QARM - Project
Optimal Responsible Investment

CASANOVA Yorik

JOUBLOT-FERRE Marin

SIDIBE Hamadoun

TCHOUGANG Malcolm

UNIL | Université de Lausanne

HEC Lausanne

Contents

List of Figures

1 Abstract

This project analyses the impact of an investor's preference regarding a firm's ESG score on the optimal equity portfolio allocation measured by maximizing the Sharpe ratio. It examines performance of the 30 largest firms by market capitalization of the SP500 from 2004 to 2018 on a monthly basis using a rolling window. A firm's current ESG score is compared to a certain percentile of the top 30 this month in order to set up an optimization constraint depending on how much the investor insists this constraint to be satisfied. The constraint compliance is defined as the weight of assets in percent of the optimal portfolio satisfying the constraint, which can be varied depending on the investor's preferences. A 100% constraint compliance leads to the exclusion of all firms below the percentile in question and thus a portfolio containing only assets which satisfy the ESG constraint. On the other hand a 0% constraint compliance leads to the opposite by excluding all the firms with an ESG score above the average and building a portfolio containing 0% of the assets that satisfy the ESG constraint. The outcome of this analysis shows that ESG investment comes at a cost in terms of risk and return ex ante as well as ex post.

2 Introduction

2.1 Terminology

Sustainable and responsible investing has recently gained a lot of popularity. According to a study by the University of Zurich in 2019 sustainability linked investments in Switzerland have risen by 83% in 2018 alone. Worldwide sustainable investments now make up more than a quarter of all assets under management. Therefore sustainable investing represents a global and serious trend. But what is meant by sustainable investing? The still young terminology already shows some different categorization in definitions. Responsible investing for example is commonly known as filtering financial assets based on the firms behaviour and therefore excluding certain firms. This negative filtering is also called divesting. On the other hand sustainable investing is more focused on positive filtering and selects certain firms based on a best-in-class approach. Impact investing is financially supporting firms with measurable environmental, social or governmental (ESG) goals which provide at the same time positive returns. If returns do not matter at all it is most likely to be categorized as philanthropy or donation. In this project the focus lies on investing based on measurable ESG scores, optimizing the portfolio by a standard mean-variance approach and hence analyzing the impact of ESG constraints on the efficient frontier as well as on the performance of the optimal portfolio.

2.2 ESG Definition

ESG stands for Environmental, Social and Governance. Firms can be individually rated according to these criteria. Environmental criteria cover their CO2 emission, usage of energy, water or other resources, their waste production, etc. On the other hand social criteria are focused on positive contribution to society and a healthy working environment. This includes granting security and health at the workplace, favoring diversity and equality in the workforce and committing locally and globally to responsible action and behaviour. Finally, governance criteria are more related to compliance in the regulatory and legal framework. The independence and diversity of the board members are strongly needed as well as fair, responsible and transparent compensation plans for the management. Other governance criteria are a firm's effort to protect minority shareholders or the integration of ESG goals into their long term strategy. After defining all necessary ESG criteria, a score is attributed to each criterion individually and aggregated

to an overall score. This project is based on these total aggregated scores. ESG scores are not fundamental data and therefore can vary between providers. The difficulty lays in finding a reliable, accurate and unbiased rating. As important as the evaluation of underlying data obviously is, this is not subject of this analysis.

2.3 Objective

This project is based on the paper of Jessen (2012) where she analyzes the trade-off between risk, expected return and responsibility in portfolio allocation. Jessen (2012) assumes a specific utility function to measure the benefit of ESG investing into different indices. For this project however, the ESG constraints are based on actual ESG scores and not on an investor specific utility function. Moreover, this project analyzes the attribution of ESG scores to individual stocks and not on an index level. The objective is, by using stock data and ESG scores for firms, to construct an efficient frontier that includes a concern for environmental, social and governance criteria. Furthermore the performance of both portfolios maximizing the Sharpe ratio i.e. the tangency portfolio, with and without ESG constraint are compared and analyzed.

3 Methodology

3.1 Strategy

By choosing an index and analyzing its components with regard to ESG criteria one could compute an efficient frontier and at the same time having an adequate benchmark. To have an adequate amount of different assets in order to obtain a diversified portfolio the index should at least have about 30 components. But the larger the index and the smaller its components, the more likely it is to have firms with missing ESG ratings. After having selected the index components each asset gets its ESG score attributed. Then different portfolios will be constructed. The reference portfolio does not take into account a firm's ESG rating and is optimized using a standard mean-variance approach by maximizing the sharpe-ratio. In order to integrate ESG scores into the optimization, some constraints have to be set up. One way to do so, is to set a constraint stating that only assets with an ESG score above a certain threshold are taken into account for the portfolio optimization. This is not completely a negative selecting (divesting) approach, because it does not discriminate any sector nor industry as long as the ESG score is high enough. It is also not entirely a best-in-class approach, since again the assets are not selected based on their sector or industry. However, there are some elements of both worlds by discriminating firms without any score at all and preferring those with higher ESG scores. This approach includes a firm's ESG score only and does not take into account any trade-off between the assets expected return (based on historical performance) and its ESG score. The only way to loosen the ESG constraint is by lowering the constraint compliance below 100%. The constraint compliance is defined as the weight of assets in percent of the optimal portfolio satisfying the constraint. The lower the constraint compliance, the less the weight of assets in the portfolio satisfying the ESG constraint. Only by setting the constraint compliance to 100% one is certain not to have any firm with really low ESG scores in the optimal ESG portfolio. In order to compare different optimal equity portfolios by considering ESG factors one needs a risk adjusted measure like the Sharpe ratio.

3.2 Data

The whole data used for this project has been retrieved on a monthly basis from Thomson Reuters. Especially the ESG scores can be very subjective and vary across providers. ESG ratings as well as the market capitalization of the SP500 are analyzed over a period of 15 years from 01.01.2004 to 01.12.2018. For the portfolio optimization a rolling window of 11 years of the SP500 total return index is used from 01.01.1993 to 01.12.2018. The initial covariance matrix is estimated from 01.01.1993 to 31.12.2003 on a monthly return basis. It corresponds to a total number of observations of 3'960 (N*T where N=30 and T=132) and 465 coefficients to be estimated (N*N/2+N/2). This results approximately to 8.5 observations per estimated parameter (N*T/#coefficient). In order to maximize the Sharpe ratio the risk free rate is needed. Since the constructed portfolios are very short term on a monthly basis, the three month US treasury bill yield is taken as proxy over the observation period.

3.3 Implementation

Since broad ESG ratings only came up between 2000 and 2005 the analysis starts in the beginning of 2004. The issue one faces by choosing a small index such as the Dow Jones industrial average is that not all its components have an ESG score attributed and the components themselves remain quite stable over time. Therefore the optimal portfolio with and without ESG constraints would only change if the firms rating change by much, which is usually not the case. In order to make it more dynamic, it has been decided to analyze only the 30 largest firms based on their market capitalization on a monthly basis of the Standard and Poor's 500 index (SP500). This strategy brings one crucial advantage that since it captures the largest firms of the US market they are more likely to be rated with an ESG score beginning in the early years of 2004.

3.4 Portfolio optimization

Once the threshold for ESG scores has been set and the firms to be considered for the portfolio optimization are chosen, the optimal portfolio weights can be computed. The portfolio optimization itself is done in Matlab with the integrated 'Portfolio' function. It follows a standard mean-variance optimization approach by maximizing the Sharpe ratio. Furthermore it allows to vary the level of constraint compliance. Again if the constraint compliance is set to 100%, 100% of the optimal portfolio assets need to satisfy the constraint. Additionally the standard short-selling constraint is set, where no short-selling is allowed.

3.5 Performance analysis

Once the optimal portfolio allocation with and without ESG constraint has been computed, its performance is tested by using an out of sample approach. This means the obtained optimal weights will be applied on the following monthly performance of the respective asset to compute the overall monthly simple portfolio return. The latest month will then become part of the new historic optimization period replacing the oldest one. Repeating this rolling window process over the whole period from 2004 to 2018 leads to a backtest with real data. The assumed monthly rebalancing does not take into account transaction costs and thus is not realistic for actual real world implementation, but leads to a more dynamic strategy for this project. Precisely, in order to compute the performance of the optimal portfolio allocation the matrix of optimal weights is multiplied by the matrix of the individual asset returns (simple) element by element. To break this down to a total portfolio performance per month this matrix is multiplied by a one vector with length of number of assets in the portfolio. This results in the simple (out of sample) portfolio return vector. To obtain the performance over the whole observation period one is

added to each element and the log of it is taken to transform the simple in log returns. Then the sum up the portfolio log returns can be taken to obtain the total portfolio performance at each month by multiplying this vector by an upper triangular matrix with ones. Finally e to the power of these log returns gives the performance at every period in time.

3.6 Issues

3.6.1 Missing ESG scores

This analysis would also be interesting in emerging market economies, since the regulatory framework there is by far not as advanced as in western countries and therefore much bigger differences could be expected. Unfortunately there comes the issue that most of the firms do not provide ESG scores at all even nowadays. By only considering the 30 biggest firms by market capitalization of the SP500 it has been tried to minimize this issue. However, there are still some firms especially in the starting period of the analysis where no ESG score is provided. For simplicity, it has been decided to set their score to zero, because it can be assumed that firms not providing or cooperating with rating agencies are anyways not interested in being ESG compliant. Excluding such firms in both optimizations would bias the top 30 approach and lead to data picking which is not desirable. After all, the issue of penalizing a firm with an overall zero ESG score if not provided or found can be relativised by the fact that it only happens for 9 firms out of the total of 101 in the top 30 over the whole analyzed period and again that such firms might not reach very high scores anyways. Another perspective might be that an investor with ESG preferences will anyways not be willing to invest in firms which do not provide ESG scores. Therefore others get into consideration even if their scores aren't this good, but having a score brings some sort of certainty and thus has to be better than no score at all.

3.6.2 Threshold for consideration in portfolio optimization

How the penalization of firms without ESG scores affects an investor's threshold of deciding which firms are to consider for the portfolio optimization, can be approached in different ways. Clearly, the threshold has to vary in time, since it would not make sense to use the same arbitrary ESG score in 2004 and 2018 for example. Society evolves and so does the overall awareness of such issues like sustainability. An ESG score of 30 might be high in 2004 but not in 2018, since firms should have incentives to improve their scores. Therefore it is better to use a moment or distribution based measure like the average, median or a certain percentile for each month as a threshold which varies over time. Investors might consider certain firms based on ESG scores compared to what is currently available on the market. A simple method would be to use the average ESG score of each month as threshold. By penalizing firms without ESG scores by setting them to zero brings the issue of directly affecting and lowering the threshold for consideration in the portfolio optimization. Intuitively it can be argued that an investor with ESG preferences is more likely to consider any firm providing an ESG score over the ones without and therefore a lower threshold makes sense. Higher order moments like the variance do not make much sense for setting a threshold, because ESG scores tend to remain quite constant over time. An alternative approach to moments would be the monthly empirical distribution using percentiles. This brings the advantage that the penalization of firms without ESG scores has a much lower impact on the threshold. The only assumption made is that firms without ESG scores are below the percentile chosen. This is much more realistic since if firms would be compliant and actually have the potential to score high, they have a strong incentive to cooperate in order to be rated. Another advantage is the investor can be much more picky by assuming he or she only wants to consider firms above the 70% percentile in his or her portfolio

optimization. The drawback of this approach of course is that the amount of assets available for the optimization decreases very fast if the constraint has to make up 100% of the portfolio, which then leads to insufficient diversification. This issue could easily be fixed by increasing the number of firms considered let's say by using the top 40 or 50 instead of only the top 30 of the SP500. However, the more firms are considered, the bigger the covariance matrix and therefore the less observations per estimated parameter one has. This trade-off leads to the need of longer observation periods which are already an issue since the strategy is quite dynamic and there are a lot of firms entering and exiting the market and thus some lacks in historical returns. Another way to fix this is by reducing the ESG constraint compliance weight in the portfolio. If this factor is set to 50%, the firms above the 70th percentile have to make up at least 50% of the portfolio for example.

3.6.3 ESG constraint

As already mentioned above, by applying a minimum ESG score constraint of each asset with regards to the average, median or percentile, obviously not the same amount of assets will be considered for the ESG portfolio optimization. The diversification effect which is usually obtained with a minimum amount of about 30 assets is therefore not present anymore. The issue lays in the comparison of portfolios consisting of different numbers of assets. To compensate this one could loose the ESG compliance restriction. Thus the investor could find himself with firms not compliant at all in his portfolio. In the optimal weights of the regular portfolio optimization, one can observe that the allocation is only in about 8 to 12 different assets. This suggests that by cutting the amount of assets available by 50% with a threshold set at the median, theoretically, it should still be possible to compute the same portfolio as the regular one with respect to the number of assets.

3.6.4 Gaps, Delisted Firms and Mergers

Lacks in historical data have a direct impact on the implementation of the strategy. Over a long time frame corporate actions can lead to difficulties in the consistency of the covariance matrix. Delistings and mergers do not have such a high impact on the covariance matrix, but much more on the ESG score ratings. Because some firms have been delisted or taken over the ESG scores are no longer available. The rolling window used to estimate the covariance matrix contains 11 years of monthly return data (132 observation). The implemented strategy considers only the top 30 of the SP500 by market capitalization and leads to some gaps in the beginning of the rolling window period. Especially in the technology or financial service sector most of today's giants like Visa, Mastercard, Alphabet, Amazon, Netflix, EBay or Facebook were not publicly listed yet. In order to keep the rolling window period constant, the returns of such firms are being set to zero. This might bias the covariance matrix in the sense that more weight is attributed to such firms due to the lack of correlation with other assets. Again there is the trade-off between the length of observation period to prevent this sort of issue and the amount of observations per estimated parameter needed for meaningful results.

3.6.5 Missing month

Due to some connection issues by retrieving our monthly data from Thomson Reuters, it somehow skipped the data of the 01.12.2013 for the market capitalization and the ESG scores. This small issue does not impact the analysis much further since by using a rolling window the error is smoothed out.

3.6.6 Double Listing

Alphabet, the holding entity of Google, has currently two share types 'A' and 'C' listed. This is due to a stock split in 2014. Economically, there is no difference between both share types. The difference is the voting right, while 'A' shares contain a voting right, 'C' shares don't. This leads to the slightly discount of 'C' shares compared to the 'A' shares. Thus the issue lies in having the same entity twice in our top 30 approach and one of both assets becoming redundant. So from 01.05.2014 on, there are infact only 29 different firms considered. Because the impact is only on the last 4 years of the analysis, it has been decided not to intervene and to extend the approach to a top 31 for this period.

4 Results

This section contains only the most important graphics and results for illustration. Since the strategy consists of rebalancing the optimal portfolio each month, the efficient frontier is re-estimated on a monthly basis too. All returns and volatility are on a monthly basis as well. In the following, it is analyzed what the impact on the top 30 portfolio optimization is, by varying the ESG constraint compliance and the percentile of consideration threshold. The focus lies on the impact on an investor's portfolio performance and risk.

4.1 Top 30 and 50th percentile

4.1.1 Efficient frontiers

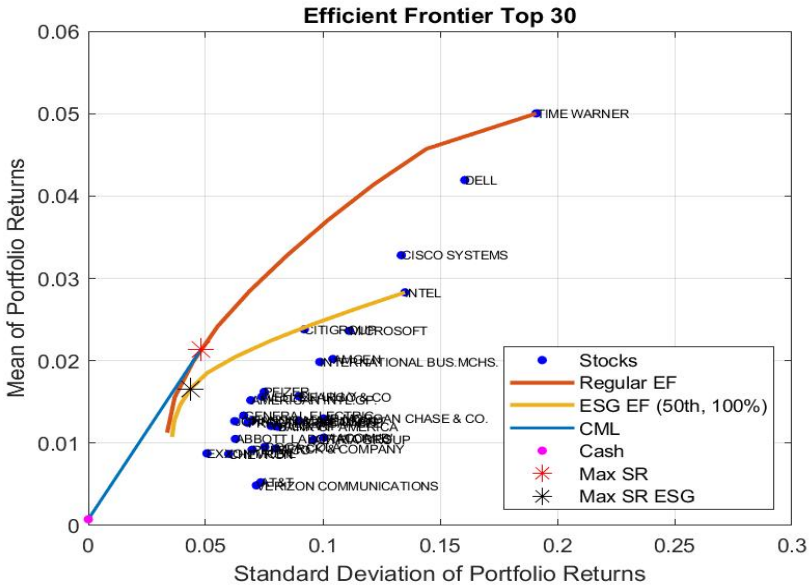

Figure 1: First efficient frontier on 01.01.2004 with 50th-percentile threshold and 100% constraint compliance.

As one can observe, the efficient frontier with ESG constraint is much flatter. This implies less expected return for the same amount of risk. Interestingly, the optimal portfolios lie very close to each other. The two frontiers tend to diverge with increasing volatility.

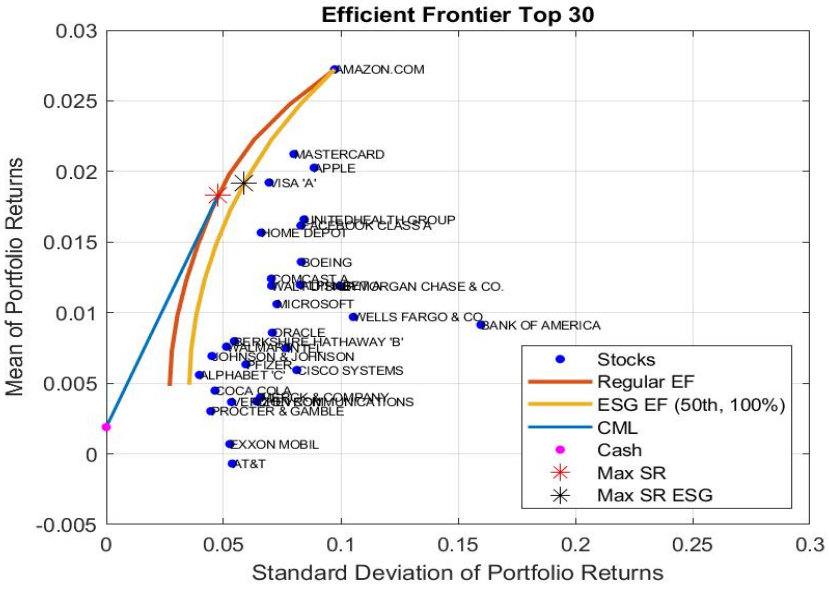

Figure 2: Last efficient frontier on 01.12.2018 with 50th-percentile threshold and 100% constraint compliance.

In the end of the observation period, the expected return of the optimal ESG portfolio exceeds the regular one. But one has to take into account the additional risk which the ESG investor is taking. Notice how the expected returns of the tech and financial service industry dominate the others. Also, the spread between the two frontiers has decreased by a lot. Furthermore, this time the frontiers converge to the same asset.

4.1.2 Optimal weights

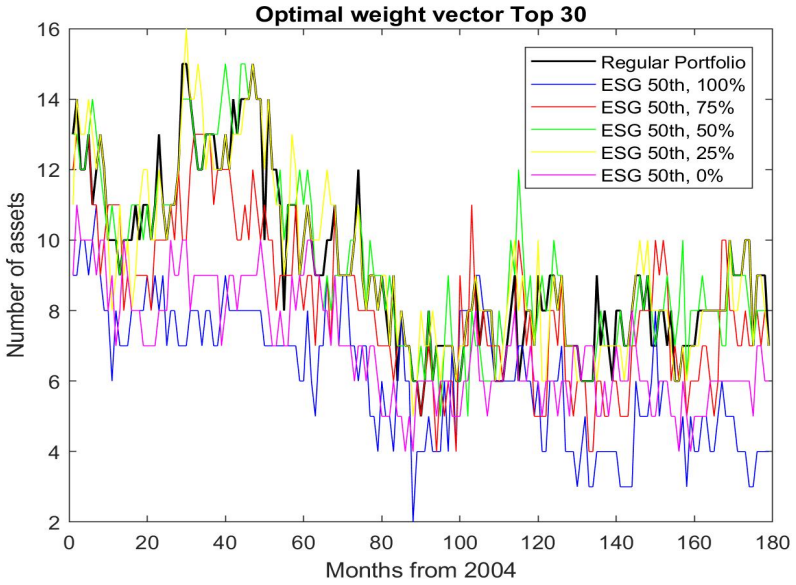

Figure 3: Number of assets in optimal weight vector over time.

This graph shows the number of different assets in the optimal weight vector of the different portfolios across time. Notice how the overall number of assets tends to decrease over time. This could be due to big tech companies coming up in the early years of 2000 and outperforming

the market up until now. Therefore the optimization should attribute more weight and focus more on those assets. Obviously, the portfolio with 100% constraint compliance has the least numbers of assets which indicates some strong diversification issues. Nevertheless, even the regular portfolio contains on average about 8 to 10 different assets. This indicates the possibility to construct an optimal mean-variance portfolio even with less assets than the ones provided in the top 30. Therefore the next step is to set the ESG score percentile threshold higher than the median.

4.1.3 Performance

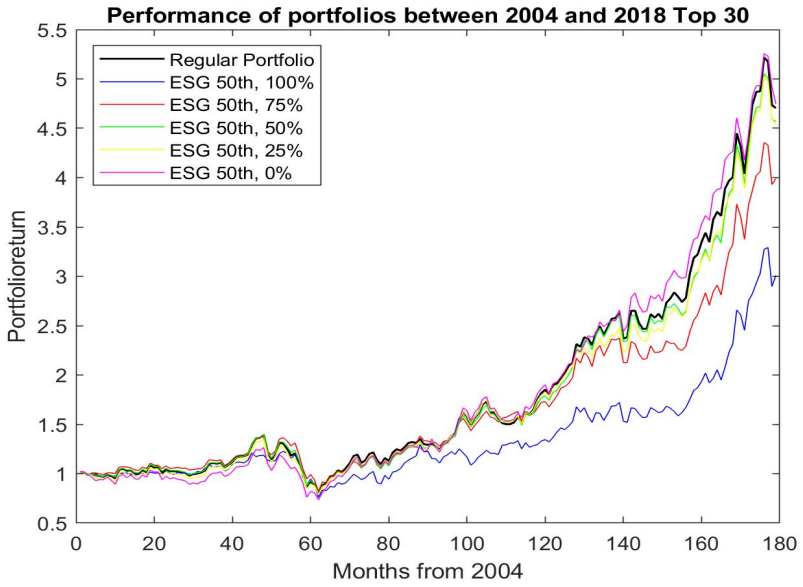

Figure 4: Out-of-sample performance.

The regular portfolio has a cumulative out-of-sample performance of 370.4%. As for the other portfolios, one can observe that the growth is exponential from approximately the 60th month. This corresponds to the low of the financial crisis of 2008 to 2009. The ESG portfolio with constraint to invest 100% in ESG score above the median has a final out-of-sample performance for the respective period of 200.9%. It is substantially lower than the regular portfolio with a difference of 169.5%. The portfolio that allocates 0% in stocks with an ESG score above the median can be seen as an ESG avers investor. For the respective period, its performance is 374.8% which outperforms both regular and the 100% constraint compliant ESG portfolio by respectively 4.4% and 173.9%.

4.1.4 Sharpe ratio

In order to compare portfolios of different sizes, one needs to not only consider the performance, but also the risk taken. Risk adjusted measures like the Sharpe ratio provide better insight into their relation. Since the portfolio optimization maximizes the Sharpe ratio based on historical data, it can of course differ ex ante and ex post. The ex ante Sharpe ratio is computed for the optimal portfolio with and without ESG constraints below.

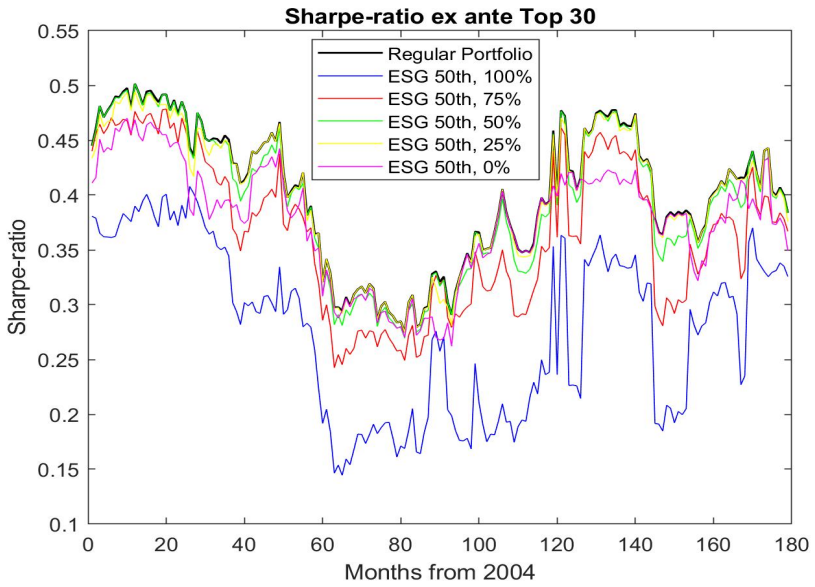

Figure 5: Ex Ante Sharpe-Ratio of optimal portfolios over time

Ex ante all Sharpe ratios are positive over the entire observation period. They range from about 0.15 during the financial crisis up to 0.5 in the beginning of the observation period. The ESG portfolio with 100% constraint compliance has always the lowest Sharpe ratio. On the other hand the ESG averse portfolio with 0% constraint compliance performs better but not as good as the regular portfolio. Since the same amount of firms are excluded due to the median ESG constraint threshold, one would expect it to be much closer to the 100% constraint compliant portfolio.

4.2 Top 30 and 80th percentile

In this section the ESG Score threshold has been risen to the 80th percentile. Only 6 firms remain considerable for an ESG investor portfolio optimization problem with 100% constraint compliance. This constraint is much more severe, but can latter be loosen by the compliance constraint. It can be viewed as an investor who is very concerned about firms with high ESG scores.

4.2.1 Efficient frontiers

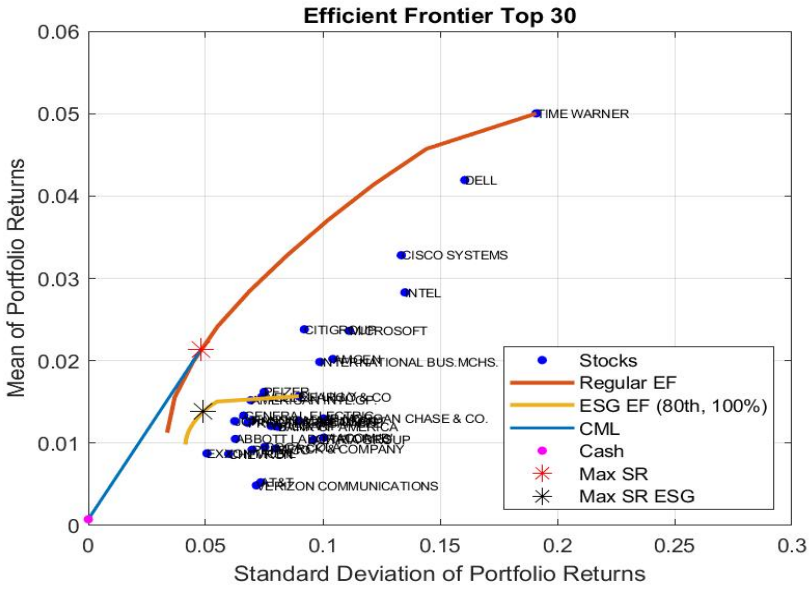

Figure 6: First efficient frontier on 01.01.2004 with 80th-percentile threshold and 100% constraint compliance.

The efficient frontier with ESG constraint writhes very fast and strong and is much shorter than the regular one. The differences become very obvious. The spread between the two curves is much bigger than with a threshold set by the median. This could be due to the lack of assets available. However, if one compares this ESG efficient frontier from 2004 to 2018, one could suggest the optimal portfolio of 2018 would contain more assets than the one of 2004. Even if both optimal ESG portfolios contain not many assets, this is not the case. The optimal weight vector of 2018 contains less assets than in 2004.

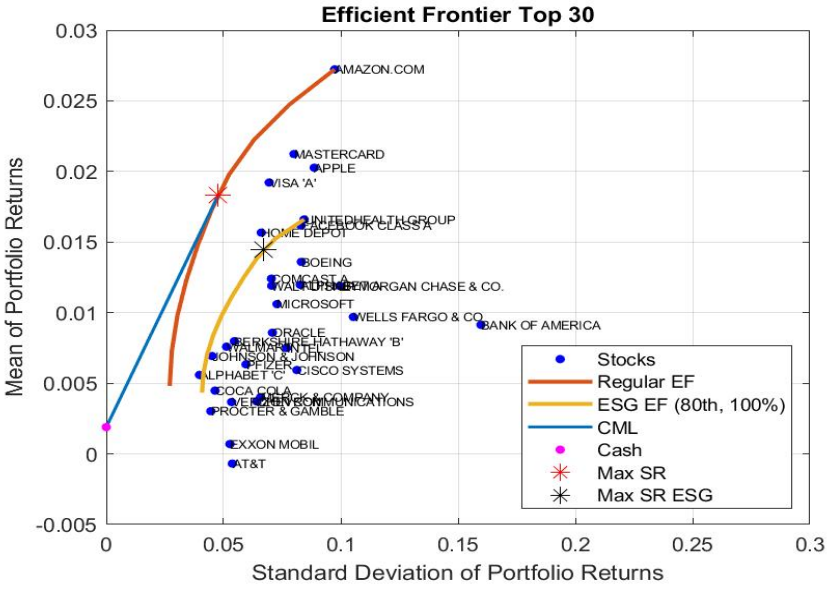

Figure 7: Last efficient frontier on 01.12.2018 with 80th-percentile threshold and 100% constraint compliance.

4.2.2 Optimal weights

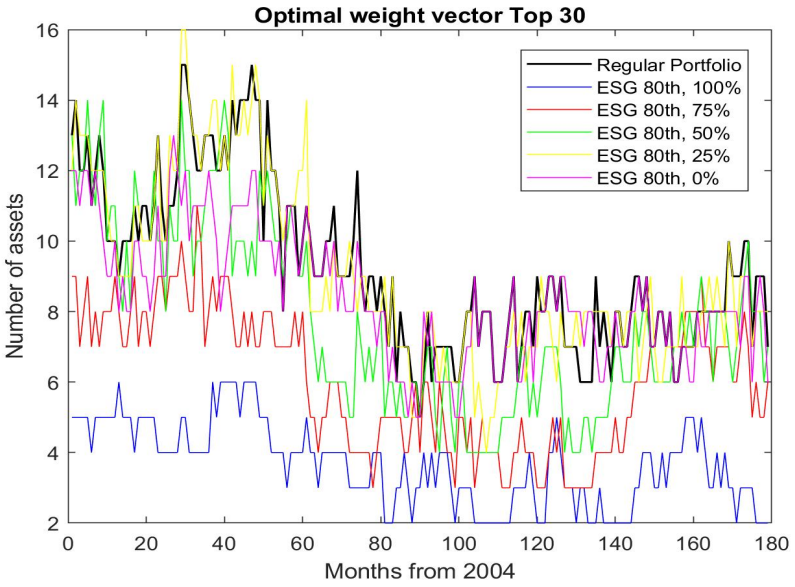

Figure 8: Number of assets in optimal weight vector over time.

4.2.3 Performance

The performance of all ESG portfolios increased compared to the one with a ESG score threshold at the 50th percentile. This might be due to less diversified portfolios containing less different assets. However, the number of different assets in the optimal weight vector only considerably diminishes for the 100% constraint compliance.

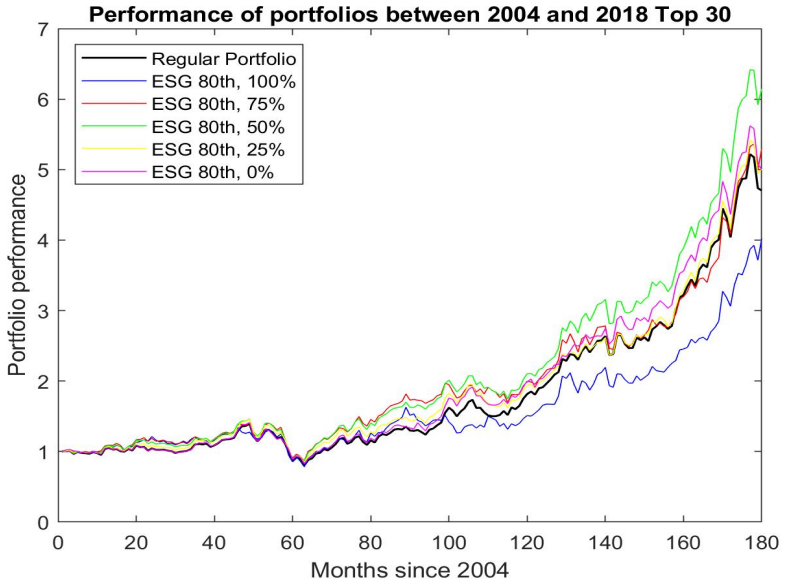

Figure 9: Out-of-sample performance.

4.2.4 Sharpe ratio

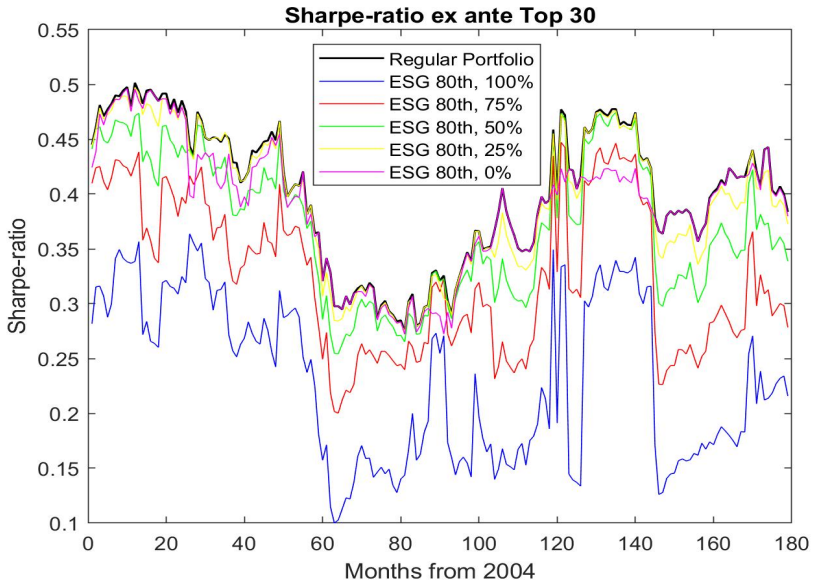

Figure 10: Ex Ante Sharpe ratio of optimal portfolios over time.

Also, the ex ante Sharpe ratio remains quite the same over the period independently of the higher percentile threshold. This indicates, that for the better performance, more risk has been taken.

5 Interpretation

5.1 Efficient Frontier

The efficient frontier of a standard mean-variance optimization lies always above the one with ESG constraint. Therefore by investing in any portfolio on this line the investor gets a better trade-off between risk and return. This has to be the case, since the optimization is based on historical data and maximizes the Sharpe ratio by minimizing the variance and maximizing the (historical) expected return. But past performance is not necessary an indicator for the future. By imposing a restriction on which assets can be considered for the optimization, the outcome could only be the same if the asset below the ESG threshold was redundant. Usually, this is not the case. The difference between the regular efficient frontier and the one with ESG constraint can be interpreted as the cost of ESG investing. An ESG investor has to ask himself how much he is willing to give up on his expected return in order to invest only in ESG compliant firms. This difference is not stationary and can vary across time. A decreasing spread could indicate a trade-off improvement of risk and return of firms with ESG scores above the median.

5.2 Performance

5.2.1 Regular portfolio

In order to be objective and to compare the performance to the real life context, the comparison has to be made taking account the period in which the data has been collected and used for this simulation. After the 2008 subprime crisis, the market entered a bull run which took over

recently. Hence, the performance of the different portfolios is carried by this positive trend. As the portfolios are less diversified than the SP500 itself, it's normal to see such performances as the excess risk taken. Hence, a more appropriate way to compare portfolios would be to consider Sharpe ratio as an indicator of performance. The regular portfolio is a typical mean-variance optimization with the only constraint of having positive weights. By comparing it to the 6 other ESG constraint portfolios with a threshold set at the 80th percentile, it is only placed at the 5th position with regards to cumulative performance. However, its sharp ratio is most of the time at the 1st position which is not really surprising as it's derived from the mean-variance optimization without constraint (expect positive weights).

5.2.2 ESG portfolio

Unlike the regular portfolio, this portfolio has to satisfy a quite tough constraint which is to allocate all the wealth into the portfolio having an ESG score above the median of the sample. Thus, it has a direct impact on its performance. As it has the lowest performance and lowest Sharpe ratio among the different portfolios, one can infer that it's relatively inefficient to invest with regards to this extreme criteria. Not only the performance is negatively affected, but the ESG criteria is not not fairly compensated by a lower risk or vice-versa. Firms with high ESG scores might be overvalued and thus provide lower returns. The opportunity cost to invest all wealth according to ESG criteria is relatively costly. However, if the 100% constraint compliance is loosen, one can obtain fairly good results by having a substantial amount of wealth invested in the top percentile of firms with high ESG scores. Investors have then to be aware, that some proportion of their portfolio might contain some firms with really low ESG scores. On the other hand, a high percentile threshold with a portfolio compliance of say 50% represents an investor's strong desire to absolutely invest half of his wealth into the top of ESG scored firms. Such a portfolio is still very close to the optimal portfolio without constraints at all in terms of performance and Sharpe ratio.

5.2.3 ESG averse portfolio

This portfolio is the opposite of the latter. The constraint states that 0% of wealth has to be allocate to assets fulfilling the ESG criteria. In terms of cumulative performance and sharp ratio the portfolio significantly outperforms its antagonist (ESG portfolio). In other words, regular stocks outperforms ESG stocks. If the threshold is set above the median this result can be explained by the fact that more stocks are available for the ESG averse portfolio optimization, since only a few stocks are completely excluded. However, if the median has been set as a threshold, this should not be the case, but still the ESG averse portfolio outperforms the 100% constraint compliant ESG portfolio. Although, it has to be considered that by setting some ESG scores to zero because they were missing, some companies might have been wrongly excluded from the ESG portfolio.

6 Conclusion

To summarize, ESG investment comes definitely at a cost. The costs consist in less performance at higher risks due to a lack of diversification. Ex ante, it can be viewed as the difference between both efficient frontiers. This spread remains not constant over time. Only for hardcore ESG investors the risk and return of a portfolio with 100% constraint compliance and 80th percentile ESG score threshold might be acceptable. However, by loosening the constraint compliance to 75% the ESG portfolio's risk-return trade-off increases by a lot. In real life, the asset universe is also not limited to the top 30 of the SP500 and therefore diversification would still be possible to extend. Of course every investor's preferences are different, but to conclude the usage of a high ESG score threshold with loosening the constraint compliance can lead to comparable results as a standard mean-variance portfolio optimization. This approach might suit a very ambitious ESG investor most. Investors with more moderate ESG preferences might use the median as threshold.

6.1 Critical Reflection

An important thing to consider by only analyzing the top 30 firms with the largest market capitalization is the momentum effect. This financial market anomaly was firstly analyzed by Jegadeesh and Titman (1993) and states that stocks with a positive past performance will continue to outperform and vice versa. Thus, firms that enter the SP500 top 30 by market capitalization might also outperform the following month according to this anomaly. Per contra the size effect discovered by Fama and French (1996) would suggest big firms to underperform smaller firms. Which of these anomalies dominates the other is ex ante unclear. Furthermore it should be analyzed if the size premium and the momentum effect were still relevant for those firms over the analyzed time frame.

After all, the investor's aim in investing into ESG compliant firms is supporting firms based on the impact investing approach and still requiring adequate returns. A firm's management might have incentives to abuse these preferences in order to get cheaper equity financing by promoting unreal ESG compliance. Firms just benefiting by freeriding on the trend must be sorted out by regulators in the long run, leading to less noise and more reliable data for ESG scores. In such cases an investor would not only end up with lower returns and higher risk for his investment, but would not actually even benefit from his utility gain in investing in really ESG compliant firms. Therefore considering ESG scores in an equity portfolio might be not as efficient as in the debt market for example. Sustainable linked bonds can bind a firm's incentive in being ESG compliant much stronger to investor's preferences by providing conditional coupons based on an the firm's behaviour. If the firm does not meet an ESG goal up the the conditional coupon payment, the latter will increase and directly punish the firm and benefit the investor. Although, this creates some conflicts of interests by attracting investors who would bet against the failure of the achievement of a firm's ESG goals. For real ESG investors the costs of ESG investments are much more transparent in the bond market.

The benefits of ESG compliance from an investor's perspective might also be observable only in an even longer run, since ESG is still quite new. ESG is based on a responsible and sustainable investment approach which is proactive by definition. Especially the impact of climate change has yet to be felt in the economy. Regulators and governments might play a crucial role by setting new frameworks for higher ESG compliance in the future. Once the implementation of those begin, ESG compliant firms will start to benefit.