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Measuring the carbon footprint of loans to domestic non-financial corporations (NFC) by banks

Abstract

The paper presents a case study on the indicator describing the transitions risk of banks loans to domestic non-financial corporations (NFC). Transition risk is due the transition of counterparties' business models towards more sustainable one. The transition risk is measured via carbon footprint of NFC loans within the banks loan stock. The purpose is to calculate the carbon footprint using granular data sources.

To calculate the emissions of the NFCs, the data (Emissions Trading System, ETS) from The Finnish Energy Authority are used. The Energy Authority is Finland's national emissions trading authority responsible for permits, registers and supervision, as well as for the auctioning of emissions allowances. The Energy Authority's dataset covers more than 90% of carbon dioxide emissions produced by the mining, manufacturing and energy industries (NACE version 2: B to D). For Finland the data include little less than 200 enterprises. The emissions of the NFCs not included in the ETS database are imputed using statistical business register and Statistics Finland's air emissions accounts by industry.

Data for domestic NFC loans of Finnish MFIs are received from the Bank of Finland's national analytical credit database (National-AnaCredit). Credit level data are linked to NFCs carbon footprint dataset at the counterparty level. This allows to calculate the counterparty level transition risk indicators using the loans to NFCs and the carbon footprint. Finally, the paper analyses the pros and cons of granular level carbon footprint indicator in measuring the transition risk of banks' domestic NFC loan stock.

Contents

1 Introduction

The Governing Council of the European Central Bank (ECB) has decided on a comprehensive action plan, with a roadmap[1] to further incorporate climate change considerations into its policy framework. An annex[2] to the roadmap includes the carbon footprint indicators of portfolios of financial institutions. Urgency is evident and during the year 2021 the Bank of Finland's statistical function launched an experimental project to compile footprint indicator for banks' non-financial corporations' loan (NFC) portfolio. Idea is to start with experimental calculations and improving them on the way.

The compilation process of carbon footprint estimate of domestic NFC's loan stock can be broken down into five steps described below. The sixth point describes the use cases of the carbon footprint.

1) The statistical business register (SBR) is used to define target population of Finnish non-financial corporations. All NFCs are downloaded from the SBR with relevant reference data
2) Other data sources are downloaded and merged using business id and industry codes. Corporation level emission data are received from the Energy Authority's emission trading system data (ETS). Corporation level loan data are acquired from national analytical credit database (AnaCredit). Finally, industry level emission totals are downloaded from Statistics Finland's air emission accounts.
3) First corporation level emission data are compiled using data directly from ETS and via mass imputation. The emission data for corporation not received from ETS are mass imputed using industry level information on emissions from air emission accounts and corporation level information on personnel from the SBR.
4) Data on loans and balance sheet totals at the corporation level are aggregated from AnaCredit and used to compile the carbon footprint indicator for each corporation having domestic loans.
5) National air emission accounts information is more structural and detailed in nature and is published with long delay. That is, National Accounts data and ETS are used for nowcasting (estimating) air emission accounts data for most recent years.
6) The carbon footprint of banks' NFC loan stock serves two main purposes. First to measure and follow the transition risk implied within the loan stock. Second to follow the role of bank finance in the national climate strategy towards net zero by the 2035.

The paper discusses each data source and methodology used for compilations in detail. Second section presents the data sources. Third section describes compilation methodology and fourth section analyses the quality and benefits and challenges in selected approach. Also use cases (such as granular analysis of transition risk and to follow up the role of banking sector in national climate-strategy) of carbon footprint are presented. The fifth section concludes the paper.

2 Data sources

2.1 Emission trading system data (ETS)

The data source for corporate level carbon emissions are the Emission trading system data (ETS). The EU ETS works on 'cap and trade'-principle, where a cap is set on the total amount of certain greenhouse gases that can be emitted by the installations covered by the system. The cap is reduced over time so that total emissions fall. Within the cap, installations buy or receive emissions allowances, which they can trade with one another as needed. The limit placed on the total number of allowances available ensures that they have a value.

[1] https://www.ecb.europa.eu/ecb/climate/roadmap/html/index.en.html
[2] https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1_annex~f84ab35968.en.pdf

Each year, an installation must surrender enough allowances to cover fully its emissions, otherwise fines are imposed. If an installation reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another installation that is short of allowances. The EU ETS operates in all EU countries and in Iceland, Liechtenstein and Norway (EEA-EFTA states). It limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries. It covers around 40% of the EU's greenhouse gas emissions.

According to Statistical classification of economic activities in the European Community (NACE) revision 2, the dataset covers mining, manufacturing, energy industries and air transport (from B to D and H51) industries. It provides two types of data:

1. Verified emissions and surrendered allowances: Once a year (May, t+4-5 months) at installation level
2. Carbon market transactions: Three years after the reference date, at transaction level

The European Commission is proposing extensions to ETS towards new sectors of the economy namely maritime, road transport and buildings.

The Energy Authority's dataset

The Energy Authority is Finland's national emissions trading authority responsible for permits, registers and supervision, as well as for the auctioning of emissions allowances. The Finnish Transport and Communications Agency (Traficom) is responsible for emissions trading regarding air traffic in Finland.

The Finnish data cover direct emissions produced by the facilities in Finland, which corresponds to the scope 1. All direct emissions by the multinationals are not covered, but only national emissions. Also there exist various thresholds depending on industry above, which enterprises need to apply right to produce emissions. If the sum of enterprises emissions stays below the threshold the enterprise does not need to apply the right for emissions and thus the data are not included in the system. Emissions are gross emissions and negative emissions by LULUCF sector is not deducted. Emission trading system data by the Finnish Energy Authority are published[3] and The Finnish Transport and Communications Agency (Traficom) delivers air traffic emissions to EU register but does not publish the data nationally.

The Energy Authority's data include little less than 200 corporates. Despite the limited coverage in the number of corporations, the coverage in terms of CO2 emission is much higher. The ETS data cover over 90% of total emissions CO2 for activities B to D. For air traffic the residence principle of ETS is not feasible and corporate level data are acquired from national air traffic corporation's (Finnair) annual report. ETS covers only flights with EU countries and with Iceland, Liechtenstein and Norway (EEA-EFTA countries).

The data are published annually three months after the reference period. The data are available from 2008 onwards. Second ETS period started from 2013, when the coverage of ETS data were increased. The published version of the data are with the company names but without the business id's (national business id and LEI). The data can be acquired from the Energy Authority with the business id's, which makes it easier to link with the corporate level loan stock data. Furthermore, the Energy Authority publishes the plant level data, which can be used for regional and industry level investigations. According to experts the ETS data are very good quality due to the administrative process behind the data.

2.2 Air emission accounts by industry

[3] https://energiavirasto.fi/en/publications-of-the-emissions-trading

The aforementioned corporate level ETS data, which includes carbon emissions, cover part of the industries (i.e. mining, manufacturing, energy industries and air transport) of an entire economy. Carbon emissions of rest of the industries are estimated based on air emission accounts statistics, which are part a larger system of environmental accounts statistics (SEEA).

The SEEA framework follows a similar accounting principles and structure as the System of National Accounts (SNA). The main benefit with SNA linkage is, that the SEEA uses also same concepts (e.g. value added), definitions (e.g. residency principle) and classifications (e.g. institutional sectors and industry - classifications). The European Union (EU) has advanced well on the top implementing these statistics within SEEA framework.

Timeliness

The environmental accounts have originally been regarded as fairly detailed, structural data, which become available with long delays. Eurostat and the Member States are assessing whether environmental accounts could be compiled and submitted earlier and are also examining ways of producing early estimates for some of the main indicators. As a result, Eurostat compiles estimates for air emission accounts 12 months after the end of the reference period. Nationally Statistics Finland publishes air emission accounts 21 months after the reference period.

Characteristics

Air emissions accounts are very widely used within the European System of Central Banks (ESCB). The main benefit is, that the data are easily linked to other industry level information. Air emission accounts include information on greenhouse gasses (GHG) including CO2. Emissions are gross emissions and negative emissions by land use, land use changes and forestry (LULUCF) sector is not deducted. The industry breakdown includes 64 industries and household sector (S14). Household sector covers emissions caused by final consumption, that is households as producers are included in industries. The sectoral information is not separated within industries and national accounts data are used to estimate the NFCs (S11) share of industry level emissions. For this NCFs share of total economy output (S11/S1) is used.

Industry coverage

Some industries are excluded from the coverage. Industries Financial and insurance activities (K), Public administration (O), Activities of households as employers (T) do not have any NFCs in Finland and these are excluded. Also, Real estate activities (L) is excluded because the methodology used for this indicator works very poorly with the industry. The industry coverage in terms of loans is 51%, which is a consequence of excluding Real estate industry, which share of all NFC loans is almost half. The coverage in terms of emissions is 100%, because scope 1 (direct) emissions by real estate sector are very low.

2.3 Statistical Business register

In the case of NFC loans' carbon footprint compilation, the statistical business register (SBR) data were needed to define the frame population of Finnish NFCs. Statistics Finland maintains statistical business register which includes all domestic non-financial corporations (NFCs) and other legal units. The business register includes information from various administrative registries and data collections straight from the NFC.

For the analysis, entity identifiers (name and national business id), institutional sector, industry and amount of personnel for all Finnish NFCs were extracted from the business register. The Bank of Finland receives monthly copy of the business register from Statistics Finland. The data were extracted for the end of years 2018–2020. Amount of personnel is exception in this case since it can fluctuate across time and in some cases, it is not available for every month. Therefore, the maximum value of amount of personnel is used.

2.4 Analytical credit database (AnaCredit)

The corporate level data on loans from MFIs to NFCs were obtained from Bank of Finland's national analytical credit database (National-AnaCredit). Information on all loans to NFCs are gathered in National-AnaCredit at a single borrower and loan level. The dataset includes loans from about 180 MFIs to over 160 000 unique debtors. On the loan level this means volume of over 700 000 loans a month. A special feature of Bank of Finland's National-AnaCredit is that it includes all loans regardless of the size of the loan whereas European Central Bank's (ECB's) AnaCredit includes only loans larger than 25 000 euro. In addition to loan information, AnaCredit also contains information on counterparties and protections related to the loans.

For the analysis, the data on loans to domestic NFCs were extracted for the end of years 2018–2020. In addition to outstanding volumes of loans, debtor and creditor identifiers and certain characteristics of firms such as age, size of the balance sheet and annual turnover were extracted. Loan level information was aggregated from a loan level to a counterparty level in the process as well.

3 Methodology

The methodology used to compile the emissions for the NFCs is combination of multiple direct data sources and imputation. First the frame population is acquired from SBR. Then the emission data for industries included in the emission trade is directly from ETS database. For other industries the mass imputation is used to split the industry total from air emission accounts to the NFCs that belong to these industries.

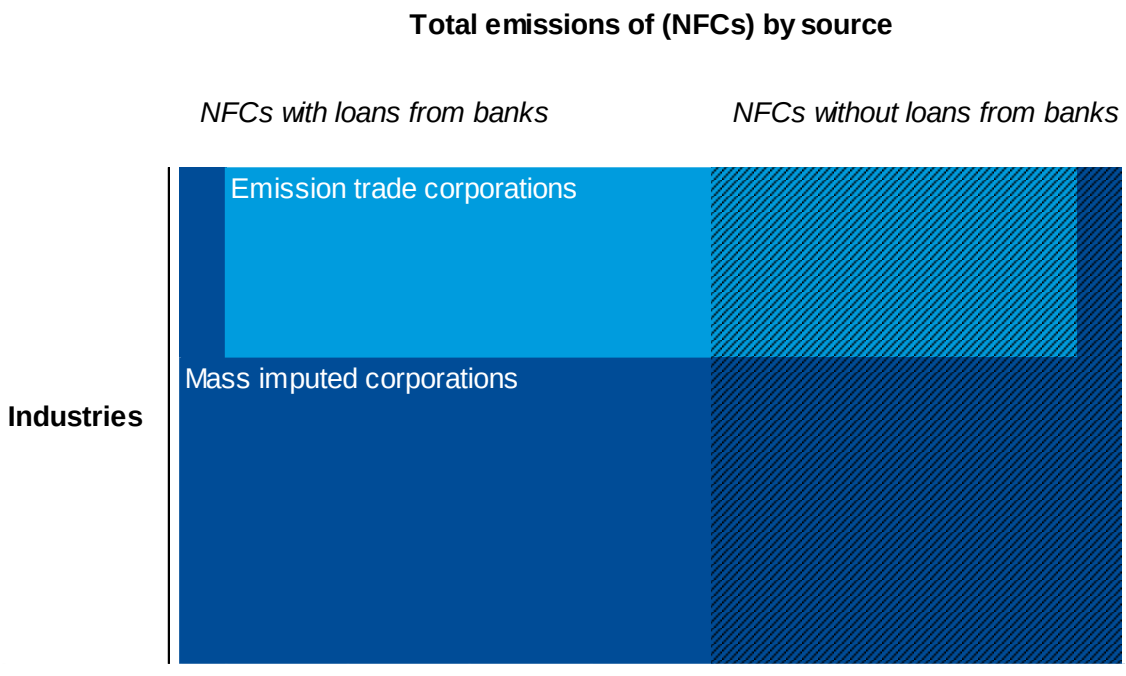


Figure 1. Combination of methodologies used to estimate the carbon emissions of non-financial corporations

The share emissions by NFCs participating to ETS is very high (77.5%). Share of loans for these NFCs is much lower (10.9%). Thus, the average amount of loans per NFC participating in ETS is high because the number of these NFCs, which are also financed via banks is very low (only 123).

Data source/methodology	Emissions (tons)	Share	Loans (euro)	Share	Nr. of NFCs	Share
ETS data	26 295 644	77.5 %	4 141 923 994	10.9 %	123	0.2 %
Imput. ETS indust.	3 325 509	9.8 %	10 963 078 749	29.0 %	12 602	20.1 %
Imputation other	4 288 541	12.6 %	22 721 163 828	60.1 %	49 891	79.7 %
Total	33 909 694	100.0 %	37 826 166 570	100.0 %	62 616	100.0 %

Table 1. Emissions (tons) by data source/methodology type. Reference year 2019.

3.1 Merging the databases

Three of four data sources are at NFC level and all NFC level data sources had common identifier: national business id, which made it noticeably easier to combine information between data sources. Merging of data sources was started by merging NFC level number of personnel totals from business register data and NFC level carbon emissions from ETS data. Since ETS data cover only fraction of Finnish NFCs and for the rest of NFCs the emission data are not available at NFC level, the next step was to link industry level (mainly NACE 2-digit level) air emission data to Business register data and ETS emissions data using NACE codes. With the industry level data linked to NFC level data, firm level CO2 emissions for firms not participating in ETS were estimated. The estimation process is described in detail in the next section. Finally, the NFC level emission data were merged with the credit dataset using national business IDs.

There are challenges in merging establishment-based air emissions accounts and corporation based ETS data at industry level. Some corporations are multi-establishment and multi-industry firms. That is, the industry breakdown from air emission accounts needs to be adjusted to get comparable aggregates from ETS and air emission accounts.

3.2 Mass imputing the missing data

Task Force on Climate-Related Financial Disclosures (TCFD) has recently published Proposed Guidance on Climate-Related Metrics, Targets and Transition Plans recently, which includes methodology for calculating financed emissions. The methodology is based on the Standard by Partnership for Carbon Accounting Financials (PCAF).

According to PCAF's Global Greenhouse Gas Accounting and Reporting Standard for the Financial Industry (see PCAF, 2020), there are three options for calculating financed emissions. The options differentiate on whether the emissions are estimated, and if they are estimated, on what indicators the estimation is based on. According to PCAF (2020, p. 63-67) the three options for the emission data are:

1. Reported emissions (verified or unverified)
2. Emissions estimated with physical activity
3. Emissions estimated with economic activity

Reported emissions would be the most desirable option obviously, but unfortunately, they are available only for limited number of corporates (from ETS dataset). Still, corporates participating in ETS account for 70 - 75 % of the total corporate emissions. Still corporations not included in ETS are also financed by the banks and their emissions need to be imputed. That is, estimation method is used to obtain full coverage of corporations' carbon footprint.

For estimation procedures, the main idea is to allocate industry level emissions to corporate level with the firm's share of the industry's energy consumption, production, revenue, or other economic activity variable. According to PCAF, estimated emissions based on physical activity would be the best option for

estimation, but unfortunately data on energy consumption nor production are not available at NFC level. Therefore, the third-best option is used, i.e. estimated emissions based on economic activity. Number of personnel is used as the measure of economic activity as it is the only variable which is available for every NFC. In addition, number of personnel is somewhat preferable to turnover as it is not as volatile as turnover is.

The estimation procedure follows PCAF, the industry level emissions are allocated to corporate level with corporate's share of the industry's personnel. Equation (1) formulates the procedure for determining NFC level (estimated) CO^2 emissions EE_{it}:

$$(1)\ EE_{it} = \begin{cases} If\ NFC\ participates\ in\ ETS, then\ ETS_{it} \\ If\ NFC\ does\ not\ participate\ in\ ETS, then\ \frac{Personnel_{it}}{Personnel_{jt}} * (E_{jt} - ETS_{jt}) \end{cases}$$

where subscript i denotes NFCs (i.e. debtors, i = 1, 2, 3, …, n), t denotes time period (year, t = 2018, 2019, 2020), subscript j denotes industry level, ETS_{it} is NFC level CO^2 emissions from emission trading system data, *Personnel* is NFC's or industry's total personnel (excluding personnel of corporates participating in ETS) at time period t, E_{jt} is the industry level CO^2 emissions from air emission accounts and ETS_{jt} is ETS_{it} aggregated to industry level.

3.3 Nowcasting the air emission accounts

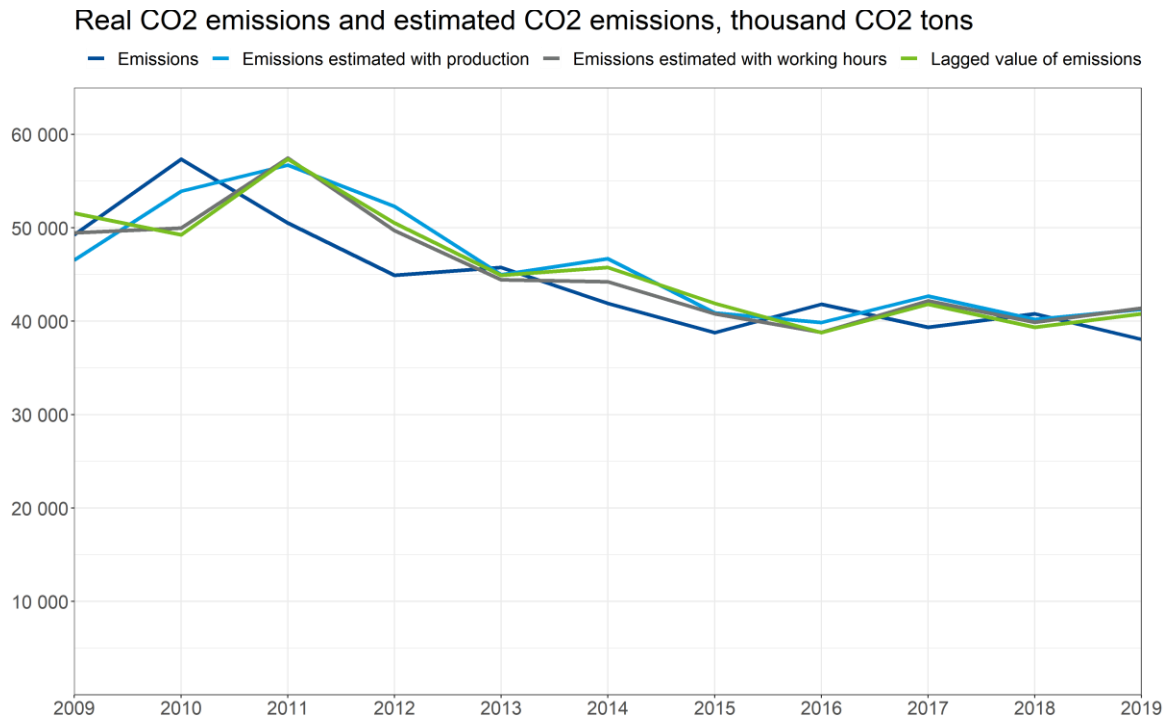
Air emission accounts are more structural and detailed statistics and published with long delays. Currently the Finnish dataset is published 21 months after the reference period. So long delay is not sufficient for central banks follow-up usage. Also, other datasets are published 1-4 months after the reference period. According the European Strategy for Environmental Accounts[4] the target is to improve the timeliness of air emission accounts too.

With current situation the central bank needs to nowcast the available data and revise it after the official statistics are published. For example, in this case, the industry level air emission accounts were available for the years 2018 and 2019 whereas the NFC level loan stock data from AnaCredit were available from 2018, 2019, and 2020. As a result, the industry level air emission data for 2020 had to be now casted based on the methodology described below.

Several nowcasting methodologies were tested and assessed to estimate the emissions by industry for the past years 2009-2018. To estimate the emissions already published national accounts industry level aggregates are used for output and hours worked. Value added was tested also, but it was too volatile and gave poor estimates.

To estimate the emissions the emission intensity (emissions per national accounts aggregate) is calculated and called technology. It describes how much emissions the industry produces with given amount of output or hours worked. Technology seems to become less emission intensive over time, but same time for most recent years from 2015 onwards there is not as much improvement in emission saving technological change as there was previously. That is, for nowcasting it was decided to be more conservative and assume that most recent known technology (the latest year for which both emissions and national accounts aggregates were available for each industry) applies also to next years. That is, the technology is copied over time before new information for emissions is published. To get the emission estimate for an industry, copied technology/emission intensity was multiplied with already available production information from national accounts (output, hours worked).

[4] https://ec.europa.eu/eurostat/documents/1798247/6191525/European+Strategy+for+Environmental+Accounts/



Source: Calculations based on Statistics Finland air emission and national accounts

Figure 2. Published CO2 emissions by Statistics Finland's air emission accounts vs estimated with different nowcasting methodologies

Also, to test the usefulness of using the technology information to estimate the most recent emissions more simple method was applied. This method was just to copy the latest emissions by industry data to next years. As such, this method does not take into an account the changes in production, because the information from national accounts (output, hours worked) is not used.

It seems that copying the technology and multiplying it with available production data does not give better estimates for emissions, if comparing with simple approach and only to copy the emission information onwards. The period for the testing covers years 2009-2019 where all datasets were available. The Covid-19 pandemic caused an exceptional drop in production of various activities such as traveling and transport from 2020 onwards. That is, to estimate the emissions for these activities requires to take the production information into account. The accuracy of nowcasting estimates could be better and more work on more timely emission data should be done. Meanwhile more nowcasting methodologies should be investigated.

3.4 Carbon footprint indicator

Carbon footprint can be measured with scope 1, 2 and 3 emissions defined by the Greenhouse Gas (GHG) Protocol[5]: Scope 1 covers direct carbon emissions from sources that are owned or controlled by the reporting entity, e.g. emissions from its own physical or chemical processing and owned vehicles. Scope 2 covers carbon emissions from consumption of purchased electricity, heat, steam, or cooling. Finally, the concept of Scope 3 is the broadest as it covers indirect emissions that occur in the value chain of a reporting company. Scope 3 emissions are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity (not covered in Scope 2). For example, emissions resulting from production or extraction of purchased materials, and waste disposal are included in Scope 3.

[5] Greenhouse Gas Protocol https://ghgprotocol.org/.

In the ECB's banking supervisions' Guide on climate-related and environmental risks it is stated that financial institutions are expected to disclose the scope 3 GHG emissions for a whole group in future. They are encouraged to adopt a granular approach to measuring carbon emission. In the case of financial institutions, the Scope 3 GHG emissions refer to financed emissions, i.e. emissions of an institution's assets. [6]. Although the ECB does not prescribe the use of a specific measurement, the paper mentions the metrics developed by the Partnership for Carbon Accounting Financials (PCAF) as one possibility. Also, the TCFD proposed[7] the carbon footprint metrics of the PCAF's standard[8] recently.

Scope 1, 2 and 3 emissions of the debtor/the investee

The PCAF's standard describes separate metrics for six asset classes, which are 1) listed equity and corporate bonds, 2) business loans and unlisted equity, 3) project finance, 4) commercial real estate, 5) mortgages, and 6) motor vehicle loans. Both, the debtors'/investees' absolute scope 1 and 2 emissions across all sectors are to be reported to calculate absolute emissions and to assess transition risks.

In addition, scope 3 emissions are needed to assess transition risks, when the amount of scope 3 emissions is relevant. PCAF's Standard provides a sector list detailing where scope 3 emissions of debtors and investees are required to be reported. The list aligns with the phased-in approach for scope 3 emissions as defined by the EU TEG[9]. In practice, this means that financial institutions shall start including scope 3 emissions for the oil, gas, and mining sectors from 2021 onward and additional sectors will be added from 2024.

Phase in period	NACE L2 sectors considered
From 2021	At least energy (oil & gas) and mining (i.e., NACE L2: 05-09, 19, 20
From 2024	At least transportation, construction, buildings, materials, and industrial activities (i.e., NACE L2: 10-18, 21-33, 41-43, 49-53, 81)
From 2026	Every sector

Table 2. List of sectors with required scope 3 emissions inclusion as defined by the EU TEG[10]

As a first step for calculating carbon footprint, in this paper it starts experimenting with calculating scope 1 emissions of the debtors as official statistical data on CO2 emissions, i.e. the corporate level emission trading system data and the industry level air emission accounts data, are readily available. Calculating scopes 1, 2 and 3 separately is also a way to avoid double counting. According to PCAF's Standard, double counting, which occurs when GHG emissions are counted more than once in the financed emissions calculation of one or more institutions, should be avoided as much possible. Double counting occurs between the different scopes of emissions from loans and investments when a financial institution invests in stakeholders that are in the same value chain. The PCAF's Standard mentions that this form of double counting cannot be avoided but can be made more transparent by separately reporting the scope 1, 2, and 3 emissions of loans and investments.

[6] The ECB, Guide on climate-related and environmental risks, November 2020 https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.202011finalguideonclimate-relatedandenvironmentalrisks~58213f6564.en.pdf.

[7] TCFD, Proposed Guidance on Climate-related Metrics, Targets, and Transition Plans, June 2021, https://assets.bbhub.io/company/sites/60/2021/05/2021-TCFD-Metrics_Targets_Guidance.pdf.

[8] PCAF, The Global GHG Accounting and Reporting Standard for the Financial Industry https://carbonaccountingfinancials.com/files/downloads/PCAF-Global-GHG-Standard.pdf.

[9] Defined by the EU Technical expert group on sustainable finance (EU TEG), included in Article 5 of the Supplementing Regulation (EU) 2016/1011 of the European Parliament and of the Council as regards minimum standards for EU Climate Transition Benchmarks and EU Paris-aligned Benchmarks.

[10] PCAF, The Global GHG Accounting and Reporting Standard for the Financial Industry, Table 5 -4.

In this paper, our aim is to calculate the financed emissions of the entire NFC loan stock in national level, i.e. the NFC loan stock of all the banks resident in Finland. At first step the scope 1 emissions, but also to test calculations for the scope 2 emissions. The produced emissions of scope 1 are usually consumed by another sectors' scope 2 or scope 3 emissions. Particularly, the scope 1 emissions produced by NFCs in electricity, gas, steam, and air conditioning industry (i.e. NACE Code 35) are consumed by NFCs in other industries, households, or rest of the world as scope 2 emissions. To measure transition risks of financed emissions more comprehensively, it is important in later stages to calculate financed scope 3 emissions of the debtors/investees as profitability of NFCs in energy intensive industries may depend on energy prices and carbon price.

Test calculations for scope 2 emissions

The idea of scope 2 emissions is to take into an account, how much the industry/corporation uses energy, warming or cooling within its business processes. Carbon footprint calculations for the scope 2 emissions were also estimated e.g. based on industry level input-output tables[11] of national accounts statistics.

		Intermediate consumption				Final consumption	Total output
	Industry	1	2	…	99	C+G+I+X	
Intermediate input	1						
	2						
	…						
	35						
	…						
	99						
Primary input							
Total input							

Figure 3. Input-output tables, the intermediate inputs by energy industry (35) used by other industries intermediate and final consumption.

The industry level intermediate inputs by energy production was acquired from input-output tables for year 2018. Within input-output tables the row for energy industry (i.e. NACE Code 35) describes how much its products (here called also intermediate inputs) were used for intermediate consumption of other industries and for final consumption (public and private, investments and exports). Equation (1) formulates the procedure for determining NFC level (estimated) CO2 scope 2 emissions for NFC i at industry j:

$$(2)\ Scope\ 2\ emissions\ for\ NFC\ i\ at\ industry\ j = E_{j=35t} * IO_{j=35jt=2018} * \frac{Personnel_{it}}{Personnel_{jt}}$$

where subscript i denotes NFCs (i.e. debtors, i = 1, 2, 3, …, n), t denotes time period (year, t = 2018, 2019, 2020), subscript j denotes industry level, $E_{j=35t}$ is industry level CO^2 emissions for energy (NACE code 35), *Personnel* is NFC's or industry's total personnel at time period t and $IO_{j=35jt=2018}$ is how much industry j uses products from energy (35) as intermediate consumption as a share of energy's (35) total output.

The intermediate inputs by energy industry (35) used by other industries intermediate and final consumption is received from Input-output tables. These inputs are divided by the total output (also from input-output tables) of energy (35) industry to compile the industry level shares of used output. The emissions of energy (35) is also assumed to be used in parallel with the output by other industries and sectors. By using these industry level coefficients and personnel split described in the equation above the emissions of energy (35) industry are allocated to industries as scope 2 emissions.

[11] Statistics Finland, Input-output, https://tilastokeskus.fi/til/pt/index_en.html.

Equations for carbon footprint indicator

The PCAF's calculation method for financed emissions from business loans (equations 3 and 4) is suitable for this paper, i.e. for measuring the carbon footprint of loans to domestic NFCs. The definition covers all loans and lines of credit for general corporate purposes (i.e., with unknown use of proceeds as defined by the GHG Protocol) to businesses, nonprofits, and any other structure of organization that are not traded on a market and are on the balance sheet of the financial institution. The equation is different for private i.e. non-listed companies (equation 3) and for listed companies (equation 4). In both equations the c stands for borrower or investee company.

$$(3)\ Financed\ emissions = \sum_{c} \frac{Outstanding\ amount_c}{Total\ equity + debt_c} \times Company\ emissions_c$$

$$(4)\ Financed\ emissions = \sum_{c} \frac{Outstanding\ amount_c}{Enterpise\ Value\ Including\ Cash_c} \times Company\ emissions_c$$

The equation (5) for non-listed companies and listed companies is used in this paper for measuring carbon footprint of domestic loans to NFCs from banks resident in Finland. The equation follows the PCAF's methodology considering the limitations of the available statistical data sources. $Outstanding\ amount_c$ stands for corporation level loan stock data, which are gained from the national AnaCredit database[12] for both, listed and non-listed companies.

$Total\ equity + debt_c$ recommended by PCAF's methodology for non-listed companies is, in the lack of data, replaced by the $Balance\ Sheet\ Total_c$ from the national AnaCredit. Also, according to PCAF's methodology the balance sheet total may be used as secondary option instead of total equity + debt. If total debt or total equity cannot be obtained from a client's balance sheet for whatever reason, financial institutions are allowed to fall back to the total balance sheet value (i.e., the sum of total equity and liabilities, which is equal to the client's total assets).

$$(5)\ Carbon\ footprint\ of\ NFC\ loans = \sum_{c} \frac{Outstanding\ amount_c}{Balance\ Sheet\ Total_c} \times Company\ CO2\ emissions_c$$

As PCAF's Standard describes, there are limitations and advantages in applying market value as denominator for listed companies. When using EVIC as the denominator, assets under management change because of fluctuating market prices. Under the influence of this fluctuation, an objective to reduce relative financed emissions (also referred to as emission intensities) by a certain percentage becomes a moving target. Using normalized assets under management may help overcome this, as prices are held constant over the target period. For example, the EU TEG and EU regulation on benchmarks require the application of an inflation correction to changes in EVIC over time.

However, applying corrections for market price fluctuations can highly influence the results and heavily reduce the comparability of results between different financial institutions when applied inconsistently. In addition, corrections could theoretically be applied to many other variables (like exchange rates, inflation, emerging versus emerging markets, etc.), further reducing comparability. For that reason, PCAF requires all financial institutions to report its uncorrected absolute emissions as a minimum. Corrected results may optionally be reported separately. If the financial institution decides to apply such adjustments, they should be made transparent.

[12] Bank of Finland, Analytical Credit Database, https://www.suomenpankki.fi/en/Statistics/reporting-instructions/analytical-credit-database/.

Based on the limitations and advantages of both denominators, it is decided in this paper to experiment the calculation of carbon footprint of listed NFCs' loans with balance sheet total. Finally, the equation (5) is in this paper transformed into a shorter form (equation 6), i.e. NFC level (estimated) CO2 emissions described in previous section stand for EE_i, CFI_{it} is the loan stock's carbon footprint indicator at the NFC level, $LoanStock_{it}$ is NFC's loan stock, and the $BalanceSheet_{it}$ is NFC's total balance sheet amount. T stands for time.

$$(6)\ CFI_{it} = \frac{LoanStock_{it}}{BalanceSheet_{it}} * EE_{it}$$

3.5 Emissions and transition risk

Climate change is forcing the economy to transit towards more sustainable one. Same time businesses and activities need to convert the production models or otherwise they face the risk of decreasing returns when the demand for high carbon products is diminishing. This implies losses to these businesses and liability risk to banks that have been financing these businesses.

One approach to assess transition risk is to measure carbon footprint, i.e. CO2 emissions and/or emissions intensity of a financial institutions' assets such as corporate loans. Larger carbon footprint indicates higher risk, as there is a greater need to adjust portfolio/production towards less carbon-intensive and/or more sustainable practices. However, carbon footprint is not a sufficient indicator alone, given the multiple drivers and transmission channels of transition risks e.g. technological change and innovation, as well as the importance of assessing the decarbonization trajectory.

However, the higher the carbon intensity of the business the greater is the need for adaption. If there exist low carbon substitutes for high carbon products, the high carbon products face higher risk to become obsolete. For example, energy can be produced with zero or high carbon emissions. Energy producers are looking pathways to replace these high carbon emission facilities with more sustainable modes of production. That is, looking at the industry level variation in the emission intensity could be useful when assessing the possible substitutes.

Based on the results of this paper measuring scope 1 financed CO2 emissions, it is possible to nationally observe the absolute level of financed emissions over time resulting from business loans to domestic NFCs from banks resident in Finland. This may be considered a carbon footprint of the loan stock.

Concerning different scopes of emissions, i.e. the scopes 1, 2, and 3, the carbon footprint can be measured based on all of them, and all 3 scopes are needed to measure transition risks. Therefore, it is needed to mention, that produced emissions of scope 1 are always consumed by another sectors' scope 2 or scope 3 emissions. To measure transition risks of financed emissions more comprehensively, it would be necessary at later stages to calculate financed scope 2 and 3 emissions of the borrowers/investees as e.g. profitability of NFCs in energy intensive industries may be somewhat dependent on energy prices and/or carbon price. The carbon footprint indicator based on scope 1 can be seen a preliminary and insufficient indicator of corporation level or industry level transition risk. However, together with other indicators such as technological change, the indicator can be helpful in measuring the transition risk of NFC loans in national level.

4 Analysis

4.1 Carbon footprint as a measure of transition risk

Loan carbon intensity (LCI)

There are several approaches to assess which industries are potentially exposed to transition risk. An approach is to measure loan carbon intensity (LCI, see e.g. Faiella & Lavecchia, 2020). LCI is defined as the amount of emissions per borrowed euro by industry. In other words, the indicator indicates how many grams of CO2 an industry *j* emits at year *t* for every borrowed euro. Usually LCI is calculated with aggregate industry level data. At that case also emissions of non-debtors are included, which is why the indicator does not truly indicate the magnitude of emissions emitted for every borrowed euro. Benefit of the granular approach is that it is possible to also identify a) total emissions of debtors and b) financed emissions (see chapter xx). LCI for industry *j* at year *t* is formulated as

(xx) $LCI_{jt} = \frac{Emissions_{jt}}{LoanStock_{jt}}$,

where $Emissions_{jt}$ can be defined as either total emissions of industry *j*, total emissions of debtors of industry *j* or total financed emissions of industry *j* and $LoanStock_{jt}$ is defined as LoanStock of industry *j*. LCI is denoted as LCI_{total}, $LCI_{debtors}$ or $LCI_{financed}$ depending on which emission measure is used.

The difference between measuring emissions as aggregate total emissions versus aggregate emissions emitted by debtors is on average 2.9 billion gCO2 (7.6 % of average total emissions) in 2018 and 2019 (table xx). Regarding LCI this leads to difference of 80 gCO2/€. LCI_{debtor} averaged out to 971 gCO2/€ in 2018 and 2019 whereas $LCI_{financed}$ averaged out to 139 gCO2/€ at the same time period. In 2019 LCI_{debtor} was above average in transportation, energy, and manufacturing industries whereas $LCI_{financed}$ was above average in transportation, energy, and mining and quarrying industries.

Emissions, loans, and loan carbon intensities (LCI) per year		
Year	**2018**	**2019**
Total emissions ($gCO2/10^9$) (a)	39 612.4	36 608.9
Debtor emissions ($gCO2/10^9$) (b)	36 522.6	33 909.7
Emissions from non-debtors ($gCO2/10^9$) (c)	3 089.8	2 698.2
Financed emissions ($gCO2/10^9$) (d)	5 437.4	4 664.9
Loans (€/10^9) (e)	35.2	37.5
LCI_{total} (gCO2/€) (a/e)	1 124.9	976.2
$LCI_{debtors}$ (gCO2/€) (b/e)	1 037.1	904.2
$LCI_{financed}$ (gCO2/€) (d/e)	154.4	124.4
Source: Based on Statistics Finland's air emissions accounts, Bank of Finland's National AnaCredit data and Finnish Energy Authority's ETS data.		

Table 3. Emissions, loans, and loan carbon intensity (LCI) per year.

Figure 4 shows distribution of loan stock, debtor emissions and financed emissions between carbon intensive and non-carbon intensive industries. An industry is defined as carbon intensive, if its LCI_{debtor} is in the 5th quintile. Carbon intensive industries covered only 29 % of the loans even though the same industries covered 95 % of the debtor emissions and 92 % of the financed emissions in 2019.

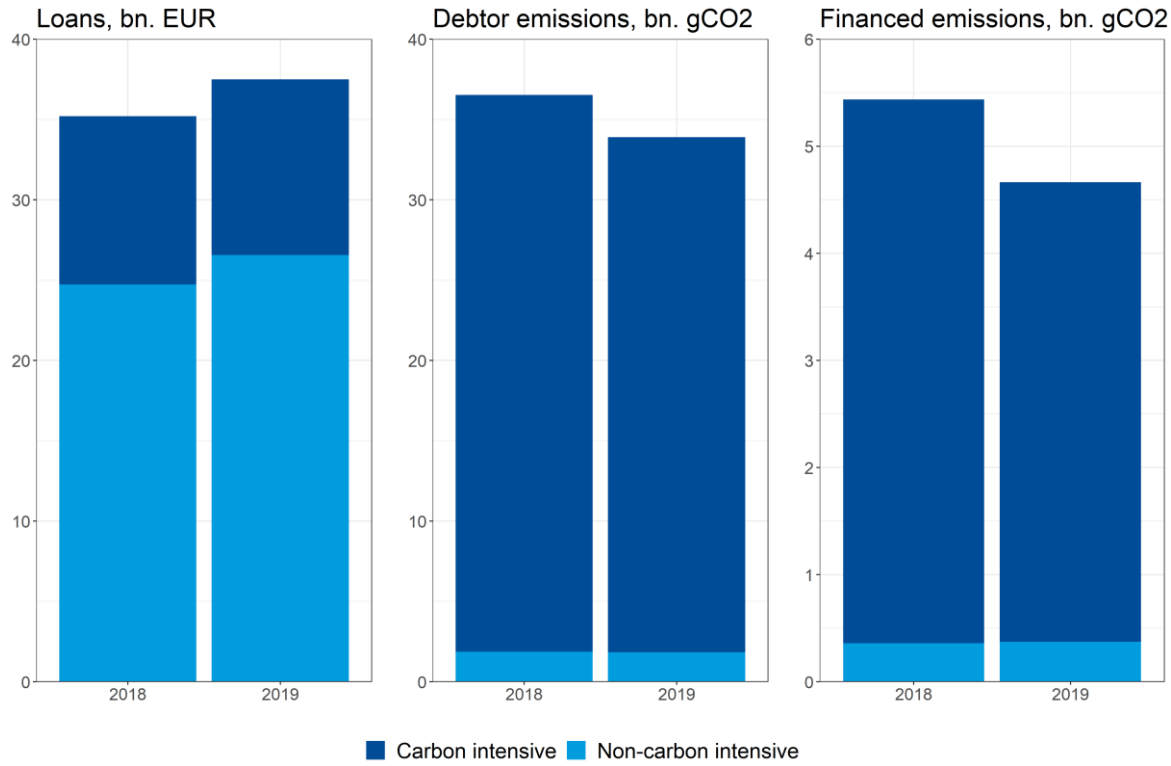


Figure 4. Shares of loans, debtor emissions and financed emissions for carbon intensive and non-carbon intensive industries. Notes: A industry is classified as carbon intensive if its LCI is in the 5th quintile.

Figure 5 shows industry's LCI_{debtor} plotted against industry's share of total debtor emissions and share of total loan stock. Carbon intensive industries are fishing and aquaculture (A03), mining and quarrying (B05-09), transportation (H49, H50, H51), some of the manufacturing industries (C17, C19-20, C23, C24), energy (D35) and sewerage and waste management (E37-39). The share of total debtor emissions is above the median for all of the industries classified as carbon intensive. Regarding share of loans, there is more deviation as four[13] of the carbon intensive industries have below average share of loans. The clear outlier is air transport industry (H51) which has one of the highest shares of total debtor emissions but is amongst the lowest regarding loan shares.

[13] A03 Fishing and aquaculture, B05-09 Mining and quarrying, C23 Manufacture of other non-metallic mineral products and H51 Air transport.

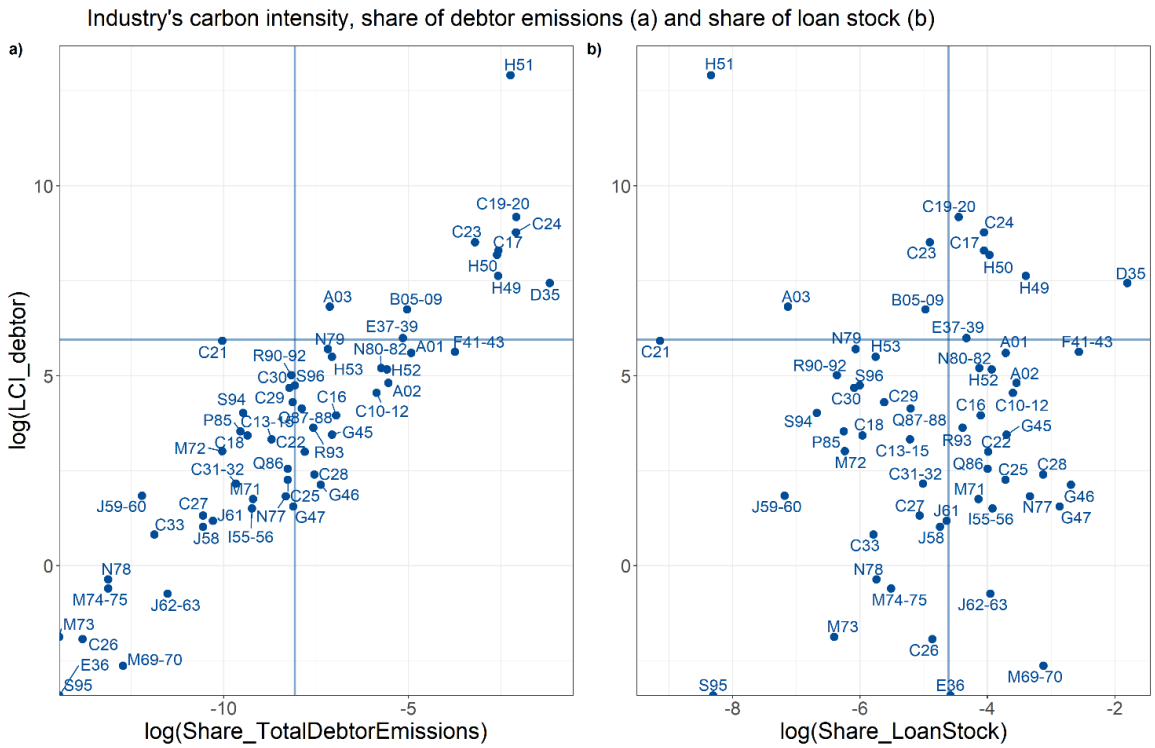


Figure 5. Relationship between LCI_{debtor} and share of total debtor emissions and share of loans. Notes: horizontal lines represent boundary of 5th quintile of logs of LCI_{debtor} (a and b), vertical line in a) represents median of logs of industry's share of total debtor emissions and vertical line in b) represents median of logs of industry's share of the total loan stock. See appendix for definitions of the industry codes.

Carbon critical sectors (CCrS)

Another approach for assessing transition risk is to identify carbon critical industries by accounting for both the amount of loans and emissions. Faiella and Lavecchia (2020) proposed spotting those industries by creating rank variable for industry's share of total emissions ($rank(DebtorEmissions_{jt})$, in this case total debtor emissions are considered) and for share of total loans ($rank(LoanStock_{jt})$. The average of these two ranks ($avgRank_{jt}$) measures relevance of each industry regarding both emissions and exposure to the financial sector (as loans from banks). Following Faiella and Lavecchia (2020), industries with $avgRank_{jt}$ in the first quintile are defined as carbon critical industries.

Figure 6 shows the distribution of loans, debtor emissions and financed emissions between carbon critical sectors and non-carbon critical sectors. Comparing to figure 4, the share of loans is now significantly higher (over 50% in 2019) but the share of debtor emissions is somewhat lower.

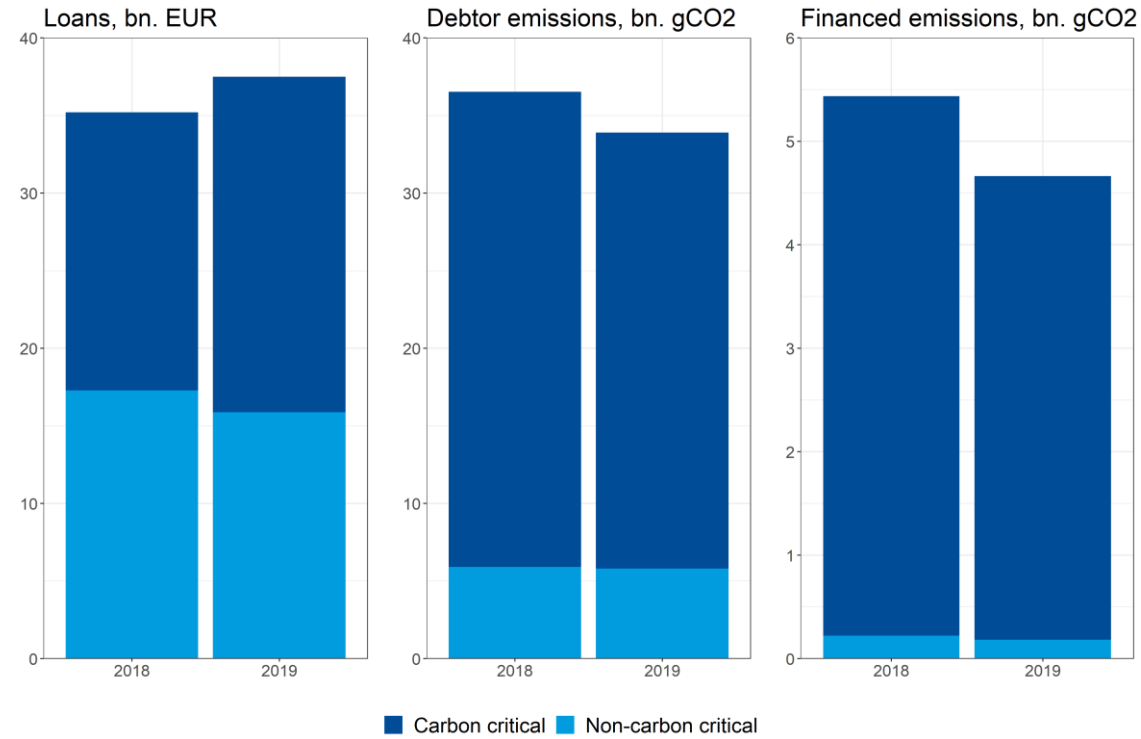


Figure 6. Shares of loans, debtor emissions and financed emissions for carbon crical and non-carbon critical industries. Notes: A industry is classified as carbon critical if its *avgRank* is in the first quintile.

Range of transition risk based on scope 1 vs. scope 2 measures

To analyze the industries exposed to transition risk only scope 1 measure of carbon footprint is not sufficient. Scope 1 measure highlights industries and NFCs that have direct CO2 emissions. Still there are industries and NFCs that do not have direct emissions but are highly depended on energy or other intermediate products that have high CO2 intensity. This exposure can be measured using also scope 2 and scope 3 emissions.

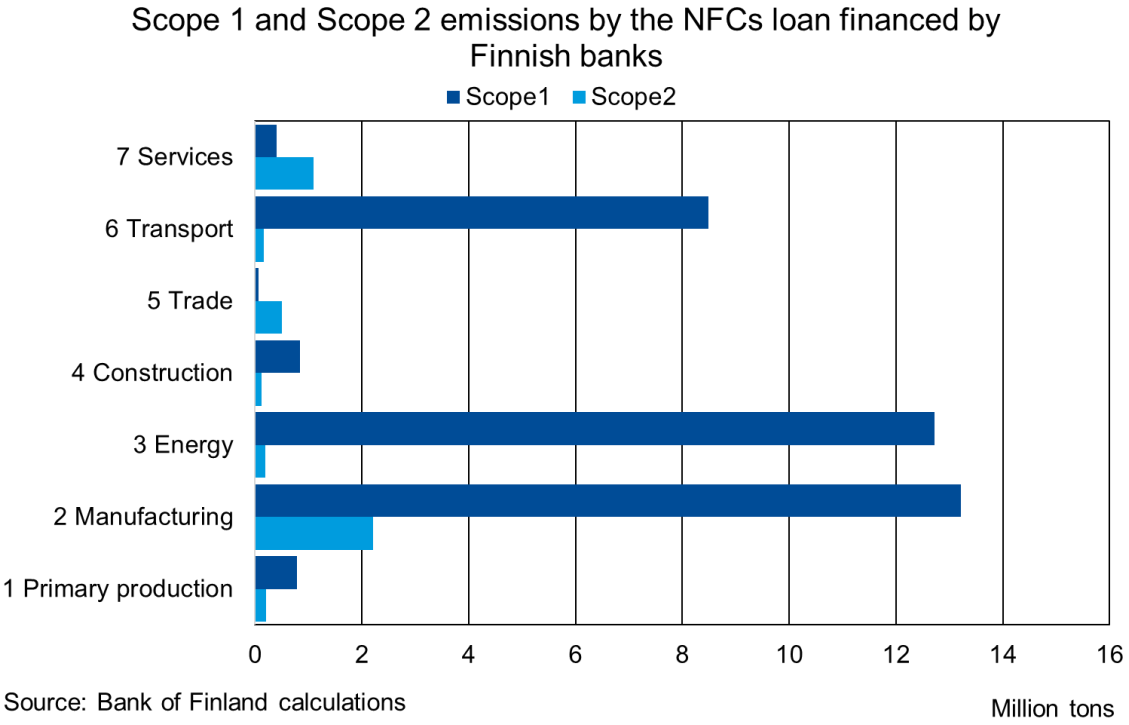


Figure 3. Scope 1 and scope 2 emissions of domestic NFCs loan financed by Finnish banks

From the figure 3 it can be followed how the exposure to transition risk spreads over economy when moving from scope 1 measure towards scope 2 emissions. The risk spills over via the use of intermediate inputs of energy industry by other industries. The methodology used here was explained in the section 3.4. When comparing scope 1 and scope 2 measures the manufacturing is highlighted by both. The energy and transport have high risk content when looking at scope 1 measure, but with scope 2 measure the risk spreads towards other industries. Especially trade and services have higher total scope 2 emissions when comparing with scope 1 measure.

As discussed earlier, the scope 2 takes into an account only use of energy industry's intermediate inputs. That is, also scope 3 measures should be developed. E.g. construction industry uses intensively products from metal, mineral and pulp producing industries, which are also high CO2 emitters. This would imply higher scope 3 emissions for construction.

4.2 National and the EU climate goals

To align the carbon footprint of the domestic corporate loan stock of Finnish banks with larger context, it is useful to proportion it with national climate goals. According to government program, Finland will be carbon neutral by the year 2035,[14] i.e. carbon will not be emitted more than the carbon sinks will be able to absorb. Carbon sinks are systems that absorb more carbon than they emit, and in greenhouse gas inventory statistics, these are included in the Land use, land use changes and forestry (LULUCF) net sink[15].

According to the greenhouse gas inventory statistics[16], the total greenhouse gas emissions were 53.1 million tons or carbon dioxide (CO2 eq.) in Finland in 2019, including all seven greenhouse gases. The amount needs to be reduced significantly to 21 million tons (i.e. reduced by 70% compared to the year 1990, and 60% compared to the year 2019) by the year 2035 in order to emit net zero amount of CO2 eq.

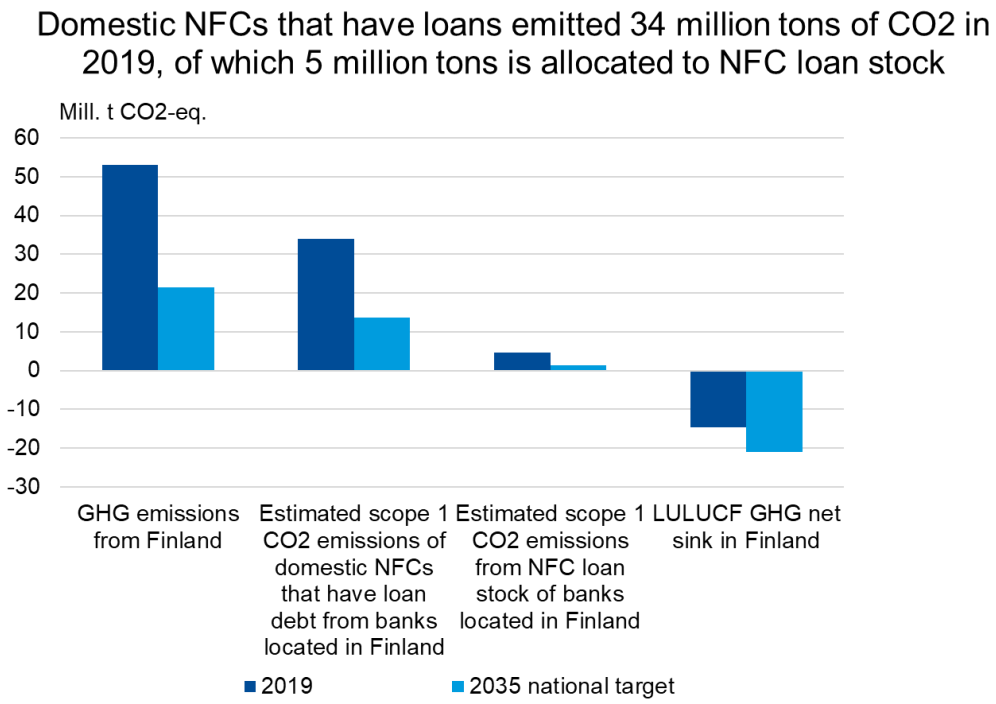
The level of emissions, i.e. 21 million tons, is based on the proposal for target for the LULUFC net sink (i.e. -21 million tons of CO2 in 2035) by Finnish Climate Change Panel[17] in January 2021[18]. Also, the emission reduction target compared to the year 1990 (i.e. -70%) is proposed by the Panel. The GHG emissions from Finland were 71,2 million tons of CO2 without the LULUCF sector in the 1990, and the LULUFC net sink was -13.5 million tons of CO2[19].

According to our estimation, the NFCs, which have loans from banks located in Finland, emit significant share of the total Scope 1 GHG emission, i.e. 64% and 33.9 million tons of CO2. This amount includes only one of the 7 greenhouse gases, i.e. the CO2 gas, and therefore, is naturally lower than the sum of all emitted GHGs (53.1 million tons of CO2 eq.). If the need to reduce the CO2 emission is estimated to be

[14] https://valtioneuvosto.fi/en/marin/government-programme/carbon-neutral-finland-that-protects-biodiversity.
[15] Statistics Finland, Land use, land use changes and forestry (LULUCF): CO2 emissions and exits from land use categories of forest land, farmland, grass areas, wetlands, built-up areas and other land. In addition, emissions from wood products, terrain fires and forest clearing, as well as N2O emissions from field clearing, forest fertilization, ditched forest lands and peat producing areas and CH4 emissions from ditched forest lands and peat producing areas are reported, https://tilastokeskus.fi/til/khki/kas.html.
[16] Statistics Finland, Greenhouse gas inventory, https://tilastokeskus.fi/tup/khkinv/index_en.html.
[17] https://www.ilmastopaneeli.fi/en/.
[18] Suomen Ilmastopaneeli, Ilmastolakiin kirjattavat pitkän aikavälin päästö-ja nielutavoitteet – Ilmastopaneelin analyysi ja suositukset, https://www.ilmastopaneeli.fi/wp-content/uploads/2021/02/ilmastopaneelin-raportti_ilmastolain-suositukset_final.pdf.
[19] Statistics Finland, Greenhouse gases, https://www.stat.fi/til/khki/2020/khki_2020_2021-05-21_tie_001_en.html.

roughly the same as for the total GHG emissions of Finland by the year 2035, the domestic NFC that have loans should emit 13.6 million tons of CO2 at the most in 2035[20].

To further estimate the CO2 emissions from the NFC loan stock, the loan stock is proportioned with the total balance sheet of the NFCs. The amount of NFC loans (38 billion euros) included in calculations correspond to 8 % of the NFC's balance sheets' total amount (473 billion euros). Therefore, the emissions from the loan stock reduces to 4.7 million tons of CO2 in 2019. Similarly, the financed emissions of the NFC loan stock should be reduced to 2 million tons of CO2 (i.e. 60%) by the year 2035.



Source: Bank of Finland, Statistics Finland

Figure 4. Emissions by the domestic debtor NFCs and the national climate target

In addition to the national target, the carbon emissions from the NFC loans are proportioned to the EU Fit for 55 -target, which states that the emissions should be reduced 55% by the year 2030 compared to the year 1990. This corresponds to reduction of 40% by the year 2030 compared to year the 2019. The EU target also includes reaching carbon neutrality by the year 2055.

Considering the EU target, the domestic NFCs that have loans from banks resident in Finland should reduce emissions from estimated 34 million tons of CO2 in 2019 to 20 million tons in 2030 (i.e. approximately 40%). Correspondingly, the emissions from the NFC loan stock should be reduced from estimated 4.7 to 2.8 million tons of CO2 by 2030.

Following carbon footprint or financed emissions of financial institutions, developing data availability, common indicators, and calculations methodologies is crucial considering the urgent need for climate action. Also, in the new European Commission Strategy for Financing the Transition to a Sustainable Economy[21] it is stated in the Action 5, that to monitor an orderly transition and ensure the integrity of the

[20] More information on GHG emissions and the plans to reduce them in Finland by Statistics Finland (only in Finnish), Suomen kasvihuonekaasupäästöt 1990-2020, https://www.tilastokeskus.fi/tup/khkinv/khkaasut_suominir.html.
[21] The European Commission, Strategy for Financing the Transition to a Sustainable Economy, July 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0390.

EU financial system, the Commission will strengthen cooperation among all relevant public authorities, including Member States, the ECB, the ESRB, the European Supervisory Authorities and the European Environment Agency, to work towards a common approach to monitor an orderly transition across the financial system. It is also stated that the Commission will develop a robust monitoring framework to measure capital flows and assist Member States in assessing the investment gap and measuring the progress made by their financial sectors by 2023. Also, a Sustainable Finance Research Forum will be established to foster knowledge exchange between researchers and the financial community.

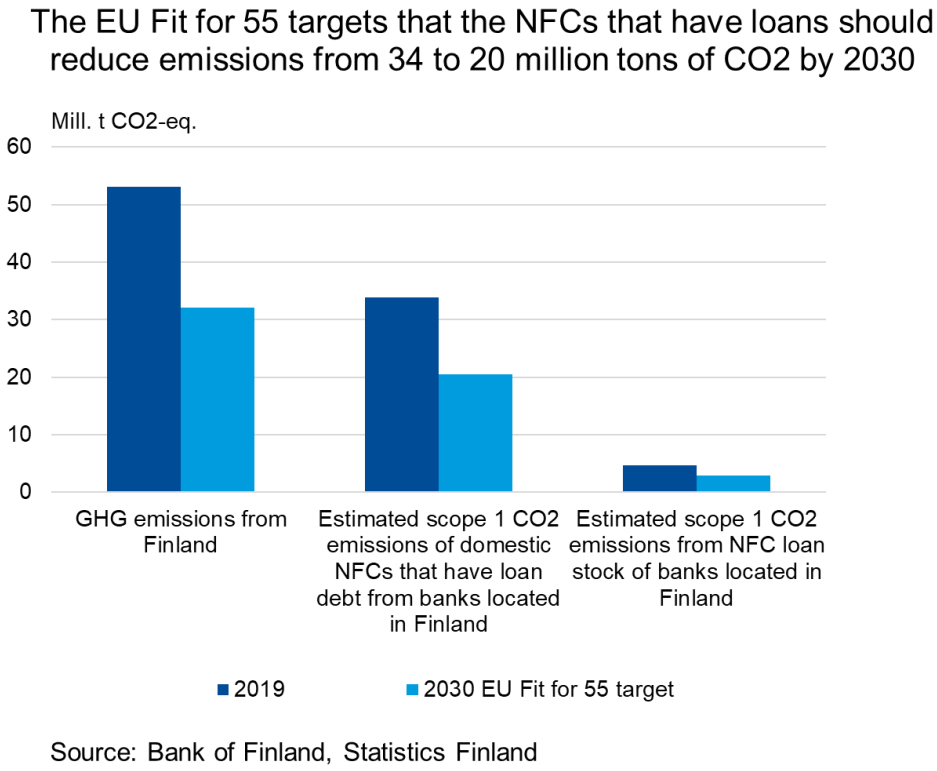


Figure 5. Emissions by the domestic debtor NFCs and the EU Fit for 55 climate target

As a next step, it would be insightful to assess carbon footprint reduction targets by economic activities, i.e. industries, from the point of view of both scope 1 and 2 emissions, and scope 3 emissions as far as the data are available. Different scopes would be interesting, as scope 1 emissions work as good measure for national target levels. However, for describing e.g., transition risk, scope 2 and 3 emissions give more insight. As the scope 1 emissions that are produced by one, are consumed by another as scope 2 and 3 emissions, which is the way the implications of transition risks, e.g. in the form of energy prices may be transmitted across the economic sectors.

4.3 Data quality assessment

The carbon footprint quality was analyzed with the following quality framework: 1) Relevance, 2) Timeliness, 3) Methodology, 4) Data sources accuracy, 5) Coverage and 6) Precision.

The **relevance** of carbon footprint of banks portfolios, here NFC loans, is evident. The data need is highlighted from at least two perspectives. First, the carbon footprint is important for analyzing the transition risk related to banks' balance sheets. The carbon intensity of the loan stock reflects how much counterparties need to adjust their businesses on the pathway to less carbon intensive economies. This transition might increase costs and decrease incomes of these counterparties. Second, the need is related to national climate goals. As government implements policies to bring the society towards net zero

emissions it is important to also follow the role of finance. An important question is that does the money flow towards those businesses, which are successful in the transition or to others? The indicator presented in this paper describes scope 1 carbon footprint of the NFCs. The benefit of the scope 1 measure is that is can be aggregated to national level over different industries. That is, same indicator can be used for individual NFCs and at the national level. At the same time the scope 1 measure does not give very good indication of transition risk for various industries. For example, real estate activities' transition risk relates to energy consumption and these emissions from energy consumption is not included in scope 1 (but included in scope 2 measure). For such industries other relevant indicators need to be developed, e.g. those that take scope 2 and 3 emissions into account.

There is a need for **timely** data on carbon footprint. Currently statistical aggregates on emissions are published with long delay (in Finland 21 months after the reference year). Still there are other sources available with shorter time lag. For example, the ETS data are published four months after the reference year. Financial data are also available at monthly level and two months after the reference month. For the NFCs included in ETS data the carbon footprint estimates can be produced with timely manner. Regarding NFCs not included in the ETS data, nowcasting is needed to improve the timeliness of basic data.

Used **methodology** is mostly based on verified emission data, which are certainly good quality. 92% of emissions for mining, manufacturing, and energy can be acquired from direct survey (ETS). That is, for these industries the methodology is very good. Other industries than ETS only imputation is used. The methodology takes into an account the industry level emissions and size of NFC (number of employees). If industry consists of NFCs with similar employee/emissions -ratio, then the methodology produced good results. For real estate -industry the methodology works very poorly, because the intensity of industry does not depend on the number of employees. Therefore, real estate industry was excluded from the scope of this indicator.

There are many data sources available for measuring NFCs emissions. Also, all sources do not give same results. For these data **accuracy** problems multisource approach is sometimes used. The ETS as data source for verified emissions has been used for a long time by Statistics Finland for GHG inventories and air emission accounts. Via the discussions with the experts the data source was defined as high quality data source. Also, the credit level data from AnaCredit are validated with aggregated results from more established banking data and assessed to be accurate. Statistical business register received from Statistics Finland provides basis for all business statistics compiled in Finland and the accuracy for this register is sufficient for producing statistics on NFSs.

The indicator **covers** fossil CO2 emissions. That is, other GHGs are left out. This causes under coverage problems for some industries. Basically, all industries included in ETS are covered very well in terms of GHG-emissions. The share of fossil CO2 varies from 96-98% within mining, manufacturing, electricity and air traffic industries. From large polluters only agriculture is not well covered. The share of fossil CO2 emissions of the total GHG-emissions is only 17% for agriculture. Coverage in terms of industries is also very good. The methodology is used for all other industries, but not for those without NFCs in Finland: Financial and insurance activities (K), Public administration (O), Activities of households as employers (T). Also, Real estate activities (L) is excluded because the methodology used for this indicator works very poorly with the industry. Excluded industries covered 30 % of the total NFC loan stock in the end of 2019. Furthermore, currently the methodology does not cover other asset types (such as securities) and institutions (such as investment funds).

Precision of the indicator is very high within industries that are included in ETS. The analysis can drill down to the most granular level of data, which is counterparty/loan level. For other industries, where mass imputation is applied to elevate the estimates to frame population level, only industry level aggregates should be used for analysis. That is, the mass imputation does not estimate figures for single counterparties correctly but provide better estimates at the industry level.

4.4 Benefits and challenges with granular indicators vs aggregated approach

The main benefit of the granular approach is that it enables the possibility of emissions of actual debtors from non-debtors. With granular data it is also possible to drill down even to debtor level, which allows to identify intensive emitters at corporate level. This is especially important within very heterogeneous industries such as energy, which include corporations from zero to very high levels of emissions. This allows more accurate analysis of transition risk and its pricing by the banks.

At the same time granular approach introduces a challenge as an emitter might not receive the financing directly from a bank. Large corporate groups can include captive financial institutions (CFIs), that can be the actual debtors of the bank loans and channel the loans to actual emitters. This would imply also group level analysis of the loans and emissions.

Also, national level analysis can't capture emissions if the corporations outsource their emissions outside of national borders. Still these corporations might be highly depended on CO2 intensive processes, but these processes are not mirrored in national data sources.

The largest drawback of the indicator based on granular data is the availability of the data. Verified emissions are available only for limited number of the companies which introduces the need for estimation. Estimation procedures make the granular approach far more complicated than the aggregated approach. At the same time, it is challenging to assess the robustness of the estimations as the verified emission data are limited.

5 Conclusions and way forward

The current indicator incorporates available granular and aggregate sources. With the circumstance it is rational to use the best possible combination of these sources. Having in mind the limitations of granular sources in coverage and aggregate sources in precision. The stepwise approach to improve to coverage and overcome the data gaps with current methodology is planned.

First identify relevant industries and then investigate alternative sources and methodologies such as

- For agricultural activity the aggregate sources for assessing other GHG than CO2 should be investigated
- Investigate data sources for measuring carbon footprint for Real estate activities (L).
- After the having solid methodology for bank loans the system should be scaled towards other asset types (such as securities) and institutions (such as investment funds)

Also, the foreseen enlargement of the ETS scope is welcomed. Currently the inclusion of transport industry is planned. Especially with aggregate sources the timeliness should be better. The improvement of timeliness of air emission accounts is also foreseen.

To capture the range of transition risk also indicators for scope 3 emissions is needed. For this the use of input-output framework would be useful to develop further.

Finally, to properly follow the national climate plans and assess the range of transition risk the forward-looking indicators should be investigated more profoundly.

References

European Central Bank (ECB). November 2020. Guide on climate-related and environmental risks. https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.202011finalguideonclimate-relatedandenvironmentalrisks~58213f6564.en.pdf

European Commission. July 2021. Strategy for Financing the Transition to a Sustainable Economy. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0390

Faiella, I., & Lavecchia, L. 2020. The carbon footprint of Italian loans. Bank of Italy Occasional Paper, (557).

Finnish Climate Panel. February 2021. Ilmastolakiin kirjattavat pitkän aikavälin päästö- ja nielutavoitteet – Ilmastopaneelin analyysi ja suositukset. https://www.ilmastopaneeli.fi/wp-content/uploads/2021/02/ilmastopaneelin-raportti_ilmastolain-suositukset_final.pdf

Greenhouse Gas Protocol. 2015. A Corporate Accounting and Reporting Standard - Revised Edition. https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Partnership for Carbon Accounting Financials (PCAF). November 2020. Global GHG Accounting and Reporting standard for Financial Industry. https://carbonaccountingfinancials.com/files/downloads/PCAF-Global-GHG-Standard.pdf

Statistics Finland. April 2021. Greenhouse gas inventory. https://tilastokeskus.fi/tup/khkinv/index_en.html

Statistics Finland. May 2021. Greenhouse gases. https://www.stat.fi/til/khki/2020/khki_2020_2021-05-21_tie_001_en.html

Statistics Finland. April 2021. Input-output. https://tilastokeskus.fi/til/pt/index_en.html

Statistics Finland. May 2021. Suomen kasvihuonekaasupäästöt 1990-2020. https://www.tilastokeskus.fi/static/media/uploads/yymp_kahup_1990-2020_2021_23462_net.pdf

Task Force on Climate-Related Financial Disclosures (TCFD). June 2021. Proposed Guidance on Climate-related Metrics, Targets, and Transition Plans. https://www.fsb-tcfd.org/publications/

Appendix

Industry (NACE) code	Description
A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B05-09	Mining and quarrying
C10-12	Food industry, etc.
C13-15	Textile, clothing and leather industries
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19-20	Manufacture of coke and refined petroleum products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31-32	Manufacture of furniture and other products
C33	Repair and installation of machinery and equipment
D35	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-39	Sewerage and waste management
F41-43	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I55-56	Accommodation and food service activities
J58	Publishing activities
J59-60	Audio-visual activities
J61	Telecommunications
J62-63	Computer and information service activities
M69-70	Business management activities

M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74-75	Other business activities and veterinary activities
N77	Rental and leasing activities
N78	Employment activities
N79	Travel agency, tour operator and other reservation service and related activities
N80-82	Other support services
P85	Education
Q86	Human health activities
Q87-88	Social work activities
R90-92	Cultural activities and gambling
R93	Sports activities and amusement and recreation activities
S94	Activities of membership organisations
S95	Repair of computers and personal and household goods
S96	Other personal service activities