UNIL | Université de Lausanne
HEC Lausanne

Sustainable Aware Asset Management

Asset Allocation with a Carbon Objective
North America - Scope 1 & 2

Master of Science in Finance

2023-2024

Group A:

Dorentin Morina

Shpetim Tafili

Contents

Introduction

Given the sustainability challenges affecting all industries, the financial investment sector is undergoing significant transformation. Investors and asset managers increasingly recognize the importance of incorporating environmental impact into their decision-making processes. As a result, asset management is evolving to prioritize not only financial returns but also the sustainability of investments.

This paper undergoes an asset allocation with specific carbon constraints. In the first part of the project, we will build a portfolio based on the mean-variance criterion using data from the MSCI World Index, focusing on North American companies. The second part involves integrating a 50% reduction in carbon emissions into the portfolio, according to Scope 1 and Scope 2 classifications. These classifications, used in greenhouse gas (GHG) accounting, identify a company's carbon emissions sources and are part of the Greenhouse Gas Protocol, a widely used international standard for measuring and managing emissions. Finally, we will conduct an asset allocation with a zero-emission objective.

Scope 1 refers to direct GHG emissions produced by a company and its controlled entities.

Scope 2 refers to indirect GHG emissions resulting from the generation of purchased energy consumed by the company. These emissions physically occur at the facility where the energy is produced.

1 Standard Asset Allocation

This part of the project focuses on constructing a Minimum Variance Portfolio. The objective is to optimize asset allocation based on past performance data by applying the principles of Markowitz's portfolio theory. An out-of-sample metholodogy is used in order to ensure that the strategy's performance is robust and not overly optimized to past data, thereby providing a more realistic assessment of its effectiveness in future, unseen market conditions.

1.1 Minimum Variance Computation

The initial sample used for our optimization consists of observations from the six-year period starting on January 1, 2000, and ending on December 31, 2005. This sample is used to compute the expected return $\hat{\mu}_{Y+1}$, which is then used to compute the covariance matrix Σ_{Y+1}. Finally, the covariance matrix is utilized to compute the volatility, which serves as our objective function to minimize. This minimization yields the optimal portfolio allocation for the year 2006.

$$\begin{aligned}
&\min_{\{\alpha_Y\}} && \sigma^2_{p,Y+1} = \alpha'_Y \Sigma_{Y+1} \alpha_Y \\
&\text{s.t.} && \alpha'_Y e = 1 \\
&\text{s.t.} && \alpha_{i,Y} \geq 0 \quad \text{for all } i
\end{aligned}$$

With

$$\Sigma_{Y+1} = \frac{1}{\tau} \sum_{k=0}^{\tau-1} (R_{t-k} - \hat{\mu}_{Y+1})'(R_{t-k} - \hat{\mu}_{Y+1})$$

Where

$$\hat{\mu}_{Y+1} = \frac{1}{\tau} \sum_{k=0}^{\tau-1} R_{t-k}$$

The two constraints applied to our minimization were the full investment constraint, requiring the sum of weights to equal 1 to invest the entirety of our budget in stocks, and the ”long only” constraint, enforcing weights to be greater than or equal to 0 to exclude short selling within our portfolio.

This same procedure was applied to the remaining data with a 1-year rolling window, which gave us the weights from 2006 to 2022. In Table 1, an example of the 10 largest weights is showcased for 2006.

Company	**Sector**	**Weights**	**Tons CO_2/million revenue**
HERSHEY	Consumer Staples	8.08%	95.5621
SOUTHERN	Utilities	5.76%	10,108.3877
MEDTRONIC	Health Care	5.44%	25.5365
BLACKROCK	Financials	5.29%	9.3395
VALHI	Materials	4.18%	770.3722
PUBLIC STORAGE	Real Estate	3.96%	188.5931
LOCKHEED MARTIN	Industrials	3.55%	35.0251
PROCTER & GAMBLE	Consumer Staples	3.40%	82.4752
AGNICO-EAGLE MNS. (NYS)	Materials	3.38%	600.3913
IMPERIAL OIL	Energy	3.31%	491.6066

Table 1: Sector, Weights and tons CO_2/mln rev of the 10 largest positions in 2006

1.1.1 Ex-Post Performance Allocation

The next step was to assess the effectiveness of our portfolio by computing its performance. An ex-post perspective was used, as it allows for an evaluation of how well a portfolio has performed in actual market conditions, providing insights into its effectiveness and enabling adjustments or improvements for future decision-making.

The first step involved calculating the alphas. Indeed, the weights of our portfolio cannot remain static throughout the year; they are constantly adjusted based on the performance of each stock. A stock yielding high returns will consequently increase its weight in the portfolio due to its augmented value, whereas an underperforming stock will witness a reduction in its weight.

$$\alpha_{i,t+k-1} = \alpha_{i,t+k-2} \cdot \frac{1 + R_{i,t+k-1}}{1 + R_{p,t+k-1}}$$

$$R_{p,t+k} = \alpha'_{t+k-1} R_{t+k}$$

After computing all the intermediate weights, referred to as alphas, they were utilized to determine our portfolio's ex-post performance. We now have a time series of ex post portfolio return.

Date	Performance
2006-01-31	0.0304
2006-02-28	0.0200
2006-03-31	0.0200
...	...
2022-10-31	0.0900
2022-11-30	0.0313
2022-12-31	-0.0506

Table 2: First three and last three rows of the performance table

1.1.2 Characteristic of the Portfolio

Assessing the effectiveness of an investment strategy provides insightful information, such as its performance and exposure to risk, among other factors.

Computing the annualized average return is crucial to rigorously evaluate the performance of the portfolio over an extended period and also to compare it with other portfolios. To determine it, we use the following formula:

$$R_p^{(m)} = \frac{1}{T}\sum_{t=1}^{T} R_{p,t}$$

$$R_p^{(y)} = 12 \times R_p^{(m)}$$

$R_p^{(m)}$ represents the monthly return and $R_p^{(y)}$ the yearly return. This method ensures that the return is compounded over the year, accurately measuring the portfolio's performance. The result of the annualized average return of the portfolio is 10.1151% per year.

The annual volatility allows us to evaluate the risk associated with the portfolio's returns and is also important for comparisons with other portfolios. We applied the following formulas to compute the monthly and yearly volatility ratios, which we converted to percentages. This resulted in an annual volatility of 12.3384%.

$$\sigma_p^{(m)} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(R_{p,t} - R_{p,m})^2}$$

$$\sigma_p^{(y)} = \sqrt{12} \times \sigma_p^{(m)}$$

Another important metric we calculated is the Sharpe Ratio, which serves as an important indicator of the return on risk. The Sharp Ratio allows investors to understand how much additional return they are receiving for the extra volatility they are exposed to. A higher Sharpe Ratio indicates a more favorable risk-adjusted return. By using this measure, we can more effectively compare the performance of our portfolio against others, as it standardizes returns by the level of risk taken. The monthly Sharpe Ratio is calculated and then converted to an annual Sharpe Ratio. Our calculation yielded an annualized Sharpe Ratio of approximately 0.7340.

$$SR_p^{(m)} = \frac{\overline{R}_p^{(m)} - R_f}{\sigma_p^{(m)}} \quad ; \quad SR_p^{(y)} = \sqrt{12} \times SR_p^{(m)}$$

To better understand monthly stock performance, we displayed the data over more than 15 years (from 2006 to 2023). During this period, the minimum monthly return was -15.0350%, and the maximum was 9.7626%. Maximum drawdown is an important metric to monitor when assessing investment performance, as it evaluates the historical maximum loss from peak to trough. In our portfolio, the maximum drawdown was -35.3612%.

Metric	Value
Annualized Average Return	10.1151%
Annualized Volatility	12.3384%
Sharpe Ratio	0.7340
Minimum	-15.0350%
Maximum	9.7626%
Maximum Drawdown	-35.3612%

Table 3: Metrics summary for the Minimum Variance Portfolio

1.2 Value Weighted Portfolio

To be able to benchmark the Minimum Variance Portfolio, the performance of the weighted portfolio is computed as:

$$R_{t+1}^{(vw)} = \sum_{i=1}^{N} w_{i,t} R_{i,t+1}$$

where

$$w_{i,t} = \frac{Cap_{i,t}}{\sum_{j=1}^{N} Cap_{j,t}}$$

The Value-Weighted Portfolio characteristics are compared to the Minimum Variance Portfolio in the following table:

Metric	Portfolio MV	Portfolio VW
Annualized Average Return	10.1151%	10.3492%
Annualized Volatility	12.3384%	15.2565%
Sharpe Ratio	0.7340	0.6776
Minimum	-15.0350%	-16.8004%
Maximum	9.7626%	12.4161%
Maximum Drawdown	-35.3612%	-47.8136%

Table 4: Metrics summary for the portfolios

The Minimum Variance Portfolio has a slightly lower average annual return compared to the Value-Weighted Portfolio. This suggests that on average, the VW portfolio yields a marginally higher return over a year. Also, the annualized volatility is higher for the VW portfolio, leading to a lower sharpe ratio. Furthermore, the minimum and maximum returns are respectively lower and higher in the VW portfolio. These extremes reflect a higher volatility in the benchmark.

The following illustration provides a clear overview of the monthly performance variations throughout the period analyzed:

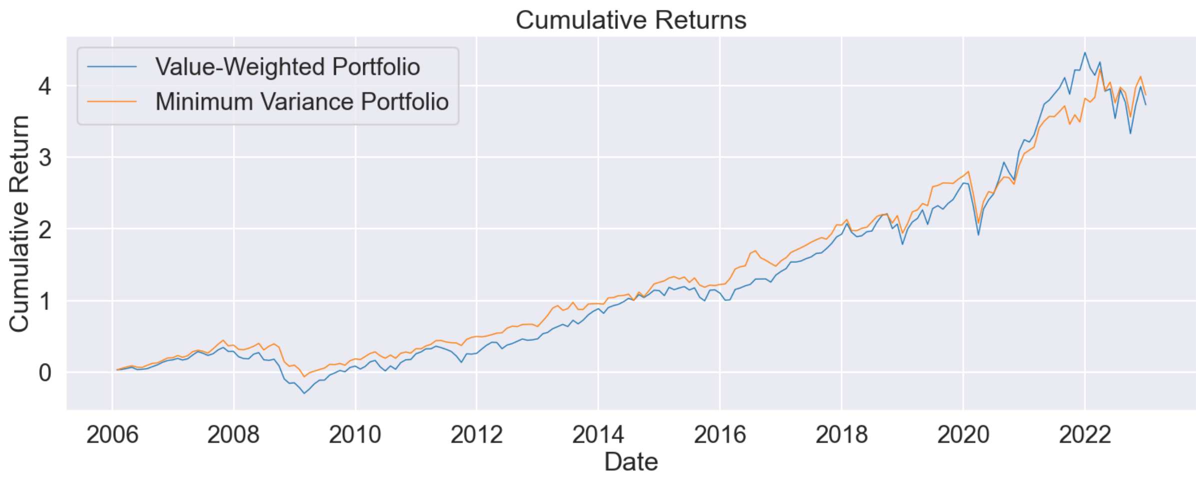


Figure 1: Cumulative return MV VS VW.

The Minimum Variance Portfolio (orange line) and the Value-Weighted Portfolio (blue line) show more or less the same trend over time. However $P_{oos}^{(mv)}$ slightly dominated $P_{oos}^{(vw)}$ until 2020, with an upswing of the cumulative returns of the Value-Weighted Portfolio afterwards.

2 Asset Allocation with a 50% Carbon Emission Reduction

This section of the project focuses on reallocating the portfolio to achieve a 50% reduction in carbon emissions. We will then analyze the changes compared to the carbon unrestricted Minimum Variance Portfolio and the Benchmark Portfolio.

Two main indicators are used to quantify the carbon impact of a portfolio:

- *Carbon Intensity* is a measure of the amount of carbon (in the form of CO2 emissions) released per unit of another variable, such as per dollar of revenue or per unit of energy produced. It is often used to compare the efficiency and environmental impact of different companies or industries. A lower carbon intensity indicates a lower environmental impact per unit of output or activity.

- *Carbon Footprint* refers to the total amount of greenhouse gases emitted by an organization, expressed as carbon dioxide equivalent (CO2e). It includes all relevant Scope 1 and Scope 2 emissions, and can also include Scope 3 emissions, which are indirect emissions from other activities such as the production of purchased goods and services, transportation, and waste disposal.

2.1 Weighted Average Carbon Intensity and Carbon Footprint

The Weighted Average Carbon Intensity (WACI) and the Carbon Footprint of the portfolio are calculated as the annual carbon emissions attributable to the investor per million U.S. dollars invested.

The Weighted Average Carbon Intensity, or WACI, is a metric used to measure the carbon intensity of the portfolio's constituents, weighted by the proportion of the portfolio invested in each firm. According to the formula:

$$WACI_Y^{(p)} = \sum_{i=1}^{N} \alpha_{i,Y} CI_{i,Y}$$

Where $CI_{i,Y}$ is the Carbon Intensity of firm i in year Y.

WACI provides a measure of the carbon emissions efficiency relative to the portfolio's investment in each firm, allowing for a detailed understanding of the portfolio's overall carbon impact per unit of investment.

The carbon footprint of the portfolio is then computed as follows:

$$CF_Y^{(p)} = \frac{1}{V_Y} \sum_{i=1}^{N} o_{i,Y} E_{i,Y}$$

where $o_{i,Y} = \frac{V_{i,Y}}{Cap_{i,Y}}$ measures the fraction of the equity of the firm owned by the portfolio. $V_{i,Y} = \alpha_i V_Y$ is the dollar value invested in firm i, and $V_Y = \sum_{i=1}^{N} V_{i,Y}$ is the total dollar value of the portfolio. The initial investment value V_{Y_0} used in this project to find the carbon footprint is USD 1,000,000.

Year	WACI - P(MV)	Carbon Footprint - P(MV)
2006	721.7339	388.4029
2007	717.8989	381.5121
2008	845.8035	448.4811
2009	909.8906	567.8470
2010	875.5798	552.6135
2011	910.7569	559.8187
2012	833.9214	477.8870
2013	783.6584	427.2612
2014	587.8217	306.4306
2015	517.5881	296.6830
2016	496.0644	263.9579
2017	500.5118	249.3645
2018	412.8067	212.6774
2019	408.6942	241.2334
2020	391.7452	159.2682
2021	252.0571	120.6300
2022	139.0558	51.0035

Table 5: WACI and Carbon Footprint Over the Years

The evolution of the carbon footprint over the years for the minimum variance portfolio shows some interesting trends. Starting in 2006, the carbon footprint was quite high at 388.4029 tons of CO2, likely because the portfolio included stocks from large polluting companies to minimize risk. Over time, the carbon footprint steadily decreases, reaching just 51 tons of CO2 in 2022. This drop suggests that companies with lower carbon emissions have become better investments, naturally fitting into a minimum variance portfolio.

2.2 Optimal Long-Only Portfolio

To construct an optimal long-only portfolio with a carbon footprint 50% below the carbon footprint of the optimal long-only portfolio $P_{\text{oos}}^{(mv)}$, we use the following objective function and constraints:

$$\begin{aligned} \min_{\{\alpha_Y\}} \quad & \sigma^2_{p,Y} = \alpha'_Y \Sigma_{Y+1} \alpha_Y \\ \text{s.t.} \quad & CF_Y^{(p)} \leq 0.5 \times CF_Y^{(P_{\text{oos}}^{(mv)})} \\ \text{s.t.} \quad & \alpha_{i,Y} \geq 0 \quad \text{for all } i \end{aligned}$$

Once the yearly weights of the portfolio $P_{oos}^{(mv)}(0.5)$ with 50% carbon reduction are optimized, they are used to compute the ex post-performances. The ex-post performances are then used to compute the market value Cap_Y as follows:

$$Cap_Y = \text{Initial investment} \times \prod_{m=1}^{Y-1} (1 + R_{p,m})$$

Where $R_{p,m}$ is the ex-post performance of month m. The performance of 2006 will serve to compute the total market value of 2007, and so on. Cap_Y will be useful to compute the carbon footprint ex-post.

The following table shows that the imposition of carbon restrictions has a minimal, but positive impact on most the annualized avereage return which increases by 0.3056% accompanied by a very low increase in volatility. The Sharpe Ratio is better, indicating that the risk-adjusted return is higher for the restricted portfolio. Other metrics, such as the maximum and minimum returns, are respectively higher and lower for the Minimum Variance Portfolio with carbon restrictions. the maximum drawdown is slightly worse for the unrestricted portfolio, with a drawdown of -35.3612% compared to -35.3253%, suggesting that the carbon restrictions may lead to slightly lower potential losses during market downturns.

	Portfolio MV	Portfolio MV(0.5)
Annualized Average Return	10.1151%	10.4207%
Annualized Volatility	12.3384%	12.3845%
Sharpe Ratio	0.7340	0.8414
Minimum	-15.0350%	-15.3694%
Maximum	9.7626%	10.3143%
Maximum Drawdown	-35.3612%	-35.3253%

Table 6: Portfolio MV and Portfolio MV(0.5) Performance Metrics

The cumulative returns graph indicates a slighty better performance of the carbon-restricted portfolio compared to the non-restricted one. The carbon-restricted portfolio (represented by the orange line) consistently follows the non-restricted portfolio (blue line) over the observed period. Despite this slight increase, the overall growth trajectory of both portfolios remains similar. The difference between the two portfolios becomes more pronounced starting from 2020. However, the overall performance trend indicates that the carbon restrictions do not drastically alter the portfolio's growth, highlighting the potential for environmentally conscious investments to achieve competitive returns.

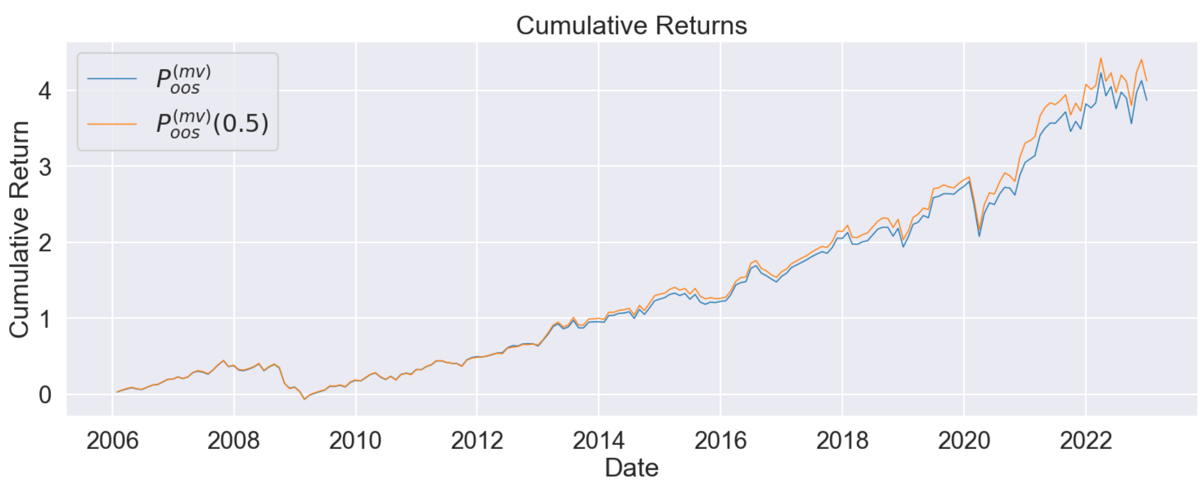


Figure 2: Cumulative Returns Restricted VS Unrestricted

The slight downshift in utilities (Appendix Figure 9) and energy suggest that excluding the highest polluting companies is enough to reduce the carbon footprint without completly changing the sector composition of the portfolio.

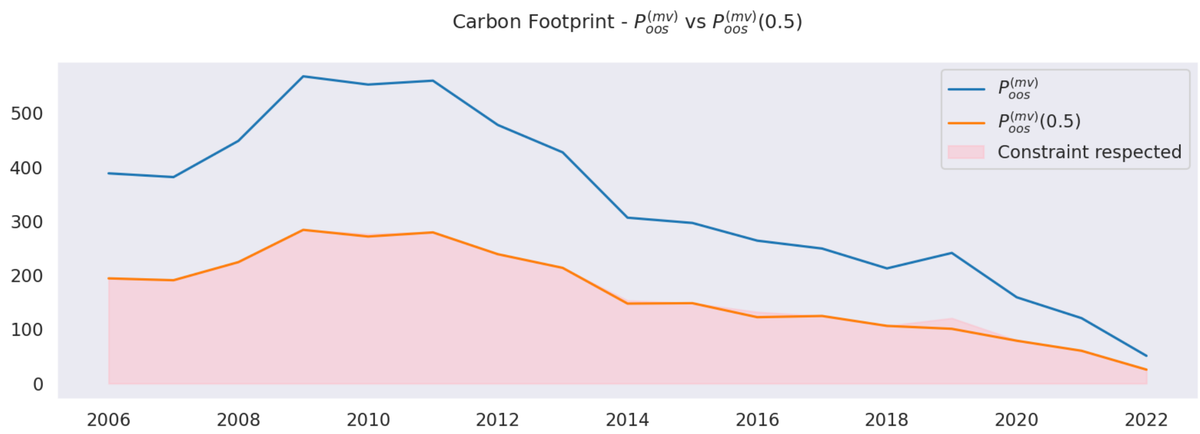


Figure 3: Carbon Footprints Restricted vs Unrestricted

2.3 Maximizing the Minimum Variance for the Tracking Error

Decarbonization of a portfolio can be done differently. Another strategy could be to create a portfolio that closely matches the benchmark portfolio while reducing the carbon footprint by 50%, this portfolio is called $P^{(vw)}_{oos}(0.5)$. This can be done by annually optimizing the portfolio to maximize the criterion of minimum variance in tracking error.

$$\begin{array}{ll} \min_{\{\alpha_Y\}} & (\mathrm{TE}_{p,Y})^2 = (\alpha_Y - \alpha_Y^{(vw)})'\Sigma_{Y+1}(\alpha_Y - \alpha_Y^{(vw)}) \\ \text{s.t.} & \mathrm{CF}_Y^{(p)} \leq 0.5 \times \mathrm{CF}_Y^{(P(vw))} \\ \text{s.t.} & \alpha_{i,Y} \geq 0 \quad \text{for all } i \end{array}$$

Where $\mathrm{CF}_Y^{(P(vw))} = \frac{1}{\mathrm{Cap}_Y} \sum_{i=1}^N E_{i,Y}$ denotes the carbon footprint of the value-weighted portfolio, with $\mathrm{Cap}_Y = \sum_{i=1}^N \mathrm{Cap}_{i,Y}$ the total market value of the investment set.

Once again, the weights of the portfolio are optimized and the ex-post performance are derived. This process is useful as it allows the calculation of the Cap_Y for the computation of the carbon footprint ex-post.

For the Value-Weighted Portfolio, the carbon restrictions appear to have a positive impact on the annualized average return, which increases by 0.2627%. Although the annualized volatility is slightly higher, the Sharpe Ratio shows an improvement in risk-adjusted performance for the restricted portfolio. The maximum and minimum values are lower for the constrained portfolio, while the maximum drawdown is also reduced, suggesting better reaction during downturns. The improved annualized return performance for the value-weighted portfolio may be attributed to a more balanced allocation across sectors, which could enhance stability and growth potential.

	Portfolio VW	Portfolio (VW) 0.5
Annualized Average Return	10.3492%	10.6119%
Annualized Volatility	15.2565%	15.3032%
Sharpe Ratio	0.6776	0.6934
Minimum	-16.8004%	-18.7801%
Maximum	12.4161%	11.8749%
Maximum Drawdown	-47.8036%	-46.9249%

Table 7: Portfolio VW and Portfolio (VW) 0.5 Performance Metrics

The following cumulative returns illustrate the performance comparison between the Value-Weighted Portfolio with and without carbon restrictions. The restricted portfolio (orange line) consistently outperforms the non-restricted portfolio (blue line) over the observed period. Despite this, both portfolios exhibit a similar overall growth trajectory, with the restricted portfolio demonstrating slightly higher gains. The results imply that carbon restrictions can lead to higher cumulative returns, highlighting the viability of incorporating environmental considerations without sacrificing returns in some cases.

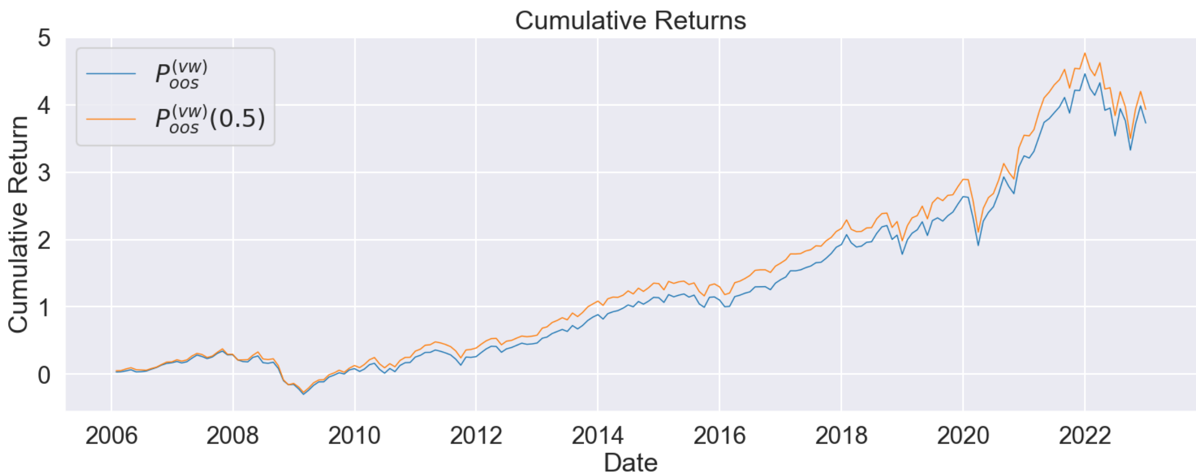


Figure 4: Cumulative Returns Restricted VS Unrestricted

2.4 Trade-off

The trade-off between the financial performances of the portfolios and the carbon footprint is quite easy. In our case, reducing the carbon footprint of both portfolios (Minimum Variance and Value-Weighted) benefits to the performance. Indeed, it slightly increases the annualized average return and the Sharpe Ratio.

	P(MV)	P(MV)(0.5)	P(VW)	P(VW)(0.5)
Annualized Average Return	10.1151%	10.4207%	10.3492%	10.6119
Annualized Volatility	12.3384%	12.3845%	15.2565%	15.3032%
Sharpe Ratio	0.7340	0.8414	0.6776	0.6934
Minimum	-15.0350%	-15.3694%	-16.8004%	-18.7801%
Maximum	9.7626%	10.3143%	12.4161%	11.8749%
Maximum Drawdown	-35.3612%	-35.3253%	-47.8136%	-46.9249%

Table 8: Performance Metrics Comparison

The slight increase in performance while reducing carbon emissions in North America might be due to the significant growth of big tech companies in the region. Since tech companies generally have lower carbon emissions, a strategy that avoids investing in highly polluting firms could naturally lead to a higher allocation in tech companies. This shift not only enhances portfolio performance but also contributes to a lower carbon footprint.

However, the carbon constraint seems to suit better the Minimum Variance Portfolio with a Sharpe Ratio increase of 0.1074, against only 0.0158 for the Value-Weighted Portfolio.

Figure 5 shows the evolution of the carbon footprint for all portfolios. While the carbon footprint is higher for Minimum Variance Portfolios at the beginning, due to lower risks in highly polluting firms, the reduction over the years is abrupt and all the values converges.

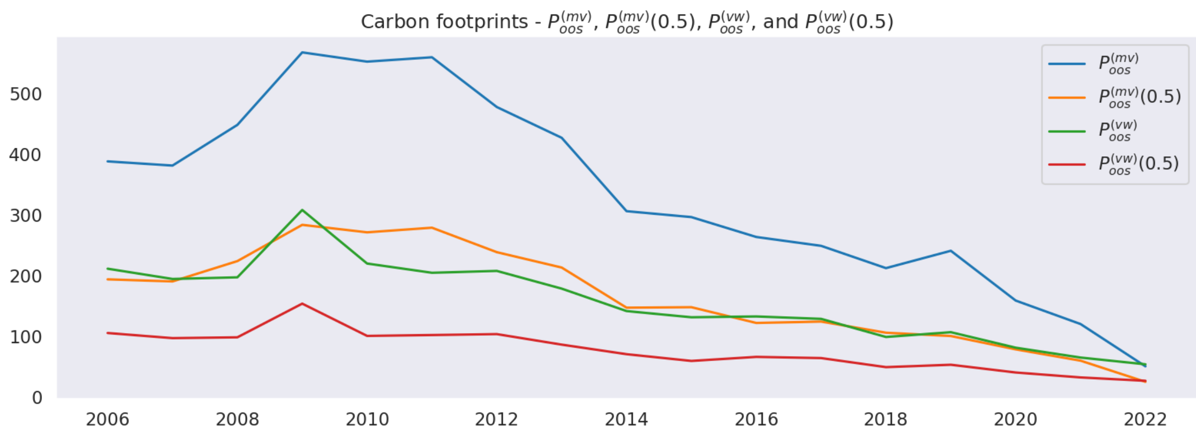


Figure 5: Carbon footprints - $P_{oos}^{(mv)}$, $P_{oos}^{(mv)}(0.5)$, $P_{oos}^{(vw)}$, and $P_{oos}^{(vw)}(0.5)$

3 Allocation with a Net Zero objective

3.1 Net Zero Objective

The final objective of the project is to construct a minimum variance portfolio, while cumulatively reducing its carbon emissions throughout the years. This step encompasses the implementation of a decarbonization strategy where the carbon footprint of the portfolio is reduced by a fixed rate θ=10% annually from December 2005 to December 2021. By adopting the perspective of the otherwise passive investor, we aim to optimize the portfolio under this carbon emission reduction constraint:

$$CF_Y^{(p)} \leq (1-\theta)^{Y-Y_0+1} \times CF_{Y_0}^{(P(vw))}$$

For Y = 2005...2021, with Y_0 = 2005. This constraint ensures a continuous and cumulative reduction of carbon emissions over time.

The Net Zero Portfolio ($P_{oos}^{vw}(NZ)$) is therefore optimized in the same way as in point 2.3, where the tracking error is minimized.

The characteristics of the portfolio exhibit that the net zero portfolio ($P_{oos}^{vw}(NZ)$) achieves an annualized average return very close to the unrestricted and partially restricted portfolios, with a return of 10.4835%. The annualized volatility for the net zero portfolio is marginally higher at 15.4157%, indicating slightly increased risk. The Sharpe Ratio is in the between at 0.6801, reflecting better risk-adjusted returns. While the minimum return is lower at -18.0939%, the maximum return is comparable at 12.1560%. The maximum drawdown is slightly reduced to -48.0909%, suggesting better resilience. Overall, the carbon constraints in the net zero portfolio lead to modest improvements in return and risk-adjusted performance, with minor increases in volatility and drawdown compared to the other portfolios.

	Portfolio VW	Portfolio (VW) 0.5	Portfolio (VW)(NZ)
Annualized Average Return	10.3492%	10.6119%	10.4835%
Annualized Volatility	15.2565%	15.3032%	15.4157%
Sharpe Ratio	0.6776	0.6934	0.6801
Minimum	-16.8004%	-18.7801%	-18.0939%
Maximum	12.4161%	11.8749%	12.1560%
Maximum Drawdown	-47.8136%	-46.9249%	-48.0909%

Table 9: Portfolio VW, Portfolio (VW) 0.5, and Portfolio (VW)(NZ) Performance Metrics

The following graph shows the evolution of the carbon footprint of each portfolio over time. The partially restricted portfolio ($P^{vw}_{oos}(0.5)$) achieves nearly the same carbon footprint reduction as the net zero portfolio ($P^{vw}_{oos}(NZ)$) after 3 to 4 years. This suggests that even partial restrictions on high-carbon investments can be highly effective, providing a flexible and cost-efficient alternative to the net zero approach while achieving similar long-term sustainability goals.

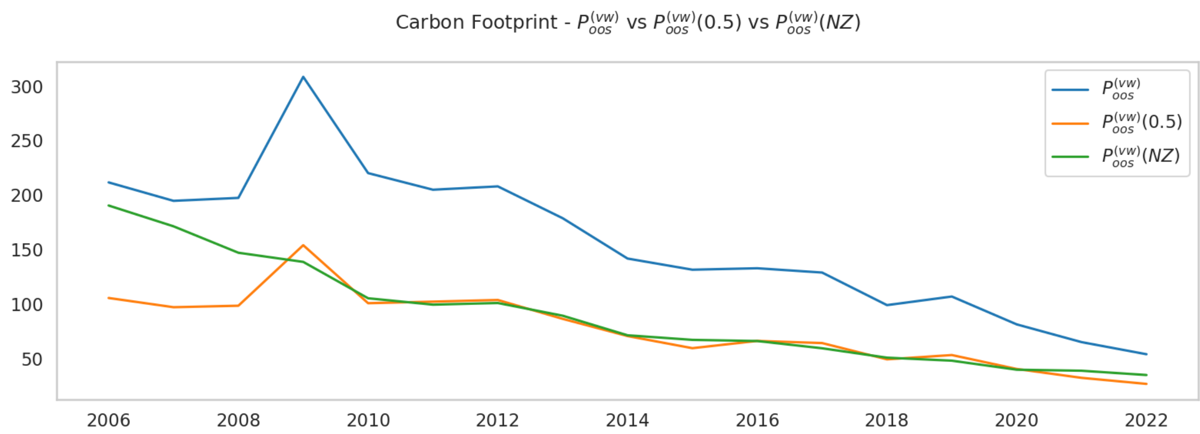


Figure 6: Carbon footprints - P^{vw}_{oos}, $P^{vw}_{oos}(0.5)$, and $P^{vw}_{oos}(NZ)$

3.2 Cumulative performances

The graph shows the cumulative performance of the three portfolios $P^{(vw)}_{oos}$, $P^{(vw)}_{oos}(0.5)$, and $P^{(vw)}_{oos}(NZ)$ from 2006 to 2022. All three portfolios exhibit similar growth patterns. This indicates that the Net Zero Portfolio does not significantly underperform the other portfolios and even outperforms the Value-Weighted Portfolio. Constructing a net zero portfolio might involve additional implementation costs and a different risk profile due to sector-specific exposures. Additionally, the carbon reduction strategy might underrepresent some sectors with the potential for strong performance. As Figure 8 in the appendix on sectors indicates, the most polluting industries have been increasingly excluded over the years, potentially causing missed opportunities for growth. However, these costs and missed opportunities appear to have a minimal impact on the long-term benefits and returns, suggesting that transitioning to a net zero portfolio is a viable and potentially advantageous strategy.

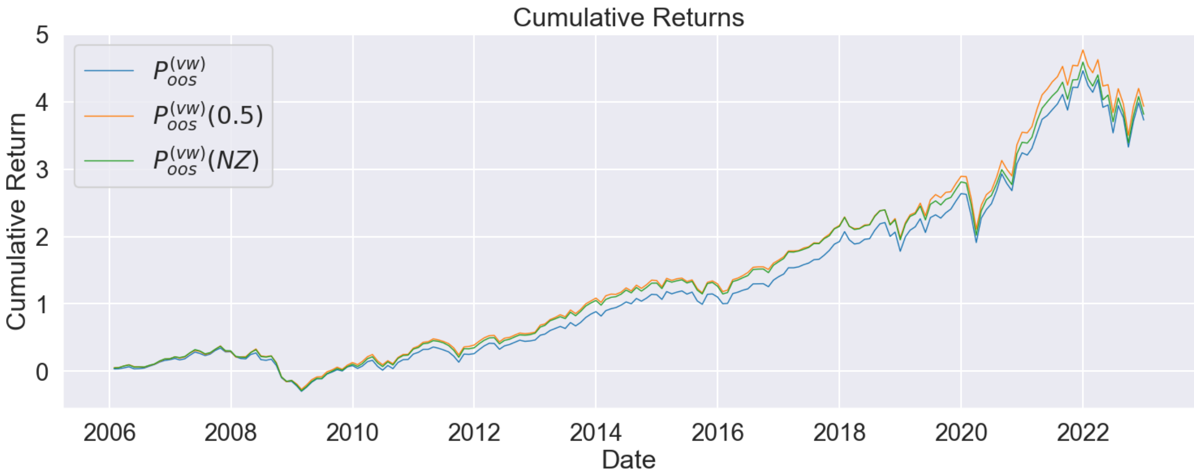


Figure 7: Cumulative Returns of Portfolios

Appendix

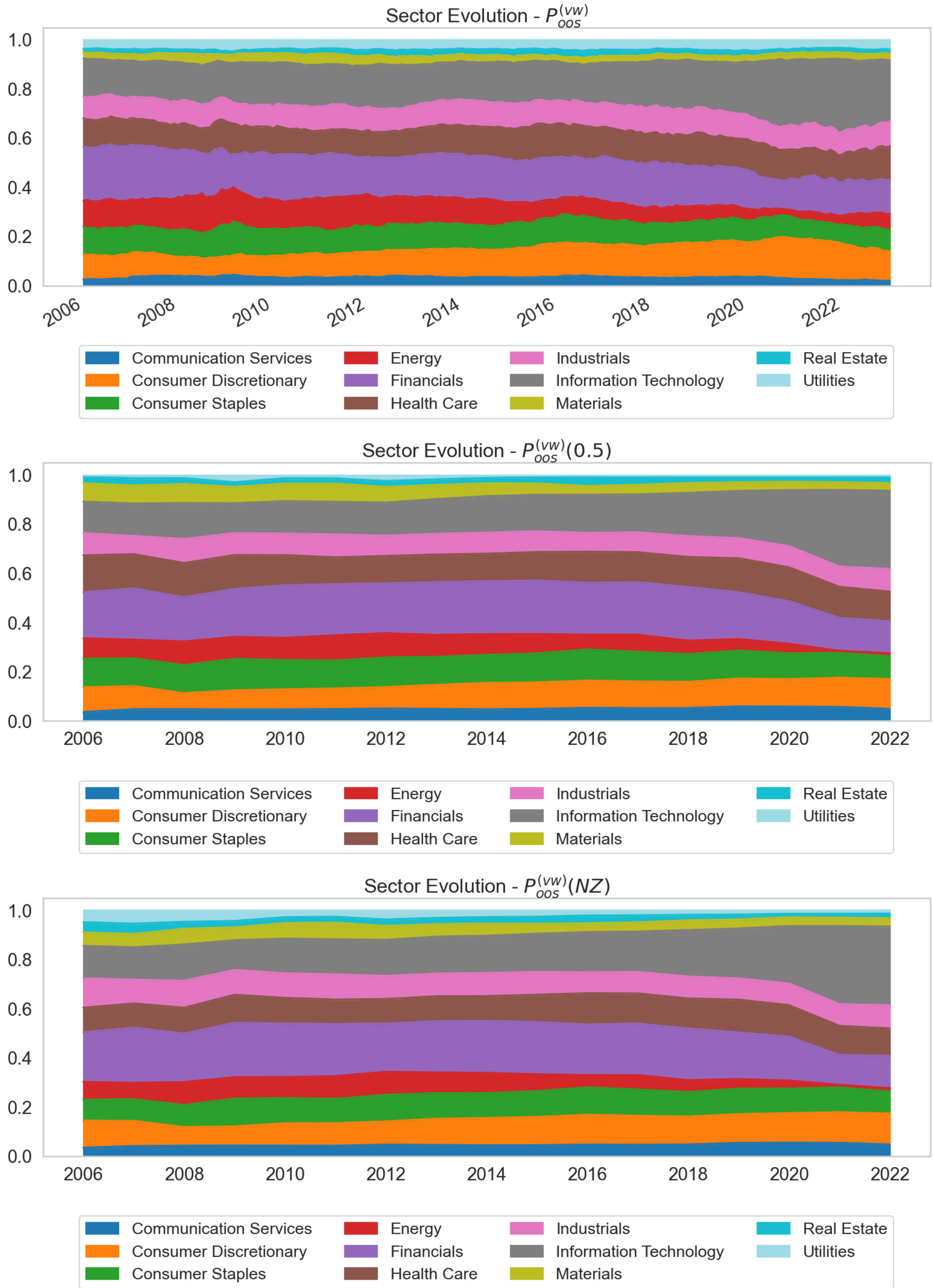
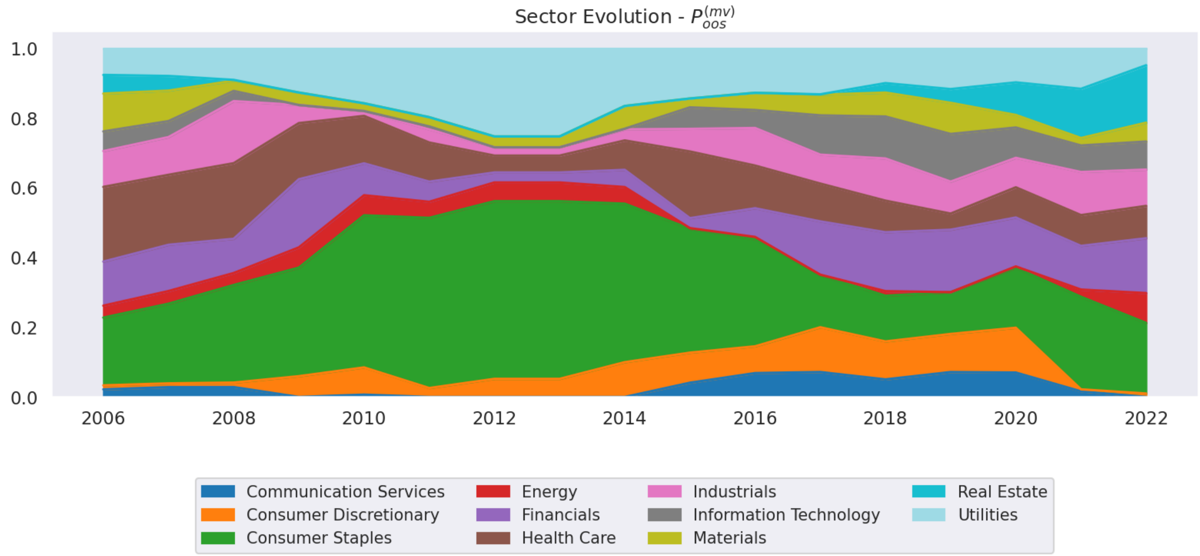


Figure 8: Sectors Evolution - Value Weighted Portfolios



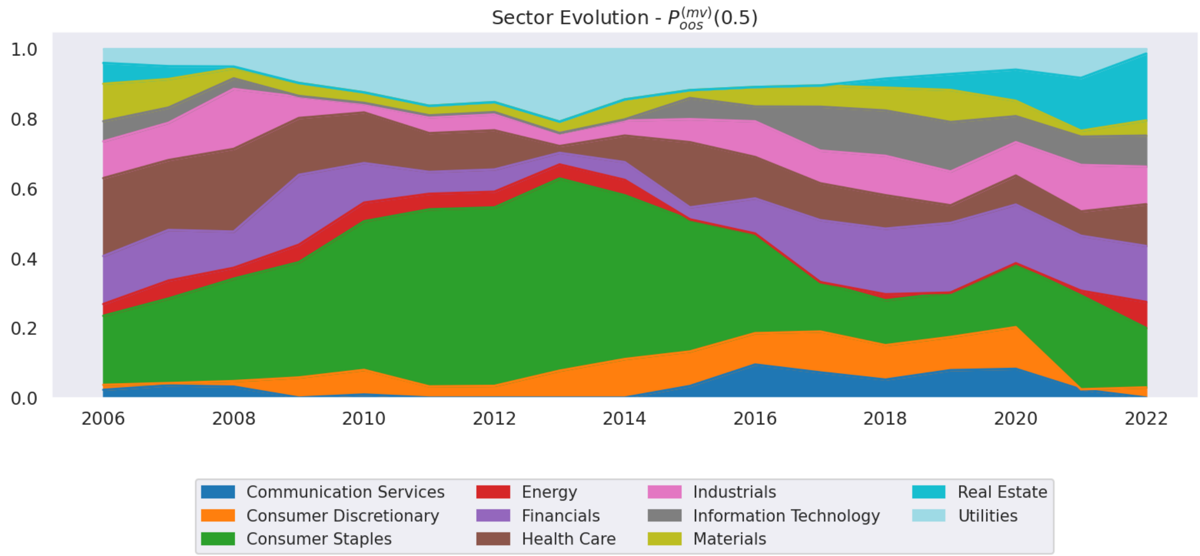


Figure 9: Sectors Evolution - Minimum Variance Portfolios

VW	VW(05)	VW(NZ)
Exxon Mobil - 3.5476%	The Hershey Company - 6.7394%	Merck & Co - 0.9093%
Microsoft - 2.8254%	Medtronic plc - 4.5024%	Verizon Communications - 0.6946%
Citigroup - 2.492%	BlackRock - 3.031%	Microsoft - 0.669%
Walmart - 1.9778%	Procter & Gamble - 2.2251%	AT&T - 0.6479%
Procter & Gamble - 1.9691%	Imperial Oil - 2.2218%	Qualcomm - 0.6095%
Bank of America - 1.8812%	Public Storage - 2.1314%	Pfizer - 0.6037%
Johnson & Johnson - 1.8148%	Markel Group - 2.1061%	Citigroup - 0.5669%
AIG - 1.7976%	Merck & Co - 2.1049%	IBM - 0.5457%
Pfizer - 1.7448%	Valhi - 2.0632%	Intel - 0.5301%
Altria Group - 1.5793%	Lockheed Martin - 2.0454%	AIG - 0.528%

Table 10: Comparison of VW, VW(05), and VW(NZ) Companies 2006

VW	VW(05)	VW(NZ)
Apple - 8.7357%	Apple - 4.2625%	Apple - 3.8477%
Microsoft - 7.602%	Microsoft - 4.0298%	Microsoft - 2.9252%
Amazon.com - 5.0909%	The Hershey Company - 3.5876%	Amazon.com - 2.6949%
NVIDIA - 2.2136%	Amazon.com - 3.4673%	Qualcomm - 1.9449%
UnitedHealth - 1.4238%	Medtronic - 3.0885%	NVIDIA - 1.8303%
JPMorgan Chase - 1.4089%	BlackRock - 2.2606%	Adobe - 1.3963%
Johnson & Johnson - 1.3559%	Merck & Co, 2.0921%	Intel - 1.3144%
Home Depot - 1.3047%	NVIDIA - 1.9624%	Merck & Co - 1.2551%
Walmart - 1.2083%	Procter & Gamble - 1.9553%	Verizon Communications - 1.1072%
Procter & Gamble - 1.1805%	Verizon Communications - 1.6433%	McDonald's - 1.0768%

Table 11: Comparison of VW, VW(05), and VW(NZ) Companies 2022