Economics of Climate Change Cluster

From national to sectoral perspective: a comprehensive analysis of GHG emissions in Spain

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Spain's post-pandemic economic growth in 2022 led to a 3.1% increase in greenhouse gas (GHG) emissions and a 4.5% rise in CO_2 emissions, challenging its commitments to reduction targets. The primary factors driving this increase include a heightened energy demand and a transitory shift towards more carbon-intensive energy sources, influenced by global geopolitical developments and exacerbated by drought conditions. Additionally, there was a notable upsurge in activities within high-emission sectors such as air transport and energy production. Nevertheless, Spain has demonstrated significant strides in enhancing energy efficiency in recent years. This progress is evidenced by a reduction in energy intensity, driven by a more efficient use of energy resources and a greener energy mix. An in-depth sector-specific analysis spanning from 2016 to 2019, employing input-output methodology for calculating Scope 3 emissions, indicates a general downward trend. Notably, sectors that are catalogued as high emitters have shown progress in decarbonization efforts, many of which are subject to the EU Emission Trading System (EU ETS). This comprehensive view underscores the differing levels of vulnerability across sectors to climate transition risks. Finally, it emphasizes the critical need for a holistic approach in climate strategies, one that considers both direct and indirect emissions to effectively address decarbonization.

1. In 2022, a more carbon-intensive energy mix, affected by geopolitical factors along with the post-pandemic economic recovery, boosted emissions in Spain

In 2022, greenhouse gasses (GHG) and CO_2 emissions increased by 3.1% and 4.5% in Spain, according to the latest Spanish Air Emission Accounts[1] published by the Spanish National Statistics Institute (INE). This increase is largely explained by the post-pandemic **resurgence in economic activity, coupled with a shift towards a more carbon-intensive energy mix. This shift was influenced by geopolitical factors and exacerbated by droughts**[2], but at the same time, **partially offset by a decrease in energy intensity -energy used per unit of GDP-** driven by high energy prices (see **Box 1**). Non-CO_2 carbon intensities also declined in 2022, **extending the well-established downward trend of emission intensities** -emissions per unit of GDP- (**Figure 1**).

1: The National Accounts system accounts for national economic activities (principle of residence) regardless of the geographical place where these emissions actually occur. Air Emissions Accounts are estimated from the National Inventories of Emissions to the Atmosphere of the Ministry for Ecological Transition and the Demographic Challenge.
2: In 2022, the hydropower sector recorded in Spain the lowest electricity production in the last three decades due to lack of rainfall (see here).

Figure 1. **SPAIN. ECONOMIC ACTIVITIES, HOUSEHOLDS GHG EMISSIONS (*) AND EMISSION INTENSITY** (THOUSANDS OF TONS, 2008=100)

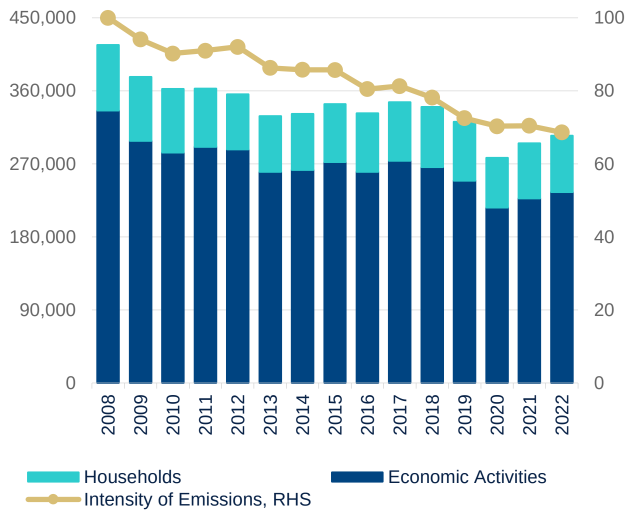
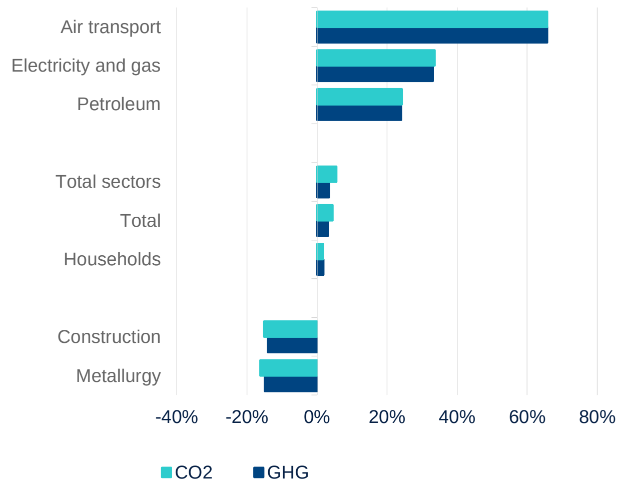


Figure 2. **SPAIN. SELECTED ACTIVITY SECTORS AND HOUSEHOLDS (*). CO_2 AND GHG EMISSIONS** 2022 VS 2021, %



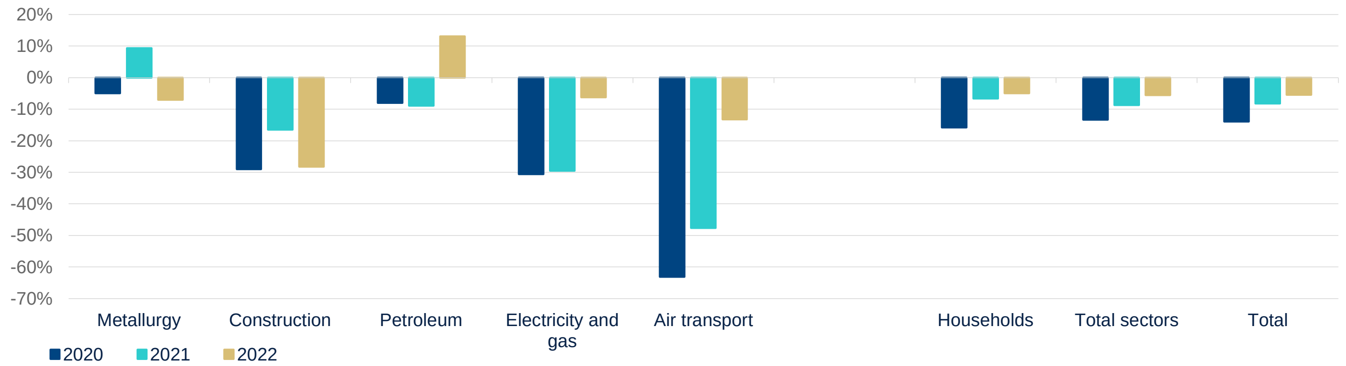
(*) Economic activities and households only include direct emissions. Direct household emissions are generated when people drive their vehicles, use fossil fuels to heat home or cook, while indirect household emissions are those emitted during the production process of products and services.
Source: BBVA Research from INE data.

In terms of sectoral allocation, air transport came up with the highest annual increase in GHG and CO_2 emissions, with a rise of over 60% in 2022 compared to 2021, followed by energy supply -electricity and gas- **and refining** -petroleum- (see **Figure 2**). The surge was driven by two factors: the energy demand rebound derived from the post-pandemic economic recovery, and a more emissions-intensive energy mix. In 2022, **numerous sectors had not fully reverted to their pre-pandemic emission levels, with overall GHG emissions remaining 5.4% lower than the 2019 benchmark. However, a discernible trend toward recovery is evident, indicating a gradual return to prior emission patterns.**

Sectoral differentiation due to the compound of temporary and structural factors (demand variations and efficiency improvement). The observed trend towards emissions recovery in 2022 **exhibited notable variance across different sectors**. Industries such as construction, air transport, and metallurgy are keeping their GHG emissions below 2019 levels. Specifically, the construction sector had a 30% decrease, while air transport and metallurgy each reported a reduction of almost 10%. This decline can be partially attributed to the successful implementation of technological innovations and efficiency improvements within their decarbonization initiatives. However, **potential exists for emissions to rebound** in the forthcoming years as these sectors experienced a resurgence in activity, suggesting that part of the emission reduction could be temporarily tied to decreased operational levels. In contrast, sectors like refining -petroleum- witnessed a 10% escalation in GHG emissions over the same period (see **Figure 3**).

In general, this dynamic reflects a process of gradual decoupling, which, despite not fully meeting decarbonization objectives, is contributing to stepwise improvements. Furthermore, there has been noticeable progress in curbing emissions of non-CO_2 gasses, particularly methane, which likely stems from a shift away from traditional energy sources.

Figure 3. **SPAIN. GHG EMISSIONS, SELECTED ACTIVITY SECTORS AND HOUSEHOLDS**
VARIATION VS 2019 LEVELS (%)

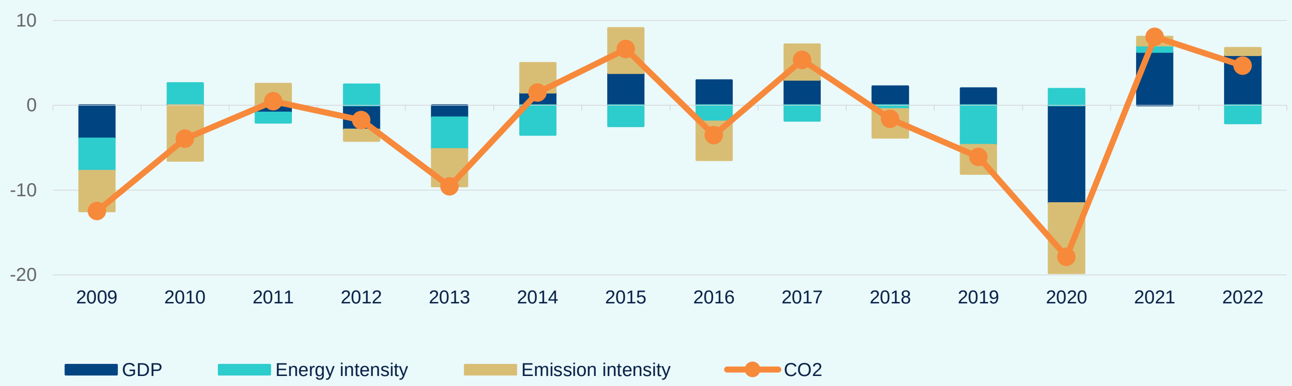


Source: BBVA Research from INE data.

BOX 1. Kaya's decomposition of CO_2 emissions growth in Spain

A thorough analysis based on the Kaya identity* reveals that the resurgence in CO_2 emissions in 2022 can not only be attributed to GDP growth, but also to the increase in carbon intensity, which reveals a rise in emissions per unit of energy consumed (see **Figure 4**). This CO_2 carbon intensity increase is not mirrored in overall GHG emissions, underscoring the favorable performance of non-CO_2 emissions, despite accounting for only 20% of total GHG emissions (80% corresponds to CO_2 emissions). On the other hand, the upsurge in CO_2 emissions has been partly offset by the improvements in energy intensity, requiring less energy per unit of GDP mainly due to the impact of high energy prices.

Figure 4. **SPAIN. KAYA IDENTITY.** CONTRIBUTIONS TO CO_2 EMISSIONS GROWTH. % AND PP

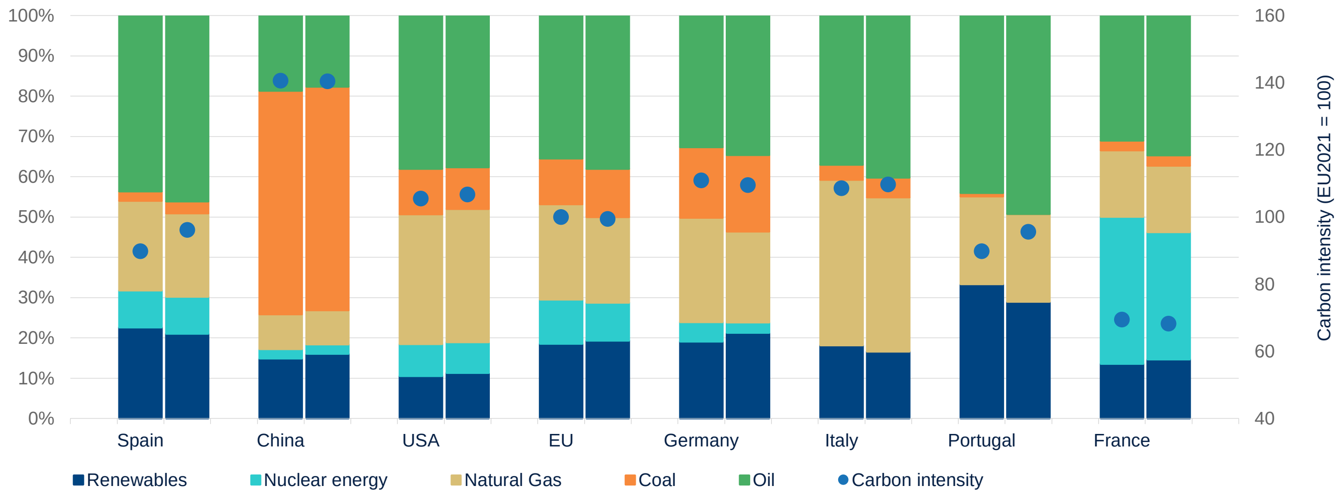


Source: BBVA Research from INE data.

*Kaya identity: CO_2 emissions growth = GDP growth + Energy intensity growth + Emission Intensity growth.

What explains the rise in carbon intensity in 2022? The rebound in fuel energy sources. The analysis of the Spanish energy mix reveals a surge in "brown" energy sources in 2022, with those based on fossil fuels increasing by 1.6% at the expense of non-fossil fuel sources. Thus, there was an upturn in oil and coal consumption, whose shares increased by 2.53% and 0.62%, respectively. In contrast, renewable energy consumption, including hydroelectric, declined by 1.57%, partly due to the impact of the geopolitical context, in light of Russia's war against Ukraine and above the average droughts. It should be noted that this growing trend in carbon intensity is not unique to Spain, but other countries, such as Portugal and Italy, also exhibited a rise in fuel consumption.[3] Conversely, France and Germany slightly improved their carbon intensity. Nevertheless, and in a broader context, it is worth noting that **the Spanish economy maintains a favorable position in relation to its energy mix**. Renewables accounted for 21% of the total energy consumed in 2022, surpassing EU's average (see **Figure 5**).

Figure 5. **ENERGY CONSUMPTION BY SOURCE.** SHARES 2021 (FIRST COLUMN) AND 2022 (SECOND COLUMN). ENERGY MIX (%) AND CARBON INTENSITY (EU, 2021 = 100)



Source: BBVA Research.

2. Exploring Spanish sectoral emissions: advancing Scope 1 assessment for completeness and stability

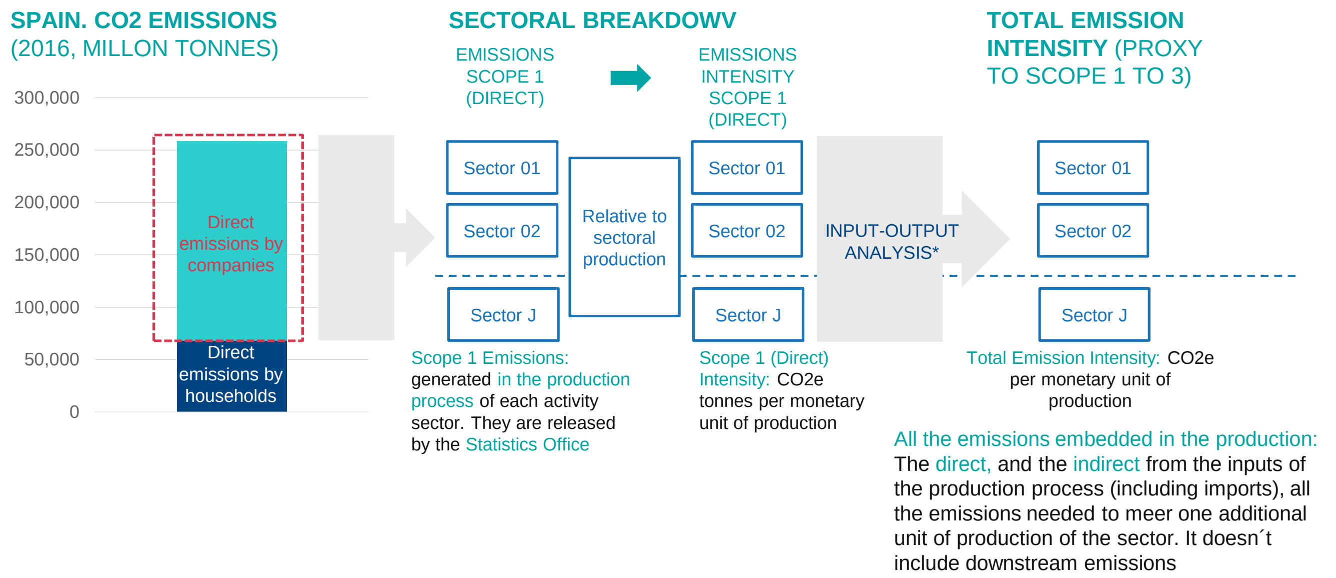
To obtain an in-depth understanding of the evolution of GHG emissions in the Spanish economic activities, it is imperative to broaden the analysis beyond Scope 1 emissions. While Scope 1 focuses on the direct emissions coming from the production of each sector, the analysis of Scope 2 and 3 extends to encompass embedded emissions in the full lifecycle of products and services -from production inputs to end use-.[4] This measurement's complexity is addressed through economic analysis tools, creating a methodological pathway for estimation.

Unraveling the Total GHG Footprint. Figure 6 illustrates a flow diagram showcasing the integration of direct emissions and input-output economic analysis, providing a proxy for total GHG emissions by sector[5]. Beyond

3: In addition, the entry into force of the "Iberian exception" for Spain and Portugal in June 2022 reduced the impact of high gas prices on energy demand.
4: For further details see: Scope 1 and Scope 2 Inventory Guidance | US EPA; Scope 3 Inventory Guidance | US EPA.
5: Downstream emissions associated with the product's final use, which are part of Scope 3, are not included.

Scope 1, companies are also responsible for Scope 2 emissions embodied in the energy used, and Scope 3 emissions encompassing inputs (upstream) and products' life cycle emissions (downstream).[6] The input-output analysis enables the calculation, sector by sector, of the amount of inputs (intermediate consumption) from other sectors required to meet an increase in demand. Given the availability of direct GHG emissions data with sectoral granularity, these can be treated as another productive input, thereby determining the amount of indirect GHG emissions from the sector in question that must be incorporated into its production process, in addition to direct emissions. However, methodological limitations hinder capturing downstream emissions associated with the product’s final use.

Figure 6. **FULL GHG FOOTPRINT PICTURE: DIRECT (SCOPE 1) AND INDIRECT EMISSIONS (SCOPE 2 AND SCOPE 3)**



*: In technical notation $EI_{total} = EI_{direct} * (I-A)^{-1}$ where EI is the emission intensity vector (emissions generated per unit of output in each homogeneous sector or product); $(I-A)^{-1}$ the Leontief inverse matrix, which captures the total effects that one unit demand has an the output.
Source: BBVA Research.

Sectoral vulnerability to climate transition. Transition climate risks are usually assessed using GHG emission-intensity indicators, with differences in the relative relevance of direct and indirect emissions. **The GHG emission-intensity of each activity sector** (emissions’ footprint per unit of production) **is a measure of its vulnerability to climate transition scenarios[7], where the use of the atmosphere as GHG repository becomes expensive** (carbon tax), or where the change of preferences of stakeholders put the business model at risk (conscientious investors increasing the cost of capital, clients demanding greener products).

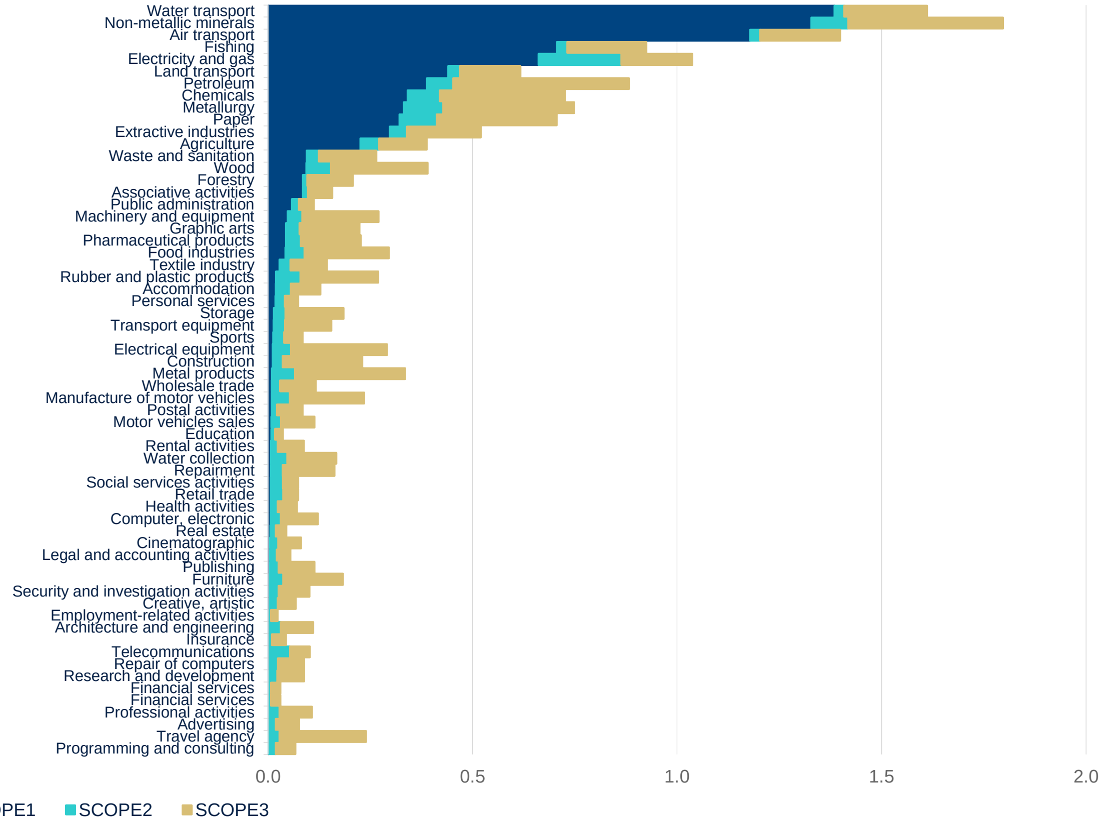
Focusing the analysis on intensity ratios narrows the dataset to 2020, as it requires using input-output (I-O) tables, with the latest available table being from that year. Considering 2020 an anomalous year significantly influenced by the impact of COVID-19 and its related policies, we based the analysis on 2019, which we regard as the latest comparable year, providing a more accurate representation of sectoral emissions intensities.

6: A responsibility of companies understood as total control in the case of Scope 1, a certain possibility of improving efficiency in Scope 2 emissions, and finally, the ability to influence that efficiency in the use of emissions in Scope 3.
7: For further details see: Analytical indicators on carbon emissions. ECB

Understanding a sector's vulnerability to climate transition requires a comprehensive examination of its value chain. Transition risks can manifest both upstream (in inputs) and downstream (in outputs for other sectors or households). This consideration becomes **particularly pertinent in sectors where direct emissions (Scope 1) may be minimal, but intricate value chains, unveiled by I-O analysis, significantly elevate their environmental impact.** This is the case of the Travel Agencies sector, which shows the second lowest direct emissions intensity among Spanish economic sectors (**Figure 7**). However, when we delve into the importance of CO_2 emissions within value chains, a different reality emerges; its vulnerability skyrockets to the 20th position out of 62 sectors, being the most emission-intensive. This shift is justified by the sector's integration with Air Transport, the second most intensive sector in terms of direct emissions.

Generally, the sectors showing the most substantial changes between direct and total emissions (excluding downstream emissions) intensities are those intricately linked to manufactured goods or services, often intended for household consumption (e.g., motor vehicles, furniture, travel agencies). Furthermore, sectors highly integrated into the value chains of others, such as repairs, manufacture of computers, electrical material production, and engineering services, also exhibit notable changes in their vulnerability to climate transition. The ratios depicted in Figure 7 illustrate the dispersion in sector intensity and the noteworthy shifts that become apparent when extending beyond Scope 1 emissions.

Figure 7. **SPAIN. INTENSITY OF EMISSIONS PER BUSINESS ACTIVITY** (CO_2 KG PER € OF PRODUCTION. 2019)

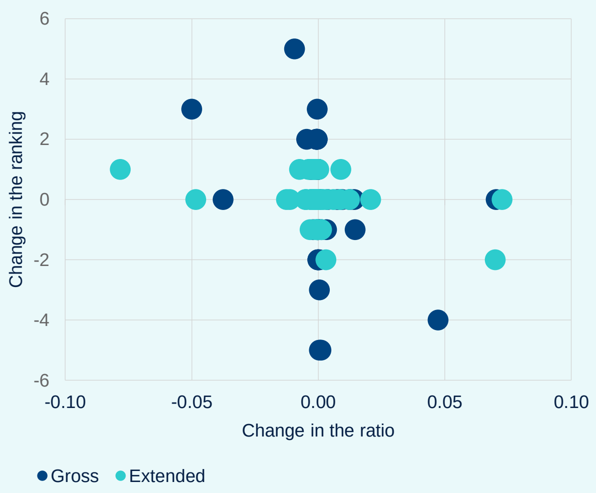


(*) Scope 3 excludes downstream emissions.
Source: BBVA Research.

BOX 2. Retrospective analysis of changes in sectoral emissions distribution due to modifications in environmental accounts

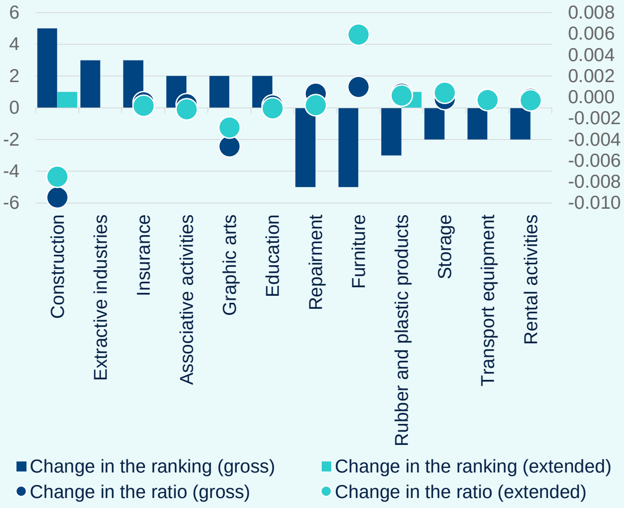
Historical environmental accounts are annually reviewed by INE, with narrow changes in aggregate terms, but relevant modifications at sectoral level. According to the last figures published in November 2023, **total emissions were slightly downwards revised in the period 2008-2021** (-0.7% GHG and -0.1% CO_2 emissions, on annual average), while changes at sectoral level were more significant.

Figure 8 **SPAIN. SECTORAL INTENSITY RATIOS.** CO_2, 2019. CHANGE IN THE RATIO (UPDATED - OLD DATA). KG / €



Source: BBVA Research.

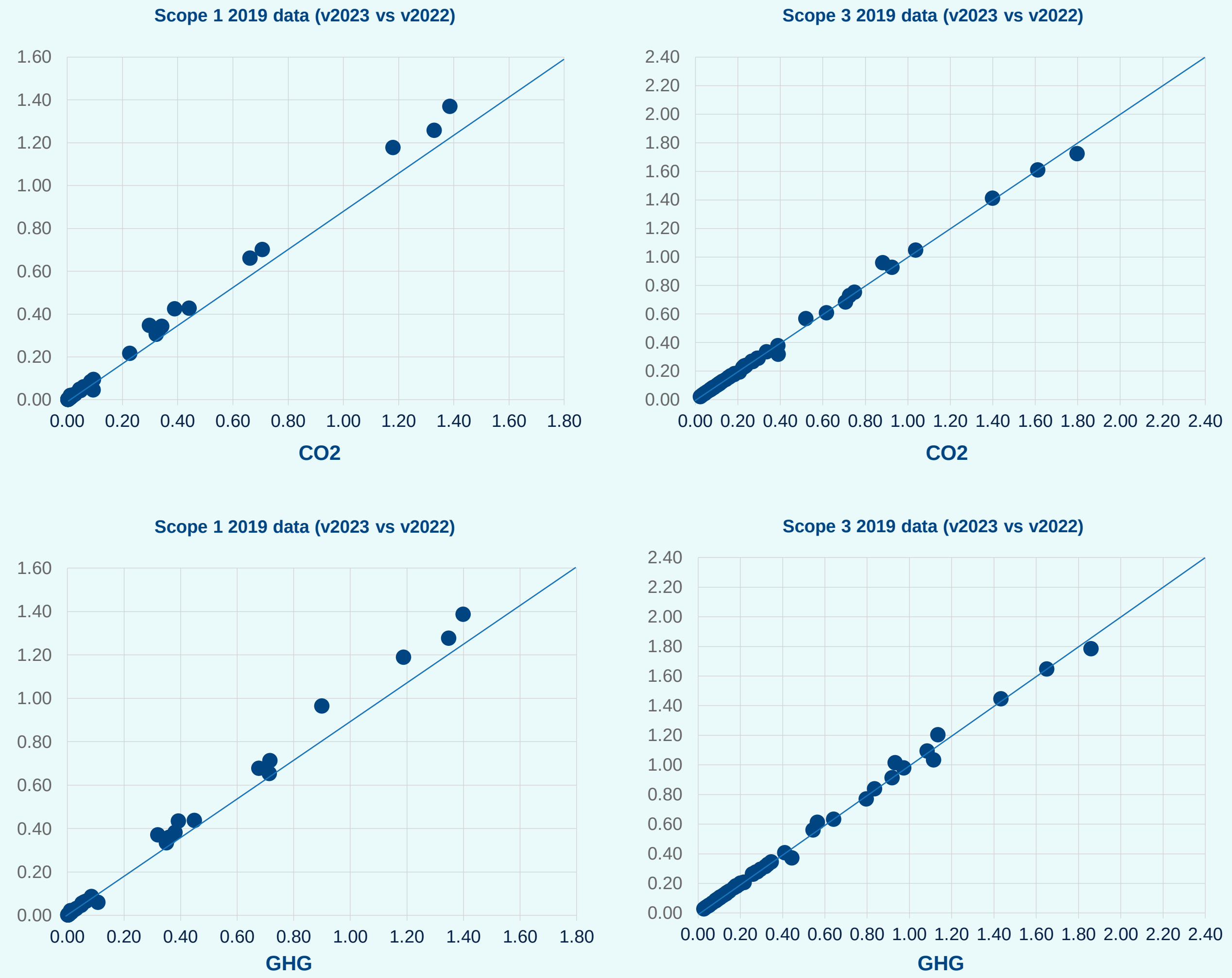
Figure 9 **SPAIN. SECTORAL INTENSITY RATIOS.** 2019. CHANGE IN THE RATIO AND IN THE RANKING (UPDATED - OLD DATA). KG / €



Source: BBVA Research.

Scope 3 emission intensity ratios, estimated by BBVA Research, have been also affected by INE data revisions, although to a notably lesser extent. As mentioned, the adjustment process involves modifying sectoral emissions to encompass the emissions linked to the intermediate products purchased by the sector. This nuanced approach ensures a more precise reflection of a sector's impact on the broader economic landscape.[8] Notably, when backward revisions predominantly involve emission reallocations within the same production chain (e.g., from cement to construction), which is the most common, the change is considerably smaller. This is particularly evident in the sectoral intensity ranking, which exhibits a greater stability (see **Figures 8** and **9**). Thus, construction moves from position 25 to 30 in the Scope 1 intensity ranking, when data are updated, and metallurgy from position 10 to 9. However, both sectors maintain their relative positions and vulnerability to transition risk in the extended (Scope 3) intensity ratio ranking. Other examples are illustrated in **Figure 10**, which portrays the change in 2019 ratios with old (2022 version) and new data (version 2023), revealing that Scope 3 ratios are closely aligned with the diagonal, underscoring their greater stability.

Figure 10 **SPAIN. SECTORAL INTENSITY RATIOS. CO_2 AND GHG, 2019. CHANGE IN RATIO (UPDATED, 2023 DATA; OLD, 2022 DATA). SCOPE 1, 2 AND 3. KG / €**



Source: BBVA Research.

In short, Scope 3 (extended) emission intensities exhibit a reduced sensitivity to the allocation criteria within the same production chain, meaning that they are less affected by backward data revisions. This reinforces the analytical value of these ratios, providing a robust and insightful perspective that considers the intricate relationships within the economic ecosystem. As businesses navigate the evolving landscape of emission measurement and climate transition, the extended intensity approach proves to be crucial for informed decision-making and strategic planning.

8: The heightened stability observed in Scope 3 emissions can be ascribed to one main reason: sectors positioned at the end of the production chain tend to remain relatively unaffected by alterations occurring within the sectors situated beneath them.

3. Temporal analysis of deflated emission intensity ratios: a heterogeneous downward trend

This section presents a detailed analysis of sector-specific inflation adjustments for the period 2016-2019[9], with the purpose to facilitate a nuanced comparative examination of the changes in real (deflated) intensity ratios. Adjusting for price effect on emission intensity ratios ensures a precise comparison over time. Hence, in order to achieve this, sector-specific price production indices (PRI), provided by the National Institute of Statistics (INE)[10] are used, which reflect the prices paid by producers. Alternatively, the Consumption Price Index (CPI) measures the change over time in the prices paid by consumers, differing from those paid by producers.[11]

The analysis primarily focused on the ten sectors with the highest absolute emissions between 2016 and 2019, which account for approximately 85% of the total sectoral emissions (CO_2 and GHG). Remarkably, nine of these sectors rank as the most polluting in both CO_2 and GHG emissions, showing consistent patterns in emission profiles. These sectors are: (1) Electricity, Gas, Steam, and Air Conditioning Supply (SEE); (2) Land and Pipeline Transport (TTT); (3) Manufacture of Other Non-Metallic Mineral Products (FPM); (4) Manufacture of Coke and Refined Petroleum Products (REP); (5) Chemical Industry (IDQ); (6) Agriculture, Forestry, Hunting, and Related Services (AGR); (7) Metallurgy; Manufacture of Iron, Steel, and Ferro-Alloy Products (MET); (8) Air Transport (TAR); (9) Food Industries, Beverage Manufacturing, and Tobacco Industry (IDA). Regarding the tenth sector, it distinguishes the Paper Industry (IDP) as significant in terms of CO_2 emissions, while in the context of GHG emissions, it is the sector encompassing Waste Management, Sanitation, and Remediation Activities (SGD) that stands out. Detailed information pertaining to these sectors is provided in the following table.

Table 1. **PERCENTAGE OF TOTAL SECTORAL EMISSIONS REPRESENTED BY NACE SECTOR IN SPAIN. CO_2 AND GHG**

%CO2		2016	2017	2018	2019	2020	%GHG		2016	2017	2018	2019	2020
SEE	Electricity and gas	28.4	31.1	27.8	22.0	18.3	AGR	Agriculture	16.7	16.2	16.8	18.0	21.2
TTT	Land transport	12.0	11.7	11.8	13.0	14.3	SEE	Electricity and gas	22.4	25.0	22.2	17.5	14.0
FPM	Non-metallic minerals	12.0	11.4	12.0	12.4	13.5	TTT	Land transport	9.5	9.4	9.4	10.3	10.8
REP	Petroleum	7.3	6.8	7.1	7.5	8.3	FPM	Non-metallic minerals	9.4	9.1	9.6	9.8	10.2
IDQ	Chemicals	6.6	5.9	6.4	6.6	7.7	SGD	Waste management	6.0	5.7	5.7	5.9	6.7
AGR	Agriculture	5.3	5.0	5.3	5.8	7.1	IDQ	Chemicals	5.8	5.2	5.6	5.7	6.3
MET	Metallurgy	4.6	4.5	4.7	4.9	5.7	REP	Petroleum	5.7	5.4	5.6	5.9	6.3
TAR	Air transport	5.7	5.5	6.1	7.0	3.1	MET	Metallurgy	4.1	4.0	4.1	4.1	4.5
IDA	Food industry	2.5	2.6	2.6	2.7	3.0	IDA	Food industry	2.5	2.5	2.5	2.5	2.7
IDP	Paper industry	2.1	2.0	2.1	2.5	2.5	TAR	Air transport	4.4	4.4	4.9	5.5	2.3

Source: BBVA Research.

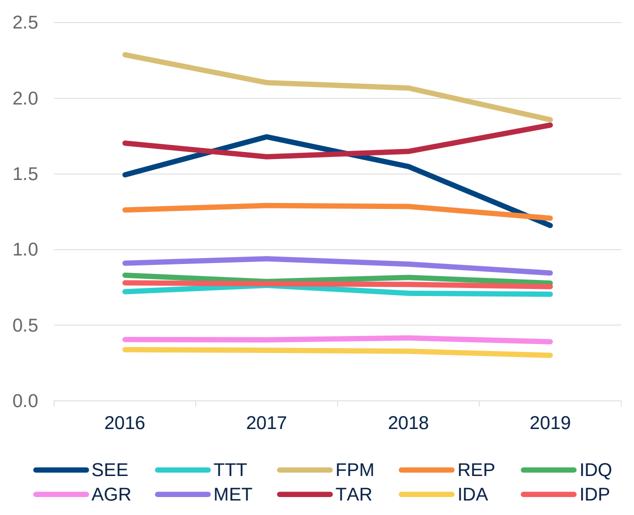
9: In this regard, it is crucial to recognize that data for 2020 might be less reliable due to the unprecedented and extraordinary conditions of the pandemic, including extensive lockdowns with significant impact on economic activities.
10: Industry (here); Services (here); Agriculture (here).
11: Using the CPI as a deflator of intermediate goods and services flows means assuming that all changes in producer prices are transferred to consumer prices.

The analysis of the real intensity ratios evolution, as depicted in **Figures 11-14**, reveals an improvement in the Scope 3 ratios of the most CO_2 polluting sectors. **Essentially, the average CO_2 emissions required to produce an additional unit of output in these sectors decreased by 8.5% over a span of four years, up to 2019 (-2.2% annually).** A similar trend is shown by GHG emissions, as illustrated in **Figures 15-18 and Table 2 below.**

The results vary when the general Consumer Price Index (CPI) is used as a deflator, instead of the production price indices of each sector (-16.4%, -4,4% annually). Inflation differs from one sector to another, so using the general CPI as a common deflator in all of them could introduce bias in the results of the analysis. Production price indices take these differences into account, so they should offer a more accurate picture of the situation.

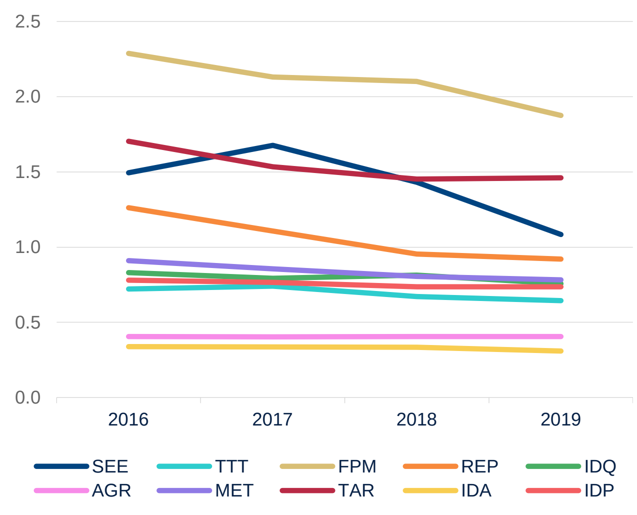
By applying the 2016 emissions as weights and pondering the intensity ratios, a weighted average is also calculated, which reveals a significant increase in the rate of reduction of CO_2 intensity, with a decrease of 22%. In contrast, this approach shows a less pronounced drop in overall GHG emissions, with a decrease of 5%. This discrepancy arises from the divergent paths of the sectors exerting the most significant impact on each type of gas. As an example, CO_2 emissions attributable to energy sources witness a 22% decrease, whereas GHG emissions from the agricultural sector undergo a mere 5% reduction over the same period.

Figure 11. **PRI (NACE) ADJUSTED SECTORAL INTENSITY RATIOS.** CO_2, KG/ OUTPUT, €. 2016-2019. SCOPE 3. 2016 PRICES



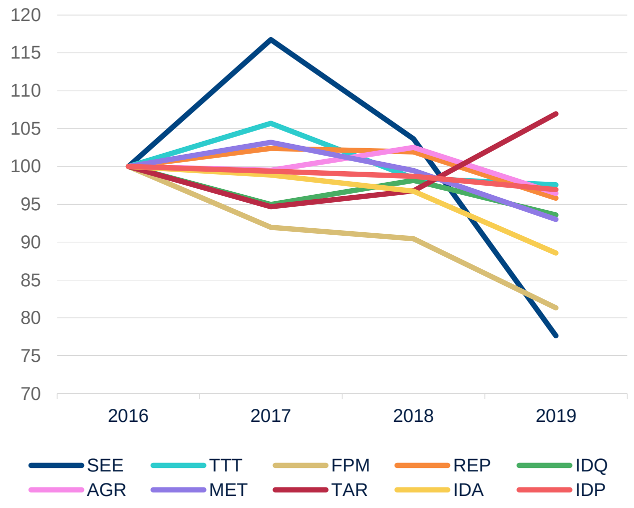
Source: BBVA Research.

Figure 12. **CPI (GENERAL) ADJUSTED SECTORAL INTENSITY RATIOS.** CO_2, KG/ OUTPUT, €. 2016-2019. SCOPE 3. 2016 PRICES



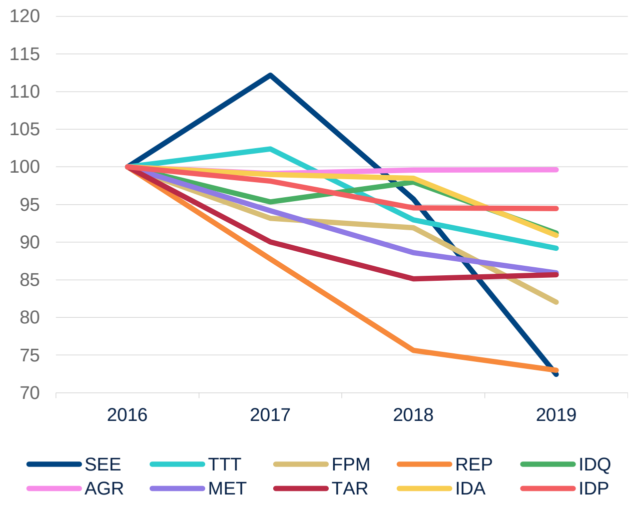
Source: BBVA Research.

Figure 13. **PRI (NACE) ADJUSTED SECTORAL INTENSITY RATIOS.** INDEX 2016=100. CO_2. 2016-2019. SCOPE 3. 2016 PRICES



Source: BBVA Research.

Figure 14. **CPI (GENERAL) ADJUSTED SECTORAL INTENSITY RATIOS.** INDEX 2016=100. CO_2. 2016-2019. SCOPE 3. 2016 PRICES



Source: BBVA Research.

Hence, a disparity exists between the sectoral evolution of the ratios, particularly among those heavily exposed to the EU Emissions Trading System (EU ETS) -mainly power generation sectors and heavy industries-, and those that are not. A more comprehensive analysis should be necessary to determine whether there is a causal relationship underlying this observed appreciation. However, preliminary observations suggest that carbon pricing may be a contributing factor. Sectors under the EU ETS, like heavy industry (cement specially) and power generation, show more significant improvements in their emissions ratios compared to sectors like transport, less affected by regulation. See Table 2 for more details.

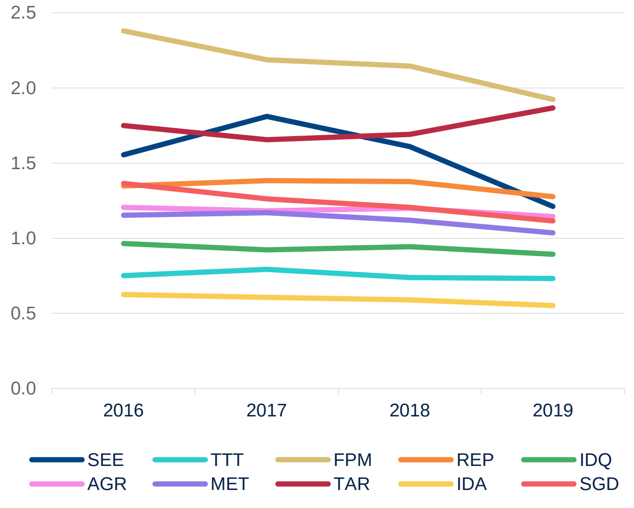
Table 2. **SCOPE 3 SECTORAL INTENSITY RATIOS EVOLUTION.** 2019 VS 2016. 2016 PRICES

	CO2				GHG			
	PRI NACE		CPI ALL		PRI NACE		CPI ALL	
	% period	% annual	% period	% annual	% period	% annual	% period	% annual
SEE	-22.4%	-6.1%	-27.6%	-7.7%	-22.1%	-6.1%	-27.3%	-7.7%
TTT	-2.4%	-0.6%	-10.8%	-2.8%	-2.6%	-0.7%	-10.9%	-2.9%
FPM	-18.7%	-5.0%	-18.0%	-4.8%	-19.2%	-5.2%	-18.5%	-5.0%
REP	-4.2%	-1.1%	-27.0%	-7.6%	-5.2%	-1.3%	-27.8%	-7.8%
IDQ	-6.4%	-1.6%	-8.8%	-2.3%	-7.4%	-1.9%	-9.8%	-2.5%
AGR	-3.5%	-0.9%	-0.4%	-0.1%	-5.0%	-1.3%	-1.8%	-0.5%
MET	-7.0%	-1.8%	-14.1%	-3.7%	-10.1%	-2.6%	-16.9%	-4.5%
TAR	6.9%	1.7%	-14.3%	-3.8%	6.7%	1.6%	-14.5%	-3.8%
IDA	-11.5%	-3.0%	-9.1%	-2.4%	-11.7%	-3.1%	-9.4%	-2.4%
IDP	-3.1%	-0.8%	-5.5%	-1.4%	-5.2%	-1.3%	-7.6%	-1.9%
SGD	-15.7%	-4.2%	-12.2%	-3.2%	-18.2%	-4.9%	-14.7%	-3.9%
TOP10 MEAN	-8.5%	-2.2%	-16.4%	-4.4%	-10.2%	-2.7%	-16.4%	-4.4%
TOP10 W.MEAN	-22.4%	-6.1%	-27.6%	-7.7%	-5.0%	-1.3%	-1.8%	-0.5%
TOTAL MEAN	-5.2%	-1.3%	-11.9%	-3.1%	-6.4%	-1.6%	-12.2%	-3.2%
TOTAL W.MEAN	-3.5%	-0.9%	-0.4%	-0.1%	-5.0%	-1.3%	-1.8%	-0.5%

Source: BBVA Research.

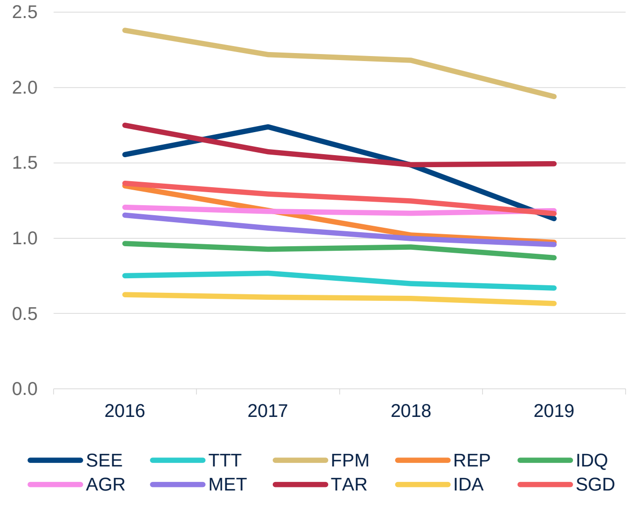
Despite the improvements in emission intensities, there are not enough to reach net-zero in 2050. The emission reduction objective outlined in Spain's National Energy and Climate Plan (PNIEC), which calls for an approximate annual reduction of 4-5%, is significantly more ambitious than the observed figures, which are closer to 2% annually in most sectors. The discrepancy is at least concerning, highlighting the urgency for more robust and focused strategies. It is particularly noteworthy that during the period analyzed, there was not only a lack of substantial improvement in the transportation intensity ratio, but also certain types of transportation, such as air travel, experienced a deterioration in their intensity ratios.

Figure 15. **PRI (NACE) ADJUSTED SECTORAL INTENSITY RATIOS.** GHG, KG/ OUTPUT, €. 2016-2019. SCOPE 3. 2016 PRICES



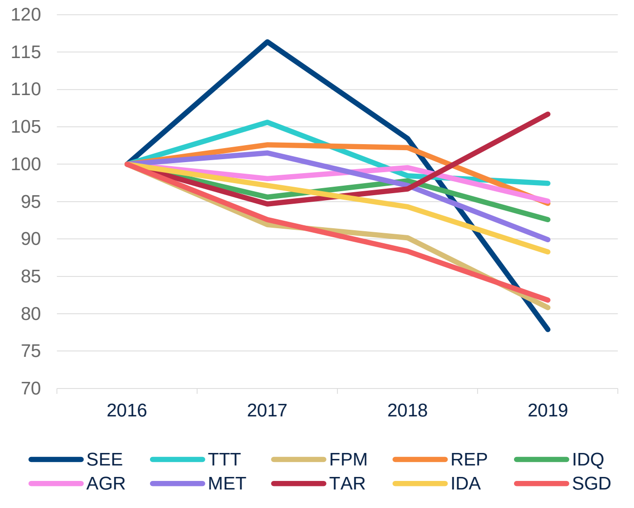
Source: BBVA Research.

Figure 16. **CPI (GENERAL) ADJUSTED SECTORAL INTENSITY RATIOS.** GHG, KG/ OUTPUT, €. 2016-2019. SCOPE 3. 2016 PRICES



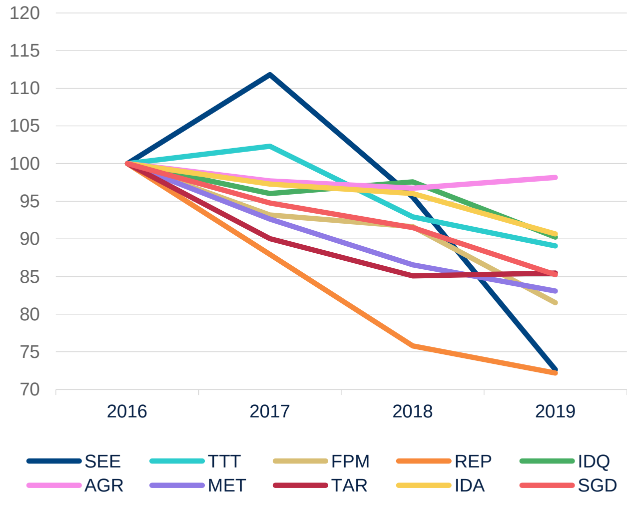
Source: BBVA Research.

Figure 17. **PRI (NACE) ADJUSTED SECTORAL INTENSITY RATIOS.** INDEX 2016=100. GHG. 2016-2019. SCOPE 3. 2016 PRICES



Source: BBVA Research.

Figure 18. **CPI (GENERAL) ADJUSTED SECTORAL INTENSITY RATIOS.** INDEX 2016=100. GHG. 2016-2019. SCOPE 3. 2016 PRICES

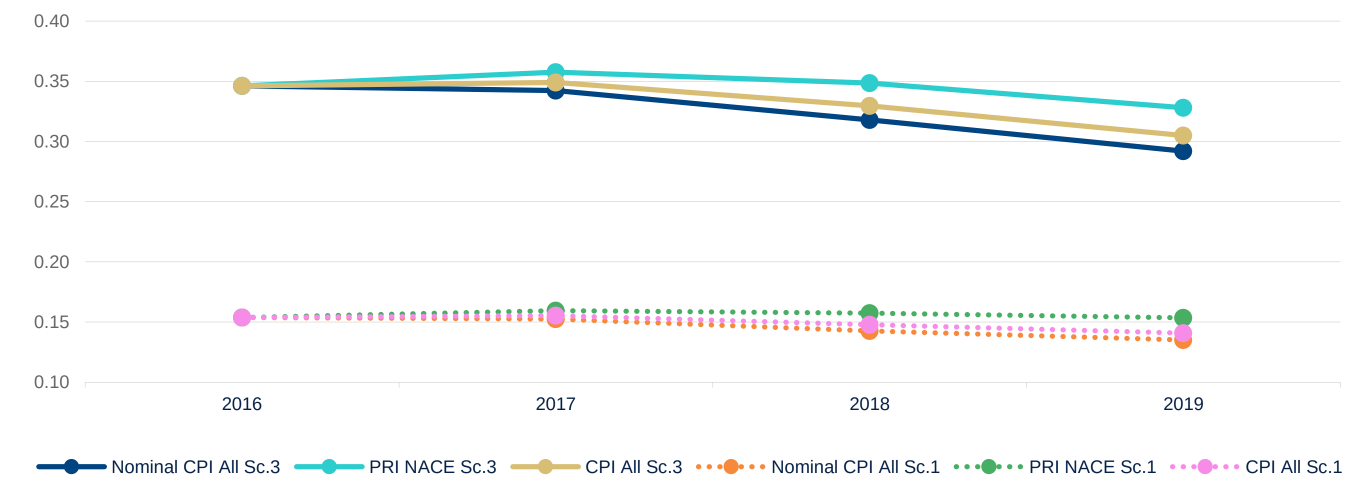


Source: BBVA Research.

Upon examining the average inflation-adjusted ratio across all sectors, data up to 2019 reveal a more concerning situation when considering all sectors, not just the top 10 most polluting ones. The overall improvement has been relatively modest, amounting to approximately 5% overall, or 1.3% annually. A key insight from this analysis is the disparity in emission intensity improvements between the economy's most and least polluting sectors. The most emission-intensive sectors have exhibited a more significant enhancement in their Scope 3 emission intensity compared to their less intensive counterparts. Several pivotal factors contribute to this variation. Firstly, the more polluting sectors typically have higher baseline levels of emissions, providing a wider scope for improvement. The relative changes in these sectors tend to be more substantial, given their elevated initial emission levels. Secondly, sectors with higher emission profiles face more rigorous regulatory oversight and even societal pressure, which prompts them to adopt more aggressive emission reduction strategies. This external impetus serves as a significant driver for environmental enhancements. Additionally, the concept of economies of scale in emission reduction is particularly relevant. Larger, more polluting industries may find it more economically feasible to implement emission reduction technologies, capitalizing on their operational scale. However, it is also noteworthy that these economies of scale come into play based on the availability of technologies that are not only proven but, above all, cost-competitive.

However, it is crucial to highlight that the scenario shifts significantly if the analysis is based on the general Consumer Price Index, a trend already discernible in earlier figures focusing on the evolution of the top 10 sectors. In this context, the average ratio improves by approximately 12% over four years (2016-2019), a figure substantially higher than the improvement observed with sector-specific price data and somewhat smaller, yet comparable, to what would be derived from nominal ratios (15.5%). This underscores the substantial impact that price adjustment has on the analysis.[12] Finally, it is important to consider the differences between the simple average and the weighted average (that takes into account absolute emissions of each sector). **This clarification emphasizes that while the top ten most polluting industries have, on average, shown greater progress in reducing emissions compared to other sectors, it's important to note that within this group, some sectors have not yet made considerable progress in reducing their environmental impact.** As a result, this mitigates the overall enhancement observed in the weighted average, exemplified by sectors such as transportation in the context of CO_2 emissions, or agriculture in terms of GHG emissions.

Figure 19. **AVERAGE SECTORAL CO_2 INTENSITY RATIOS.** 2016-2019. SCOPE 3. CO_2, KG/ OUTPUT, €. 2016 PRICES



Source: BBVA Research.

12: If these sectors experience lower (or higher) inflation than the overall economy, or even deflation in some cases, as it is the case in this analysis, using the general CPI for adjustments could lead to a bias. Using CPI as deflator means assuming that all changes in producer prices are transferred to consumer prices.

Improvements in Scope 1 of the most emission-intensive sectors are key to Scope 3 of the rest. Finally, in a similar vein, the assessment of average sectoral ratios for Scope 1, as shown in **Figure 19**, indicates **a decrease in the average real ratio of approximately 1.5%.** This provides us with an insight, especially when compared with the evolution of Scope 3, where ratios have further decreased, into how sectoral emissions have evolved. Some of the most significant sectors in value chains have improved their direct real ratios, contributing to an overall average improvement in Scope 3 ratios. However, less relevant sectors, in terms of their weight in the value chain, have not shown this progression, resulting in a Scope 1 ratio that does not show much improvement. Conversely, when analyzing the average ratio adjusted with the general CPI or nominal values, an improvement of nearly 8.4% is noted from 2016 to 2019.

In summary, while Spain has made significant progress in enhancing energy efficiency and tackling climate change, it is still far from achieving its goals, indicating the need for a more effective strategy. The reductions in emissions have not reached the targets set by the authorities, with most sectors only seeing modest declines in emissions. Therefore, there is a pressing requirement for more efficient approaches, especially in key areas such as transportation, agriculture, and refining.

ANNEX I. Impact of Input-Output updates on Scope 3 estimates

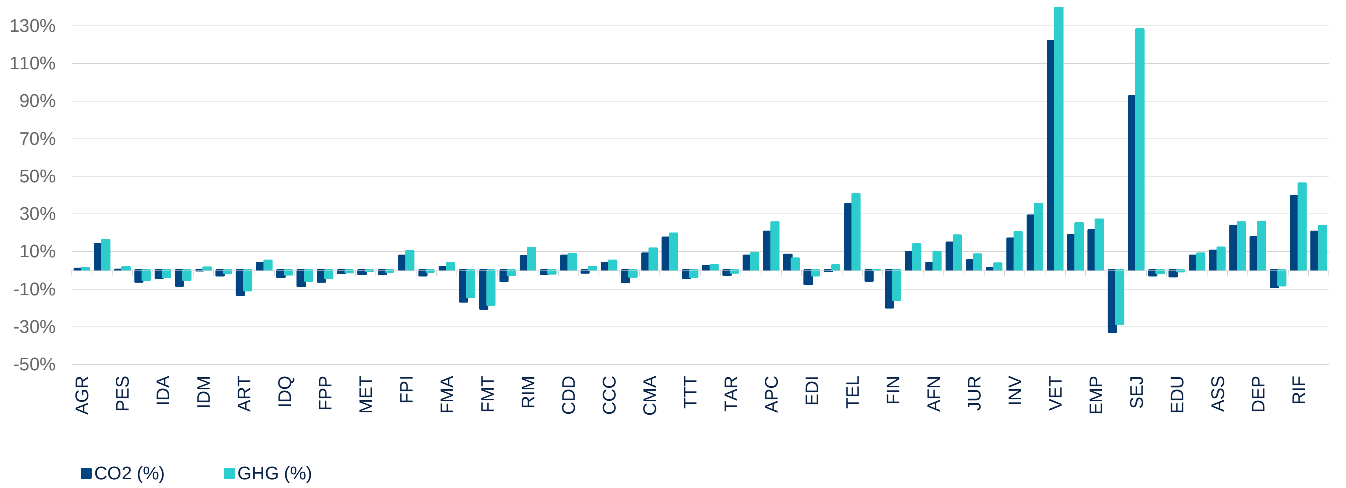
INE has recently released the Input-Output (I-O) tables covering the period 2017-2020.[13] This new data provides a valuable tool for analyzing the impact of these changes on Scope 3 emission intensity ratios. Before this release, only the 2016 I-O table was available, so BBVA Research's estimates of Scope 3 intensity ratios were based on 2016 Leontief matrix coefficients for the whole analyzed period (2016-2020).

With the updated I-O tables, it is possible to make a more accurate assessment of how I-O changes impact on Scope 3 calculations. Exploring the effect of these changes on 2020 Scope 3 intensity ratios, assuming constant emission levels, the possibility emerges to understand the shifts resulting from variations in sectoral dependencies. It should be noted that the comparison of the 2020 Leontief matrix with that of 2016 does not take into account the different impacts that relative price evolution could have on different sectors.

The recent I-O tables lead to noticeable changes in Scope 3 emission intensity ratios. On average, the Scope 3 ratio for GHG emissions rose by 10.4% in 2020, being the increase of 6.6% for CO_2 ratios. **Figure 20** illustrates the percentage difference[14] in Scope 3 ratios when comparing data from the 2020 I-O table to the 2016 table. It is clear that the impact on **Scope 3 ratios varies significantly across different sectors**. For instance, security and research activities, including veterinary services, experienced an increase of about 120% in their Scope 3 CO_2 ratios, while travel agencies' ratios decreased by nearly 33%.[15] **The most significant changes were observed in tertiary activities,** which are characterized by a lower direct intensity ratio (Scope 1), meaning they produce less direct emissions per monetary unit of production. Thus, changes in the I-O tables have a more substantial effect on these activities due to their relatively higher share of indirect emissions.

13: Input-Output Tables 2017-2020.
14: The methodology for deriving the data presented in Figures 20 and 21 is as follows: Initially, the Scope 3 ratios for the year 2020 are determined utilizing the Leontief input-output model from 2016. Subsequently, we recalibrate the Scope 3 ratios for 2020, this time employing the Leontief input-output model corresponding to the year 2020. In the final step, we ascertain both the absolute and percentage differences between the Scope 3 ratios obtained in the latter calculation and those derived from the initial step, with the absolute difference showcased in Figure 21 and the percentage difference depicted in Figure 20.
15: Otherwise, the intensity ratios do not show changes greater than 20% in absolute value.

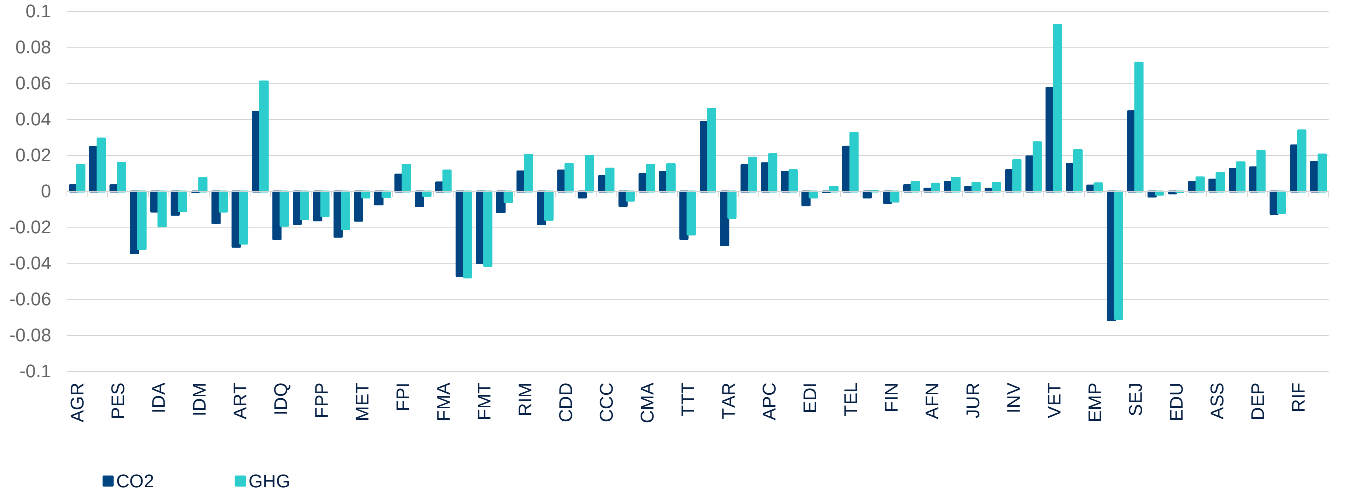
Figure 20. **PERCENTAGE CHANGE IN SECTORAL SCOPE 3 RATIOS FOR THE YEAR 2020 USING THE 2020 LEONTIEF MATRIX INSTEAD OF THAT OF 2016**



Source: BBVA Research.

In contrast, the impact of updating I-O data in absolute terms is relatively minor and more evenly spread across sectors than % difference. When examining the absolute change in Scope 3 ratios -that is, the actual increase or decrease in emissions per unit of output-, the influence of Leontief I-O model is less significant than when considering percentage changes, as illustrated in **Figure 21**. These adjustments, quantified as the additional kilograms of CO_2 emitted by the economy to generate an extra unit of monetary output by sector, do not surpass 0.1 kg per unit of output (€). Furthermore, it is possible to observe that, with some exceptions, the changes in absolute values are more balanced, since activities in primary and secondary sectors are more emissions-intensive than those of the tertiary sector, and therefore, their percentage change relative to the same absolute variation is smaller.

Figure 21. **ABSOLUTE CHANGE IN SECTORAL SCOPE 3 RATIOS FOR THE YEAR 2020 USING THE 2020 LEONTIEF MATRIX INSTEAD OF THAT OF 2016. KG/€**



Source: BBVA Research.

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