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## Quantitative Portfolio Management Through Carbon Budgeting in PSX Perspective

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**Abstract:** Portfolio management requires investment managers to consider investor preferences before taking any investment decisions. Some of the investors might be interested in building a clean, environmentally friendly, and carbon-free portfolio, assuming it as their corporate social responsibility (CSR) or owing to some fear of future loss arising from the ban on environment-hampering companies that might not be following the environmental, social, and governance (ESG) requirements. Historically, we have seen a ban on Chinese products because of the issues of carbon emissions. Similarly, during SMOG, many brick kilns and iron foundries are closed in Pakistan every year. The carbon budgeting on the portfolio can help achieve the CSR and sustainability goals of investors. The study attempts to develop a portfolio based on historical data, which could yield optimum results while remaining carbon conscious. The study aims to find the best-performing portfolio that could be more ESG compliant and may achieve CSR objectives to protect the environment and investors' interests simultaneously. The findings show that companies segregated based on carbon footprint can create a carbon-free portfolio (approximately 25%) without a material impact on the expected risk and return profile. To be more ESG compliant, an investor can compromise slightly on returns, that is, only compromising 3% of the profit, we can maintain a 50% compliant portfolio in Pakistan's environment. The study tries to improve the understanding of regulatory requirements but would also help us gain the confidence of investors who are keen to see carbon-free portfolios or in other words want to ensure investments in environmentally friendly industries.

**Keywords:** carbon budgeting, CSR, ESG, GHG, portfolio returns.

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## INTRODUCTION

Greenhouse gases emission has become a major global issue because of human activities pertaining to energy production and supply, manufacturing, transportation, communities, and waste (Rokhmawati & Gunardi, 2017; Setiawan & Iswati, 2019; Makan & Kabra, 2021). All these show their effects on climate which in turn impacts humans and the environment. Land erosion and reduction in forests also add to pollution by reducing the ability to handle GHG emissions (Das et al., 2020). Carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) are the main gases that are emitted into the atmosphere.



The sectors mentioned can release GHGs, especially CO<sub>2</sub> directly into the air however the same can also be removed from ecosystems through adopting certain management activities including emission control as well as enhancing the absorption of GHGs in plants, trees, and the soil. Examples of reduction in GHG emission strategies include decreasing direct emission from factories and devising strategies to encourage and vigorously influence business units to understand their environmental responsibility along with adopting traditional forestation and reforestation strategies of agriculture and forestry.

When portfolio managers are required to manage a portfolio for someone, they first gather information about investor preferences (Roeth et al., 2019; Litterscheidt & Streich, 2020). The amount of risk any investor is ready to take, the kind of securities in which he may be interested in, as some of the investors may be more interested in Shariah-compliant stocks, etc. (Zaimović et al., 2020; Akguc & Al Rahahleh, 2021). Similarly, some of the investors might be interested in building a clean, environment-friendly, and carbon-free portfolio assuming it as their corporate social responsibility or due to some fear of future loss arising from the ban on environment hampering companies that might not be following ESG requirements (Chaudhry et al., 2021).

In the evolution of the investment process, various efforts have been made to make investing socially responsible (Chatzitheodorou et al., 2019; García-Sánchez & García-Sánchez, 2020; Barauskaite & Streimikiene, 2021). Sustainable investing is a part of this evolution of investing which demands investment activities to be aligned in such a way to ensure they could be beneficial for all or at least could avoid harmful impact to the stakeholders which makes it important to incorporate material ESG factors (Kölbel et al., 2020; Widyawati, 2020).

The impact of climate change has an obvious growing impact on the economies and financial markets (Louche, 2019; Goodell, 2020; Stroebel & Wurgler, 2021). The estimates on the cost of climate don't give a healthy picture and are of a wide range. The estimated costs due to climate change in the USA has been estimated to be US\$4.0 trillion and the estimate of such costs on saving from such changes or adapting to such climate changes in underdeveloped countries could go from \$280 to \$500 billion per year by 2050 (Orsagh, 2020).

The increasing awareness about ESG has pushed the world towards becoming environmentally more responsible (Mavlutova et al., 2021; Sciarelli et al., 2021). The investors are required by the Principles of Responsible Investment (PRI) given by UNO to incorporate ESG issues into the investment analysis and decision-making process (Sloggett, 2016).

The studies in developed countries have shown that a manager can successfully create a significantly carbon-free portfolio (from 30%–40%) due to the skewed nature of corporate carbon emissions without bringing material impact on the expected risk and return profile (Furdak & Wee, 2020). However, in the PSX environment, there is still a need to conduct a study in which the effect of Carbon footprints on PSX member companies' performance may be measured. There is a need to find out if fund managers can offer a carbon-free portfolio to CSR and ESG conscious investors.

The planet earth is a habitat (Ross, 2010) of so many types of living things that maintain the balance of the echo system. The balanced ecosystem has led us to the present world where we have an abundance of resources for all if fairly used and distributed. Presently even after a tremendous increase in population, the man has remained successful in fulfilling the needs of the population. Increased development activities and industrialization has started hampering the balance of the echo system resulting in pollution of air, water and soil.

We are facing problems like smog (Elsom, 2014), deteriorating air and water quality index which eventually hamper the health of the masses. The greed of minting money and unawareness has become a hindrance on the way of spending resources on preventive measures as well as of taking corrective measures. Increased

awareness and the world's attention towards giving a sustainable living place for the next generations has paved the way for becoming socially more responsible. UN is creating awareness among people and enforcing governments of the world to become responsible in seven areas identified. Among these seven controls, carbon emission is one of the most important requirements.

Investment managers have increasing demand from investors for perusing ESG objectives due to increased awareness of CSR on one side and international pressure for achieving benchmark ESG levels as per international communities' demands and regulations (Sloggett, 2016). The countries like China have seen much pressure and faced trade barriers due to excessive carbon-emitting factories. Corporate carbon output profiling is not a choice but an obligation that can be achieved by using simple constraints in portfolio construction. In recent times due to smoke emission and SMOG issues government in Pakistan closed some of the industrial units and brick kilns in Pakistan. This type of scenario where GHG emissions can lead to the closure of businesses and eventually impact profitability, returns and reputation of such companies is not at all acceptable for investors. Similarly, we may see a trade embargo on some of the countries and on some of the companies due to excessive Co<sub>2</sub> emission. The regulatory requirements from UN and state regulators, restrictions from many developed countries and stakeholders' pressure for ensuring sustainable development and corporate social responsibility pushes businesses to become ESG compliant. This study is aimed at identifying and suggesting possibilities of sustainable investing in a carbon-free portfolio.

The study will not only help us in achieving regulatory requirements but would also help us win the confidence of the investors who are keen to see a carbon-free portfolio or in other words want to ensure environment-friendly industries. These environment-friendly industries would eventually lead to a healthier and cleaner environment for our next generations. The decreased pollution would also decrease smog type of hazardous weather conditions. Pollution has long been discussed as a problem for society and every production unit is adding to it but practical steps towards eliminating carbon footprints are hardly taken (Yadav, 2022). Green House gases Emission has become a major global issue because of human activities pertaining to energy production and supply, manufacturing, transportation, communities, and waste. All these show their effects on climate which in turn impacts humans and the environment. Land erosion and reduction in forests also add to pollution by reducing the ability to handle GHG emissions. Resultantly we are facing problems like SMOG in our cities. Daily carbon emission from factories kilns and motor vehicles has increased the temperature of the atmosphere and creating health issues (von Hinke, 2022).

The need of working for Sustainable development was first time recognized by the world in 2002 in the World Summit held in Johannesburg which emphasized the need and importance of eliminating unsustainable patterns of production as well as consumption (UNGA, 2002). The United Nations Global Compact resolved in December 2015 was aimed at encouraging businesses worldwide to adopt socially responsible and sustainable policies. These Sustainable Development Goals (SDG) has paved way for 2030 Sustainable Development agenda which is the reflection of global commitment to bring back balance between social, environmental and development activities (Mensah, 2019; Montesano et al., 2021).

Carbon Budgeting is a commonly used term worldwide and explained as carbon budget, emissions budget, emissions quota, or allowable emissions, which is an upper limit of total carbon dioxide emissions associated with remaining below a specific global average temperature (Pearce, 2014). In Finance Carbon Budgeting Term is used at various places i.e in a case study published in CFA institute (Furdak & Wee, 2020). The study would help emphasize the carbon-free portfolios by giving them preference over the dirty portfolios. We would be able to analyse the impact of carbon budgeting trying to reach better options in terms of returns and remaining socially responsible in terms of ESG compliance.

## METHODS

The KSE 100 index would be used as the pool of stocks for analysis purposes. PSX has 540 listed companies with a market capitalization of PKR 8.3 trillion (CEIC, 2021). With the initiative of OBOR in 2014 and in the context of CPEC the 40% shares of PSX are transferred to the Chinese consortium for strategic alliance after the competitive bidding process. On a positive note, so far, the market witnessed higher liquidity, less excessive volatility, and better returns for investors in the post-merger period compared to the pre-merger period (Sharif, 2017). Out of KSE 100 stocks those companies, mainly the service sector, which are not subject to direct GHG emission have been eliminated as studies have shown that service sector is more concerned with social performance while manufacturing is more concerned with environmental protection (Nurim & Asmara, 2019). Further, those companies which do not have sustainability reports and do not publish assurance statements are also eliminated to reach companies with carbon data availability. The companies which have defined ESG goals and declarations as per UN requirements have been considered as non-compliant and placed in the non-compliant list. Those companies which have defined ESG goals and work for the reduction of carbon footprints are placed in the compliant category.

The daily closing prices data of 72 companies' stocks over the 10 years, a total of 262,800 stock prices were analyzed for the calculation of return and analysis of portfolios. The time span of stocks selection for the purpose of valuation and analysis of the optimization model used was 10 years i.e., from 1<sup>st</sup> July 2011 to 30<sup>th</sup> June 2021.

There is a total of 20 companies that are ESG compliant so a portfolio of 100% ESG compliant companies can only be made with 20 companies. Therefore, the size of the portfolio has been fixed at 20 companies to get mutually comparable results.

The log returns have been calculated for all the stocks and the best-performing stocks thus selected are filtered through carbon budgeting. Resultantly we got two sets of stocks: 1) Those who had better returns as compared to other stocks; 2) Those who were compliant in terms of ESG compliance and reduction of carbon footprints.

The daily returns have been used to reach yearly returns of selected stocks and have been calculated by following the methodology of (Biglova et al., 2004)

$$\text{Returns} = \ln \left( \frac{P_{it}}{P_{it-1}} \right) \quad (1)$$

i.e.,  $\ln(\text{Current stock price/Previous stock price})$

Beta was calculated for each selected stock on the above-mentioned parameters. The beta can be calculated by regression and slope function but here the same is calculated using the inbuilt slope function in Ms. Excel. The risk-free rate is taken from T Bill Rates at the end of the selected period. For Market Return KSE 100 index performance is considered. Portfolios with 100% compliant stocks, 75% compliant stocks, 50% compliant stocks, 25% compliant stocks have been formed. Then we calculated Returns for the selected portfolios formed based on carbon data. We further calculated Weighted Average Returns by assigning equal weights to the stocks, Standard Deviation, Variance, Sharp Ratio, Treynor Ratio to calculate risk and return associated with derived portfolios.

The research methods use comparative analysis as well as the quantitative analysis of Pakistan-based (100 Index) companies that are listed in the stock exchange and carry Carbon Data. It is a Longitudinal study for portfolio performance and a Cross-Sectional Study for carbon budgeting and the purpose of the study is

evaluating returns using Equal Weighted Returns, Beta, SD, Variance, Sharpe ratio, Treynor Ratio. This is a Minimal and Non-contrived study collecting data from the website of PSX and related companies, Yahoo Finance.

## RESULTS & DISCUSSIONS

The current study examined stock returns of KSE 100 stocks of 10 years from July 2011 to July 2021. Out of these 100 KSE stocks service sector was eliminated at the first stage due to the non-presence of direct GHG emission. Resultantly 72 stocks were left for analysis purposes.

The KSE 100 index service sector was eliminated as it is not involved in stage 1 emissions. Out of the remaining 72 stocks, 20 stocks were found ESG compliant and had sustainability reports as well as some GHG emission reduction goals in it and were found working were segregated. Daily Log returns were calculated for these stocks to reach the average return of each stock for 10 years. The standard deviation of each stock and beta of each stock is calculated of the remaining 72 companies including 20 companies who were identified applying carbon budget and returns of such companies were calculated along with calculating returns of 20 best-performing stocks.

**Table 1 List of ESG Compliant Companies in KSC 100 Index**

SR	Company Name	GHG Emission Target/ Achievement
1	Atlas Honda Limited	Emission Reduction 826 Tons Declared in Sustainability Report
2	Colgate-Palmolive (Pak) Ltd.	Assurance of 187,700 metric tons of emission. Presently 38 % reduction from 2002
3	Engro Corporation Limited	25 % Reduction in GHG in 2019-2020
4	Engro Polymer & Chem. Ltd	25 % Reduction in GHG in 2019-2020
5	Fauji Cement Company Limited	Annual Reduction of DGG Emission by 50,000 tons
6	Fauji Fertilizer Bin Qasim Ltd.	GHG emissions increased by 1% due to an increase in production.
7	Fauji Fertilizer Company Ltd.	GHG emissions increased by 1% due to an increase in production.
8	GlaxoSmithKline Pak Ltd.	Emission Reduction from 892 in 2014 to 773 in 2020
9	Honda Atlas Cars (Pak) Ltd.	1% Reduction as mentioned in Sustainability Report
10	ICI Pakistan Limited	Targeting at a reduction from 845720 in 2019-2020 to 800,000 in 2020-2021 inc. in Sustainability Report
11	Indus Motor Company Ltd.	Emission 12989 Metric Ton -Decreased by 47% in last year
12	Nestle Pakistan Limited	14.9 % Reduction in Emission from 2010
13	Packages Limited	Reduced more than 50% co2 Emission per ton of Production
14	Shell Pakistan Limited	2-3% by 2021 by 3-4% by 2022 by 6-8 20 20% by 2030 by 45% by 2035* by 100% by 2050
15	Feroze1888 Mills Limited	Reduced co2 by 15000 tons
16	Frieslandcampina Engro Pak. Ltd	25 % Reduction in GHG in 2019-2020
17	K-Electr*ic Limited	13858 MT reduction in co2 since 2016
18	Engro Fertilizers Limited	25 % reduction in GHG in 2019-2020
19	GlaxoSmithKline Consumer Healthcare	Sustainability report commits Net Zero impact climate by 2030.
20	Interloop Limited	Sustainability Report show 2% Reduction in Emission in last year



There are a total of 20 companies that are ESG compliant so a portfolio of 100% ESG compliant companies can only be made with 20 companies (Table 1). Therefore, the size of the portfolio has been fixed at 20 companies to get mutually comparable results.

The portfolios formed for analysis purposes include four portfolios: a) The best performing portfolio comprising of 20 stocks with the best returns which may or may not include ESG compliant stocks. The portfolio thus formed constituted 25% compliant and 75% non-compliant stocks; b) The 100% compliant portfolio comprises of stocks that are ESG compliant; c) 50% non-compliant portfolio which consists of 50% ESG compliant and 50% non-compliant stocks and was given the best results in their category; d) 25% non-compliant portfolio which consists of 25% non-compliant and 75% compliant stocks; e) The fifth category of 25% compliant portfolio has purposefully been dropped because the best performing portfolio is 25% compliant.

The analysis has been done calculating Weighted Average Returns, Standard Deviation, Variance, Sharp Ratio, Portfolio Beta and Treynor Ratio (Table 2). The objective of all these calculations was to evaluate results not only with respect to returns but also incorporating risk factors associated with these returns as well.

We can maintain ESG compliant portfolio of 25% contrary to the US environment where in a similar study in the US concluded that a manager can successfully create a significant carbon-free portfolio (from 30%–40%) due to the skewed nature of corporate carbon emissions without bringing material impact on expected risk and return profile (Furdak & Wee, 2020).

**Table 2 Comparative Analysis of Portfolio's on The Basis of 10 Years Returns**

<b>Weighted Average Returns</b>				
	<b>Best Performing Portfolio</b>	<b>50% Non Comp Portfolio</b>	<b>25% Non Comp Portfolio</b>	<b>100% ESG Comp Portfolio</b>
Portfolio Returns	35.4423	30.5361	16.6753	4.5372
SD	0.0284	0.0277	0.0278	0.0258
Variance	0.0011	0.0010	0.0010	0.0009
Sharp Ratio	13.8258	13.4891	10.0852	4.3881
Portfolio Beta	0.0687	0.0711	0.1286	0.2944
Treynor Ratio	12.2250	10.2481	6.8609	-0.7933

Returns with four combinations of compliant and non-compliant stocks have been studied and is concluded that returns decreased with the addition of compliant stocks but we can see that while compromising on almost 3 % profit we can maintain a 50% compliant portfolio. The best-performing stocks give a return of 35.4423 while 50% non-compliant stock gives a return of 30.5361 and 25% non-compliant stock gives a return of 16.6753 and 100% compliant stock further reduces returns to 4.5372. Standard Deviation remained almost the same for all the combinations of portfolios under consideration. The variance remained almost the same for all the combinations of portfolios under consideration. The Sharp ratio is positive and quite high for performing portfolios (13.8258 for best-performing stocks and 13.4891 for 50% compliant stocks) but decreased with the decrease in returns which are in turn driven by ESG compliance. This shows that the best performing portfolio and 50 % compliant portfolio are well risk-adjusted portfolios. Portfolio beta for lesser return portfolios is higher and vice versa. The high value of ratio shows that stocks are not an easy subject to volatilities and Treynor Ratio of portfolios show that they are easy subject to volatilities. While studying portfolio returns, Sharp ratios all other

indicators bring us to the conclusion that portfolio performance of ESG compliant portfolio is presently lesser as compared to non-Compliant Portfolio in PSX. However, the combination of both yielded varied results.

It has been observed that if investors want to maintain a compliant portfolio, they can ensure almost similar returns by adding 50% compliant and the same amount of non-compliant stocks in their portfolio. Reduction in compliant stocks in the portfolio improves returns and vice versa. A similar study in the US market concluded that a manager can successfully create a significant carbon-free portfolio (from 30%–40%) due to the skewed nature of corporate carbon emissions without bringing material impact on expected risk and return profile (Furdak & Wee, 2020). In PSX significantly greener portfolio compromising about 3% of the returns at 50% compliance as is presently appearing from the results. The results could further improve with the passage of time due to increased awareness and implementation of sustainability policy. The results would also improve if the environmental protections were properly propagated as environmental reporting improves profitability (Zamil & Hassan, 2019; Nuskiya et al., 2021).

The increasing level of pollution urges us to take immediate corrective measures and impose restrictions, ensuring a mechanism for measurement and control of carbon emission (Huang et al., 2021). We need to enhance awareness in the public for becoming environmentally friendly and take necessary measures by providing tax rebates to environment-friendly producers, users, and investors (Huong et al., 2021).

The government should take necessary measures to promote green financing and sustainable investments (Cui et al., 2020; Falcone, 2020). The installation of green energy units in factories and for domestic use should be encouraged. The factories and industrial units should be moved away from cities so that the public may remain safe from environmental hazards. The government should provide subsidies on the import of solar panels, environmentally friendly machinery, electrical cars, and smoke detecting and controlling machines so that necessary environment-friendly infrastructure could be established.

There is still a gap available to conduct the same study based on future returns as the present study has taken into account only the historic data. Portfolio optimization can also be done by incorporating carbon budgeting constraints. We may also try a similar study incorporating the remaining six sustainability goals given by the UN, especially the female empowerment and corruption.

## CONCLUSION

Sustainability has become the requirement of today's world as we have already suffered from a lot of deterioration. The polluted water and air and emergence of SMOG are hampering the health of us all. We know want sustainable growth to provide next generations with the same world if not better. The control of GHG emission is one of the most important aspects of controlling environmental pollution along with many other factors. Sustainable investing is the drive of the UN for encouraging investors to invest in stocks which are environmentally friendly. Corporate social responsibility requires investors to look for investment options which could yield equally good results while taking care of the environment. This study has tried to provide the solution to the investors to maintain almost the same returns while remaining more environmentally conscious and responsible. The study has tried different combinations of ESG compliant and non-compliant stocks to suggest some better option to the investors. From the calculations, we may conclude that at present in the PSX environment 100% non-compliant and 100% Compliant stocks do not form the best portfolio. The best portfolio is maintained with 25% compliant stocks as the best performing portfolio calculated contains 15 non-compliant and 5 compliant stocks. However, it has been observed that by losing only about 3% of the profit we can maintain a 50% compliant portfolio in the present PSX environment. This minor proportion of profit can be compromised

by the investors for the greater good of humans and they can still win back this profit by propagating their contribution towards society. To conclude we can say that a 50% ESG compliant portfolio can be maintained in PSX environment without bringing material loss to the investors.

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