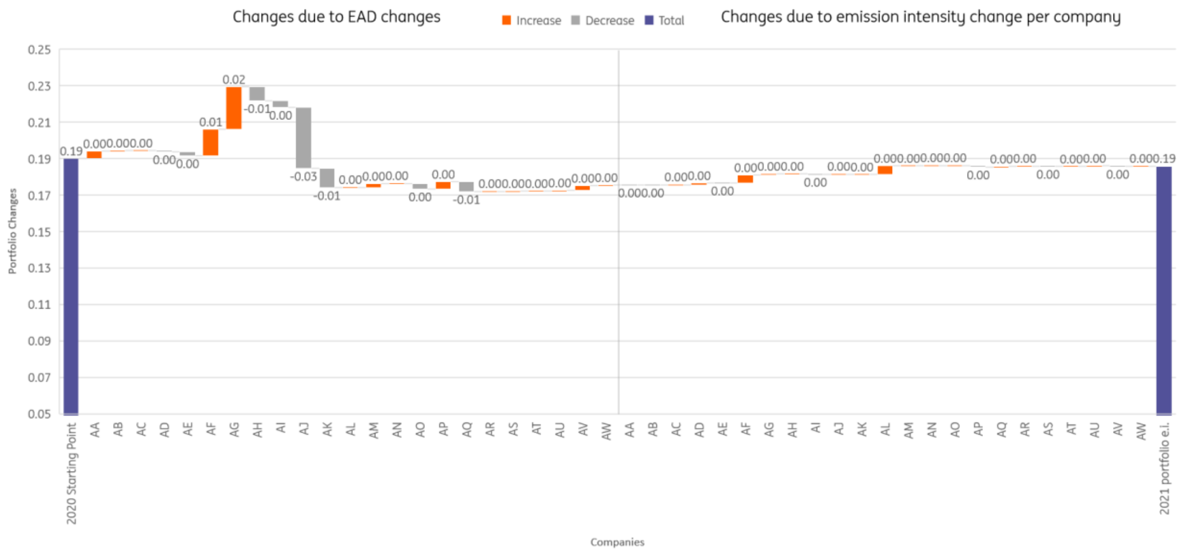

Figure 32. Changes of Emission Intensity Based on EAD from 2020 to 2021

Figure 32 shows changes of emission intensity based on EAD from 2020 and 2021. We see that company AJ has the most significant change caused by outstanding while not having any changes in its emission intensity. Also, company AG fluctuates. Although there are no significant changes in the emission intensity for all companies, company AF and AL have relatively more changes in their emission intensities.

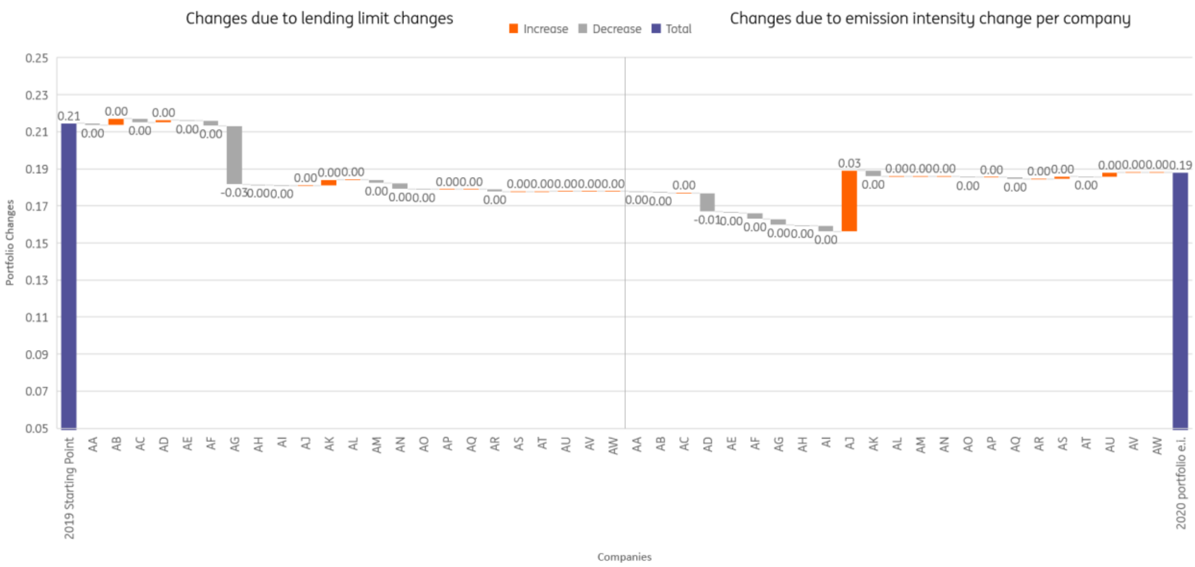

Figure 31. Changes of Emission Intensity Based on Lending Limit from 2019 to 2020

In addition, Figure 31 shows changes of emission intensity based on EAD from 2019 to 2020. As outstanding and EAD, we can see that company AJ contributed the most to the changes caused by the emission intensity while not having any changes cause by its metric. Also, company AG follows the same trend as outstanding and EAD. It contributes the most to changes caused by lending limit changes and it has decrease in its portfolio size while having slight changes in its emission intensity. However, it is generally stable.

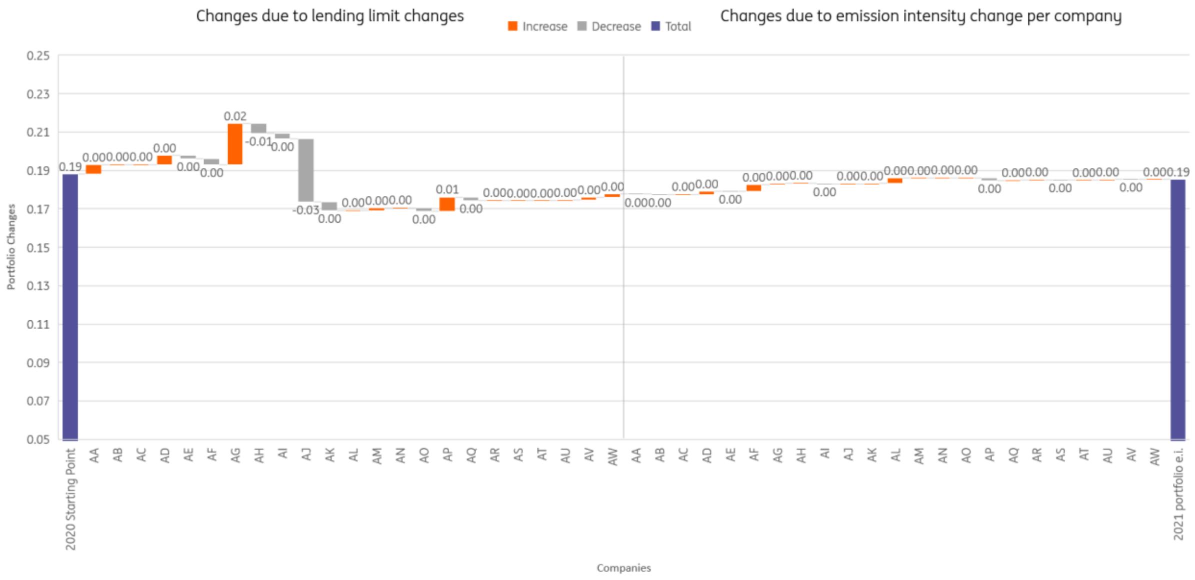

Figure 34. Changes of Emission Intensity Based on Lending Limit from 2020 to 2021

Figure 34 shows changes of emission intensity based on lending limit from 2020 and 2021. We see that company AI has the most significant change caused by lending limit while not having any changes in its emission intensity. On the one hand, company AG has a significant increase in the changes caused by lending limit changes. There are no significant changes in the emission intensity for all companies, but company AF and AL have relatively more changes in their emission intensities. Company AF has a slight increase in its emission intensity while having decrease in changes due to lending limit changes. In addition, company AL has a slight increase in its emission intensity.

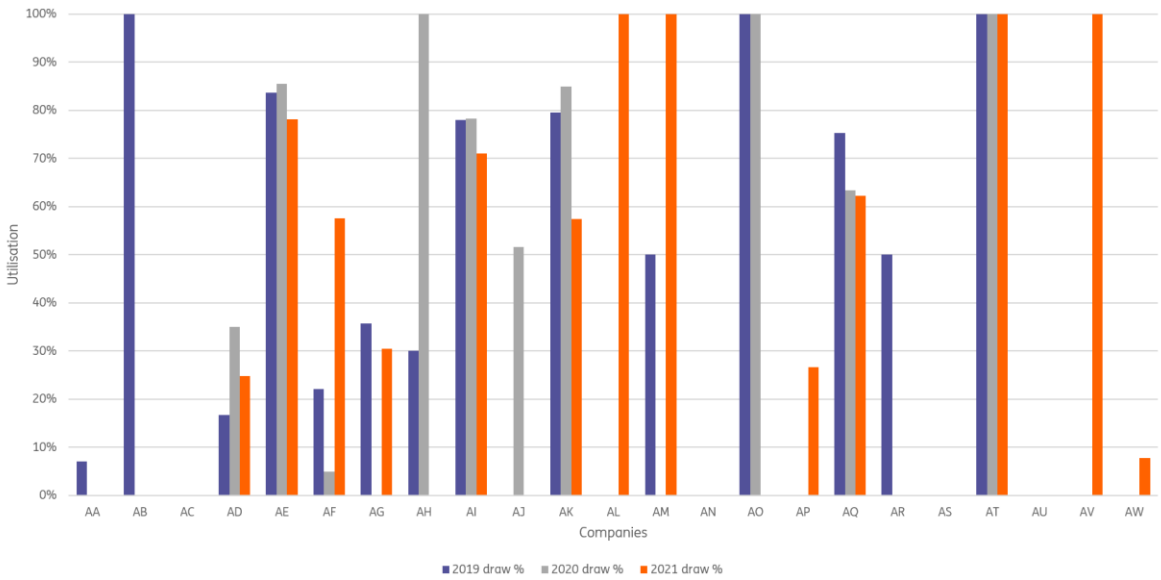

Figure 35. Lending Limit Year-to-Year Utilisation Comparison

Figure 35 shows the withdrawal percentage in terms of lending limit and how the company is utilising the limit and it is changing from year to year in terms of utilisation. In Figure 31, we see that company AT utilises the full amount of limit and company AE and AI utilises relatively stable amount of lending limit over the years. On the one hand, company AD utilises relatively stable amount over the years and company AF shows volatile pattern since it drastically decreases in 2020 and increases in 2021. In order to check what metric represents the best in terms of utilisation, we look at breakdown of the portfolio based on each metric.

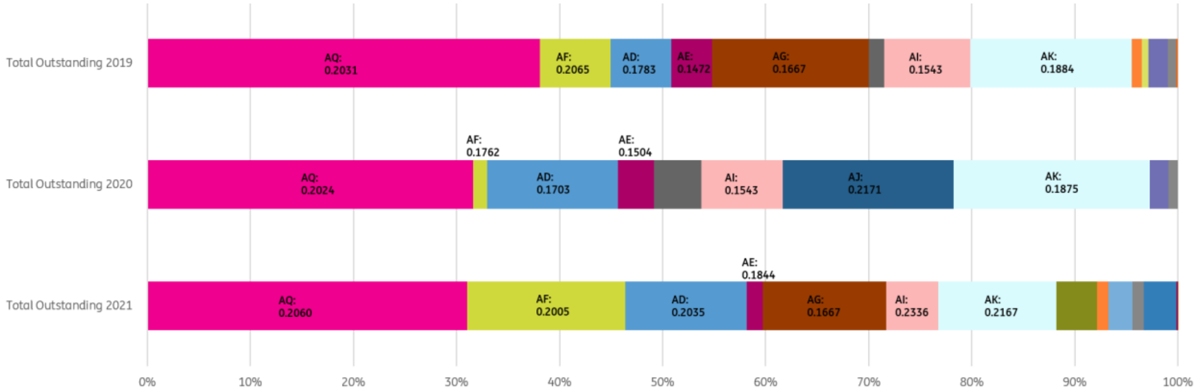

Figure 36. Breakdown of the Portfolio Based on Outstanding

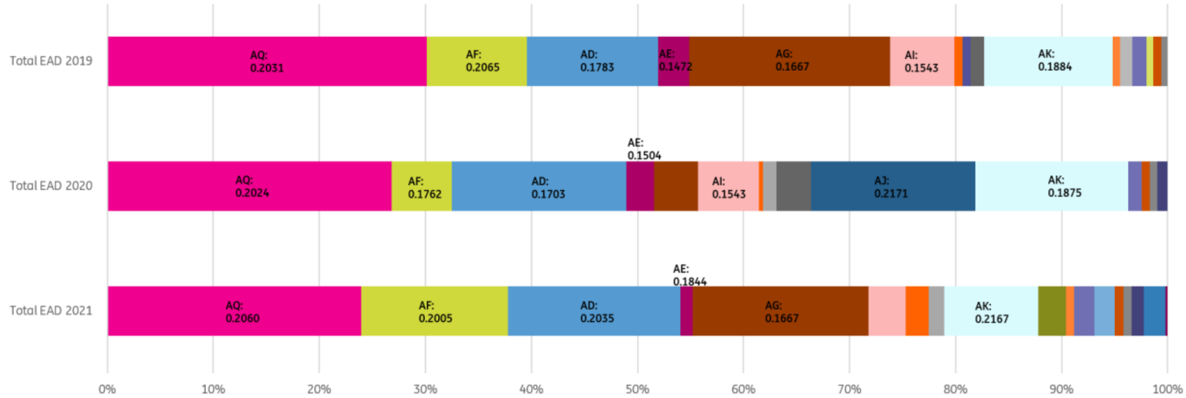

Figure 37. Breakdown of the Portfolio Based on EAD

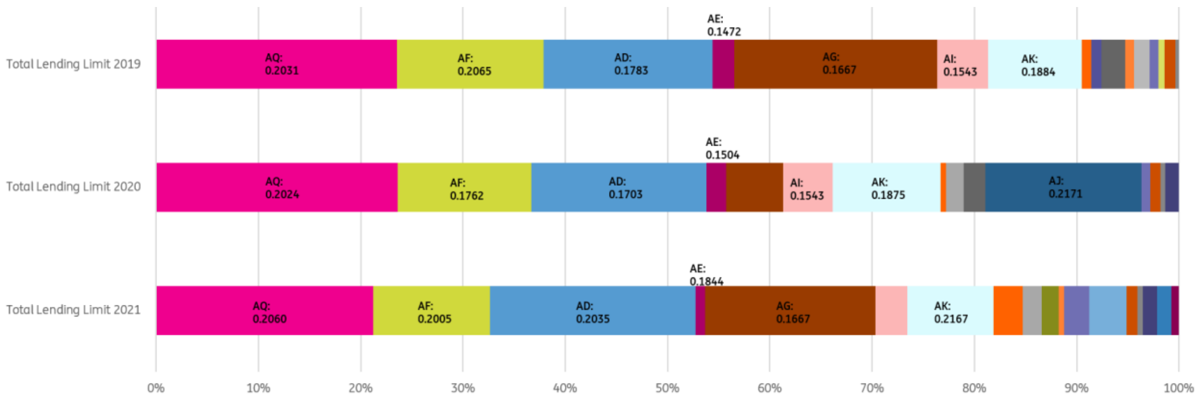

Figure 38. Breakdown of the Portfolio Based on Lending Limit

Figure 36, Figure 37, and Figure 38 show details about how the relative percentage illustrates over the years. If we look at company AD based on Figure 38, which is based on the lending limit, it shows the limit of company AD was continuously increased in terms of its relative share. In addition, the relative share of company AG is relatively high. However, if we look at Figure 36 that is based on outstanding, the relative share is different. The relative share of company AD is increased from 2019 to 2020 and decreased from 2020 to 2021. In addition, based on Figure 36, the relative share of company AQ is continuously increased even though there is a slight increase from 2019 to 2021 and decrease from 2020 to 2021 in Figure 38, which is based on lending limit.

In summary, based on the breakdown of the portfolio, we see that company AQ has approximately 20% of the limit based on Figure 38, but it has 30% of the outstanding in Figure 36. In terms of lending limit, company AF remains quite stable from 2019 to 2021 in Figure 38, but Figure 26 shows it is volatile in terms of outstanding. In addition, based on Figure 38, the relative share of company AD is continuously increased in terms of lending limit, but Figure 36 shows it increases in 2020 and decreases in 2021 in terms of outstanding.

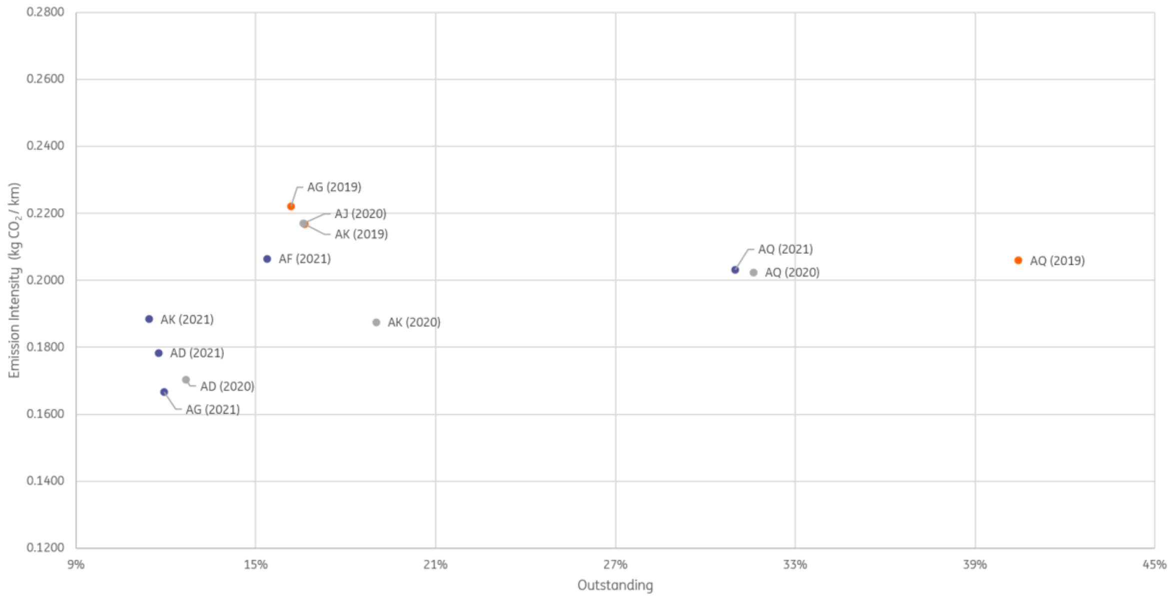

Figure 39. Year-to-Year Portfolio Composition Change based on Outstanding

In order to analyse the weight of each company based on its emission intensity, scatter plots are made. For the x-axis, the minimum scale was set to 9% to see companies to focus on the companies that have significant weights in the portfolio. Figure 39 shows the portfolio composition change based on outstanding from 2019 to 2021. Although company AD from 2020 to 2021 and company AQ from 2019 to 2021 are clustered, it is difficult to see clusters and most of the companies are dispersed. Thus, most of the companies are not stable over the years in terms of outstanding.

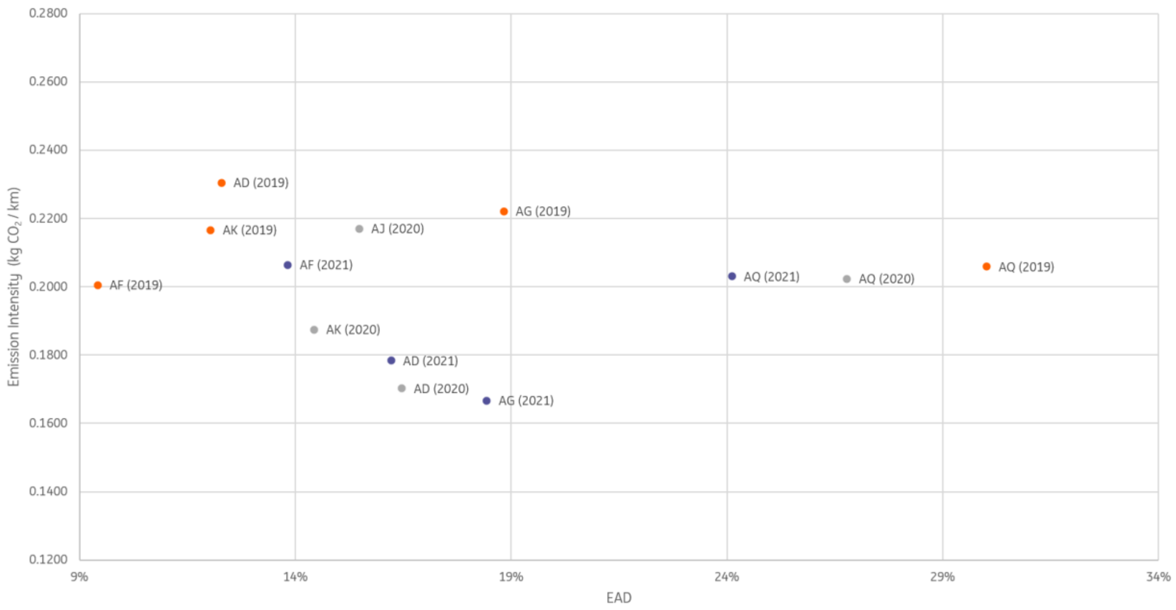

Figure 40. Year-to-Year Portfolio Composition Change based on EAD

In addition, Figure 40 shows the portfolio composition change based on EAD from 2019 to 2021. We see that company AD from 2020 to 2021 and AQ from 2020 to 2021 are relatively clustered, but company AQ shows a decreasing pattern over the years and there is a gap between the datasets from 2020 to 2021 and the dataset from 2019.

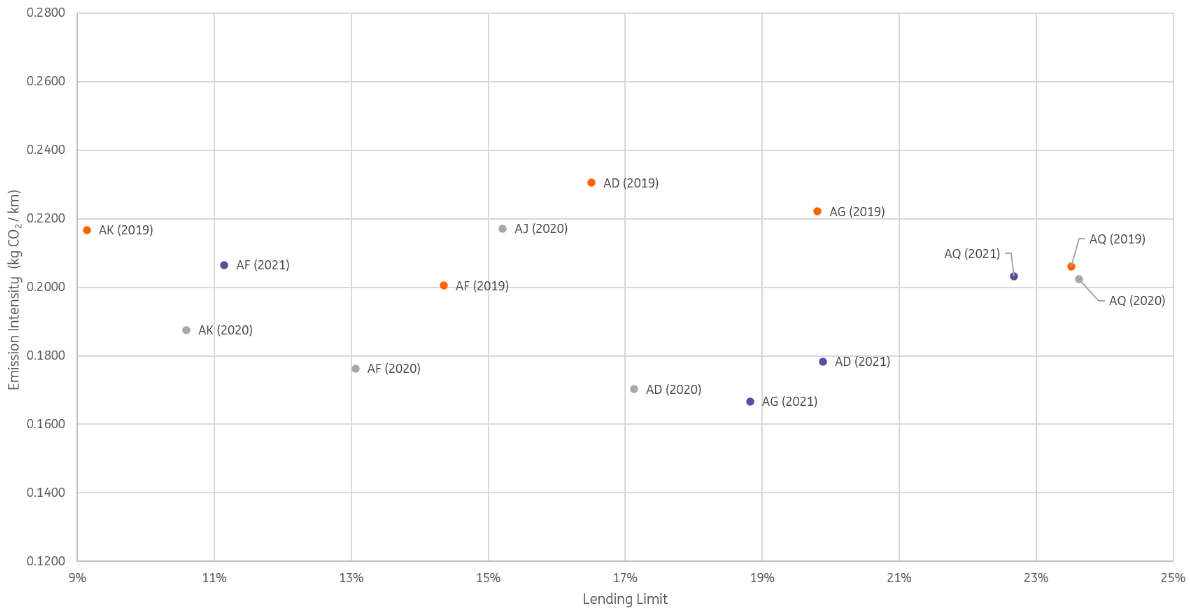

Figure 41. Year-to-Year Portfolio Composition Change based on EAD

On the one hand, Figure 41 shows portfolio composition change based on lending limit from 2019 to 2021. Based on Figure 41, we see that company AQ are clustered over the years and some companies maintain relatively close distance each other. For example, company AD from 2020 and 2021, company AL from 2019 and 2021, and company AD from 2020 and 2021 have relatively close distance to each other. Unlike outstanding and EAD, we see two complete clusters.

Based on the year-to-year composition changes, it is possible to see that lending limit showed the most stable pattern since most of the companies are clustered. However, outstanding and EAD relatively have dispersed pattern over the years. Similar analysis was conducted for the portfolio without applying product filters for better understanding (see Appendix D) and monthly analysis due to the limited number of samples in the yearly analysis (see Appendix E). The yearly analysis without the product filters shows that outstanding and EAD have the similar pattern in terms of the portfolio size, but lending limit has a different trend since it is continuously increased over the years. Unlike the yearly analysis with the product filters, the portfolio size of outstanding, EAD, and lending limit is continuously increased over the years. Nevertheless, the yearly analysis with the product filters showed the similar results as the yearly analysis. On the one hand, the monthly analysis shows that lending limit is the most stable in terms of the portfolio size and emission intensity and outstanding and EAD follow the same pattern. In terms of the utilisation, lending limit showed the most stable pattern over the months.

5.2 Answering Knowledge Problems and Management Implications

Portfolio emission intensity shows the emissions produced by the companies that the bank finances and the emissions resulted from the bank's own operations. Hence, by tracking the portfolio emission intensity, ING is able to evaluate its exposure to climate risks, identify climate risks, and seek opportunities in its lending and investment activities towards decarbonisation.

The current measurement methodology is based on outstanding. It is volatile because it depends on the company needs and clients and how much money the company is deciding to withdraw, and it is not reflecting how much the company is spending or could have spent in the year. In addition, there is a significant drawback since it is not possible for ING to control outstanding. On the one hand, EAD considers the bank's exposure to climate risks by looking at the probability of default and the expected loss in the case of default so it can lead to a more accurate estimate the bank's exposure to climate risk On the other hand, lending limit is the loan that ING signs, and what ING offers to its clients so it is more constant because it is decided by ING and the money that ING is eager to give to its clients, so it is more reflecting the reality. exposure to climate risk. Hence, they might be an alternative metric.

Based on the analysis of the cement sector, outstanding showed the most stable pattern. However, the analysis of automotive sector showed that lending limit is the metric that is stable and involatile. Although outstanding showed stability in the cement sector, it has drawbacks that ING is not able to control its actions because it depends on the demand of clients. Hence, considering the controllable characteristics of lending limit, lending limit is able to represent ING's actions and emission intensity since it is possible for ING to control the actions of clients and have impacts on the lending activities of its clients based on their performance and emission intensities towards the net zero goal.

5.3 Summary

Based on the analysis of the cement sector with and without the product filters, the portfolio emission intensity measured in outstanding is the highest and lending limit is the lowest. In addition, the portfolio composition in outstanding is more stable from year to year compared to EAD and lending limit. Generally, lending limit shows more stability compared to outstanding and EAD. On the one hand, the analysis of the automotive sector shows that the portfolio emission intensity measured in outstanding is highest and lending limit is generally lower than EAD except in 2019. In addition, the portfolio compositions from year-to-year comparison are similar in terms of outstanding, EAD, and lending limit. The analyses show different results in terms of stability. Considering the importance of having controllable and actionable metric from ING's perspective, lending limit can help ING to take actions such as increasing or decreasing the lending limit based on the performance of its clients.

6 Conclusions

The research has analysed the portfolio emission intensities of the cement and automotive sector. Based on the analysis of the cement sector, outstanding showed the most stable trend over the years. Based on the observation, all metrics move with the same trend over the years, but outstanding is more stable than the other two metrics. Also, the portfolio emission intensity measured in outstanding is the highest, and lending limit is the lowest. In addition, volatility of each company becomes higher when EAD and lending limit are used, and lending limit shows more stability between EAD and lending limit. The yearly analysis without the product filters shows the similar results with the yearly analysis with the product filters.

The analysis of the automotive sector, however, showed different findings. The portfolio emission intensity measured in outstanding is the highest, and generally lending limit is lower than EAD except for 2019. However, the portfolio compositions in year-to-year comparison are similar in terms of outstanding, EAD, and lending limit. Based on the yearly analysis, lending limit shows more stability in terms of year-to-year composition and there are no significant differences between the yearly analysis with the product filters and without product filters. In addition, based on monthly analysis, lending limit shows a more stable pattern in terms of portfolio size and emission intensity changes compared to month-to-month composition changes.

If the lending limit is used for the measurement metric, ING is able to control the limits based on the performance of its clients. For example, if a company has a negative performance in the portfolio, ING can take actions such as lowering the lending limit to encourage the company to perform better in the portfolio. However, if the outstanding is used, there is a possibility that it might show volatility since it is unpredictable. If such situations occur, it is not possible for ING to take actions against it since it is dependent on the needs of clients. In addition, EAD is a metric that ING cannot control, and it is partially outstanding, so it still makes difficult for ING to control its portfolio towards decarbonisation. Therefore, by tracking the portfolio emission intensity with lending limit, it is possible for ING to control and take suitable actions based on the performance of its clients and make decisions based on their emission intensities towards the net zero goal.

6.1 Limitations and Future Research

The research has analysed portfolio emission intensities in the cement and automotive sector. Therefore, it implies the limitations in terms of utilisation of the proposed method in other sectors. For example, the oil and gas sector is depending on the oil price. Hence, it is difficult to predict if the company will draw or not. Therefore, in this case, it might be ideal to use both outstanding and lending limit to measure the performance of the portfolio.

For future research, the impact of using a combination of outstanding and lending limit on the portfolio is recommended. Also, it might be interesting to analyse predictable and unpredictable characteristics of each sector and do experimental studies to examine different results of using one metric or combined metric.

On the one hand, due to the data limitations, the research can be extended as analysing the correlations between different sectors and conducting time series analysis to predict the emission intensity. The main limitation of the study is the limited number of observations for the analysis, but the monthly analysis is conducted for the automotive sector (see Appendix E). Due to the data availability issue, the monthly analysis is only conducted for the automotive sector. In order to have a solid conclusion, it is required to do the same analysis without the product filters including all lending products and more frequent analysis such as monthly and quarterly analysis.

References

Adnan, K. M. M., Ying, L., Ayoub, Z., Sarker, S. A., Menhas, R., Chen, F., & Yu, M. (2020). Risk management strategies to cope catastrophic risks in agriculture: the case of contract farming, diversification and precautionary savings. *Agriculture*, *10*(8), 351. https://doi.org/10.3390/agriculture10080351

Ardia, D., Bluteau, K., Neely, C. J., & Inghelbrecht, K. (2022). Climate change concerns and the performance of green vs. brown stocks. *Management Science*. https://doi.org/10.1287/mnsc.2022.4636

Barrett, G. B. (2000). The Coefficient of Determination: Understanding r squared and R squared. *Mathematics Teacher: Learning and Teaching PK–12*, *93*(3), 230–234. https://doi.org/10.5951/mt.93.3.0230

Birindelli, G., & Palea, V. (2022). To green or not to green? How CSR mechanisms at the governance level affect the likelihood of banks pursuing green product strategies. *Corporate Governance*, *23*(1), 219–242. https://doi.org/10.1108/cg-09-2021-0349

Chevron Policy, Government and Public Affairs. (2022). Explainer: What is carbon intensity? *chevron.com*. https://www.chevron.com/newsroom/2022/q4/explainer-what-is-carbon-intensity

Dorey, F. J. (2010). The p value: what is it and what does it tell you? *Clinical Orthopaedics and Related Research*. https://doi.org/10.1007/s11999-010-1402-9

Fu, J., & Ng, A. W. (2021). Scaling up Renewable Energy Assets: Issuing Green Bond via Structured Public-Private Collaboration for Managing Risk in an Emerging Economy. *Energies*, *14*(11), 3076. https://doi.org/10.3390/en14113076

Guenedal, T. L., Girault, J., Jouanneau, M., Lepetit, F., & Sekine, T. (2020). Trajectory Monitoring in Portfolio Management and Issuer Intentionality Scoring. *Social Science Research Network*. https://doi.org/10.2139/ssrn.3630302

ING. (2021). 2021 Climate Report. https://www.ing.com/web/file?uuid=0c2f37a6-778d-4631-8a07-555c877353b4&owner=b03bc017-e0db-4b5d-abbf-003b12934429&contentid=54093

Jankowski, K. R. B., Flannelly, K. J., & Flannelly, L. T. (2017). The *t*-test: An Influential Inferential Tool in Chaplaincy and Other Healthcare Research. *Journal of Health Care Chaplaincy*, *24*(1), 30–39. https://doi.org/10.1080/08854726.2017.1335050

Kedward, K., Ryan-Collins, J., & Chenet, H. (2022). Biodiversity loss and climate change interactions: financial stability implications for central banks and financial supervisors. *Climate Policy*, 1–19. https://doi.org/10.1080/14693062.2022.2107475

Khan, M. S., Riaz, H., Ahmed, M., & Saeed, A. (2022). Does green finance really deliver what is expected? An empirical perspective. *Borsa Istanbul Review*, *22*(3), 586–593. https://doi.org/10.1016/j.bir.2021.07.006

Pyka, I., & Nocoń, A. (2021). Banks' Capital Requirements in Terms of Implementation of the Concept of Sustainable Finance. *Sustainability*, *13*(6), 3499. https://doi.org/10.3390/su13063499

Rana, A., Zhu, Q., Detken, A., Whalley, K., & Castet, C. C. (2022). Strengthening climate-resilient development and transformation in Viet Nam. *Climatic Change*, *170*(1–2). https://doi.org/10.1007/s10584-021-03290-y

Steady state: Prioritising stability in a volatile market. (2021, September 13). McKinsey & Company. https://www.mckinsey.com/featured-insights/asia-pacific/steady-state-prioritising-stability-in-a-volatile-market

Toma, P., & Stefanelli, V. (2022). What are the banks doing in managing climate risk? Empirical evidence from a position map. *Ecological Economics*, *200*, 107530. https://doi.org/10.1016/j.ecolecon.2022.107530

Travers, J. C., Cook, B. G., & Cook, L. (2017). Null hypothesis significance testing and P values. *Learning Disabilities Research and Practice*. https://doi.org/10.1111/ldrp.12147

United Nations. (n.d.). *The Paris Agreement | United Nations*. https://www.un.org/en/climatechange/paris-agreement

Appendices

Appendix A. The Concept Matrix of How Banks can Manage Climate Risks

Table A-1. The Concept Matrix of the Concept Matrix of How Banks can Manage Climate Risks

Articles/Concepts	Study	Main objective	Definition of climate risk	Impacts of managing climate risk
Toma & Stefanelli (2022)	Effective climate risk management and sustainable economic development.	Evaluation of the effectiveness of the strategic choices that banks are currently making to comply with supervisory regulations and mitigate climate risk.	Poses a threat to the stability and soundness of financial companies through physical risks and transition risks.	Provide valuable insights for policy and managerial orientations to better protect the interests of stakeholders.
Kedward et al. (2022)	Drawbacks of the prevailing ‘manage by measuring’ approach in climate finance policy.	Proposal of alternative options for policymakers to assess and manage biodiversity-related financial risks and climate-related financial risks.	Not found.	Banks can use policy toolkits to finance and coordinate activities.
Fu and Ng (2021)	Analysis of the developing green financial system supported by public and	Explore how the underlying risks of financing renewable	Not found.	Scale up renewable energy assets under clear

	private organisations.	energy assets are managed.		restrictions ad standards.
Rana et al. (2022)	Assess current and future climate impacts facing Vietnam from tropical cyclones (TCs), particularly winds and tidal waves, and evaluate various adaptation measures to manage these risks.	Help decisionmakers to make more informed decisions.	Persistent and significant threat to various regions, communities and infrastructure around the world.	Creation of an economic framework for policy and decision makers to understand benefits of risk reduction and the costs associated with developing adaptation strategies.
Adnan et al. (2021)	Different risk management strategies chosen by farmers.	Identification of the correlation between the farmers' choices and risk management strategy.	The biggest challenges of our time.	Increased likehood of extraordinary, unforeseen, and unfavorable circumstances.
Ardia et al. (2022)	Verify the hypothesis of Pástor et al. (2021) that environmentally sustainable companies surpass fossil fuel-oriented companies during times of sudden rise in climate change	Evaluate whether effects apply to both transition and physical climate change risk issues by analysing cash flow and discount rates of brown and green firms.	Not found.	Concern about climate change also impact a company's stock, and exposure can be managed by changing the intensity of greenhouse gas emissions.

	concerns by analyzing data of S&P 500 corporations from January 2010 to June 2018.			
Reguero et al. (2020)	Assessment of the resilience insurance with hypothetical cases for coral reef restoration.	Evaluate whether the resilience insurance mechanism can be applied to a significant number of coastlines and can help finance nature-based adaptation.	Not found.	Sea level rise.
Doeffinger & Rubinyi (2023)	The secondary benefits of urban flood protection.	Provide an overview of the current debate on secondary benefits, with a focus on methods for project selection of urban food control interventions and methodological issues.	Not found.	Increase the vulnerability in urban areas.
Liao and Ren (2020)	Analysis of the impact of energy-biased technological advances on	Use a regression model to measure the progress of energy bias	Not found.	Not found.

	energy efficiency.	technology and energy efficiency.		

Appendix B. The Concept Matrix of Green Financing

Table B-1. The Concept Matrix of Green Financing

Articles/Concepts	Study	Main objective of the study	Definition of the green financing	Impacts of green financing
Pyka & Nocon (2021)	How the new banking regulations change the way that the banks hold and manage capital to mitigate risk.	How the risks of the volatile environment of credit institutions can be used to shape expectations for sustainable finance implementation.	Drivers of change in attitudes of banks towards bank operations.	Increasement of the bank's resilience to sustainable development risks.
Khan et al. (2022)	The effect on the ecological footprint in 26 economies in Asia.	How the green finance reduces the ecological footprints.	Climate mitigation finance.	Reduction of the ecological footprints and improvement of environmental quality.
Birindeli & Palea (2023)	The development of CSR characteristics and green product strategies across regions and time.	Examine how bank's governance-level corporate social responsibility (CSR) mechanisms relate to their probability of pursuing eco-friendly product strategies.	Capital investments directed towards sustainable development projects and initiatives, eco-friendly products, and policies that promote the growth of a more sustainable economy.	Increase in the financial performance of the company in the long term while improving energy efficiency in the country.
Geddes et al. (2020)	Analysis of the parliamentary	How green products that	Not found.	Not found.

	discussions that led to the creation and structure of the UK's Green Investment Bank and Australia's Clean Energy Finance Corporation.	banks provide to encourage their clients to adopt a sustainable approach.		
Tolliver et al. (2019)	How much of the green bond proceeds were used to fund projects and assets that align with environmental outcomes related to SDGs and NDCs.	Examine green bond issuers, how they invest in eco-friendly categories, and the expected environmental impacts of these investments to determine their contribution towards achieving SDG and NDC objectives.	Not found.	Not found.
Tolliver et al. (2020)	Evaluation of how green bond finance for renewable energy is affected by the Nationally Determined Contributions (NDCs) to the Paris Agreement.	Assessment of the distinctive effects that NDCs have on the distribution of green bonds for renewable energy.	Not found.	Not found.

D’Orazio (2021)	Various financial strategies to avoid reinforcing the high-carbon bias of current policies and to address climate-related risks directly in the financial sector.	Propose an enhanced macro-prudential policy framework to achieve three interrelated objectives: tackle climate-related financial risks, scale up green finance for a greener and more sustainable recovery, and preserve the global financial system’s resilience.	Not found.	Not found.
Aleluia (2022)	A review of Southeast Asia's energy sector trends, specifically examining the supply and demand of electricity concerning global efforts to decarbonise.	Identification of the essential role of public policy and governments in hastening the clean energy transition in the region.	Not found.	Not found.
Zhou et al. (2020)	Examination of potential future directions for energy consumption in	Analyse what kind of change in the portfolio is required to reach the target of well below 2 degrees	Not found.	Mobilise expanded investment channels, particularly in

	developing Asian countries.	and the scenarios to reach the target.		the private sector.

Appendix C. Cement Sector without Product Filter

Generally, there was no significance difference between with and without product filter analysis in terms of emission intensity. Table C-1 shows the overview of the emission intensity and the portfolio size based on each metric from 2018 to 2021. On the one hand, Figure C-1 represents the size of the portfolio and emission intensity based on each metric and Figure C-2, Figure C-3, and Figure C-4 show the portfolio composition based on each metric from year-to-year.

Table C-1. Cement Portfolio Emission Intensity Overview without Product Filter

Reporting Year	2018	2019	2020	2021
Emission intensity from the climate report (in tons of CO_2 per tonne of cement)	-	0.7045	0.7042	0.7092
Emission intensity (Outstanding, in in tons of CO_2 per tonne of cement)	0.6943	0.7053	0.7050	0.7116
Emission intensity (EAD, in in tons of CO_2 per tonne of cement)	0.6920	0.7177	0.7144	0.7188
Emission intensity (Lending limit, in in tons of CO_2 per tonne of cement)	0.6904	0.7122	0.7027	0.7092
Total Outstanding	840X	744X	521X	388X
Total EAD	1178Y	1665Y	1379Y	1315Y
Total Lending Limit	1726Z	2746Z	1166Z	1598Z

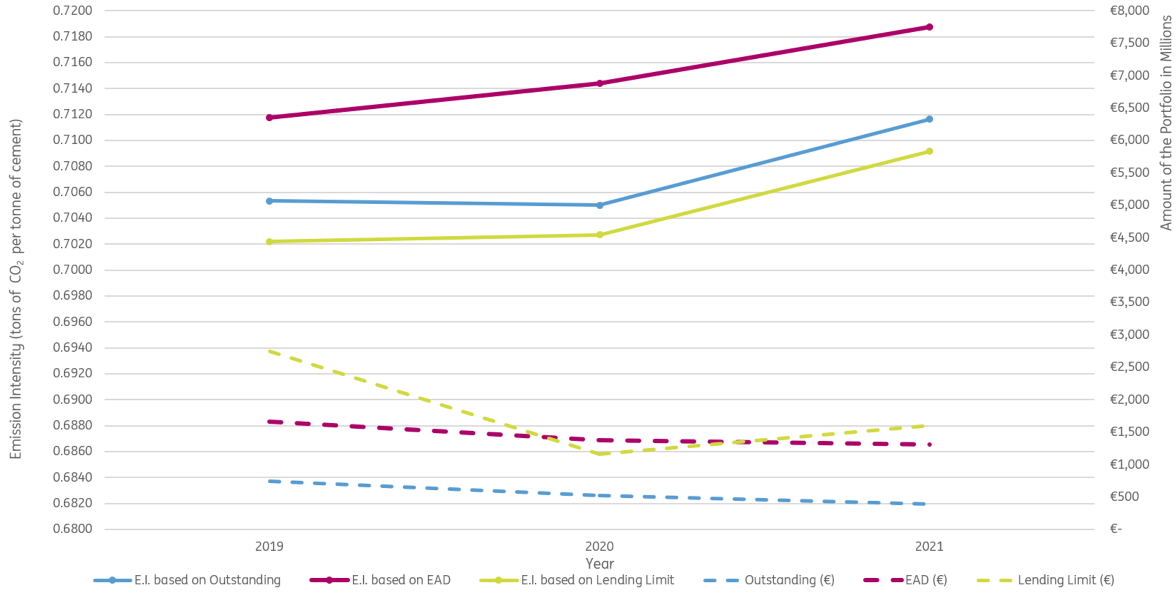

Figure C-1. The Size of the Portfolio with Portfolio Emission Intensities without Product Filter

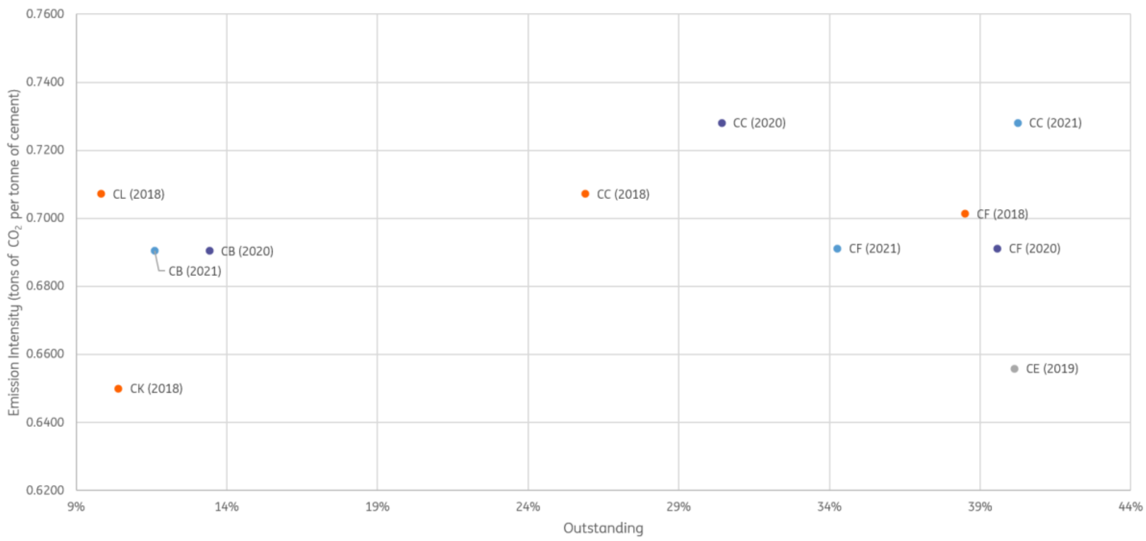

Figure C-2. Year to Year Portfolio Composition Change based on Outstanding without Product Filter

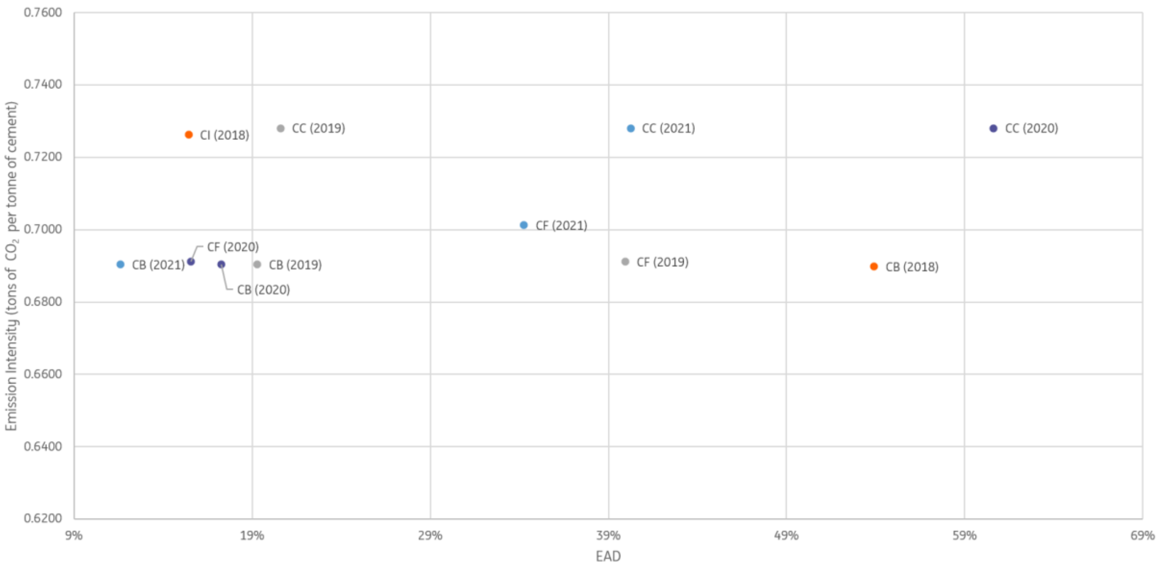

Figure C-3. Year to Year Portfolio Composition Change based on EAD without Product Filter

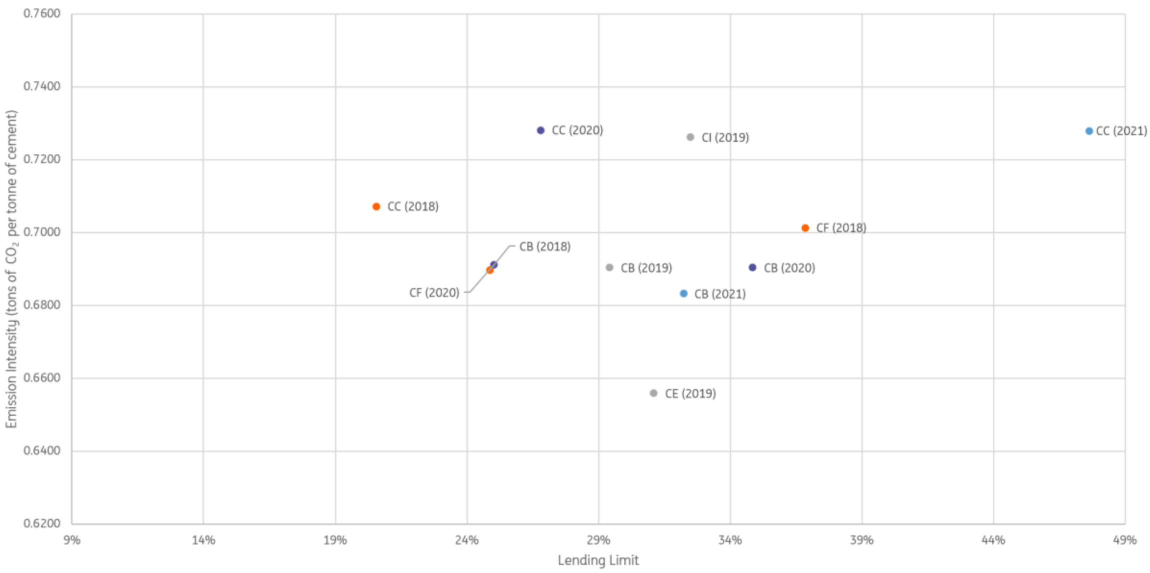

Figure C-4. Year to Year Portfolio Composition Change based on Lending Limit without Product Filter

Appendix D. Automotive Sector without Product Filter

There was no significance difference between with and without product filter analysis in terms of emission intensity. Table D-1 shows the overview of the emission intensity and portfolio size from 2019 to 2021. On the one hand, Figure D-1 represents the size of the portfolio and emission intensity based on each metric and Figure D-2, Figure D-3, and Figure D-4 show the portfolio composition based on each metric from year-to-year.

Table D-1. Cement Portfolio Emission Intensity Overview without Product Filter

Reporting Year	2019	2020	2021
Emission intensity (Outstanding, in kg CO_2/km)	0.2150	0.1935	0.1879
Emission intensity (EAD, in kg CO_2/km)	0.2147	0.1901	0.1862
Emission intensity (Lending Limit, in kg CO_2/km)	0.2148	0.1857	0.1829
Total Outstanding	€ 2,591,178,336	€ 2,775,628,744	€ 2,963,481,686
Total EAD	€ 3,698,354,040	€ 3,906,130,099	€ 3,901,206,307
Total Lending Limit	€ 5,578,827,848	€ 6,488,173,535	€ 8,444,375,377

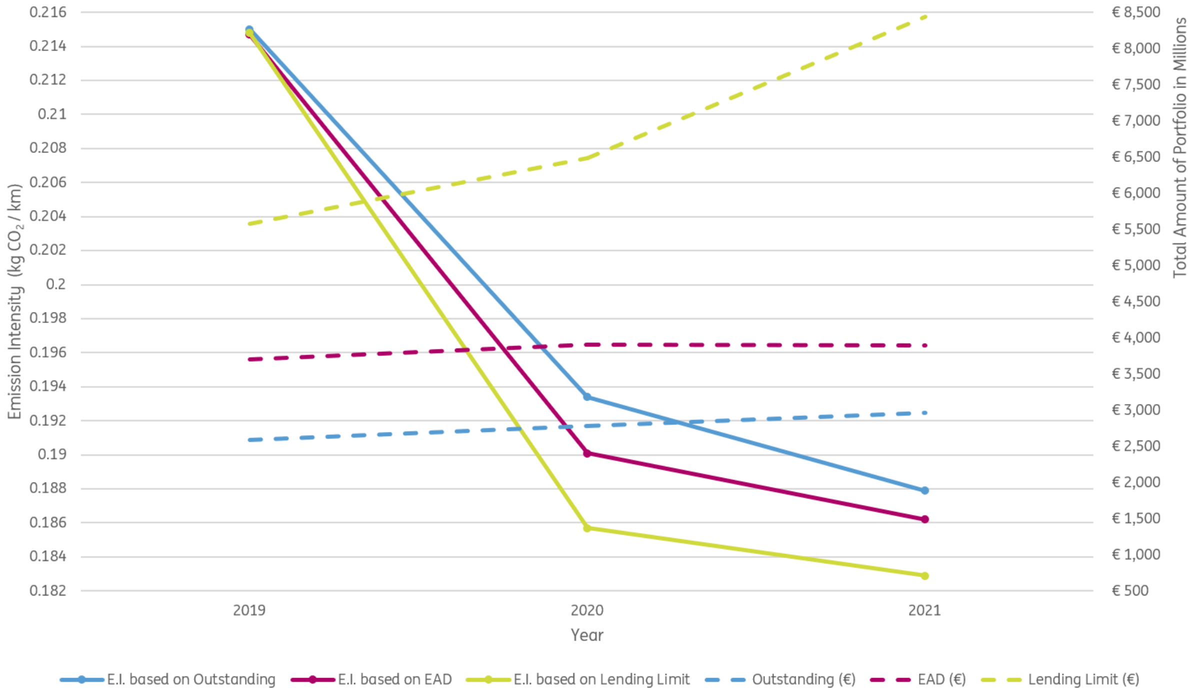

Figure D-1. Portfolio Size and Emission Intensities from 2019 to 2021

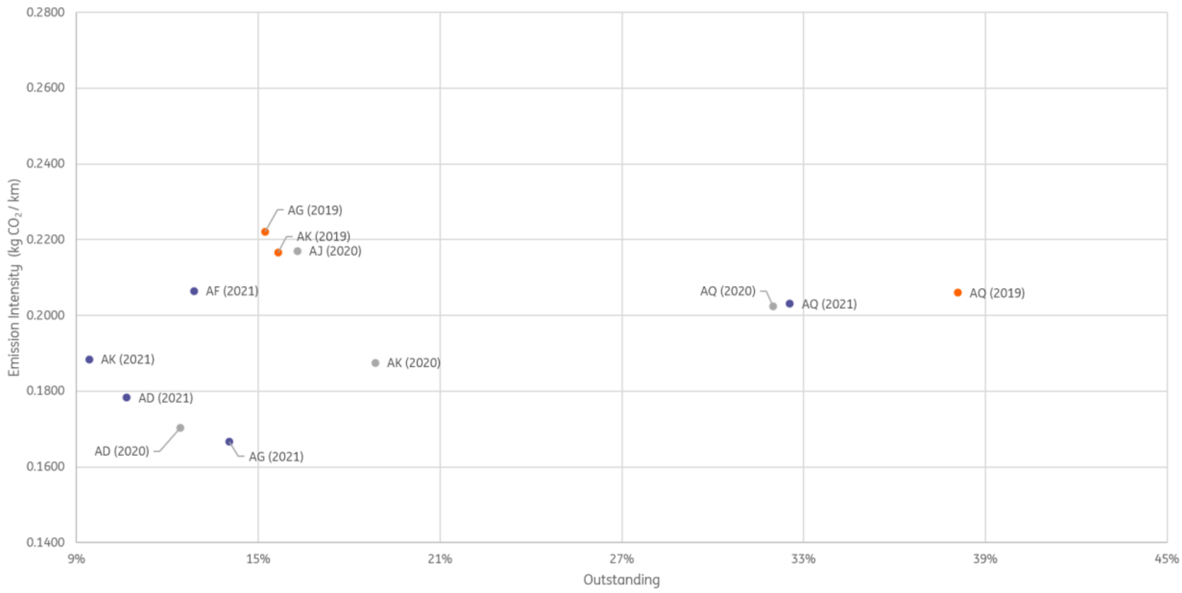

Figure D-2. Year to Year Portfolio Composition Change based on Outstanding without Product Filter

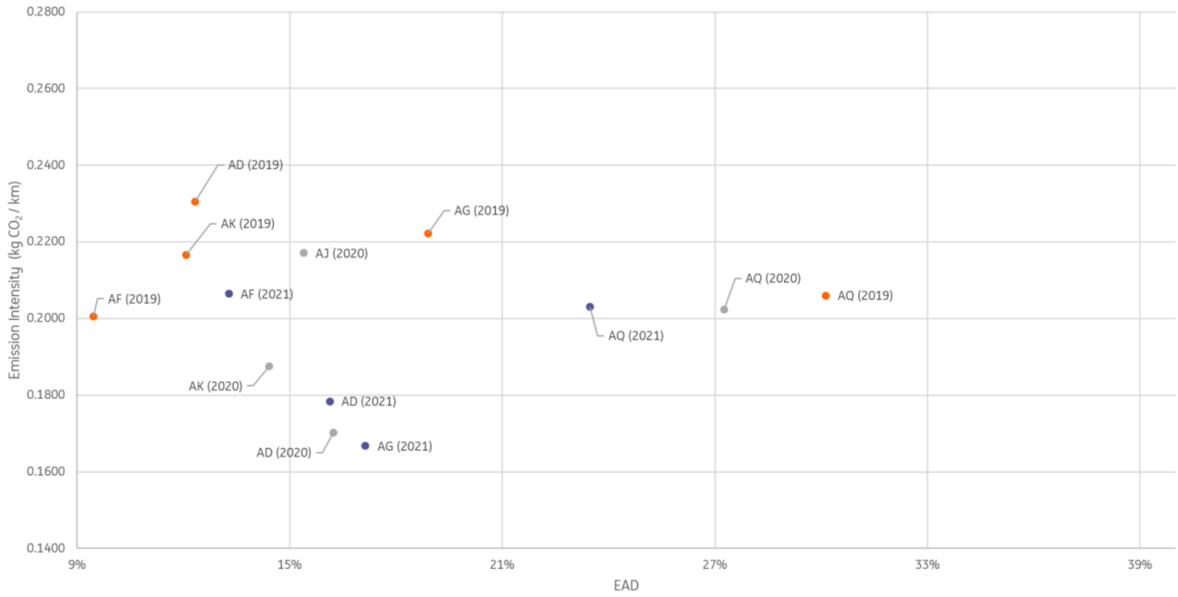

Figure D-3. Year to Year Portfolio Composition Change based on EAD without Product Filter

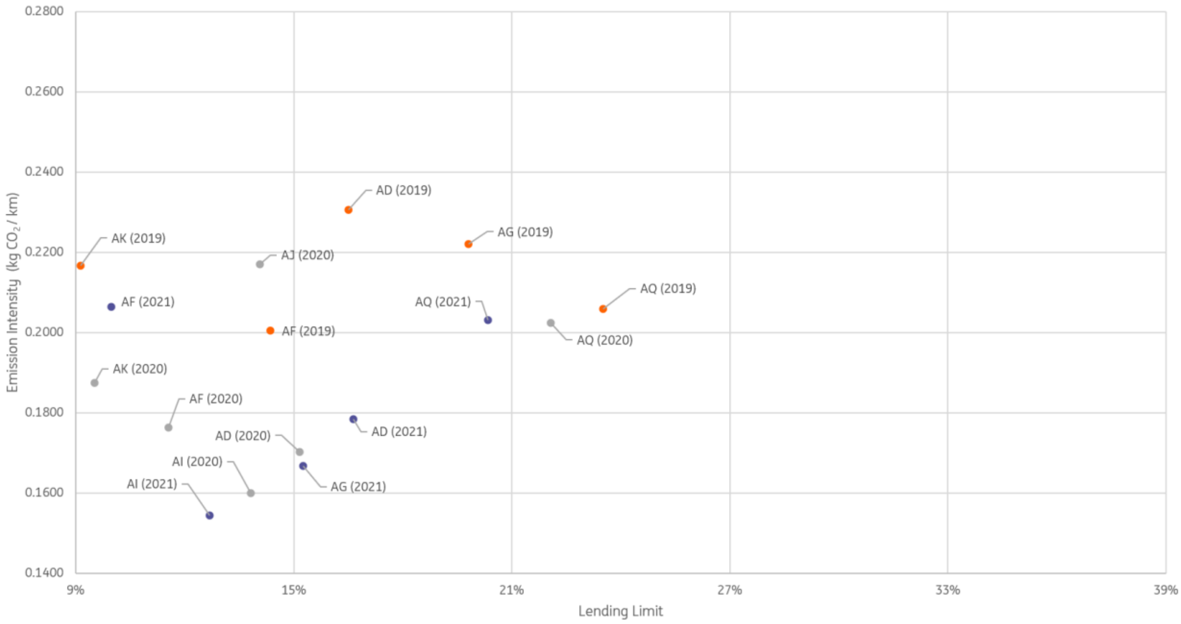

Figure D-4. Year to Year Portfolio Composition Change based on Lending Limit without Product Filter

Appendix E. Automotive Sector: Monthly Analysis

Table E-1 and Table E-2 show the quarterly overview of emission intensity and portfolio size in 2021. Unlike the yearly overview, emission intensity measured in outstanding is the highest except for the first quarter, and emission intensity measured in lending limit is higher than EAD except for the third and fourth quarter.

Table E-1. Automotive Portfolio Emission Intensity Overview with Product Filter

Reporting Year	Q1	Q2	Q3	Q4
Emission intensity (Outstanding) (in kg CO_2/ km)	0.1812	0.1842	0.1871	0.1875
Emission intensity (EAD) (in kg CO_2/ km)	0.1810	0.1831	0.1850	0.1855
Emission intensity (Lending Limit) (in kg CO_2/ km)	0.1828	0.1837	0.1842	0.1848
Total Outstanding	2775X	2697X	2395X	2440X
Total EAD	3769Y	3702Y	3411Y	3628X
Total Lending Limit	5530Z	5645Z	5349Z	5675Z

Table E-2. Automotive Portfolio Emission Intensity Overview without Product Filter

Reporting Year	Q1	Q2	Q3	Q4
Emission intensity (Outstanding) (in kg CO_2/ km)	0.1811	0.1838	0.1867	0.1867
Emission intensity (EAD) (in kg CO_2/ km)	0.1811	0.1830	0.1849	0.1854
Emission intensity (Lending Limit) (in kg CO_2/ km)	0.1802	0.1811	0.1814	0.1821
Total Outstanding	2866X	2753X	2481X	2497X
Total EAD	3854Y	3755Y	3491Y	3683X
Total Lending Limit	6250Z	6334Z	6056Z	6387Z

In order to mathematically analyse the patterns, a statistical test is conducted. Tables below show the results of t-test for monthly analysis in terms of emissions intensities. Table E-3 shows the number of observations, mean, variance, and p-value for each metric based on the amount of outstanding, EAD, and lending limit with the confidence level of 95%. On the one hand, Table E-3 shows the results of t-test and how the metrics are different in terms of emission intensity. The statistical analysis showed similar results as the yearly analysis.

Table E-3. T-test for Monthly Analysis in terms of Emission Intensities

Dataset	Pair Composition	# Observations	Mean	Variance	P-Value
With Filter	Outstanding and EAD	11	0.18454	0.000006604	0.0003736
	Outstanding and Lending Limit	11	0.18454	0.000006604	0.1044097

	EAD and Lending Limit	11	0.18340	0.00000311	0.1967494
Without Filter	Outstanding and EAD	11	0.18430	0.00000611	0.0008132
	Outstanding and Lending Limit	11	0.18430	0.00000611	0.0001136
	EAD and Lending Limit	11	0.18332	0.00000296	0.0000384

Table E-4. T-test for Monthly Analysis in terms of Amount of Outstanding, EAD, and Lending Limit

Dataset	Pair Composition	# Observations	Mean	Variance	P-Value
With Filter	Outstanding and EAD	11	0.18454	0.0000066	0.0003736
	Outstanding and Lending Limit	11	0.18454	0.0000066	0.1044097
	EAD and Lending Limit	11	0.18337	0.0000031	0.1967494
Without Filter	Outstanding and EAD	11	0.18430	0.0000061	0.0008132
	Outstanding and Lending Limit	11	0.18430	0.0000061	0.0001136
	EAD and Lending Limit	11	0.18332	0.0000030	0.0000384

Table E-5 shows results of regression test including R^2 values and p-values. In terms of emission intensities with filter, outstanding explains 48.4% of the variance, EAD explains 41.5% of the variance, and lending limit explains 42.1% of the variance. Hence, outstanding has the highest R^2 value and lending limit have the lowest R^2 value. On the one hand, the regression test without filter showed different results. It showed outstanding explains 33.6% of the variance, EAD explains 38.4% of the variance, and lending limit explains 34.2% of the variance. Hence, EAD has the highest R^2 value and outstanding has the lowest R^2 value.

Table E-5. Regression Test for Monthly Analysis

Dataset	Independent Variables	R^2	Significance F (P-Value)
With Filter	All Metrics	0.40994	2.04437978672837E-61
	Outstanding	0.48351	3.1736509152593E-22
	EAD	0.41501	2.77813822492361E-23
	Lending Limit	0.42113	7.92984109472749E-24
	Outstanding and EAD	0.44117	1.05468712102262E-43
	Outstanding and Lending Limit	0.41283	2.97092899476171E-40
	EAD and Lending Limit	0.38784	0.000196344979391973
Without Filter	All Metrics	0.31846	2.23517025537825E-44
	Outstanding	0.33608	4.32813526310502E-16
	EAD	0.38356	8.72148567461849E-20
	Lending Limit	0.34227	2.40373806150321E-17
	Outstanding and EAD	0.35989	2.13023503354407E-34
	Outstanding and Lending Limit	0.30288	3.83243114807085E-28
	EAD and Lending Limit	0.33400	2.21013472155036E-32

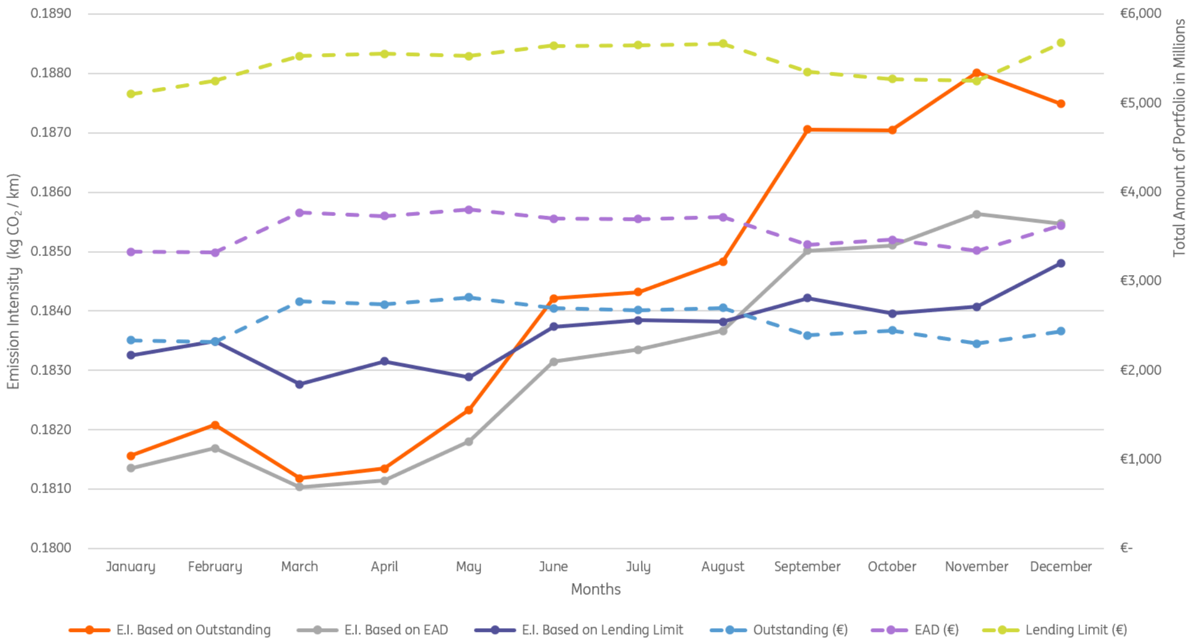

Figure E-1. The Size of the Portfolio with Portfolio Emission Intensities without Product Filter

Figure E-1 shows the size of the portfolio with the portfolio emission intensities without filter. It shows lending limit is the most stable metric in terms of the portfolio size and emission intensity. In addition, outstanding and EAD follow the similar pattern in terms of portfolio size and emission intensity.

In order to see if the portfolio construction is stable or not within a year, Figure E-2, Figure E-3, and Figure E-4 are made to show the portfolio based on each metric from January to December in 2021. Figure E-2 shows that company AQ, company AG, and company AF have volatile patterns over the months in terms of outstanding. On the one hand, Figure E-3 shows that the company AG and company AF have volatile patterns in terms of EAD. Also, most of the companies generally showed the stable patterns over the months. Based on the observation, lending limit is the most stable from January to September in 2021.

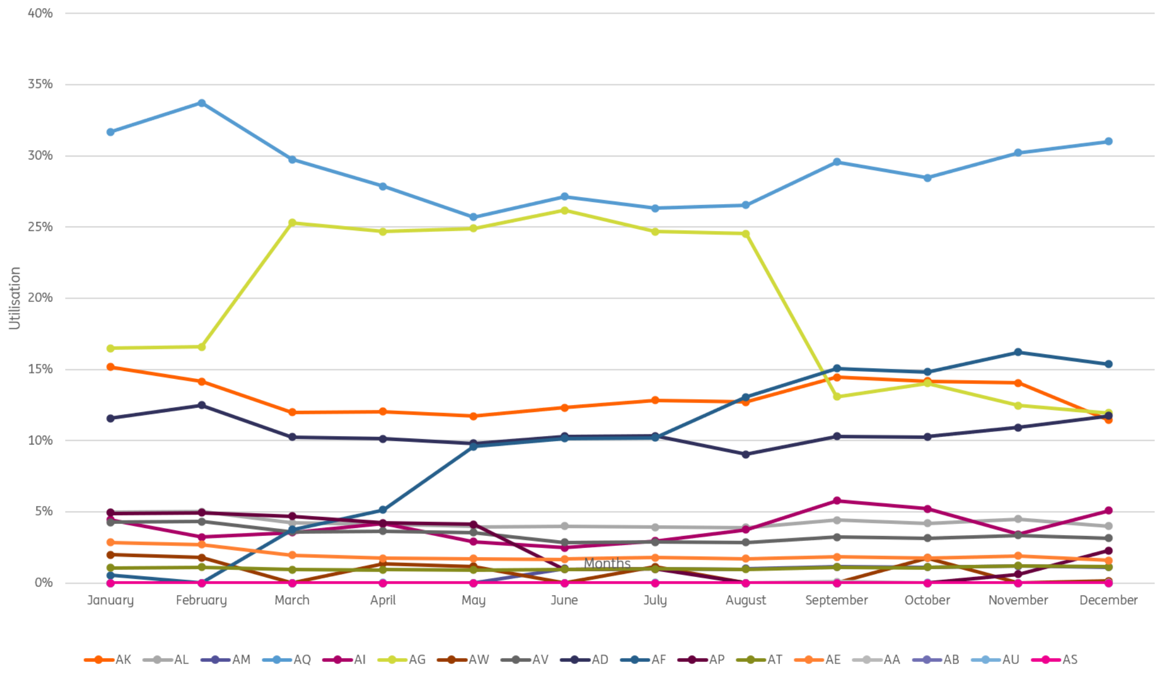

Figure E-2. Portfolio Based on Outstanding from 2021 January to 2021 December

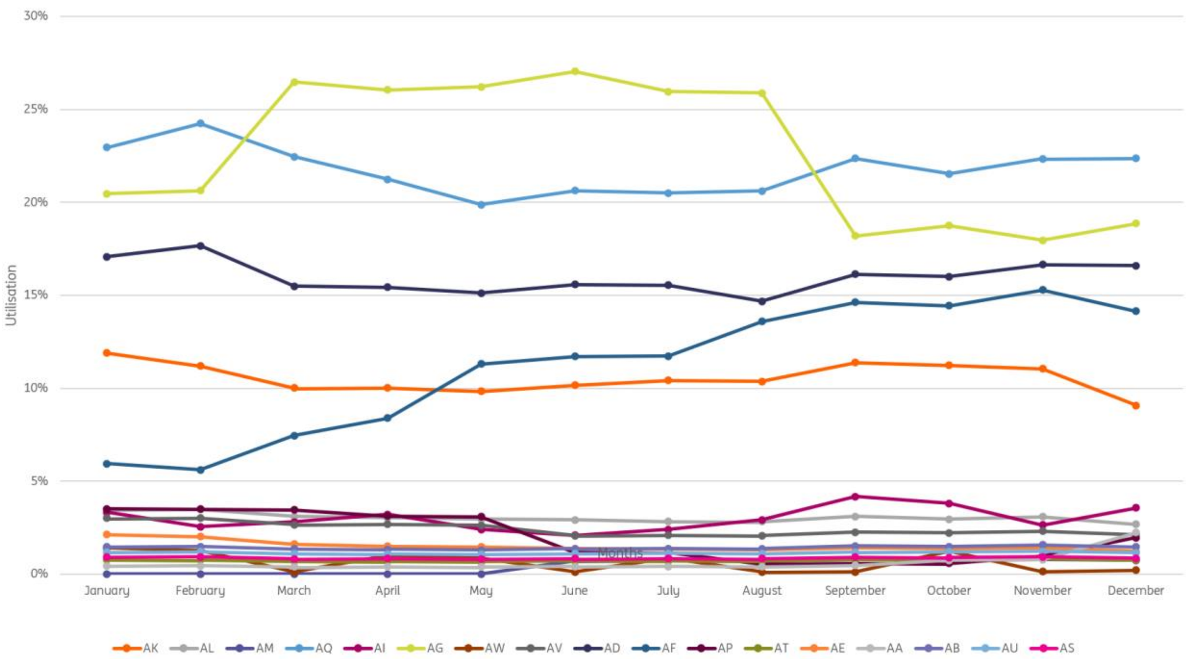

Figure E-3. Portfolio Based on EAD from 2021 January to 2021 December

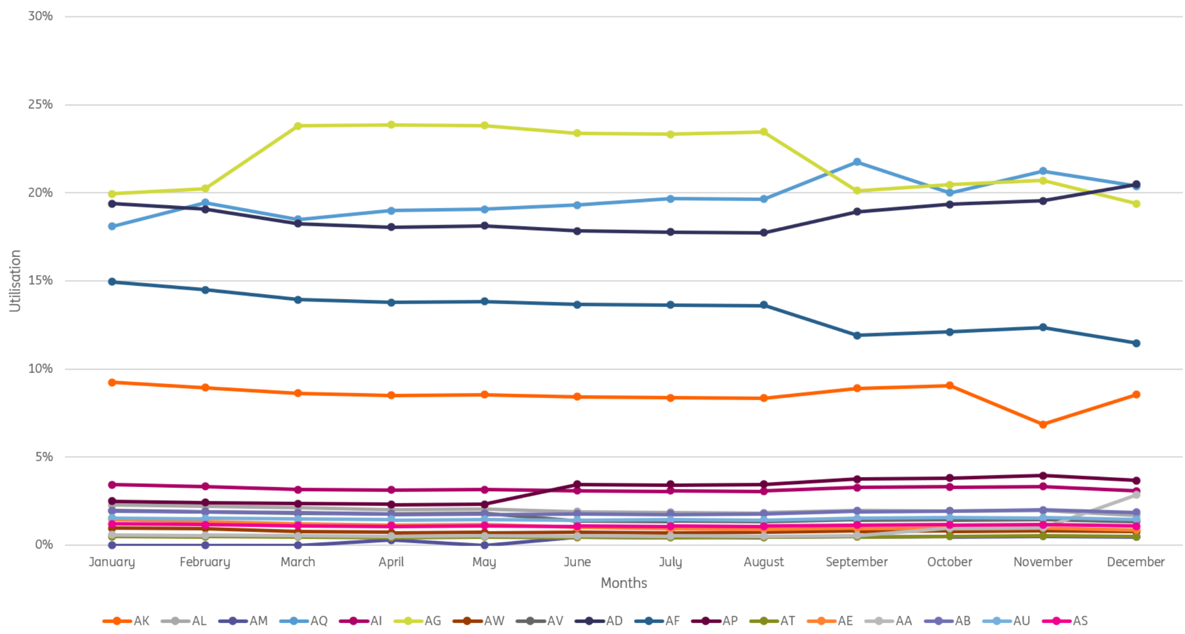

Figure E-4. Portfolio Based on Lending Limit from 2021 January to 2021 December