AN ESTIMATION OF THE CARBON FOOTPRINT IN SPANISH CREDIT INSTITUTIONS' BUSINESS LENDING PORTFOLIO

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Abstract

This paper proposes an indicator to estimate the carbon footprint of the business lending of Spanish credit institutions. The growing interest in our societies in environmental issues means that the action taken by financial institutions to support the fight against climate change and the green transition needs to be analysed. In this respect, it is essential to have quality environmental information available and to establish robust methodologies to assess the climate exposure of the financial sector. This paper seeks to contribute to this debate, offering an experimental statistic to measure the degree of exposure of the banking sector in Spain to the risks involved in the transition to a more sustainable economic model.

The results obtained show that the carbon footprint of the loans of Spanish credit institutions seems to have been significantly reduced recently. This decline is compatible with the overall reduction in the intensity of pollutant emissions that has taken place in the Spanish economy in recent years, but also with a slight shift in the composition of the loan portfolio towards less polluting activities.

Keywords: climate change, carbon footprint, financial risks.

JEL classification: Q50, Q56, G10, G20.

Resumen

Este documento realiza una propuesta de estimación de la huella de carbono en la financiación a empresas por parte de las entidades de crédito españolas. El creciente interés de nuestras sociedades por cuestiones medioambientales exige abordar un análisis de la actuación de las entidades financieras en su labor para facilitar la lucha contra el cambio climático y la transición ecológica. En este ámbito, es indispensable disponer de información medioambiental de calidad y establecer metodologías robustas que permitan la evaluación de las exposiciones climáticas del sector financiero. Este trabajo pretende realizar una aportación a este debate, ofreciendo una estadística de carácter experimental para la medición del grado de exposición del sector bancario en España a los riesgos de transición hacia un modelo económico más sostenible.

Los resultados obtenidos muestran que la huella de carbono de los préstamos de las entidades de crédito españolas se habría reducido de forma significativa en el período más reciente. Este descenso resulta compatible con la reducción en la intensidad de las emisiones contaminantes que ha tenido lugar en el conjunto de la economía española durante los últimos años, pero también con una ligera recomposición de la cartera de préstamos hacia las ramas de actividad menos contaminantes.

Palabras clave: cambio climático, huella de carbono, riesgos financieros.

Códigos JEL: Q50, Q56, G10, G20.

Contents

1 Introduction

The growing social demand regarding environmental issues observed in recent decades and the response from public authorities (including the establishment of climate targets) have driven reflections on the role the financial system should play in this transformation towards more sustainable economic growth models. The financial sector must prioritise efficiency when channelling the resources needed to drive this transformation, while simultaneously paying attention to the potential transition and physical risks that in the near term will affect companies and households, and, consequently, financial institutions.[1]

One of the most significant international environmental public policy commitments of recent years has been the 2015 Paris Agreement. This Agreement sets targets for reducing greenhouse gas (GHG) emissions, which have been identified as the main cause of global warming. Since then, important initiatives[2] have emerged in the field of financial sector regulation which factor in environmental and green transition considerations compatible with the climate targets. These new regulations (e.g. in relation to financial stability and prudential supervision) flag a need to assess the financial sector's behaviour and its environmental responsibility, as well as to put more emphasis on evaluating the exposures of financial institutions (in particular, credit institutions) through the use of environmental parameters.[3] However, the initiatives for assessing financial institutions' environmental risks are still in the early stages of development and international harmonisation, which prevents a clear understanding of the efforts and progress needed to meet the climate change targets.

This paper presents a proposal for an indicator to quantify the GHG carbon footprint of Spanish credit institutions' portfolio of loans to resident firms, with the aim of evaluating the banking sector's behaviour in: (i) channelling financial resources towards less polluting activities and (ii) measuring the transition risks to which financial institutions will be subject in the coming years, due to the economic and financial performance of certain economic sectors in the face of the decarbonisation of the economy (however, measuring their exposure to climate-related risks is beyond the scope of this paper).

This proposal will thus contribute to the current methodological debate over the selection of potential indicators to measure these transition risks, in the absence of an internationally agreed definition. So far, the selection of such indicators has taken place only as part of independent initiatives.[4]

1 Banco de España (2022). Chapter 4 of the Annual Report includes a detailed analysis of the challenges that our society will have to contend with due to climate change and the key role that the financial system will play in the green transition.

2 Notable among these, at the European level, are the recommendations issued by the European Banking Authority and the European Central Bank addressing climate change-related risks for credit institutions and the introduction of the first climate risk stress tests.

3 Box 2, "Información sobre sostenibilidad en las sociedades no financieras", *Central de Balances.* Annual results of non-financial corporations, 2020, Banco de España.

4 Notably including estimates from commercial data providers (such as Urgentem), proposals forwarded by financial institutions (e.g. Barrutiabengoa et al. (2022)), and the methodology developed by Alogoskoufis et al. (2021) for the climate risk stress test exercise.

In the spirit of ensuring that the proposed methodology can be reproduced by other interested countries or agents, information sources and calculation procedures that are broadly available in other jurisdictions have primarily been used when defining the methodology.

To this end, the second section briefly describes the data sources and the methodology used to calculate this carbon footprint indicator. The third section shows the main results obtained, in aggregate and individual terms. Lastly, in the fourth section, possible refinements in and extensions to the application of this procedure are reviewed. A final section of conclusions is also included.

2 Data sources and methodology

Before describing the procedure and the methodology used to prepare the carbon footprint indicator, an in-depth review of the data sources used is provided. This description will allow a better understanding of the characteristics, benefits and limitations of the information content of the indicator and serve as a model for its replicability in other arenas and geographical areas.

2.1 Pollutant emissions

In order to assess the carbon footprint of financial institutions' loan portfolio, it is key that information on the GHG emissions generated by productive activity is available. Ideally this information[5] would be obtained through individual, firm-level data on: (i) direct emissions (known as "scope 1" emissions) generated in companies' direct consumption of fossil fuels, and (ii) indirect emissions ("scope 2 and 3" emissions), which derive from suppliers' fuel consumption to generate the inputs used by companies in their production process.

However, at present such information is far from being available. Detailed information on pollutant emissions is only available for a handful of firms (generally large corporations) and it is not always easy to attribute emissions to specific companies, since the data are diffuse in terms of business groups or installations and lack specifics regarding the emitting company or geographical allocation.

Given the limited access to granular information, aggregate statistics on pollutants emitted into the atmosphere by each sector of activity can be used as an initial approach. While these are less accurate than the real firm-level data, they do enable a uniform comparison with complete information for the economy as a whole. These aggregate data are available in the environmental accounts that are usually drawn up by the national statistics institutes (in the case of Spain, by the Instituto Nacional de Estadística, or INE), following the methodology established by the United Nations for the System of Environmental-Economic Accounting.

The variable selected for measuring these pollutant emissions in Spain is total GHG emissions,[6] measured in thousands of tonnes of CO_2 equivalent in annual terms, which are available in the INE's Air Emissions Accounts.[7] The level of detail used corresponds to the breakdown of the 64 sectors of activity according to the National Classification of Economic Activities (NACE Rev. 2).

2.2 Output level

In order to calibrate the pollution intensity of each sector of activity, the emissions must be compared with a measure of the quantity of goods and services produced by the economic

5 The ISO 14064 standard establishes an international framework for quantifying and reporting firms' GHG emissions, setting out the classification of direct and indirect emissions.

6 Pollutant emissions include, in addition to carbon dioxide (CO_2) other greenhouse gases, such as methane or nitrous oxide, expressed in units of CO_2 equivalent based on their global warming potential.

7 See the dedicated section of the INE website.

sectors. Of the several options available, the indicator selected for measuring overall activity is the level of output in a financial year, measured in terms of monetary units (millions of euro). This variable is available in the annual National Accounting statistics,[8] which in the case of Spain is also prepared by the INE.

2.3 Input-output table

To calculate the carbon footprint of each sector of activity, the information on direct pollution needs to be completed with an assessment of indirect GHG emissions stemming from the inputs used in the production process. These can be calculated using the input-output table available as part of the National Accounts. This statistic contains a very detailed description of the characteristics of the productive sectors of the economies. In the case of Spain, the most recent information prepared by the INE corresponds to 2016.[9]

2.4 Bank loan portfolio

Information on Spanish banks' credit exposures to resident companies is taken from the quarterly financial reporting statement that credit institutions send to the Banco de España. This return[10] contains details of the stock of loans broken down by economic activity of the borrowers (NACE Rev. 2 sections).

This information has been supplemented with aggregate data from the Banco de España's Central Credit Register (CCR) for those sectors of activity[11] not covered by the reporting returns.

2.5 Direct and indirect polluting emission coefficients

In the proposed procedure for calculating the carbon footprint indicator, obtaining the CO_2 emission coefficients per unit of output for each sector of activity is key. These coefficients or ratios seek to assess the intensity of (direct and indirect) polluting emissions in the output of each economic sector.

The direct coefficients (q^{direct}) are calculated as the ratio between GHG emissions (expressed in thousands of tonnes of CO_2 equivalent) and the total output of each sector (in millions of euro), according to formula [1]:

$$q_{it}^{directs} = \frac{\text{Greenhouse gasses}_{it}}{\text{Total output}_{it}} \qquad [1]$$

for each sector of activity (i) and year (t).

8 See the INE website for details of the Annual National Accounts for Spain (aggregated by sector of activity).

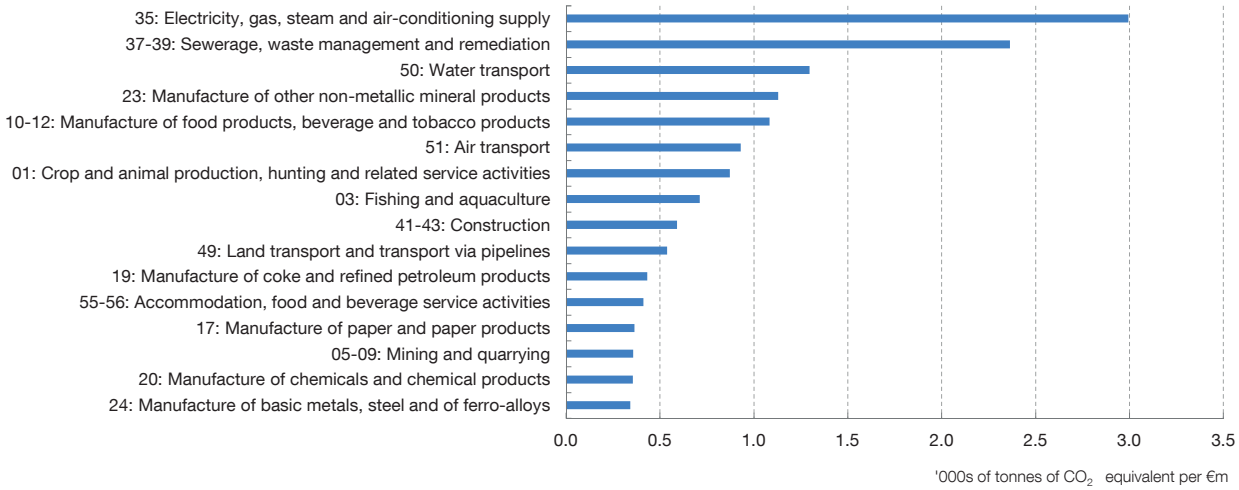
9 See the input-output tables section of the INE website.

10 Return FI 130, module "Breakdown of loans to other customers (business in Spain). Loans to non-financial business activity. National Classification of Economic Activities (residents in Spain)". The reporting return used by credit institutions can be downloaded from the Banco de España website.

11 For further details (NACE Rev. 2 sectors at two-digit level) on the manufacturing, mining and telecommunications sectors.

Chart 1

MOST POLLUTING SECTORS. DIRECT EMISSION COEFFICIENTS PER UNIT OF OUTPUT IN 2019



SOURCES: INE and Banco de España.

The total coefficients (q^{totals}) are the sum of the direct coefficients and the indirect effect of the polluting emissions produced in obtaining the intermediate inputs[12] used by each sector of activity, as expressed in formula [2]. This estimate draws on information from the National Accounts input-output matrix, which includes how the final output of each sector is incorporated as inputs by the other sectors:[13]

$$q_{it}^{total} = (I - A)^{-1} q_{it}^{direct} \qquad [2]$$

where A is the coefficient matrix of the input-output table in the Annual National Accounts of Spain for 2016 and $(I–A)^{-1}$ is the Leontief inverse matrix.

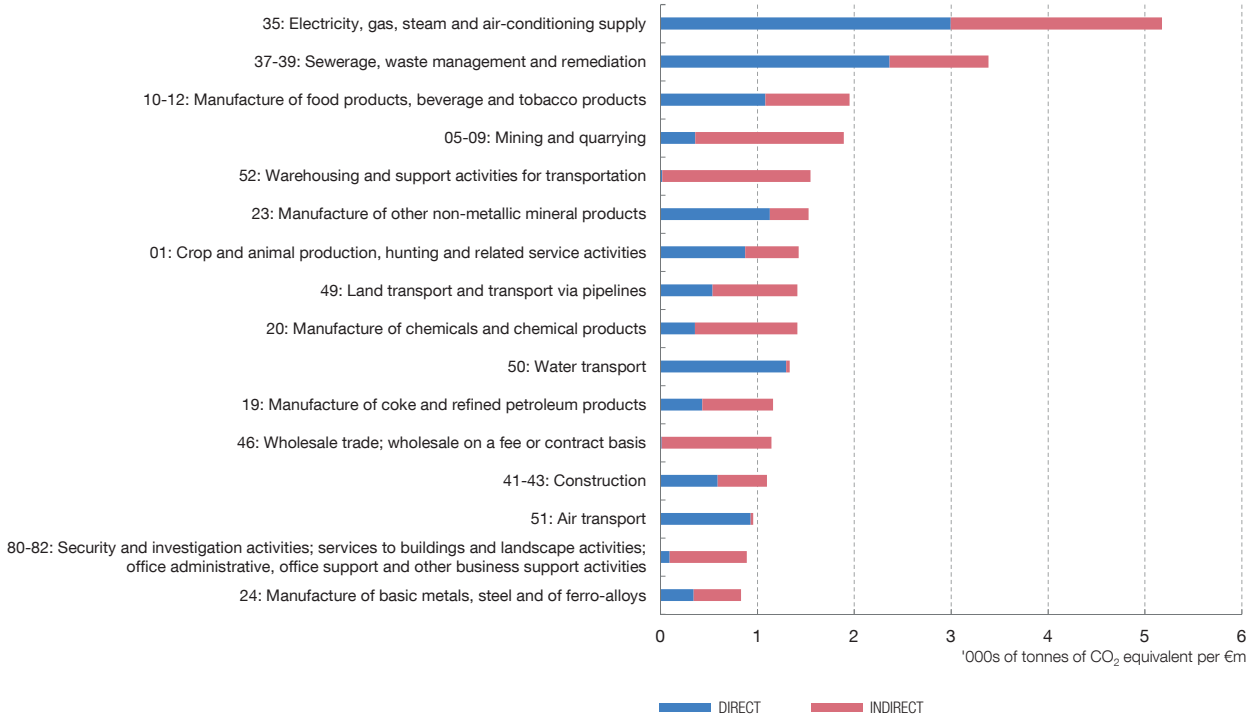
The values of the direct coefficients will depend on the inherent characteristics of the productive structure of each sector of activity (e.g. inputs used, capital/labour ratio, productive equipment, etc.). This means that the changes in the coefficients over time are small and that the changes in the sectors' relative positions in pollution intensity levels are also infrequent over the near term. Chart 1 shows the results obtained from the direct coefficients of the most polluting sectors in Spain. The results indicate that electricity and gas supply, transportation, manufacturing and agriculture are the productive sectors with the highest GHG emissions per unit of output.

12 One limitation of this methodology is that it only includes the polluting emissions of the intermediate inputs generated in the domestic economy and excludes emissions produced by imported inputs. Therefore, these estimates could potentially be improved by factoring in the pollution generated in third countries (through border adjustment mechanisms) and avoiding any "greenwashing", whereby certain activities that are not environmentally sustainable on an overall basis might be classified as non-polluting.

13 A similar methodology to estimate total emissions is used in Estrada and Santabárbara (2021).

Chart 2

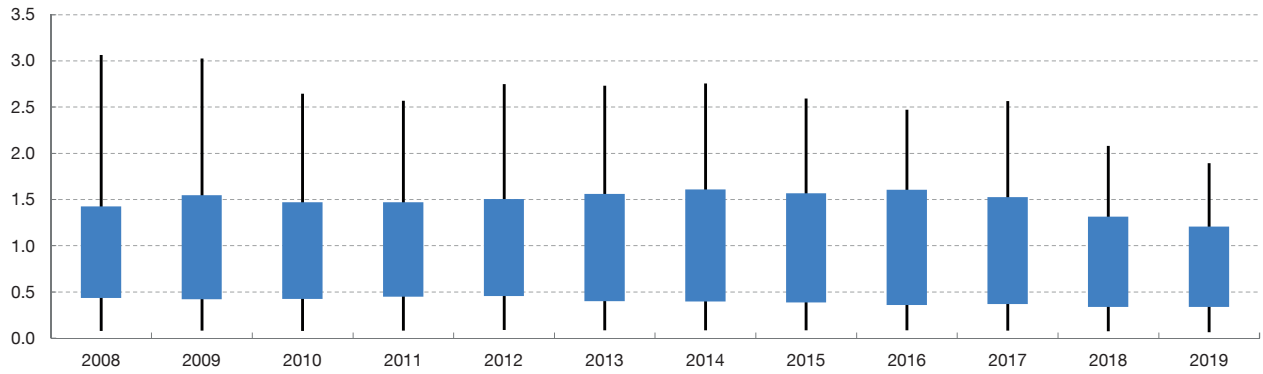
MOST POLLUTING SECTORS. TOTAL COEFFICIENTS PER UNIT OF OUTPUT IN 2019



SOURCES: INE and Banco de España.

Chart 3

TOTAL CO_2 EMISSION COEFFICIENTS, BY SECTOR OF ACTIVITY (90th, 75th, 25th and 10th PERCENTILES)



SOURCES: INE and Banco de España.

In the results of the total coefficients by sector of activity (which also take into account the polluting effects of the inputs), some new sectors are included among the group of most polluting industries (e.g. mining and quarrying and storage activities). Turning to the indirect component, electricity and gas supply again stands out as the industry with the largest component stemming from emissions generated in obtaining the inputs used in its production process (see Chart 2).

The time analysis of the total coefficients for each sector of activity facilitates an analysis of production efficiency over time and, potentially, the degree of compliance with the GHG emission reduction targets. Chart 3 shows the statistical distribution of the sectors' coefficients in the period 2008-2019 (represented through the percentiles observed in each year). As can be seen, emission intensity has decreased across the board in recent years, particularly in the most polluting sectors (decrease in the 90th and 75th percentiles).

2.6 Indicator of the carbon footprint intensity of loans

Once the information on the total GHG emission coefficients at the sector of activity level is available, the indicator measuring the carbon footprint intensity of the business lending portfolio ($IHCO_2P$) is calculated[14] as the average of the coefficient totals of the sectors of activity, by each sector's share in the stock of bank lending, as expressed in formula [3].

$$IHCO_2P_t = \frac{\sum_i P_{it}\, q_{it}^{total}}{\sum_i P_{it}} \qquad [3]$$

P_{it}: stock of loans at year-end by sector of activity (i) and year (t).

The $IHCO_2P$, calculated for the credit institutions as a whole, thus represents the average ratio of polluting emissions of productive activities that obtain bank financing to total bank loans granted in Spain.

This indicator is interpreted as follows: a drop in the level of the indicator signifies an improvement in the carbon footprint (less financing provided to more polluting activities), while an increase represents a worsening (increased financing for activities with higher GHG pollution intensity).

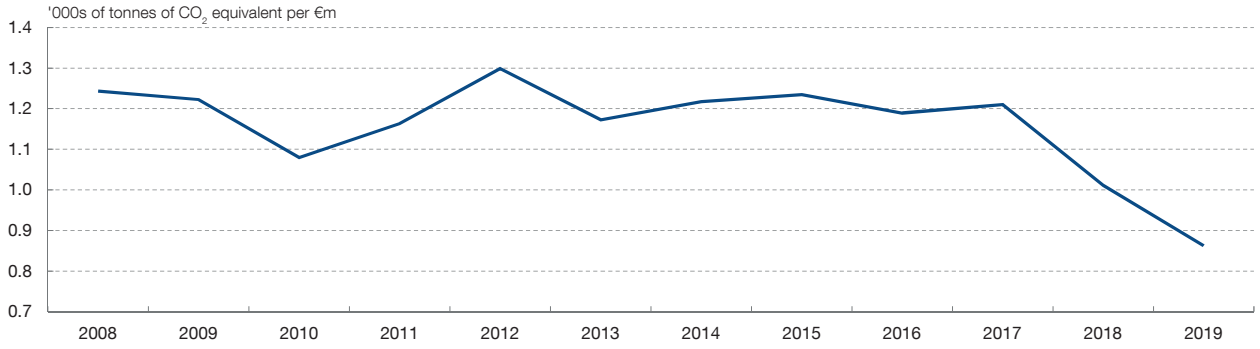
14 Similar to the approach proposed by Guan et al. (2017) and used by the International Monetary Fund in its Climate Change Indicators Dashboard.

3 Main results

The methodology proposed in the previous section for calculating the overall $IHCO_2P$ indicator for Spanish credit institutions in the period 2008-2019 can be used to assess changes in the intensity of the polluting emissions generated by bank lending. Chart 4 shows the results of the $IHCO_2P$, revealing a downward trend in the indicator in recent years, in line with the general improvement in the polluting emission coefficients.

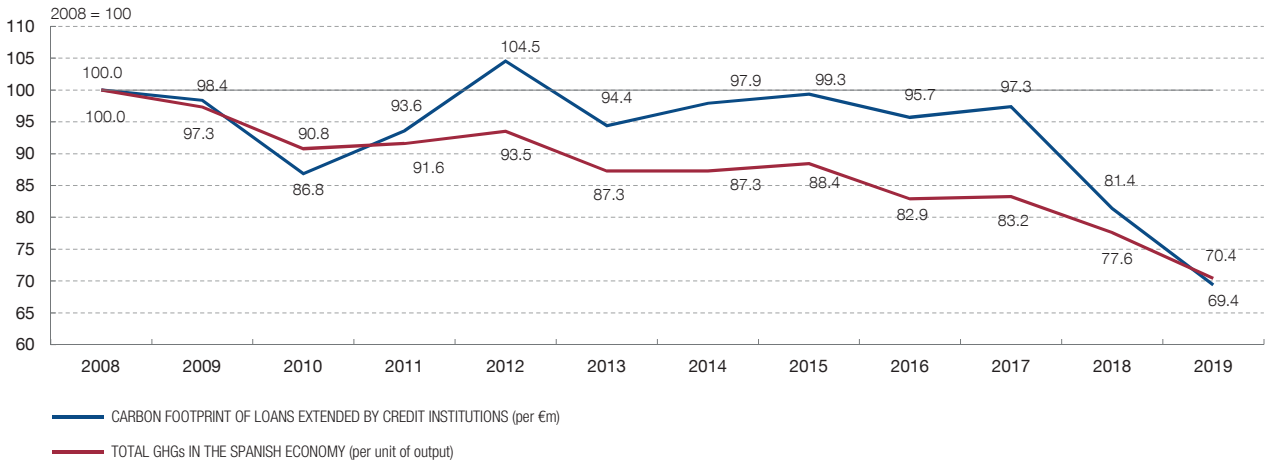
Given the difficulties in interpreting the indicator in its original units (tonnes of CO_2 per million euro) and for comparison purposes, the indicator is re-expressed in terms of an index (with a base year of 2008, the start of the series). A comparison of the $IHCO_2P$ with changes in the emission intensity of the Spanish economy in 2008-2019 shows a cumulative reduction of a very similar magnitude (see Chart 5).

Chart 4
CARBON FOOTPRINT OF LOANS EXTENDED BY CREDIT INSTITUTIONS IN SPAIN



SOURCES: INE and Banco de España.

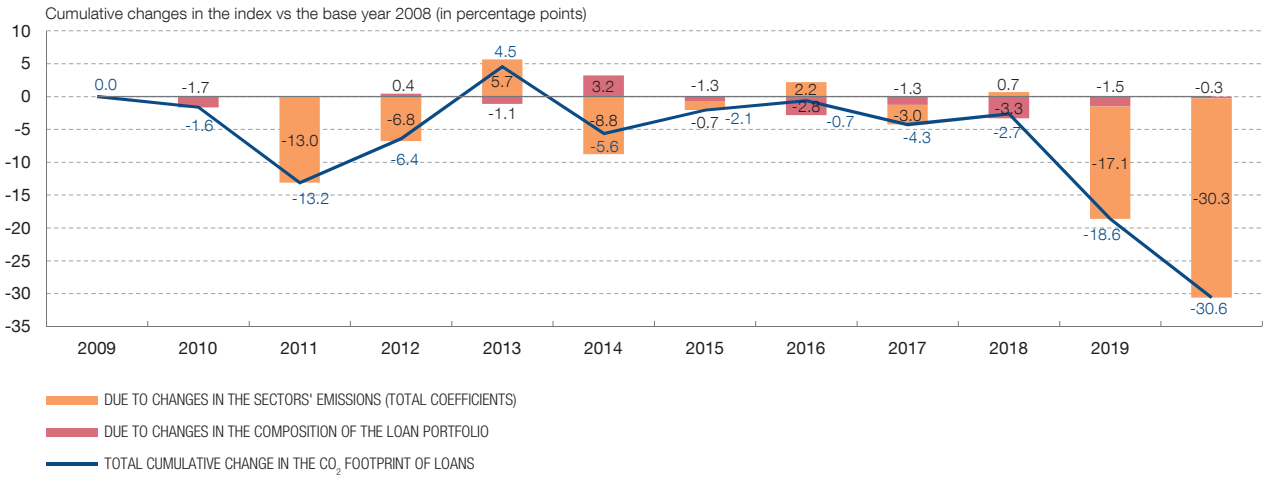
Chart 5
CARBON FOOTPRINT OF LOANS EXTENDED BY CREDIT INSTITUTIONS IN SPAIN



SOURCES: INE and Banco de España.

Chart 6

CUMULATIVE CHANGES IN THE CARBON FOOTPRINT (PER MILLION EURO) OF LOANS EXTENDED BY CREDIT INSTITUTIONS IN SPAIN



SOURCES: INE and Banco de España.

To identify the elements behind the changes in the $IHCO_2P$, the factors underlying this behaviour have been analysed, identifying the influence of (i) the changes in the sectors' polluting emission intensity and (ii) the changes due to shifts in the composition of the loan portfolio of the banks as a whole.

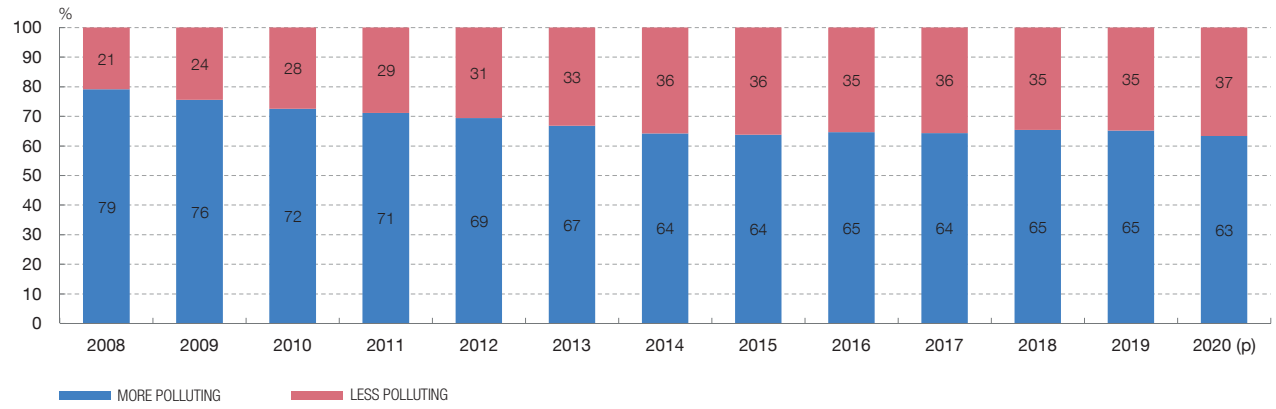
These effects have been identified using a simulation exercise, where the baseline scenario is a stable loan portfolio composition from the base year (data from 2008). The results obtained show that the primary factor behind the improvement in the $IHCO_2P$ is the decrease in the emission coefficients, while, in cumulative terms, the contribution of the changes in the composition of credit exposures (i.e. the decisions of credit institutions) appears to be quite marginal (see Chart 6).

To provide a more detailed analysis of the changes in the loan portfolio composition, the sectors of activity can be classified by the values of their total emission coefficients. In the absence of a universally accepted taxonomy for categorising productive sectors based on their pollution intensity, in this exercise the sectors of activity are divided into two groups – more polluting and less polluting – based on their average polluting emission intensity in 2008-2019. Thus, those sectors that exceed the median emission coefficient of the 64 analysed sectors are classified in the "more polluting" category, while those whose emission coefficients are below the median of the distribution are classified as "less polluting".

Chart 7 shows the result of this analysis, revealing a slight shift in the composition of Spanish credit institutions' loan portfolio towards less polluting sectors in the later years of the analysed period, although the influence of this on the $IHCO_2P$ is minor. These results, which appear to contradict those set out in Chart 6, may owe to the simplification inherent in

Chart 7

STRUCTURE OF THE LOAN PORTFOLIO OF SPANISH CREDIT INSTITUTIONS, BY CO_2 EMISSIONS OF THE PRODUCTIVE ACTIVITIES FINANCED



SOURCES: INE and Banco de España.

classifying the loan portfolio into just two categories, a distribution that alters the contribution of each sector to the behaviour of the indicator.

More specifically, the bulk of financing granted to the more polluting productive sectors was concentrated in (i) transportation and storage; (ii) electricity, gas, steam and air conditioning supply and (iii) the manufacture of food products (see Chart 8).

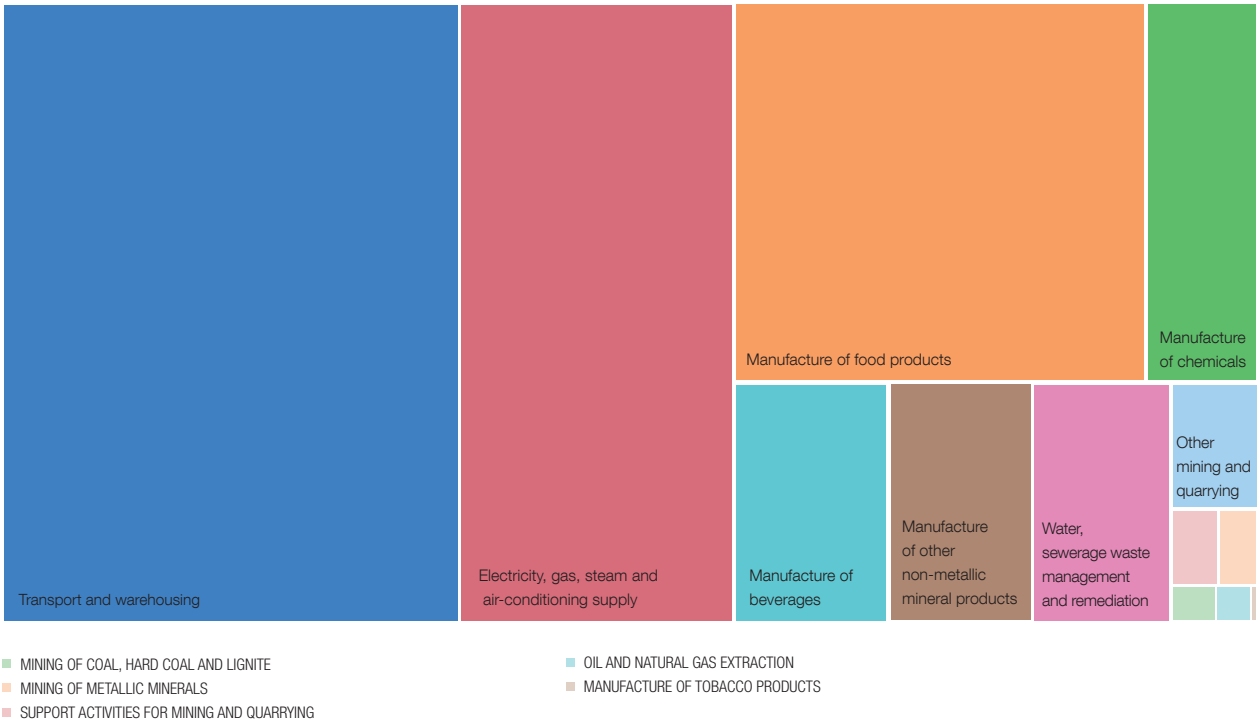
The results analysed above in the behaviour of the $IHCO_2P$ derive from the application of the methodology drawing on the aggregate information of the Spanish credit institutions sector. However, the approach proposed to calculate the carbon footprint can be applied to the individual data of the aggregate loan portfolio of each credit institution operating in the Spanish market, and the changes in this indicator can be evaluated on an individual basis. This approach is complementary to the aggregate analysis and can be used to analyse specific behaviours (for example, to identify influential observations) in the distribution of the $IHCO_2P$ for the entire sample of credit institutions in Spain.

To this end, the $IHCO_2P$ values have been calculated for each credit institution at two moments in time (in 2017 and 2020). The results for the population of 160 institutions have been represented using kernel density functions to plot the distribution of the $IHCO_2P$ values within the population of institutions (see Chart 9).

This approach, which is complementary to the aggregate view and uses more granular information, indicates a shift to the left of the density function in 2020 compared to 2017, suggesting that the reduction in the carbon footprint was broad-based across the overall population of credit institutions in Spain in the most recent period.

Chart 8

BREAKDOWN OF LENDING TO HIGHLY POLLUTING SECTORS (a)

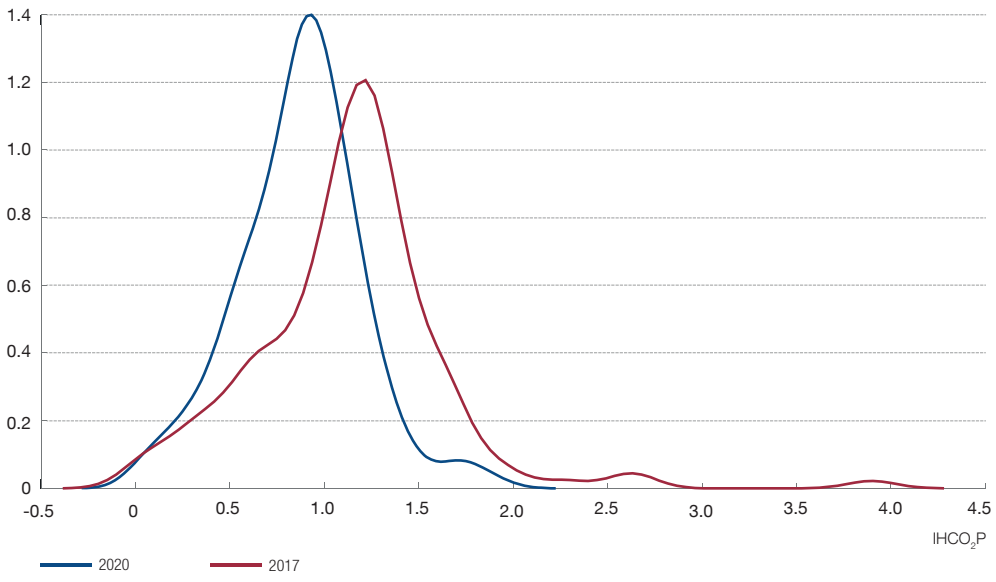


SOURCES: INE and Banco de España.

a "Highly polluting" sectors have total emission coefficients higher than the 75th percentile of the distribution.

Chart 9

IHCO$_2$P ANALYSIS BASED ON INDIVIDUAL DATA (CREDIT INSTITUTION LEVEL)



SOURCES: INE and Banco de España.

4 Possible methodological extensions in the calculation of the indicator

The methodology proposed in the foregoing sections for the calculation of the loan portfolio carbon footprint generates both aggregate and individual data, which can then be used to assess the composition of the financial flows channelled towards more polluting activities and to analyse the risks assumed by the financial sector in these exposures. However, this approach may be refined or extended, based on any additional information available or the required focus in terms of the indicator information. This section examines a series of reflections and potential methodological improvements to the definition of the indicator, which is per se an experimental statistic.

4.1 Use of features related to the productive and financial structure of the sectors

When evaluating the carbon footprint in business financing, it may also by useful to include elements that estimate the impact on the provision of funding for productive activities that, in turn, affect the level of polluting emissions. For example, it might be worth identifying and discriminating those sectors that operate with low debt levels (low funding amounts) but at the same time are responsible for highly polluting productive activity. These factors could be related to the intrinsic characteristics of the economic activities, relating to the productive and financial structures of the economic sectors.

As regards the productive structure, one highly conditioning element when gauging the influence of the financing granted is the level of investment needed to pursue productive activities (e.g. the amount of capital goods needed). This is often specific to each sector of activity. For example, industrial sectors generally have higher capital goods investment needs than services sector firms.

Likewise, financing structures are not unique to each company and are often also determined by the sector of activity in which the firm operates. For example, retail companies can access relatively large volumes of non-interest-bearing funding (e.g. trade credit), while in other sectors financial liabilities are only available in the shape of interest-bearing borrowing (bank financing).

Thus, both the productive and the financial structure can have a bearing when assessing the carbon footprint of bank loans, given that the same volume of financing granted to two companies engaged in different activities may have a completely unequal effects on the scale of the financed activity and its environmental impact. However, the inclusion of this change in the $IHCO_2P$ calculation, geared towards gauging the influence of bank loans on polluting emissions, appears less important for measuring transition risks and banks' balance sheet exposures. To evaluate the transition risks, the key is to identify the balance of financing extended to the more polluting firms and industries.

Formula [4] incorporates this modification in the definition of the polluting emission coefficients, on the basis of the coefficients obtained in formula [3], by including information on the economic and financial characteristics of the sectors of activity.

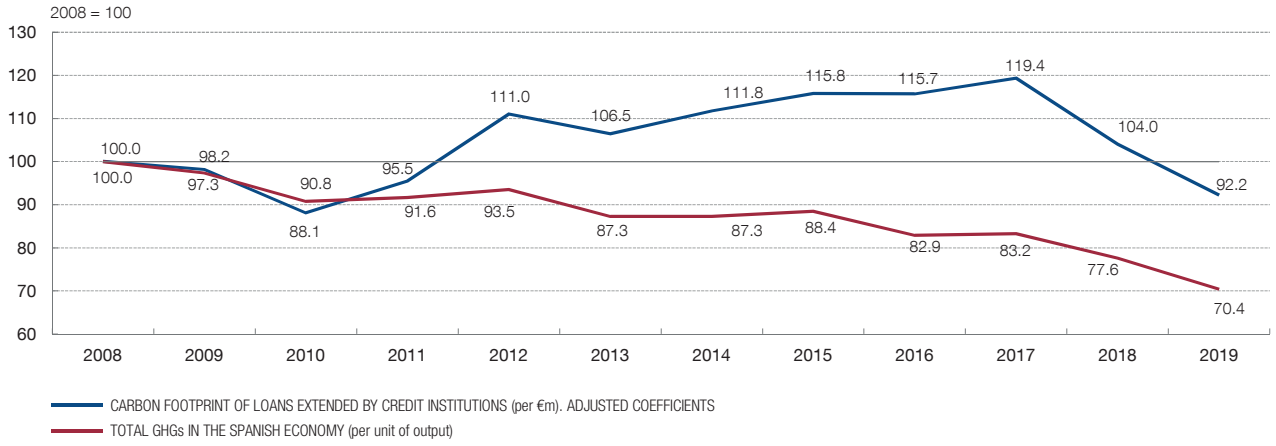
Given that these variables are often only available for samples of companies, rather than for the population as a whole, the adjustment of the calculations of the corrected emission coefficients (modified totals) uses ratios from representative information bases for non-financial corporations, such as those prepared by the Central Balance Sheet Data Office of the Banco de España. To make this exercise more reproducible for other countries, Spain's contribution to the BACH[15] (Bank for the Accounts of Companies Harmonized) database of the European Committee of Central Balance Sheet Data Offices is used. The ratios used to incorporate the productive and financial structures of the sectors of activity into these calculations correspond to the BACH variables R41 (Asset-turnover ratio) and L (Liabilities), respectively. To ensure the data provided by these coefficients are more structural, the averages of these values in the period 2008-2019 for the sample of Spanish non-financial corporations have been used in the breakdown of the 64 sectors of activity.

$$q_{it}^{\text{amended total}} = q_{it}^{\text{total}} * \underbrace{\frac{\text{Output (net turnover)}_{it}}{\text{Total balance}_{it}}}_{\text{Productive structure ratio}} * \underbrace{\frac{\text{Total balance}_{it}}{\text{Financial liabilities (borrowing)}_{it}}}_{\text{Leverage ratio (inverse)}} \quad [4]$$

This new definition of the polluting emission coefficients for the sectors of activity has been used to obtain the results of the carbon footprint indicator, allowing the influence of bank loans on the impact of the companies' polluting activities to be adjusted. As Chart 10 shows, once these adjustments are included, the results would show a less pronounced decrease in the $IHCO_2P$, although a declining trend is evident in the last two years of the sample.

Chart 10

CARBON FOOTPRINT OF LOANS EXTENDED BY CREDIT INSTITUTIONS IN SPAIN



SOURCES: INE and Banco de España.

15 The BACH database can be accessed here.

4.2 Limitations in the use of information on loans according to economic activity rather than purpose

One of the most significant limitations in analyses of the impact of the financial sector's actions on polluting emissions derives from restricted access to information on the specific environmental characteristics of the business projects that are being financed, beyond the firm's general activity. Usually, information on financing extended only includes reference data on the risk holder, not on the purpose for which the funds are used. The exercises to quantify the footprint could be enriched if the purpose of the loans were included in the loan portfolio classification (for example, the acquisition of electric vehicles or energy efficiency and environmental sustainability projects), which would help to more accurately gauge the future carbon footprint trajectory.

4.3 The current classifications of economic activities do not contain adequate details to assess polluting emissions

The current international classifications of economic activities do not include a breakdown of the sectors of activity that would allow a detailed and tailored analysis of the carbon footprint. This hampers the availability of information on changes in production models that need to be identified and driven through public policy action. One example of such information deficits is the lack of differentiation of renewable electricity generation activities in the electricity production sector.

The ongoing discussions on reforming and adapting these classifications include debate over the significant shortcomings in the current international codes of economic activities (ISIC Rev 4 and NACE).[16] As a result, deliberations on future updates of these classifications now include the possibility of refining the details of environmental information. A successful adaptation of these details will enable higher quality statistical work to be prepared, which is crucial for economic agents and public authorities in their decision-making.

4.4 Access to individual data on emissions and loans (at company level) could refine this measurement

The methodology proposed in this paper for calculating the carbon footprint exclusively uses aggregate information (at the sector of activity level) both in the analysis of the behaviour of polluting emissions and as regards the composition of loan portfolios. The estimation of the carbon footprint of bank loans could potentially be improved by taking information from those corporate segments (mainly large companies) for which detailed and comprehensive information on polluting emissions and loans is available, and incorporating it into these calculations.[17] However, no such detailed firm-level information is available for the bulk of

16 In 2021, the technical subgroup on ISIC classifications recommended that the next version of this statistical classification of economic activities include new details to facilitate the identification of environmental issues.

17 Examples include the institutional collaboration between the Ministry of Ecological Transition and Demographic Challenge, the National Statistics Institute and the Banco de España to exploit firms' environmental information.

the population of companies. Therefore, aggregate data will always need to be used or individual data will have to be estimated and imputed.

4.5 Treatment of loans to holding companies and head offices

Certain weaknesses in these carbon footprint estimation exercises hinder the precise calibration of the impact of the funds received by holding companies and head offices of business groups (sectors 6420 and 7010, respectively, in the NACE classification). The firms classified in these sectors often channel the financing that they receive towards group companies, which are the firms that actually undertake the business activities and, therefore, that generate the polluting emissions. However, this channelling of financing towards subsidiaries is not reflected in the activity sector breakdown of credit exposures.

One way to overcome these limitations and more accurately map the carbon footprint of the bank loans granted to holding companies and head offices would necessitate detailed information on the economic activities undertaken by the "productive" subsidiaries of their business groups (for example, industrial or service activities). In the case of Spain, bank financing extended to holding companies and head offices represents around 10% of the total financing to non-financial corporations. As a result, incorporating this adjustment into the carbon footprint calculations would have a not insignificant impact.

5 Conclusions

In recent years, increased social awareness of environmental degradation and global concerns about climate change have prompted various initiatives undertaken by public authorities to set targets for reducing GHG emissions. Similarly, international fora have included discussions on the need to calibrate the role that the financial system will play in fostering the green transition towards more sustainable economic models.

In this respect, establishing indicators capable of calibrating financial institutions' carbon footprint will allow us to analyse developments in the funds channelled towards more or less polluting activities and identify the risks that will be assumed by financial agents as part of the shift in economic consumption and production patterns. This paper seeks to make a methodological contribution to the current debate on the most appropriate indicators for measuring these phenomena, as well as to serve as a reference for measuring the carbon footprint in credit institutions' business lending.

The method selected in this proposal – for the experimental calculation of the carbon footprint of the Spanish credit institutions' business loans – has prioritised elements to help extrapolate this experience both to other geographical areas (countries or jurisdictions) and to other levels of aggregation (individual institutions or entire sectors), thus making for more comparable results. To this end, readily accessible information sources and reproducible calculation methods have been used. However, this paper also flags the limitations of the methodology selected and suggests potential areas of improvement that would help refine the results.

The carbon footprint index of Spanish credit institutions' loans shows something of a decrease in recent years, although this mainly owes to the reduction in the productive sectors' polluting emissions, while the shift in the composition of the credit portfolio towards more sustainable activities has had a minor impact.

The experimental statistics obtained for measuring the carbon footprint of business loans by credit institutions in Spain and the methodological reflections presented in this paper seek to contribute to the current debate on the selection of indicators for measuring the financial sector's impact on environmental targets and to serve to assess climate change-related risks. Further, one benefit of the approach used in this paper is its potential to be extended to other instruments (e.g. investment funds and insurance companies).

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