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Modified sectoral average greenhouse gas intensity for more accurate carbon risk analysis

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Abstract

Thanks to the existing data gaps, Monitoring climate-related financial risks is no easy task. Greenhouse gases play an important role in climate change; therefore, examining economic activities' emissions can be a suitable way to analyse climate risks. However, relying only on activities' average greenhouse gas emissions can be misleading, as substantial emitters can greatly divert the average values upwards. Modifying these sectoral average emissions by subtracting substantial emitters' data results in a clearer picture of climate risk analysis. The modified sectoral average method, which primarily relies on data from the emission trading systems, treats companies under the EU Emissions Trading System (ETS) regulation separately. With this treatment, sectors with high emission values can experience a significant drop in sectoral average emission intensity compared to companies under ETS regulation. To use an already available but not applied data cluster is an affordable, easy-to-implement way to increase the accuracy of climate risk indicators. Results in Hungary show that implementing this information reduces sectoral average intensity for companies not under ETS regulation.

Keywords
transition risk, sectoral exposure, greenhouse gas intensity

1. Introduction

Failure to adequately mitigate and adapt to climate change could have serious socio-economic impacts, whether in terms of physical risks from extreme weather or negative impacts on economic activities. In recent years, the financial risks associated with climate change have become increasingly pronounced, alongside the natural impacts of climate change. Climate change and its negative economic impacts can significantly impact human society, including its economic performance. Economic effects may include market shocks, physical damage, regulatory responses, and other impacts due to climate change and changing human attitudes. To ensure financial stability, it is important to examine these possible negative effects in order to be able to prepare for their potential impacts. Taking timely preventive action can help avoid potential risks. We consider the negative impacts of measures taken to create a low-carbon and climate-resilient economy as transition risks. Risks can include rapid repricing of financial assets (both positive and negative) due to rapidly changing consumer and regulatory expectations, reduced profitability of the company's activities or obsolescence of its business model (carbon tax, production technologies becoming more expensive due to the banning of old technologies), which can lead to a drastic change in the default rate of certain activities. Late, simultaneous, large-scale regulatory measures to achieve a climate-neutral economy could cause even greater financial shocks, affecting investment and credit portfolios. In many areas, a green transition is required to reduce these shocks. For example, monetary policy can aid a smoother and faster transition to a low-carbon economy (Kolozsi et al., 2022). Although ESG ratings improve and sustainable disclosure requirements are becoming more stringent (Marczis et al., 2023), we still lack, in many cases, meaningful, easy-to-interpret environmental data, which is needed at the very least to aid a rapid transition. Emission trading systems appear to be effective tools for lowering regulated companies' emissions (David, 2022), and as later shown, they could be useful input for risk analysis as a source of much-needed environmental data.

A fully developed, common methodology for assessing climate risks does not yet exist. A reliable way to assess climate transition risks is to quantify the risks based on the greenhouse gas intensity (hereafter GHG intensity) of individual

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economic activities. GHG intensity reveals how much pollution is needed in each economic sector to produce one value added. Combining this sectoral average data with company-level information is usually the first step for financial institutions for transition risk calculations. Several methods have already been defined to quantify carbon risks based on GHG intensity. If individual emission data is unavailable, these methods all build on the sectoral average GHG intensity of economic activities. However, incorporating individual emission data without modifying sectoral average GHG intensity values could lead to false results. A new method was developed to incorporate individual emission data into GHG intensity-based studies, achieving more realistic results compared to calculations based only on sectoral average GHG intensity values.

2. Basis of GHG intensity analysis

GHG intensity shows the GHG emissions per unit of added value. Equation (1) shows how GHG intensity values are calculated for a sector (Eurostat, 2023d).

$$INT_i = \frac{GHG_i}{GVA_I} \qquad \text{(Eq. 1)}$$

where

INT_i is the GHG intensity value for the sector I in grams GHG/euro,

GHG_i is the total GHG emissions for the sector I in grams,

GVA_i is the Gross Value Added (hereafter GVA) for sector *i* in Euro using current exchange rates.

GHG intensity data are compiled by Eurostat (Eurostat, 2023b) for countries in the European Union (hereafter EU). Data coverage is complete at a section level (NACE Rev2 level 1: A-T) and non-complete at a sector level (NACE Rev2 level 2: A01-T98). GHG intensity data are available for Hungary from 1995 onwards, with the latest data for 2020. Eurostat regularly updates the database with a lag of about two years. This data is the basis of the MNB’s Bank Carbon Risk Index (BCRI), used since 2021. The index captures the potential risks arising from the GHG intensity of the activities financed by banks based on two types of functions: (i) the linear function assumes that the higher the GHG intensity of the activity, the higher the associated risk, which is mainly due to regulatory activities (e.g. carbon taxes); while (ii) Gompertz’s function assumes that up to a certain level, the exposure of activity to climate regulations is negligible, but beyond a critical point the activity is certainly affected (Bokor, 2021; MNB, 2021, 2022b) (Figure 1). The Gompertz function can be considered the more stringent one of the two functions. Therefore, it estimates higher risk levels. Based on the index, at the end of 2022, between 9 and 15 per cent of the Hungarian corporate exposures can be considered risky credit exposures (calculated based on the linear Gompertz function). The EU Emissions Trading System (hereafter ETS) supports the logic of the latter function, as only activities considered large polluters have been covered so far, while activities below a certain emission level are completely unaffected by the regulation.

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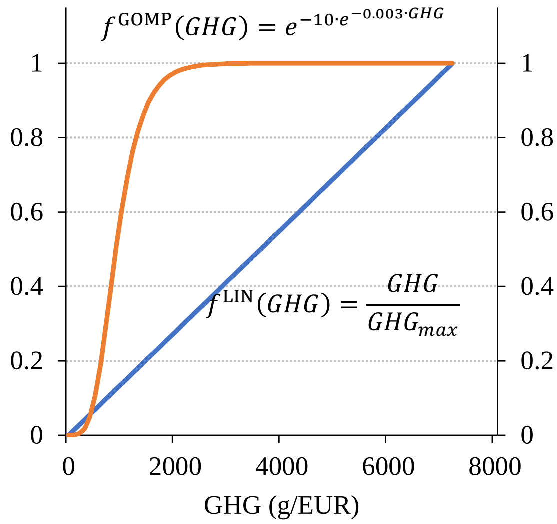

Figure 1: Transition risk weights as a function of GHG intensity (Bokor, 2021: 9)

The Task Force on Climate-Related Financial Disclosures (hereafter TCFD) also recommends the use of GHG intensity data (TCFD, 2017b), defining indicators to assess the carbon exposure of the portfolios of banks, insurers, fund managers, and investment service providers (TCFD, 2017a). Their most important indicator is the weighted average carbon intensity indicator, which was used, among others, by the MNB in its TCFD 2022 report to quantify the carbon intensity of the foreign exchange reserve, the government bond purchase programme and the Bond Funding for Growth scheme (287 tonnes CO_2e/million EUR GDP, 495 tonnes CO_2e/million EUR GDP, 551 tonnes CO_2e/million EUR GDP were the intensity of the named programmes, respectively) (MNB, 2022a). In their surveys, the European Banking Authority (hereafter EBA) and Ritter (EBA, 2021; Ritter, 2022) created 6 GHG groups (from very low to very high) based on the GHG intensity of activities by ranking the values and breaking them up at certain points.[1] Based on the 2021 results, 53 per cent of domestic corporate exposures financed exposures above the median GHG intensity, while in the EU, only 35 per cent of corporate exposures financed such activities in the EBA survey (EBA, 2021; Ritter, 2022). An important difference was that EBA used individual emissions data in creating the groups in addition to the available sectoral average intensity data without modifying it, while the domestic analysis used only sectoral average intensity data.

The advantage of using GHG intensity data is data availability at the sectoral level. The problem lies in the reliance on the debtor's main activity, the NACE code only. Companies are usually active in more than one economic sector. Therefore, using only one NACE code per debtor can mislead the analysis. The other problem arises from the usage of average GHG intensity data. As shown in the EBA analysis, including individual intensity data could significantly affect the results, thus providing a more nuanced picture of our credit portfolio's riskiness. Although the calculation and publication of GHG intensity values at the company level is not widespread nationally, this data type is available for a certain number of companies.

3. Modified sectoral average GHG intensity

Using sectoral average GHG intensity data can be a good starting point for analysis, yet altering it by treating large polluting companies separately can greatly change these values. Due to the functioning of the EU ETS, individual emissions data for large polluting companies have been available since the start of the trading scheme in 2005 (EC, 2023a). The EU database publishes site-level CO_2 emissions data for each ETS period. After aggregating the site-level data to the company level, we obtain company-level annual CO_2 emissions data. Since sectoral emissions data are available from Eurostat and the economic sector of the companies operating under the ETS regulation can be easily found, subtracting the two from each

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[1] In the analysis, the 10th percentile, 1st quartile (25th percentile), median (50th percentile), 3rd quartile (75th percentile), 90th percentile were the cut-off points for the categories, with exposures above the median being considered risky in particular.

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other gives the annual GHG emissions of a given economic sector without the values of the companies whose emissions data are available. It is important to note that the Eurostat data include a range of GHG emissions, whereas the EU ETS database only considers CO_2 emissions. As Eurostat GHG data are published in CO_2 equivalent, it is possible to subtract the two. In Hungary, between 2005 and 2021, between 120 and 150 companies per year were covered by the EU ETS regulation, with the manufacturing and energy supply sectors (C and D) being the most affected (Table 1).

The expected future tightening of the EU ETS regulation will decrease the amount of allowances available for free allocation and purchase, hence raising the allowance's price and extending the range of activities covered by the regulation. EU policymakers would phase in CO_2 emissions from all large ships in maritime transport entering EU ports, which is responsible for a significant amount of emissions globally, accounting for 3 per cent of total emissions in 2018 (EC, 2023b). In addition, a completely separate scheme will be established to regulate pollution from land transport and buildings from 2025 onwards (Liese, 2022), which is expected to affect the H-transport and F-building sectors directly.

In order to modify the sectoral average intensity data presented in Equation (1) with the individual emission data of companies under ETS regulation, it was also necessary to calculate the GVA data in the denominator at the company level (Equation 2). The GVA values were calculated based on the methodological guidelines of the Hungarian Central Statistical Office on gross domestic product (GDP) (KSH, 2023). For this purpose, the annual reporting data available on the Ministry of Justice website (MJ, 2023) were used. Most companies use the two most common profit and loss account procedures, so the GVA values calculated on their basis are presented in more detail below.

$$GVA = output - intermediate\ consumption \qquad \text{(Eq. 2)}$$

$$GVA_1 = A \pm B - C \qquad \text{(Eq. 3)}$$

where GVA_1 is the GVA of the companies using the total cost method,
A is the net sales revenue,
B is the capitalised value of one's performance,
C is the value of material expenditure.

$$GVA_2 = A - B - C \qquad \text{(Eq. 4)}$$

where GVA_2 is the GVA of the companies using the turnover cost method,
A is the net sales revenue,
B is the direct costs linked to sales,
C is the value of the material expenditure.

Not all companies examined had income statement data available in all cases from which GVA could be derived. Companies with data gaps were excluded from the analysis in years without income statement information, so their emissions data were not considered in subsequent calculations in those periods. Depending on the year, between 95 and 99 per cent of the annual reports (based on the number of companies) were available for companies under ETS regulation.

In the remainder of the analysis, companies under ETS regulation with individual emissions data are referred to as ETS companies, and the remaining companies not under ETS regulation are non-ETS companies. For perspective, presenting the CO_2 emissions and value-added data of ETS companies concerning the national data might be worthwhile. It can be said that ETS companies contribute largely to CO_2 emissions in Hungary, while they are responsible to a much lesser extent for the generated gross value added in the country. The CO_2 pollution of these companies was responsible for 37–44% of the domestic pollution between 2005 and 2021, while their gross value added accounted for only 4.8–6.6% of the national value added (Figure 2) on the same time horizon. Based on these, we can assume that the GHG intensity of non-ETS companies in sectors affected by ETS regulation may be much lower than their ETS-affected counterparts.

Table 1: Breakdown of all Hungarian companies under ETS regulation by sector of their main activity (top), a ratio of Hungarian companies under ETS regulation with annual reports to all companies participating in the ETS in each sector (bottom)
Source: EC 2023a, MJ 2023, own analysis

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Year	Sector (number of companies)				Total
	C	D	H	Other	
2005	87	50	3	12	152
2006	87	51	3	13	154
2007	85	52	3	9	149
2008	80	52	3	9	144
2009	76	51	4	10	141
2010	76	52	4	10	142
2011	75	52	4	10	141
2012	72	51	8	10	141
2013	67	49	4	10	130
2014	64	46	6	8	124
2015	61	42	6	8	117
2016	61	41	6	8	116
2017	65	42	6	7	120
2018	64	44	7	7	122
2019	66	46	6	5	123
2020	67	43	5	5	120
2021	71	41	5	4	121

Year	Sector (proportion of annual reports available by number of companies)				Total
	C	D	H	Other	
2005	93%	100%	100%	92%	95%
2006	94%	98%	100%	92%	95%
2007	94%	98%	100%	100%	96%
2008	95%	98%	100%	100%	97%
2009	96%	100%	100%	100%	98%
2010	92%	100%	100%	100%	96%
2011	93%	100%	100%	100%	96%
2012	96%	100%	88%	100%	97%
2013	97%	100%	100%	100%	98%
2014	95%	100%	100%	100%	98%
2015	95%	100%	100%	100%	97%
2016	97%	100%	100%	100%	98%
2017	98%	100%	100%	100%	99%
2018	98%	100%	100%	100%	99%
2019	98%	100%	100%	100%	99%
2020	99%	100%	100%	100%	99%
2021	97%	95%	100%	100%	97%

* Note: C – Manufacturing; D – Energy supply; H – Transportation; Other – other sectors aggregated

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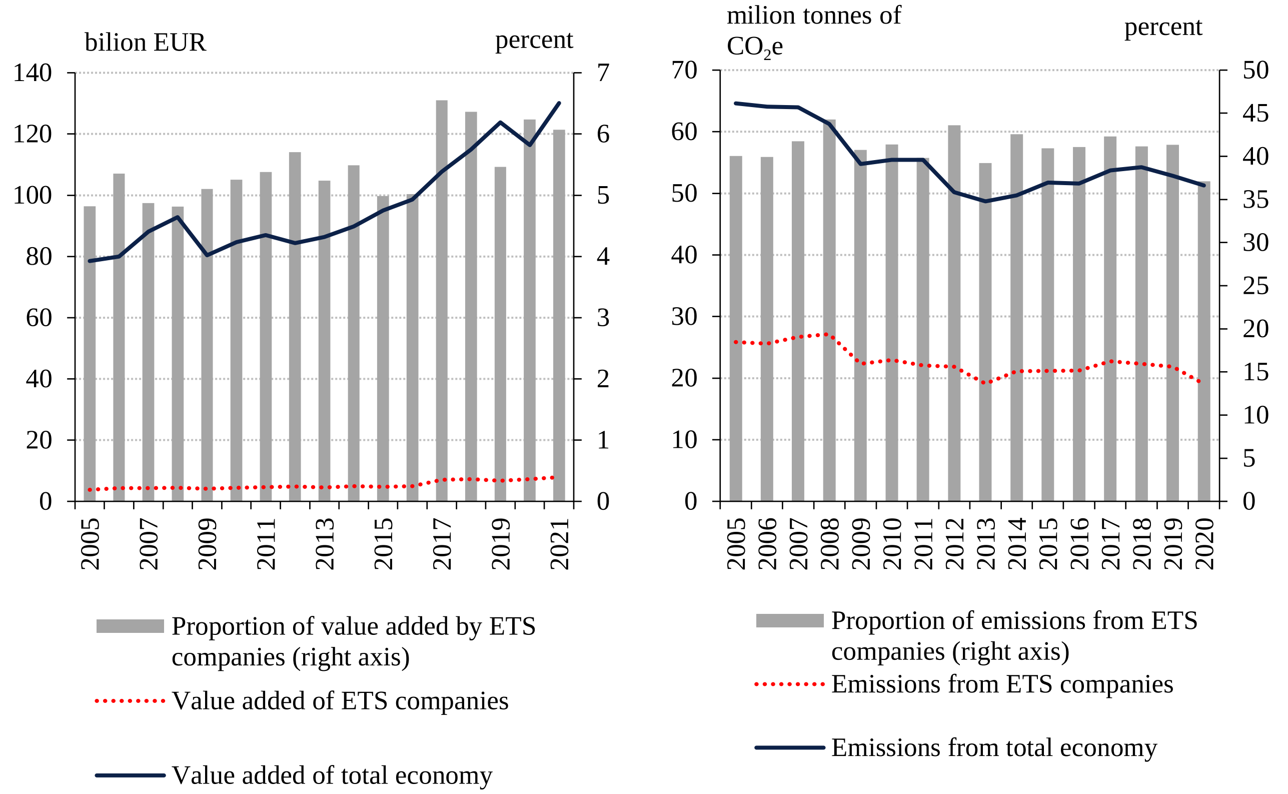

Figure 2: The share of companies under ETS regulation in value-added generated by the Hungarian economy (left) and national GHG emissions (right)

Source: Eurostat 2023a, Eurostat 2023c, EC 2023a, MJ 2023, own analysis

The modified sectoral average GHG intensity differs from the one presented in Equation (1) because, from both the denominator and the numerator, the emissions and value-added data of ETS companies active in the sector in the given year were removed if both data points were available. The resulting modified sectoral average GHG intensity data can be taken as non-ETS companies' new average intensity data.

$$INT_{NONETS_i} = \frac{GHG_i - GHG_{ETSi}}{GVA_i - GVA_{ETSi}} \qquad \text{(Eq. 5)}$$

where $INT_{NONETSi}$ is the GHG intensity of non-ETS companies in sector i,
GHG_i is the total GHG emissions in sector i,
GHG_{ETSi} is the GHG emissions of ETS companies in sector i,
GVA_i is the total GVA of companies in sector i,
GVA_{ETSi} is the GVA of ETS companies in sector i.

Both GHG_i and GVA_i correspond to the original sectoral values published by Eurostat (Eurostat, 2023a, 2023c), while GHG_{ETSi} values are from the EU ETS GHG emissions inventory of ETS companies (EC, 2023a) and GVA_{ETSi} values are calculated using the two GVA calculation methods described above using annual reporting data (MJ, 2023).

3. Results and discussion

The modified sectoral average GHG intensity values calculated for non-ETS companies are no longer influenced by ETS companies' values, which are the largest CO_2 emitters. Using the modified values gives a more accurate picture of the GHG intensity of non-ETS companies in each ETS-affected sector, and hence, their GHG intensity-based climate change risk values will likely decrease. We can refine our existing risk measurement tools based on sectoral GHG intensities using modified sectoral average GHG intensity data for non-ETS companies. Unsurprisingly, the two sectors most heavily involved in the ETS are the ones where the modification results are most noticeable (Figure 3).

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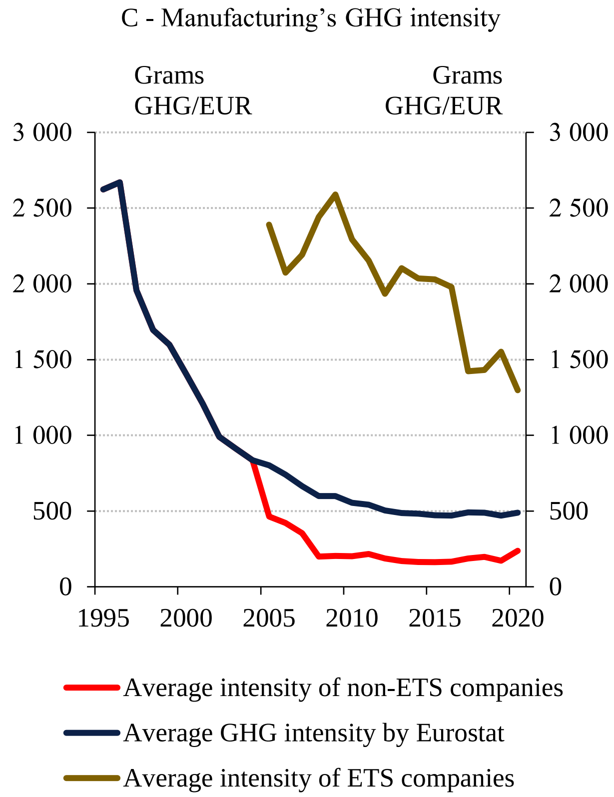
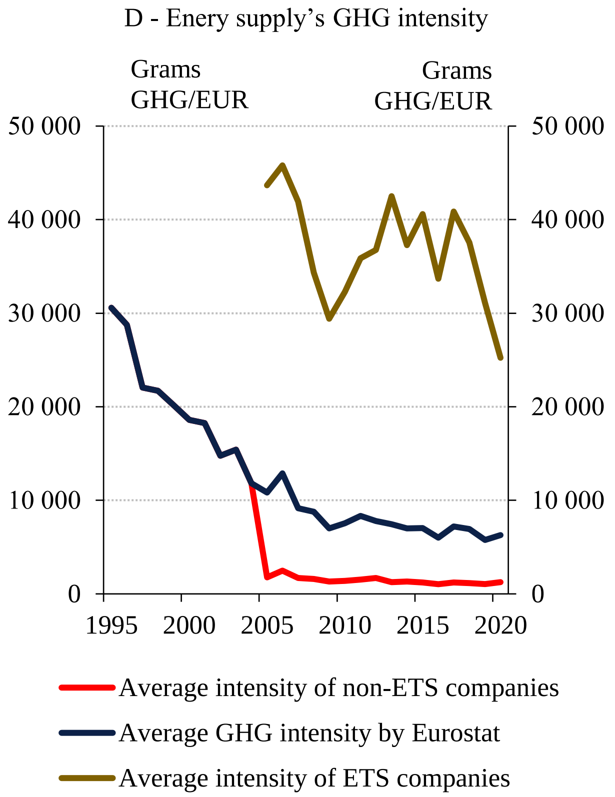
Sectors C–Manufacturing and D–Energy supply show a drastic GHG intensity decrease compared to the average intensity values produced by Eurostat (blue lines), with the former showing a 42–67% decrease and the latter a 78–84% decrease in average GHG intensity values for non-ETS companies (red lines) depending on the year. We see drastic differences if we compare the sectoral average GHG intensity of non-ETS and ETS companies in the two sectors. On average, ETS companies (brown lines) can have up to 7–33 times higher average GHG intensity than their non-ETS counterparts in the D–Energy sector, while the same value was 3–12 times higher for ETS-companies in the C–Manufacturing sector.

Surprisingly, results for the initial period can be observed in the H-Transportation sector. In the first years, several ETS companies produced much higher added value than the rest of the sector. As a result, although fewer GHG emissions remained in the numerator, the large reduction in value-added emissions resulted in higher GHG emissions per value-added produced than before the modification. So, the modified average GHG intensity values for non-ETS companies were initially higher than those calculated by Eurostat. This trend was reversed in 2014, and since then, as in the other two sectors above, the modified average intensity values of non-ETS companies have been lower than the original ones.

Looking at the average GHG intensity of the Hungarian economy, there has also been a significant reduction. Although there has been a steady decline in the economy's GHG intensity since 1995 with the decline of heavy industry and the growth of the service sector, modifying it with ETS companies' data has resulted in a further 30–41% reduction compared to the average intensity values calculated by Eurostat, depending on the year. When comparing the non-ETS and ETS companies, the differences are as striking as for the first two mentioned sectors (manufacturing and energy supply). The average GHG intensity of ETS companies in the whole economy was 7–15 times higher than the average GHG intensity of non-ETS companies.





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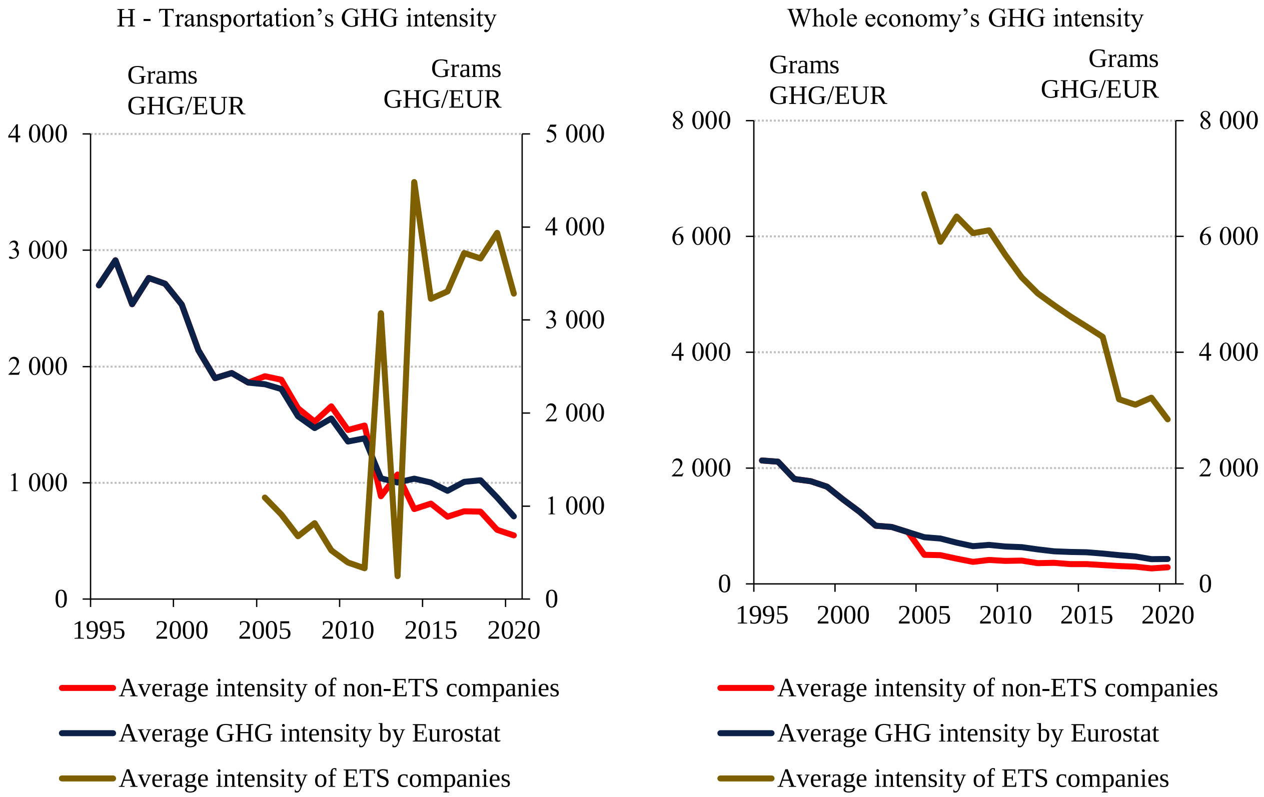

Figure 3: Change in sectoral average GHG intensity of most affected sectors and economy as a whole
Source: Eurostat 2023a-c, EC 2023a, MJ 2023, own analysis

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4. Conclusion

Introducing new individual emission data to already in-use sectoral average GHG intensity data for climate risk analysis could significantly improve our existing analytical tools. However, applying only the individual emission data to the company, where possible, and not modifying the sectoral average data can cause misleading results. To overcome this, a modification method was introduced to the sectoral average GHG intensity values. With the method applied, where most of the companies with individual emission data were active, a drastic change could be observed in the sectoral average GHG intensity value. An already available data cluster, namely the emissions data from the EU ETS, was used for the modification. Many companies will likely disclose their CO_2 emissions values shortly. Using these values the way introduced above will benefit the disclosing companies and their sectoral average, thus avoiding double counting their emissions.

However, one problem arises when relying on GHG intensity data: the effect of the value added by high GHG emitter companies. The high enough value-added generation of companies and sectors can mask high pollution. Thus, GHG intensity follows the weak sustainability approach, which postulates the full substitutability of natural capital, as GHG intensity does not recognise some companies as high polluters as long as they do it with high enough value-added generation. On the other hand, strong sustainability assumes that human and natural capital are complementary but not interchangeable. Therefore, only GHG emission values should be used instead of GHG intensity. This approach could result in higher climate risks, as high polluters with high value-added would be considered risky exposures compared to the current situation. Of course, some now high GHG intensity activities could become low emission activities as well, as high GHG intensity can occur when low pollution is coupled with even lower value added. Further research and comparison between the two approaches is necessary to reveal the true impact of this methodological transition.

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