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Research Article

A Novel Approach of Measuring Portfolio Carbon Emission Intensity to Rank, Score and Take Investment Decision

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ABSTRACT

A range of carbon emission metrics are available for investors for the purpose of measuring carbon risk management, reporting and to take proper investment decisions. As industry frameworks continue to evolve, investors are moving from revenue-based carbon intensity metrics towards metrics based on enterprise value including cash (EVIC). This shift has some important implications and can move in opposite directions in identical scenarios. Since the distribution of a firm's carbon intensity is very skewed, the exclusion of a small fraction of highly polluting firms can massively reduce the carbon footprint of a portfolio and can mislead the investors in taking proper investment decisions. To address such misreporting/false reporting, this study proposes a new carbon intensity metric which will be useful to investors in assessing, ranking and scoring the portfolios so that they can take proper investment decisions.

Keywords: Carbon Footprint, Carbon Intensity, GHG Emissions, Portfolio Investment.

I. INTRODUCTION

Global warming with the development of industrialization has caused irreversible damage to the environment that human beings depend on in terms of sea level rise, food crises, water shortages and so on. Research shows that the main cause of global warming is greenhouse gas emissions(GHG). The first assessment report of the Intergovernmental Panel on Climate Change (IPCC) was released in 1990 and from then the reduction in GHG emissions has become the primary goal of the world. The Paris Agreement in 2016 proposed that global warming should be limited to 1.5^{o}C in order to avoid serious climate change impacts. In 2022, the 6th assessment report released by IPCC, indicates that in a scenario where the GHG emissions are very low, there is more than 0.5 probability that global warming will reach or exceed 1.5^{o}C in the near period. Hence the ambitious goal of reducing emissions requires joint efforts of governments and industries across the world. To achieve the ambitious goal of reducing the GHG emissions, the accurate and precise assessment of GHG emissions from human activities is an essential prerequisite for carbon-reduction strategies. The increasing climate related risks are more important for investors, financial intermediaries, and their regulators. One way to both encourage greener means of production and ways of life and safeguard against climate risk is to reallocate investment towards greener corporates. On one hand, the financial sector and especially asset managers have to safeguard against climate risks to ensure the preservation of their portfolio value. On the other hand, they need to assess what this reallocation would imply in terms of financial performance. To decarbonize a portfolio such that its carbon footprint is compatible with a 1.5^{o}C temperature increase above pre-industrial levels, the first obvious route is to exclude the most polluting firms. Large institutional investors and financial authorities are already taking necessary actions in this regard. The Network for Greening the Financial System promotes best practices and contributes to the development of environment and climate risk management in the financial sector (NGFS, 2020). Several asset managers have already realized that the claim that portfolios can be safeguarded against climate risk with little to no damage to performance through exclusion restrictions is both accurate and easy to implement. As a small number of firms contribute disproportionately to carbon emissions, marginal reallocation of the market portfolio that excludes such firms would have strikingly smaller carbon footprint than a portfolio that includes all firms. The exclusion approach is in principle very effective because corporates carbon emissions are extremely right skewed. A drawback of this pure exclusion approach is that the excluded firms often belong to the same sectors (utilities, energy, and materials) and to the same regions (Emerging Countries).

LITERATURE REVIEW

Research on carbon emissions was initiated with a focus on volatile organic carbon emissions of cooling tower water [1] in 1981. Since then, many researchers explored the domain without significant impacts until the Kyoto protocol was signed in 1997. Climate change has become a major global concern with the rising global temperatures and considered as the most serious issue which the global community has to address in the 21st century [2]. Research on global carbon emissions has significantly increased after identifying carbon emissions as the leading cause of climate change. Increasing carbon emissions have caused significant concern amongst the countries such as China, United States, Russia, India, European Union, and Japan as the leading carbon emitters of the world [3]. The research on carbon emission expands over the research areas like environmental sciences, engineering, economics, energy, etc. and it is evident that the majority of carbon emission research relates to environment-related aspects. Economics, energy fuels, ecology, and civil engineering are some of the other notable research areas which have been affected by carbon emission research.

The research on carbon emission initially focused on capturing global emission trends and practices. However, with the heightened significance of sustainable development, researchers have focused on developing methods to comprehend and mitigate the effects of carbon emissions [4]. Life Cycle Assessment is recognized as one of the basic methodologies which consider the inputs and outputs associated with a process or a product in determining the carbon emissions [5]. As sustainable development required the integration of not only environmental but also social and economic components, carbon emission research expanded over various research areas. Despite various methods and concepts developed for social and economic evaluations of carbon emissions such as Social LCA (SLCA) [6] and Life Cycle Cost Analysis (LCCA), researchers have kept searching for new opportunities and developing new methods such as carbon emission trading, carbon tax, etc. [7], [8], [9].

In recent times, there has been a growing interest in estimating and revealing carbon emission drivers via carbon footprint analysis at different scales. The carbon footprint originates from the concept of ecological footprint which is a measure of the impact on the environment expressed as the amount of land required to sustain natural resources. However, the carbon footprint of a functional unit, when it is not associated with the ecological footprint, is the climate impact under a specified metric that considers all relevant emission sources, sinks and storage in both consumption and production within the specified spatial and temporal system boundary [10]. Although a specific definition of carbon footprint has been not stated, according to Wiedmann and Minx [11] carbon footprint is the measure of the total amount of carbon dioxide emissions directly and indirectly caused by an activity or accumulated over the life stages of a product. Specifically, the carbon footprint is the overall amount of carbon emissions associated with a country, city or product, along its supply chain including end-of-life recovery and disposal. The carbon footprint is an environmental indicator and, as such, it needs to be used in appropriate contexts thus providing the right information. When properly used, it is essential for making decisions and performance evaluations and for allowing policymakers to have a solid basis upon which climate policies can be established and implemented.

Several carbon emission research studies have grabbed the attention of global researchers due to the rapidly changing global climate. The study conducted by Allen, et al. [12] on "warming caused by cumulative carbon emissions towards the trillionth tonne" was reveals that anthropogenic emissions of one trillion tonnes of carbon are likely to cause an increase of global temperatures by two degrees Celsius. The research article by West and Marland [13] focuses on agriculture-related carbon emissions and calculated the impact of the US agriculture sector towards global carbon emissions. The study further indicated that adopting newer technologies and methods to harvest crops emit less carbon compared to conventional methods. This further indicates that global carbon researchers are in search of methods and technologies to reduce global carbon emissions. Dietz, et al. discusses how household actions can contribute to reducing the US carbon emissions [14]. This study reveals that national implementation of interventions on five distinct categories of household actions could reduce 20% of the US household carbon emissions. The research article on "energy consumption, carbon emissions and economic growth in China" by Zhang and Cheng [15], "Energy consumption, income and carbon emissions in the United States", by Soytas, et al. [16] reveals that, large countries like China and the United States are significantly concerned about the impact of global carbon emissions to their economy and have taken significant efforts to investigate and concluded that income growth is not a solution to environmental problems. Pastor et al. [17] identified that in equilibrium, green assets command lower expected returns because these assets hedge climate risk and investors are ready to pay a premium to hold them. Pedersen et al. [18] describe a theoretical framework that could explain why the relation between an environmental score and financial performance of firms may actually switch from positive to negative. If the market is driven by investors using the environ- mental score only as an indicator of high future performance, high-environmental-score stocks should deliver high expected returns. However, as soon as the market is

driven by investors with environmental preferences, these investors are willing to pay a premium to hold high-environmental-score stocks, which therefore deliver lower expected returns. Interestingly, this model may explain why empirical studies have found contradicting evidence over time or across regions or industries. Go ̈rgen et al. [19] construct a carbon risk factor- mimicking portfolio and find that stock returns are positively affected by this factor, indicating that brown firms must generate higher returns on average. Bolton and Kacperczyk [20] find that investors are already demanding a compensation for their exposure to carbon emission risk. In contrast, consistent with Andersson et al. [21], Garvey et al. [22] find that reducing the carbon footprint of a portfolio is associated with a higher future profitability and a positive stock returns in a global universe of stocks. In et al. [23] also report evidence that an investment strategy of "long carbon-efficient firms and short carbon-inefficient firms" would earn positive abnormal returns. Eric Jondeau et al. [24][talks about decreasing carbon foot print by adopting exclusion of most polluting firms from the portfolio.
These studies clearly indicate that global researchers are focusing heavily on different areas of the carbon research domain. Thus, exploring the patterns and trends of global carbon emission research would provide a thorough insight into the carbon emission research domain.

METHODOLOGY

In order to understand and reduce the greenhouse gas emissions, one has to know the source of emissions. There are three scopes of emissions a company can emit in its direct and indirect(suppliers and customers) operations.

***Scope I emissions**:* These emissions are direct emissions operated and controlled by the company. Example: emissions from combustion in owned or controlled boilers, furnaces, vehicles etc.
Scope II emissions: These emissions are caused indirectly by the company and come from the energy the company purchases and uses for production. Example: The electricity used in the companies.
***Scope III Emissions*:** The emissions that are not produced by the company and are not resulted from the activities owned and controlled by the company. These emissions are indirect and caused by the suppliers and customers of the company. Example: Extraction and production of purchased materials, Transportation.

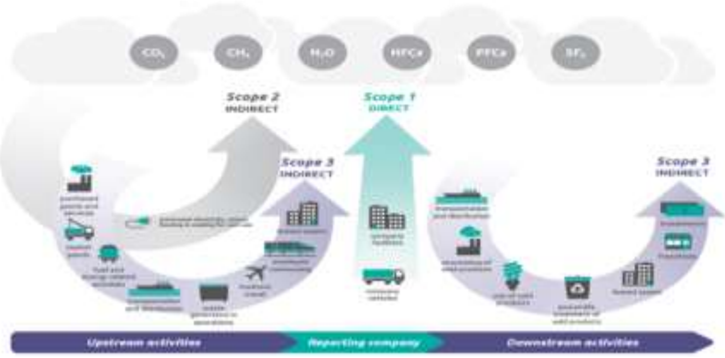

Figure 1: Scheme explaining Scope 1, 2 & 3 emissions

The carbon footprint (CF) captures a lot of interest among many scholars. Derived from the concept of the ecological footprint, CF has become a catchphrase in public discussion. CF is a type of ecological footprint in terms of carbon emissions from individual or mass production, consumption, and organizational activities. It is important to realize that CF originates from the ecological footprint but is not equivalent to it. Despite its name, CF is not expressed in terms of area, as the ecological footprint is. The widely accepted definition of CF is the total amount of carbon emissions caused by an activity directly and indirectly or accumulated of a product over its life stages, which is expressed in terms of carbon dioxide (CO_2) equivalents generally.
The metrics used for calculating carbon emissions are:
a) Total Financed Emissions
b) Carbon Footprint
c) Weighted Average Carbon Intensity
d) Modified Weighted Carbon Intensity

Total Financed Emissions (TFE): Financed emissions are the greenhouse gas (GHG) emissions linked to the investment and lending activities of financial institutions like investment managers, banks and insurers. It measures the total emissions (tCO_2e) attributed to a portfolio where the company emissions are apportioned based on a relevant ownership/ financing share and is defined as

$$\text{TFE } (tCO_2e) = \sum_{i=1}^{n} \left[\frac{Investment_i}{Market\ Cap_i} * Emissios_i\right] \quad (1)$$

***Carbon Footprint (CF)*: This metric is defined as the ratio of the TFE and the Total value invested in the given portfolio and is defined as**

$$CF(tCO_2e/\$Minvested)=\frac{TFE}{Total\ Investment\ of\ the\ portfolio} \quad (2)$$

Weighted Average Carbon Intensity (WACI): Weighted Average Carbon Intensity is a measure of carbon emissions normalized by revenues and is a relevant comparison point across issuers. This metric is useful for portfolio decomposition and attribution analyses across sectors and asset classes. It is useful to compare the carbon efficiency of companies across different industries and is defined as follows:

$$WACI = \sum_{i}^{n} w_i^{(p)} * \left(\frac{E_i}{Rev_i}\right) \quad (3)$$

Where
E_i - the amount of carbon emitted by firm i in year t,
Rev_i - the revenues generated by the firm I in year t,
$w_i^{(p)}$ is the weight of i^{th} firm in the portfolio.
The portfolio weight is defined as

$$w_i^{(p)} = \frac{V_i^{(p)}}{V^{(p)}},$$

Where
$V_i^{(p)}$ - the dollar value invested in firm i
$V^{(p)} = \sum_{i=1}^{n} V_i^{(p)}$ - the dollar value of the portfolio and n - the number of firms.

The Weighted Average Carbon Intensity has the following shortcomings:

a. ***Lack of Granularity*:** The WACI measure do not capture the nuances of emissions within specific sectors or activities.
b. ***Quality and Availability of Data*:** The accuracy of WACI measure depends on the availability and quality of the data. Hence the data collected on carbon emissions must be complete, consistent and up-to-date across sectors, industries and regions.
c. ***Temporal Dynamics*:** Carbon intensity can vary over time due to policy changes, economic movements and technological advancements. The WACI measure may not sufficiently account for these temporal dynamics which may cause discrepancies between estimated and actual emissions.
d. ***Assumptions of Homogeneity*:** WACI assumes homogeneity within sectors or regions. But in heterogeneous environments with diverse production processes, regulatory frameworks and energy sources this assumption may not hold good.
e. ***Scope of Analysis*:** It may happen that WACI measure may not associated with upstream or downstream activities in the supply chain i.e., it may focus only on direct emissions and may neglect the emissions from transportation, raw material extraction and disposal.
f. ***Limitations of Metrics*:** The WACI measure focuses on CO_2 emissions and may not account for other GHG gases or non-CO_2 climate factors which are significant contributors of global warming.

These shortcomings and research gaps can be addressed by
i. improving the data quality and granularity.
ii. Incorporating temporal dynamics and heterogeneity into models
iii. Including upstream and downstream emissions and other GHG gas emissions and climate factors.
iv. Use of advanced technology, data analytics to understand carbon emissions

***Modified Weighted Average Carbon Intensity $MWACI$)*:** The Modified Weighted Average Carbon Intensity ($MWACI$) is a novel method of assessing both the company carbon emissions and the corresponding sector carbon emissions. Since the weight used in WACI is based on the investment ratio of the company and the portfolio, the inclusion of the product of company and sector carbon emissions weight strengthens the Modified WACI over WACI. The new metric enhances the accuracy and relevance of the weighted average carbon intensity metric by making it a more robust tool assessing environmental performance. This can be useful for investors, policymakers and other stakeholders seeking to make informed decisions regarding sustainability and carbon emission reduction efforts. The Modified Weighted Average Carbon Intensity defined as follows:

$$MWACI = \left[\sum_{i}^{n} S_i * C_i * w_i^{(p)} * \left(\frac{E_i}{Rev_i}\right)\right] \quad (4)$$

Where

S_i - the i[th] company's sector carbon emission weight.
C_i - the i[th] company carbon emission weight.

The sector weight S_i ensures the broader context of the industry's environmental impact. The company weight C_i emphasizes the significance of individual company within the sector and can provide a more precise understanding of companies which are most influential in terms of carbon emissions within their respective sectors. The sector and company carbon emission weight can be taken from published reports.
The new metric will be helpful in ranking the portfolios/companies and also to assign a score to each portfolio based on their improvement in reducing the carbon emissions over a period of time. The portfolios with lower MWACI values to Higher MWACI values will be ranked from 1 to 'n' respectively.
MWACI values are also useful in Scoring the portfolio based on their performance over a given period of time. The percentage of the ratio of present year to previous/base year MWACI values is defined as the Carbon emission Score of a portfolio over the given period. A Score more than 100 indicates that the portfolio failed to reduce the carbon emissions and a Score less than 100 indicates that the portfolio got some success in reducing the carbon emissions compared to previous/base year. i.e., the lower the Score the greener the portfolio. This score will be helpful to investors in making appropriate decisions to choose greener portfolios and to invest in. This score is also useful to replace the high carbon emitting firms of a portfolio with other low carbon emitting firms. The inclusion of the product of Sector and Company carbon weight to the weighted average carbon intensity measure will address the issues related to wrongly reported carbon emissions by companies and enables to compare the portfolio performance with other portfolios. The trend analysis of the performance of the portfolio will be useful to assign a score related to carbon emissions of a portfolio. The Carbon emission measures can be compared to the previous/base year and the percentage of reduction in carbon emissions measure can calculated. Based on the percentage of reduction, a score can be assigned accordingly.

The Modified WACI offers a more nuanced and actionable framework for assessing emissions, incentivizing emission reductions, and promotes sustainable business practices across sectors and companies. Some of the advantages are:

a. ***Increased Granularity*****:** The Modified WACI provides more granular understanding of emissions within and across sectors by incorporating both sector and company-specific carbon emission weights. This allows for better identification of high-emission entities and area targeted mitigation efforts.

b. ***Includes Company-level Contributions***: Unlike the traditional WACI, the Modified WACI acknowledges the variability in emissions among companies within same sector and provides a more accurate representation of their corresponding carbon emissions.

c. ***Rewards for Emission Reduction*****:** Companies whose emissions are higher relative to their sector peers impacts the overall sector's carbon intensity. This approach suggest stronger rewards for such companies to implement emission reduction measures in order to improve their environmental performance.

d. ***Facilitates Benchmarking and Goal Setting*****:** Stakeholders can set performance benchmark in reducing carbon emissions by comparing company level carbon intensities against sector averages. This enables companies to identify areas where they lag behind peers and implement strategies to enhance their competitiveness and sustainability.

e. ***Transparency and Accountability*****:** The Modified WACI brings up transparency by highlighting the contributions of individual companies to sectoral carbon intensity. This will enhance the accountability among companies, investors, regulators and other stakeholders which will lead to improved environmental governance and reporting standards.

f. ***Policy and Intervention*****:** The company level carbon intensity data can be used by policymakers and regulators to design policies and interventions which will address specific emission hotspots within sectors. This will allow for the effective allocation of resources and regulatory incentives to encourage emission reduction where they are most needed.

g. ***Enhances Risk Management*****:** Companies with higher carbon intensities may face increased regulatory, financial and reputational risks associated with climate change. By quantifying and disclosing their emissions relative to sector benchmarks, companies can better identify and manage these risks, improving their resilience in a carbon-constrained world.

RESULTS.

The differences between the existing and the newly proposed metrics are explained through the following examples in three different cases. The column abbreviations in the tables are:
I-Investment($M); MC-Market Cap($M);
R-Revenue($M); CF-Carbon Footprint (tCO_2e/$M invested); WACI- Weighted Average Carbon Intensity(tCO_2e/$M Revenue); MWACI- Modified Weighted Average Carbon Intensity(tCO_2e/$M Revenue)

Case I: Portfolio with 3 different companies from different sectors over a period of three years
Trend of a Portfolio

Table 1: First Year portfolio Carbon Emission Data

Weights		Name of the Company& Sector	Scope wise Emissions (tCO_2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				1&2	1, 2 &3			
0.02	0.02	A, Renew	7000	10000	12000	29000	15	120	80	2125.00	3625.00	60.42	90.63	0.04
0.04	0.05	B, Tech	12000	15000	18000	45000	25	180	130	3750.00	6250.00	104.17	144.23	0.29
0.14	0.07	C, Manu	20000	25000	30000	75000	20	150	100	6000.00	10000.00	166.67	250.00	2.45
		Total	**39000**	**50000**	**60000**	**149000**	**60**	**450**	**310**	**11875.00**	**19875.00**	**331.25**	**484.86**	**2.77**

Table 2: 2nd Year portfolio Carbon Emission Data

Weights		Name of the Company& Sector	Scope wise Emissions (tCO_2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				1&2	1, 2 &3			
0.015	0.02	A, Renew	6500	9500	11500	27500	17	125	85	2176.00	3740.00	56.67	83.33	0.03
0.03	0.04	B, Tech	11500	14500	17500	43500	27	185	135	3794.59	6348.65	96.19	131.82	0.16
0.14	0.09	C, Manu	19500	24500	29500	73500	22	155	105	6245.16	10432.26	158.06	233.33	2.94
		Total	**37500**	**48500**	**58500**	**144500**	**66**	**465**	**325**	**12215.76**	**20520.91**	**310.92**	**448.48**	**3.12**

Table 3: 3rd Year portfolio Carbon Emission Data

Weights		Name of the Company& Sector	Scope wise Emissions (tCO_2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				S	C			
0.01	0.02	A, Renew	6000	9000	11000	26000	20	130	90	2307.69	4000.00	53.33	77.04	0.02
0.02	0.03	B,Tech	11000	14000	17000	42000	30	190	140	3947.37	6631.58	88.42	120.00	0.07
0.12	0.08	C, Manu	19000	24000	29000	72000	25	160	110	6718.75	11250.00	150.00	218.18	2.09
		Total	**36000**	**47000**	**57000**	**140000**	**75**	**480**	**340**	**12973.81**	**21881.58**	**291.75**	**415.22**	**2.18**

Table 1,2 and 3 illustrates the performance of a portfolio over three years. The total carbon emissions of the portfolio are declining whereas the financial values are increasing over the three years. Subsequently, the Financed Emissions are increasing and the Carbon Footprint and Weighted Average Carbon Intensity metric values are decreasing. Based on CF and WACI values it can be concluded that the portfolio is performing better towards reducing the carbon emissions year by year. But on observing the Modified Weighted Average Carbon Intensity values of the portfolio over the three years, it is evident that the portfolio in the second year failed to reduce the carbon emissions but in the third year the carbon emissions are highly reduced when compared to the first and second years. Table 4 compares the carbon emission metrics CF, WACI and MWACI whereas Table 5 shows the Score values of the portfolio for second and third years assuming the first year as base year.

Table 4: Comparison between WACI & MWACI

Year	CF	WACI	MWACI
First	331.25	484.86	2.77
Second	310.92	448.48	3.12
Third	291.75	415.22	2.18

Table 5: Scoring using MWACI

Year	MWACI	Ratio	
		Present/Previous	Present/Base
1	2.77	---	---
2	3.12	112.6	112.5
3	2.18	69.87	78.7

Case 2: Different portfolios with 3 different companies and three different Sectors.
Diversified Portfolios

Table 6: Portfolio I Carbon Emission Data

Weights		Name of the Company& Sector	Scope wise Emissions (tCO2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				1 & 2	1, 2 &3			
0.01	0.02	A, Renew	5000	10000	15000	30000	20	150	100	2000.00	4000.00	53.33	80.00	0.02
0.04	0.03	B, Tech	15000	20000	25000	60000	30	200	150	5250.00	9000.00	120.00	160.00	0.19
0.15	0.12	C, Retail	10000	15000	20000	45000	25	180	120	3472.22	6250.00	83.33	125.00	2.25
		Total	**30000**	**45000**	**60000**	**135000**	**75**	**530**	**370**	**10722.22**	**19250.00**	**256.67**	**365.00**	**2.46**

Table 7: Portfolio II Carbon Emission Data

Weights		Name of the Company& Sector	Scope wise Emissions (tCO2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				1&2	1, 2 & 3			
0.05	0.06	D, Health	8000	12000	16000	36000	15	120	80	2500.00	4500.00	72.58	108.87	0.33
0.12	0.08	E, Finance	12000	18000	24000	54000	25	180	130	4166.67	7500.00	120.97	167.49	1.61
0.15	0.09	F, Manu	20000	25000	30000	75000	22	160	110	6187.50	10312.50	166.33	241.94	3.27
		Total	**40000**	**55000**	**70000**	**165000**	**62**	**460**	**320**	**12854.17**	**22312.50**	**359.88**	**518.30**	**5.20**

Table 8: Portfolio III Carbon Emission Data

Weights		Name of the Company & Sector	Scope wise Emissions (tCO2e)				I	MC	R	Scope wise Financed Emissions in tonnes		CF	WACI	MWACI
S_i	C_i		1	2	3	Total				1 & 2	1,2,& 3			
0.15	0.08	G, Biotech	6000	9000	12000	27000	18	130	90	2076.92	3738.46	59.34	85.71	1.03
0.22	0.15	H, Transport	10000	16000	20000	46000	20	170	140	3058.82	5411.76	85.90	104.31	3.44
0.3	0.21	I, Food and Beverage	15000	20000	25000	60000	25	190	120	4605.26	7894.74	125.31	198.41	12.50
		Total	**31000**	**45000**	**57000**	**133000**	**63**	**490**	**350**	**9741.01**	**17044.96**	**270.55**	**388.44**	**16.97**

Table 6,7 and 8 illustrates the performance of 3 portfolios with 3 different companies and different sectors. On comparing the portfolios based on CF and WACI measures, the 3 portfolios are ranked 1, 3 and 2 respectively but the MWACI values ranks the portfolios as 1, 2 and 3 respectively which is shown in table 9.

Table 9: Ranks of Portfolios using C F, WACI & MWACI

Portfolio	CF, Rank	WACI, Rank	MWACI, Rank
1	256.67, 1	365.00, 1	2.46, 1
2	359.88, 3	518.30, 3	5.2, 2
3	270.55, 2	388.44, 2	16.97, 3

Case 3: Portfolios in the Same Sector with different companies.

Table 10: Portfolio A Carbon Emission Data

Weights		**Name of the Company**	**Scope wise Emissions (tCO_2e)**				**I**	**MC**	**R**	**Scope wise Financed Emissions in tonnes**		**CF**	**WACI**	**MWACI**
S_i	**C_i**		**1**	**2**	**3**	**Total**				**1 & 2**	**1,2 &3**			
0.04	0.05	A	15000	80000	250000	345000	50	500	300	9500.00	34500.00	230.00	383.33	0.77
0.04	0.04	B	12000	70000	200000	282000	40	450	280	7288.89	25066.67	167.11	268.57	0.43
0.04	0.03	C	18000	90000	280000	388000	60	600	350	10800.00	38800.00	258.67	443.43	0.53
		Total	**45000**	**240000**	**730000**	**1015000**	**150**	**1550**	**930**	**27588.89**	**98366.67**	**655.78**	**1095.33**	**1.73**

Table 11: Portfolio B Carbon Emission Data

Weights		**Name of the Company**	**Scope wise Emissions (tCO_2e)**				**I**	**MC**	**R**	**Scope wise Financed Emissions in tonnes**		**CF**	**WACI**	**MWACI**
S_i	**C_i**		**1**	**2**	**3**	**Total**				**1 & 2**	**1,2 & 3**			
0.04	0.06	D	14000	75000	230000	319000	45	480	320	8343.75	29906.25	221.53	332.29	0.80
0.04	0.07	E	16000	85000	260000	361000	55	550	380	10100.00	36100.00	267.41	387.04	1.08
0.04	0.09	F	10000	60000	180000	250000	35	400	250	6125.00	21875.00	162.04	259.26	0.93
		Total	**40000**	**220000**	**670000**	**930000**	**135**	**1430**	**950**	**24568.75**	**87881.25**	**650.97**	**978.59**	**2.81**

Table 10 and 11 illustrates the performance of 2 portfolios in the same sector. The Financed emissions, Carbon Footprint and WACI values suggest that portfolio B is better that portfolio A. But the Modified WACI values, which includes the company carbon emission weights, suggest that portfolio A is performing better than portfolio.

CONCLUSION AND FUTURE WORK

In this study, the focus is on improving the existing weighted average carbon Intensity by incorporating the product of the sector and company-specific carbon emission proportions, which offers a more robust and comprehensive method for assessing carbon footprints, enabling more informed decision-making and targeted interventions to mitigate climate change. The Modified weighted average carbon intensity can be used to compare various portfolios and rank them accordingly across the sectors. Also this measure can be used to assign a score to companies and sectors based on the performance in reducing the carbon emissions over a period and make appropriate decisions to reduce the carbon emissions. Further, there is a need to find ways to address geographical environmental fluctuations in terms of carbon emissions and come up with policies and make informed decisions to reduce the global carbon emissions.

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