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## "EFFECTS OF SRI ON PORTFOLIO PERFORMANCE: AN ANALYSIS FOLLOWING CHOW-KRITZMAN AND MICHAUD APPROACHES"


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# Introduction

Social responsibility has been an increasing concern in the last decades to such an extent that even investors have been requiring more suitable solutions for their needs.

In the ‘60s, the main purpose of SRI strategies was avoiding companies that produced war materials or that violated civil rights. But over time, as awareness has grown over global warming and climate change, SRI has moved toward companies that positively impact the environment by reducing emissions or investing in sustainable or clean energy sources. So, these strategies evolve over time as investors’ priorities change.

Socially Responsible Investment (SRI) tries to achieve a financial gain for this category of investors, even though the two aims (financial return and sustainable investment) do not necessarily go hand in hand. A socially responsible investment implies that many companies might be excluded from the investment universe due to their peculiarities, thus reducing the available choices. In a Markowitz approach to the problem, this would reduce the diversification opportunities, leading to a rightward shift of the efficient frontier (loss in terms of mean-variance efficiency). In addition, companies with high Corporate Social Responsibility records are often expected to deliver lower returns and, consequently, lower dividend payments because of the belief that social and financial performances are negatively correlated. This could make the more sceptical investors unwilling to sustain companies with alleged competitive disadvantages.

However, it is premature to reach the conclusion that returns will necessarily decrease as the social performance improves. There are many studies aimed to examine whether the underperformance is relevant or not, and nearly all demonstrated that there is no clear evidence supporting this argument. Similarly, other researches demonstrated that the diversification opportunities are not always reduced when applying a sustainability-based methodology. In particular, they found that investors are no worse off by excluding socially responsible assets from their portfolio in case they face a short sales restriction. However, if the no short-selling restriction is removed, investors are worse off in terms of foregone risk reduction opportunities.

This master’s thesis aims to further discuss this issue, starting from the previous results but focusing on the European equity market; more specifically, the companies will be the ones of the Euro Stoxx 600. The portfolios will be tracked over time, monitoring their performance to assess the impact of SRI restrictions. The assets will be selected using different approaches: the initial selection will be implemented through the use of the Markowitz model but then this strategy will be enhanced using the Chow-Kritzman and the Michaud approaches. Different constraints will be applied to the unconstrained situation to build more realistic portfolios. A no short-selling constraint will be used to avoid negative weights, since many investors face this limitation. Then, this limitation will be removed, however weights will be bounded on both sides. Finally, a turnover constraint will impose weights rigidity, as excessive portfolio rotation could seriously increase transaction costs. Also, different methodologies will be adopted to estimate the inputs used in the models.

I will consider three possible ways of implementing a portfolio: the first way consists in using the whole investment universe, without any limitation deriving from socially responsible behaviour; the second one consists in eliminating from the sample all the companies that engages in "sin" activities (activities considered to be unethical or immoral); the last one consists in eliminating from the sample all the companies that do not have a sufficiently high ESG score. The latter element goes from 0 to 100, where 100 represents the best compliance, and it is calculated as the average of three scores: Environmental score, Social score and Governance score, hence the acronym ESG.

The investment universe will vary a lot due to the SRI restrictions applied, therefore the constraints applied must be reasonable. For instance, a 1% upper bound might enhance diversification when dealing with an investment universe of 500 assets, but it would be completely useless if it were composed of 100 assets.

The performance will be assessed using several indicators, investigating whether the removal of certain assets will have an impact on the overall results. I will use both absolute and relative measures. The former includes Sharpe ratio, Sortino ratio, Treynor Ratio, Value-at-Risk, Expected Shortfall, Farinelli-Tibiletti Ratio, and measures using drawdowns as risk indicator (Sterling Ratio and Calmar Ratio). The latter measures, such as the Tracking Error, will instead use the Euro Stoxx 600 as a benchmark for performance evaluation.

# Document Structure

The first chapter briefly explains the meaning of SRI and the history of this practice. Then, it lists the main rating agencies, partially explaining their evaluation process, and the main SRI indices. The core part of the chapter however is the explanation of the different SRI strategies and their recent developments. Then, the chapter describes the major players in the SRI field, the obstacles to the SRI integration, and the role that governments should play to facilitate this kind of investment.

Chapter 2 analyses the existing literature, and the main hypothesis proposed by several authors about the performance differences between conventional and responsible investments. It also includes a description of the main indicators and techniques used in literature to compare these two investments.

Chapter 3 explains the methodology used in this study, firstly describing the Markowitz model and the concept of efficient frontier, Global Minimum Variance and Max Sharpe portfolios. Then the chapter deepens the Markowitz findings, describing the model proposed by Chow and Kritzman, and the one proposed by Michaud.

Chapter 4 contains the process used to retrieve and elaborate the data, the different strategies used in the research, the constraints applied, and the methodologies adopted to estimate the inputs for the models. The end of the chapter lists and briefly explains the performance indicators used to compare the strategies. The results are displayed in chapter 5.

# Chapter 1

# Socially Responsible Investment

## 1.1 Definitions

According to Gond and Boxenbaum (2004), Socially Responsible Investment (SRI) is both a product and a practice. It is a product because investors acquire, hold, or dispose of companies' shares on the basis of environmental, social, and governance (ESG) factors as well as ethical factors. It is a practice because it is a way to identify companies with high ESG scores, therefore encouraging companies to improve their ESG performance.

The definition has often been a matter of discussion, Dorfleitner and Utz (2012) stated that a general definition of SRI is not needed as sustainability means something different for every investor, and that the name itself is enough to summarize every desirable non-financial impact of the investment. Sandberg et al. (2009) stated that the SRI definitions have something in common: ‘‘the integration of certain non-financial concerns, such as ethical, social or environmental, into the investment process.’’
More in general, socially responsible investing, also called sustainable investing, ethical investing, green investing, refers to investment strategies that aim to obtain a positive social impact alongside the financial return. It can be applied in many ways, the easiest example is an investor who avoids investing in any morally questionable or unethical industry, the so-called sin industries, such as those involved in alcohol, tobacco, gambling, animal testing, or weapons. However, the choice could also be based on hundreds of Environmental, Social and Governance (ESG) indicators, that are used to obtain an overall ESG performance evaluation of the company. In the former case a company is excluded from the investment universe if it is involved in a particular activity, in the latter case if the company's score is not satisfactory.

## 1.2 History and Origins

Someone states that SRI origins could be traced back to the biblical times, as Jewish law imposed specific guidance on ethical investment. Others find the origins in the eighteenth century, back to the Religious Society of Friends (Quakers) that prohibited members from participating in the slave trade. In the same period, the Methodist Church drew the concept of values-based investing that refused all the investments connected with slavery and war, and the investments that were potentially harmful for the health of workers.

The Pioneer Mutual Fund, launched in the United States in 1928, was the first SRI mutual fund, based on a negative screening approach (the decision not to invest in companies that are involved in unethical businesses). This can be considered the first relevant case of the modern era.

More recent examples evolved during the political climate of the 1960s and 1970s in the US due to increasing concerns over the Vietnam War, the environment, civil rights and gender equality. In 1971 the Pax World Fund was launched in the US, created by the desire to make it possible for investors to sustain companies that were coherent with their values. It was also aimed at challenging companies to improve their sustainability. In the same period, the Church of Sweden created the Ansvar Aktiefond Sverige in 1965, the first European SRI fund.

A significant increase in popularity of SRI can be observed in the 1980s, caused by many events: the apartheid in South Africa, the nuclear disaster in Chernobyl, and the oil spill in Alaska. A famous fund created in this period was the Friends Provident Stewardship Unit Trust, launched in Europe in 1984.

Throughout the 1990s, Nike was criticized for selling goods produced in sweatshops, and a further increase in the environmental concerns, resulted in an increasing respect for indigenous populations, tropical deforestation, leading to a further boost of SRI.

As stated by Louche (2014), it must be highlighted the important role played by the various religious organization in the establishment and development of the first funds. In addition to the previous examples, there are other cases in which the first national ethic fund was created thanks to a religious movement: in Sweden, the Church of Sweden established the Ansvar Aktiefond Sverige in 1965; in Germany, the first ethical funds were created by local Church banks; in France, the Nouvelle Strategie Fund was created in 1983 by the Notre-Dame Order in Paris; in the Netherlands an initiative of Church groups and environmental movements created in 1990 the first SRI fund; the Church of Finland launched the two first Finnish ethical funds.

Nowadays, religious organisations are still very active. In the last twenty years many religious-based indexes have been created: the FTSE Global Islamic Index Series in 1998, the Dow Jones

Islamic Market Index family in 1999, the India Islamic Index in 2008, the Dharma Indexes in 2008, the STOXX Europe Christian Index in 2010.

Louche and Lydenberg (2010) summarized the aforementioned SRI history in 5 main periods:

- Roots phase in the 18th Century, when the main actors were religious institutions;
- Development phase from 1970s to late 1980s, when SRI started changing from a faith-based activity into an activity promoting social responsibility. During this phase SRI was mainly driven by political and protest movements.
- Transition phase in the 1990s. In this period environmental concerns began to grow, therefore the so-called green funds emerged, especially in Europe. In addition, also the number of SRI rating agencies and indexes increased;
- Expansion phase in the 2000s was characterised by the professionalisation and growth. SRI began to find acceptance in the mainstream investment community, leaving behind its more activist image and becoming a more commercially viable endeavour (Déjean, 2004; Louche, 2004);
- Mainstreaming phase in the 2010s. SRI increasing acceptance by institutional investors was marked by the launch of the Principles for Responsible Investment in 2006. By 2010, the PRI had grown into a group of more than 800 of the largest institutional investors and asset managers worldwide, managing $22 trillion. SRI was ready to become a mainstream investment practice applied to asset classes beyond public equities.

## 1.3 SRI rating agencies

As the ESG rating market has developed considerably over the past decades, the number of agencies has increased markedly. Even though in the last few years the market has stabilized, the ESG rating market is still a dynamic one as agencies are diversifying their products and services to investors. So, now, the biggest agencies offer a complete range of products and services and a large geographic coverage, for this reason the ESG market is becoming always more concentrated around these main companies.

The ratings are used by investment managers to build SRI funds and serve to compare the ESG levels of both listed and unlisted securities. The work made by rating agencies is mostly based on publicly available data reported by the companies and other information produced by NGOs, governmental organisations and trade unions. Although they might seem similar to classical financial rating agencies, ESG rating agencies are paid by investors for the information provided.

The main rating agencies active in Europe include: Vigeo (France), MSCI ESG Research and GMI Ratings (US), EIRIS (UK), Oekom (Germany), Inrate (Switzerland) and Sustainalytics (Netherlands). As mentioned above, the market has stabilized, therefore some agencies are the result of mergers or acquisitions. This consolidation can be explained by the increasing business model complexity and by the financial instability of the pioneer agencies.

- EIRIS Ltd: was created in 1983 in the UK so it has 35 years of experience in ESG analysis. Now it offers a wide range of ESG research products, but in its early days, it was focused on research products based on the exclusion criteria. The company assessment is based on 80 ESG research criteria. Each includes several indicators (200 in all) about environment, stakeholders, human rights and governance. Each indicator receives a score (poor, medium, good, excellent) which enables the evaluation of the company on the issue in question. EIRIS Ltd also controls companies' involvement in sin businesses (alcohol, animal testing, gambling, etc.).

- GMI Ratings: in the past it was mainly known for its analysis of corporate governance, but now it offers ESG analysis of many companies. The rating is based on 150 Key Metrics divided into six ESG categories: Board, Compensation, Ownership and Control, Accounting, Environmental Performance and Social Performance. Each category receives a flag for the key metrics in which there is a negative risk factor. A raw score is calculated by summing the flags and this score is then converted to a percentile.

- Inrate: it is a Switzerland agency created from the 2010 merger between Centre Info SA and Inrate SA, and it is now one of the oldest SRI rating agencies in continental Europe. It concentrates on small caps and companies in emerging countries, but its research universe covers about 2,600 companies and more than 200 bond issuers. The ESG criteria are divided into four main categories: environment, human resources, social issues and governance.

- MSCI ESG Research: it is the subsidiary of the MSCI group (Morgan Stanley Capital International) and it is the result of the absorption of several ESG research companies. The research universe is made of 5,000 companies and the team of 185 research analysts assesses thousands of data points across 37 ESG Key Issues, providing a rating from AAA to CCC. To arrive at a final letter rating, the weighted averages of the Key Issue

Scores are aggregated and companies' scores are normalized by their industries.

| 3 Pillars | 10 Themes | 37 ESG Key Issues | |
|---|---|---|---|
| **Environment** | **Climate Change** | Carbon Emissions<br>Product Carbon Footprint | Financing Environmental Impact<br>Climate Change Vulnerability |
| | **Natural Resources** | Water Stress<br>Biodiversity & Land Use | Raw Material Sourcing |
| | **Pollution & Waste** | Toxic Emissions & Waste<br>Packaging Material & Waste | Electronic Waste |
| | **Environmental Opportunities** | Opportunities in Clean Tech<br>Opportunities in Green Building | Opp's in Renewable Energy |
| **Social** | **Human Capital** | Labor Management<br>Health & Safety | Human Capital Development<br>Supply Chain Labor Standards |
| | **Product Liability** | Product Safety & Quality<br>Chemical Safety<br>Financial Product Safety | Privacy & Data Security<br>Responsible Investment<br>Health & Demographic Risk |
| | **Stakeholder Opposition** | Controversial Sourcing | |
| | **Social Opportunities** | Access to Communications<br>Access to Finance | Access to Health Care<br>Opp's in Nutrition & Health |
| **Governance** | **Corporate Governance*** | Board*<br>Pay* | Ownership*<br>Accounting* |
| | **Corporate Behavior** | Business Ethics<br>Anti-Competitive Practices<br>Tax Transparency | Corruption & Instability<br>Financial System Instability |

*Figure 1.3a: MSCI ESG Research*

- Oekom Research: was created in Germany in 1993. Oekom analyses the ESG performance of companies, business sectors, local authorities and countries. It is deemed the European leader in country ratings because of its experience in the area. Company ratings are based on a universe of 3,000 companies, initially evaluated using public information in order to determine which ones are eligible for the "Prime" status. Companies are rated using 100 different ESG criteria, then the analysts contact companies to complete the assessment that goes from A+ to D-.

- Sustainalytics: is a Netherlands based company founded in 2002 that provides information on more than 4,000 companies, countries and public institutions throughout the world. Sustainalytics assessments of ESG performance of companies use sector-specific indicators. Its model has between 60 and 100 sector-weighted indicators.

- Vigeo: was founded in 2002 after the acquisition of ARESE. Vigeo has two separate entities: Vigeo Rating that is dedicated to ESG ratings for investors, and Vigeo Enterprise that offers social responsibility audits for companies. Its ratings are based on 38 ESG issues in six sections (environment, human rights, human resources, community involvement, business behaviour, corporate governance). The rating for each sector derives from 20 to 25 issues weighted by business sector, and more than 300 indicators are used per company.

- Asset4: is a Swiss non-financial data provider founded in 2003 and later acquired by Thomson Reuters in 2009. Asset4 provides research containing both financial and non-financial information. It offers an evaluation of 4,300 companies based on four areas: financial performance, environmental performance, social performance and corporate governance. The company uses 250 key performance indicators and 750 criteria, which are split in 18 categories. The Asset4 system is based on publicly available data.

## 1.4 SRI indices

The previous information explains how broad the ESG research can be. In addition to producing ESG data, many rating agencies create SRI indices that can be used to compare the performance of SRI funds against a benchmark. Moreover, companies would like to be included in these SRI indices as the inclusion would improve their reputations, therefore, to achieve this result they change their ESG strategy, increasing their effort to obtain better ESG results.

The main indices are: Domini 400 Social Index, the FTSE4Good Index Series by EIRIS, the MSCI ESG Indices by MSCI, the Global Challenges Index by Oekom, the Jantzi Social Index and the STOXX Global ESG Leaders Indices by Sustainalytics, and the ASPI Eurozone, the Ethibel Sustainability Index, the Euronext Vigeo by Vigeo.

## 1.5 SRI strategies

SRI strategies are classified in different ways. Louche and Lydenberg distinguish four strategies:

- Avoidance strategy consists in avoiding companies engaged in activities considered to be dangerous or immoral (will be later called “Negative Screening” in the Eurosif definition).

- Inclusion strategy consists in investing in companies involved in activities considered to be useful for society.

- Relative selection aims to choose the assets with an ESG score above a certain threshold, so the ones that have the best ESG performances.

- Engagement consists in an active collaboration aimed at influencing companies' behaviour with the final objective of an ESG improvement.

A more detailed classification is provided by Eurosif, a European association for the promotion of sustainable and responsible investment. It distinguishes 7 different strategies that an investor could use to implement a socially responsible investment.

**Best in Class**: in this approach, best-performing investments within a universe are selected or weighted based on ESG criteria. It is also called "Positive Screening". This approach includes Best-in-Class, best-in-universe, and best-effort.

**Engagement & Voting**: this is a long-term process that tries to influence behaviour or increase disclosure, and it requires an active ownership through voting shares and engagement with companies on ESG matters. However, even though engagement and voting are necessary, they are not enough for this strategy.

**ESG integration**: is the explicit inclusion of ESG risks and opportunities into traditional financial analysis and investment decisions based on a systematic process and appropriate research sources. The integration process focuses on the potential impact of ESG issues on company results, which in turn may affect the investment decision.

**Exclusion (Negative Screening)**: it is an approach that consists in excluding from the investible universe specific assets or classes of assets such as companies, sectors, or even countries. The exclusion is based on the involvement in certain activities deemed unacceptable or harmful to society. These criteria include weapons, pornography, gambling, alcohol, tobacco and animal testing. This approach is also referred to as ethical-based exclusions, as exclusion criteria are typically based on the preferences of asset managers or asset owners.

**Impact Investing**: even though they obviously aim to generate a financial return, they are investments in companies, organisations and funds with the intention to generate also social and environmental effects. Impact investments are often project-specific and can be made in both emerging and developed markets. An important aspect is the distinction from philanthropy, as the investor retains ownership of the asset and expects a positive financial return.

**Norms-Based screening**: consists in the screening of the assets held in the portfolio with the objective of verifying whether they are compliant with international ESG standards and norms or not. International norms about ESG are those issued by international bodies such as the United Nations or the OECD.

**Sustainability-Themed**: consists in the Investment in themes or assets linked to the development of sustainability, such as climate change, health, and eco-efficiency, usually with the aim of supporting entities during the transition to sustainable processes.

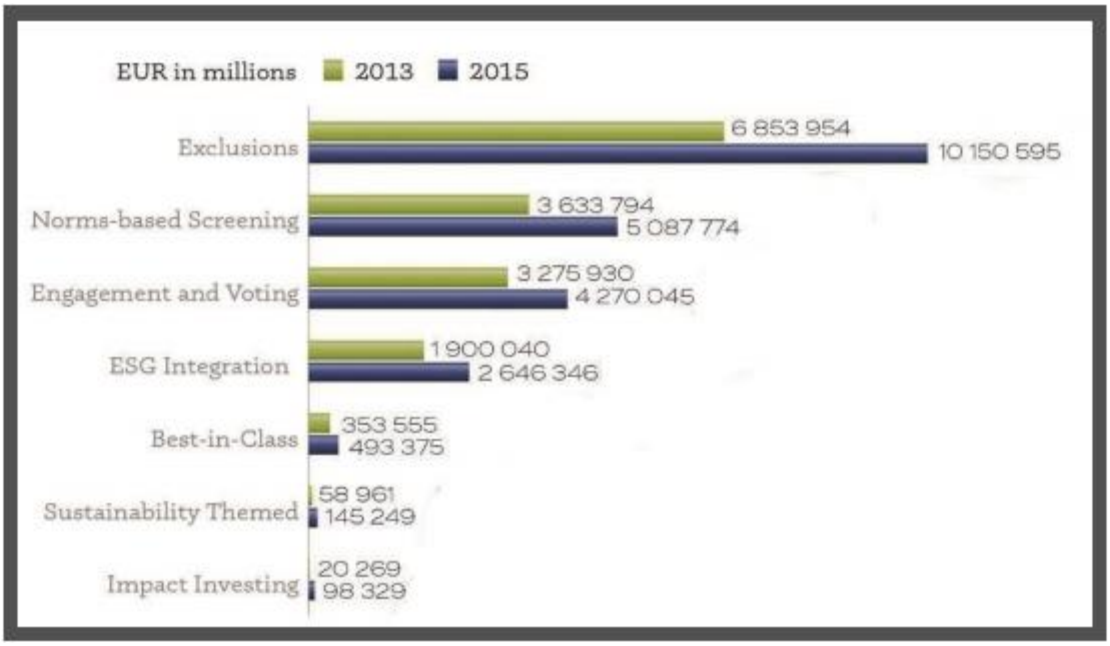


*Figure 1.5: SRI Strategies*

According to a Eurosif (2016) study, European sustainable and responsible assets grew by 12 percent from 2014 to 2016, reaching $12 trillion. Exclusion remains the dominant strategy with more than €10 trillion managed and a growth rate of 48% from 2014, it represents almost a half of all European professionally managed assets. Meanwhile, Impact Investing is the strategy with the greatest growth rate (385%), so it could be considered the most promising approach.
The different categories of SRI strategies can be applied individually or in an aggregated fashion. This figure shows that exclusions-based strategies were the most adopted with more than 10 trillion euros of assets. Despite the extraordinary CAGR (120%), the less relevant strategy in 2015 was Impact Investing with €98 billion invested.

## 1.6 SRI in the 2010s

The Global Sustainable Investment Review for the year 2016 (GSIR), made by Global Sustainable Investment Alliance, highlighted the actual sustainable investment situation. Socially responsible assets are continuing to increase worldwide: at the beginning of 2016, SRI assets reached $22.9 trillion, a 25% increase from 2014 ($18.3 trillion). Nevertheless, they're growing at a slower pace than in previous years, in fact from 2012 to 2014 the growth rate was 61%. In the last period, in nearly all countries, SRI assets increased relative to their total professionally managed assets, even if on a global basis this relation is reversed (Figure 1.6b).

| Region | 2014 | 2016 | Growth over period | Compound Annual Growth Rate |
|---|---|---|---|---|
| Europe | $ 10,775 | $ 12,040 | 11.7% | 5.7% |
| United States | $ 6,572 | $ 8,723 | 32.7% | 15.2% |
| Canada | $ 729 | $ 1,086 | 49.0% | 22.0% |
| Australia/New Zealand | $ 148 | $ 516 | 247.5% | 86.4% |
| Asia ex Japan | $ 45 | $ 52 | 15.7% | 7.6% |
| Japan | $ 7 | $ 474 | 6689.6% | 724.0% |
| **Total** | **$ 18,276** | **$ 22,890** | **25.2%** | **11.9%** |

*Figure 1.6a: Growth of SRI Assets by Region 2014-2016*

| Region | 2014 | 2016 |
|---|---|---|
| Europe | 58.8% | 52.6% |
| United States | 17.9% | 21.6% |
| Canada | 31.3% | 37.8% |
| Australia/New Zealand | 16.6% | 50.6% |
| Asia | 0.8% | 0.8% |
| Japan | | 3.4% |
| Global | 30.2% | 26.3% |

*Figure 1.6b: Proportion of SRI Relative to Total Managed Assets*

Figure 1.6c shows the proportion of SRI assets held by region. Europe is still the leading region in this respect, holding more than a half of total SRI assets. Between 2012 and 2014, Japan has been the fastest growing region, due in part to new surveys providing information for the first time on many large asset owners. Japan is followed by Australia and New Zealand, and then Canada and the United States.

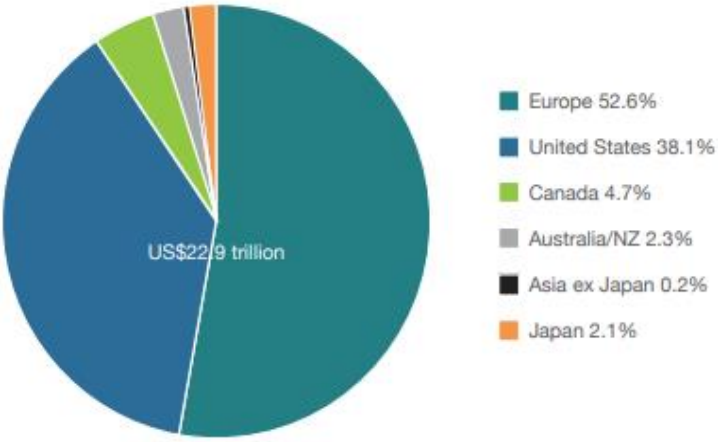


*Figure 1.6c: Proportion of Global SRI Assets by Region*

Another relevant feature revealed by the GSIR is that the interest by retail investors in SRI is continuing to grow: the proportion of retail investments in Canada, Europe and the United States increased from 13% in 2014 to 26% at the start of 2016. To clarify, retail assets are investments by individuals in professionally managed funds purchased in banks or through investment platforms; instead, institutional assets refers to large asset owners such as pension funds and insurers.

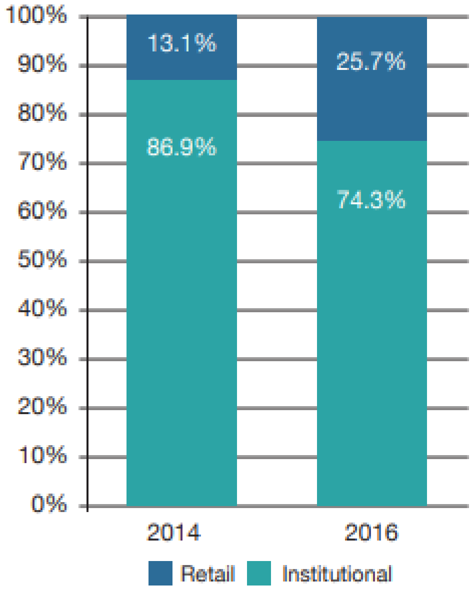


*Figure 1.6d: Institutional/Retail SRI Assets*

As time goes by, SRI assets change not only in dimensions, but also in type. The same research shows a meaningful shift from equities to bonds for the Canadian and European markets, in fact, while the 2014 data reveal a predominance of equities over bonds (50% of assets vs 40% respectively), this relation is reversed in 2016, with bonds overtaking equities (64% vs 33%).

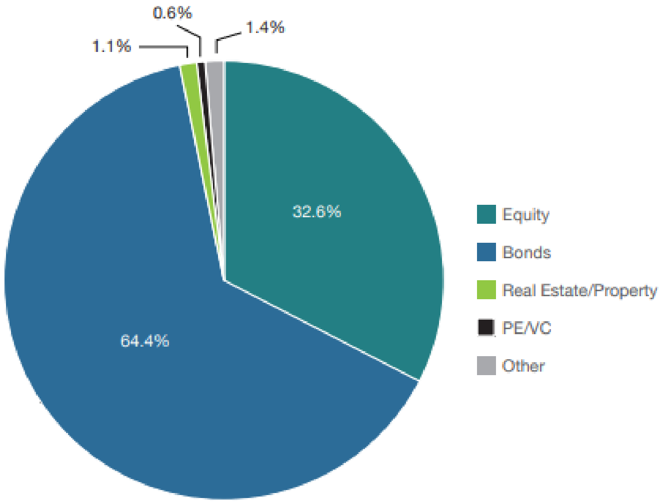


*Figure 1.6e: Asset Allocation in Canada and Europe*

## 1.7 Major players

As SRI has evolved, the number and variety of players in the field has increased. The major players in the SRI community today, as stated by Louche and Lydenberg, can be divided into three categories: asset owners, providers of support services to the SRI field, and related organizations.

### 1.7.1 Asset Owners

Asset owners can be divided, as previously anticipated, in two sections: institutional investors and retail investors.

*Retail investors* are individuals wishing to invest in companies with high ESG scores and to avoid those engaging in sin activities. Retail investors may participate in the SRI market individually or through retirement savings plans offered by institutional investors. They usually invest in SRI mutual funds and this market is particularly developed in the United States and Japan. In the United States, retail investors, along with religious organizations, were historically one of the driving forces of the RI movement as it evolved during the 1970s and 1980s (Louche and Lydenberg 2006). Data support this thesis, in fact according to the U.S. Social Investment Forum (2007), in the United States there were 260 SRI mutual funds with $202 billion of assets, and retail investors were the main clients of these funds.

*Institutional Investors* are large asset owners, such as pension funds and insurance companies that, since the late 1990s and particularly in Europe, have become a major factor in the SRI field (Albareda and Balaguer 2009). In this period, Europe experienced an increase of interest in sustainability and, as a consequence, institutional investors became increasingly interested too.

Furthermore, governments began promoting the ESG responsibility, and many pension funds began adopting sustainable rules. A relevant event for institutional investors has been the creation of the Principles for Responsible Investment (PRI) launched in 2006. By signing the PRI, pension funds and other large institutional investors agree to use six practices in their investing:

- Incorporate ESG issues into their investment analysis and decision making;
- Incorporate ESG issues into their ownership policies and practices;
- Seek ESG disclosure;
- Promote the PRI principles within the financial industry;
- Work cooperatively to implement the PRI principles;
- Report on progress in implementing the PRI principles.

### 1.7.2 Support Services

This class consists of money managers, financial consultants, research providers, and those offering engagement services.

*Money Managers and Financial Consultants*

With the growing market for SRI products, many money managers and financial institutions in the United Kingdom have felt compelled to apply sustainable practices to all their assets.

For example, F&C describes its commitment as "fundamental to our global investment philosophy across all our funds" and Hermes Asset Management describes itself as "completely committed to responsible investment and the long-term approach that it entails".

On the same path are financial consultants, those who advise managers helping them to implement their financial objectives. They are suiting their advices in order to recognize their clients' interest for sustainability.

*Research Providers*

Research providers are organizations that rate and rank publicly traded companies' sustainability performances, building ESG data based on their records. Their information is used mainly by institutional investors for investment decisions or shareholder engagement.

Some of the major research providers are EIRIS (United Kingdom), GES Investment Services (Scandinavia), Jantzi-Sustainalytics (Canada and the Netherlands), PIRC (United Kingdom), RiskMetrics Group (including KLD Research & Analytics, United States), SIRIS (Australia), and Vigeo (France).

*Engagement Services*

Engagement services aim to encourage corporations to positively change their behaviours and activities. There are many organizations with a focus on engagement but the most important are: F&C Investments, Principles for Responsible Investment Engagement Clearinghouse; GES Investment Services Engagement Forum.

In addition, some companies provide recommendations on how to vote on ESG issues during the many shareholder resolutions filed each year, these are called "proxy voting advisory services". The most important characters in this field are MSCI ESG Research and Glass Lewis in North America and PIRC in the United Kingdom.

## 1.8 Obstacles to ESG integration

According to the EFAMA, there are many obstacles which must be addressed by both policymakers and industry participants. For instance, the access to empirical data concerning many medium-long term risks can be difficult in particular for small issuers. Also, the data quality is still insufficient, despite it has dramatically improved over the last years. Additionally, asset managers might find it difficult to deal with the variety of new responsible investment methods required by various institutional clients, and on the other hand, acceptance by clients may also be problematic. Lastly, the technological solutions needed for the integration of ESG information must be improved as well.

## 1.9 Role of the governments

According to the EFAMA, responsible investment goes beyond legislation, encouraging corporate responsibility without the necessity of legislative requirements on investors in corporations. In its opinion, imposing this kind of rules would be less effective in achieving the public authority's goal. However, legislation is far more useful when it makes corporate socially responsible behaviour more transparent, as "the development of CSR should be led by enterprises themselves". Therefore, regulators can help improve CSR cognisance and awareness, for example by implementing mandatory reporting. In addition, the EFAMA does not consider necessary neither the standardisation nor the regulation of sustainable methods and procedures, regarding any legal requirement as overly restrictive and potentially detrimental to innovation. This is the reason why transparency must be the regulators' goal.

Additionally, the EFAMA believes that tax incentives are not the best way of promoting social responsibility as responsible integration impacts the asset manager's entire operation. Moreover, tax incentives can lead to inefficient capital allocations, and tax rules are a national, rather than EU competence.

## 1.10 Market drivers and future trends

### 1.10.1 Drivers of SRI demand

According to a research conducted by Eurosif in 2016, the main drivers for future growth are the following:

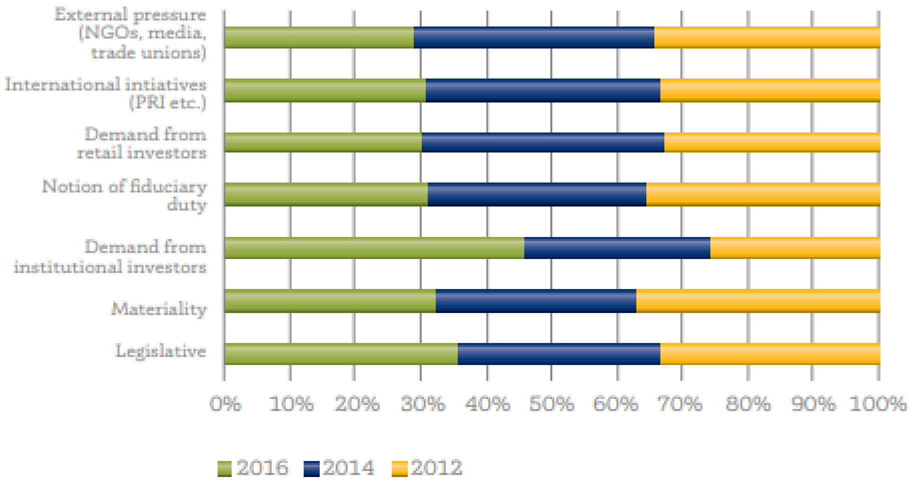


*Figure 1.10.1 Drivers of SRI Demand*

It is interesting to note that institutional investors became the principal driver for future growth, despite they were initially considered the less important factor. The decrease in the role played by external parties demonstrates that the industry is becoming increasingly mature and that exogenous drivers are the weakest ones. Many respondents to the survey also believed that legislation will be a key factor for future growth, hoping that regulators will do much to respond to their needs.

### 1.10.2 Drivers and Deterrents of SRI Strategies

Despite the leading role played by fiduciary duty as a main driver for SRI strategies, several fund managers see it as a deterrent to ESG criteria incorporation into their investment process. Fiduciary duty refers to the moral obligation of investors to act in the best interests of beneficiaries. This term has been too often interpreted by investors as a duty to maximise short-term financial return, but since ESG risks are significant for business, acting in the beneficiaries' best interest means having a long-term approach to business and fully including the ESG issues in investment decisions. Therefore, asset managers and institutional investors, should be able to measure and manage the ESG risks in their portfolios.

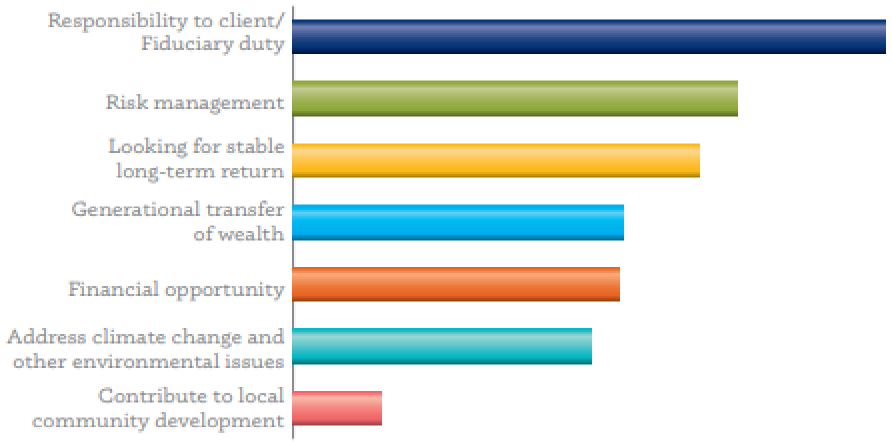


*Figure 1.10.2a: Drivers of SRI Strategies*

The survey has also investigated what are the main deterrents to SRI strategies. The first concern, as usual, regards performance, despite it has been proved that SRI strategies are almost never detrimental to portfolio performance. Conversely, a potentially bigger concern for the retail demand of responsible investments relates to the lack of viable products.

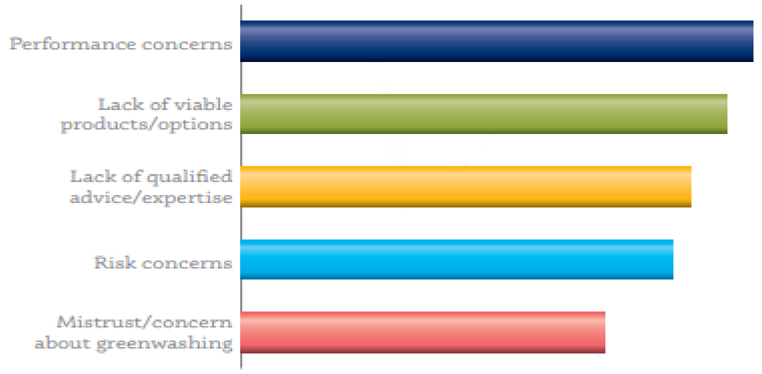


*Figure 1.10.2b: Deterrents of SRI Strategies*

# Chapter 2

# Literature Review

## 2.1 Hypothesis

There is much debate over whether or not SRI funds underperform conventional funds. This chapter aims to analyse the main results of previous studies which tried to answer this question.

However, before viewing the results, it is better to clarify the three different hypotheses made in these researches. In particular, Statman and Glushkov (2009) distinguish the following: “doing good but not well”, “doing good while doing well” and “no effect”.

### 2.1.1 Doing Good but not Well

This hypothesis states that the expected returns of socially responsible stocks are lower than the expected returns of conventional stocks. For instance, Abowd (1989) found that increases in wages increase the costs borne by a company without increasing the benefits to shareholders.

Jensen and Meckling (1976) and Bertrand and Mullainathan (2003) argued that managers might prefer to increase employee’s wages to create a pleasant working environment for themselves, even though the money comes from the shareholders who gain nothing from it.

A similar result was found by Barnea and Rubin (2006), who stated that managers are willing to engage in socially responsible actions whose costs exceed the benefits to shareholders because they achieve private benefits. These reasons explain the low returns to shareholders.

Another reason supporting this hypothesis comes from investors avoiding “sin” companies. Indeed, Heinkel, Kraus, and Zechner (2001) demonstrated that this strategy keeps low the prices of the stocks of sin companies, increasing their expected returns. This finding was supported by Hong and Kacperczyk (2007) who found that the realized returns of “sin” stocks were higher than the returns of other stocks.

### 2.1.2 Doing Good while Doing Well

According to this hypothesis the expected returns of socially responsible stocks are higher than those of conventional stocks. This situation could be reasonable if managers and investors underestimate the benefits of being socially responsible or overestimate its costs.

For instance, Edmans (2008) noted that sometimes companies underestimate the value of intangible capital because its cost immediately reduces current earnings, while its benefits are difficult to forecast. The same is true for the benefits of R&D expenditures: Lev, Sarath and Sougiannis (2004) found out that investors focus on reported profitability measures, underestimating the benefits of R&D.

Derwall (2005) proved that stocks of companies with good environmental records earned higher returns than other stocks. A similar result was achieved by Kempf and Osthoff (2007) who found that stocks of companies respecting the community, the environment and the human rights and promoting diversity and employee relations, did better than the other companies.

Additionally, Hamilton (1993) stated that investors could underestimate the probability of bad news concerning traditional companies: for instance, an oil spill may seriously impair a company reputation and profitability, therefore reducing the returns of conventional investors.

### 2.1.3 No Effect

The last hypothesis argues that the expected returns of socially responsible stocks are equal to the expected returns of conventional stocks. This might be true if social responsibility is costless or when the costs increase the benefits by the same amount, leaving profitability unchanged.

Using a previous example, this may happen when an increase in wages is offset by an increase in productivity. Even if the costs are greater than the benefits, the no effect hypothesis might still hold if investors overestimate the benefits of social responsibility actions or underestimate their costs.

Additionally, this hypothesis might be true if different elements compensate each other: an element which is coherent with the “doing good while doing well” hypothesis might be counterbalanced by another element which is coherent with the “doing good but not well” hypothesis. According to Statman (2008), companies with high scores on social responsibility characteristics such as community, employee relations and environment have a return advantage relative to conventional portfolios (consistent with the “doing good while doing well” hypothesis) however, companies engaging in ”sin” activities such as tobacco, alcohol, gambling, firearms, military, and nuclear operations, have an advantage relative to socially responsible companies (for a sustainable company this is consistent with the “doing good but not well” hypothesis). Therefore, socially responsible companies tend to offset the benefits deriving from the former characteristic, with the costs coming from the latter one.

## 2.2 Performance Measurement

The main methodology used to assess whether socially responsible portfolios have different performances with respect to the traditional ones, consists in obtaining the Jensen's alpha (Jensen, 1968) from benchmark models such as CAPM, Fama-French (1993) and Carhart (1997).

The CAPM regresses the excess returns of socially responsible stocks on the excess return of the market. The OLS estimation produces a constant (the Jensen's alpha) and a coefficient beta which represents the systematic risk. The Jensen's alpha measures the part of stock's return not explained by the level of systematic risk. A positive alpha indicates that the corresponding mutual fund outperforms the benchmark assets, while a negative one is a signal of underperformance.

Criticisms about CAPM have emerged over time, and many authors proposed alternatives to improve it, for instance using multi-factor models. Fama and French (1993, 1996) proposed the following three-factor model:

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t + \varepsilon_{it}$$

In this equation, $SMB_t$ (Small Minus Big) is the difference between the returns of diversified portfolios of small and big capitalization stocks, and $HML_t$ (High Minus Low) is the difference between the returns of diversified portfolios of high and low book-to-market stocks. According to Fama and French, portfolios with many small-cap companies should outperform portfolios with many large-cap companies over the long run. Similarly, companies with high book-to-market ratios should outperform those with lower book-to-market values.

A further improvement has been achieved by Carhart (1997) who introduced a four-factor model, adding a momentum element to the Fama-French regression, with the aim of capturing the momentum anomaly detected by Jegadeesh and Titman (1993).

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t + \beta_{ip}BW_t + \varepsilon_{it}$$

Where BW is the current month's difference in returns between the previous year's best-performing and worst-performing stocks.

Jegadeesh and Titman found out that stocks performing well (or bad) over a three to 12 months period tend to continue to perform well (poorly) over the subsequent three to 12 months. In a follow up study, Jegadeesh and Titman (2001) showed that momentum strategies remained profitable also in the nineties: the returns of a zero-cost portfolio with a long position in past winners and a short position in past losers were positive in every five-year period from 1965 to 2004.

Another method used to compare SRI and conventional portfolios performances consists in the use of spanning tests. Some researchers tried to find out whether one set of risky assets can improve the investment opportunities of another set of risky assets, or, in other words, whether adding a new set of risky assets improves the minimum-variance frontier from a given set of risky assets. Huberman and Kandel (1987) were the first researchers addressing this issue.

## 2.3 Results

Statman (2000) published the first major study of the 21st century regarding the performance of SRI funds. His research used 31 different SRI mutual funds and compared their performances with 62 conventional funds with similar size, between 1990 and 1998. The SRI funds generally outperformed the conventional funds, but the results were not statistically significant. Additionally, when using the S&P 500 as a benchmark, the average performance of both types of funds was worse than the index, with -5.02% annualized average difference for the SRI funds and -7.45% for the conventional funds. Only one socially responsible fund had a positive alpha relative to the S&P 500, while the mean annual alpha was negative (-5.02 pps). However, only three of the alphas were statistically significant. In addition, Statman found that the DSI 400 index had a higher Sharpe ratio than the S&P 500 index (0.97 vs. 0.92), which indicated that a mean-variance optimizing investor should prefer investing in the first index.

Statman evaluated also the Domini Social Index (DSI) performance relative to the S&P 500. The beta of the regression was 1.05, indicating that the DSI was slightly riskier than the S&P 500, and the alpha was 0.94 percent a year (not statistically significant).

Schröder (2004) analysed the performance of 40 US and 16 German and Swiss SRI funds and the performance of different SRI indices, between 1990 and 2002. Again, the focus was on the Jensen's alpha, concluding that 38 out of 46 SRI funds had a negative alpha, but just 4 were significant (5% significance level). This led to the implication that SRI funds did not underperform their benchmark. An additional finding concerned the funds exposition to different stocks. In particular, American SRI funds were more exposed to large-cap stocks whereas German and Swiss ones were more exposed to small-cap stocks. Additionally, most of the SRI indices examined had positive but statistically insignificant alphas, leading to the author's conclusion that investors do not have to expect a significantly lower performance due to the restricted investment universe.

Kreander, Gray, Power and Sinclair (2005) analysed the performance of 60 European funds: 30 SRI funds and 30 conventional funds, between January 1995 and December 2001. These funds came from the United Kingdom, Sweden, Germany and Netherlands, with 34, 14, 8 and 4 funds in each country respectively. The average weekly return for ethical and conventional funds during the period was 0.13%, but the average Sharpe ratio for ethical funds was slightly higher than the ratio for non-ethical funds (0.034 and 0.024 respectively). The average monthly alpha was 0.20% and 0.13% but the difference was not statistically significant.

Bauer, Koedijk and Otten (2005) conducted a research using the CAPM, the Fama-French 3-factor model and the Carhart 4-factor model to analyse 103 socially responsible funds in the period 1990-2001. The results corroborate the previous studies: there seems to be no significant difference in the returns of SRI conventional funds. In addition, the authors proved that German and US ethical funds passed through a learning phase: after an initial underperformance period in the beginning of the 1990s, they caught up conventional funds over the 1998-2001 period. Another sign of the learning process was documented by the better performance of older ethical funds (launched before the end of 1997) over the younger ethical funds (launched since 1998). Therefore, adding other factors such as book to market, capitalization and momentum to the analysis does not modify the previous findings even though the Carhart model seems to provide, as expected, more confident results when compared to the CAPM.

Bauer, Otten and Alireza Tourani Rad (2006) concentrated on the use of the Carhart 4-factor model, as previous studies had proven its superiority over the CAPM. The research was conducted for 25 SRI open-ended mutual funds and 291 conventional funds, in the period between November 1992 to April 2003.

The results were not unambiguous: the Australian ethical funds underperformed the conventional ones between 1992 and 1996, whereas between 1996 and 2003 ethical funds matched the performance of conventional funds more closely, undergoing a catching up phase. The overall result was an underperformance of -1.56% per year. Additionally, the international ethical funds had an opposite result, beating the conventional funds (+3.31%). However, both results were again not statistically significant.

Also, the research found out that ethical funds exhibited a significantly lower market exposure compared to conventional funds, and Australian funds were relatively more exposed to small caps.

Hamilton, Jo and Statman (1993) investigated the performance of 32 SRI funds and 320 randomly selected conventional funds in the US for the period between 1981 and 1990, measuring the Jensen's alpha against the NYSE index. They found different results, depending on the funds' age:  for the 17 SRI funds with a longer history (established before 1985), the average alpha was -0.06% per month, which was higher than the average monthly alpha (-0.14%) of the corresponding 170 conventional funds; instead, for the 15 SRI funds with a shorter history the average alpha was -0.28% per month, which was worse than the average monthly alpha (-0.04%) of the 150 conventional funds. However, these performance differences were not statistically significant.

Geczy, Stambaugh and Levin (2003) investigated the diversification cost of an investor who invested in SRI funds but not in conventional funds for the period 1963-2001. The authors constructed optimal portfolios using the mean-variance approach, adding short-sale constraints. The comparison was made between 35 SRI funds and 894 conventional funds, and the diversification cost caused by the SRI constraint was measured by the difference between the certainty-equivalent returns (the expected return that would make the investor indifferent from a riskless return) of the two portfolios. The results highlighted the presence of financial costs due to the SRI constraint on mean-variance optimizing investors. Additionally, the research demonstrated that the SRI cost depended on investors' believes in asset pricing models and fund managers' stock-picking skills.

For instance, investors who strongly believed in the CAPM and ruled out selection skills (a market index investor), borne a financial cost of just 5 basis points per month, instead an investor believing in multifactor pricing models, borne a cost of at least 30 basis points per month. The costs increased for investors who relied heavily on individual funds' historical risk-adjusted returns to predict future performances (more than 1.5% per month). Moreover, further restrictions such as the elimination of "sin" stocks from the investment universe, increased the monthly cost by an additional 10 basis points.

Additionally, the authors compared the performance of an equally weighted portfolio of 35 SRI funds to an equally weighted portfolio of 894 conventional funds. The monthly alpha measured by an extended version of the Carhart model proposed by Pastor and Stambaugh (2002) was higher for the SRI equally weighted portfolio (0.21% vs. 0.08%), but the difference was not significant. Meanwhile, the exposure to the size factor (SMB) was greater for the SRI portfolio than for the conventional one (0.20 vs. 0.16), implying a bias of SRI funds towards small-cap companies. Instead, the momentum factor and the book-to-market factor had a similar effect on both portfolios.

Goldreyer, Ahmed and Diltz (1999) studied the performance of 49 SRI funds for the period between 1981 and 1997, of which 29 were equity funds. The average Jensen's alpha of the SRI equity funds was not statistically different from that of the conventional equity funds, indicating a similar performance. The paper also found out that the SRI funds using positive screens outperformed SRI funds that used other screens (a monthly alpha of -0.11% vs -0.81% respectively). The difference is statistically significant with a t-statistic of 3.36.

Barnett and Salomon (2006) analysed the effect of more stringent social screens on the returns of 67 SRI funds. They found a non-linear relationship between fund performance and investment screens. The returns declined at first, but then rebounded as the number of screens reached a maximum, and this was true for both positive and negative screens.

According to Pena and Cortez (2017) investors can pursue their ethical investment policies without sacrificing financial returns. Their research investigated the relationship between the risk-adjusted performance and the screening strategies of 330 US and European mutual funds compliant with social responsibility criteria. The period examined by the authors goes from 2003 to 2014 and finds out different results for US and Scandinavian funds and the other European funds. The former showed a curvilinear relationship between screening intensity and performance. In particular, US funds had an inverted U-shaped effect, while Scandinavian funds exhibited a U-shaped effect which was consistent with Barnett and Salomon (2006). UK funds instead showed a negative linear relationship between the number of screens and returns, while other European countries did not have significant relationships. Additionally, US funds were negatively impacted by environmental and products screens, while corporate governance screens improved their performance. Instead, UK funds using products screens had a stronger performance.

Derwall, Gunster, Bauer and Koedijk (2005) analysed the relation between stock returns and environmental performance over the period 1997-2003, constructing equity portfolios based on the "eco-efficiency" scores from Innovest Strategic Value Advisors. They used the Carhart four-factor model and demonstrated that a portfolio of firms with high environmental scores based on positive screening outperformed a portfolio of firms with low scores by 6% per year. Two reasons could explain these results: the stock market undervalued the environmental information; or the highest return could have captured the premium of some missing risk factors in asset pricing models.

Kempf and Osthoff (2007) investigated the relation between diverse socially responsible screens and financial performance of US stocks in the S&P 500 and Domini 400 Social Index, using the KLD Research & Analytics Inc. data for the period from 1991 to 2004. They used a multitude of socially responsible criteria: a negative screen excluding all companies involved in the alcohol, tobacco, gambling, military, firearms or nuclear power business; different positive screens evaluating the company performance on community, diversity, employee relations, environment, human rights and product. The authors distinguished between high-rated and low-rated portfolios: the high-rated portfolio consisted of stocks with high ratings on the investigated screen, and the opposite holds true for the low rated portfolio. The methodology employed consisted in the use of the Carhart four-factor model. The results for the positive screening indicated that there was no performance loss for high-rated portfolios, also if the positive screen was combined with a negative one. Instead, investors using the low-rated portfolio generally had to pay a performance penalty. Kempf and Osthoff also analysed the performance of a trading strategy going long in the high-rated portfolio and short in the low-rated portfolio, founding an abnormally positive performance of the trading strategies.

Stone, Guerard, Gultekin, and Adams (2001) studied the impact of social screening strategies on actively managed portfolios, from 1984 to 1997, using the social screens provided by Kinder, Lydenberg, and Domini (KLD). They reached the conclusion that SRI screens do not affect significantly the portfolio performance of actively managed portfolios.

Diltz (1995) analysed 28 stock portfolios over the period 1989-1991, to assess whether ethical screening affected portfolio performance. The research used eleven distinct ethical screens and three combinations of screens, revealing little impact. He used the Jensen's alpha as performance indicator, founding out that the market appeared to reward good environmental performance, charitable giving, and the absence of nuclear and defence work, and it appeared to penalize firms providing family-related benefits such as parental leave, job sharing, and dependent care assistance. However, the author's overall evaluation of results was consistent with the "no effect" hypothesis.

Galema, Plantinga and Scholtens (2009) analysed the diversification consequences of socially responsible investing. The main questions investigated in this study were:

- Does restricting the universe to socially responsible stocks decrease diversification opportunities of investors in terms of foregone returns?
- Does restricting the universe to socially responsible stocks decrease diversification opportunities of investors in terms of foregone risk reduction opportunities?
- Does restricting the universe to socially responsible stocks decrease diversification opportunities of investors when they are subject to short sales constraints?

The ratings data on social responsibility were obtained from KLD Research & Analytics, for more than 2,000 US based companies for the period 1991-2004. They used mean-variance spanning tests to investigate whether socially responsible investors were worse off in mean-variance terms. For investors who did not face a short sales restriction, they found that spanning was rejected for all the SRI constraints except governance, therefore, restricting the universe often limited diversification possibilities. Instead, for investors facing a short sales restriction, spanning was almost never rejected, suggesting that without the possibility to take short positions, SRI investors were not worse off by avoiding conventional stocks. However, it must be specified that investors that paid a price in terms of foregone risk reduction opportunities, did not suffer any loss in terms of returns.

Hong and Kacperczyk (2009) investigated the effects of social norms on markets by studying "sin" stocks. They hypothesized that investors and institutions subject to norms, paid a financial cost in abstaining from "sin" stocks. They used data on US firms coming from CRSP and Compustat, over the period 1962-2006. From CRSP they obtained daily closing stock prices, daily shares outstanding, and daily dollar trading volumes for NYSE, Amex, and Nasdaq stocks, instead from Compustat they obtained annual information on a variety of accounting variables. As done in other researches, they used the CAPM, the three-factor Fama-French model and the four-factor Carhart model. The results were consistent with their hypothesis, in fact they found that "sin" stocks were less held by norm-constrained institutions such as pension plans as compared to mutual or hedge funds. "Sin" stocks also had higher expected returns since norm-constrained investors cannot buy.

Becchetti, Ciciretti, Dalo and Herzel (2014) investigated the performance of SRI and conventional funds in different market segments over the period 1992-2012, using a sample of more than 22,000 funds. The evaluation was made using the single-factor and multi-factor models and through the use of the beta-distance "nearest neighbour" approach comparing pairs of SRI and conventional funds based on proximity in terms of risk factors. They found three main results, confirmed by descriptive evidence, by econometric evidence through one-factor and multi-factor models, and by the nearest neighbour approach that looked at differences in Jensen's alphas between pairs of SRI and conventional funds close in terms of risk factors. The first results confirmed that there was no clear dominance of any investment style over the others. Secondly, after the financial crises socially responsible superfunds generally performed better than conventional ones. Third, the diversification constraint influencing SRI funds did not worsen their performance most of the times.

Renneboog, Ter Horst, and Zhang (2007) studied the risk and return characteristics of SRI mutual funds around the world for the period 1991-2003, using a database consisting of 463 SRI mutual funds in the US, UK, Continental Europe and Asia-Pacific. They hypothesized that investors may be willing to pay a premium for firms meeting socially responsible standards, leading to a stock price above the fundamental value, and therefore to an underperformance. Using a multi-factor model, the authors noticed that SRI funds in many European and Asia-Pacific countries underperformed domestic benchmark portfolios, while the risk-adjusted returns of SRI funds in the UK and US were not statistically different from those of conventional funds. Additionally, they found mixed results on the existence of a "smart money" effect in the SRI fund industry: investors were unable to identify the funds that would have outperformed their benchmarks, but they had the ability to identify the SRI funds that would have performed poorly. They also found that the SRI constraints on the investment universe had a minimal impact on risk diversification, and funds employing more SRI screens had better returns, in accordance with Barnett and Salomon's research (2006).

Statman and Glushkov (2009) analysed the performance of socially responsible stocks for the period 1992-2007, using ratings by KLD and the companies in the S&P 500 and Domini 400 Social Index. Later, the companies were expanded to the ones included in the Russell 1000 Index and in the Russell 3000 Index. They used the CAPM, the three-factor Fama-French model and the four-factor Carhart model. The authors found that investors who invested in companies with good SRI scores had a return advantage relative to conventional investors. However, the exclusion of "sin" companies from the investment universe brought to the opposite result. Therefore, the results were often offset, leading to an overall neutral position.

Herzel, Nicolosi, Stărică (2012) examined the impact of sustainability constraints in optimal portfolio decision-making. Their investment universe included the components of the S&P500 from 1993 to 2008. The research compared the efficient frontiers with and without screening, focusing on the three main dimensions of sustainability: environmental, social and governance. They found that socially responsible screening had a great impact on the market capitalization of the optimal portfolio, but it slightly reduced the Sharpe ratio. In addition, by using the spanning test, they found that the ex-post differences between the two frontiers, when short selling was not allowed, were significant only in the case of environmental screening. instead, if short-selling was allowed, the spanning test almost always rejected the null hypothesis of spanning, meaning that the two frontiers were different. These results were coherent with the ones obtained by Galema et al. (2009).

## 2.4 Literature Conclusions

These researches provide the overall conclusion that socially responsible investments and conventional investments have very similar performances, therefore the “no effect” hypothesis seems to hold true most of the times. This result could be slightly different if the analysis is conducted in certain geographical areas for specific time periods, or with the use of particular screening strategies. Additionally, some researches highlighting differences between SRI and conventional strategies, agree that the inclusion of a short-selling constraint cancels most of the differences.

# Chapter 3

# Models

## 3.1 Markowitz Model

This research is based on the Modern Portfolio Theory proposed by Markowitz. This theory introduces the Mean-Variance model which consists in selecting a group of assets with lower collective risk than any of the single assets, allowing to build a maximum return portfolio for a given risk as well as a minimum risk portfolio for a given return. This information is expressed in the concept of "Efficient Frontier", a line in the risk-return space that highlights the portfolios with minimum risk for different given returns.

Modern Portfolio Theory relies on many assumptions, the main ones are the following:

- There are no transaction costs nor taxes and there is no bid-ask spread.
- There are no weights limitations, meaning that an investor can take any position of any size. Additionally, the investor has no impact on the market, thus his positions cannot move the market.
- The investor is interested in the total return; therefore, he is indifferent towards receiving dividends or capital gains.
- Investors are rational and risk adverse. They are aware of all the risk contained in the investments and demand a higher return for a greater volatility.
- Investors seek to control risk only through portfolio diversification.
- Politics and investor psychology have no influence on market.
- An investor either maximizes his return for the minimum risk or maximizes his portfolio return for a given level of risk.
- Analysis is based on a single period model of investment.

It's exactly because of the many assumptions that the Modern Portfolio Theory has been subjected to critics. For instance, behavioural economists criticize the model reliance on investors' rationality. Additionally, investors have often biased expectations regarding returns and variance. However, all the assumptions are in contrast with the real world, for instance it is obviously unfeasible for an investor to take any position, there are in fact minimum order sizes and securities cannot be bought or sold in fractions, and most of the time an investor can't sell short. Similarly, the other assumptions demonstrate the flaws in the model but at the same time are necessary for the implementation.

The model requires specific information about the assets, namely their expected returns and the expected variance-covariance matrix of returns. These can be estimated with different approaches: sample estimators, exponential smoothing methods (such as moving averages with weights decreasing over time), models taken from the literature (such as CAPM, APT, VARMA-GARCH).

Given these inputs, the portfolio return and portfolio variance are:

$$\mu_p = r'w = \sum_{i=1}^{n} r_i w_i$$

$$\sigma_p^2 = w'\Sigma w = \sum_{i=1}^{n} w_1^2 \sigma_i^2 + 2\sum_{i=1}^{n} \sum_{j=i+1}^{n} w_i w_j \sigma_i \sigma_j \rho_{ij}$$

As previously mentioned, the efficient frontier is the set of all the efficient portfolios, obtained fixing the return and minimizing the risk. An efficient portfolio is the solution of the following problem:

$$\min_w w'\Sigma w$$

$$\mu_p = w'r$$

$$w'1_n = 1$$

Where $w'\Sigma w$ is the variance of portfolio $P$, the second element is the constraint imposing a target return, and the third element is the constraint imposing the sum of the weights equal to 1, therefore guaranteeing the full investment of the available funds.

To obtain the optimal solution we need to minimize the Lagrangian function:

$$\min_w L(w) = \frac{1}{2} w'\Sigma w - \lambda_1 (w'1_n - 1) - \lambda_2 (w'r - \mu_p)$$

Given the scalars $A = r' \Sigma^{-1} r$ $B = 1_n' \Sigma^{-1} r$ $C = 1_n' \Sigma^{-1} 1_n$

and $\Delta = AC - B^2$

The optimal solution is

$$w^* = \frac{A\Sigma^{-1}1_n - B\Sigma^{-1}r}{AC - B^2} - \frac{C\Sigma^{-1}r - B\Sigma^{-1}1_n}{AC - B^2}\mu_p$$

To determine the portfolio variance, the optimal weights are used in the variance expression leading to a relation between $\sigma_p^2$ and $\mu_p$ that represents the efficient frontier

$$\sigma_p^2 = \frac{C}{\Delta}\mu_p^2 - \frac{2B}{\Delta}\mu_p + \frac{A}{\Delta}$$

For the research, two portfolios will be particularly useful: The Global Minimum Variance and the Maximum Trade-Off. The first one is the portfolio at the vertex of the hyperbola representing the efficient frontier and is obtained by simply minimizing the portfolio variance under the full investment constraint:

$$\min_w w'\Sigma w$$

$$w'1_n = 1$$

The maximum Trade-Off is instead the result of a maximization problem which aims to maximize the ratio between the expected return and the expected standard deviation, always under the full investment constraint:

$$\max_w \frac{w'r}{\sqrt{w'\Sigma w}}$$

$$w'1_n = 1$$

The minimization and maximization problems lead to the following results:

$$w_V^* = \frac{\Sigma^{-1}1_n}{1_n'\Sigma^{-1}1_n} \quad r_V = \frac{r'\Sigma^{-1}1_n}{1_n'\Sigma^{-1}1_n} \quad \sigma_V = \frac{1}{\sqrt{1_n'\Sigma^{-1}1_n}}$$

$$w_T^* = \frac{\Sigma^{-1}r}{1_n'\Sigma^{-1}r} \quad r_T = \frac{r'\Sigma^{-1}r}{1_n'\Sigma^{-1}r} \quad \sigma_T = \frac{\sqrt{r'\Sigma^{-1}r}}{|1_n'\Sigma^{-1}r|}$$

These solutions have a drawback: they could easily suggest taking extreme positions in different assets, and this could lead to a portfolio too exposed to certain markets. In practice, there are also legal constraints binding the position size, and many investors cannot use short selling. This is the reason why the former expressions must be adapted, considering different needs.

The first way to get rid of extreme solutions consists in imposing positivity of weights: if a weight can't be negative, also extreme positive weights will be avoided as the sum of the weights must always be equal to 1 (weights will be included between 0 and 1). This result is achieved by solving the problem:

$$\min_{w} w'\Sigma w$$

$$\mu_p = w'r$$

$$w'1_n = 1$$

$$w_i \geq 0 \quad i = 1,2,\ldots n$$

In this case, the optimal weights must be estimated using numerical methods since an analytical solution does not exist. The efficient frontier will be upward and downward limited: the upper bound is obtained by investing only in the asset with the highest expected return; the lower bound instead is obtained by investing in the choice providing the highest expected return among the GMV portfolio and the asset with the lowest return.

The constrained efficient frontier is shifted to the right with respect to the unconstrained one, since the positivity constraint, as all constraints, reduces the diversification opportunities, limiting the available portfolios.

The second way to avoid extreme solutions consists in imposing upper and lower bounds to every asset or group of assets using linear equalities and inequalities. In this case the lower bound could be negative, therefore allowing short selling. In this situation the problem to be solved is:

$$\min_{w} w'\Sigma w$$

$$\mu_p = w'r$$

$$w'1_n = 1$$

$$L \leq w_i \leq U \quad i = 1,2,\ldots n$$

The upper bound must be reasonable, in fact if there are few assets a very low upper bound will be useless. For instance, if there are just 10 assets, an upper bound of 0.1 will lead to an equally weighted portfolio since the weights must sum up to 1.

By construction, the efficient frontier with bounds allows for fewer possible portfolios, therefore it will be narrower and shifted to the right compared to the one with no constraints.

As mentioned above, another problem connected with the Markowitz model comes from its assumption of absence of transaction costs. To overcome this problem, turnover constraints can be added to the model, reducing the number of changes in positions, thus reducing transaction costs to a tolerable level. More precisely, the turnover is a measure of how much a portfolio changes in time, and it is calculated as the sum of the absolute values of the weights difference between two periods. The problem becomes now:

$$\min_{w} w'\Sigma w$$

$$\mu_p = w'r$$

$$w'1_n = 1$$

$$\frac{1}{2}|w - \widetilde{w}|'1_n \leq \tau$$

Where $\widetilde{w}$ is the actual portfolio composition or a reference portfolio composition and $\tau$ is the maximum turnover expressed as the fraction of portfolio that changes. The changes are divided by 2 as closing a position implies the opening of another one, for instance a 10% portfolio change implies trades for 20% of the portfolio value but the turnover constraints aim to control just the 10% change.

## 3.2 Chow-Kritzman Model

The just mentioned approach is the basic Markowitz model, however, in this research I will try to deepen the analysis, using two other models. The first one was introduced by Chow and Kritzman, who aimed to solve some Markowitz' shortcomings.

The basic mean-variance model does not distinguish between different levels of uncertainty when estimating the inputs. However, economic conditions can vary significantly, oscillating between a steady state characterized by low volatility and economic growth, and a turbulent state characterized by high volatility and economic contraction.

Regime shifts represent challenges for portfolio managers. For example, Ang and Bekaert (2002) demonstrated that correlations between international equity market returns increase in highly volatile bear markets, lowering the benefits of international diversification. Indeed, previous studies have shown that international diversification is less effective in periods of contraction than in periods of expansion, due to sudden increases in correlations during economic downturns.

Recently, Chua, Kritzman and Page (2009) conducted an empirical study on conditional correlations and concluded that diversification based on unconditional covariances is largely a myth, as it fails in market environments when diversification is most needed.

Therefore, it may be preferable to manage risk on the basis of regime specific estimates of the relevant inputs, building regime-dependent investment strategies.

According to Chow, Jacquier, Kritzman and Lowry (1999), we can define the concept of financial market turbulence as a condition in which asset prices behave in an uncharacteristic way given their historical pattern of behaviour, including extreme price moves, decoupling of correlated assets, and convergence of uncorrelated assets.

The financial turbulence can be noticed by looking at a multivariate distance measure (also called "squared Mahalanobis distance"):

$$d_t = (y_t - \mu)\Sigma^{-1}(y_t - \mu)'$$

$y_t$ = vector of observed asset returns for period t

μ = sample average vector of historical returns

∑ = sample covariance matrix of historical returns

If we assume that the returns are distributed according to a multivariate normal distribution with expectations coincident with the historical/sample moments, i.e.

$$Y_t \sim N(\mu, \Sigma)$$

then, the measure of market turbulence is distributed as a sum of squared standardized normal random variables, and therefore

$$D_t \; = \; D{\sim}X^2(n)$$

this can be used to statistically detect the presence of multivariate outliers among the returns by comparing the sample value (i.e. $d_t$) computed for each time t with the corresponding critical value (given a first order error probability, α) of the *D* distribution (*Dα*). Therefore, an outlier will be identified if $d_t \geq D_t$ otherwise it will be considered an inlier.

The two subsamples have different behaviours and expectations in terms of returns and in terms of risk: returns will be higher and slightly positive for inliers, lower and potentially negative for outliers, instead variances and covariances will be higher and positive for outliers, lower and mixed for inliers.

The Chow-Kritzman model considers the information of both regimes by averaging their outcomes using a given probability $p$ of incurring into a market stress condition.

$$\mu = (1 - p)\mu_{IN} + p\mu_{OUT}$$

$$\Sigma = (1 - p)\Sigma_{IN} + p\Sigma_{OUT}$$

However, the use of a fixed probability $p$ might be considered naive. Therefore, the approach has been implemented using the Hidden Markov Model. This approach allows to modify $p$ in every point in time, according to the actual market condition, providing a more reliable value for the probability of incurring into a market stress condition.

It relies on the turbulence measure to infer what the actual market condition is. In fact, a high or low turbulence measure does not necessarily imply a stressed or quiet market condition. Instead, the observed turbulence is just an indicator of the probability of being in a certain market condition in a specific moment. Therefore, in every period, $p$ is calculated and it is then used to estimate the new inputs of the model.

To fully define the Hidden Markov Model and given N possible states $s_1, s_2, \dots, s_N$, the following probabilities must be specified:

Matrix of Transition Probabilities: $A = (a_{ij}),\ a_{ij} = P(s_i|s_j)$

Matrix of Observation Probabilities: $B = (b_i(v_m)),\ b_i(v_m) = P(v_m|s_i)$

The Vector of Initial Probabilities: $\pi = (\pi_i),\ \pi_i = P(s_i)$

The model is therefore represented by $M = (A, B, \pi)$.

This model is based on the Markov Assumption and on the Output-Independent Assumption: the former states that the state transition depends only on the origin and destination, the latter states that all observation frames are dependent on the state that generated them, not on neighbouring observation frames.

The Hidden Markov Model has three main issues to solve:

- The Evaluation Problem aims to calculate the probability that model M has generated the observed sequence $O = o_1, o_2, \dots, o_K$ where $o_i \in \{v_1, \dots, v_M\}$

- The Decoding Problem aims to calculate the most likely sequence of hidden states $s_i$ that produced the observation sequence O given the model M.

- The Learning Problem aims to adjust M to maximize the probability, given some training observation sequence $O = o_1, o_2, \dots, o_K$ and a general structure of a Hidden Markov Model (numbers of hidden and visible states, if any).

### 3.2.1 Evaluation Problem

An approach could consist in trying to find the probability of observations $O = o_1, o_2, \dots, o_T$ considering all the hidden state sequences (where the state sequence is represented by S):

$$P(o_1\, o_2 \dots o_T\,) = \sum\nolimits_{all\ S} P(o_1\, o_2 \dots o_T\,, S) = \sum\nolimits_{all\ S} P(o_1\, o_2 \dots o_T\, |S) P(S)$$

Where $P(S) = \pi_{s_1} a_{s_1 s_2} a_{s_2 s_3} \dots a_{s_{T-1} s_T}$ for the Markov Assumption

and $P(o_1\, o_2 \dots o_T\, |S) = \prod_{t=1}^{T} b_{s_t}(o_t)$ for the Output-Independent Assumption

However, there are $N^T$ hidden state sequences, which means an exponential complexity. So, there is the necessity to use a Forward-Backward algorithm for efficient calculations. It is necessary to define the forward variable $\alpha_k(i)$ as the joint probability of the partial observation sequence $O = o_1, o_2, \dots, o_k$ and the hidden state at time $k$ is $s_i$:

$$\alpha_k(i) = P(o_1\, o_2 \dots o_k, q_k = s_i)$$

The Forward Recursion for the Hidden Markov Model consists of three steps:

1. Initialization

$$\alpha_1(i) = P(o_1, q_1 = s_i) = \pi_i b_i(o_1) \quad for\ 1 \le i \le N$$

2. Forward Recursion

$$\alpha_{k+1}(j) = P\big(o_1\, o_2\, \dots o_{k+1}, q_{k+1} = s_j\big) =$$

$$\sum\nolimits_i P\big(o_1\, o_2\, \dots o_{k+1}, q_k = s_i, q_{k+1} = s_j\big) = \sum\nolimits_i P(o_1\, o_2\, \dots o_k, q_k = s_i) a_{ij} b_j(o_{k+1}) =$$

$$\left[\sum_i \alpha_k(i) a_{ij}\right] b_j(o_{k+1})$$

3. Termination

$$P(o_1\, o_2 \ldots o_K) = \sum_i P(o_1\, o_2\, \ldots o_K, q_K = s_i) = \sum_i \alpha_K(i)$$

Now it is necessary to define the backward variable $\beta_k(i) =$ as conditional of the partial observation sequence $O = o_{k+1}, o_{k+2}, \ldots, o_K$ and the hidden state at time $k$ is $s_i$:

$$\beta_k(i) = P(o_{k+1}\, o_{k+2} \ldots o_K |\, q_k = s_i)$$

The Backward Recursion for the Hidden Markov Model is divided in:

1. Initialization

$$\beta_K(i) = 1 \quad for\; 1 \leq i \leq N$$

2. Forward Recursion

$$\beta_K(j) = P\big(o_{k+1}\, o_{k+2}\, \ldots o_K | q_k = s_j\big) =$$

$$\sum_i P\big(o_{k+1}\, o_{k+2}\, \ldots o_K, q_{k+1} = s_i | q_k = s_j\big) =$$

$$\sum_i P(o_{k+2}\, o_{k+3}\, \ldots o_K | q_{k+1} = s_i) a_{ji} b_i(o_{k+1}) = \sum_i \beta_{k+1}(i) a_{ji} b_i(o_{k+1})$$

3. Termination

$$P(o_1\, o_2\, \ldots o_K) = \sum_i P(o_1\, o_2\, \ldots o_K, q_1 = s_i) =$$

$$\sum_i P(o_1\, o_2\, \ldots o_K | q_1 = s_i)\, P(q_1 = s_i) = \sum_i \beta_1(i)\, b_i(o_1) \pi_i$$

Therefore, by combining the two parts the results are the following:

$$\alpha_k(i) \beta_k(i) = P(o_1\, o_2 \ldots o_K, q_k = s_i)$$

$$P(o_1\, o_2 \ldots o_K) = \sum_{\boldsymbol{i}} \alpha_k(i) \beta_k(i)$$

### 3.2.2 Decoding Problem

The Viterbi algorithm can be used to find the state sequence $Q = q_1, \ldots, q_K$ which maximizes $P(Q|o_1\, o_2 \ldots o_K)$ or $P(Q, o_1, o_2, \ldots, o_K)$, solving this section's problem.

The maximum probability of producing the observation sequence $O = o_1, o_2, \ldots, o_k$ when moving along any hidden state sequence $q_1, \ldots, q_{k-1}$ and getting into $q_k = s_j$ can be expressed by a variable $\delta_k(j) = max\, P(q_1, \ldots, q_{k-1}, q_k = s_j, o_1, o_2, \ldots, o_k)$, where the maximum is computed by considering all the possible paths $q_1, \ldots, q_{k-1}$.

If the best path ending in $q_k = s_j$ goes through $q_{k-1} = s_i$, then it should coincide with the best path ending in $q_{k-1} = s_i$. Therefore, the previous expression becomes:

$$\delta_k(j) = max_i\left[a_{ij} b_j(o_k) max\, P(q_1, \ldots, q_{k-1} = s_i, o_1, o_2, \ldots, o_{k-1})\right]$$

1. Initialization

$$\delta_1(i) = max\, P(q_1 = s_i, o_1) = \pi_i b_i(o_1)$$

2. Forward recursion

$$\delta_k(j) = maxP\left(q_1, \ldots, q_{k-1}, q_k = s_j, o_1, o_2, \ldots, o_k\right) =$$

$$max_i\left[a_{ij} b_j(o_k) max\, P(q_1, \ldots, q_{k-1} = s_i, o_1, o_2, \ldots, o_{k-1})\right] =$$

$$max_i\left[a_{ij} b_j(o_k) \delta_{k-1}(i)\right]$$

3. Termination and Backtracking

   This section aims to choose the best path ending at time $K$ such to compute $max_i[\delta_K(i)]$, then the final step consists in the backtracking of the best path.

### 3.2.3 Learning Problem

This problem is usually solved by reverting to the Baum-Welch (known as Forward-Backward) algorithm and the EM (Expectation-Maximization) algorithm. The algorithm requires first the definition of a variable $\gamma_k(s)$ such that:

$$\gamma_k(s_i) = P[q_k = s_i | O, M]$$

which is the probability that the system is at state $s_i$ at time $k$, given the observation sequence $O = o_1, o_2, \dots, o_T$ and the model $M$. Using smoothing it becomes:

$$\gamma_k(s_i) = \frac{\alpha_k(s_i)\beta_k(s_i)}{P[O|M]} = \frac{\alpha_k(s_i)\beta_k(s_i)}{\sum_{s\in Q}\alpha_K(s_i)}$$

To compute how many times the state trajectory is expected to pass from state $s_i$:

$$\boldsymbol{E}[\#\ of\ transitions\ from\ s_i] = \sum_{k=1}^{K-1}\gamma_k(s_i)$$

And similarly:

$$\xi_k(s_j, s_i) = P\left[q_k = s_j,\ q_{k+1} = s_i | O, M\right] = \eta_k \alpha_k(s_j) A_{s_j,s_i} B_{s_i,o(k+1)} \beta_{k+1}(s_i)$$

Where $\xi_k(s_j, s_i)$ is the probability of being at state $s_j$ at time *k*, and at state $s_i$ at time $k + 1$, given the observations and the current HMM model, and $\eta_k$ is a normalization factor, such that $\sum_{s_j,s_i}\xi_k(s_j, s_i) = 1$.

Now, to compute how many times the state trajectory is expected to pass from state $s_j$ to state $s_i$:

$$\boldsymbol{E}\left[\#\ of\ transitions\ from\ s_j\ to\ s_i\right] = \sum_{k=1}^{K-1}\xi_k(s_j, s_i)$$

Based on the probability estimates and expectations computed so far using the model M = (A, B, π), a new model M' = (A', B', π') can be constructed, sharing the same states and observations. The new initial condition distribution is the one obtained by smoothing:

$$\pi'_{s_i} = \gamma_1(s_i)$$

The entries of the new transition matrix and the entries of the new observation matrix are respectively:

$$A'_{s_j,s_i} = \frac{\boldsymbol{E}\left[\#\ of\ transitions\ from\ s_j\ to\ s_i\right]}{\boldsymbol{E}\left[\#\ of\ transitions\ from\ s_j\right]} = \frac{\sum_{k=1}^{K-1}\xi_k(s_j, s_i)}{\sum_{k=1}^{K-1}\gamma_k(s_j)}$$

$$B'_{s_i,m} = \frac{\boldsymbol{E}[\#\ of\ times\ in\ state\ s_i\ when\ the\ observation\ was\ m]}{\boldsymbol{E}[\#\ of\ times\ in\ state\ s_i]}$$

$$= \frac{\sum_{k=1}^{K} \gamma_k(s_i)\,.\,1(o_k = m)}{\sum_{k=1}^{K} \gamma_k(s_i)}$$

Baum et al. (1970) demonstrated that the model $M'$ is such that $P[O|M'] \geq P[O|M]$.

## 3.3 Michaud Model

The second model used in this research to deepen the analysis is the one proposed by Michaud. According to Michaud (1989), since there are no exact estimates of either expected returns or variances and covariances, these estimates are subject to estimation errors. The model gives precedence to securities with high expected return and negative correlation and underweights those with low expected returns and positive correlation. However, according to Michaud, these securities are those that are most subject to large estimation errors. An estimator is “admissible” if there exists no other estimator that dominates it for a given risk or loss function[1]. Stein (1955) has shown that, under standard conditions, sample means are not an admissible estimator of expected returns as they ignore the inherent multivariate nature of the problem, so they can only be considered suboptimal. Therefore, the use of historical data to produce a sample mean and the replacement of the expected return with the sample mean contributes to the error-maximization of the Markowitz mean-variance model. Additionally, mean-variance optimizations are highly unstable (small changes in the input assumptions can lead to large changes in the solutions). A reason explaining this behaviour is the ill-conditioning of the covariance matrix: an ill-conditioned matrix will generally result in unstable solutions. This state could be the result of input assumptions that do not reflect financially meaningful estimates, or the use of parameter estimates based on insufficient historical data. In addition, the process produces a unique optimal portfolio for any given level of risk. However, this appearance of exactness could be misleading as the solution depends on the erroneous assumption that the inputs are without statistical estimation error. In fact, given a point in the efficient frontier, there is a neighbourhood of points that includes an infinite number of statistically equivalent portfolios, which may have radically different structures.

In the seminal paper “The Markowitz Optimization Enigma: Is 'Optimized' Optimal?”, Michaud dealt with the estimation error problem introducing the concept of resampled frontier. Portfolios

[1] Admissibility is a minimum condition used to reduce the decision problem without loss of relevant information (E. Lehmann, Testing Statistical Hypothesis, 1959).

on the resampled frontier are composed of assets weight vectors which are the average of the mean-variance efficient portfolios weight vectors given a certain level of portfolio return. After averaging, the weight vectors on the resampled frontier still sum up to one. The resampled weight for a portfolio m (portfolio number along the frontier) is given by

$$w_m^{resampled} = \frac{1}{T}\sum_{i=1}^{T} w_{i,m}$$

where $w_{i,m}$ denotes the weight vector of the $m^{th}$ portfolio along the frontier for the $i^{th}$ resampling.

The initial resampling process consists in generating simulated returns by taking $T$ draws from the input distribution and calculate a new variance-covariance matrix from the sampled series. With these new inputs a new efficient frontier (the $i^{th}$) is calculated and the optimal portfolio weights are recorded. This process is repeated many times in order to build many new efficient frontiers, then the portfolios weights of different EF are averaged for every given return. At the end, the frontier of averaged portfolios is compared with the one obtained using historical sample returns and variance-covariance matrix.

The resampling process has the advantage to produce portfolio allocations which are less sensitive to input perturbations. The reason behind this result is the greater diversification and lower riskiness of the resampled portfolios with respect to the classical Markowitz portfolios.

Additionally, the resampling process guarantees a stable process as it is based on averages, therefore, a small change in the inputs is generally associated with a small change in the optimal portfolios, providing protection against the overfitting of data.

However, there are also disadvantages. Firstly, this process does not have a sound theoretical foundation as it cannot be argued theoretically that the resampled portfolios outperform the mean-variance efficient portfolios. Secondly, the averaging process of the resampled portfolios is not supported by a statistical reason. Additionally, the process of resampling uses the original estimate of the mean return vector and the variance-covariance matrix to simulate $\mu^*$and $\sum^*$ and evaluate the resampled efficient frontier, amplifying any errors in the original estimation.

# Chapter 4

# Empirical Research

This chapter describes the procedures used to assess the impact of SRI strategies on portfolio performance. The first part describes the data selection process and management, then the focus will be on the methodologies used to implement the SRI strategies.

## 4.1 Data

As mentioned above, this research aims to analyse how the SRI strategies perform in the European market. For this reason, the investment universe is the STOXX Europe 600, a broad European equity index derived from the STOXX Europe Total Market Index and it is a subset of the STOXX Global 1800 Index.

The reference index is composed by 600 components and includes large, mid and small capitalization companies across 17 countries of the European region[2]. The index was introduced in 1998 and is reviewed quarterly, in March, June, September, December. The various monthly constituents of the index, from January 2001 to December 2017, were retrieved from Thomson Reuters Eikon. Then, using Matlab, I obtained the list of all companies that have been included in the index in the period of interest (2001-2017). The result was a list of 1278 companies for which the daily price in Euros (expressed as Total Return) was subsequently downloaded from Eikon. The prices expressed in foreign currencies have been converted in euros using the daily value of the exchange rate. Prices were then used to compute daily returns for the period of interest.

## 4.2 ESG Ratings

In addition to daily prices, monthly ESG ratings were downloaded to implement the SRI strategies. As previously mentioned, the ESG ratings are not a "0-1" variable, instead they are scores that range from 0 to 100 depending on the company level of compliance with certain characteristics.

[2] Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

By using Thomson Reuters Eikon, after having selected the companies of interest, you can access to the Asset4 ESG database. It provides environmental, social and governance (ESG) information based on more than 250 indicators computed from 750 data points, for more than 4000 companies worldwide, so it is an excellent database for people looking to investigate sustainability and governance on a company level. The entire process produces three numeric values for each company:

1. **Raw Score:** every company with at least one reported KPI in a given year is scored from 0 to 1 for each pillar, and each pillar is based on many Key Performance Indicators (KPI). Environmental Ratings are derived from a total of 70 KPIs; Social Ratings are derived from a total of 88 KPIs; and Governance Ratings are derived from a total of 68 KPIs.

2. **Ratings**: To eliminate idiosyncratic characteristics and assure comparability the raw scores are converted into ratings using a particular procedure. The raw scores are normalized and adjusted for skewness and the differential between the mean and the median, then fitted to a bell curve to derive ratings between 0 and 100 for each company.

3. **Percentile Rank**: Percentile ranks are calculated for all companies and are based on the companys' raw scores.

The values I was interested in for this research were the ratings for the Environmental (ENV), Social (SOC) and Corporate Governance (GOV) pillars for the 1278 companies. These were equally weighted to provide an overall assessment of performance. I did not consider the economic performance score, as it is not meaningful for an ESG analysis.

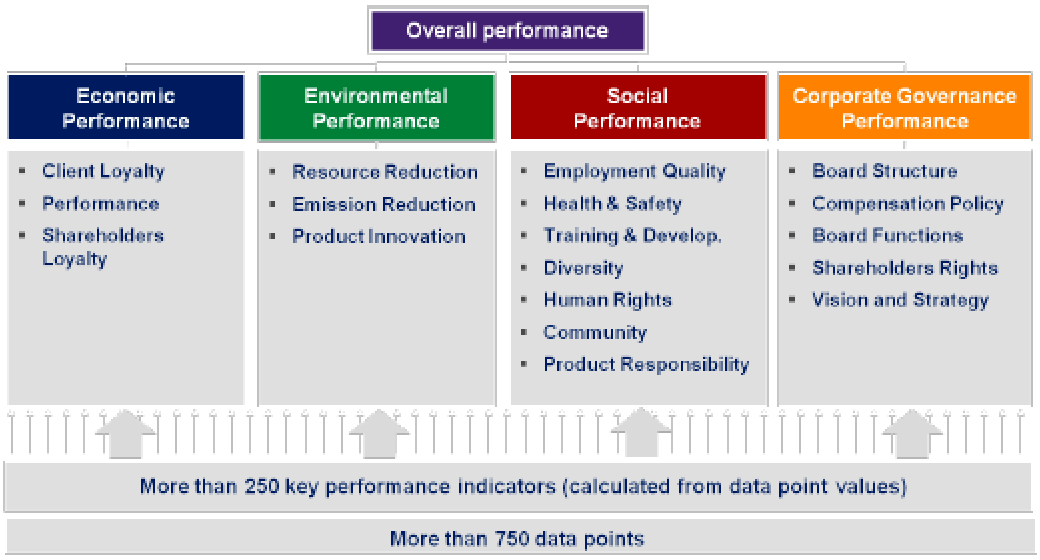


*Figure 4.2: ESG Pillars according to Asset4*

## 4.3 SIN Activities

The exclusion of companies under a certain threshold of the ESG score is just one of the two ways of selecting an SRI universe of companies. The second way is excluding all the entities that are associated or involved in activities considered to be unethical or immoral.

The necessary monthly data were downloaded using the same platform and consisted in "yes"-"no" responses, indicating whether there was a participation to such activity for that month or not. These unethical practices were: production of alcoholic beverages, gambling activities, production of tobacco, production of vehicles, planes, armaments, or any combat materials used by the military and production or distribution of pornography. Hence, the results are 5 monthly responses for each company.

Once downloaded, they had to be elaborated to assure that the participation to just one of those businesses would have implied the exclusion of the company from the investment universe.

## 4.4 Data Elaboration

For practicality, I thought it would have been better to work with something summarizing all these data, for this reason I followed this approach: all the matrices including companies' data (203 months x 1278 companies) were firstly ordered alphabetically, and secondly five new matrices were built (one for each strategy). These were composed by zeros and ones indicating whether for that month, that company was included in the investment universe or not. With this elaboration, every subsequent step can rely on these matrices.

In matrix number 1 a '1' was present if that month, that company was included in the STOXX Europe 600, so no SRI constraints were applied.

In matrix number 2, 3 and 4 a '1' was present if that month, that company was included in the STOXX Europe 600 and if it was above a predefined ESG threshold (50%, 70%, 90%).

In matrix number 5 a '1' was present if that month, that company was included in the STOXX Europe 600 and if it was not involved in any "sin" activity.

In the four matrices with SRI constraints, companies with no ESG or SIN data available were excluded from the universe (so a '0' is present for all months).

Moreover, to implement any strategy there is a necessary requirement that must be satisfied: every company must have enough past data. In particular, the chosen temporal window is 5 years long, so for every month a '1' can be assign only if the previous 5 years of daily data are available. The result of this procedure is that, even in the case with no SRI restrictions, the investment universe is not necessarily coincident with the 600 index components.

## 4.5 Strategies Implemented

As previously mentioned, there are two different types of data: the ESG score is a value from 0 to 100, while the sin data is a 0-1 value. Therefore, two different SRI strategies can be implemented: a negative screening strategy (also called ethical screening strategy) that consists in excluding all the assets involved in sin activities, and a positive screening strategy that, vice versa, consists in selecting companies with the ESG score above a pre-defined threshold.

For the latter, the Best-in-Universe methodology was adopted, so the companies were chosen among all the companies in the investment universe, on the contrary, a Best-in-Class methodology would have implied an industry by industry selection.

In the positive screening strategy, three different thresholds were chosen to observe how the portfolio performance changed: 90%, 70% and 50%.

## 4.6 Parameters Estimation

The use of efficient frontiers to estimate the best portfolio composition requires the use of reliable ways to estimate the assets' means and covariances. This section describes the three ways adopted in the research for the estimation.

### 4.6.1 Sample Moments

In this case, given a series of returns, assets' moments are calculated as the historical means and covariances.

$$\hat{\mu} = \frac{1}{T}\sum_{t=1}^{T} R_t$$

$$\hat{\Sigma} = \frac{1}{T}\sum_{t=1}^{T}(R_t - \hat{\mu})(R_t - \hat{\mu})'$$

Where $\hat{\Sigma}$ represents the variance-covariance matrix estimation. The diagonal includes the assets' variance estimators $\hat{\sigma}_i^2 = \frac{1}{T}\sum_{t=1}^{T}(R_{i,t} - \hat{\mu}_i)^2$ while the other elements are the assets' covariance estimators $\hat{\sigma}_{ij} = \frac{1}{T}\sum_{t=1}^{T}(R_{i,t} - \hat{\mu}_i)(R_{j,t} - \hat{\mu}_j)$.

### 4.6.2 Exponentially Weighted Moving Average

The second parameters estimator aims to give greater importance to recent observations through the use of a "smoothing factor" which weighs past observations, this is the so called Exponentially Weighted Moving Average (EWMA). The general form is:

$$\boldsymbol{r_t} = \frac{1}{\bar{\lambda}} \sum_{j=1}^{t} \lambda_j r_{t-j} \quad \text{where} \quad \bar{\lambda} = \sum_{j=1}^{t} \lambda_j$$

Usually $\lambda_j = (1-\lambda)\lambda^{j-1}$ with $\lambda \in (0.9, 0.99)$. Additionally, it must be noted that

$$\sum_{j=0}^{t} \lambda^j = \frac{1-\lambda^{t+1}}{1-\lambda}$$

therefore $$\bar{\lambda} = \sum_{j=0}^{t} (1-\lambda)\lambda^j = 1 - \lambda^{t+1}$$

Since $\lambda^{t+1}$ is small for common choices of $t$ and $\lambda$, the sum of weights $\bar{\lambda}$ is close to 1. These observations lead to the result:

$$\boldsymbol{r_t} = \sum_{j=1}^{t} (1-\lambda)\lambda^{j-1} r_{t-j} = (1-\lambda) r_{t-1} + \lambda \sum_{j=1}^{t-1} (1-\lambda)\lambda^{j-1} r_{t-j-1}$$

$$\boldsymbol{r_t} = \sum_{j=1}^{t} (1-\lambda)\lambda^{j-1} r_{t-j} = (1-\lambda) r_{t-1} + \lambda \boldsymbol{r_{t-1}}$$

Similarly, for the evaluation of the covariance matrix, assuming returns have a zero mean:

$$\textstyle\sum_t = (1-\lambda) r_{t-1} r'_{t-1} + \lambda \textstyle\sum_{t-1}$$

Where bold letters represent the estimators.

### 4.6.3 Equilibrium Moments

The third methodology consists in the use of the Capital Asset Pricing Model to calculate the returns. To describe this model, it is useful to distinguish between systematic and idiosyncratic risk. The first refers to market risks that cannot be eliminated through diversification (for instance, interest rate fluctuations and recessions are sources of systematic risk), instead the second is specific to individual stocks and can be reduced with a proper diversification strategy.

In the CAPM model beta is a measure of systematic risk of a security in comparison to the market and can be seen as the tendency of a security's returns to respond to fluctuations in the market. Therefore, it can be used to compare a stock's market risk to that of other stocks. A beta of 1 indicates that the security's price will move with the market. A beta lower or greater than 1 means that the security will be, respectively, less or more volatile than the market. It is calculated using regression analysis:

$$r_{i,t} - rf_t = \alpha_i + \beta_i(r_t^m - rf_t) + \varepsilon_t$$

In equilibrium, the expected return is:

$$\boldsymbol{E}[r_{i,t}] = rf_t + \beta_i(\boldsymbol{E}([r_t^m] - rf_t)$$

The variance is decomposed into systematic and idiosyncratic risks:

$$\boldsymbol{V}[r_{i,t}] = \beta_i^2 \boldsymbol{V}[r_t^m] + \sigma_\varepsilon^2$$

And in equilibrium:

$$\boldsymbol{V}[R_t] = \beta\beta' \boldsymbol{V}[r_t^m] + diag(\sigma_{\varepsilon_1^2, \varepsilon_2^2, \dots \varepsilon_k^2})$$

## 4.7 Constraints

The basic Markowitz model allows for short-selling and for potentially extreme weights. However, these results might be unfeasible to implement even for professional investors and of course they are unfeasible for individual private investors. Here comes the necessity to limit the exposures. Fortunately, all these “problems” can be easily solved using the MATLAB Portfolio function. In particular, for every strategy considered, the following cases were applied:

- Case 1: No restrictions applied, weights can be negative and extreme;
- Case 2: No short-selling, all weights must be positive and, since they sum up to 1, they must be included between 0 and 1, so they are not as extreme as in case 1;
- Case 3 and 4: two levels of upper and lower bounds were applied; this case allows for short-selling but limits the weights’ dimensions on both directions;
- Case 5: Turnover constraints were introduced; this case allows for short-selling and extreme weights but, once the initial portfolio is built up, the turnover constraint limits portfolio revisions with the aim to avoid extreme transaction costs. However, this case was not implemented because of its excessive computational power requirement.

## 4.8 Models used

By now, I’ve explained how the parameters have been estimated and which constraints have been applied. As introduced in chapter 3, the Chow-Kritzman and the Michaud approaches have been introduced in this research to deepen the results of the standard Markowitz model. For all these three models, the same constraints were imposed, and the inputs were estimated using the formulas in paragraph 4.6, however, for the Resampled Frontier approach the inputs were estimated only with Sample Estimators and Equilibrium Estimators, therefore disregarding the EWMA case.

## 4.9 Track records of allocation strategies

This research employs different constraints and different approaches to recover the inputs of the models. But then it is necessary to compare the pros and cons of every single allocation methodology. To achieve this result, I simulated every portfolio allocation strategy for an extended period and I tracked the portfolio performance over time, assessing the evolution of returns and risks. Given the relevant amount of assets, evaluating the evolution of weights through an area plot or a bar plot would be trivial. Therefore, the focus remains on portfolio performances.

The realized returns are computed by multiplying assets’ weights by returns, and the cumulated returns are calculated as follows:

$$R_t = \left[\prod_{i=m+1}^{t} (1 + r_i)\right] - 1$$

Where *m* is the time window used for the parameters’ estimation.

Monthly returns can be compared by looking at their descriptive statistics: mean, median, minimum, maximum, standard deviations, quantiles, skewness, kurtosis and total return over the sample. However, different investment strategies can be compared using several performance measures which have the common element of being ratios of a reward index and a risk measure. They can be divided between absolute and relative performance measures.

## 4.10 Absolute Measures

### 4.10.1 Sharpe Ratio

The Sharpe ratio is a metric which aims to measure the desirability of a risky investment strategy or instrument, and it is computed as the average return earned above the risk-free rate per unit of volatility. The subtraction of the risk-free rate from the mean allows to isolate the performance associated with risk-taking activities, in fact a portfolio investing in a zero-risk activity has a Sharpe ratio equal to zero.

$$Sh = \frac{\overline{r_p} - r_f}{\sigma_p}$$

When comparing different investments, the one with the highest Sharpe ratio is considered the most attractive. However, if the asset returns are not normally distributed, this ratio could lead to misinterpretations. For instance, kurtosis and skewness can be problematic, as standard deviation doesn't have the same effectiveness when these situations exist.

### 4.10.2 Sortino Ratio

The Sharpe ratio has some value as a measure of investment quality, but it also has a few limitations. The main flaw is that it does not distinguish between upside and downside volatility: high outlier returns can have the effect of increasing the value of the denominator (standard deviation) more than the value of the numerator, lowering the value of the ratio.

Additionally, for positively skewed return distributions, the risk suggested by the Sharpe ratio is higher than the real one. Conversely, for negative skewed return distributions the Sharpe ratio underestimates the real risk.

The Sortino ratio is based on the different desirability of downside and upside volatility, considering only the former as a source of risk. Therefore, this ratio improves the Sharpe ratio by isolating downside volatility from total volatility and dividing the excess return by the downside deviation.

$$So = \frac{\overline{r_p} - r_f}{\sigma_{pN}}$$

Where $\sigma_{pN}$ is the standard deviation of negative returns.

### 4.10.3 Treynor Ratio

This ratio indicates how much return an investment earned for the amount of risk assumed. As for the Sharpe ratio, the excess return refers to the difference between the return earned and the risk-free rate. However, this indicator has a different denominator: the risk in the Treynor ratio refers to the market risk measured by beta (systematic risk).

$$Sh = \frac{\overline{r_p} - r_f}{\beta}$$

This measure relies on the use of proper benchmarks to measure beta. For instance, if it is used to measure the risk-adjusted return of a mutual fund investing in large capitalization companies, it would be inappropriate to measure the beta using an index composed of small capitalization companies. In addition, this ratio ignores the reward for unsystematic or unique risk.

### 4.10.4 Value-at-Risk

Value-at-risk is a quantile of the returns density and it satisfies:

$$\int_{-\infty}^{Var(\alpha)} R_t f(R_t) dR_t = \alpha$$

That is, the probability of observing returns below the VaR (α) equals α. Alternatively, the VaR (α) can be defined as the maximum loss that an investment can suffer with probability 1-α in a horizon equivalent to the returns' frequency, therefore with probability α the loss will be larger than the Value-at-Risk, but in this case no information about the extent of losses is provided by the VaR. Additionally, two investments could have the same VaR but different returns distribution in case of extreme losses. Therefore, in this case the VaR approach would suggest that the investments have identical risk, even though in extremely bad situations an investment is worse than the other.

### 4.10.5 Expected Shortfall

The Expected Shortfall is a conditional expectation calculated as the average of all losses which are greater or equal than the VaR. It is important to clarify that this measure is not the worst-case scenario, since the worst-case scenario is always a 100% loss. For 95% VaR, the ES will represent the average of outcomes in the worst 5% of the cases.

$$ES(R_t, \alpha) = \boldsymbol{E}[R_t | R_t \leq VaR(\alpha)]$$

The Expected Shortfall was proposed to overcome a limit of the VaR, the lack of the sub-additivity property of a risk measure (the VaR of a portfolio should be smaller than the combination of the VaR of the underlying assets) and the fact that the VaR does not take into account the severity of an incurred damage event.

### 4.10.6 Drawdown

The Drawdown of a portfolio is its peak-to-trough[3] decline over a period. At a given starting point, the Drawdown is set at zero ($D_1 = 0$) and then it is calculated as:

$$D_t = min(0, (1 + D_{t-1})(1 + R_t) - 1)$$

The Drawdown sequence is graphically analysed to identify the largest losses and the recovery time and allows to compare several strategies and identify the best one (a good strategy has small losses and quick recoveries from the minimums). Risk measures based on the Drawdown consider the largest Drawdown or functions of the largest Drawdowns.

### 4.10.7 Sterling Ratio and Calmar Ratio

The Sterling ratio is the return per unit of extreme risks where those are set to the average of the k largest Drawdowns (with k being small and the Drawdowns taken in absolute value). Instead, the Calmar ratio is calculated using the largest Drawdown as denominator. Therefore, the Sterling-Ratio is less sensitive to outliers than the Calmar-Ratio

$$Ste = \frac{\overline{r_p}}{\frac{\sum_1^k DD_k}{k}}$$

$$Cal = \frac{\overline{r_p}}{DD_1}$$

Where DD is the vector containing the Drawdowns in descending order.

### 4.10.8 Farinelli-Tibiletti Ratio

The Farinelli-Tibiletti ratio is a ratio between an upside and a downside partial moment of the portfolio return distribution. In particular it is the ratio of average gains to average losses with respect to a target $\tau$, each raised by a power index, $p$ and $q$.

[3] The stage of the business or market cycle from the end of a period of growth (peak) into declining activity and contraction until it hits its ultimate cyclical bottom (trough)

$$FT(\tau, p, q) = \frac{\boldsymbol{E}[max(R_t - \tau)^p]^{1/p}}{\boldsymbol{E}[max(\tau - R_t)^q]^{1/q}}$$

This ratio allows to express the favour (disfavour) of upside (downside) deviations of various investors. Different risk indicators can be obtained by changing $p$ and $q$: if p = 1 and q = 2, the result is the upside-potential ratio; if p = q = 1, the result is the Omega ratio. Thus, the Farinelli-Tibiletti ratio expresses investors' preferences in respect of returns and associated risks.

### 4.10.9 Composite Index

The use of several performance measures could easily lead to contrasting results, therefore there is the necessity of using a summarizing measure. The use of a composite index summing up all ranks could be the solution; however, many performance measures have similar informative content leading to similar ranks, therefore, the selection of performance measures for the composite index is important to avoid redundancy.

## 4.11 Relative Measures

In many cases it is useful to compare the portfolio performance with respect to a market, to risk factors or to a benchmark. The latter is of fundamental relevance for the evaluation of managed portfolios whose purpose is to beat a certain benchmark. The deviations of the portfolio return from those of the benchmark are called Tracking Errors.

$$TE = \boldsymbol{E}[R_t - R_t^B]$$

$$TEV = \boldsymbol{V}[R_t - R_t^B]$$

These measures are called Tracking Error (TE) and Tracking Error Volatility (TEV), and their ratio TE/TEV is known as Information Ratio (IR). The IR is equivalent to a Sharpe Ratio computed on tracking errors and without the risk-free. The Tracking Error Volatility can be computed only on downside deviations, obtaining the Semi-TEV and, consequently, the Semi-IR.

# Chapter 5

## Results

As mentioned above, for each strategy both the Global Minimum Variance and the Max Sharpe portfolios will be analysed and tracked over time. This allows to compare different strategies through the use of performance indicators. The first comparison aims to find differences between conventional portfolios and sustainable ones, using the three typologies of estimators for mean and covariances. Then the analysis will concentrate on another topic which was often discussed in previous works: the importance of short selling restrictions to enhance portfolio performances. At the end of the chapter I will introduce the findings coming from the resampling process. Appendix 1 contains the additional information used to compare the strategies.

### 5.1 Sample Estimators

#### 5.1.1 Sample Estimators and Negative Screening

When negative screening is applied (no sin companies in the investment universe), all indicators seem to agree that Global Minimum Variance portfolios, combined with upper and lower bounds of 5% for each asset, are superior to any other investment strategy. In addition, the application of the static Chow-Kritzman model (second highlighted row) improves the results. Instead, for several strategies allowing short selling, Max Sharpe portfolios underperform their corresponding Global Minimum Variance ones. Another relevant fact is that most strategies consistently beat the benchmark: just few extreme strategies provide lower performances when the MS portfolio is chosen. This result is confirmed by the IR and the Semi-IR calculation in Appendix 1. The Static Chow-Kritzman model has little effect on performances and it seems to be useful to enhance GMV portfolios performances. Additionally, when the bounds increase, portfolios performances worsen, despite the improvement expectations.

Figure 5.1.1 shows the cumulated returns of two GMV portfolios using sample estimators and negative screening. It shows those portfolios’ cushioning ability during the last financial crises, and their performance above the market throughout the period of interest.

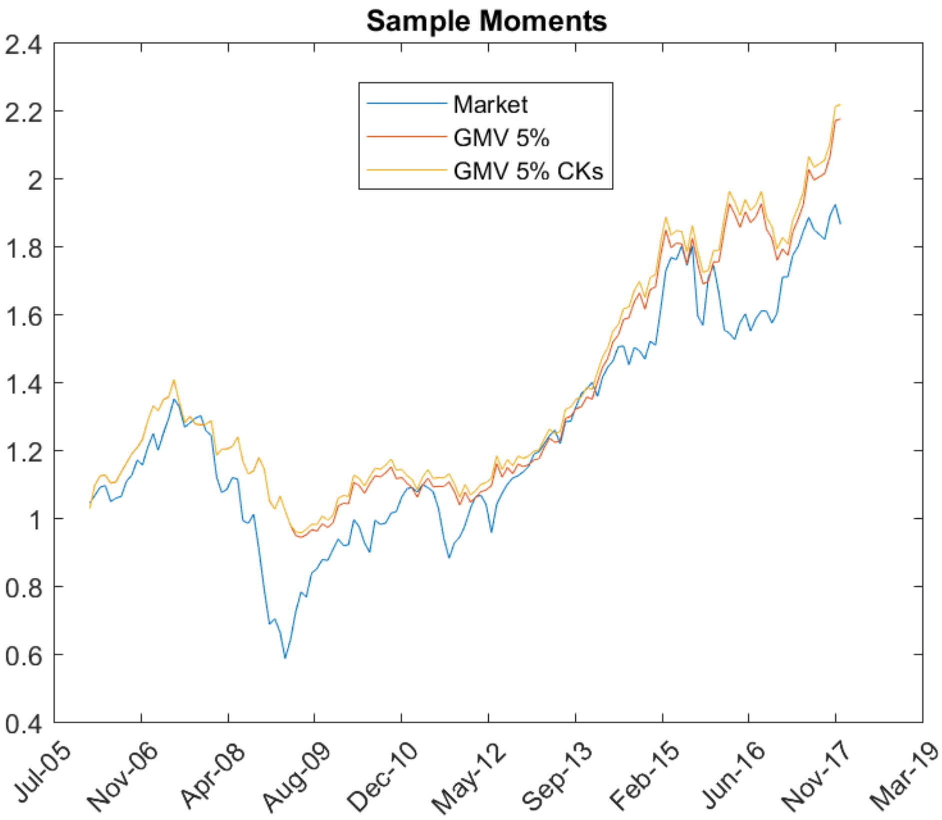


*Figure 5.1.1: Negative Screening*

### 5.1.2 Sample Estimators and Positive Screening

When applying a positive screening strategy, the threshold separating "good" companies from "bad" ones plays an important role in portfolio performances. In fact, the application of a positive screening of 90% reduces the investment sample to such an extent that performance is markedly reduced with respect to looser screenings: as reported in the Appendix, screenings using a threshold of 50% and 70% provide better results.

While most of the other strategies consistently beat the reference benchmark, the 90% screening portfolio has worse performances than the Stoxx 600, and only the use of the no-short selling restriction allows an investor using this screening to beat the benchmark.

Generally, the Global Minimum Variance portfolio has better performances with respect to the Max Sharpe portfolio when the positive screening is imposed at the 50% and 70% levels. Additionally, when comparing the 50% screening with the 70% one, the latter appears to overwhelm the former, especially among the no-short selling strategies. This is in contrast with the standard idea that the greater the investment sample, the better the performance, while it still confirms the need to broaden the universe built with a 90% screening. The IR and Semi-IR confirm this result: when using the 90% screening these indicators are many times negative, instead the 70% screening guarantees the best performances among the three screening levels.

Figure 5.1.2 shows two GMV portfolios using a 70% screening compared to the reference index.

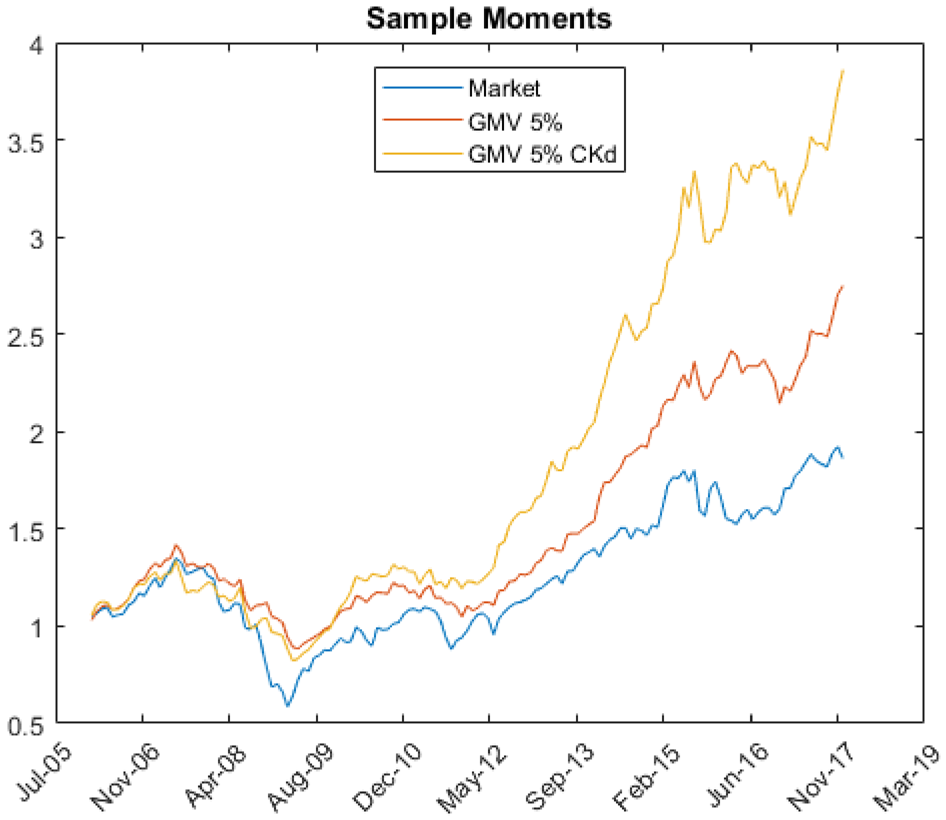


*Figure 5.1.2: 70% Positive Screening*

### 5.1.3 Sample Estimators and No Screening

This is the broadest case, and it includes all the assets with available data. The sample estimators allow to create portfolios which are often able to beat the benchmark in terms of performance indicators. The use of a no-short selling restriction is particularly effective in achieving this result, and almost always the Global Minimum Variance portfolio beats its corresponding Max Sharpe portfolio. Additionally, when the MS portfolio is implemented without short sales restrictions, they always perform worse than the benchmark. Also, when the upper and lower bounds increase (e.g. from 0.05 to 1) the performance worsens.

When using relative performance indicators, the scene is less positive as most of the time the IR is negative, and of course the same holds true for the Semi-IR. This contrasts with several sustainable portfolios: as seen before the negative screening strategies often lead to IRs greater than zero, and the use of a 70% or 50% positive screening is particularly effective in obtaining positive IRs.

As mentioned above, the 5% bounds are particularly effective. Two results are presented in figure 5.1.3.

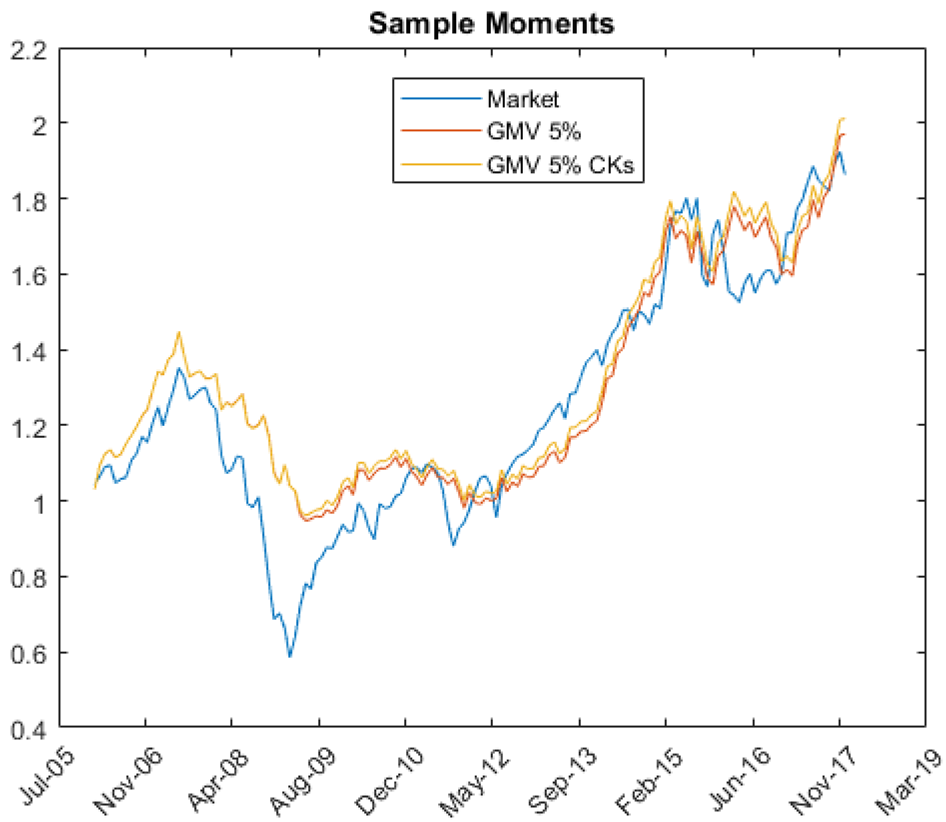


*Figure 5.1.3: No Screening*

## 5.2 Exponentially Weighted Moving Average

### 5.2.1 EWMA Estimators and Negative Screening

These results have been obtained using a 0.99 weight in the formula. Analogously to the approach adopting Sample Estimators, the EWMA case produces portfolios superior to the benchmark according to the performance indicators. By looking at the tables it can be noticed that all the approaches including a short selling restriction obtained better results than the Stoxx 600. In particular the MS portfolios beat their corresponding GMV ones likewise the previous case. However, when short selling is allowed the situation is reverted, with the GMV allocations overwhelming the MS strategies. Again, as the bounds increase the portfolios decrease in profitability, sometimes performing worse than the benchmark. Particularly negative results are obtained in the unconstrained approach. A remarkable point is the ability of the Static Chow-Kritzman model to improve performances, especially when applied to GMV portfolios.

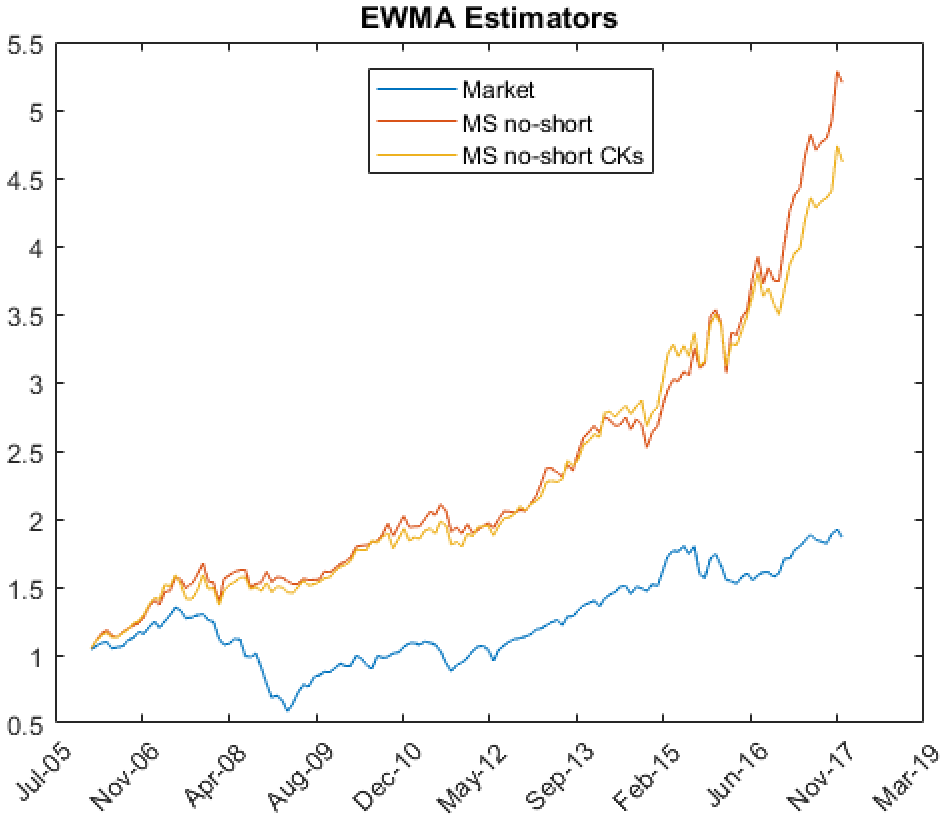


*Figure 5.2.1: Negative Screening*

### 5.2.2 EWMA Estimators and Positive Screening

Even with the use of EWMA estimators, the 90% screening demonstrates to be inferior to the other approaches as most of the times it performs worse than the benchmark. Again, only the case without short selling allows to obtain more profitable results, despite its counter-intuitiveness. In addition, the Chow-Kritzman model does not seem to provide any useful way to get around the problem, maybe due to the limited diversification opportunities offered by the reduced investment universe. The IR corroborates the superiority of the no-short selling case.

The enlargement obtained with a 70% screening shows to be optimal as most of the strategies beat the benchmark. In particular, the dynamic Chow-Kritzman approach allows to build the most profitable portfolios, even though it seems to be more effective in the GMV case. Additionally, most of the times the MS portfolios are overwhelmed by their corresponding GMV portfolios, and the performance is inversely proportional to the upper and lower bounds dimensions, coherently with the earlier findings.

While the use of sample estimators proved the superiority of the 70% screening, the EWMA approach has contrasting results because neither the 50% screening nor the 70% one can be considered the greatest. However, in both cases most strategies beat the Stoxx 600 in terms of performance indicators and IR.

The following figure shows the good results obtained with the Dynamic Chow-Kritzman approach when the 70% and the 50% positive screenings are chosen, highlighting a substantial equivalence among the two screenings and the two bounds.

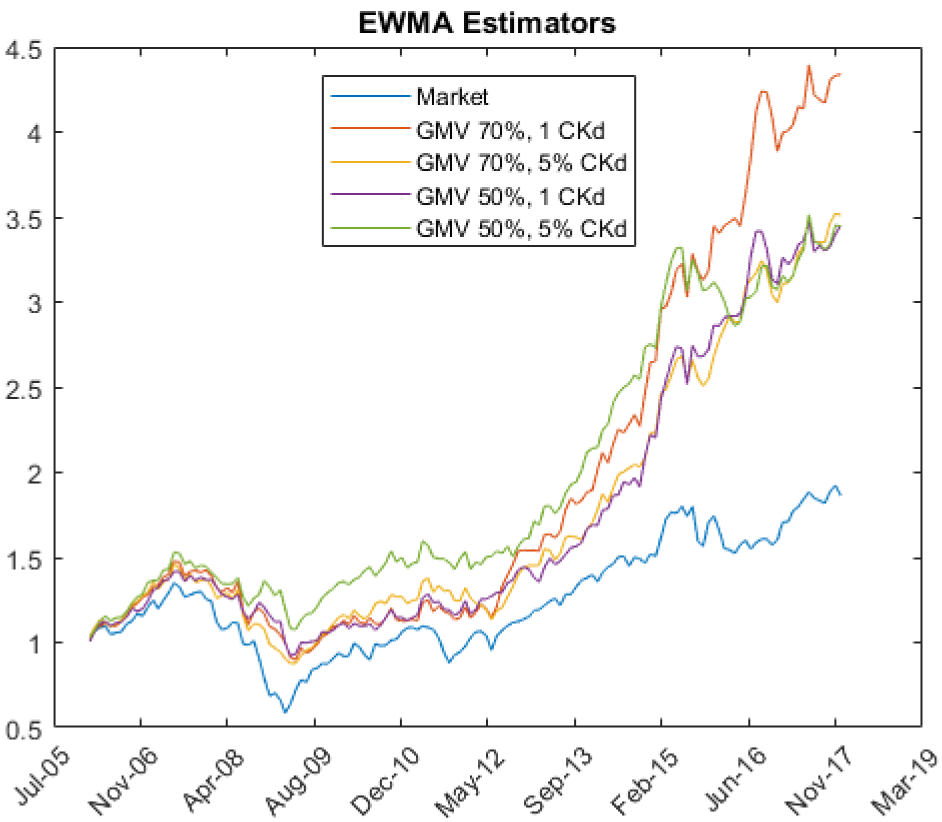


*Figure 5.2.2: Positive Screening*

### 5.2.3 EWMA Estimators and No Screening

This case highlights again the importance of short sale restrictions: all portfolios compliant with this rule overperform the Stoxx 600, while most of the others have bad performances. Among these best performers, MS portfolios are particularly profitable when compared to GMV ones, however this is not true when short sales are allowed. In addition, the Chow-Kritzman implementation enhances performances when the initial portfolio is already profitable, instead in the other cases the results are varying.

The relative performance indicators are substantially coherent with the aforementioned analysis, highlighting a positive performance of portfolios disregarding short sales, and vice versa attributing negative results to most of the other strategies. Again, the MS portfolios avoiding short selling are confirmed to be the best choices, as showed in the following figure.

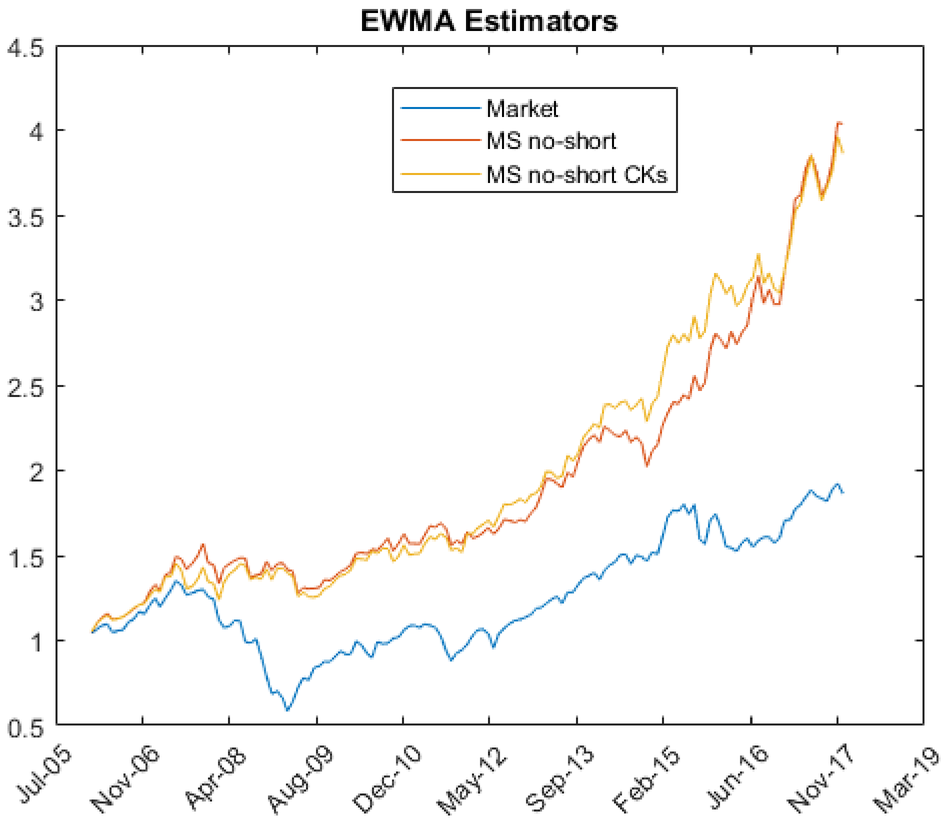


*Figure 5.2.3: No Screening*

## 5.3 Equilibrium Moments

### 5.3.1 Equilibrium Moments and Negative Screening

The parameters estimation exploiting the Capital Asset Pricing Model revealed to be very successful: almost all portfolios consistently beat the market return, so this is a situation never seen in previous strategies. Once again, the dominant role is played by the no-short selling cases which overwhelmed the other allocations, and also the aid of the Chow-Kritzman model allowed to improve their performances among the no-short selling field.

GMV portfolios confirm to be the point of reference among the allocations, since their performance is constantly above their corresponding Max Sharpe portfolios. It is noteworthy that this time the best performing solution is a GMV strategy with bounds equal to $\pm 1$, achieving the highest Sharpe Ratio and Sortino Ratio among the rivals. The same strategy is a little less effective when the bounds are reduced to $\pm 0.05$ and stays almost equal when bounds are deleted in either direction. However, as mentioned before, the other situations in which negative weights are included in the process are not as profitable as their corresponding no-short selling cases, so the overall result confirms the superiority of the strategies imposing positivity of weights. Good performances are also reported in the Relative Indicators table.

The following figure shows the portfolio improvements obtained by increasing the upper and lower bounds. The unconstrained portfolio overlaps the one with bounds set at $\pm 1$.

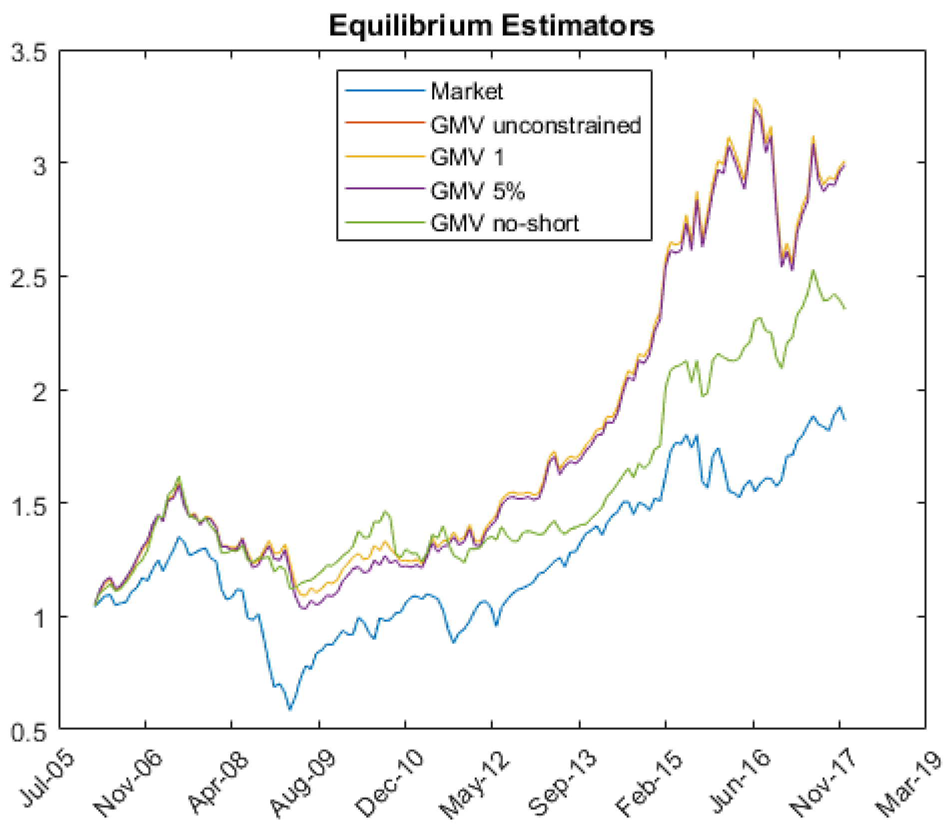


*Figure 5.3.1: Negative Screening*

### 5.3.2 Equilibrium Moments and Positive Screening

As done before, this section is dedicated to the comparison between different portfolios adopting the three positive screening levels. The more selecting one once again fails to achieve satisfactory results, with the majority of the strategies barely replicating the market portfolio or even doing worse than it. As before, only the no-short selling portfolios continue to maintain a valuable performance, with the GMV portfolios outperforming their respective MS ones. The relative performance indicators corroborate the weak situation borne by this screening strategy.

Therefore, it seems pretty obvious that investors with strong ethical believes would either adopt a no-short selling strategy or undergo some financial losses with respect to the market index.

The adoption of a 70% threshold is confirmed to be a strong approach, indeed almost all strategies overperformed in the reference period, and the GMV portfolios played a central role. Additionally, the performance improves whenever the lower and upper bounds decrease, signalling a performance dependence on diversification. As before, portfolios imposing the positivity of weights are among the best performers. The 50% screening shows slightly worse results; displaying however smoother performances, without extreme results in either direction (performances are neither good nor bad). The Chow-Kritzman approach is not always useful to bolster the initial situations, however the static approach combined with a 70% screening provides the best GMV portfolios, as shown in the figure below. These pieces of information are also supported by the relative performance indicators which show good performances for the two loosest screenings.

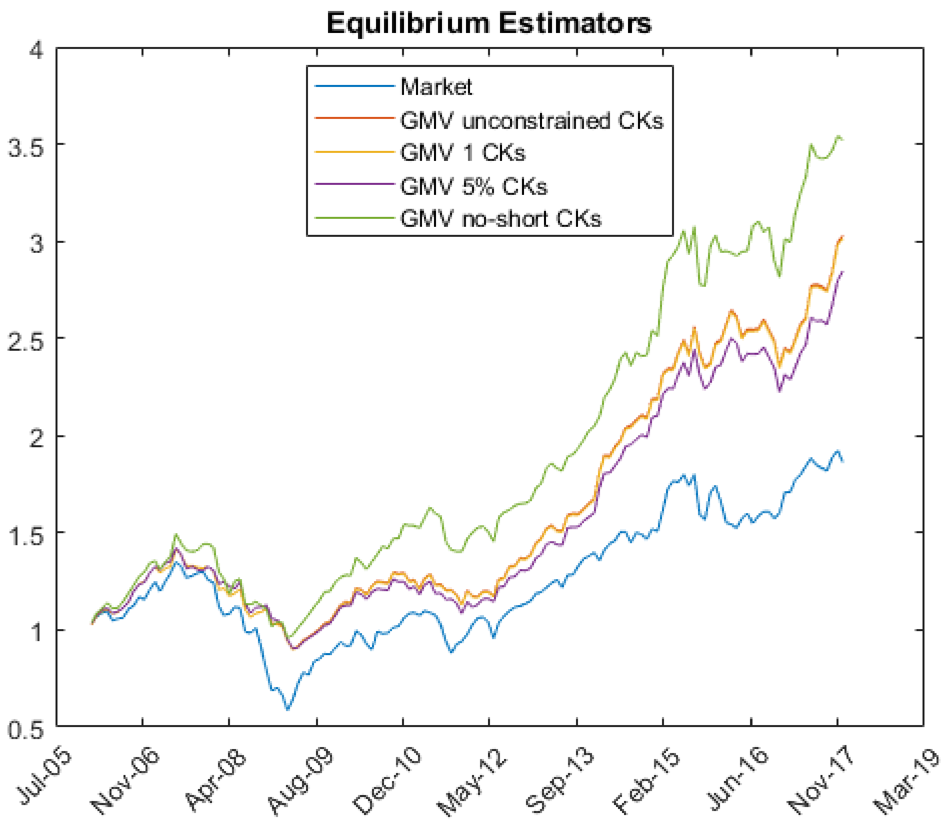


*Figure 5.3.2: 70% Positive Screening*

### 5.3.3 Equilibrium Moments and No Screening

This group of strategies clearly denotes the dominance of Global Minimum Variance portfolios over the Max Sharpe ones: the performance is unequivocally better for strategies adopting the former allocation, while the use of the latter approach reveals some drawbacks.

This is one of the few cases in which the no-short selling strategies are not dominant, for instance when considering the GMV portfolios we can easily see in the ranking table which allocation is the most performing one: the unconstrained has the best scores among its rivals, and it is followed by the one with upper and lower bounds of 1, the one with upper and lower bounds of 0.05 and finally the one imposing positivity of weights. Despite this relation is not always clear for the other strategies, the no-short selling case is not the best performer anymore, as shown in the figure below.

It is noteworthy that the Chow-Kritzman approaches are not able to improve performances in several cases. The relative indicators agree on the overall good performance of strategies with no screening, but they also highlight a better performance of MS portfolios over GMV ones.

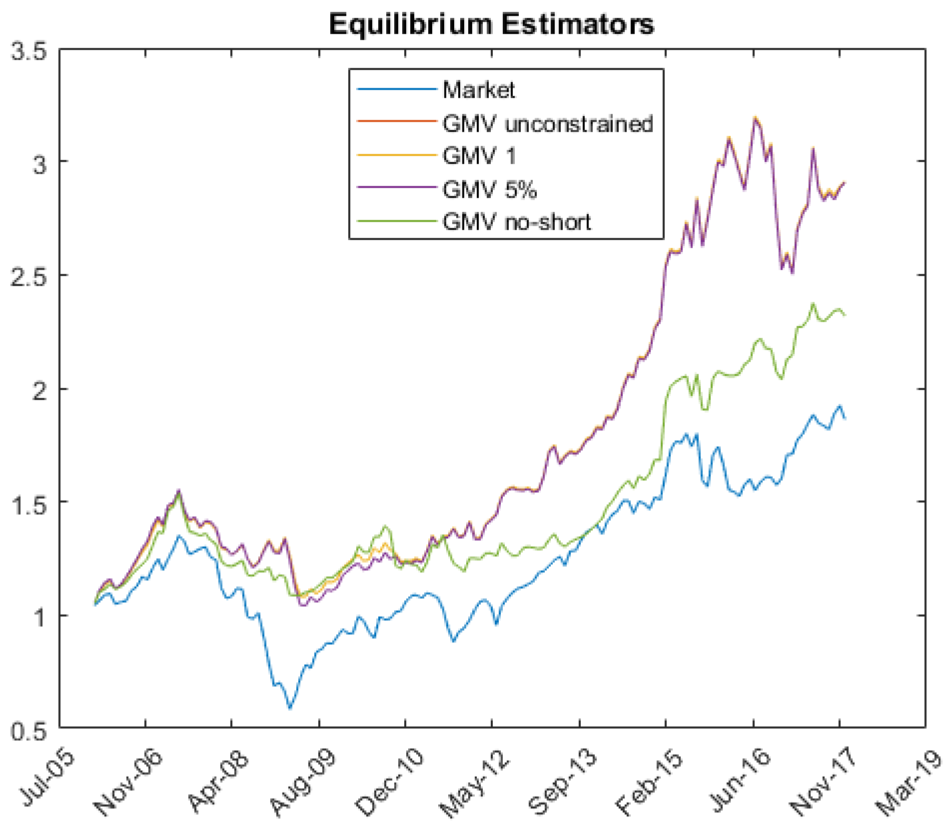


*Figure 5.3.3: No Screening*

## 5.4 Performance and Short Selling

By now, the results listed aimed to analyse the performance differences within a given screening strategy and for a given parameters estimation. However, the most interesting section regards the discrepancies between different screening techniques. Additionally, as mentioned in chapter 2, several researches demonstrated the presence of performance differences between sustainable and conventional investments whenever the investor had the possibility to sell short. These differences were quickly nullified when the no-short selling restriction was introduced. Therefore, this section aims to verify whether performance differences are present or not between different screenings, and whether any possible difference is influenced by the non-negativity constraint. To do so, I will compare all portfolios coming from the full investment sample, with the portfolios limited by different screening strategies.

To limit comparisons, I will analyse the differences between global minimum variance portfolios, since they have largely proven their overperforming ability during the course of this research. All tables will be presented in Appendix 1 for simplicity.

### 5.4.1 Sample Estimators

Despite some studies found differences between sustainable and conventional investments (e.g. conventional investments were more profitable) when short selling was permitted, tables 5.4.1 suggest that it is not true. In fact, they highlight a consistent difference between the two investment methodologies only when the screening is above the 90% threshold. In this case sustainable investments substantially underperform the portfolios built on an unrestricted universe, probably due to the extreme reduction in the investment sample, diminishing the diversification opportunities. However, almost all the portfolios built using negative screening criteria overperform the conventional ones, with few exceptions adopting the Chow-Kritzman model, in which the situation is the opposite. Nevertheless, these last strategies (both conventional and sustainable ones) perform poorly when compared to the former strategies (without the Chow-Kritzman model), therefore there would be no incentive for an investor to adopt any of them, since he would be better off using the ones highlighting an overperformance of sustainable investments.

Furthermore, when the investor chooses a looser positive screening, using a 70% threshold, there is no doubt about the results: sustainable investments clearly beat their respective strategies. Therefore, this screening is definitely the most performing approach within the Sample Estimators class. The 50% screening, as pointed out in the previous paragraphs of chapter 5, is inferior to the 70% screening, despite being more profitable than conventional portfolios. This could be due to investment universe similarities: the 50% screening produces an investment universe which is closer to the unrestricted one, instead the 70% screening excludes more companies (if compared to the 50% screening) while still allowing for great diversification opportunities. This could explain the counter-intuitive performance behaviours.

However, the short selling constraint is not playing a positive role in determining the relative profitability of sustainable portfolios to conventional ones, despite changing the absolute performance of most portfolios as seen above. In fact, when shifting from a lower bounded case to a no-short selling one, conventional portfolios are only able to reduce their performance gap, so short sale restrictions truly smooth performances, but on the other way around. Therefore, sustainable portfolios (excluding the 90% screening case) perform better than conventional ones either with or without short selling.

### 5.4.2 EWMA Estimators

This estimation method leads to results which are similar to the findings of the previous section. In particular, the 90% screening is inferior to the other strategies most of the time, coherently with the general belief considering sustainable practices unrewarding. However, portfolios based on an unrestricted universe are just above them, meaning that the expansion of available choices is not necessarily beneficial, as they might seem appealing using a MV approach but at the same time they are unprofitable. While the use of sample estimators led to the unequivocal evidence supporting the superiority of the 70% screening over the other practices, now the situation is a little different, since also the 50% screening and sometimes the negative screening look attractive. Also, the adoption of the Chow-Kritzman model contributes to improve performances several times.

As in the previous case, the results do not support the classical idea that sustainable investments are unprofitable when compared to a no-screening portfolio, and also the idea that short selling plays a fundamental role in SRI's profitability is disproved. In fact, theory sustains that short-selling restrictions eliminate the advantages of no-screening portfolios, however it is precisely in this situation that sustainable investments are relatively less performing, meaning that no-short selling constraints really erode differences, but on the other way around. Therefore, this constraint might smooth performances regardless of which strategy is initially overperforming.

Additionally, small upper and lower bounds seem to provide better results than in case of higher bounds, probably due to the imposition of greater diversification, a situation rarely achieved when weights can be extreme. Also, when comparing the no-short selling case with the unconstrained one we can notice a general dominance of the former over the latter, despite few occasional good results in the unbounded portfolios.

### 5.4.3 Equilibrium Moments

The equilibrium estimators provide slightly different results: the 70% screening is not always the best choice as sometimes the no-screening or the negative screening strategies are more profitable. However, it must be noticed that among the first 9 strategies (CI less than 100), 5 adopted a 70% screening and only 2 were based on an unrestricted investment universe. Therefore, there seems to be again a dominance of sustainable investments over conventional ones, even though results are not unambiguous. Moreover, the 90% screening is confirmed to be once again the worst strategy among the rivals, and the negative screening portfolios are in line with the unscreened ones.

The tables highlight that the short selling constraint is generally relevant in smoothening results, since its absence produces a greater performance variability, while its presence flattens the results, improving bad strategies while worsening good ones. The Chow-Kritzman approach provides contrasting results as sometimes it enhances performances while in other occasions it impairs profitability.

As just seen, different estimators provided slightly different results, therefore the estimation techniques must be compared to understand which technique is the best one. Given the GMV portfolios and the same evaluation method used so far it emerges that the equilibrium estimators generally provide the best results among the three choices, therefore they should be preferred over the others. When a single screening strategy is considered the results are similar, showing the superiority of equilibrium estimators over sample estimators, or at least their equality. Only when the 70% positive screening is considered the results are slightly in favour of sample estimators.

## 5.5 Michaud Approach

The original aim of this research was to take advantage of Michaud's considerations to deepen the analysis. However, when dealing with a large number of assets, the Matlab function optimizing the Mean-Variance problem becomes computationally too slow to be used for all the constraints that were initially supposed to be applied. Therefore, I was forced to reduce the cases, limiting the analysis to just the unconstrained case and the no-short selling one. The following paragraphs will verify whether this additional model improves performances, considering both GMV and MS portfolios.

### 5.5.1 Global Minimum Variance Portfolios

A recent study by Markowitz and Usmen (2003) found that the investment performance of Resampled Efficiency optimized portfolios (Michaud 1998) is superior to that of Markowitz (1959) mean-variance optimized portfolios. However, despite these findings, when applying the resampling process to the Global Minimum Variance portfolios the scene looks different. In fact, Appendix 1 shows a dominance of the traditional MV approach over the Resampled Frontier method. Sample estimators produce similar results for the two approaches, with a slight dominance of the MV optimization, except for the 90% screening, which benefits from the resampling process. However, the equilibrium estimators using the Michaud approach consistently underperform the MV method. Therefore, given these results, it seems that an investor would not benefit from the resampling process, unless he wants to adopt a 90% screening strategy.

### 5.5.2 Max Sharpe Portfolios

As just seen, GMV portfolios do not benefit from the introduction of the Resampled Frontier approach, on the contrary, MS portfolios often do. Sample estimators combined with the no-short selling restriction prove to be very useful in improving performances through the Michaud approach: tables 5.5.2 in Appendix 1 show a better or at least equal performance for those portfolios. However, most of the improvements are made by the unscreened portfolio, despite hierarchies are maintained. The unconstrained case adopting the same inputs has instead contrasting and volatile results, showing improvements but also deteriorations. As most of the time during this research, the unconstrained case proves to be unstable, as a small change in the inputs could lead to extreme portfolio rotations, exposing the allocation to potential impairments.

The Resampled Frontier approach is very beneficial when the inputs are calculated with the CAPM and the investor imposes the positivity of weights. In this situation in fact, all portfolios get better through the resampling process. However, this is still not sufficient to catch up with sample estimators: the no-short selling strategies show higher performances in the latter case. The unrestricted strategies look very profitable when adopting the resampling process, however as previously mentioned this situation is just theoretical, because portfolios' weights are too extreme to be feasible. Therefore, despite the unscreened portfolio with no weight restrictions seems to be very attractive, its performance cannot be an indicator of sustainable portfolios inferiority.

### 5.5.3 Comparison Between Resampled GMV and MS portfolios

After the examination of GMV and MS portfolios contrasting results emerged, highlighting the importance of equilibrium estimators for the former and of sample estimators coupled with resampling for the latter. Therefore, an additional comparison between the two cases could show whether the implementation of the resampling process allows MS portfolios to catch up with GMV portfolios. The following tables demonstrates that, despite they achieved significant improvements through the use of the resampling process, MS portfolios are still less performing than GMV portfolios.

*Table 5.5.3a: Performance Indicators*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| GMV EQ no-short | 0.203 | 0.278 | 1.747 | 0.124 | 0.094 | 0.022 | 0.022 | 0.755 |
| GMV EQ sin no-short | 0.200 | 0.279 | 1.686 | 0.124 | 0.092 | 0.021 | 0.022 | 0.759 |
| GMV EQ ESG50 no-short | 0.221 | 0.253 | 1.457 | 0.169 | 0.087 | 0.018 | 0.018 | 0.714 |
| GMV EQ ESG70 no-short | 0.273 | 0.352 | 1.696 | 0.166 | 0.112 | 0.026 | 0.027 | 0.839 |
| GMV EQ ESG90 no-short | 0.174 | 0.221 | 1.098 | 0.102 | 0.072 | 0.016 | 0.018 | 0.692 |
| MS sample no-short MIC | 0.175 | 0.211 | 1.237 | 0.108 | 0.072 | 0.016 | 0.016 | 0.674 |
| MS sample sin no-short MIC | 0.205 | 0.248 | 1.411 | 0.118 | 0.083 | 0.019 | 0.020 | 0.718 |
| MS sample ESG50 no-short MIC | 0.212 | 0.221 | 1.169 | 0.146 | 0.079 | 0.016 | 0.017 | 0.673 |
| MS sample ESG70 no-short MIC | 0.263 | 0.293 | 1.366 | 0.153 | 0.098 | 0.021 | 0.023 | 0.770 |
| MS sample ESG90 no-short MIC | 0.168 | 0.192 | 0.894 | 0.113 | 0.062 | 0.014 | 0.014 | 0.649 |

*Table 5.5.3b: Performance Indicators*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| GMV EQ no-short | 30 | 6 | 4 | 1 | 6 | 3 | 2 | 4 | 4 |
| GMV EQ sin no-short | 32 | 7 | 3 | 3 | 5 | 4 | 4 | 3 | 3 |
| GMV EQ ESG50 no-short | 36 | 3 | 5 | 4 | 1 | 5 | 6 | 6 | 6 |
| GMV EQ ESG70 no-short | 10 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 |
| GMV EQ ESG90 no-short | 64 | 9 | 7 | 9 | 10 | 8 | 7 | 7 | 7 |
| MS sample no-short MIC | 67 | 8 | 9 | 7 | 9 | 9 | 8 | 9 | 8 |
| MS sample sin no-short MIC | 44 | 5 | 6 | 5 | 7 | 6 | 5 | 5 | 5 |
| MS sample ESG50 no-short MIC | 57 | 4 | 8 | 8 | 4 | 7 | 9 | 8 | 9 |
| MS sample ESG70 no-short MIC | 22 | 2 | 2 | 6 | 3 | 2 | 3 | 2 | 2 |
| MS sample ESG90 no-short MIC | 78 | 10 | 10 | 10 | 8 | 10 | 10 | 10 | 10 |

## 5.6 Conclusions

Despite SRI's increasing popularity, many investors are still reluctant to include sustainability principles in their investment process. As shown in chapter 1, performance concerns are still the main deterrent of SRI strategies. However, investors should not be worried about returns, as several studies are consistent with the "No Effect Hypothesis", suggesting that investors should be indifferent between conventional and socially responsible investments. Some studies also highlighted certain features on the evolutionary path of sustainable investments, demonstrating that SRI underwent a catch-up phase in the end of the twentieth century. In fact, their performances improved with respect to the previous decades, thus becoming more attractive.

The main purpose of this thesis was to verify whether sustainable investments underperform conventional ones, using different constraints and estimators. As discussed in chapter 1, there are several screening strategies, however this research concentrated on negative screening and three different levels of positive screening. Most of the studies mentioned before used the Jensen's alpha or a multi-factor model to indagate SRI's performances, instead I tried to build up different portfolios and track them over time using performance indicators to assess results. In addition, the dataset considered refers to a different geographical area and time period, allowing me to evaluate whether or not my results corroborate the previous findings.

As shown in the previous paragraphs, the results depend on the estimators chosen, however all methodologies have something in common. Firstly, according to the chosen performance indicators, GMV portfolios overwhelm their corresponding MS portfolios. Secondly, the adoption of more sophisticated techniques such as the Chow-Kritzman and the Michaud models do not necessarily improve performances. However, the most interesting findings regard the performance differences between sustainable and conventional investments. As shown throughout this chapter, an excessive level of positive screening reduces the investment universe to such an extent that performances are seriously impaired, however it is not clear whether this result is caused by a generally bad performance of top-rated companies or by the limited diversification opportunities. On the contrary, an intermediate screening level obtains extraordinary results, beating both the benchmark and the unscreened portfolio. For a low screening level, the same holds true even though with generally worse results. Since this last case includes also the companies present in the intermediate screening level, this slight performance decline cannot be produced by a reduction in diversification opportunities, instead it must be caused by the companies with a score between the 50% and the 70% levels, proving that investors do not gain anything by loosening their screening criteria.

The strategies using negative screening are successful most of the times in beating the unscreened portfolios, nevertheless they cannot be compared, in terms of performances, with the portfolios adopting a 70% positive screening level, as the latter is often the best choice. However, it must be remarked that positive and negative screening methodologies concern different company's characteristics, therefore an investor could be interested in just one of these screenings. For instance, an investor whose priority is to avoid companies that engage in armaments production would certainly adopt a negative screening strategy, but he would not necessarily combine it with a positive screening one. Therefore, he might be neither interested in the 70% positive screening's good results, nor willing to adopt such a screening methodology.

Another topic discussed in this study regards the introduction of no-short selling. Past researches found out that conventional portfolios advantages are cancelled out when this restriction is present, however the results showed in this chapter are coherent with a more general statement: constraints imposing positivity of weights smooth performances, regardless of which strategy is initially the best-performing one.

The aforementioned results prove that investors can pursue their sustainability objectives without renouncing to financial performances, and most of the times they can also achieve better results than investors using an unscreened investment universe. Probably these results are due to the different time period analysed and might be the outcome of what was called "the catch-up phase" in past researches.

**Recommendations for Future Research**

As mentioned above, this research faced serious computational constraints due to the extreme complexity of many codes and the limited power of the computers available to me. For this reason, part of the code was not executed. Therefore, the inclusion of the remaining results could strengthen the actual analysis, for instance by applying the Resampled Frontier approach coupled with the upper and lower bounds. A similar problem regarded the execution of the code including the turnover constraint, as the variable investment universe forced me to impose an upper and lower bound equal to zero for certain assets (excluding them from the universe) while keeping the normal constraints for the others. This slowed the process down to such an extent that it was not feasible to run most of the codes. Therefore, also this situation could be added to the study to enhance and deepen the analysis.

Additionally, while most researches are based on the US region, my thesis focuses on the European market and in particular on a small subset of this area, considering only the companies included in the Stoxx Europe 600. However, next studies could broaden the investment universe or could even change it, choosing a different geographical region.

# Appendix 1

## 5.1.1

*Table 5.1.1a: Performance Indicators, Sample Estimators and Negative Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.11992 | 0.15057 | 0.53818 | 0.05959 | 0.04715 | 0.00950 | 0.01046 | 0.61693 |
| GMV sample sin no-short | 0.18019 | 0.22642 | 1.53203 | 0.10544 | 0.07944 | 0.01993 | 0.02062 | 0.69149 |
| MS sample sin no-short | 0.18612 | 0.22879 | 1.46405 | 0.10270 | 0.07602 | 0.02069 | 0.02124 | 0.69616 |
| GMV sample sin no-short CKs | 0.18116 | 0.22810 | 1.54328 | 0.10596 | 0.07995 | 0.02016 | 0.02088 | 0.69305 |
| MS sample sin no-short CKs | 0.18617 | 0.22895 | 1.46650 | 0.10256 | 0.07611 | 0.02076 | 0.02132 | 0.69643 |
| GMV sample sin no-short CKd | 0.15581 | 0.19280 | 1.17503 | 0.09049 | 0.06253 | 0.01334 | 0.01371 | 0.65324 |
| MS sample sin no-short CKd | 0.17040 | 0.22206 | 1.26543 | 0.09296 | 0.07255 | 0.01672 | 0.01718 | 0.69664 |
| GMV sample sin bounds 1 | 0.18594 | 0.25922 | 2.55401 | 0.10862 | 0.08611 | 0.01601 | 0.01665 | 0.74237 |
| MS sample sin bounds 1 | 0.09805 | 0.13002 | -2.12892 | 0.07015 | 0.04108 | 0.01910 | 0.01937 | 0.59589 |
| GMV sample sin bounds 1 CKs | 0.18938 | 0.26341 | 2.57121 | 0.11212 | 0.08783 | 0.01671 | 0.01737 | 0.74663 |
| MS sample sin bounds 1 CKs | 0.09105 | 0.12007 | -1.87977 | 0.06641 | 0.03768 | 0.01777 | 0.01796 | 0.58582 |
| GMV sample sin bounds 1 CKd | 0.04452 | 0.05695 | 0.60822 | 0.02595 | 0.01799 | 0.00356 | 0.00363 | 0.53478 |
| MS sample sin bounds 1 CKd | -0.03797 | -0.04843 | 5.22157 | -0.02062 | -0.01471 | -0.00828 | -0.00828 | 0.44015 |
| GMV sample sin bounds 5% | 0.20941 | 0.32609 | 2.36718 | 0.14440 | 0.10381 | 0.01767 | 0.01810 | 0.80575 |
| MS sample sin bounds 5% | 0.12123 | 0.14520 | -3.25674 | 0.07496 | 0.04890 | 0.01152 | 0.01159 | 0.60793 |
| GMV sample sin bounds 5% CKs | 0.21485 | 0.32972 | 2.36230 | 0.14632 | 0.10576 | 0.01858 | 0.01910 | 0.81058 |
| MS sample sin bounds 5% CKs | 0.11419 | 0.13279 | -2.88996 | 0.07222 | 0.04536 | 0.01085 | 0.01091 | 0.58825 |
| GMV sample sin bounds 5% CKd | 0.09950 | 0.12088 | 1.30938 | 0.06706 | 0.03857 | 0.00885 | 0.00897 | 0.58456 |
| MS sample sin bounds 5% CKd | 0.17694 | 0.23920 | 8.98186 | 0.10859 | 0.07706 | 0.02229 | 0.02392 | 0.71916 |
| GMV sample sin unconstrained | 0.18560 | 0.25866 | 2.55026 | 0.10845 | 0.08588 | 0.01596 | 0.01660 | 0.74176 |
| MS sample sin unconstrained | 0.09800 | 0.12998 | -2.12890 | 0.07011 | 0.04106 | 0.01909 | 0.01936 | 0.59589 |
| GMV sample sin unconstrained CKs | 0.19015 | 0.26499 | 2.62022 | 0.11272 | 0.08837 | 0.01699 | 0.01768 | 0.74842 |
| MS sample sin unconstrained CKs | 0.09142 | 0.12043 | -1.88478 | 0.06665 | 0.03781 | 0.01785 | 0.01804 | 0.58587 |
| GMV sample sin unconstrained CKd | 0.16150 | 0.21241 | 1.95274 | 0.09745 | 0.06957 | 0.01794 | 0.01844 | 0.68938 |
| MS sample sin unconstrained CKd | -0.07706 | -0.06113 | -2.46093 | -0.10816 | -0.03246 | -0.06832 | -0.07981 | 0.10533 |

*Table 5.1.1b: Performance Indicators, Sample Estimators and Negative Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 144 | 16 | 15 | 18 | 22 | 16 | 21 | 21 | 15 |
| GMV sample sin no-short | 71 | 10 | 11 | 11 | 9 | 8 | 5 | 5 | 12 |
| MS sample sin no-short | 65 | 6 | 9 | 13 | 10 | 11 | 3 | 3 | 10 |
| GMV sample sin no-short CKs | 63 | 9 | 10 | 10 | 8 | 7 | 4 | 4 | 11 |
| MS sample sin no-short CKs | 59 | 5 | 8 | 12 | 11 | 10 | 2 | 2 | 9 |
| GMV sample sin no-short CKd | 122 | 14 | 14 | 16 | 14 | 14 | 18 | 18 | 14 |
| MS sample sin no-short CKd | 101 | 12 | 12 | 15 | 13 | 12 | 14 | 15 | 8 |
| GMV sample sin bounds 1 | 64 | 7 | 5 | 5 | 5 | 5 | 16 | 16 | 5 |
| MS sample sin bounds 1 | 124 | 19 | 18 | 22 | 17 | 18 | 6 | 6 | 18 |
| GMV sample sin bounds 1 CKs | 53 | 4 | 4 | 4 | 4 | 4 | 15 | 14 | 4 |
| MS sample sin bounds 1 CKs | 150 | 22 | 22 | 19 | 21 | 22 | 11 | 12 | 21 |
| GMV sample sin bounds 1 CKd | 178 | 23 | 23 | 17 | 23 | 23 | 23 | 23 | 23 |
| MS sample sin bounds 1 CKd | 170 | 24 | 24 | 2 | 24 | 24 | 24 | 24 | 24 |
| GMV sample sin bounds 5% | 39 | 2 | 2 | 7 | 2 | 2 | 12 | 10 | 2 |
| MS sample sin bounds 5% | 140 | 15 | 16 | 25 | 15 | 15 | 19 | 19 | 16 |
| GMV sample sin bounds 5% CKs | 29 | 1 | 1 | 8 | 1 | 1 | 8 | 8 | 1 |
| MS sample sin bounds 5% CKs | 150 | 17 | 17 | 24 | 16 | 17 | 20 | 20 | 19 |
| GMV sample sin bounds 5% CKd | 157 | 18 | 20 | 14 | 19 | 20 | 22 | 22 | 22 |
| MS sample sin bounds 5% CKd | 43 | 11 | 7 | 1 | 6 | 9 | 1 | 1 | 7 |
| GMV sample sin unconstrained | 73 | 8 | 6 | 6 | 7 | 6 | 17 | 17 | 6 |
| MS sample sin unconstrained | 128 | 20 | 19 | 21 | 18 | 19 | 7 | 7 | 17 |
| GMV sample sin unconstrained CKs | 44 | 3 | 3 | 3 | 3 | 3 | 13 | 13 | 3 |
| MS sample sin unconstrained CKs | 144 | 21 | 21 | 20 | 20 | 21 | 10 | 11 | 20 |
| GMV sample sin unconstrained CKd | 91 | 13 | 13 | 9 | 12 | 13 | 9 | 9 | 13 |
| MS sample sin unconstrained CKd | 198 | 25 | 25 | 23 | 25 | 25 | 25 | 25 | 25 |

*Table 5.1.1c: Relative Indicators, Sample Estimators and Negative Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV sample sin no-short | 0.0270 | 15.1194 | 2.9137 | 0.0018 | 0.0093 |
| MS sample sin no-short | 0.1482 | 14.8558 | 2.9859 | 0.0100 | 0.0496 |
| GMV sample sin no-short CKs | 0.0294 | 15.1413 | 2.9201 | 0.0019 | 0.0101 |
| MS sample sin no-short CKs | 0.1481 | 14.8784 | 2.9929 | 0.0100 | 0.0495 |
| GMV sample sin no-short CKd | -0.0054 | 13.5683 | 2.7418 | -0.0004 | -0.0020 |
| MS sample sin no-short CKd | 0.0917 | 13.7535 | 2.6463 | 0.0067 | 0.0347 |
| GMV sample sin bounds 1 | -0.0055 | 19.9463 | 3.1727 | -0.0003 | -0.0017 |
| MS sample sin bounds 1 | 1.2603 | 390.6267 | 14.3911 | 0.0032 | 0.0876 |
| GMV sample sin bounds 1 CKs | 0.0026 | 19.8222 | 3.1480 | 0.0001 | 0.0008 |
| MS sample sin bounds 1 CKs | 1.1532 | 401.4376 | 14.7071 | 0.0029 | 0.0784 |
| GMV sample sin bounds 1 CKd | -0.3832 | 21.9907 | 3.6903 | -0.0174 | -0.1038 |
| MS sample sin bounds 1 CKd | -1.3653 | 501.0587 | 17.8475 | -0.0027 | -0.0765 |
| GMV sample sin bounds 5% | 0.0453 | 17.9751 | 3.0064 | 0.0025 | 0.0151 |
| MS sample sin bounds 5% | 0.3090 | 79.4452 | 7.5828 | 0.0039 | 0.0407 |
| GMV sample sin bounds 5% CKs | 0.0587 | 17.6804 | 2.9453 | 0.0033 | 0.0199 |
| MS sample sin bounds 5% CKs | 0.2732 | 81.9393 | 7.8408 | 0.0033 | 0.0348 |
| GMV sample sin bounds 5% CKd | -0.1924 | 21.5792 | 3.4635 | -0.0089 | -0.0555 |
| MS sample sin bounds 5% CKd | 0.3145 | 39.5375 | 4.9083 | 0.0080 | 0.0641 |
| GMV sample sin unconstrained | -0.0063 | 19.9518 | 3.1730 | -0.0003 | -0.0020 |
| MS sample sin unconstrained | 1.2594 | 390.6028 | 14.3928 | 0.0032 | 0.0875 |
| GMV sample sin unconstrained CKs | 0.0055 | 19.9583 | 3.1453 | 0.0003 | 0.0018 |
| MS sample sin unconstrained CKs | 1.1593 | 401.1673 | 14.7131 | 0.0029 | 0.0788 |
| GMV sample sin unconstrained CKd | 0.0206 | 20.5848 | 3.2704 | 0.0010 | 0.0063 |
| MS sample sin unconstrained CKd | -13.9949 | 30291.5598 | 217.5461 | -0.0005 | -0.0643 |

## 5.1.2

*Tables 5.1.2a: Performance Indicators, Sample Estimators and Positive Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.11992 | 0.15057 | 0.53818 | 0.05959 | 0.04715 | 0.00950 | 0.01046 | 0.61693 |
| GMV sample ESG90 no-short | 0.14199 | 0.18690 | 0.82138 | 0.07545 | 0.06021 | 0.01242 | 0.01362 | 0.66535 |
| MS sample ESG90 no-short | 0.15678 | 0.18706 | 0.91641 | 0.11644 | 0.05975 | 0.01335 | 0.01341 | 0.64986 |
| GMV sample ESG90 no-short CKs | 0.14169 | 0.18642 | 0.81926 | 0.07539 | 0.06008 | 0.01240 | 0.01360 | 0.66478 |
| MS sample ESG90 no-short CKs | 0.15639 | 0.18687 | 0.91418 | 0.11625 | 0.05966 | 0.01332 | 0.01338 | 0.64998 |
| GMV sample ESG90 no-short CKd | 0.13469 | 0.17281 | 0.77984 | 0.07189 | 0.05599 | 0.01128 | 0.01242 | 0.64964 |
| MS sample ESG90 no-short CKd | 0.12183 | 0.16590 | 0.71060 | 0.07788 | 0.05268 | 0.01143 | 0.01233 | 0.64974 |
| GMV sample ESG90 bounds 1 | 0.07765 | 0.10273 | 0.68314 | 0.03897 | 0.03238 | 0.00656 | 0.00692 | 0.58791 |
| MS sample ESG90 bounds 1 | 0.12241 | 0.14743 | -2.53848 | 0.08586 | 0.05161 | 0.01504 | 0.01556 | 0.58318 |
| GMV sample ESG90 bounds 1 CKs | 0.07861 | 0.10363 | 0.69047 | 0.03951 | 0.03276 | 0.00667 | 0.00704 | 0.58872 |
| MS sample ESG90 bounds 1 CKs | 0.12113 | 0.14548 | -2.50392 | 0.08528 | 0.05103 | 0.01508 | 0.01560 | 0.58041 |
| GMV sample ESG90 bounds 1 CKd | 0.08039 | 0.10989 | 0.72615 | 0.04382 | 0.03353 | 0.00686 | 0.00728 | 0.60218 |
| MS sample ESG90 bounds 1 CKd | 0.02767 | 0.04043 | -2.88100 | 0.01875 | 0.01311 | 0.00596 | 0.00596 | 0.54162 |
| GMV sample ESG90 bounds 5% | 0.05959 | 0.08159 | 0.40935 | 0.03022 | 0.02410 | 0.00417 | 0.00436 | 0.58320 |
| MS sample ESG90 bounds 5% | 0.17908 | 0.25514 | 2.08030 | 0.10462 | 0.07935 | 0.01549 | 0.01583 | 0.74147 |
| GMV sample ESG90 bounds 5% CKs | 0.05975 | 0.08180 | 0.41047 | 0.03029 | 0.02417 | 0.00418 | 0.00438 | 0.58332 |
| MS sample ESG90 bounds 5% CKs | 0.17887 | 0.25461 | 2.07529 | 0.10496 | 0.07929 | 0.01548 | 0.01581 | 0.74081 |
| GMV sample ESG90 bounds 5% CKd | 0.04494 | 0.06199 | 0.31030 | 0.02213 | 0.01834 | 0.00311 | 0.00323 | 0.56685 |
| MS sample ESG90 bounds 5% CKd | 0.13208 | 0.19075 | 1.20471 | 0.07742 | 0.05592 | 0.00971 | 0.00998 | 0.68247 |
| GMV sample ESG90 unconstrained | 0.07765 | 0.10273 | 0.68314 | 0.03897 | 0.03238 | 0.00656 | 0.00692 | 0.58791 |
| MS sample ESG90 unconstrained | -0.02541 | -0.02288 | -6.85425 | -0.03518 | -0.00957 | -0.00490 | -0.00548 | 0.20740 |
| GMV sample ESG90 unconstrained CKs | 0.07861 | 0.10363 | 0.69047 | 0.03951 | 0.03276 | 0.00667 | 0.00704 | 0.58872 |
| MS sample ESG90 unconstrained CKs | 0.00656 | 0.00702 | 1.90205 | 0.00963 | 0.00287 | 0.00171 | 0.00192 | 0.25973 |
| GMV sample ESG90 unconstrained CKd | 0.06237 | 0.08298 | 0.62028 | 0.03414 | 0.02523 | 0.00517 | 0.00537 | 0.57185 |
| MS sample ESG90 unconstrained CKd | 0.12687 | 0.79597 | -12.33266 | 0.33730 | 0.24763 | 0.11294 | 0.12988 | 1.33285 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.11992 | 0.15057 | 0.53818 | 0.05959 | 0.04715 | 0.00950 | 0.01046 | 0.61693 |
| GMV sample ESG70 no-short | 0.27639 | 0.34877 | 1.61984 | 0.16249 | 0.11302 | 0.02621 | 0.02833 | 0.83966 |
| MS sample ESG70 no-short | 0.25275 | 0.29674 | 1.47265 | 0.14860 | 0.09958 | 0.02238 | 0.02378 | 0.77561 |
| GMV sample ESG70 no-short CKs | 0.27626 | 0.34887 | 1.61745 | 0.16211 | 0.11301 | 0.02622 | 0.02836 | 0.83978 |
| MS sample ESG70 no-short CKs | 0.25226 | 0.29629 | 1.46832 | 0.14812 | 0.09939 | 0.02232 | 0.02372 | 0.77491 |
| GMV sample ESG70 no-short CKd | 0.28114 | 0.36560 | 1.69320 | 0.15066 | 0.12075 | 0.02828 | 0.03042 | 0.85860 |
| MS sample ESG70 no-short CKd | 0.27776 | 0.36637 | 1.65523 | 0.20005 | 0.12026 | 0.02653 | 0.02839 | 0.85929 |
| GMV sample ESG70 bounds 1 | 0.25789 | 0.36695 | 2.40520 | 0.16918 | 0.12073 | 0.02136 | 0.02242 | 0.86022 |
| MS sample ESG70 bounds 1 | 0.08830 | 0.10339 | -1.57476 | 0.06725 | 0.03779 | 0.00830 | 0.00854 | 0.53335 |
| GMV sample ESG70 bounds 1 CKs | 0.26319 | 0.37423 | 2.38358 | 0.18061 | 0.12379 | 0.02206 | 0.02345 | 0.86861 |
| MS sample ESG70 bounds 1 CKs | 0.07480 | 0.08334 | -1.27115 | 0.05573 | 0.03149 | 0.00627 | 0.00646 | 0.49700 |
| GMV sample ESG70 bounds 1 CKd | 0.24272 | 0.34828 | 2.48940 | 0.16383 | 0.11065 | 0.02653 | 0.02924 | 0.83913 |
| MS sample ESG70 bounds 1 CKd | 0.10222 | 0.15884 | -2.37538 | 0.06432 | 0.04743 | 0.02470 | 0.02499 | 0.65677 |
| GMV sample ESG70 bounds 5% | 0.25012 | 0.36155 | 2.36952 | 0.14448 | 0.12006 | 0.01994 | 0.02107 | 0.84918 |
| MS sample ESG70 bounds 5% | 0.19283 | 0.24271 | -14.10427 | 0.14562 | 0.08586 | 0.01927 | 0.01977 | 0.71313 |
| GMV sample ESG70 bounds 5% CKs | 0.25640 | 0.36734 | 2.35622 | 0.15200 | 0.12268 | 0.02104 | 0.02213 | 0.85662 |
| MS sample ESG70 bounds 5% CKs | 0.19031 | 0.23763 | -13.34262 | 0.14469 | 0.08450 | 0.01902 | 0.01950 | 0.70646 |
| GMV sample ESG70 bounds 5% CKd | 0.28764 | 0.39212 | 3.18348 | 0.16383 | 0.13494 | 0.02625 | 0.02810 | 0.88947 |
| MS sample ESG70 bounds 5% CKd | 0.22896 | 0.32638 | 9.59663 | 0.16298 | 0.10991 | 0.02563 | 0.02673 | 0.81572 |
| GMV sample ESG70 unconstrained | 0.25647 | 0.36232 | 2.38794 | 0.16867 | 0.11947 | 0.02116 | 0.02220 | 0.85499 |
| MS sample ESG70 unconstrained | 0.07876 | 0.08645 | -1.37612 | 0.06195 | 0.03308 | 0.00606 | 0.00626 | 0.49665 |
| GMV sample ESG70 unconstrained CKs | 0.26319 | 0.37423 | 2.38358 | 0.18061 | 0.12379 | 0.02206 | 0.02345 | 0.86861 |
| MS sample ESG70 unconstrained CKs | 0.05088 | 0.04960 | -0.83020 | 0.04173 | 0.02085 | 0.00328 | 0.00339 | 0.41119 |
| GMV sample ESG70 unconstrained CKd | 0.21119 | 0.30714 | 2.32049 | 0.13587 | 0.09548 | 0.02062 | 0.02224 | 0.79504 |
| MS sample ESG70 unconstrained CKd | 0.13808 | 0.24763 | -24.13687 | 0.15985 | 0.09181 | 0.08120 | 0.09881 | 0.63269 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.11992 | 0.15057 | 0.53818 | 0.05959 | 0.04715 | 0.00950 | 0.01046 | 0.61693 |
| GMV sample ESG50 no-short | 0.20478 | 0.22245 | 1.29002 | 0.15236 | 0.07880 | 0.01676 | 0.01746 | 0.67304 |
| MS sample ESG50 no-short | 0.22250 | 0.23920 | 1.37653 | 0.17299 | 0.08791 | 0.01956 | 0.02080 | 0.69865 |
| GMV sample ESG50 no-short CKs | 0.20491 | 0.22328 | 1.28902 | 0.15198 | 0.07886 | 0.01678 | 0.01749 | 0.67329 |
| MS sample ESG50 no-short CKs | 0.22185 | 0.23830 | 1.37206 | 0.17231 | 0.08764 | 0.01951 | 0.02074 | 0.69745 |
| GMV sample ESG50 no-short CKd | 0.12830 | 0.11268 | 0.91904 | 0.11427 | 0.04705 | 0.01048 | 0.01067 | 0.47803 |
| MS sample ESG50 no-short CKd | 0.20895 | 0.21709 | 1.33136 | 0.13788 | 0.07732 | 0.01686 | 0.01776 | 0.66924 |
| GMV sample ESG50 bounds 1 | 0.21639 | 0.32663 | 2.25385 | 0.17181 | 0.10251 | 0.01802 | 0.01898 | 0.81789 |
| MS sample ESG50 bounds 1 | 0.14353 | 0.17746 | -2.94827 | 0.08403 | 0.06149 | 0.02055 | 0.02091 | 0.62641 |
| GMV sample ESG50 bounds 1 CKs | 0.22113 | 0.33116 | 2.26103 | 0.17233 | 0.10517 | 0.01879 | 0.01970 | 0.82261 |
| MS sample ESG50 bounds 1 CKs | 0.12595 | 0.14285 | -2.44763 | 0.07557 | 0.05217 | 0.00937 | 0.00968 | 0.57064 |
| GMV sample ESG50 bounds 1 CKd | 0.15396 | 0.20218 | 2.58407 | 0.11127 | 0.06695 | 0.01912 | 0.02000 | 0.67937 |
| MS sample ESG50 bounds 1 CKd | -0.01156 | -0.01451 | 1.00574 | -0.00616 | -0.00430 | -0.00320 | -0.00320 | 0.45121 |
| GMV sample ESG50 bounds 5% | 0.22335 | 0.34417 | 2.33308 | 0.15300 | 0.11035 | 0.01833 | 0.01944 | 0.83453 |
| MS sample ESG50 bounds 5% | 0.18364 | 0.21248 | -6.20893 | 0.13815 | 0.07714 | 0.01983 | 0.02002 | 0.67212 |
| GMV sample ESG50 bounds 5% CKs | 0.22903 | 0.35148 | 2.34445 | 0.15914 | 0.11330 | 0.01926 | 0.02038 | 0.84232 |
| MS sample ESG50 bounds 5% CKs | 0.17964 | 0.20354 | -5.90596 | 0.13533 | 0.07452 | 0.01919 | 0.01937 | 0.65906 |
| GMV sample ESG50 bounds 5% CKd | 0.15067 | 0.22086 | 2.47157 | 0.09790 | 0.06763 | 0.01322 | 0.01392 | 0.71550 |
| MS sample ESG50 bounds 5% CKd | 0.20374 | 0.32683 | 5.58450 | 0.14187 | 0.09884 | 0.01875 | 0.01937 | 0.81435 |
| GMV sample ESG50 unconstrained | 0.21626 | 0.32633 | 2.25316 | 0.17173 | 0.10246 | 0.01799 | 0.01895 | 0.81757 |
| MS sample ESG50 unconstrained | 0.15058 | 0.19369 | -3.22823 | 0.09207 | 0.06697 | 0.02036 | 0.02076 | 0.64631 |
| GMV sample ESG50 unconstrained CKs | 0.22048 | 0.32791 | 2.25090 | 0.17212 | 0.10456 | 0.01872 | 0.01963 | 0.81995 |
| MS sample ESG50 unconstrained CKs | 0.13283 | 0.15691 | -2.70448 | 0.08327 | 0.05704 | 0.00870 | 0.00901 | 0.58892 |
| GMV sample ESG50 unconstrained CKd | 0.21835 | 0.27342 | 3.37651 | 0.15075 | 0.09411 | 0.02571 | 0.02817 | 0.74971 |
| MS sample ESG50 unconstrained CKd | 0.14400 | 0.63399 | 39.79809 | 0.32335 | 0.19770 | 0.18186 | 0.18779 | 1.16633 |

*Tables 5.1.2b: Performance Indicators, Sample Estimators and Positive Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 429 | 55 | 52 | 51 | 58 | 55 | 54 | 53 | 51 |
| GMV sample ESG90 no-short | 357 | 43 | 44 | 41 | 52 | 43 | 48 | 46 | 40 |
| MS sample ESG90 no-short | 338 | 36 | 43 | 39 | 37 | 45 | 45 | 48 | 45 |
| GMV sample ESG90 no-short CKs | 366 | 44 | 46 | 42 | 53 | 44 | 49 | 47 | 41 |
| MS sample ESG90 no-short CKs | 345 | 37 | 45 | 40 | 38 | 46 | 46 | 49 | 44 |
| GMV sample ESG90 no-short CKd | 387 | 46 | 48 | 43 | 54 | 48 | 51 | 50 | 47 |
| MS sample ESG90 no-short CKd | 393 | 53 | 49 | 45 | 49 | 50 | 50 | 51 | 46 |
| GMV sample ESG90 bounds 1 | 483 | 63 | 62 | 49 | 65 | 63 | 62 | 62 | 57 |
| MS sample ESG90 bounds 1 | 412 | 52 | 53 | 62 | 45 | 52 | 44 | 44 | 60 |
| GMV sample ESG90 bounds 1 CKs | 466 | 61 | 59 | 47 | 63 | 61 | 60 | 60 | 55 |
| MS sample ESG90 bounds 1 CKs | 415 | 54 | 54 | 61 | 46 | 53 | 43 | 43 | 61 |
| GMV sample ESG90 bounds 1 CKd | 445 | 58 | 57 | 44 | 60 | 58 | 58 | 58 | 52 |
| MS sample ESG90 bounds 1 CKd | 539 | 70 | 70 | 64 | 70 | 70 | 65 | 65 | 65 |
| GMV sample ESG90 bounds 5% | 517 | 67 | 67 | 53 | 68 | 67 | 68 | 68 | 59 |
| MS sample ESG90 bounds 5% | 266 | 34 | 27 | 22 | 42 | 32 | 41 | 41 | 27 |
| GMV sample ESG90 bounds 5% CKs | 509 | 66 | 66 | 52 | 67 | 66 | 67 | 67 | 58 |
| MS sample ESG90 bounds 5% CKs | 272 | 35 | 28 | 23 | 41 | 33 | 42 | 42 | 28 |
| GMV sample ESG90 bounds 5% CKd | 533 | 69 | 68 | 54 | 69 | 69 | 70 | 70 | 64 |
| MS sample ESG90 bounds 5% CKd | 366 | 48 | 42 | 36 | 50 | 49 | 53 | 54 | 34 |
| GMV sample ESG90 unconstrained | 475 | 62 | 61 | 48 | 64 | 62 | 61 | 61 | 56 |
| MS sample ESG90 unconstrained | 580 | 73 | 73 | 69 | 73 | 73 | 73 | 73 | 73 |
| GMV sample ESG90 unconstrained CKs | 458 | 60 | 58 | 46 | 62 | 60 | 59 | 59 | 54 |
| MS sample ESG90 unconstrained CKs | 522 | 71 | 71 | 24 | 71 | 71 | 71 | 71 | 72 |
| GMV sample ESG90 unconstrained CKd | 505 | 65 | 65 | 50 | 66 | 65 | 66 | 66 | 62 |
| MS sample ESG90 unconstrained CKd | 128 | 50 | 1 | 70 | 1 | 1 | 2 | 2 | 1 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 429 | 55 | 52 | 51 | 58 | 55 | 54 | 53 | 51 |
| GMV sample ESG70 no-short | 106 | 4 | 14 | 27 | 17 | 13 | 9 | 8 | 14 |
| MS sample ESG70 no-short | 163 | 11 | 24 | 29 | 27 | 22 | 13 | 13 | 24 |
| GMV sample ESG70 no-short CKs | 106 | 5 | 13 | 28 | 18 | 14 | 8 | 7 | 13 |
| MS sample ESG70 no-short CKs | 171 | 12 | 25 | 30 | 28 | 23 | 14 | 14 | 25 |
| GMV sample ESG70 no-short CKd | 85 | 2 | 9 | 25 | 26 | 7 | 4 | 4 | 8 |
| MS sample ESG70 no-short CKd | 68 | 3 | 8 | 26 | 3 | 9 | 6 | 6 | 7 |
| GMV sample ESG70 bounds 1 | 84 | 8 | 7 | 9 | 12 | 8 | 17 | 17 | 6 |
| MS sample ESG70 bounds 1 | 467 | 57 | 60 | 58 | 55 | 57 | 57 | 57 | 66 |
| GMV sample ESG70 bounds 1 CKs | 71 | 7 | 5 | 12 | 5 | 5 | 16 | 16 | 5 |
| MS sample ESG70 bounds 1 CKs | 500 | 64 | 64 | 56 | 59 | 64 | 63 | 63 | 67 |
| GMV sample ESG70 bounds 1 CKd | 90 | 14 | 15 | 7 | 14 | 15 | 5 | 5 | 15 |
| MS sample ESG70 bounds 1 CKd | 342 | 56 | 50 | 59 | 56 | 54 | 12 | 12 | 43 |
| GMV sample ESG70 bounds 5% | 133 | 13 | 11 | 13 | 31 | 10 | 23 | 21 | 11 |
| MS sample ESG70 bounds 5% | 277 | 30 | 30 | 72 | 29 | 30 | 27 | 29 | 30 |
| GMV sample ESG70 bounds 5% CKs | 107 | 10 | 6 | 14 | 23 | 6 | 19 | 20 | 9 |
| MS sample ESG70 bounds 5% CKs | 290 | 31 | 33 | 71 | 30 | 31 | 31 | 32 | 31 |
| GMV sample ESG70 bounds 5% CKd | 47 | 1 | 3 | 5 | 15 | 3 | 7 | 10 | 3 |
| MS sample ESG70 bounds 5% CKd | 115 | 16 | 21 | 2 | 16 | 17 | 11 | 11 | 21 |
| GMV sample ESG70 unconstrained | 100 | 9 | 10 | 10 | 13 | 11 | 18 | 19 | 10 |
| MS sample ESG70 unconstrained | 491 | 59 | 63 | 57 | 57 | 59 | 64 | 64 | 68 |
| GMV sample ESG70 unconstrained CKs | 63 | 6 | 4 | 11 | 4 | 4 | 15 | 15 | 4 |
| MS sample ESG70 unconstrained CKs | 530 | 68 | 69 | 55 | 61 | 68 | 69 | 69 | 71 |
| GMV sample ESG70 unconstrained CKd | 186 | 25 | 23 | 17 | 35 | 25 | 20 | 18 | 23 |
| MS sample ESG70 unconstrained CKd | 248 | 45 | 29 | 73 | 19 | 27 | 3 | 3 | 49 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 429 | 55 | 52 | 51 | 58 | 55 | 54 | 53 | 51 |
| GMV sample ESG50 no-short | 271 | 28 | 35 | 34 | 22 | 35 | 40 | 40 | 37 |
| MS sample ESG50 no-short | 194 | 18 | 31 | 31 | 6 | 28 | 25 | 23 | 32 |
| GMV sample ESG50 no-short CKs | 268 | 27 | 34 | 35 | 24 | 34 | 39 | 39 | 36 |
| MS sample ESG50 no-short CKs | 204 | 19 | 32 | 32 | 8 | 29 | 26 | 25 | 33 |
| GMV sample ESG50 no-short CKd | 411 | 49 | 56 | 38 | 39 | 56 | 52 | 52 | 69 |
| MS sample ESG50 no-short CKd | 281 | 26 | 37 | 33 | 34 | 36 | 38 | 38 | 39 |
| GMV sample ESG50 bounds 1 | 183 | 23 | 20 | 19 | 10 | 20 | 36 | 36 | 19 |
| MS sample ESG50 bounds 1 | 336 | 42 | 47 | 65 | 47 | 42 | 21 | 22 | 50 |
| GMV sample ESG50 bounds 1 CKs | 159 | 20 | 17 | 18 | 7 | 18 | 32 | 30 | 17 |
| MS sample ESG50 bounds 1 CKs | 441 | 51 | 55 | 60 | 51 | 51 | 55 | 55 | 63 |
| GMV sample ESG50 bounds 1 CKd | 258 | 38 | 40 | 6 | 40 | 41 | 30 | 28 | 35 |
| MS sample ESG50 bounds 1 CKd | 539 | 72 | 72 | 37 | 72 | 72 | 72 | 72 | 70 |
| GMV sample ESG50 bounds 5% | 170 | 17 | 16 | 16 | 21 | 16 | 35 | 33 | 16 |
| MS sample ESG50 bounds 5% | 297 | 32 | 38 | 68 | 33 | 37 | 24 | 27 | 38 |
| GMV sample ESG50 bounds 5% CKs | 140 | 15 | 12 | 15 | 20 | 12 | 28 | 26 | 12 |
| MS sample ESG50 bounds 5% CKs | 319 | 33 | 39 | 67 | 36 | 38 | 29 | 35 | 42 |
| GMV sample ESG50 bounds 5% CKd | 286 | 39 | 36 | 8 | 43 | 39 | 47 | 45 | 29 |
| MS sample ESG50 bounds 5% CKd | 196 | 29 | 19 | 3 | 32 | 24 | 33 | 34 | 22 |
| GMV sample ESG50 unconstrained | 192 | 24 | 22 | 20 | 11 | 21 | 37 | 37 | 20 |
| MS sample ESG50 unconstrained | 325 | 40 | 41 | 66 | 44 | 40 | 22 | 24 | 48 |
| GMV sample ESG50 unconstrained CKs | 171 | 21 | 18 | 21 | 9 | 19 | 34 | 31 | 18 |
| MS sample ESG50 unconstrained CKs | 421 | 47 | 51 | 63 | 48 | 47 | 56 | 56 | 53 |
| GMV sample ESG50 unconstrained CKd | 148 | 22 | 26 | 4 | 25 | 26 | 10 | 9 | 26 |
| MS sample ESG50 unconstrained CKd | 52 | 41 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |

*Tables 5.1.2c: Relative Indicators, Sample Estimators and Positive Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV sample ESG90 no-short | -0.011 | 8.072 | 1.951 | -0.001 | -0.006 |
| MS sample ESG90 no-short | 0.211 | 10.048 | 2.312 | 0.021 | 0.091 |
| GMV sample ESG90 no-short CKs | -0.012 | 8.060 | 1.948 | -0.001 | -0.006 |
| MS sample ESG90 no-short CKs | 0.210 | 10.065 | 2.314 | 0.021 | 0.091 |
| GMV sample ESG90 no-short CKd | -0.030 | 8.126 | 1.867 | -0.004 | -0.016 |
| MS sample ESG90 no-short CKd | 0.054 | 10.190 | 1.940 | 0.005 | 0.028 |
| GMV sample ESG90 bounds 1 | -0.233 | 17.572 | 3.294 | -0.013 | -0.071 |
| MS sample ESG90 bounds 1 | 2.302 | 603.508 | 21.385 | 0.004 | 0.108 |
| GMV sample ESG90 bounds 1 CKs | -0.229 | 17.559 | 3.287 | -0.013 | -0.070 |
| MS sample ESG90 bounds 1 CKs | 2.281 | 607.276 | 21.506 | 0.004 | 0.106 |
| GMV sample ESG90 bounds 1 CKd | -0.217 | 18.278 | 3.312 | -0.012 | -0.066 |
| MS sample ESG90 bounds 1 CKd | 0.057 | 490.888 | 15.332 | 0.000 | 0.004 |
| GMV sample ESG90 bounds 5% | -0.297 | 12.792 | 3.078 | -0.023 | -0.096 |
| MS sample ESG90 bounds 5% | 0.372 | 28.335 | 4.514 | 0.013 | 0.082 |
| GMV sample ESG90 bounds 5% CKs | -0.296 | 12.791 | 3.077 | -0.023 | -0.096 |
| MS sample ESG90 bounds 5% CKs | 0.370 | 28.306 | 4.501 | 0.013 | 0.082 |
| GMV sample ESG90 bounds 5% CKd | -0.355 | 12.955 | 3.115 | -0.027 | -0.114 |
| MS sample ESG90 bounds 5% CKd | 0.102 | 22.239 | 4.079 | 0.005 | 0.025 |
| GMV sample ESG90 unconstrained | -0.233 | 17.572 | 3.294 | -0.013 | -0.071 |
| MS sample ESG90 unconstrained | -3.520 | 13771.924 | 130.916 | 0.000 | -0.027 |
| GMV sample ESG90 unconstrained CKs | -0.229 | 17.559 | 3.287 | -0.013 | -0.070 |
| MS sample ESG90 unconstrained CKs | 0.292 | 16038.519 | 118.837 | 0.000 | 0.002 |
| GMV sample ESG90 unconstrained CKd | -0.275 | 20.858 | 3.699 | -0.013 | -0.074 |
| MS sample ESG90 unconstrained CKd | 21.439 | 30099.104 | 28.263 | 0.001 | 0.759 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV sample ESG70 no-short | 0.402 | 8.332 | 2.075 | 0.048 | 0.194 |
| MS sample ESG70 no-short | 0.486 | 8.547 | 2.050 | 0.057 | 0.237 |
| GMV sample ESG70 no-short CKs | 0.402 | 8.309 | 2.070 | 0.048 | 0.194 |
| MS sample ESG70 no-short CKs | 0.485 | 8.523 | 2.047 | 0.057 | 0.237 |
| GMV sample ESG70 no-short CKd | 0.390 | 8.959 | 2.169 | 0.043 | 0.180 |
| MS sample ESG70 no-short CKd | 0.680 | 9.734 | 1.894 | 0.070 | 0.359 |
| GMV sample ESG70 bounds 1 | 0.262 | 16.365 | 3.008 | 0.016 | 0.087 |
| MS sample ESG70 bounds 1 | 1.490 | 599.633 | 20.944 | 0.002 | 0.071 |
| GMV sample ESG70 bounds 1 CKs | 0.276 | 15.954 | 2.911 | 0.017 | 0.095 |
| MS sample ESG70 bounds 1 CKs | 1.273 | 663.982 | 23.258 | 0.002 | 0.055 |
| GMV sample ESG70 bounds 1 CKd | 0.404 | 19.959 | 3.305 | 0.020 | 0.122 |
| MS sample ESG70 bounds 1 CKd | 1.657 | 518.768 | 14.855 | 0.003 | 0.112 |
| GMV sample ESG70 bounds 5% | 0.217 | 16.418 | 3.070 | 0.013 | 0.071 |
| MS sample ESG70 bounds 5% | 0.797 | 71.911 | 7.137 | 0.011 | 0.112 |
| GMV sample ESG70 bounds 5% CKs | 0.233 | 16.003 | 2.968 | 0.015 | 0.079 |
| MS sample ESG70 bounds 5% CKs | 0.788 | 72.677 | 7.229 | 0.011 | 0.109 |
| GMV sample ESG70 bounds 5% CKd | 0.472 | 19.694 | 3.089 | 0.024 | 0.153 |
| MS sample ESG70 bounds 5% CKd | 0.718 | 44.985 | 5.404 | 0.016 | 0.133 |
| GMV sample ESG70 unconstrained | 0.259 | 16.357 | 3.008 | 0.016 | 0.086 |
| MS sample ESG70 unconstrained | 1.347 | 648.213 | 23.047 | 0.002 | 0.058 |
| GMV sample ESG70 unconstrained CKs | 0.276 | 15.954 | 2.911 | 0.017 | 0.095 |
| MS sample ESG70 unconstrained CKs | 0.848 | 829.338 | 29.555 | 0.001 | 0.029 |
| GMV sample ESG70 unconstrained CKd | 0.291 | 21.168 | 3.317 | 0.014 | 0.088 |
| MS sample ESG70 unconstrained CKd | 19.240 | 20568.678 | 77.784 | 0.001 | 0.247 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV sample ESG50 no-short | 0.177 | 10.005 | 2.414 | 0.018 | 0.073 |
| MS sample ESG50 no-short | 0.424 | 10.685 | 2.668 | 0.040 | 0.159 |
| GMV sample ESG50 no-short CKs | 0.177 | 9.973 | 2.405 | 0.018 | 0.074 |
| MS sample ESG50 no-short CKs | 0.422 | 10.680 | 2.672 | 0.039 | 0.158 |
| GMV sample ESG50 no-short CKd | 0.018 | 14.561 | 3.799 | 0.001 | 0.005 |
| MS sample ESG50 no-short CKd | 0.425 | 12.254 | 3.047 | 0.035 | 0.140 |
| GMV sample ESG50 bounds 1 | 0.113 | 17.562 | 3.048 | 0.006 | 0.037 |
| MS sample ESG50 bounds 1 | 2.932 | 651.897 | 19.998 | 0.004 | 0.147 |
| GMV sample ESG50 bounds 1 CKs | 0.124 | 17.314 | 2.994 | 0.007 | 0.042 |
| MS sample ESG50 bounds 1 CKs | 2.676 | 724.191 | 22.741 | 0.004 | 0.118 |
| GMV sample ESG50 bounds 1 CKd | 0.032 | 24.959 | 3.554 | 0.001 | 0.009 |
| MS sample ESG50 bounds 1 CKd | -0.859 | 801.980 | 22.566 | -0.001 | -0.038 |
| GMV sample ESG50 bounds 5% | 0.101 | 17.294 | 3.044 | 0.006 | 0.033 |
| MS sample ESG50 bounds 5% | 0.742 | 77.058 | 7.420 | 0.010 | 0.100 |
| GMV sample ESG50 bounds 5% CKs | 0.114 | 17.043 | 2.980 | 0.007 | 0.038 |
| MS sample ESG50 bounds 5% CKs | 0.726 | 78.323 | 7.560 | 0.009 | 0.096 |
| GMV sample ESG50 bounds 5% CKd | -0.002 | 24.065 | 3.696 | 0.000 | -0.001 |
| MS sample ESG50 bounds 5% CKd | 0.491 | 38.228 | 4.719 | 0.013 | 0.104 |
| GMV sample ESG50 unconstrained | 0.113 | 17.567 | 3.048 | 0.006 | 0.037 |
| MS sample ESG50 unconstrained | 3.264 | 704.995 | 20.067 | 0.005 | 0.163 |
| GMV sample ESG50 unconstrained CKs | 0.124 | 17.306 | 2.993 | 0.007 | 0.041 |
| MS sample ESG50 unconstrained CKs | 3.003 | 783.642 | 22.821 | 0.004 | 0.132 |
| GMV sample ESG50 unconstrained CKd | 0.295 | 24.750 | 3.459 | 0.012 | 0.085 |
| MS sample ESG50 unconstrained CKd | 21.221 | 22832.132 | 33.928 | 0.001 | 0.625 |
| MS sample ESG50 unconstrained CKd | 0.144 | 0.634 | 39.798 | 0.323 | 0.198 |

### 5.1.3

*Table 5.1.3a: Performance Indicators, Sample Estimators and No Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV sample no-short | 0.171782 | 0.212309 | 1.462075 | 0.102067 | 0.075343 | 0.018138 | 0.019052 | 0.668967 |
| MS sample no-short | 0.143921 | 0.178764 | 1.218299 | 0.085668 | 0.059745 | 0.014241 | 0.014517 | 0.645099 |
| GMV sample no-short CKs | 0.172461 | 0.213178 | 1.472315 | 0.102884 | 0.075758 | 0.018351 | 0.019294 | 0.669896 |
| MS sample no-short CKs | 0.144216 | 0.179254 | 1.225334 | 0.086153 | 0.059888 | 0.014354 | 0.01464 | 0.645799 |
| GMV sample no-short CKd | 0.136683 | 0.157798 | 1.090611 | 0.075208 | 0.05205 | 0.013107 | 0.013638 | 0.600425 |
| MS sample no-short CKd | 0.140994 | 0.179432 | 1.122617 | 0.070172 | 0.057894 | 0.014973 | 0.015604 | 0.651401 |
| GMV sample bounds 1 | 0.157346 | 0.240341 | 2.091843 | 0.102253 | 0.074833 | 0.014156 | 0.014551 | 0.73192 |
| MS sample bounds 1 | 0.072964 | 0.102158 | -1.45968 | 0.053871 | 0.031493 | 0.013761 | 0.013914 | 0.577817 |
| GMV sample bounds 1 CKs | 0.126786 | 0.184844 | 1.754016 | 0.074152 | 0.058074 | 0.008694 | 0.008847 | 0.679204 |
| MS sample bounds 1 CKs | 0.068909 | 0.095189 | -1.30549 | 0.050733 | 0.029395 | 0.013154 | 0.013276 | 0.569234 |
| GMV sample bounds 1 CKd | 0.127595 | 0.182221 | 1.467437 | 0.074087 | 0.059767 | 0.011403 | 0.011741 | 0.665589 |
| MS sample bounds 1 CKd | -0.05683 | -0.06955 | 1.388933 | -0.0339 | -0.02205 | -0.01222 | -0.01222 | 0.408198 |
| GMV sample bounds 5% | 0.179694 | 0.276182 | 2.129564 | 0.120963 | 0.086769 | 0.014982 | 0.015223 | 0.76556 |
| MS sample bounds 5% | 0.079799 | 0.089733 | -2.00447 | 0.047225 | 0.031236 | 0.007282 | 0.007352 | 0.53831 |
| GMV sample bounds 5% CKs | 0.185779 | 0.291415 | 2.143347 | 0.124208 | 0.090677 | 0.015802 | 0.016136 | 0.774453 |
| MS sample bounds 5% CKs | 0.073756 | 0.080254 | -1.77224 | 0.043619 | 0.02839 | 0.006737 | 0.006799 | 0.521169 |
| GMV sample bounds 5% CKd | 0.134436 | 0.196656 | 1.864463 | 0.079559 | 0.062848 | 0.014908 | 0.015049 | 0.68892 |
| MS sample bounds 5% CKd | 0.156804 | 0.201678 | 9.010135 | 0.086473 | 0.065116 | 0.020749 | 0.021589 | 0.675351 |
| GMV sample unconstrained | 0.142152 | 0.207221 | 1.89371 | 0.088468 | 0.064754 | 0.010511 | 0.010747 | 0.697468 |
| MS sample unconstrained | 0.071849 | 0.100856 | -1.429 | 0.053073 | 0.031023 | 0.013546 | 0.013691 | 0.577427 |
| GMV sample unconstrained CKs | 0.140205 | 0.203887 | 1.857366 | 0.08964 | 0.063793 | 0.010194 | 0.010397 | 0.695417 |
| MS sample unconstrained CKs | 0.058457 | 0.081381 | -1.10943 | 0.042509 | 0.024985 | 0.011141 | 0.01122 | 0.559662 |
| GMV sample unconstrained CKd | 0.083624 | 5.41E+09 | 6.787495 | 2.4E+09 | 1.73E+09 | 3.69E+08 | 3.93E+08 | 5.41E+09 |
| MS sample unconstrained CKd | 0.083624 | 7.34E+08 | 6.787495 | 3.39E+09 | 3.41E+08 | 2.18E+08 | 7.68E+08 | 1.02E+09 |

*Table 5.1.3b: Performance Indicators, Sample Estimators and No Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 147 | 16 | 18 | 19 | 18 | 18 | 21 | 20 | 17 |
| GMV sample no-short | 59 | 4 | 7 | 13 | 7 | 6 | 5 | 5 | 12 |
| MS sample no-short | 105 | 8 | 16 | 16 | 12 | 14 | 11 | 12 | 16 |
| GMV sample no-short CKs | 49 | 3 | 6 | 11 | 5 | 5 | 4 | 4 | 11 |
| MS sample no-short CKs | 95 | 7 | 15 | 15 | 11 | 12 | 10 | 10 | 15 |
| GMV sample no-short CKd | 127 | 12 | 17 | 18 | 14 | 17 | 16 | 15 | 18 |
| MS sample no-short CKd | 103 | 10 | 14 | 17 | 17 | 16 | 8 | 7 | 14 |
| GMV sample bounds 1 | 57 | 5 | 5 | 6 | 6 | 7 | 12 | 11 | 5 |
| MS sample bounds 1 | 146 | 21 | 19 | 23 | 19 | 19 | 13 | 13 | 19 |
| GMV sample bounds 1 CKs | 120 | 15 | 12 | 10 | 15 | 15 | 22 | 22 | 9 |
| MS sample bounds 1 CKs | 160 | 23 | 21 | 21 | 21 | 22 | 15 | 16 | 21 |
| GMV sample bounds 1 CKd | 115 | 14 | 13 | 12 | 16 | 13 | 17 | 17 | 13 |
| MS sample bounds 1 CKd | 189 | 25 | 25 | 14 | 25 | 25 | 25 | 25 | 25 |
| GMV sample bounds 5% | 38 | 2 | 4 | 5 | 4 | 4 | 7 | 8 | 4 |
| MS sample bounds 5% | 177 | 19 | 22 | 25 | 22 | 20 | 23 | 23 | 23 |
| GMV sample bounds 5% CKs | 29 | 1 | 3 | 4 | 3 | 3 | 6 | 6 | 3 |
| MS sample bounds 5% CKs | 186 | 20 | 24 | 24 | 23 | 23 | 24 | 24 | 24 |
| GMV sample bounds 5% CKd | 82 | 13 | 11 | 8 | 13 | 11 | 9 | 9 | 8 |
| MS sample bounds 5% CKd | 51 | 6 | 10 | 1 | 10 | 8 | 3 | 3 | 10 |
| GMV sample unconstrained | 86 | 9 | 8 | 7 | 9 | 9 | 19 | 19 | 6 |
| MS sample unconstrained | 153 | 22 | 20 | 22 | 20 | 21 | 14 | 14 | 20 |
| GMV sample unconstrained CKs | 95 | 11 | 9 | 9 | 8 | 10 | 20 | 21 | 7 |
| MS sample unconstrained CKs | 173 | 24 | 23 | 20 | 24 | 24 | 18 | 18 | 22 |
| GMV sample unconstrained CKd | 27 | 17 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| MS sample unconstrained CKd | 31 | 18 | 2 | 3 | 1 | 2 | 2 | 1 | 2 |

*Table 5.1.3c: Relative Indicators, Sample Estimators and No Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV sample no-short | -0.01963 | 14.96617 | 2.960899 | -0.00131 | -0.00663 |
| MS sample no-short | -0.03136 | 15.78444 | 3.294034 | -0.00199 | -0.00952 |
| GMV sample no-short CKs | -0.01819 | 15.00484 | 2.962932 | -0.00121 | -0.00614 |
| MS sample no-short CKs | -0.03053 | 15.84312 | 3.297246 | -0.00193 | -0.00926 |
| GMV sample no-short CKd | -0.08059 | 14.4475 | 2.75346 | -0.00558 | -0.02927 |
| MS sample no-short CKd | -0.01399 | 15.15395 | 2.671133 | -0.00092 | -0.00524 |
| GMV sample bounds 1 | -0.06937 | 19.98987 | 3.252269 | -0.00347 | -0.02133 |
| MS sample bounds 1 | 0.80084 | 393.8738 | 13.86771 | 0.002033 | 0.057749 |
| GMV sample bounds 1 CKs | -0.17287 | 20.05283 | 3.261436 | -0.00862 | -0.053 |
| MS sample bounds 1 CKs | 0.746502 | 407.3427 | 14.31762 | 0.001833 | 0.052139 |
| GMV sample bounds 1 CKd | -0.09521 | 20.03352 | 3.249843 | -0.00475 | -0.0293 |
| MS sample bounds 1 CKd | -1.7638 | 520.774 | 18.05039 | -0.00339 | -0.09772 |
| GMV sample bounds 5% | -0.02168 | 18.63222 | 3.255567 | -0.00116 | -0.00666 |
| MS sample bounds 5% | 0.01535 | 79.37881 | 7.840111 | 0.000193 | 0.001958 |
| GMV sample bounds 5% CKs | -0.00756 | 18.32578 | 3.193468 | -0.00041 | -0.00237 |
| MS sample bounds 5% CKs | -0.01654 | 82.01585 | 8.120403 | -0.0002 | -0.00204 |
| GMV sample bounds 5% CKd | -0.12285 | 20.71167 | 3.186159 | -0.00593 | -0.03856 |
| MS sample bounds 5% CKd | 0.302253 | 45.10973 | 5.558112 | 0.0067 | 0.054381 |
| GMV sample unconstrained | -0.13258 | 19.65384 | 3.231802 | -0.00675 | -0.04102 |
| MS sample unconstrained | 0.780997 | 394.4278 | 13.85859 | 0.00198 | 0.056355 |
| GMV sample unconstrained CKs | -0.1392 | 19.58533 | 3.206109 | -0.00711 | -0.04342 |
| MS sample unconstrained CKs | 0.556302 | 410.4197 | 14.33899 | 0.001355 | 0.038796 |
| GMV sample unconstrained CKd | 1.16E+10 | 1.92E+22 | 3.445908 | 6.04E-13 | 3.36E+09 |
| MS sample unconstrained CKd | 4.72E+11 | 3.18E+25 | 630.1075 | 1.48E-14 | 7.48E+08 |

## 5.2.1

*Table 5.2.1a: Performance Indicators, EWMA Estimators and Negative Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA sin no-short | 0.182311 | 0.189635 | 1.640646 | 0.153562 | 0.077133 | 0.01886 | 0.019835 | 0.618638 |
| MS EWMA sin no-short | 0.333181 | 0.471532 | 3.56505 | 0.252394 | 0.156552 | 0.070959 | 0.100696 | 0.989191 |
| GMV EWMA sin no-short CKs | 0.212315 | 0.252313 | 1.915068 | 0.16669 | 0.092134 | 0.025483 | 0.027252 | 0.711478 |
| MS EWMA sin no-short CKs | 0.323871 | 0.47166 | 2.882168 | 0.18741 | 0.153474 | 0.081766 | 0.100992 | 0.967724 |
| GMV EWMA sin no-short CKd | 0.138464 | 0.158987 | 1.137497 | 0.090386 | 0.053314 | 0.012601 | 0.013056 | 0.60533 |
| MS EWMA sin no-short CKd | 0.184273 | 0.24889 | 1.425524 | 0.10953 | 0.080196 | 0.027004 | 0.028122 | 0.728873 |
| GMV EWMA sin bounds 1 | 0.13687 | 0.211305 | 3.614851 | 0.080444 | 0.066153 | 0.01501 | 0.015286 | 0.704062 |
| MS EWMA sin bounds 1 | 0.043324 | 0.052956 | -1.126523 | 0.029733 | 0.019328 | 0.010947 | 0.011867 | 0.506332 |
| GMV EWMA sin bounds 1 CKs | 0.203428 | 0.262944 | 3.25179 | 0.127086 | 0.085702 | 0.015039 | 0.01542 | 0.738825 |
| MS EWMA sin bounds 1 CKs | 0.066776 | 0.087361 | -0.883015 | 0.042415 | 0.027143 | 0.014576 | 0.015086 | 0.559653 |
| GMV EWMA sin bounds 1 CKd | 0.128448 | 0.17658 | 1.831314 | 0.077153 | 0.055465 | 0.010223 | 0.010308 | 0.660618 |
| MS EWMA sin bounds 1 CKd | 0.073536 | 0.08776 | -1.098076 | 0.047059 | 0.028999 | 0.011212 | 0.013248 | 0.52029 |
| GMV EWMA sin bounds 5% | 0.177751 | 0.275273 | 3.541079 | 0.120911 | 0.085224 | 0.015662 | 0.015957 | 0.767813 |
| MS EWMA sin bounds 5% | 0.127079 | 0.173523 | -5.37834 | 0.074122 | 0.053363 | 0.011557 | 0.011754 | 0.659981 |
| GMV EWMA sin bounds 5% CKs | 0.226562 | 0.294971 | 3.228671 | 0.159176 | 0.100802 | 0.014934 | 0.01537 | 0.77622 |
| MS EWMA sin bounds 5% CKs | 0.120883 | 0.148775 | -2.581425 | 0.090746 | 0.049472 | 0.013485 | 0.014107 | 0.613325 |
| GMV EWMA sin bounds 5% CKd | 0.172055 | 0.21911 | 2.043993 | 0.129957 | 0.075381 | 0.012638 | 0.012752 | 0.690647 |
| MS EWMA sin bounds 5% CKd | 0.091141 | 0.115828 | -11.16975 | 0.057834 | 0.037489 | 0.008525 | 0.00884 | 0.588569 |
| GMV EWMA sin unconstrained | 0.136815 | 0.211216 | 3.614359 | 0.08041 | 0.066125 | 0.015004 | 0.015279 | 0.703973 |
| MS EWMA sin unconstrained | -0.071539 | -0.051027 | 9.766701 | -0.225162 | -0.031433 | -0.16119 | -0.178866 | 0.069526 |
| GMV EWMA sin unconstrained CKs | 0.19936 | 0.25528 | 3.065 | 0.122479 | 0.082855 | 0.015186 | 0.015586 | 0.729722 |
| MS EWMA sin unconstrained CKs | -0.020617 | -0.019607 | 0.340578 | -0.015215 | -0.006739 | -0.007912 | -0.009908 | 0.335042 |
| GMV EWMA sin unconstrained CKd | 0.137662 | 0.188485 | 2.13992 | 0.076779 | 0.058102 | 0.011009 | 0.011182 | 0.669796 |
| MS EWMA sin unconstrained CKd | -0.003006 | -0.002713 | 0.179418 | -0.00653 | -0.001332 | -8.13E-05 | -9.97E-05 | 0.190628 |

*Table 5.2.1b: Performance Indicators, EWMA Estimators and Negative Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 145 | 18 | 17 | 17 | 18 | 18 | 21 | 20 | 16 |
| GMV EWMA sin no-short | 73 | 8 | 12 | 14 | 5 | 9 | 5 | 5 | 15 |
| MS EWMA sin no-short | 14 | 1 | 2 | 4 | 1 | 1 | 2 | 2 | 1 |
| GMV EWMA sin no-short CKs | 46 | 4 | 7 | 12 | 3 | 4 | 4 | 4 | 8 |
| MS EWMA sin no-short CKs | 20 | 2 | 1 | 9 | 2 | 2 | 1 | 1 | 2 |
| GMV EWMA sin no-short CKd | 119 | 11 | 16 | 16 | 12 | 16 | 15 | 15 | 18 |
| MS EWMA sin no-short CKd | 61 | 7 | 8 | 15 | 10 | 8 | 3 | 3 | 7 |
| GMV EWMA sin bounds 1 | 77 | 13 | 10 | 2 | 13 | 11 | 9 | 10 | 9 |
| MS EWMA sin bounds 1 | 168 | 22 | 22 | 22 | 22 | 22 | 19 | 17 | 22 |
| GMV EWMA sin bounds 1 CKs | 49 | 5 | 5 | 6 | 7 | 5 | 8 | 8 | 5 |
| MS EWMA sin bounds 1 CKs | 148 | 21 | 21 | 20 | 21 | 21 | 12 | 12 | 20 |
| GMV EWMA sin bounds 1 CKd | 125 | 15 | 14 | 13 | 15 | 14 | 20 | 21 | 13 |
| MS EWMA sin bounds 1 CKd | 153 | 20 | 20 | 21 | 20 | 20 | 17 | 14 | 21 |
| GMV EWMA sin bounds 5% | 49 | 9 | 4 | 5 | 9 | 6 | 6 | 6 | 4 |
| MS EWMA sin bounds 5% | 135 | 16 | 15 | 24 | 17 | 15 | 16 | 18 | 14 |
| GMV EWMA sin bounds 5% CKs | 43 | 3 | 3 | 7 | 4 | 3 | 11 | 9 | 3 |
| MS EWMA sin bounds 5% CKs | 129 | 17 | 18 | 23 | 11 | 17 | 13 | 13 | 17 |
| GMV EWMA sin bounds 5% CKd | 87 | 10 | 9 | 11 | 6 | 10 | 14 | 16 | 11 |
| MS EWMA sin bounds 5% CKd | 164 | 19 | 19 | 25 | 19 | 19 | 22 | 22 | 19 |
| GMV EWMA sin unconstrained | 85 | 14 | 11 | 3 | 14 | 12 | 10 | 11 | 10 |
| MS EWMA sin unconstrained | 176 | 25 | 25 | 1 | 25 | 25 | 25 | 25 | 25 |
| GMV EWMA sin unconstrained CKs | 55 | 6 | 6 | 8 | 8 | 7 | 7 | 7 | 6 |
| MS EWMA sin unconstrained CKs | 185 | 24 | 24 | 18 | 24 | 24 | 24 | 24 | 23 |
| GMV EWMA sin unconstrained CKd | 113 | 12 | 13 | 10 | 16 | 13 | 18 | 19 | 12 |
| MS EWMA sin unconstrained CKd | 181 | 23 | 23 | 19 | 23 | 23 | 23 | 23 | 24 |

*Table 5.2.1c: Relative Indicators, EWMA Estimators and Negative Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EWMA sin no-short | 0.093691 | 16.63916 | 2.903323 | 0.005631 | 0.03227 |
| MS EWMA sin no-short | 0.68884 | 19.83897 | 2.949102 | 0.034722 | 0.233576 |
| GMV EWMA sin no-short CKs | 0.152607 | 16.19641 | 2.849043 | 0.009422 | 0.053564 |
| MS EWMA sin no-short CKs | 0.599167 | 16.57711 | 2.702012 | 0.036144 | 0.221748 |
| GMV EWMA sin no-short CKd | -0.07115 | 14.97857 | 3.084243 | -0.00475 | -0.02307 |
| MS EWMA sin no-short CKd | 0.223805 | 15.70807 | 2.998039 | 0.014248 | 0.07465 |
| GMV EWMA sin bounds 1 | 0.019841 | 30.54406 | 4.044676 | 0.00065 | 0.004905 |
| MS EWMA sin bounds 1 | 0.910363 | 1189.838 | 27.69084 | 0.000765 | 0.032876 |
| GMV EWMA sin bounds 1 CKs | 0.103289 | 22.13731 | 3.380589 | 0.004666 | 0.030553 |
| MS EWMA sin bounds 1 CKs | 1.512443 | 1056.727 | 25.06282 | 0.001431 | 0.060346 |
| GMV EWMA sin bounds 1 CKd | -0.06793 | 23.19958 | 3.331723 | -0.00293 | -0.02039 |
| MS EWMA sin bounds 1 CKd | 1.558656 | 910.1284 | 25.41148 | 0.001713 | 0.061337 |
| GMV EWMA sin bounds 5% | 0.113213 | 26.15978 | 3.446536 | 0.004328 | 0.032848 |
| MS EWMA sin bounds 5% | 0.215515 | 60.96031 | 6.033526 | 0.003535 | 0.03572 |
| GMV EWMA sin bounds 5% CKs | 0.144716 | 20.70552 | 3.316762 | 0.006989 | 0.043632 |
| MS EWMA sin bounds 5% CKs | 0.317399 | 83.58492 | 7.700544 | 0.003797 | 0.041218 |
| GMV EWMA sin bounds 5% CKd | 0.068775 | 20.62347 | 3.243775 | 0.003335 | 0.021202 |
| MS EWMA sin bounds 5% CKd | 0.009671 | 58.24826 | 6.071574 | 0.000166 | 0.001593 |
| GMV EWMA sin unconstrained | 0.019607 | 30.5451 | 4.044441 | 0.000642 | 0.004848 |
| MS EWMA sin unconstrained | -42.711 | 347716.3 | 814.9654 | -0.00012 | -0.05241 |
| GMV EWMA sin unconstrained CKs | 0.095478 | 21.91504 | 3.402755 | 0.004357 | 0.028059 |
| MS EWMA sin unconstrained CKs | -1.69038 | 3279.493 | 59.81232 | -0.00052 | -0.02826 |
| GMV EWMA sin unconstrained CKd | -0.05267 | 2.34E+01 | 3.561917 | -2.25E-03 | -0.01479 |
| MS EWMA sin unconstrained CKd | -1.17783 | 4.54E+04 | 229.3833 | -2.59E-05 | -0.00513 |

### 5.2.2

*Tables 5.2.2a: Performance Indicators, EWMA Estimators and Positive Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA ESG90 no-short | 0.158963 | 0.19396 | 0.983941 | 0.084548 | 0.063375 | 0.012421 | 0.013298 | 0.662531 |
| MS EWMA ESG90 no-short | 0.1612 | 0.220185 | 1.035455 | 0.113631 | 0.07002 | 0.014432 | 0.015449 | 0.700231 |
| GMV EWMA ESG90 no-short CKs | 0.175668 | 0.224765 | 1.072413 | 0.104871 | 0.075189 | 0.015945 | 0.017525 | 0.696571 |
| MS EWMA ESG90 no-short CKs | 0.131929 | 0.14505 | 0.84352 | 0.11161 | 0.052589 | 0.013199 | 0.013733 | 0.581208 |
| GMV EWMA ESG90 no-short CKd | 0.155816 | 0.207003 | 0.940462 | 0.094893 | 0.068251 | 0.013593 | 0.014723 | 0.685179 |
| MS EWMA ESG90 no-short CKd | 0.177497 | 0.301738 | 1.255724 | 0.140103 | 0.088967 | 0.023159 | 0.023893 | 0.803082 |
| GMV EWMA ESG90 bounds 1 | 0.143119 | 0.184733 | 1.563641 | 0.078419 | 0.05769 | 0.011701 | 0.012367 | 0.659453 |
| MS EWMA ESG90 bounds 1 | 0.003548 | 0.004173 | -0.060661 | 0.002247 | 0.001277 | 0.000824 | 0.000825 | 0.446222 |
| GMV EWMA ESG90 bounds 1 CKs | 0.09267 | 0.12492 | 0.90599 | 0.05197 | 0.038505 | 0.007782 | 0.008375 | 0.610237 |
| MS EWMA ESG90 bounds 1 CKs | 0.051935 | 0.058647 | -0.88765 | 0.036591 | 0.020537 | 0.012322 | 0.012325 | 0.489479 |
| GMV EWMA ESG90 bounds 1 CKd | 0.091672 | 0.127885 | 0.884873 | 0.0478 | 0.039828 | 0.009372 | 0.01034 | 0.617945 |
| MS EWMA ESG90 bounds 1 CKd | 0.063073 | 0.083252 | -1.865226 | 0.045899 | 0.026234 | 0.013935 | 0.013952 | 0.55052 |
| GMV EWMA ESG90 bounds 5% | 0.074688 | 0.098313 | 0.515517 | 0.037339 | 0.030183 | 0.005046 | 0.005244 | 0.585523 |
| MS EWMA ESG90 bounds 5% | 0.092609 | 0.115382 | 0.887235 | 0.046592 | 0.03552 | 0.00684 | 0.006862 | 0.589665 |
| GMV EWMA ESG90 bounds 5% CKs | 0.052515 | 0.071046 | 0.368111 | 0.030019 | 0.021043 | 0.003517 | 0.003687 | 0.566802 |
| MS EWMA ESG90 bounds 5% CKs | 0.06756 | 0.084133 | 0.631496 | 0.031365 | 0.025354 | 0.004875 | 0.005017 | 0.559581 |
| GMV EWMA ESG90 bounds 5% CKd | 0.040762 | 0.054744 | 0.273678 | 0.020336 | 0.016662 | 0.002707 | 0.002848 | 0.550121 |
| MS EWMA ESG90 bounds 5% CKd | 0.062508 | 0.08133 | 0.470015 | 0.031147 | 0.024282 | 0.004482 | 0.004691 | 0.562778 |
| GMV EWMA ESG90 unconstrained | 0.143119 | 0.184733 | 1.563641 | 0.078419 | 0.05769 | 0.011701 | 0.012367 | 0.659453 |
| MS EWMA ESG90 unconstrained | -0.029617 | -0.036646 | 2.771096 | -0.032514 | -0.01155 | -0.000202 | -0.000838 | 0.294095 |
| GMV EWMA ESG90 unconstrained CKs | 0.09267 | 0.12492 | 0.90599 | 0.05197 | 0.038505 | 0.007782 | 0.008375 | 0.610237 |
| MS EWMA ESG90 unconstrained CKs | 0.001722 | 0.001664 | 0.053829 | 0.003342 | 0.000863 | 0.001207 | 0.001285 | 0.19553 |
| GMV EWMA ESG90 unconstrained CKd | 0.09021 | 0.122487 | 0.897674 | 0.049963 | 0.036646 | 0.007803 | 0.008194 | 0.606896 |
| MS EWMA ESG90 unconstrained CKd | -0.044396 | -0.038882 | 3.305894 | -0.060221 | -0.01703 | -0.007375 | -0.02172 | 0.166981 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA ESG70 no-short | 0.222792 | 0.283734 | 1.411251 | 0.137202 | 0.091233 | 0.018386 | 0.019538 | 0.759924 |
| MS EWMA ESG70 no-short | 0.198801 | 0.263266 | 1.322909 | 0.127469 | 0.082909 | 0.016382 | 0.017753 | 0.742619 |
| GMV EWMA ESG70 no-short CKs | 0.23781 | 0.310146 | 1.522214 | 0.16536 | 0.101509 | 0.022364 | 0.02421 | 0.793195 |
| MS EWMA ESG70 no-short CKs | 0.20807 | 0.202346 | 1.370592 | 0.156705 | 0.076692 | 0.018343 | 0.019755 | 0.641004 |
| GMV EWMA ESG70 no-short CKd | 0.213776 | 0.271475 | 1.317634 | 0.150346 | 0.087918 | 0.018079 | 0.019388 | 0.744419 |
| MS EWMA ESG70 no-short CKd | 0.245357 | 0.362315 | 1.529449 | 0.165301 | 0.115489 | 0.028925 | 0.031667 | 0.849565 |
| GMV EWMA ESG70 bounds 1 | 0.12559 | 0.18401 | 2.124903 | 0.079365 | 0.057979 | 0.01024 | 0.010556 | 0.676721 |
| MS EWMA ESG70 bounds 1 | 0.081278 | 0.112123 | -1.684871 | 0.052639 | 0.035392 | 0.02759 | 0.027746 | 0.590916 |
| GMV EWMA ESG70 bounds 1 CKs | 0.226047 | 0.331645 | 2.585282 | 0.158892 | 0.107612 | 0.018699 | 0.02008 | 0.821988 |
| MS EWMA ESG70 bounds 1 CKs | 0.05933 | 0.074859 | -0.801481 | 0.039577 | 0.024762 | 0.024771 | 0.02484 | 0.531027 |
| GMV EWMA ESG70 bounds 1 CKd | 0.281119 | 0.455222 | 3.178393 | 0.203883 | 0.149686 | 0.028325 | 0.030083 | 0.952019 |
| MS EWMA ESG70 bounds 1 CKd | 0.043002 | 0.061267 | -0.983515 | 0.026297 | 0.018195 | 0.013305 | 0.013305 | 0.555955 |
| GMV EWMA ESG70 bounds 5% | 0.20983 | 0.27934 | 2.393656 | 0.126793 | 0.092708 | 0.01578 | 0.016067 | 0.760406 |
| MS EWMA ESG70 bounds 5% | 0.14828 | 0.191267 | -24.9933 | 0.084651 | 0.060452 | 0.012943 | 0.013342 | 0.665371 |
| GMV EWMA ESG70 bounds 5% CKs | 0.237665 | 0.323809 | 2.635492 | 0.152258 | 0.105619 | 0.019049 | 0.020488 | 0.810241 |
| MS EWMA ESG70 bounds 5% CKs | 0.166635 | 0.235814 | -6.836653 | 0.106922 | 0.071502 | 0.01797 | 0.019039 | 0.724249 |
| GMV EWMA ESG70 bounds 5% CKd | 0.265697 | 0.412344 | 2.458714 | 0.200729 | 0.135031 | 0.023634 | 0.024865 | 0.901929 |
| MS EWMA ESG70 bounds 5% CKd | 0.197143 | 0.263637 | 8.141546 | 0.132156 | 0.085434 | 0.016972 | 0.017604 | 0.744096 |
| GMV EWMA ESG70 unconstrained | 0.124783 | 0.182803 | 2.114191 | 0.078844 | 0.057599 | 0.010127 | 0.010436 | 0.675487 |
| MS EWMA ESG70 unconstrained | -0.05827 | -0.043942 | -1.318873 | -0.102623 | -0.021111 | -0.036488 | -0.059511 | 0.135518 |
| GMV EWMA ESG70 unconstrained CKs | 0.230039 | 0.336731 | 2.623108 | 0.161885 | 0.108952 | 0.019627 | 0.021156 | 0.826762 |
| MS EWMA ESG70 unconstrained CKs | -0.120216 | -0.085504 | -4.587439 | -0.446612 | -0.03889 | -0.023989 | -0.02742 | 0.052382 |
| GMV EWMA ESG70 unconstrained CKd | 0.243284 | 0.380329 | 3.052297 | 0.189118 | 0.122844 | 0.024252 | 0.025477 | 0.872633 |
| MS EWMA ESG70 unconstrained CKd | 0.11222 | 0.244769 | 5.981348 | 0.142354 | 0.081926 | 0.014973 | 0.026478 | 0.666858 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA ESG50 no-short | 0.098284 | 0.07272 | 0.785495 | 0.110811 | 0.037298 | 0.007332 | 0.007544 | 0.356201 |
| MS EWMA ESG50 no-short | 0.26319 | 0.371542 | 2.125804 | 0.168765 | 0.12117 | 0.033178 | 0.037755 | 0.865541 |
| GMV EWMA ESG50 no-short CKs | 0.158567 | 0.131135 | 1.132697 | 0.158966 | 0.060844 | 0.012787 | 0.01332 | 0.495933 |
| MS EWMA ESG50 no-short CKs | 0.262252 | 0.333442 | 1.775132 | 0.191485 | 0.114495 | 0.035558 | 0.050527 | 0.820891 |
| GMV EWMA ESG50 no-short CKd | 0.088493 | 0.076053 | 0.623694 | 0.078989 | 0.033231 | 0.006476 | 0.006674 | 0.429711 |
| MS EWMA ESG50 no-short CKd | 0.171698 | 0.226851 | 0.977425 | 0.102086 | 0.072769 | 0.01596 | 0.017688 | 0.702748 |
| GMV EWMA ESG50 bounds 1 | 0.148761 | 0.189912 | 1.675324 | 0.088487 | 0.064376 | 0.0133 | 0.013995 | 0.655984 |
| MS EWMA ESG50 bounds 1 | 0.088678 | 0.105398 | -3.38583 | 0.049156 | 0.033593 | 0.025057 | 0.025115 | 0.552618 |
| GMV EWMA ESG50 bounds 1 CKs | 0.232357 | 0.296936 | 2.452399 | 0.149779 | 0.097569 | 0.019651 | 0.020506 | 0.774937 |
| MS EWMA ESG50 bounds 1 CKs | 0.056348 | 0.063303 | -0.819489 | 0.035194 | 0.021045 | 0.022595 | 0.023005 | 0.481791 |
| GMV EWMA ESG50 bounds 1 CKd | 0.265626 | 0.389126 | 3.31676 | 0.2075 | 0.126096 | 0.026499 | 0.029396 | 0.884209 |
| MS EWMA ESG50 bounds 1 CKd | 0.048751 | 0.072342 | -0.657337 | 0.028494 | 0.021936 | 0.014085 | 0.014422 | 0.576412 |
| GMV EWMA ESG50 bounds 5% | 0.219732 | 0.339801 | 2.712521 | 0.139706 | 0.109564 | 0.018229 | 0.018672 | 0.831753 |
| MS EWMA ESG50 bounds 5% | 0.172239 | 0.240093 | -33.02135 | 0.10956 | 0.075529 | 0.016372 | 0.017197 | 0.72918 |
| GMV EWMA ESG50 bounds 5% CKs | 0.272633 | 0.377298 | 2.920252 | 0.17054 | 0.121484 | 0.024366 | 0.025749 | 0.872821 |
| MS EWMA ESG50 bounds 5% CKs | 0.155504 | 0.20502 | -4.294164 | 0.104527 | 0.064229 | 0.016684 | 0.017921 | 0.683349 |
| GMV EWMA ESG50 bounds 5% CKd | 0.273966 | 0.40361 | 4.252125 | 0.218449 | 0.130404 | 0.031043 | 0.034856 | 0.893445 |
| MS EWMA ESG50 bounds 5% CKd | 0.218702 | 0.281327 | -6.090634 | 0.166452 | 0.098643 | 0.024609 | 0.026366 | 0.759353 |
| GMV EWMA ESG50 unconstrained | 0.147793 | 0.189401 | 1.667021 | 0.087927 | 0.063969 | 0.013131 | 0.013808 | 0.65569 |
| MS EWMA ESG50 unconstrained | 0.099745 | 0.166869 | -2.667923 | 0.095063 | 0.058554 | 0.004341 | 0.007279 | 0.575345 |
| GMV EWMA ESG50 unconstrained CKs | 0.228267 | 0.281556 | 2.227822 | 0.150223 | 0.091822 | 0.018774 | 0.019525 | 0.753768 |
| MS EWMA ESG50 unconstrained CKs | 0.179126 | 0.498075 | 10.56997 | 0.697364 | 0.200482 | 0.004915 | 0.006817 | 0.992537 |
| GMV EWMA ESG50 unconstrained CKd | 0.225746 | 0.311905 | 2.012741 | 0.151633 | 0.103002 | 0.020948 | 0.022045 | 0.797458 |
| MS EWMA ESG50 unconstrained CKd | -0.055023 | -0.044864 | 0.902254 | -0.058289 | -0.016276 | -0.008339 | -0.010216 | 0.225931 |

*Tables 5.2.2b: Performance Indicators, EWMA Estimators and Positive Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 380 | 44 | 44 | 51 | 48 | 46 | 52 | 51 | 44 |
| GMV EWMA ESG90 no-short | 313 | 32 | 35 | 38 | 42 | 37 | 46 | 46 | 37 |
| MS EWMA ESG90 no-short | 261 | 31 | 31 | 37 | 29 | 32 | 36 | 36 | 29 |
| GMV EWMA ESG90 no-short CKs | 252 | 27 | 30 | 36 | 34 | 29 | 33 | 33 | 30 |
| MS EWMA ESG90 no-short CKs | 343 | 41 | 45 | 47 | 30 | 45 | 42 | 42 | 51 |
| GMV EWMA ESG90 no-short CKd | 284 | 34 | 32 | 40 | 38 | 33 | 39 | 37 | 31 |
| MS EWMA ESG90 no-short CKd | 167 | 26 | 17 | 34 | 23 | 22 | 14 | 16 | 15 |
| GMV EWMA ESG90 bounds 1 | 325 | 39 | 39 | 26 | 46 | 42 | 48 | 47 | 38 |
| MS EWMA ESG90 bounds 1 | 527 | 67 | 67 | 57 | 68 | 67 | 68 | 68 | 65 |
| GMV EWMA ESG90 bounds 1 CKs | 389 | 48 | 48 | 41 | 50 | 48 | 55 | 54 | 45 |
| MS EWMA ESG90 bounds 1 CKs | 471 | 63 | 65 | 61 | 59 | 64 | 47 | 49 | 63 |
| GMV EWMA ESG90 bounds 1 CKd | 394 | 51 | 47 | 46 | 54 | 47 | 53 | 53 | 43 |
| MS EWMA ESG90 bounds 1 CKd | 429 | 58 | 56 | 65 | 56 | 57 | 38 | 40 | 59 |
| GMV EWMA ESG90 bounds 5% | 448 | 56 | 54 | 52 | 58 | 56 | 60 | 62 | 50 |
| MS EWMA ESG90 bounds 5% | 419 | 50 | 51 | 45 | 55 | 52 | 58 | 59 | 49 |
| GMV EWMA ESG90 bounds 5% CKs | 488 | 62 | 62 | 54 | 63 | 63 | 65 | 65 | 54 |
| MS EWMA ESG90 bounds 5% CKs | 461 | 57 | 55 | 49 | 61 | 58 | 62 | 63 | 56 |
| GMV EWMA ESG90 bounds 5% CKd | 511 | 66 | 66 | 55 | 66 | 66 | 66 | 66 | 60 |
| MS EWMA ESG90 bounds 5% CKd | 473 | 59 | 57 | 53 | 62 | 60 | 63 | 64 | 55 |
| GMV EWMA ESG90 unconstrained | 333 | 40 | 40 | 27 | 47 | 43 | 49 | 48 | 39 |
| MS EWMA ESG90 unconstrained | 492 | 69 | 69 | 10 | 69 | 69 | 69 | 69 | 68 |
| GMV EWMA ESG90 unconstrained CKs | 397 | 49 | 49 | 42 | 51 | 49 | 56 | 55 | 46 |
| MS EWMA ESG90 unconstrained CKs | 531 | 68 | 68 | 56 | 67 | 68 | 67 | 67 | 70 |
| GMV EWMA ESG90 unconstrained CKd | 406 | 52 | 50 | 44 | 52 | 51 | 54 | 56 | 47 |
| MS EWMA ESG90 unconstrained CKd | 500 | 70 | 70 | 6 | 71 | 71 | 70 | 71 | 71 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 380 | 44 | 44 | 51 | 48 | 46 | 52 | 51 | 44 |
| GMV EWMA ESG70 no-short | 179 | 17 | 19 | 30 | 25 | 21 | 23 | 24 | 20 |
| MS EWMA ESG70 no-short | 217 | 23 | 25 | 32 | 27 | 25 | 30 | 30 | 25 |
| GMV EWMA ESG70 no-short CKs | 130 | 10 | 16 | 29 | 11 | 16 | 16 | 15 | 17 |
| MS EWMA ESG70 no-short CKs | 219 | 22 | 34 | 31 | 16 | 27 | 24 | 23 | 42 |
| GMV EWMA ESG70 no-short CKd | 193 | 20 | 23 | 33 | 19 | 23 | 26 | 26 | 23 |
| MS EWMA ESG70 no-short CKd | 83 | 8 | 9 | 28 | 12 | 9 | 4 | 4 | 9 |
| GMV EWMA ESG70 bounds 1 | 320 | 42 | 41 | 20 | 43 | 41 | 50 | 50 | 33 |
| MS EWMA ESG70 bounds 1 | 334 | 55 | 52 | 64 | 49 | 53 | 6 | 7 | 48 |
| GMV EWMA ESG70 bounds 1 CKs | 126 | 15 | 13 | 14 | 15 | 13 | 22 | 22 | 12 |
| MS EWMA ESG70 bounds 1 CKs | 378 | 60 | 59 | 59 | 57 | 59 | 9 | 14 | 61 |
| GMV EWMA ESG70 bounds 1 CKd | 28 | 1 | 2 | 7 | 4 | 2 | 5 | 5 | 2 |
| MS EWMA ESG70 bounds 1 CKd | 463 | 65 | 64 | 62 | 65 | 65 | 40 | 45 | 57 |
| GMV EWMA ESG70 bounds 5% | 195 | 21 | 22 | 17 | 28 | 19 | 34 | 35 | 19 |
| MS EWMA ESG70 bounds 5% | 348 | 37 | 36 | 72 | 41 | 39 | 44 | 43 | 36 |
| GMV EWMA ESG70 bounds 5% CKs | 123 | 11 | 14 | 12 | 17 | 14 | 20 | 21 | 14 |
| MS EWMA ESG70 bounds 5% CKs | 274 | 30 | 28 | 71 | 33 | 31 | 27 | 27 | 27 |
| GMV EWMA ESG70 bounds 5% CKd | 59 | 4 | 3 | 15 | 5 | 3 | 13 | 13 | 3 |
| MS EWMA ESG70 bounds 5% CKd | 184 | 24 | 24 | 2 | 26 | 24 | 28 | 32 | 24 |
| GMV EWMA ESG70 unconstrained | 332 | 43 | 42 | 21 | 45 | 44 | 51 | 52 | 34 |
| MS EWMA ESG70 unconstrained | 568 | 72 | 71 | 63 | 72 | 72 | 73 | 73 | 72 |
| GMV EWMA ESG70 unconstrained CKs | 111 | 13 | 11 | 13 | 13 | 12 | 19 | 19 | 11 |
| MS EWMA ESG70 unconstrained CKs | 578 | 73 | 73 | 69 | 73 | 73 | 72 | 72 | 73 |
| GMV EWMA ESG70 unconstrained CKd | 66 | 9 | 6 | 8 | 7 | 6 | 12 | 11 | 7 |
| MS EWMA ESG70 unconstrained CKd | 200 | 45 | 26 | 3 | 22 | 26 | 35 | 8 | 35 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 380 | 44 | 44 | 51 | 48 | 46 | 52 | 51 | 44 |
| GMV EWMA ESG50 no-short | 417 | 47 | 60 | 48 | 31 | 50 | 57 | 57 | 67 |
| MS EWMA ESG50 no-short | 62 | 6 | 8 | 19 | 9 | 8 | 2 | 2 | 8 |
| GMV EWMA ESG50 no-short CKs | 317 | 33 | 46 | 35 | 14 | 38 | 45 | 44 | 62 |
| MS EWMA ESG50 no-short CKs | 73 | 7 | 12 | 23 | 6 | 10 | 1 | 1 | 13 |
| GMV EWMA ESG50 no-short CKd | 447 | 54 | 58 | 50 | 44 | 55 | 59 | 61 | 66 |
| MS EWMA ESG50 no-short CKd | 254 | 29 | 29 | 39 | 36 | 30 | 32 | 31 | 28 |
| GMV EWMA ESG50 bounds 1 | 290 | 36 | 37 | 24 | 39 | 34 | 41 | 39 | 40 |
| MS EWMA ESG50 bounds 1 | 358 | 53 | 53 | 67 | 53 | 54 | 8 | 12 | 58 |
| GMV EWMA ESG50 bounds 1 CKs | 141 | 12 | 18 | 16 | 21 | 18 | 18 | 20 | 18 |
| MS EWMA ESG50 bounds 1 CKs | 402 | 61 | 63 | 60 | 60 | 62 | 15 | 17 | 64 |
| GMV EWMA ESG50 bounds 1 CKd | 41 | 5 | 5 | 5 | 3 | 5 | 7 | 6 | 5 |
| MS EWMA ESG50 bounds 1 CKd | 435 | 64 | 61 | 58 | 64 | 61 | 37 | 38 | 52 |
| GMV EWMA ESG50 bounds 5% | 137 | 18 | 10 | 11 | 24 | 11 | 25 | 28 | 10 |
| MS EWMA ESG50 bounds 5% | 279 | 28 | 27 | 73 | 32 | 28 | 31 | 34 | 26 |
| GMV EWMA ESG50 bounds 5% CKs | 61 | 3 | 7 | 9 | 8 | 7 | 11 | 10 | 6 |
| MS EWMA ESG50 bounds 5% CKs | 296 | 35 | 33 | 68 | 35 | 35 | 29 | 29 | 32 |
| GMV EWMA ESG50 bounds 5% CKd | 26 | 2 | 4 | 4 | 2 | 4 | 3 | 3 | 4 |
| MS EWMA ESG50 bounds 5% CKd | 177 | 19 | 21 | 70 | 10 | 17 | 10 | 9 | 21 |
| GMV EWMA ESG50 unconstrained | 302 | 38 | 38 | 25 | 40 | 36 | 43 | 41 | 41 |
| MS EWMA ESG50 unconstrained | 407 | 46 | 43 | 66 | 37 | 40 | 64 | 58 | 53 |
| GMV EWMA ESG50 unconstrained CKs | 160 | 14 | 20 | 18 | 20 | 20 | 21 | 25 | 22 |
| MS EWMA ESG50 unconstrained CKs | 151 | 25 | 1 | 1 | 1 | 1 | 61 | 60 | 1 |
| GMV EWMA ESG50 unconstrained CKd | 137 | 16 | 15 | 22 | 18 | 15 | 17 | 18 | 16 |
| MS EWMA ESG50 unconstrained CKd | 536 | 71 | 72 | 43 | 70 | 70 | 71 | 70 | 69 |

*Tables 5.2.2c: Relative Indicators, EWMA Estimators and Positive Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EWMA ESG90 no-short | 0.053502 | 9.772473 | 2.053437 | 0.005475 | 0.026055 |
| MS EWMA ESG90 no-short | 0.268908 | 13.81117 | 2.424988 | 0.01947 | 0.11089 |
| GMV EWMA ESG90 no-short CKs | 0.10374 | 9.382379 | 1.867207 | 0.011057 | 0.055559 |
| MS EWMA ESG90 no-short CKs | 0.173074 | 15.2409 | 3.085358 | 0.011356 | 0.056095 |
| GMV EWMA ESG90 no-short CKd | 0.048624 | 9.189992 | 1.938654 | 0.005291 | 0.025081 |
| MS EWMA ESG90 no-short CKd | 0.281811 | 15.17918 | 2.098765 | 0.018566 | 0.134275 |
| GMV EWMA ESG90 bounds 1 | 0.066488 | 22.41345 | 3.632748 | 0.002966 | 0.018302 |
| MS EWMA ESG90 bounds 1 | -0.45493 | 625.833 | 21.50339 | -0.00073 | -0.02116 |
| GMV EWMA ESG90 bounds 1 CKs | -0.17099 | 19.51497 | 3.255089 | -0.00876 | -0.05253 |
| MS EWMA ESG90 bounds 1 CKs | 0.710613 | 654.9771 | 22.86843 | 0.001085 | 0.031074 |
| GMV EWMA ESG90 bounds 1 CKd | -0.14342 | 20.71391 | 3.292138 | -0.00692 | -0.04356 |
| MS EWMA ESG90 bounds 1 CKd | 0.832593 | 522.078 | 17.50548 | 0.001595 | 0.047562 |
| GMV EWMA ESG90 bounds 5% | -0.24957 | 12.52156 | 3.190578 | -0.01993 | -0.07822 |
| MS EWMA ESG90 bounds 5% | -0.10794 | 22.19063 | 4.164267 | -0.00486 | -0.02592 |
| GMV EWMA ESG90 bounds 5% CKs | -0.33389 | 12.91871 | 3.111463 | -0.02585 | -0.10731 |
| MS EWMA ESG90 bounds 5% CKs | -0.20783 | 22.97842 | 4.558522 | -0.00904 | -0.04559 |
| GMV EWMA ESG90 bounds 5% CKd | -0.3761 | 12.0953 | 3.038009 | -0.03109 | -0.1238 |
| MS EWMA ESG90 bounds 5% CKd | -0.23274 | 17.84135 | 3.881946 | -0.01304 | -0.05995 |
| GMV EWMA ESG90 unconstrained | 0.066488 | 22.41345 | 3.632748 | 0.002966 | 0.018302 |
| MS EWMA ESG90 unconstrained | -4.07678 | 14346.93 | 95.77643 | -0.00028 | -0.04257 |
| GMV EWMA ESG90 unconstrained CKs | -0.17099 | 19.51497 | 3.255089 | -0.00876 | -0.05253 |
| MS EWMA ESG90 unconstrained CKs | -0.19508 | 39462.29 | 204.5667 | -4.94E-06 | -0.00095 |
| GMV EWMA ESG90 unconstrained CKd | -0.16443 | 20.53474 | 3.326717 | -0.00801 | -0.04943 |
| MS EWMA ESG90 unconstrained CKd | -7.31045 | 23372.23 | 172.3445 | -0.00031 | -0.04242 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EWMA ESG70 no-short | 0.184779 | 10.03525 | 2.345902 | 0.018413 | 0.078767 |
| MS EWMA ESG70 no-short | 0.299775 | 12.39257 | 2.678226 | 0.02419 | 0.11193 |
| GMV EWMA ESG70 no-short CKs | 0.288181 | 10.34807 | 2.263162 | 0.027849 | 0.127335 |
| MS EWMA ESG70 no-short CKs | 0.456479 | 13.76054 | 2.661883 | 0.033173 | 0.171487 |
| GMV EWMA ESG70 no-short CKd | 0.20845 | 9.513764 | 2.217235 | 0.02191 | 0.094014 |
| MS EWMA ESG70 no-short CKd | 0.549752 | 11.14895 | 2.337505 | 0.04931 | 0.235187 |
| GMV EWMA ESG70 bounds 1 | -0.00755 | 27.93273 | 3.860369 | -0.00027 | -0.00196 |
| MS EWMA ESG70 bounds 1 | 2.299883 | 1307.252 | 26.53866 | 0.001759 | 0.086662 |
| GMV EWMA ESG70 bounds 1 CKs | 0.236692 | 19.81776 | 3.282622 | 0.011943 | 0.072104 |
| MS EWMA ESG70 bounds 1 CKs | 1.951575 | 1906.302 | 34.66781 | 0.001024 | 0.056294 |
| GMV EWMA ESG70 bounds 1 CKd | 0.570054 | 21.63632 | 3.535526 | 0.026347 | 0.161236 |
| MS EWMA ESG70 bounds 1 CKd | 0.792212 | 1031.774 | 22.0736 | 0.000768 | 0.03589 |
| GMV EWMA ESG70 bounds 5% | 0.238246 | 20.76629 | 3.495498 | 0.011473 | 0.068158 |
| MS EWMA ESG70 bounds 5% | 0.349981 | 57.44828 | 6.369795 | 0.006092 | 0.054944 |
| GMV EWMA ESG70 bounds 5% CKs | 0.256853 | 19.17922 | 3.318713 | 0.013392 | 0.077396 |
| MS EWMA ESG70 bounds 5% CKs | 0.526828 | 67.26269 | 6.759066 | 0.007832 | 0.077944 |
| GMV EWMA ESG70 bounds 5% CKd | 0.406886 | 17.30911 | 2.8696 | 0.023507 | 0.141792 |
| MS EWMA ESG70 bounds 5% CKd | 0.51989 | 43.7101 | 5.081758 | 0.011894 | 0.102305 |
| GMV EWMA ESG70 unconstrained | -0.01103 | 27.94313 | 3.855109 | -0.00039 | -0.00286 |
| MS EWMA ESG70 unconstrained | -18.3852 | 93284.68 | 402.3508 | -0.0002 | -0.04569 |
| GMV EWMA ESG70 unconstrained CKs | 0.251285 | 19.79478 | 3.296344 | 0.012694 | 0.076231 |
| MS EWMA ESG70 unconstrained CKs | -88.3581 | 532904.5 | 1019.029 | -0.00017 | -0.08671 |
| GMV EWMA ESG70 unconstrained CKd | 0.399609 | 22.62304 | 3.231018 | 0.017664 | 0.123679 |
| MS EWMA ESG70 unconstrained CKd | 23.28544 | 44928.25 | 96.10805 | 0.000518 | 0.242284 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EWMA ESG50 no-short | -0.10457 | 17.36894 | 4.015558 | -0.00602 | -0.02604 |
| MS EWMA ESG50 no-short | 0.539669 | 16.48851 | 2.453615 | 0.03273 | 0.219949 |
| GMV EWMA ESG50 no-short CKs | 0.115425 | 13.88748 | 3.14291 | 0.008311 | 0.036726 |
| MS EWMA ESG50 no-short CKs | 0.556082 | 12.72011 | 2.141131 | 0.043717 | 0.259714 |
| GMV EWMA ESG50 no-short CKd | -0.15995 | 13.981 | 3.548211 | -0.01144 | -0.04508 |
| MS EWMA ESG50 no-short CKd | 0.242077 | 8.636532 | 2.053398 | 0.028029 | 0.117891 |
| GMV EWMA ESG50 bounds 1 | 0.072802 | 22.31858 | 3.395358 | 0.003262 | 0.021442 |
| MS EWMA ESG50 bounds 1 | 1.980511 | 856.8076 | 24.28362 | 0.002312 | 0.081557 |
| GMV EWMA ESG50 bounds 1 CKs | 0.216317 | 18.29149 | 3.168545 | 0.011826 | 0.06827 |
| MS EWMA ESG50 bounds 1 CKs | 1.792342 | 1845.315 | 37.20179 | 0.000971 | 0.048179 |
| GMV EWMA ESG50 bounds 1 CKd | 0.392631 | 21.11531 | 3.252648 | 0.018595 | 0.120711 |
| MS EWMA ESG50 bounds 1 CKd | 1.076937 | 1216.723 | 23.80104 | 0.000885 | 0.045247 |
| GMV EWMA ESG50 bounds 5% | 0.300898 | 22.26193 | 3.505192 | 0.013516 | 0.085844 |
| MS EWMA ESG50 bounds 5% | 0.435814 | 53.3058 | 5.618382 | 0.008176 | 0.077569 |
| GMV EWMA ESG50 bounds 5% CKs | 0.289503 | 17.94003 | 3.165058 | 0.016137 | 0.091468 |
| MS EWMA ESG50 bounds 5% CKs | 0.479045 | 72.47228 | 6.954556 | 0.00661 | 0.068882 |
| GMV EWMA ESG50 bounds 5% CKd | 0.386905 | 22.77837 | 3.601257 | 0.016986 | 0.107436 |
| MS EWMA ESG50 bounds 5% CKd | 0.712517 | 61.11511 | 6.707062 | 0.011659 | 0.106234 |
| GMV EWMA ESG50 unconstrained | 0.068934 | 22.34504 | 3.393845 | 0.003085 | 0.020312 |
| MS EWMA ESG50 unconstrained | 12.66848 | 17750.23 | 76.58506 | 0.000714 | 0.165417 |
| GMV EWMA ESG50 unconstrained CKs | 0.219035 | 17.45327 | 3.201506 | 0.01255 | 0.068416 |
| MS EWMA ESG50 unconstrained CKs | 63.88751 | 129134.7 | 126.6009 | 0.000495 | 0.504637 |
| GMV EWMA ESG50 unconstrained CKd | 0.264783 | 16.72245 | 3.085716 | 0.015834 | 0.085809 |
| MS EWMA ESG50 unconstrained CKd | -6.89391 | 13646.44 | 142.3451 | -0.00051 | -0.04843 |

### 5.2.3

*Table 5.2.3a: Performance Indicators, EWMA Estimators and No Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA no-short | 0.150335 | 0.141217 | 1.562339 | 0.130135 | 0.060857 | 0.012931 | 0.013403 | 0.528933 |
| MS EWMA no-short | 0.318453 | 0.46427 | 3.868528 | 0.214732 | 0.148134 | 0.055947 | 0.060837 | 0.972116 |
| GMV EWMA no-short CKs | 0.180339 | 0.203059 | 1.717066 | 0.134887 | 0.075982 | 0.019781 | 0.020593 | 0.64118 |
| MS EWMA no-short CKs | 0.307078 | 0.467704 | 3.431147 | 0.192777 | 0.151826 | 0.06772 | 0.073203 | 0.967359 |
| GMV EWMA no-short CKd | 0.157686 | 0.173165 | 1.603493 | 0.141799 | 0.064447 | 0.015937 | 0.016744 | 0.595788 |
| MS EWMA no-short CKd | 0.233722 | 0.298766 | 2.252208 | 0.154188 | 0.098268 | 0.040967 | 0.042162 | 0.779425 |
| GMV EWMA bounds 1 | 0.023608 | 0.037253 | 0.62298 | 0.014364 | 0.012088 | 0.001813 | 0.001856 | 0.571598 |
| MS EWMA bounds 1 | 0.068785 | 0.079918 | -2.894663 | 0.043025 | 0.028592 | 0.018886 | 0.019613 | 0.513515 |
| GMV EWMA bounds 1 CKs | 0.088538 | 0.115111 | 1.311426 | 0.049555 | 0.036251 | 0.00596 | 0.006026 | 0.591087 |
| MS EWMA bounds 1 CKs | 0.040217 | 0.047183 | -0.676379 | 0.026465 | 0.015394 | 0.008839 | 0.009209 | 0.490511 |
| GMV EWMA bounds 1 CKd | 0.016934 | 0.020991 | 0.221507 | 0.00961 | 0.006354 | 0.001009 | 0.001025 | 0.496982 |
| MS EWMA bounds 1 CKd | 0.185581 | 0.239728 | -6.192412 | 0.119368 | 0.079995 | 0.05091 | 0.050913 | 0.705968 |
| GMV EWMA bounds 5% | 0.108508 | 0.162796 | 2.049594 | 0.068236 | 0.051113 | 0.008305 | 0.008485 | 0.661976 |
| MS EWMA bounds 5% | 0.076309 | 0.106386 | -11.47469 | 0.04765 | 0.032773 | 0.006136 | 0.006253 | 0.604898 |
| GMV EWMA bounds 5% CKs | 0.138226 | 0.172834 | 1.981738 | 0.080233 | 0.055928 | 0.009371 | 0.009485 | 0.639131 |
| MS EWMA bounds 5% CKs | 0.092371 | 0.10945 | -2.33737 | 0.066462 | 0.037066 | 0.008629 | 0.008938 | 0.569208 |
| GMV EWMA bounds 5% CKd | 0.123462 | 0.173861 | 1.376695 | 0.088678 | 0.056695 | 0.008857 | 0.008934 | 0.65565 |
| MS EWMA bounds 5% CKd | 0.047825 | 0.054245 | -3.193013 | 0.029419 | 0.018953 | 0.004002 | 0.004012 | 0.497214 |
| GMV EWMA unconstrained | 0.037215 | 0.058304 | 0.926907 | 0.022549 | 0.018977 | 0.003102 | 0.003194 | 0.586213 |
| MS EWMA unconstrained | 0.027197 | 0.023897 | 0.876176 | 0.027852 | 0.010618 | 1.29E-05 | 1.79E-05 | 0.274129 |
| GMV EWMA unconstrained CKs | 0.110901 | 0.146735 | 1.459466 | 0.069385 | 0.046282 | 0.007964 | 0.008249 | 0.624413 |
| MS EWMA unconstrained CKs | -0.020831 | -0.019751 | 0.522471 | -0.01321 | -0.006733 | -0.008004 | -0.010076 | 0.309598 |
| GMV EWMA unconstrained CKd | 0.101864 | 0.134785 | 1.325667 | 0.066769 | 0.042558 | 0.007759 | 0.008046 | 0.614483 |
| MS EWMA unconstrained CKd | -0.019786 | -0.019263 | -13.76816 | -0.03994 | -0.009058 | -1.34E-02 | -1.41E-02 | 0.158922 |

*Table 5.2.3b: Performance Indicators, EWMA Estimators and No Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 89 | 10 | 10 | 16 | 14 | 11 | 9 | 9 | 10 |
| GMV EWMA no-short | 74 | 7 | 12 | 8 | 6 | 7 | 8 | 8 | 18 |
| MS EWMA no-short | 12 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 |
| GMV EWMA no-short CKs | 43 | 5 | 5 | 6 | 5 | 5 | 5 | 5 | 7 |
| MS EWMA no-short CKs | 12 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 |
| GMV EWMA no-short CKd | 57 | 6 | 7 | 7 | 4 | 6 | 7 | 7 | 13 |
| MS EWMA no-short CKd | 26 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 |
| GMV EWMA bounds 1 | 159 | 22 | 21 | 15 | 22 | 21 | 21 | 21 | 16 |
| MS EWMA bounds 1 | 120 | 17 | 17 | 21 | 17 | 17 | 6 | 6 | 19 |
| GMV EWMA bounds 1 CKs | 121 | 15 | 14 | 12 | 15 | 15 | 18 | 18 | 14 |
| MS EWMA bounds 1 CKs | 143 | 19 | 20 | 19 | 20 | 20 | 12 | 11 | 22 |
| GMV EWMA bounds 1 CKd | 175 | 23 | 23 | 18 | 23 | 23 | 22 | 22 | 21 |
| MS EWMA bounds 1 CKd | 52 | 4 | 4 | 23 | 7 | 4 | 3 | 3 | 4 |
| GMV EWMA bounds 5% | 79 | 12 | 9 | 4 | 11 | 10 | 14 | 14 | 5 |
| MS EWMA bounds 5% | 134 | 16 | 16 | 24 | 16 | 16 | 17 | 17 | 12 |
| GMV EWMA bounds 5% CKs | 67 | 8 | 8 | 5 | 9 | 9 | 10 | 10 | 8 |
| MS EWMA bounds 5% CKs | 118 | 14 | 15 | 20 | 13 | 14 | 13 | 12 | 17 |
| GMV EWMA bounds 5% CKd | 71 | 9 | 6 | 10 | 8 | 8 | 11 | 13 | 6 |
| MS EWMA bounds 5% CKd | 154 | 18 | 19 | 22 | 18 | 19 | 19 | 19 | 20 |
| GMV EWMA unconstrained | 145 | 20 | 18 | 13 | 21 | 18 | 20 | 20 | 15 |
| MS EWMA unconstrained | 168 | 21 | 22 | 14 | 19 | 22 | 23 | 23 | 24 |
| GMV EWMA unconstrained CKs | 92 | 11 | 11 | 9 | 10 | 12 | 15 | 15 | 9 |
| MS EWMA unconstrained CKs | 186 | 25 | 25 | 17 | 24 | 24 | 24 | 24 | 23 |
| GMV EWMA unconstrained CKd | 105 | 13 | 13 | 11 | 12 | 13 | 16 | 16 | 11 |
| MS EWMA unconstrained CKd | 198 | 24 | 24 | 25 | 25 | 25 | 25 | 25 | 25 |

*Table 5.2.3c: Relative Indicators, EWMA Estimators and No Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EWMA no-short | -0.10081 | 17.32787 | 3.094845 | -0.00582 | -0.03257 |
| MS EWMA no-short | 0.494762 | 19.90581 | 3.612799 | 0.024855 | 0.136947 |
| GMV EWMA no-short CKs | 0.036597 | 16.81472 | 3.081174 | 0.002177 | 0.011878 |
| MS EWMA no-short CKs | 0.464092 | 19.02682 | 3.518595 | 0.024391 | 0.131897 |
| GMV EWMA no-short CKd | -0.05538 | 17.38647 | 3.280372 | -0.00319 | -0.01688 |
| MS EWMA no-short CKd | 0.307994 | 18.11394 | 3.627273 | 0.017003 | 0.084911 |
| GMV EWMA bounds 1 | -0.45348 | 27.53477 | 4.022925 | -0.01647 | -0.11272 |
| MS EWMA bounds 1 | 1.629667 | 1043.574 | 26.93337 | 0.001562 | 0.060507 |
| GMV EWMA bounds 1 CKs | -0.26369 | 21.32068 | 3.620075 | -0.01237 | -0.07284 |
| MS EWMA bounds 1 CKs | 0.728742 | 1087.967 | 27.62735 | 0.00067 | 0.026378 |
| GMV EWMA bounds 1 CKd | -0.47812 | 21.79773 | 3.611604 | -0.02193 | -0.13238 |
| MS EWMA bounds 1 CKd | 4.551069 | 805.2821 | 20.96719 | 0.005652 | 0.217057 |
| GMV EWMA bounds 5% | -0.12615 | 26.46177 | 3.812215 | -0.00477 | -0.03309 |
| MS EWMA bounds 5% | -0.09466 | 55.47747 | 5.98564 | -0.00171 | -0.01582 |
| GMV EWMA bounds 5% CKs | -0.1075 | 21.09414 | 3.554095 | -0.0051 | -0.03025 |
| MS EWMA bounds 5% CKs | 0.099747 | 78.82802 | 7.447117 | 0.001265 | 0.013394 |
| GMV EWMA bounds 5% CKd | -0.0878 | 20.26991 | 3.534594 | -0.00433 | -0.02484 |
| MS EWMA bounds 5% CKd | -0.247 | 60.88399 | 6.809808 | -0.00406 | -0.03627 |
| GMV EWMA unconstrained | -0.40522 | 27.12675 | 4.010357 | -0.01494 | -0.10104 |
| MS EWMA unconstrained | 3.756238 | 24755.42 | 173.9221 | 0.000152 | 0.021597 |
| GMV EWMA unconstrained CKs | -0.20182 | 20.05574 | 3.431434 | -0.01006 | -0.05881 |
| MS EWMA unconstrained CKs | -2.14642 | 6104.844 | 78.20058 | -0.00035 | -0.02745 |
| GMV EWMA unconstrained CKd | -0.19985 | 2.09E+01 | 3.359104 | -9.57E-03 | -0.0595 |
| MS EWMA unconstrained CKd | -7.24305 | 1.15E+05 | 339.8502 | -6.31E-05 | -0.02131 |

### 5.3.1

*Table 5.3.1a: Performance Indicators, Equilibrium Moments and Negative Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ sin no-short | 0.200447 | 0.278611 | 1.685798 | 0.124121 | 0.092287 | 0.021275 | 0.022131 | 0.759489 |
| MS EQ sin no-short | 0.127528 | 0.161285 | 0.583505 | 0.068708 | 0.052949 | 0.010551 | 0.011394 | 0.625941 |
| GMV EQ sin no-short CKs | 0.18106 | 0.227544 | 1.535903 | 0.105858 | 0.079725 | 0.02012 | 0.020799 | 0.692752 |
| MS EQ sin no-short CKs | 0.185904 | 0.228477 | 1.461102 | 0.102288 | 0.075941 | 0.020654 | 0.021208 | 0.695809 |
| GMV EQ sin no-short CKd | 0.16791 | 0.216373 | 1.43118 | 0.088851 | 0.071087 | 0.018503 | 0.019449 | 0.685428 |
| MS EQ sin no-short CKd | 0.18083 | 0.252469 | 1.431094 | 0.105434 | 0.081412 | 0.022198 | 0.024413 | 0.735469 |
| GMV EQ sin bounds 1 | 0.235564 | 0.340953 | 4.623018 | 0.152247 | 0.110451 | 0.026658 | 0.027584 | 0.826482 |
| MS EQ sin bounds 1 | 0.127522 | 0.161295 | 0.583493 | 0.068748 | 0.05295 | 0.010553 | 0.011396 | 0.625947 |
| GMV EQ sin bounds 1 CKs | 0.191905 | 0.266384 | 2.52913 | 0.114366 | 0.088823 | 0.017166 | 0.017871 | 0.747933 |
| MS EQ sin bounds 1 CKs | 0.087475 | 0.114615 | -1.79612 | 0.062975 | 0.035819 | 0.017053 | 0.017232 | 0.578998 |
| GMV EQ sin bounds 1 CKd | 0.118343 | 0.184908 | 1.85536 | 0.070388 | 0.055543 | 0.010156 | 0.010199 | 0.691115 |
| MS EQ sin bounds 1 CKd | 0.042862 | 0.058739 | -1.44443 | 0.024299 | 0.017943 | 0.010703 | 0.010713 | 0.54469 |
| GMV EQ sin bounds 5% | 0.230469 | 0.325561 | 4.633328 | 0.148477 | 0.10633 | 0.024115 | 0.024942 | 0.810241 |
| MS EQ sin bounds 5% | 0.127521 | 0.161295 | 0.58349 | 0.068747 | 0.052949 | 0.010553 | 0.011396 | 0.625947 |
| GMV EQ sin bounds 5% CKs | 0.21879 | 0.334215 | 2.352356 | 0.150337 | 0.107907 | 0.019425 | 0.019919 | 0.815739 |
| MS EQ sin bounds 5% CKs | 0.110974 | 0.128842 | -2.75815 | 0.068933 | 0.04425 | 0.010512 | 0.010571 | 0.583341 |
| GMV EQ sin bounds 5% CKd | 0.14105 | 0.197964 | 1.460806 | 0.080099 | 0.062004 | 0.013239 | 0.013726 | 0.681502 |
| MS EQ sin bounds 5% CKd | 0.088889 | 0.131796 | 5.726361 | 0.05673 | 0.041809 | 0.009196 | 0.010307 | 0.627864 |
| GMV EQ sin unconstrained | 0.235564 | 0.340953 | 4.623018 | 0.152247 | 0.110451 | 0.026658 | 0.027584 | 0.826482 |
| MS EQ sin unconstrained | 0.127521 | 0.161295 | 0.58349 | 0.068747 | 0.052949 | 0.010553 | 0.011396 | 0.625947 |
| GMV EQ sin unconstrained CKs | 0.191196 | 0.265252 | 2.52491 | 0.113878 | 0.088444 | 0.017114 | 0.017818 | 0.746675 |
| MS EQ sin unconstrained CKs | 0.087375 | 0.114483 | -1.79313 | 0.062904 | 0.035779 | 0.017035 | 0.017214 | 0.578862 |
| GMV EQ sin unconstrained CKd | 0.181615 | 0.275985 | 2.697066 | 0.114759 | 0.08747 | 0.017826 | 0.018542 | 0.765819 |
| MS EQ sin unconstrained CKd | 0.031134 | 0.053774 | 4.993907 | 0.057442 | 0.023789 | 0.029628 | 0.031315 | 0.338123 |

*Table 5.3.1b: Performance Indicators, Equilibrium Moments and Negative Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 166 | 18 | 19 | 21 | 22 | 19 | 24 | 23 | 20 |
| GMV EQ sin no-short | 49 | 5 | 5 | 11 | 5 | 5 | 6 | 6 | 6 |
| MS EQ sin no-short | 146 | 14 | 18 | 17 | 19 | 18 | 21 | 20 | 19 |
| GMV EQ sin no-short CKs | 79 | 10 | 11 | 12 | 9 | 10 | 8 | 8 | 11 |
| MS EQ sin no-short CKs | 77 | 8 | 10 | 13 | 11 | 11 | 7 | 7 | 10 |
| GMV EQ sin no-short CKd | 96 | 12 | 12 | 15 | 12 | 12 | 10 | 10 | 13 |
| MS EQ sin no-short CKd | 74 | 11 | 9 | 16 | 10 | 9 | 5 | 5 | 9 |
| GMV EQ sin bounds 1 | 16 | 1 | 1 | 5 | 2 | 2 | 2 | 2 | 1 |
| MS EQ sin bounds 1 | 130 | 15 | 15 | 18 | 16 | 15 | 18 | 17 | 16 |
| GMV EQ sin bounds 1 CKs | 64 | 6 | 7 | 7 | 7 | 6 | 12 | 12 | 7 |
| MS EQ sin bounds 1 CKs | 160 | 22 | 22 | 24 | 20 | 22 | 14 | 14 | 22 |
| GMV EQ sin bounds 1 CKd | 131 | 19 | 14 | 10 | 14 | 14 | 23 | 25 | 12 |
| MS EQ sin bounds 1 CKd | 182 | 24 | 24 | 22 | 25 | 25 | 17 | 21 | 24 |
| GMV EQ sin bounds 5% | 30 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 4 |
| MS EQ sin bounds 5% | 139 | 16 | 16 | 19 | 18 | 16 | 19 | 18 | 17 |
| GMV EQ sin bounds 5% CKs | 43 | 4 | 3 | 9 | 3 | 3 | 9 | 9 | 3 |
| MS EQ sin bounds 5% CKs | 166 | 20 | 21 | 25 | 15 | 20 | 22 | 22 | 21 |
| GMV EQ sin bounds 5% CKd | 112 | 13 | 13 | 14 | 13 | 13 | 16 | 16 | 14 |
| MS EQ sin bounds 5% CKd | 151 | 21 | 20 | 1 | 24 | 21 | 25 | 24 | 15 |
| GMV EQ sin unconstrained | 18 | 2 | 2 | 4 | 1 | 1 | 3 | 3 | 2 |
| MS EQ sin unconstrained | 145 | 17 | 17 | 20 | 17 | 17 | 20 | 19 | 18 |
| GMV EQ sin unconstrained CKs | 72 | 7 | 8 | 8 | 8 | 7 | 13 | 13 | 8 |
| MS EQ sin unconstrained CKs | 166 | 23 | 23 | 23 | 21 | 23 | 15 | 15 | 23 |
| GMV EQ sin unconstrained CKd | 62 | 9 | 6 | 6 | 6 | 8 | 11 | 11 | 5 |
| MS EQ sin unconstrained CKd | 126 | 25 | 25 | 2 | 23 | 24 | 1 | 1 | 25 |

*Table 5.3.1c: Relative Indicators, Equilibrium Moments and Negative Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EQ sin no-short | 0.114587 | 15.14808 | 2.757719 | 0.007564 | 0.041551 |
| MS EQ sin no-short | 0.116136 | 1.296644 | 0.74344 | 0.089566 | 0.156214 |
| GMV EQ sin no-short CKs | 0.029351 | 15.08112 | 2.908881 | 0.001946 | 0.01009 |
| MS EQ sin no-short CKs | 0.147549 | 14.84151 | 2.98577 | 0.009942 | 0.049417 |
| GMV EQ sin no-short CKd | 0.029719 | 15.59573 | 2.859072 | 0.001906 | 0.010395 |
| MS EQ sin no-short CKd | 0.207519 | 16.15675 | 2.833931 | 0.012844 | 0.073227 |
| GMV EQ sin bounds 1 | 0.298057 | 25.45593 | 3.708401 | 0.011709 | 0.080373 |
| MS EQ sin bounds 1 | 0.116511 | 1.302628 | 0.745137 | 0.089443 | 0.156362 |
| GMV EQ sin bounds 1 CKs | 0.01045 | 19.5753 | 3.114706 | 0.000534 | 0.003355 |
| MS EQ sin bounds 1 CKs | 1.091999 | 403.9972 | 14.8756 | 0.002703 | 0.073409 |
| GMV EQ sin bounds 1 CKd | -0.16399 | 22.01395 | 3.198337 | -0.00745 | -0.05127 |
| MS EQ sin bounds 1 CKd | 0.520789 | 660.0673 | 18.14632 | 0.000789 | 0.028699 |
| GMV EQ sin bounds 5% | 0.296155 | 25.99218 | 3.854148 | 0.011394 | 0.076841 |
| MS EQ sin bounds 5% | 0.116509 | 1.302642 | 0.745141 | 0.089441 | 0.156359 |
| GMV EQ sin bounds 5% CKs | 0.068801 | 17.44295 | 2.906819 | 0.003944 | 0.023669 |
| MS EQ sin bounds 5% CKs | 0.253608 | 82.60959 | 7.926913 | 0.00307 | 0.031993 |
| GMV EQ sin bounds 5% CKd | -0.06458 | 18.35497 | 3.15239 | -0.00352 | -0.02049 |
| MS EQ sin bounds 5% CKd | -0.0482 | 47.07803 | 5.150444 | -0.00102 | -0.00936 |
| GMV EQ sin unconstrained | 0.298057 | 25.45593 | 3.708401 | 0.011709 | 0.080373 |
| MS EQ sin unconstrained | 0.116509 | 1.302642 | 0.745141 | 0.089441 | 0.156359 |
| GMV EQ sin unconstrained CKs | 0.008109 | 19.58864 | 3.113084 | 0.000414 | 0.002605 |
| MS EQ sin unconstrained CKs | 1.090175 | 404.0338 | 14.87331 | 0.002698 | 0.073297 |
| GMV EQ sin unconstrained CKd | 0.046464 | 21.77121 | 3.166862 | 0.002134 | 0.014672 |
| MS EQ sin unconstrained CKd | 6.350449 | 48918.21 | 125.1279 | 0.00013 | 0.050752 |

### 5.3.2

*Tables 5.3.2a: Performance Indicators, Equilibrium Estimators and Positive Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ ESG90 no-short | 0.173772 | 0.221465 | 1.097536 | 0.101519 | 0.071888 | 0.01642 | 0.017581 | 0.692079 |
| MS EQ ESG90 no-short | 0.083777 | 0.109139 | 0.38889 | 0.050997 | 0.034039 | 0.006845 | 0.007458 | 0.584837 |
| GMV EQ ESG90 no-short CKs | 0.141632 | 0.186294 | 0.818858 | 0.075318 | 0.060046 | 0.012387 | 0.013584 | 0.664633 |
| MS EQ ESG90 no-short CKs | 0.156349 | 0.186554 | 0.914102 | 0.116299 | 0.059604 | 0.013321 | 0.01338 | 0.649343 |
| GMV EQ ESG90 no-short CKd | 0.135562 | 0.177971 | 0.81077 | 0.070133 | 0.056807 | 0.011753 | 0.012697 | 0.656673 |
| MS EQ ESG90 no-short CKd | 0.11083 | 0.160433 | 0.626504 | 0.070264 | 0.051134 | 0.009717 | 0.010236 | 0.650122 |
| GMV EQ ESG90 bounds 1 | 0.082834 | 0.103695 | 3.399868 | 0.045485 | 0.031811 | 0.008871 | 0.0097 | 0.577532 |
| MS EQ ESG90 bounds 1 | 0.083777 | 0.109138 | 0.388889 | 0.050997 | 0.034039 | 0.006845 | 0.007458 | 0.584836 |
| GMV EQ ESG90 bounds 1 CKs | 0.078305 | 0.103117 | 0.686537 | 0.039305 | 0.032615 | 0.006631 | 0.007003 | 0.58807 |
| MS EQ ESG90 bounds 1 CKs | 0.120694 | 0.145209 | -2.500528 | 0.084915 | 0.050826 | 0.014885 | 0.015396 | 0.579373 |
| GMV EQ ESG90 bounds 1 CKd | 0.077407 | 0.098672 | 0.743811 | 0.043261 | 0.030577 | 0.006751 | 0.007244 | 0.577437 |
| MS EQ ESG90 bounds 1 CKd | 0.013789 | 0.019125 | -1.161255 | 0.009009 | 0.005923 | 0.002954 | 0.002957 | 0.516578 |
| GMV EQ ESG90 bounds 5% | 0.065379 | 0.084439 | 0.750207 | 0.033908 | 0.025167 | 0.004964 | 0.005168 | 0.571666 |
| MS EQ ESG90 bounds 5% | 0.086632 | 0.114938 | 0.402045 | 0.052859 | 0.035821 | 0.007067 | 0.007714 | 0.593887 |
| GMV EQ ESG90 bounds 5% CKs | 0.059603 | 0.081675 | 0.409083 | 0.030218 | 0.024087 | 0.004165 | 0.00436 | 0.582854 |
| MS EQ ESG90 bounds 5% CKs | 0.17891 | 0.254881 | 2.076549 | 0.104757 | 0.079312 | 0.01548 | 0.01581 | 0.741159 |
| GMV EQ ESG90 bounds 5% CKd | 0.060288 | 0.082803 | 0.429932 | 0.032895 | 0.024218 | 0.004182 | 0.004359 | 0.583361 |
| MS EQ ESG90 bounds 5% CKd | 0.087288 | 0.123072 | 0.835392 | 0.051245 | 0.037145 | 0.007122 | 0.007225 | 0.621234 |
| GMV EQ ESG90 unconstrained | 0.082834 | 0.103695 | 3.399868 | 0.045485 | 0.031811 | 0.008871 | 0.0097 | 0.577532 |
| MS EQ ESG90 unconstrained | 0.083777 | 0.109139 | 0.38889 | 0.050997 | 0.034039 | 0.006845 | 0.007458 | 0.584837 |
| GMV EQ ESG90 unconstrained CKs | 0.078305 | 0.103117 | 0.686537 | 0.039305 | 0.032615 | 0.006631 | 0.007003 | 0.58807 |
| MS EQ ESG90 unconstrained CKs | 0.013122 | 0.014636 | 4.624955 | 0.019131 | 0.005883 | 0.003876 | 0.004325 | 0.275033 |
| GMV EQ ESG90 unconstrained CKd | 0.077407 | 0.098672 | 0.743811 | 0.043261 | 0.030577 | 0.006751 | 0.007244 | 0.577437 |
| MS EQ ESG90 unconstrained CKd | -0.08203 | -0.055356 | -1.418026 | -4.294862 | -0.047255 | -0.114773 | -0.322957 | 0.005226 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ ESG70 no-short | 0.273248 | 0.351541 | 1.696316 | 0.165778 | 0.111856 | 0.025636 | 0.027059 | 0.839073 |
| MS EQ ESG70 no-short | 0.130547 | 0.165979 | 0.595001 | 0.06857 | 0.054214 | 0.010881 | 0.011815 | 0.632415 |
| GMV EQ ESG70 no-short CKs | 0.276806 | 0.349162 | 1.62002 | 0.162578 | 0.113182 | 0.026273 | 0.028432 | 0.840143 |
| MS EQ ESG70 no-short CKs | 0.252852 | 0.296642 | 1.472129 | 0.148311 | 0.099554 | 0.022431 | 0.023844 | 0.775463 |
| GMV EQ ESG70 no-short CKd | 0.257197 | 0.308381 | 1.496587 | 0.169506 | 0.099961 | 0.024952 | 0.0271 | 0.787535 |
| MS EQ ESG70 no-short CKd | 0.220469 | 0.283917 | 1.322178 | 0.127278 | 0.090759 | 0.019253 | 0.021431 | 0.76265 |
| GMV EQ ESG70 bounds 1 | 0.20868 | 0.278791 | 6.963618 | 0.137015 | 0.086875 | 0.025401 | 0.027102 | 0.761944 |
| MS EQ ESG70 bounds 1 | 0.130547 | 0.165979 | 0.595001 | 0.06857 | 0.054214 | 0.010881 | 0.011815 | 0.632415 |
| GMV EQ ESG70 bounds 1 CKs | 0.265912 | 0.378024 | 2.387151 | 0.182389 | 0.125225 | 0.022425 | 0.023936 | 0.871871 |
| MS EQ ESG70 bounds 1 CKs | 0.071451 | 0.077882 | -1.202629 | 0.055426 | 0.030162 | 0.005522 | 0.005701 | 0.485397 |
| GMV EQ ESG70 bounds 1 CKd | 0.166834 | 0.204183 | 2.317435 | 0.110415 | 0.069238 | 0.013016 | 0.013503 | 0.667467 |
| MS EQ ESG70 bounds 1 CKd | 0.030888 | 0.051646 | -1.043708 | 0.017861 | 0.01539 | 0.007815 | 0.007838 | 0.585267 |
| GMV EQ ESG70 bounds 5% | 0.20932 | 0.279715 | 7.067137 | 0.142004 | 0.087564 | 0.025641 | 0.027355 | 0.762968 |
| MS EQ ESG70 bounds 5% | 0.130547 | 0.165979 | 0.595001 | 0.06857 | 0.054214 | 0.010881 | 0.011815 | 0.632415 |
| GMV EQ ESG70 bounds 5% CKs | 0.25947 | 0.371192 | 2.368031 | 0.15394 | 0.12447 | 0.02137 | 0.022553 | 0.86121 |
| MS EQ ESG70 bounds 5% CKs | 0.188816 | 0.234707 | -13.03664 | 0.140808 | 0.083761 | 0.018855 | 0.019326 | 0.702892 |
| GMV EQ ESG70 bounds 5% CKd | 0.24263 | 0.368477 | 2.062525 | 0.146962 | 0.114995 | 0.021559 | 0.022944 | 0.856253 |
| MS EQ ESG70 bounds 5% CKd | 0.200573 | 0.293759 | 7.299374 | 0.143276 | 0.093749 | 0.026022 | 0.027043 | 0.779235 |
| GMV EQ ESG70 unconstrained | 0.20868 | 0.278791 | 6.963618 | 0.137015 | 0.086875 | 0.025401 | 0.027102 | 0.761944 |
| MS EQ ESG70 unconstrained | 0.130547 | 0.165979 | 0.595001 | 0.06857 | 0.054214 | 0.010881 | 0.011815 | 0.632415 |
| GMV EQ ESG70 unconstrained CKs | 0.26675 | 0.379297 | 2.408535 | 0.183004 | 0.125647 | 0.022654 | 0.024197 | 0.873333 |
| MS EQ ESG70 unconstrained CKs | 0.049839 | 0.048001 | -0.806796 | 0.042483 | 0.020522 | 0.003014 | 0.003125 | 0.406527 |
| GMV EQ ESG70 unconstrained CKd | 0.115999 | 0.161952 | 1.265929 | 0.069715 | 0.050706 | 0.008523 | 0.008891 | 0.65305 |
| MS EQ ESG70 unconstrained CKd | 0.117003 | 1.335898 | -6.966928 | 0.924229 | 0.475268 | 0.002418 | 0.002651 | 2.06018 |

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ ESG50 no-short | 0.221331 | 0.252732 | 1.457077 | 0.16882 | 0.087047 | 0.017887 | 0.018311 | 0.714105 |
| MS EQ ESG50 no-short | 0.133968 | 0.169095 | 0.611822 | 0.070627 | 0.055648 | 0.011094 | 0.011977 | 0.633731 |
| GMV EQ ESG50 no-short CKs | 0.205563 | 0.223271 | 1.291462 | 0.152511 | 0.07911 | 0.016853 | 0.017598 | 0.674096 |
| MS EQ ESG50 no-short CKs | 0.222415 | 0.238944 | 1.374952 | 0.172913 | 0.0879 | 0.019551 | 0.020774 | 0.698259 |
| GMV EQ ESG50 no-short CKd | 0.200266 | 0.235504 | 1.349687 | 0.153068 | 0.07467 | 0.018529 | 0.020293 | 0.700378 |
| MS EQ ESG50 no-short CKd | 0.233929 | 0.307624 | 1.574685 | 0.18754 | 0.098574 | 0.0239 | 0.029117 | 0.791141 |
| GMV EQ ESG50 bounds 1 | 0.218187 | 0.298164 | 6.308013 | 0.134555 | 0.094919 | 0.024347 | 0.025505 | 0.780346 |
| MS EQ ESG50 bounds 1 | 0.133969 | 0.169097 | 0.611828 | 0.070628 | 0.055649 | 0.011094 | 0.011977 | 0.633734 |
| GMV EQ ESG50 bounds 1 CKs | 0.221624 | 0.33012 | 2.223415 | 0.175614 | 0.105005 | 0.019043 | 0.019913 | 0.81939 |
| MS EQ ESG50 bounds 1 CKs | 0.123222 | 0.134639 | -2.330505 | 0.076075 | 0.050921 | 0.007004 | 0.007226 | 0.551734 |
| GMV EQ ESG50 bounds 1 CKd | 0.094854 | 0.13437 | 1.296759 | 0.051624 | 0.039236 | 0.008456 | 0.008687 | 0.626968 |
| MS EQ ESG50 bounds 1 CKd | 0.148861 | 0.214738 | -54.00893 | 0.100462 | 0.06676 | 0.034882 | 0.035489 | 0.697526 |
| GMV EQ ESG50 bounds 5% | 0.219483 | 0.299251 | 6.409239 | 0.139525 | 0.095313 | 0.024634 | 0.02582 | 0.781568 |
| MS EQ ESG50 bounds 5% | 0.133968 | 0.169096 | 0.611825 | 0.070628 | 0.055649 | 0.011094 | 0.011977 | 0.633732 |
| GMV EQ ESG50 bounds 5% CKs | 0.229753 | 0.351397 | 2.311417 | 0.156513 | 0.113645 | 0.019567 | 0.020633 | 0.842411 |
| MS EQ ESG50 bounds 5% CKs | 0.175537 | 0.196481 | -5.710977 | 0.132409 | 0.072615 | 0.018607 | 0.01878 | 0.649004 |
| GMV EQ ESG50 bounds 5% CKd | 0.199009 | 0.275112 | 2.00175 | 0.151258 | 0.085195 | 0.01624 | 0.016614 | 0.761089 |
| MS EQ ESG50 bounds 5% CKd | 0.219167 | 0.357235 | 13.03391 | 0.152794 | 0.108383 | 0.023873 | 0.02466 | 0.846549 |
| GMV EQ ESG50 unconstrained | 0.218187 | 0.298164 | 6.308013 | 0.134555 | 0.094919 | 0.024347 | 0.025505 | 0.780346 |
| MS EQ ESG50 unconstrained | 0.133968 | 0.169096 | 0.611825 | 0.070628 | 0.055649 | 0.011094 | 0.011977 | 0.633732 |
| GMV EQ ESG50 unconstrained CKs | 0.221799 | 0.330664 | 2.225745 | 0.1757 | 0.105166 | 0.01907 | 0.019943 | 0.819961 |
| MS EQ ESG50 unconstrained CKs | 0.131364 | 0.149564 | -2.598201 | 0.084798 | 0.056346 | 0.006398 | 0.006612 | 0.571282 |
| GMV EQ ESG50 unconstrained CKd | 0.146876 | 0.184805 | 2.046322 | 0.112112 | 0.058626 | 0.013141 | 0.013983 | 0.653855 |
| MS EQ ESG50 unconstrained CKd | 0.104208 | 0.709172 | 9.68746 | 0.566237 | 0.240939 | 0.012058 | 0.050412 | 1.269697 |

*Tables 5.3.2b: Performance Indicators, Equilibrium Estimators and Positive Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 402 | 48 | 49 | 55 | 52 | 52 | 48 | 47 | 51 |
| GMV EQ ESG90 no-short | 254 | 30 | 31 | 36 | 35 | 32 | 29 | 30 | 31 |
| MS EQ ESG90 no-short | 460 | 57 | 57 | 60 | 58 | 57 | 58 | 56 | 57 |
| GMV EQ ESG90 no-short CKs | 290 | 35 | 36 | 39 | 40 | 35 | 36 | 35 | 34 |
| MS EQ ESG90 no-short CKs | 280 | 32 | 35 | 37 | 31 | 36 | 33 | 37 | 39 |
| GMV EQ ESG90 no-short CKd | 309 | 36 | 38 | 40 | 46 | 38 | 38 | 38 | 35 |
| MS EQ ESG90 no-short CKd | 371 | 51 | 48 | 46 | 45 | 48 | 47 | 48 | 38 |
| GMV EQ ESG90 bounds 1 | 417 | 60 | 60 | 12 | 61 | 62 | 50 | 50 | 62 |
| MS EQ ESG90 bounds 1 | 468 | 58 | 58 | 61 | 59 | 58 | 59 | 57 | 58 |
| GMV EQ ESG90 bounds 1 CKs | 472 | 62 | 62 | 44 | 65 | 60 | 63 | 63 | 53 |
| MS EQ ESG90 bounds 1 CKs | 379 | 47 | 51 | 68 | 37 | 50 | 32 | 33 | 61 |
| GMV EQ ESG90 bounds 1 CKd | 483 | 64 | 64 | 43 | 63 | 64 | 61 | 59 | 65 |
| MS EQ ESG90 bounds 1 CKd | 560 | 71 | 71 | 64 | 72 | 71 | 71 | 71 | 69 |
| GMV EQ ESG90 bounds 5% | 503 | 66 | 65 | 41 | 67 | 66 | 66 | 66 | 66 |
| MS EQ ESG90 bounds 5% | 438 | 55 | 55 | 58 | 54 | 55 | 55 | 54 | 52 |
| GMV EQ ESG90 bounds 5% CKs | 524 | 68 | 67 | 57 | 69 | 68 | 68 | 67 | 60 |
| MS EQ ESG90 bounds 5% CKs | 223 | 28 | 25 | 20 | 34 | 28 | 31 | 32 | 25 |
| GMV EQ ESG90 bounds 5% CKd | 518 | 67 | 66 | 56 | 68 | 67 | 67 | 68 | 59 |
| MS EQ ESG90 bounds 5% CKd | 421 | 54 | 54 | 38 | 56 | 54 | 54 | 61 | 50 |
| GMV EQ ESG90 unconstrained | 411 | 59 | 59 | 11 | 60 | 61 | 49 | 49 | 63 |
| MS EQ ESG90 unconstrained | 452 | 56 | 56 | 59 | 57 | 56 | 57 | 55 | 56 |
| GMV EQ ESG90 unconstrained CKs | 470 | 61 | 61 | 45 | 66 | 59 | 62 | 62 | 54 |
| MS EQ ESG90 unconstrained CKs | 506 | 72 | 72 | 10 | 70 | 72 | 69 | 69 | 72 |
| GMV EQ ESG90 unconstrained CKd | 475 | 63 | 63 | 42 | 62 | 63 | 60 | 58 | 64 |
| MS EQ ESG90 unconstrained CKd | 577 | 73 | 73 | 66 | 73 | 73 | 73 | 73 | 73 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 402 | 48 | 49 | 55 | 52 | 52 | 48 | 47 | 51 |
| GMV EQ ESG70 no-short | 78 | 2 | 8 | 24 | 11 | 9 | 5 | 9 | 10 |
| MS EQ ESG70 no-short | 362 | 43 | 43 | 52 | 49 | 44 | 43 | 43 | 45 |
| GMV EQ ESG70 no-short CKs | 71 | 1 | 10 | 25 | 12 | 8 | 2 | 4 | 9 |
| MS EQ ESG70 no-short CKs | 137 | 7 | 18 | 28 | 19 | 14 | 15 | 17 | 19 |
| GMV EQ ESG70 no-short CKd | 98 | 6 | 13 | 27 | 9 | 13 | 8 | 8 | 14 |
| MS EQ ESG70 no-short CKd | 179 | 15 | 20 | 32 | 30 | 20 | 21 | 20 | 21 |
| GMV EQ ESG70 bounds 1 | 134 | 21 | 22 | 5 | 25 | 24 | 7 | 7 | 23 |
| MS EQ ESG70 bounds 1 | 368 | 42 | 44 | 51 | 48 | 46 | 45 | 45 | 47 |
| GMV EQ ESG70 bounds 1 CKs | 67 | 4 | 4 | 14 | 5 | 4 | 16 | 16 | 4 |
| MS EQ ESG70 bounds 1 CKs | 516 | 65 | 68 | 65 | 53 | 65 | 65 | 65 | 70 |
| GMV EQ ESG70 bounds 1 CKd | 250 | 31 | 33 | 16 | 33 | 33 | 35 | 36 | 33 |
| MS EQ ESG70 bounds 1 CKd | 504 | 70 | 69 | 63 | 71 | 70 | 53 | 53 | 55 |
| GMV EQ ESG70 bounds 5% | 118 | 20 | 21 | 4 | 22 | 22 | 4 | 5 | 20 |
| MS EQ ESG70 bounds 5% | 383 | 45 | 46 | 54 | 51 | 47 | 46 | 46 | 48 |
| GMV EQ ESG70 bounds 5% CKs | 86 | 5 | 5 | 15 | 14 | 5 | 18 | 19 | 5 |
| MS EQ ESG70 bounds 5% CKs | 255 | 27 | 29 | 72 | 23 | 27 | 24 | 26 | 27 |
| GMV EQ ESG70 bounds 5% CKd | 102 | 8 | 6 | 21 | 20 | 6 | 17 | 18 | 6 |
| MS EQ ESG70 bounds 5% CKd | 117 | 24 | 19 | 3 | 21 | 19 | 3 | 10 | 18 |
| GMV EQ ESG70 unconstrained | 136 | 22 | 23 | 6 | 26 | 25 | 6 | 6 | 22 |
| MS EQ ESG70 unconstrained | 371 | 44 | 45 | 53 | 50 | 45 | 44 | 44 | 46 |
| GMV EQ ESG70 unconstrained CKs | 58 | 3 | 3 | 13 | 4 | 3 | 14 | 15 | 3 |
| MS EQ ESG70 unconstrained CKs | 545 | 69 | 70 | 62 | 64 | 69 | 70 | 70 | 71 |
| GMV EQ ESG70 unconstrained CKd | 369 | 50 | 47 | 35 | 47 | 51 | 51 | 51 | 37 |
| MS EQ ESG70 unconstrained CKd | 268 | 49 | 1 | 71 | 1 | 1 | 72 | 72 | 1 |

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 402 | 48 | 49 | 55 | 52 | 52 | 48 | 47 | 51 |
| GMV EQ ESG50 no-short | 183 | 14 | 26 | 29 | 10 | 23 | 27 | 28 | 26 |
| MS EQ ESG50 no-short | 347 | 40 | 42 | 50 | 44 | 43 | 42 | 42 | 44 |
| GMV EQ ESG50 no-short CKs | 222 | 23 | 30 | 34 | 17 | 29 | 28 | 29 | 32 |
| MS EQ ESG50 no-short CKs | 167 | 11 | 27 | 30 | 8 | 21 | 20 | 21 | 29 |
| GMV EQ ESG50 no-short CKd | 206 | 25 | 28 | 31 | 15 | 30 | 26 | 23 | 28 |
| MS EQ ESG50 no-short CKd | 95 | 9 | 14 | 26 | 3 | 15 | 12 | 3 | 13 |
| GMV EQ ESG50 bounds 1 | 127 | 18 | 16 | 9 | 27 | 17 | 11 | 13 | 16 |
| MS EQ ESG50 bounds 1 | 323 | 37 | 39 | 47 | 41 | 40 | 39 | 39 | 41 |
| GMV EQ ESG50 bounds 1 CKs | 123 | 13 | 12 | 19 | 7 | 12 | 23 | 25 | 12 |
| MS EQ ESG50 bounds 1 CKs | 437 | 46 | 52 | 67 | 39 | 49 | 56 | 60 | 68 |
| GMV EQ ESG50 bounds 1 CKd | 400 | 53 | 53 | 33 | 55 | 53 | 52 | 52 | 49 |
| MS EQ ESG50 bounds 1 CKd | 241 | 33 | 32 | 73 | 36 | 34 | 1 | 2 | 30 |
| GMV EQ ESG50 bounds 5% | 113 | 16 | 15 | 7 | 24 | 16 | 9 | 11 | 15 |
| MS EQ ESG50 bounds 5% | 332 | 38 | 40 | 48 | 43 | 41 | 40 | 40 | 42 |
| GMV EQ ESG50 bounds 5% CKs | 105 | 10 | 9 | 17 | 13 | 7 | 19 | 22 | 8 |
| MS EQ ESG50 bounds 5% CKs | 285 | 29 | 34 | 70 | 29 | 31 | 25 | 27 | 40 |
| GMV EQ ESG50 bounds 5% CKd | 202 | 26 | 24 | 23 | 18 | 26 | 30 | 31 | 24 |
| MS EQ ESG50 bounds 5% CKd | 85 | 17 | 7 | 1 | 16 | 10 | 13 | 14 | 7 |
| GMV EQ ESG50 unconstrained | 129 | 19 | 17 | 8 | 28 | 18 | 10 | 12 | 17 |
| MS EQ ESG50 unconstrained | 338 | 39 | 41 | 49 | 42 | 42 | 41 | 41 | 43 |
| GMV EQ ESG50 unconstrained CKs | 115 | 12 | 11 | 18 | 6 | 11 | 22 | 24 | 11 |
| MS EQ ESG50 unconstrained CKs | 432 | 41 | 50 | 69 | 38 | 39 | 64 | 64 | 67 |
| GMV EQ ESG50 unconstrained CKd | 266 | 34 | 37 | 22 | 32 | 37 | 34 | 34 | 36 |
| MS EQ ESG50 unconstrained CKd | 100 | 52 | 2 | 2 | 2 | 2 | 37 | 1 | 2 |

*Tables 5.3.2c: Relative Indicators, Equilibrium Estimators and Positive Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EQ ESG90 no-short | 0.091033 | 10.15872 | 2.013015 | 0.008961 | 0.045222 |
| MS EQ ESG90 no-short | -0.09338 | 2.258511 | 1.06719 | -0.04134 | -0.0875 |
| GMV EQ ESG90 no-short CKs | -0.01215 | 8.058558 | 1.947205 | -0.00151 | -0.00624 |
| MS EQ ESG90 no-short CKs | 0.210364 | 10.07686 | 2.315038 | 0.020876 | 0.090868 |
| GMV EQ ESG90 no-short CKd | -0.01768 | 9.02327 | 2.187193 | -0.00196 | -0.00808 |
| MS EQ ESG90 no-short CKd | 0.090072 | 11.8808 | 2.031312 | 0.007581 | 0.044342 |
| GMV EQ ESG90 bounds 1 | -0.14229 | 38.29102 | 5.080969 | -0.00372 | -0.02801 |
| MS EQ ESG90 bounds 1 | -0.09338 | 2.25851 | 1.067192 | -0.04135 | -0.0875 |
| GMV EQ ESG90 bounds 1 CKs | -0.23034 | 17.53369 | 3.287981 | -0.01314 | -0.07005 |
| MS EQ ESG90 bounds 1 CKs | 2.269543 | 606.5403 | 21.51738 | 0.003742 | 0.105475 |
| GMV EQ ESG90 bounds 1 CKd | -0.21901 | 19.85711 | 3.605122 | -0.01103 | -0.06075 |
| MS EQ ESG90 bounds 1 CKd | -0.24544 | 481.0363 | 16.04028 | -0.00051 | -0.0153 |
| GMV EQ ESG90 bounds 5% | -0.23645 | 25.23903 | 4.488246 | -0.00937 | -0.05268 |
| MS EQ ESG90 bounds 5% | -0.08299 | 2.143431 | 0.990691 | -0.03872 | -0.08377 |
| GMV EQ ESG90 bounds 5% CKs | -0.29688 | 12.77087 | 3.077433 | -0.02325 | -0.09647 |
| MS EQ ESG90 bounds 5% CKs | 0.370729 | 28.31841 | 4.500493 | 0.013091 | 0.082375 |
| GMV EQ ESG90 bounds 5% CKd | -0.29791 | 13.51251 | 3.217511 | -0.02205 | -0.09259 |
| MS EQ ESG90 bounds 5% CKd | -0.11585 | 23.1865 | 4.010339 | -0.005 | -0.02889 |
| GMV EQ ESG90 unconstrained | -0.14229 | 38.29102 | 5.080969 | -0.00372 | -0.02801 |
| MS EQ ESG90 unconstrained | -0.09338 | 2.258511 | 1.06719 | -0.04134 | -0.0875 |
| GMV EQ ESG90 unconstrained CKs | -0.23034 | 17.53369 | 3.287981 | -0.01314 | -0.07005 |
| MS EQ ESG90 unconstrained CKs | 1.099065 | 15574.23 | 113.1318 | 7.06E-05 | 0.009715 |
| GMV EQ ESG90 unconstrained CKd | -0.21901 | 19.85711 | 3.605122 | -0.01103 | -0.06075 |
| MS EQ ESG90 unconstrained CKd | -258.368 | 9871785 | 4586.021 | -2.62E-05 | -0.05634 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EQ ESG70 no-short | 0.395864 | 9.645372 | 2.420706 | 0.041042 | 0.163532 |
| MS EQ ESG70 no-short | 0.11894 | 0.991733 | 0.656414 | 0.119931 | 0.181196 |
| GMV EQ ESG70 no-short CKs | 0.403814 | 8.299365 | 2.063467 | 0.048656 | 0.195697 |
| MS EQ ESG70 no-short CKs | 0.487643 | 8.531138 | 2.045421 | 0.05716 | 0.238407 |
| GMV EQ ESG70 no-short CKd | 0.374293 | 8.167814 | 1.980709 | 0.045825 | 0.188969 |
| MS EQ ESG70 no-short CKd | 0.465162 | 10.28447 | 1.95802 | 0.04523 | 0.237567 |
| GMV EQ ESG70 bounds 1 | 0.316439 | 31.96839 | 4.65538 | 0.009899 | 0.067973 |
| MS EQ ESG70 bounds 1 | 0.11894 | 0.991726 | 0.656413 | 0.119932 | 0.181196 |
| GMV EQ ESG70 bounds 1 CKs | 0.284323 | 15.82885 | 2.895094 | 0.017962 | 0.098208 |
| MS EQ ESG70 bounds 1 CKs | 1.222543 | 686.3638 | 24.14133 | 0.001781 | 0.050641 |
| GMV EQ ESG70 bounds 1 CKd | 0.092136 | 23.45831 | 3.736226 | 0.003928 | 0.02466 |
| MS EQ ESG70 bounds 1 CKd | 0.218245 | 649.0667 | 15.31044 | 0.000336 | 0.014255 |
| GMV EQ ESG70 bounds 5% | 0.316936 | 31.95496 | 4.650205 | 0.009918 | 0.068155 |
| MS EQ ESG70 bounds 5% | 0.11894 | 0.991731 | 0.656415 | 0.119931 | 0.181196 |
| GMV EQ ESG70 bounds 5% CKs | 0.240644 | 15.90178 | 2.953171 | 0.015133 | 0.081487 |
| MS EQ ESG70 bounds 5% CKs | 0.779205 | 72.8902 | 7.260578 | 0.01069 | 0.10732 |
| GMV EQ ESG70 bounds 5% CKd | 0.298225 | 15.6889 | 2.967464 | 0.019009 | 0.100498 |
| MS EQ ESG70 bounds 5% CKd | 0.506345 | 41.49603 | 4.930323 | 0.012202 | 0.1027 |
| GMV EQ ESG70 unconstrained | 0.316439 | 31.96839 | 4.65538 | 0.009899 | 0.067973 |
| MS EQ ESG70 unconstrained | 0.11894 | 0.991733 | 0.656414 | 0.119931 | 0.181196 |
| GMV EQ ESG70 unconstrained CKs | 0.287093 | 15.90982 | 2.895094 | 0.018045 | 0.099165 |
| MS EQ ESG70 unconstrained CKs | 0.83485 | 847.6675 | 30.21064 | 0.000985 | 0.027634 |
| GMV EQ ESG70 unconstrained CKd | -0.07808 | 21.23297 | 3.895877 | -0.00368 | -0.02004 |
| MS EQ ESG70 unconstrained CKd | 77.7596 | 448295.2 | 56.96008 | 0.000173 | 1.36516 |

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EQ ESG50 no-short | 0.233965 | 10.96518 | 2.592633 | 0.021337 | 0.090242 |
| MS EQ ESG50 no-short | 0.136802 | 1.087378 | 0.707908 | 0.125809 | 0.193248 |
| GMV EQ ESG50 no-short CKs | 0.179743 | 9.945738 | 2.403697 | 0.018072 | 0.074778 |
| MS EQ ESG50 no-short CKs | 0.423637 | 10.66367 | 2.671081 | 0.039727 | 0.158601 |
| GMV EQ ESG50 no-short CKd | 0.186901 | 11.60945 | 2.687848 | 0.016099 | 0.069536 |
| MS EQ ESG50 no-short CKd | 0.545018 | 13.87337 | 2.303824 | 0.039285 | 0.236571 |
| GMV EQ ESG50 bounds 1 | 0.314714 | 29.97406 | 4.443721 | 0.0105 | 0.070822 |
| MS EQ ESG50 bounds 1 | 0.136808 | 1.087391 | 0.707907 | 0.125814 | 0.193258 |
| GMV EQ ESG50 bounds 1 CKs | 0.126522 | 17.09342 | 2.956417 | 0.007402 | 0.042796 |
| MS EQ ESG50 bounds 1 CKs | 2.679232 | 757.5123 | 24.09463 | 0.003537 | 0.111196 |
| GMV EQ ESG50 bounds 1 CKd | -0.19948 | 22.36928 | 3.13795 | -0.00892 | -0.06357 |
| MS EQ ESG50 bounds 1 CKd | 2.791353 | 522.8959 | 16.06235 | 0.005338 | 0.173782 |
| GMV EQ ESG50 bounds 5% | 0.318261 | 29.98371 | 4.448745 | 0.010614 | 0.071539 |
| MS EQ ESG50 bounds 5% | 0.136805 | 1.08738 | 0.707907 | 0.125811 | 0.193252 |
| GMV EQ ESG50 bounds 5% CKs | 0.115697 | 16.84486 | 2.940805 | 0.006868 | 0.039342 |
| MS EQ ESG50 bounds 5% CKs | 0.706401 | 79.18776 | 7.684707 | 0.008921 | 0.091923 |
| GMV EQ ESG50 bounds 5% CKd | 0.133278 | 18.01252 | 2.917196 | 0.007399 | 0.045687 |
| MS EQ ESG50 bounds 5% CKd | 0.70696 | 48.56844 | 5.126172 | 0.014556 | 0.137912 |
| GMV EQ ESG50 unconstrained | 0.314714 | 29.97406 | 4.443721 | 0.0105 | 0.070822 |
| MS EQ ESG50 unconstrained | 0.136804 | 1.08738 | 0.707908 | 0.125811 | 0.193251 |
| GMV EQ ESG50 unconstrained CKs | 0.126845 | 17.09471 | 2.956417 | 0.00742 | 0.042905 |
| MS EQ ESG50 unconstrained CKs | 3.048147 | 821.0614 | 24.2652 | 0.003712 | 0.125618 |
| GMV EQ ESG50 unconstrained CKd | -0.02478 | 22.2525 | 3.209045 | -0.00111 | -0.00772 |
| MS EQ ESG50 unconstrained CKd | 44.24583 | 184524 | 62.37697 | 0.00024 | 0.70933 |

### 5.3.3

*Table 5.3.3a: Performance Indicators, Equilibrium Estimators and No Screening*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ no-short | 0.20262 | 0.278094 | 1.74697 | 0.123544 | 0.09355 | 0.0218 | 0.022126 | 0.755301 |
| MS EQ no-short | 0.132385 | 0.166576 | 0.604953 | 0.071096 | 0.05449 | 0.010837 | 0.011675 | 0.630861 |
| GMV EQ no-short CKs | 0.17215 | 0.212682 | 1.461383 | 0.102439 | 0.075425 | 0.018285 | 0.019188 | 0.669423 |
| MS EQ no-short CKs | 0.144005 | 0.178838 | 1.217881 | 0.085666 | 0.059771 | 0.014256 | 0.014534 | 0.645165 |
| GMV EQ no-short CKd | 0.147316 | 0.185355 | 1.220624 | 0.076535 | 0.060534 | 0.015036 | 0.015801 | 0.647126 |
| MS EQ no-short CKd | 0.168493 | 0.239609 | 1.310689 | 0.101737 | 0.077078 | 0.018462 | 0.02007 | 0.726866 |
| GMV EQ bounds 1 | 0.228833 | 0.331896 | 4.938427 | 0.140534 | 0.107964 | 0.026896 | 0.027901 | 0.820461 |
| MS EQ bounds 1 | 0.13238 | 0.166585 | 0.604944 | 0.071131 | 0.054491 | 0.010839 | 0.011677 | 0.630868 |
| GMV EQ bounds 1 CKs | 0.130147 | 0.189925 | 1.737011 | 0.076161 | 0.059588 | 0.009042 | 0.009217 | 0.681085 |
| MS EQ bounds 1 CKs | 0.062524 | 0.08526 | -1.19332 | 0.046012 | 0.026479 | 0.011865 | 0.011962 | 0.556872 |
| GMV EQ bounds 1 CKd | 0.14189 | 0.206264 | 1.815163 | 0.082887 | 0.064618 | 0.01085 | 0.011242 | 0.68986 |
| MS EQ bounds 1 CKd | 0.005062 | 0.006651 | -0.10821 | 0.00326 | 0.002035 | 0.001196 | 0.001202 | 0.474971 |
| GMV EQ bounds 5% | 0.224057 | 0.31778 | 5.001684 | 0.138191 | 0.102709 | 0.024717 | 0.025623 | 0.805187 |
| MS EQ bounds 5% | 0.13238 | 0.166585 | 0.604943 | 0.071131 | 0.054491 | 0.010839 | 0.011677 | 0.630867 |
| GMV EQ bounds 5% CKs | 0.191056 | 0.30045 | 2.141326 | 0.127876 | 0.095069 | 0.016782 | 0.017122 | 0.785644 |
| MS EQ bounds 5% CKs | 0.06841 | 0.07363 | -1.65059 | 0.040804 | 0.026302 | 0.006233 | 0.006287 | 0.511245 |
| GMV EQ bounds 5% CKd | 0.181615 | 0.258186 | 2.056668 | 0.134965 | 0.083141 | 0.018285 | 0.0188 | 0.74487 |
| MS EQ bounds 5% CKd | 0.125093 | 0.173254 | -14.7874 | 0.077211 | 0.056394 | 0.014443 | 0.015907 | 0.657023 |
| GMV EQ unconstrained | 0.228833 | 0.331896 | 4.938427 | 0.140534 | 0.107964 | 0.026896 | 0.027901 | 0.820461 |
| MS EQ unconstrained | 0.13238 | 0.166585 | 0.604943 | 0.071131 | 0.054491 | 0.010839 | 0.011677 | 0.630867 |
| GMV EQ unconstrained CKs | 0.150943 | 0.220026 | 1.920367 | 0.096625 | 0.068785 | 0.011852 | 0.012139 | 0.708701 |
| MS EQ unconstrained CKs | 0.061565 | 0.0841 | -1.17311 | 0.04535 | 0.026095 | 0.011689 | 0.011782 | 0.556485 |
| GMV EQ unconstrained CKd | 0.192412 | 0.309403 | 2.916882 | 0.130605 | 0.097947 | 0.020205 | 0.020951 | 0.796832 |
| MS EQ unconstrained CKd | 0.08003 | 0.137092 | -5.87219 | 0.143006 | 0.052913 | 0.084202 | 0.092044 | 0.488408 |

*Table 5.3.3b: Performance Indicators, Equilibrium Estimators and No Screening*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 165 | 20 | 20 | 19 | 21 | 21 | 22 | 22 | 20 |
| GMV EQ no-short | 49 | 4 | 6 | 9 | 8 | 6 | 5 | 5 | 6 |
| MS EQ no-short | 147 | 14 | 19 | 15 | 20 | 19 | 21 | 20 | 19 |
| GMV EQ no-short CKs | 76 | 8 | 10 | 11 | 9 | 9 | 9 | 8 | 12 |
| MS EQ no-short CKs | 106 | 12 | 14 | 14 | 12 | 13 | 13 | 13 | 15 |
| GMV EQ no-short CKd | 101 | 11 | 13 | 13 | 15 | 12 | 11 | 12 | 14 |
| MS EQ no-short CKd | 69 | 9 | 8 | 12 | 10 | 8 | 7 | 7 | 8 |
| GMV EQ bounds 1 | 19 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 2 |
| MS EQ bounds 1 | 131 | 15 | 16 | 16 | 17 | 16 | 18 | 17 | 16 |
| GMV EQ bounds 1 CKs | 127 | 18 | 12 | 10 | 16 | 14 | 23 | 23 | 11 |
| MS EQ bounds 1 CKs | 161 | 23 | 22 | 22 | 22 | 22 | 14 | 15 | 21 |
| GMV EQ bounds 1 CKd | 104 | 13 | 11 | 8 | 13 | 11 | 17 | 21 | 10 |
| MS EQ bounds 1 CKd | 195 | 25 | 25 | 20 | 25 | 25 | 25 | 25 | 25 |
| GMV EQ bounds 5% | 25 | 3 | 3 | 1 | 4 | 3 | 4 | 4 | 3 |
| MS EQ bounds 5% | 139 | 16 | 17 | 17 | 18 | 17 | 19 | 18 | 17 |
| GMV EQ bounds 5% CKs | 53 | 6 | 5 | 5 | 7 | 5 | 10 | 10 | 5 |
| MS EQ bounds 5% CKs | 187 | 22 | 24 | 23 | 24 | 23 | 24 | 24 | 23 |
| GMV EQ bounds 5% CKd | 56 | 7 | 7 | 6 | 5 | 7 | 8 | 9 | 7 |
| MS EQ bounds 5% CKd | 124 | 19 | 15 | 25 | 14 | 15 | 12 | 11 | 13 |
| GMV EQ unconstrained | 13 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 |
| MS EQ unconstrained | 147 | 17 | 18 | 18 | 19 | 18 | 20 | 19 | 18 |
| GMV EQ unconstrained CKs | 85 | 10 | 9 | 7 | 11 | 10 | 15 | 14 | 9 |
| MS EQ unconstrained CKs | 169 | 24 | 23 | 21 | 23 | 24 | 16 | 16 | 22 |
| GMV EQ unconstrained CKd | 39 | 5 | 4 | 4 | 6 | 4 | 6 | 6 | 4 |
| MS EQ unconstrained CKd | 113 | 21 | 21 | 24 | 1 | 20 | 1 | 1 | 24 |

*Table 5.3.3c: Relative Indicators, Equilibrium Estimators and No Screening*

| Strategy | TE | TEV | SemiTEV | IR | SemiIR |
|---|---|---|---|---|---|
| GMV EQ no-short | 0.100745338 | 15.35168608 | 2.818329325 | 0.006562493 | 0.035746475 |
| MS EQ no-short | 0.129036949 | 1.115788958 | 0.700819226 | 0.115646376 | 0.184123016 |
| GMV EQ no-short CKs | -0.01883158 | 14.92654789 | 2.956941552 | -0.00126162 | -0.0063686 |
| MS EQ no-short CKs | -0.03098329 | 15.76999428 | 3.291977977 | -0.0019647 | -0.00941176 |
| GMV EQ no-short CKd | -0.04963665 | 15.01606696 | 2.870397884 | -0.00330557 | -0.0172926 |
| MS EQ no-short CKd | 0.142575553 | 15.54269182 | 2.867657691 | 0.009173157 | 0.04971847 |
| GMV EQ bounds 1 | 0.274893716 | 26.13291872 | 3.853373158 | 0.010519059 | 0.071338462 |
| MS EQ bounds 1 | 0.129364652 | 1.120032315 | 0.701913984 | 0.115500821 | 0.184302714 |
| GMV EQ bounds 1 CKs | -0.16423171 | 19.72407248 | 3.212501615 | -0.00832646 | -0.05112269 |
| MS EQ bounds 1 CKs | 0.624799149 | 405.3763343 | 14.48567109 | 0.001541282 | 0.04313222 |
| GMV EQ bounds 1 CKd | -0.08683179 | 20.24267942 | 3.410434075 | -0.00428954 | -0.02546063 |
| MS EQ bounds 1 CKd | -0.41161731 | 692.2976958 | 19.43258294 | -0.00059457 | -0.02118181 |
| GMV EQ bounds 5% | 0.27706369 | 26.8136075 | 4.003265155 | 0.010332951 | 0.069209428 |
| MS EQ bounds 5% | 0.129364786 | 1.120060498 | 0.701923071 | 0.115498034 | 0.184300518 |
| GMV EQ bounds 5% CKs | 0.004769479 | 18.00265781 | 3.131405123 | 0.000264932 | 0.001523112 |
| MS EQ bounds 5% CKs | -0.05103656 | 82.73525874 | 8.217335896 | -0.00061687 | -0.00621084 |
| GMV EQ bounds 5% CKd | 0.049135507 | 19.09509883 | 3.304622264 | 0.0025732 | 0.014868721 |
| MS EQ bounds 5% CKd | 0.173169724 | 54.41449983 | 5.594021386 | 0.003182419 | 0.030956214 |
| GMV EQ unconstrained | 0.274893716 | 26.13291872 | 3.853373158 | 0.010519059 | 0.071338462 |
| MS EQ unconstrained | 0.129364769 | 1.120060765 | 0.701923234 | 0.115497992 | 0.184300452 |
| GMV EQ unconstrained CKs | -0.10897167 | 19.22280945 | 3.167518215 | -0.00566887 | -0.03440286 |
| MS EQ unconstrained CKs | 0.608077435 | 406.1555185 | 14.47581431 | 0.001497154 | 0.042006441 |
| GMV EQ unconstrained CKd | 0.085041963 | 22.02479059 | 3.35523861 | 0.003861193 | 0.025346025 |
| MS EQ unconstrained CKd | 9.382806921 | 15455.88584 | 71.49779962 | 0.00060707 | 0.131232107 |

## 5.4.1

*Table 5.4.1a: Performance Indicators, Sample Estimators and Different Constraints*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV sample no-short | 0.171782 | 0.212309 | 1.462075 | 0.102067 | 0.075343 | 0.018138 | 0.019052 | 0.668967 |
| GMV sample sin no-short | 0.180185 | 0.226418 | 1.532029 | 0.105442 | 0.079443 | 0.019925 | 0.020624 | 0.691492 |
| GMV sample ESG50 no-short | 0.204781 | 0.222449 | 1.290017 | 0.152362 | 0.078797 | 0.016762 | 0.017459 | 0.673042 |
| GMV sample ESG70 no-short | 0.276389 | 0.348775 | 1.619843 | 0.162494 | 0.113016 | 0.026208 | 0.028329 | 0.839663 |
| GMV sample ESG90 no-short | 0.141985 | 0.186899 | 0.821379 | 0.075452 | 0.060211 | 0.012419 | 0.013617 | 0.665348 |
| GMV sample no-short CKs | 0.172461 | 0.213178 | 1.472315 | 0.102884 | 0.075758 | 0.018351 | 0.019294 | 0.669896 |
| GMV sample sin no-short CKs | 0.181162 | 0.228095 | 1.543279 | 0.105964 | 0.079948 | 0.020164 | 0.020882 | 0.693051 |
| GMV sample ESG50 no-short CKs | 0.204905 | 0.223279 | 1.289021 | 0.151976 | 0.078864 | 0.016776 | 0.017494 | 0.673293 |
| GMV sample ESG70 no-short CKs | 0.276258 | 0.348866 | 1.617449 | 0.162114 | 0.113009 | 0.026218 | 0.028359 | 0.839779 |
| GMV sample ESG90 no-short CKs | 0.141693 | 0.186418 | 0.819258 | 0.075385 | 0.060079 | 0.012401 | 0.013599 | 0.664778 |
| GMV sample no-short CKd | 0.136683 | 0.157798 | 1.090611 | 0.075208 | 0.05205 | 0.013107 | 0.013638 | 0.600425 |
| GMV sample sin no-short CKd | 0.155815 | 0.192801 | 1.175028 | 0.090491 | 0.062531 | 0.013338 | 0.013705 | 0.653236 |
| GMV sample ESG50 no-short CKd | 0.1283 | 0.112681 | 0.919038 | 0.114271 | 0.047053 | 0.010484 | 0.010667 | 0.478029 |
| GMV sample ESG70 no-short CKd | 0.281141 | 0.365605 | 1.693199 | 0.150661 | 0.120749 | 0.028282 | 0.030417 | 0.858601 |
| GMV sample ESG90 no-short CKd | 0.134688 | 0.17281 | 0.779838 | 0.07189 | 0.055992 | 0.011284 | 0.012417 | 0.649644 |
| GMV sample bounds 1 | 0.157346 | 0.240341 | 2.091843 | 0.102253 | 0.074833 | 0.014156 | 0.014551 | 0.73192 |
| GMV sample sin bounds 1 | 0.18594 | 0.259217 | 2.55401 | 0.108619 | 0.08611 | 0.016009 | 0.016651 | 0.742368 |
| GMV sample ESG50 bounds 1 | 0.216394 | 0.326631 | 2.25385 | 0.171814 | 0.10251 | 0.018017 | 0.018976 | 0.817893 |
| GMV sample ESG70 bounds 1 | 0.257895 | 0.366953 | 2.405203 | 0.169181 | 0.120726 | 0.021363 | 0.022419 | 0.860217 |
| GMV sample ESG90 bounds 1 | 0.07765 | 0.102731 | 0.683143 | 0.038974 | 0.032377 | 0.006558 | 0.006921 | 0.587909 |
| GMV sample bounds 1 CKs | 0.126786 | 0.184844 | 1.754016 | 0.074152 | 0.058074 | 0.008694 | 0.008847 | 0.679204 |
| GMV sample sin bounds 1 CKs | 0.18938 | 0.263409 | 2.571206 | 0.112118 | 0.087833 | 0.016706 | 0.017372 | 0.746632 |
| GMV sample ESG50 bounds 1 CKs | 0.221134 | 0.331162 | 2.261032 | 0.172334 | 0.105169 | 0.018789 | 0.019704 | 0.822605 |
| GMV sample ESG70 bounds 1 CKs | 0.263191 | 0.374229 | 2.383576 | 0.180612 | 0.123792 | 0.022057 | 0.023446 | 0.868608 |
| GMV sample ESG90 bounds 1 CKs | 0.078614 | 0.103629 | 0.690465 | 0.039515 | 0.032765 | 0.006666 | 0.007041 | 0.58872 |
| GMV sample bounds 1 CKd | 0.127595 | 0.182221 | 1.467437 | 0.074087 | 0.059767 | 0.011403 | 0.011741 | 0.665589 |
| GMV sample sin bounds 1 CKd | 0.044524 | 0.056946 | 0.608216 | 0.025946 | 0.01799 | 0.003561 | 0.003631 | 0.534776 |
| GMV sample ESG50 bounds 1 CKd | 0.153958 | 0.202178 | 2.584069 | 0.11127 | 0.066954 | 0.019124 | 0.02 | 0.679372 |
| GMV sample ESG70 bounds 1 CKd | 0.242725 | 0.348284 | 2.489396 | 0.163834 | 0.110648 | 0.026534 | 0.029244 | 0.839133 |
| GMV sample ESG90 bounds 1 CKd | 0.08039 | 0.10989 | 0.726146 | 0.043822 | 0.033527 | 0.006863 | 0.007284 | 0.602182 |
| GMV sample bounds 5% | 0.179694 | 0.276182 | 2.129564 | 0.120963 | 0.086769 | 0.014982 | 0.015223 | 0.76556 |
| GMV sample sin bounds 5% | 0.209412 | 0.326093 | 2.367182 | 0.144398 | 0.103807 | 0.017669 | 0.018097 | 0.805749 |
| GMV sample ESG50 bounds 5% | 0.22335 | 0.34417 | 2.333084 | 0.153004 | 0.110346 | 0.018326 | 0.019436 | 0.834526 |
| GMV sample ESG70 bounds 5% | 0.250116 | 0.361552 | 2.369521 | 0.14448 | 0.120061 | 0.019936 | 0.021065 | 0.849185 |
| GMV sample ESG90 bounds 5% | 0.05959 | 0.081591 | 0.409349 | 0.030218 | 0.024099 | 0.004166 | 0.004361 | 0.583199 |
| GMV sample bounds 5% CKs | 0.185779 | 0.291415 | 2.143347 | 0.124208 | 0.090677 | 0.015802 | 0.016136 | 0.774453 |
| GMV sample sin bounds 5% CKs | 0.214847 | 0.329721 | 2.362296 | 0.146317 | 0.105759 | 0.018577 | 0.019102 | 0.810578 |
| GMV sample ESG50 bounds 5% CKs | 0.229026 | 0.351482 | 2.344454 | 0.159145 | 0.113295 | 0.019261 | 0.020385 | 0.842322 |
| GMV sample ESG70 bounds 5% CKs | 0.256401 | 0.367344 | 2.356217 | 0.152001 | 0.122677 | 0.021038 | 0.022128 | 0.856623 |
| GMV sample ESG90 bounds 5% CKs | 0.059754 | 0.081798 | 0.410467 | 0.030289 | 0.024167 | 0.004181 | 0.004376 | 0.583321 |
| GMV sample bounds 5% CKd | 0.134436 | 0.196656 | 1.864463 | 0.079559 | 0.062848 | 0.014908 | 0.015049 | 0.68892 |
| GMV sample sin bounds 5% CKd | 0.099503 | 0.12088 | 1.309376 | 0.067063 | 0.038571 | 0.008848 | 0.008966 | 0.584556 |
| GMV sample ESG50 bounds 5% CKd | 0.150667 | 0.220864 | 2.471575 | 0.097899 | 0.067628 | 0.01322 | 0.013921 | 0.715499 |
| GMV sample ESG70 bounds 5% CKd | 0.287637 | 0.392122 | 3.183482 | 0.16383 | 0.134944 | 0.026249 | 0.028098 | 0.889472 |
| GMV sample ESG90 bounds 5% CKd | 0.044935 | 0.061988 | 0.310298 | 0.022127 | 0.018339 | 0.003108 | 0.003235 | 0.566855 |
| GMV sample unconstrained | 0.142152 | 0.207221 | 1.89371 | 0.088468 | 0.064754 | 0.010511 | 0.010747 | 0.697468 |
| GMV sample sin unconstrained | 0.1856 | 0.258658 | 2.550262 | 0.108453 | 0.085885 | 0.015962 | 0.016601 | 0.741756 |
| GMV sample ESG50 unconstrained | 0.216256 | 0.326327 | 2.253155 | 0.171735 | 0.102462 | 0.017994 | 0.018951 | 0.817573 |
| GMV sample ESG70 unconstrained | 0.256467 | 0.362315 | 2.387937 | 0.168669 | 0.119467 | 0.021164 | 0.022199 | 0.854994 |
| GMV sample ESG90 unconstrained | 0.07765 | 0.102731 | 0.683143 | 0.038974 | 0.032377 | 0.006558 | 0.006921 | 0.587909 |
| GMV sample unconstrained CKs | 0.140205 | 0.203887 | 1.857366 | 0.08964 | 0.063793 | 0.010194 | 0.010397 | 0.695417 |
| GMV sample sin unconstrained CKs | 0.190145 | 0.264994 | 2.62022 | 0.112718 | 0.088373 | 0.016992 | 0.017682 | 0.74842 |
| GMV sample ESG50 unconstrained CKs | 0.220485 | 0.327911 | 2.250901 | 0.172119 | 0.104561 | 0.018717 | 0.019625 | 0.819947 |
| GMV sample ESG70 unconstrained CKs | 0.263191 | 0.374229 | 2.383576 | 0.180612 | 0.123792 | 0.022057 | 0.023446 | 0.868608 |
| GMV sample ESG90 unconstrained CKs | 0.078614 | 0.103629 | 0.690465 | 0.039515 | 0.032765 | 0.006666 | 0.007041 | 0.588720 |
| GMV sample unconstrained CKd | 0.083624 | 5.41E+09 | 6.787495 | 2.4E+09 | 1.73E+09 | 3.69E+08 | 3.93E+08 | 5.41E+09 |
| GMV sample sin unconstrained CKd | 0.161499 | 0.212405 | 1.95274 | 0.09745 | 0.069572 | 0.017935 | 0.018445 | 0.689383 |
| GMV sample ESG50 unconstrained CKd | 0.218351 | 0.273418 | 3.376509 | 0.15075 | 0.094107 | 0.025706 | 0.028165 | 0.749711 |
| GMV sample ESG70 unconstrained CKd | 0.211192 | 0.307137 | 2.320487 | 0.13587 | 0.09548 | 0.020622 | 0.022243 | 0.795043 |
| GMV sample ESG90 unconstrained CKd | 0.062374 | 0.082979 | 0.620284 | 0.034141 | 0.025231 | 0.005166 | 0.005371 | 0.571849 |

*Table 5.4.1b: Performance Indicators, Sample Estimators and Different Constraints*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 401 | 49 | 49 | 58 | 51 | 49 | 49 | 48 | 48 |
| GMV sample no-short | 272 | 33 | 37 | 41 | 37 | 34 | 24 | 24 | 42 |
| GMV sample sin no-short | 229 | 30 | 31 | 38 | 34 | 30 | 16 | 16 | 34 |
| GMV sample ESG50 no-short | 249 | 23 | 33 | 43 | 16 | 32 | 31 | 31 | 40 |
| GMV sample ESG70 no-short | 96 | 3 | 12 | 35 | 12 | 11 | 6 | 5 | 12 |
| GMV sample ESG90 no-short | 346 | 40 | 43 | 48 | 44 | 43 | 42 | 42 | 44 |
| GMV sample no-short CKs | 259 | 32 | 35 | 39 | 35 | 33 | 22 | 22 | 41 |
| GMV sample sin no-short CKs | 220 | 29 | 30 | 37 | 33 | 29 | 14 | 15 | 33 |
| GMV sample ESG50 no-short CKs | 246 | 22 | 32 | 44 | 18 | 31 | 30 | 30 | 39 |
| GMV sample ESG70 no-short CKs | 96 | 4 | 11 | 36 | 13 | 12 | 5 | 4 | 11 |
| GMV sample ESG90 no-short CKs | 354 | 41 | 44 | 49 | 45 | 44 | 43 | 43 | 45 |
| GMV sample no-short CKd | 363 | 43 | 48 | 46 | 46 | 48 | 41 | 41 | 50 |
| GMV sample sin no-short CKd | 330 | 36 | 42 | 45 | 40 | 42 | 39 | 40 | 46 |
| GMV sample ESG50 no-short CKd | 376 | 46 | 51 | 47 | 27 | 50 | 47 | 47 | 61 |
| GMV sample ESG70 no-short CKd | 79 | 2 | 7 | 34 | 20 | 6 | 2 | 2 | 6 |
| GMV sample ESG90 no-short CKd | 373 | 44 | 47 | 50 | 49 | 47 | 45 | 44 | 47 |
| GMV sample bounds 1 | 268 | 35 | 29 | 28 | 36 | 35 | 38 | 38 | 29 |
| GMV sample sin bounds 1 | 211 | 26 | 27 | 7 | 31 | 27 | 33 | 33 | 27 |
| GMV sample ESG50 bounds 1 | 150 | 17 | 18 | 23 | 6 | 19 | 25 | 25 | 17 |
| GMV sample ESG70 bounds 1 | 64 | 7 | 6 | 11 | 8 | 7 | 10 | 10 | 5 |
| GMV sample ESG90 bounds 1 | 445 | 56 | 56 | 55 | 56 | 56 | 56 | 56 | 54 |
| GMV sample bounds 1 CKs | 359 | 48 | 45 | 33 | 47 | 46 | 51 | 51 | 38 |
| GMV sample sin bounds 1 CKs | 201 | 25 | 26 | 6 | 29 | 25 | 32 | 32 | 26 |
| GMV sample ESG50 bounds 1 CKs | 124 | 14 | 15 | 22 | 4 | 16 | 19 | 19 | 15 |
| GMV sample ESG70 bounds 1 CKs | 53 | 6 | 4 | 14 | 3 | 4 | 9 | 9 | 4 |
| GMV sample ESG90 bounds 1 CKs | 429 | 54 | 54 | 53 | 54 | 54 | 54 | 54 | 52 |
| GMV sample bounds 1 CKd | 358 | 47 | 46 | 40 | 48 | 45 | 44 | 45 | 43 |
| GMV sample sin bounds 1 CKd | 480 | 61 | 61 | 57 | 60 | 61 | 60 | 60 | 60 |
| GMV sample ESG50 bounds 1 CKd | 223 | 37 | 40 | 5 | 30 | 38 | 18 | 18 | 37 |
| GMV sample ESG70 bounds 1 CKd | 75 | 11 | 13 | 9 | 10 | 13 | 3 | 3 | 13 |
| GMV sample ESG90 bounds 1 CKd | 412 | 52 | 52 | 51 | 52 | 52 | 52 | 52 | 49 |
| GMV sample bounds 5% | 228 | 31 | 23 | 27 | 26 | 26 | 36 | 36 | 23 |
| GMV sample sin bounds 5% | 174 | 21 | 20 | 16 | 23 | 18 | 28 | 28 | 20 |
| GMV sample ESG50 bounds 5% | 134 | 13 | 14 | 20 | 15 | 14 | 23 | 21 | 14 |
| GMV sample ESG70 bounds 5% | 102 | 10 | 9 | 15 | 22 | 8 | 15 | 14 | 9 |
| GMV sample ESG90 bounds 5% | 471 | 59 | 59 | 60 | 59 | 59 | 59 | 59 | 57 |
| GMV sample bounds 5% CKs | 215 | 27 | 22 | 26 | 25 | 23 | 35 | 35 | 22 |
| GMV sample sin bounds 5% CKs | 151 | 19 | 16 | 17 | 21 | 15 | 21 | 23 | 19 |
| GMV sample ESG50 bounds 5% CKs | 109 | 12 | 10 | 19 | 14 | 10 | 17 | 17 | 10 |
| GMV sample ESG70 bounds 5% CKs | 86 | 9 | 5 | 18 | 17 | 5 | 12 | 13 | 7 |
| GMV sample ESG90 bounds 5% CKs | 463 | 58 | 58 | 59 | 58 | 58 | 58 | 58 | 56 |
| GMV sample bounds 5% CKd | 311 | 45 | 41 | 31 | 43 | 41 | 37 | 37 | 36 |
| GMV sample sin bounds 5% CKd | 398 | 50 | 50 | 42 | 50 | 51 | 50 | 50 | 55 |
| GMV sample ESG50 bounds 5% CKd | 266 | 38 | 34 | 10 | 38 | 37 | 40 | 39 | 30 |
| GMV sample ESG70 bounds 5% CKd | 32 | 1 | 2 | 3 | 11 | 2 | 4 | 7 | 2 |
| GMV sample ESG90 bounds 5% CKd | 483 | 60 | 60 | 61 | 61 | 60 | 61 | 61 | 59 |
| GMV sample unconstrained | 311 | 39 | 38 | 30 | 42 | 39 | 46 | 46 | 31 |
| GMV sample sin unconstrained | 220 | 28 | 28 | 8 | 32 | 28 | 34 | 34 | 28 |
| GMV sample ESG50 unconstrained | 158 | 18 | 19 | 24 | 7 | 20 | 26 | 26 | 18 |
| GMV sample ESG70 unconstrained | 77 | 8 | 8 | 12 | 9 | 9 | 11 | 12 | 8 |
| GMV sample ESG90 unconstrained | 437 | 55 | 55 | 54 | 55 | 55 | 55 | 55 | 53 |
| GMV sample unconstrained CKs | 323 | 42 | 39 | 32 | 41 | 40 | 48 | 49 | 32 |
| GMV sample sin unconstrained CKs | 188 | 24 | 25 | 4 | 28 | 24 | 29 | 29 | 25 |
| GMV sample ESG50 unconstrained CKs | 135 | 15 | 17 | 25 | 5 | 17 | 20 | 20 | 16 |
| GMV sample ESG70 unconstrained CKs | 45 | 5 | 3 | 13 | 2 | 3 | 8 | 8 | 3 |
| GMV sample ESG90 unconstrained CKs | 421 | 53 | 53 | 52 | 53 | 53 | 53 | 53 | 51 |
| GMV sample unconstrained CKd | 58 | 51 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| GMV sample sin unconstrained CKd | 263 | 34 | 36 | 29 | 39 | 36 | 27 | 27 | 35 |
| GMV sample ESG50 unconstrained CKd | 120 | 16 | 24 | 2 | 19 | 22 | 7 | 6 | 24 |
| GMV sample ESG70 unconstrained CKd | 152 | 20 | 21 | 21 | 24 | 21 | 13 | 11 | 21 |
| GMV sample ESG90 unconstrained CKd | 456 | 57 | 57 | 56 | 57 | 57 | 57 | 57 | 58 |

## 5.4.2

*Table 5.4.2a: Performance Indicators, EWMA Estimators and Different Constraints*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EWMA no-short | 0.150335 | 0.141217 | 1.562339 | 0.130135 | 0.060857 | 0.012931 | 0.013403 | 0.528933 |
| GMV EWMA sin no-short | 0.182311 | 0.189635 | 1.640646 | 0.153562 | 0.077133 | 0.01886 | 0.019835 | 0.618638 |
| GMV EWMA ESG50 no-short | 0.098284 | 0.07272 | 0.785495 | 0.110811 | 0.037298 | 0.007332 | 0.007544 | 0.356201 |
| GMV EWMA ESG70 no-short | 0.222792 | 0.283734 | 1.411251 | 0.137202 | 0.091233 | 0.018386 | 0.019538 | 0.759924 |
| GMV EWMA ESG90 no-short | 0.158963 | 0.19396 | 0.983941 | 0.084548 | 0.063375 | 0.012421 | 0.013298 | 0.662531 |
| GMV EWMA no-short CKs | 0.180339 | 0.203059 | 1.717066 | 0.134887 | 0.075982 | 0.019781 | 0.020593 | 0.64118 |
| GMV EWMA sin no-short CKs | 0.212315 | 0.252313 | 1.915068 | 0.16669 | 0.092134 | 0.025483 | 0.027252 | 0.711478 |
| GMV EWMA ESG50 no-short CKs | 0.158567 | 0.131135 | 1.132697 | 0.158966 | 0.060844 | 0.012787 | 0.01332 | 0.495933 |
| GMV EWMA ESG70 no-short CKs | 0.23781 | 0.310146 | 1.522214 | 0.16536 | 0.101509 | 0.022364 | 0.02421 | 0.793195 |
| GMV EWMA ESG90 no-short CKs | 0.175668 | 0.224765 | 1.072413 | 0.104871 | 0.075189 | 0.015945 | 0.017525 | 0.696571 |
| GMV EWMA no-short CKd | 0.157686 | 0.173165 | 1.603493 | 0.141799 | 0.064447 | 0.015937 | 0.016744 | 0.595788 |
| GMV EWMA sin no-short CKd | 0.138464 | 0.158987 | 1.137497 | 0.090386 | 0.053314 | 0.012601 | 0.013056 | 0.60533 |
| GMV EWMA ESG50 no-short CKd | 0.088493 | 0.076053 | 0.623694 | 0.078989 | 0.033231 | 0.006476 | 0.006674 | 0.429711 |
| GMV EWMA ESG70 no-short CKd | 0.213776 | 0.271475 | 1.317634 | 0.150346 | 0.087918 | 0.018079 | 0.019388 | 0.744419 |
| GMV EWMA ESG90 no-short CKd | 0.155816 | 0.207003 | 0.940462 | 0.094893 | 0.068251 | 0.013593 | 0.014723 | 0.685179 |
| GMV EWMA bounds 1 | 0.023608 | 0.037253 | 0.62298 | 0.014364 | 0.012088 | 0.001813 | 0.001856 | 0.571598 |
| GMV EWMA sin bounds 1 | 0.13687 | 0.211305 | 3.614851 | 0.080444 | 0.066153 | 0.01501 | 0.015286 | 0.704062 |
| GMV EWMA ESG50 bounds 1 | 0.148761 | 0.189912 | 1.675324 | 0.088487 | 0.064376 | 0.0133 | 0.013995 | 0.655984 |
| GMV EWMA ESG70 bounds 1 | 0.12559 | 0.18401 | 2.124903 | 0.079365 | 0.057979 | 0.01024 | 0.010556 | 0.676721 |
| GMV EWMA ESG90 bounds 1 | 0.143119 | 0.184733 | 1.563641 | 0.078419 | 0.05769 | 0.011701 | 0.012367 | 0.659453 |
| GMV EWMA bounds 1 CKs | 0.088538 | 0.115111 | 1.311426 | 0.049555 | 0.036251 | 0.00596 | 0.006026 | 0.591087 |
| GMV EWMA sin bounds 1 CKs | 0.203428 | 0.262944 | 3.25179 | 0.127086 | 0.085702 | 0.015039 | 0.01542 | 0.738825 |
| GMV EWMA ESG50 bounds 1 CKs | 0.232357 | 0.296936 | 2.452399 | 0.149779 | 0.097569 | 0.019651 | 0.020506 | 0.774937 |
| GMV EWMA ESG70 bounds 1 CKs | 0.226047 | 0.331645 | 2.585282 | 0.158892 | 0.107612 | 0.018699 | 0.02008 | 0.821988 |
| GMV EWMA ESG90 bounds 1 CKs | 0.09267 | 0.12492 | 0.90599 | 0.05197 | 0.038505 | 0.007782 | 0.008375 | 0.610237 |
| GMV EWMA bounds 1 CKd | 0.016934 | 0.020991 | 0.221507 | 0.00961 | 0.006354 | 0.001009 | 0.001025 | 0.496982 |
| GMV EWMA sin bounds 1 CKd | 0.128448 | 0.17658 | 1.831314 | 0.077153 | 0.055465 | 0.010223 | 0.010308 | 0.660618 |
| GMV EWMA ESG50 bounds 1 CKd | 0.265626 | 0.389126 | 3.31676 | 0.2075 | 0.126096 | 0.026499 | 0.029396 | 0.884209 |
| GMV EWMA ESG70 bounds 1 CKd | 0.281119 | 0.455222 | 3.178393 | 0.203883 | 0.149686 | 0.028325 | 0.030083 | 0.952019 |
| GMV EWMA ESG90 bounds 1 CKd | 0.091672 | 0.127885 | 0.884873 | 0.0478 | 0.039828 | 0.009372 | 0.01034 | 0.617945 |
| GMV EWMA bounds 5% | 0.108508 | 0.162796 | 2.049594 | 0.068236 | 0.051113 | 0.008305 | 0.008485 | 0.661976 |
| GMV EWMA sin bounds 5% | 0.177751 | 0.275273 | 3.541079 | 0.120911 | 0.085224 | 0.015662 | 0.015957 | 0.767813 |
| GMV EWMA ESG50 bounds 5% | 0.219732 | 0.339801 | 2.712521 | 0.139706 | 0.109564 | 0.018229 | 0.018672 | 0.831753 |
| GMV EWMA ESG70 bounds 5% | 0.20983 | 0.27934 | 2.393656 | 0.126793 | 0.092708 | 0.01578 | 0.016067 | 0.760406 |
| GMV EWMA ESG90 bounds 5% | 0.074688 | 0.098313 | 0.515517 | 0.037339 | 0.030183 | 0.005046 | 0.005244 | 0.585523 |
| GMV EWMA bounds 5% CKs | 0.138226 | 0.172834 | 1.981738 | 0.080233 | 0.055928 | 0.009371 | 0.009485 | 0.639131 |
| GMV EWMA sin bounds 5% CKs | 0.226562 | 0.294971 | 3.228671 | 0.159176 | 0.100802 | 0.014934 | 0.01537 | 0.77622 |
| GMV EWMA ESG50 bounds 5% CKs | 0.272633 | 0.377298 | 2.920252 | 0.17054 | 0.121484 | 0.024366 | 0.025749 | 0.872821 |
| GMV EWMA ESG70 bounds 5% CKs | 0.237665 | 0.323809 | 2.635492 | 0.152258 | 0.105619 | 0.019049 | 0.020488 | 0.810241 |
| GMV EWMA ESG90 bounds 5% CKs | 0.052515 | 0.071046 | 0.368111 | 0.030019 | 0.021043 | 0.003517 | 0.003687 | 0.566802 |
| GMV EWMA bounds 5% CKd | 0.123462 | 0.173861 | 1.376695 | 0.088678 | 0.056695 | 0.008857 | 0.008934 | 0.65565 |
| GMV EWMA sin bounds 5% CKd | 0.172055 | 0.21911 | 2.043993 | 0.129957 | 0.075381 | 0.012638 | 0.012752 | 0.690647 |
| GMV EWMA ESG50 bounds 5% CKd | 0.273966 | 0.40361 | 4.252125 | 0.218449 | 0.130404 | 0.031043 | 0.034856 | 0.893445 |
| GMV EWMA ESG70 bounds 5% CKd | 0.265697 | 0.412344 | 2.458714 | 0.200729 | 0.135031 | 0.023634 | 0.024865 | 0.901929 |
| GMV EWMA ESG90 bounds 5% CKd | 0.040762 | 0.054744 | 0.273678 | 0.020336 | 0.016662 | 0.002707 | 0.002848 | 0.550121 |
| GMV EWMA unconstrained | 0.037215 | 0.058304 | 0.926907 | 0.022549 | 0.018977 | 0.003102 | 0.003194 | 0.586213 |
| GMV EWMA sin unconstrained | 0.136815 | 0.211216 | 3.614359 | 0.08041 | 0.066125 | 0.015004 | 0.015279 | 0.703973 |
| GMV EWMA ESG50 unconstrained | 0.147793 | 0.189401 | 1.667021 | 0.087927 | 0.063969 | 0.013131 | 0.013808 | 0.65569 |
| GMV EWMA ESG70 unconstrained | 0.124783 | 0.182803 | 2.114191 | 0.078844 | 0.057599 | 0.010127 | 0.010436 | 0.675487 |
| GMV EWMA ESG90 unconstrained | 0.143119 | 0.184733 | 1.563641 | 0.078419 | 0.05769 | 0.011701 | 0.012367 | 0.659453 |
| GMV EWMA unconstrained CKs | 0.110901 | 0.146735 | 1.459466 | 0.069385 | 0.046282 | 0.007964 | 0.008249 | 0.624413 |
| GMV EWMA sin unconstrained CKs | 0.19936 | 0.25528 | 3.065 | 0.122479 | 0.082855 | 0.015186 | 0.015586 | 0.729722 |
| GMV EWMA ESG50 unconstrained CKs | 0.228267 | 0.281556 | 2.227822 | 0.150223 | 0.091822 | 0.018774 | 0.019525 | 0.753768 |
| GMV EWMA ESG70 unconstrained CKs | 0.230039 | 0.336731 | 2.623108 | 0.161885 | 0.108952 | 0.019627 | 0.021156 | 0.826762 |
| GMV EWMA ESG90 unconstrained CKs | 0.09267 | 0.12492 | 0.90599 | 0.05197 | 0.038505 | 0.007782 | 0.008375 | 0.610237 |
| GMV EWMA unconstrained CKd | 0.101864 | 0.134785 | 1.325667 | 0.066769 | 0.042558 | 0.007759 | 0.008046 | 0.614483 |
| GMV EWMA sin unconstrained CKd | 0.137662 | 0.188485 | 2.13992 | 0.076779 | 0.058102 | 0.011009 | 0.011182 | 0.669796 |
| GMV EWMA ESG50 unconstrained CKd | 0.225746 | 0.311905 | 2.012741 | 0.151633 | 0.103002 | 0.020948 | 0.022045 | 0.797458 |
| GMV EWMA ESG70 unconstrained CKd | 0.243284 | 0.380329 | 3.052297 | 0.189118 | 0.122844 | 0.024252 | 0.025477 | 0.872633 |
| GMV EWMA ESG90 unconstrained CKd | 0.09021 | 0.122487 | 0.897674 | 0.049963 | 0.036646 | 0.007803 | 0.008194 | 0.606896 |

*Table 5.4.2b: Performance Indicators, EWMA Estimators and Different Constraints*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 370 | 45 | 44 | 57 | 50 | 46 | 43 | 41 | 44 |
| GMV EWMA no-short | 291 | 31 | 46 | 36 | 23 | 34 | 32 | 32 | 57 |
| GMV EWMA sin no-short | 192 | 22 | 31 | 32 | 13 | 23 | 14 | 15 | 42 |
| GMV EWMA ESG50 no-short | 407 | 49 | 56 | 54 | 29 | 52 | 53 | 53 | 61 |
| GMV EWMA ESG70 no-short | 158 | 15 | 15 | 39 | 21 | 18 | 17 | 16 | 17 |
| GMV EWMA ESG90 no-short | 273 | 27 | 29 | 47 | 36 | 33 | 36 | 34 | 31 |
| GMV EWMA no-short CKs | 186 | 23 | 28 | 29 | 22 | 24 | 10 | 11 | 39 |
| GMV EWMA sin no-short CKs | 120 | 18 | 22 | 27 | 7 | 16 | 4 | 4 | 22 |
| GMV EWMA ESG50 no-short CKs | 292 | 28 | 48 | 45 | 11 | 35 | 33 | 33 | 59 |
| GMV EWMA ESG70 no-short CKs | 104 | 7 | 12 | 37 | 8 | 12 | 8 | 8 | 12 |
| GMV EWMA ESG90 no-short CKs | 215 | 25 | 23 | 46 | 30 | 26 | 20 | 20 | 25 |
| GMV EWMA no-short CKd | 243 | 29 | 40 | 33 | 19 | 30 | 21 | 21 | 50 |
| GMV EWMA sin no-short CKd | 318 | 36 | 43 | 44 | 32 | 44 | 35 | 35 | 49 |
| GMV EWMA ESG50 no-short CKd | 429 | 55 | 55 | 55 | 41 | 55 | 54 | 54 | 60 |
| GMV EWMA ESG70 no-short CKd | 169 | 17 | 19 | 42 | 16 | 19 | 19 | 18 | 19 |
| GMV EWMA ESG90 no-short CKd | 248 | 30 | 27 | 48 | 31 | 27 | 29 | 29 | 27 |
| GMV EWMA bounds 1 | 470 | 60 | 60 | 56 | 60 | 60 | 60 | 60 | 54 |
| GMV EWMA sin bounds 1 | 207 | 39 | 25 | 2 | 37 | 28 | 26 | 27 | 23 |
| GMV EWMA ESG50 bounds 1 | 253 | 32 | 30 | 30 | 34 | 31 | 30 | 30 | 36 |
| GMV EWMA ESG70 bounds 1 | 284 | 42 | 36 | 21 | 40 | 37 | 40 | 40 | 28 |
| GMV EWMA ESG90 bounds 1 | 291 | 34 | 34 | 34 | 43 | 38 | 37 | 37 | 34 |
| GMV EWMA bounds 1 CKs | 419 | 54 | 53 | 43 | 54 | 54 | 55 | 55 | 51 |
| GMV EWMA sin bounds 1 CKs | 161 | 20 | 20 | 6 | 25 | 20 | 25 | 25 | 20 |
| GMV EWMA ESG50 bounds 1 CKs | 108 | 9 | 13 | 17 | 18 | 14 | 11 | 12 | 14 |
| GMV EWMA ESG70 bounds 1 CKs | 97 | 13 | 9 | 15 | 12 | 9 | 16 | 14 | 9 |
| GMV EWMA ESG90 bounds 1 CKs | 395 | 50 | 50 | 50 | 51 | 50 | 50 | 48 | 46 |
| GMV EWMA bounds 1 CKd | 485 | 61 | 61 | 61 | 61 | 61 | 61 | 61 | 58 |
| GMV EWMA sin bounds 1 CKd | 313 | 41 | 38 | 28 | 45 | 43 | 41 | 44 | 33 |
| GMV EWMA ESG50 bounds 1 CKd | 30 | 5 | 4 | 5 | 2 | 4 | 3 | 3 | 4 |
| GMV EWMA ESG70 bounds 1 CKd | 19 | 1 | 1 | 8 | 3 | 1 | 2 | 2 | 1 |
| GMV EWMA ESG90 bounds 1 CKd | 388 | 52 | 49 | 53 | 55 | 49 | 44 | 43 | 43 |
| GMV EWMA bounds 5% | 331 | 47 | 42 | 23 | 48 | 45 | 47 | 47 | 32 |
| GMV EWMA sin bounds 5% | 156 | 24 | 18 | 4 | 28 | 21 | 23 | 23 | 15 |
| GMV EWMA ESG50 bounds 5% | 106 | 16 | 7 | 12 | 20 | 7 | 18 | 19 | 7 |
| GMV EWMA ESG70 bounds 5% | 155 | 19 | 17 | 18 | 26 | 15 | 22 | 22 | 16 |
| GMV EWMA ESG90 bounds 5% | 445 | 56 | 54 | 58 | 56 | 56 | 56 | 56 | 53 |
| GMV EWMA bounds 5% CKs | 315 | 37 | 41 | 26 | 39 | 42 | 45 | 45 | 40 |
| GMV EWMA sin bounds 5% CKs | 123 | 12 | 14 | 7 | 10 | 13 | 28 | 26 | 13 |
| GMV EWMA ESG50 bounds 5% CKs | 47 | 3 | 6 | 11 | 6 | 6 | 5 | 5 | 5 |
| GMV EWMA ESG70 bounds 5% CKs | 91 | 8 | 10 | 13 | 14 | 10 | 13 | 13 | 10 |
| GMV EWMA ESG90 bounds 5% CKs | 456 | 57 | 57 | 59 | 57 | 57 | 57 | 57 | 55 |
| GMV EWMA bounds 5% CKd | 327 | 44 | 39 | 40 | 33 | 41 | 46 | 46 | 38 |
| GMV EWMA sin bounds 5% CKd | 219 | 26 | 24 | 24 | 24 | 25 | 34 | 36 | 26 |
| GMV EWMA ESG50 bounds 5% CKd | 15 | 2 | 3 | 1 | 1 | 3 | 1 | 1 | 3 |
| GMV EWMA ESG70 bounds 5% CKd | 44 | 4 | 2 | 16 | 4 | 2 | 7 | 7 | 2 |
| GMV EWMA ESG90 bounds 5% CKd | 469 | 58 | 59 | 60 | 59 | 59 | 59 | 59 | 56 |
| GMV EWMA unconstrained | 450 | 59 | 58 | 49 | 58 | 58 | 58 | 58 | 52 |
| GMV EWMA sin unconstrained | 215 | 40 | 26 | 3 | 38 | 29 | 27 | 28 | 24 |
| GMV EWMA ESG50 unconstrained | 262 | 33 | 32 | 31 | 35 | 32 | 31 | 31 | 37 |
| GMV EWMA ESG70 unconstrained | 297 | 43 | 37 | 22 | 42 | 40 | 42 | 42 | 29 |
| GMV EWMA ESG90 unconstrained | 299 | 35 | 35 | 35 | 44 | 39 | 38 | 38 | 35 |
| GMV EWMA unconstrained CKs | 362 | 46 | 45 | 38 | 47 | 47 | 48 | 50 | 41 |
| GMV EWMA sin unconstrained CKs | 169 | 21 | 21 | 9 | 27 | 22 | 24 | 24 | 21 |
| GMV EWMA ESG50 unconstrained CKs | 130 | 11 | 16 | 19 | 17 | 17 | 15 | 17 | 18 |
| GMV EWMA ESG70 unconstrained CKs | 79 | 10 | 8 | 14 | 9 | 8 | 12 | 10 | 8 |
| GMV EWMA ESG90 unconstrained CKs | 403 | 51 | 51 | 51 | 52 | 51 | 51 | 49 | 47 |
| GMV EWMA unconstrained CKd | 382 | 48 | 47 | 41 | 49 | 48 | 52 | 52 | 45 |
| GMV EWMA sin unconstrained CKd | 281 | 38 | 33 | 20 | 46 | 36 | 39 | 39 | 30 |
| GMV EWMA ESG50 unconstrained CKd | 105 | 14 | 11 | 25 | 15 | 11 | 9 | 9 | 11 |
| GMV EWMA ESG70 unconstrained CKd | 49 | 6 | 5 | 10 | 5 | 5 | 6 | 6 | 6 |
| GMV EWMA ESG90 unconstrained CKd | 411 | 53 | 52 | 52 | 53 | 53 | 49 | 51 | 48 |

## 5.4.3

*Table 5.4.3a: Performance Indicators, Equilibrium Estimators and Different Constraints*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.119922 | 0.150571 | 0.538181 | 0.059593 | 0.047149 | 0.009499 | 0.010458 | 0.616932 |
| GMV EQ no-short | 0.202620 | 0.278094 | 1.746970 | 0.123544 | 0.093550 | 0.021800 | 0.022126 | 0.755301 |
| GMV EQ sin no-short | 0.200447 | 0.278611 | 1.685798 | 0.124121 | 0.092287 | 0.021275 | 0.022131 | 0.759489 |
| GMV EQ ESG50 no-short | 0.221331 | 0.252732 | 1.457077 | 0.168820 | 0.087047 | 0.017887 | 0.018311 | 0.714105 |
| GMV EQ ESG70 no-short | 0.273248 | 0.351541 | 1.696316 | 0.165778 | 0.111856 | 0.025636 | 0.027059 | 0.839073 |
| GMV EQ ESG90 no-short | 0.173772 | 0.221465 | 1.097536 | 0.101519 | 0.071888 | 0.016420 | 0.017581 | 0.692079 |
| GMV EQ no-short CKs | 0.172150 | 0.212682 | 1.461383 | 0.102439 | 0.075425 | 0.018285 | 0.019188 | 0.669423 |
| GMV EQ sin no-short CKs | 0.181060 | 0.227544 | 1.535903 | 0.105858 | 0.079725 | 0.020120 | 0.020799 | 0.692752 |
| GMV EQ ESG50 no-short CKs | 0.205563 | 0.223271 | 1.291462 | 0.152511 | 0.079110 | 0.016853 | 0.017598 | 0.674096 |
| GMV EQ ESG70 no-short CKs | 0.276806 | 0.349162 | 1.620020 | 0.162578 | 0.113182 | 0.026273 | 0.028432 | 0.840143 |
| GMV EQ ESG90 no-short CKs | 0.141632 | 0.186294 | 0.818858 | 0.075318 | 0.060046 | 0.012387 | 0.013584 | 0.664633 |
| GMV EQ no-short CKd | 0.147316 | 0.185355 | 1.220624 | 0.076535 | 0.060534 | 0.015036 | 0.015801 | 0.647126 |
| GMV EQ sin no-short CKd | 0.167910 | 0.216373 | 1.431180 | 0.088851 | 0.071087 | 0.018503 | 0.019449 | 0.685428 |
| GMV EQ ESG50 no-short CKd | 0.200266 | 0.235504 | 1.349687 | 0.153068 | 0.074670 | 0.018529 | 0.020293 | 0.700378 |
| GMV EQ ESG70 no-short CKd | 0.257197 | 0.308381 | 1.496587 | 0.169506 | 0.099961 | 0.024952 | 0.027100 | 0.787535 |
| GMV EQ ESG90 no-short CKd | 0.135562 | 0.177971 | 0.810770 | 0.070133 | 0.056807 | 0.011753 | 0.012697 | 0.656673 |
| GMV EQ bounds 1 | 0.228833 | 0.331896 | 4.938427 | 0.140534 | 0.107964 | 0.026896 | 0.027901 | 0.820461 |
| GMV EQ sin bounds 1 | 0.235564 | 0.340953 | 4.623018 | 0.152247 | 0.110451 | 0.026658 | 0.027584 | 0.826482 |
| GMV EQ ESG50 bounds 1 | 0.218187 | 0.298164 | 6.308013 | 0.134555 | 0.094919 | 0.024347 | 0.025505 | 0.780346 |
| GMV EQ ESG70 bounds 1 | 0.208680 | 0.278791 | 6.963618 | 0.137015 | 0.086875 | 0.025401 | 0.027102 | 0.761944 |
| GMV EQ ESG90 bounds 1 | 0.082834 | 0.103695 | 3.399868 | 0.045485 | 0.031811 | 0.008871 | 0.009700 | 0.577532 |
| GMV EQ bounds 1 CKs | 0.130147 | 0.189925 | 1.737011 | 0.076161 | 0.059588 | 0.009042 | 0.009217 | 0.681085 |
| GMV EQ sin bounds 1 CKs | 0.191905 | 0.266384 | 2.529130 | 0.114366 | 0.088823 | 0.017166 | 0.017871 | 0.747933 |
| GMV EQ ESG50 bounds 1 CKs | 0.221624 | 0.330120 | 2.223415 | 0.175614 | 0.105005 | 0.019043 | 0.019913 | 0.819390 |
| GMV EQ ESG70 bounds 1 CKs | 0.265912 | 0.378024 | 2.387151 | 0.182389 | 0.125225 | 0.022425 | 0.023936 | 0.871871 |
| GMV EQ ESG90 bounds 1 CKs | 0.078305 | 0.103117 | 0.686537 | 0.039305 | 0.032615 | 0.006631 | 0.007003 | 0.588070 |
| GMV EQ bounds 1 CKd | 0.141890 | 0.206264 | 1.815163 | 0.082887 | 0.064618 | 0.010850 | 0.011242 | 0.689860 |
| GMV EQ sin bounds 1 CKd | 0.118343 | 0.184908 | 1.855360 | 0.070388 | 0.055543 | 0.010156 | 0.010199 | 0.691115 |
| GMV EQ ESG50 bounds 1 CKd | 0.094854 | 0.134370 | 1.296759 | 0.051624 | 0.039236 | 0.008456 | 0.008687 | 0.626968 |
| GMV EQ ESG70 bounds 1 CKd | 0.166834 | 0.204183 | 2.317435 | 0.110415 | 0.069238 | 0.013016 | 0.013503 | 0.667467 |
| GMV EQ ESG90 bounds 1 CKd | 0.077407 | 0.098672 | 0.743811 | 0.043261 | 0.030577 | 0.006751 | 0.007244 | 0.577437 |
| GMV EQ bounds 5% | 0.224057 | 0.317780 | 5.001684 | 0.138191 | 0.102709 | 0.024717 | 0.025623 | 0.805187 |
| GMV EQ sin bounds 5% | 0.230469 | 0.325561 | 4.633328 | 0.148477 | 0.106330 | 0.024115 | 0.024942 | 0.810241 |
| GMV EQ ESG50 bounds 5% | 0.219483 | 0.299251 | 6.409239 | 0.139525 | 0.095313 | 0.024634 | 0.025820 | 0.781568 |
| GMV EQ ESG70 bounds 5% | 0.209320 | 0.279715 | 7.067137 | 0.142004 | 0.087564 | 0.025641 | 0.027355 | 0.762968 |
| GMV EQ ESG90 bounds 5% | 0.065379 | 0.084439 | 0.750207 | 0.033908 | 0.025167 | 0.004964 | 0.005168 | 0.571666 |
| GMV EQ bounds 5% CKs | 0.191056 | 0.300450 | 2.141326 | 0.127876 | 0.095069 | 0.016782 | 0.017122 | 0.785644 |
| GMV EQ sin bounds 5% CKs | 0.218790 | 0.334215 | 2.352356 | 0.150337 | 0.107907 | 0.019425 | 0.019919 | 0.815739 |
| GMV EQ ESG50 bounds 5% CKs | 0.229753 | 0.351397 | 2.311417 | 0.156513 | 0.113645 | 0.019567 | 0.020633 | 0.842411 |
| GMV EQ ESG70 bounds 5% CKs | 0.259470 | 0.371192 | 2.368031 | 0.153940 | 0.124470 | 0.021370 | 0.022553 | 0.861210 |
| GMV EQ ESG90 bounds 5% CKs | 0.059603 | 0.081675 | 0.409083 | 0.030218 | 0.024087 | 0.004165 | 0.004360 | 0.582854 |
| GMV EQ bounds 5% CKd | 0.181615 | 0.258186 | 2.056668 | 0.134965 | 0.083141 | 0.018285 | 0.018800 | 0.744870 |
| GMV EQ sin bounds 5% CKd | 0.141050 | 0.197964 | 1.460806 | 0.080099 | 0.062004 | 0.013239 | 0.013726 | 0.681502 |
| GMV EQ ESG50 bounds 5% CKd | 0.199009 | 0.275112 | 2.001750 | 0.151258 | 0.085195 | 0.016240 | 0.016614 | 0.761089 |
| GMV EQ ESG70 bounds 5% CKd | 0.242630 | 0.368477 | 2.062525 | 0.146962 | 0.114995 | 0.021559 | 0.022944 | 0.856253 |
| GMV EQ ESG90 bounds 5% CKd | 0.060288 | 0.082803 | 0.429932 | 0.032895 | 0.024218 | 0.004182 | 0.004359 | 0.583361 |
| GMV EQ unconstrained | 0.228833 | 0.331896 | 4.938427 | 0.140534 | 0.107964 | 0.026896 | 0.027901 | 0.820461 |
| GMV EQ sin unconstrained | 0.235564 | 0.340953 | 4.623018 | 0.152247 | 0.110451 | 0.026658 | 0.027584 | 0.826482 |
| GMV EQ ESG50 unconstrained | 0.218187 | 0.298164 | 6.308013 | 0.134555 | 0.094919 | 0.024347 | 0.025505 | 0.780346 |
| GMV EQ ESG70 unconstrained | 0.208680 | 0.278791 | 6.963618 | 0.137015 | 0.086875 | 0.025401 | 0.027102 | 0.761944 |
| GMV EQ ESG90 unconstrained | 0.082834 | 0.103695 | 3.399868 | 0.045485 | 0.031811 | 0.008871 | 0.009700 | 0.577532 |
| GMV EQ unconstrained CKs | 0.150943 | 0.220026 | 1.920367 | 0.096625 | 0.068785 | 0.011852 | 0.012139 | 0.708701 |
| GMV EQ sin unconstrained CKs | 0.191196 | 0.265252 | 2.524910 | 0.113878 | 0.088444 | 0.017114 | 0.017818 | 0.746675 |
| GMV EQ ESG50 unconstrained CKs | 0.221799 | 0.330664 | 2.225745 | 0.175700 | 0.105166 | 0.019070 | 0.019943 | 0.819961 |
| GMV EQ ESG70 unconstrained CKs | 0.266750 | 0.379297 | 2.408535 | 0.183004 | 0.125647 | 0.022654 | 0.024197 | 0.873333 |
| GMV EQ ESG90 unconstrained CKs | 0.078305 | 0.103117 | 0.686537 | 0.039305 | 0.032615 | 0.006631 | 0.007003 | 0.588070 |
| GMV EQ unconstrained CKd | 0.192412 | 0.309403 | 2.916882 | 0.130605 | 0.097947 | 0.020205 | 0.020951 | 0.796832 |
| GMV EQ sin unconstrained CKd | 0.181615 | 0.275985 | 2.697066 | 0.114759 | 0.087470 | 0.017826 | 0.018542 | 0.765819 |
| GMV EQ ESG50 unconstrained CKd | 0.146876 | 0.184805 | 2.046322 | 0.112112 | 0.058626 | 0.013141 | 0.013983 | 0.653855 |
| GMV EQ ESG70 unconstrained CKd | 0.115999 | 0.161952 | 1.265929 | 0.069715 | 0.050706 | 0.008523 | 0.008891 | 0.653050 |
| GMV EQ ESG90 unconstrained CKd | 0.077407 | 0.098672 | 0.743811 | 0.043261 | 0.030577 | 0.006751 | 0.007244 | 0.577437 |

*Table 5.4.3b: Performance Indicators, Equilibrium Estimators and Different Constraints*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 410 | 49 | 51 | 59 | 51 | 51 | 49 | 48 | 52 |
| GMV EQ no-short | 211 | 26 | 27 | 35 | 32 | 23 | 18 | 21 | 29 |
| GMV EQ sin no-short | 215 | 27 | 26 | 38 | 31 | 24 | 21 | 20 | 28 |
| GMV EQ ESG50 no-short | 227 | 17 | 33 | 44 | 6 | 29 | 32 | 33 | 33 |
| GMV EQ ESG70 no-short | 82 | 2 | 5 | 37 | 7 | 7 | 7 | 10 | 7 |
| GMV EQ ESG90 no-short | 315 | 37 | 37 | 51 | 40 | 38 | 38 | 37 | 37 |
| GMV EQ no-short CKs | 300 | 38 | 40 | 42 | 39 | 36 | 31 | 30 | 44 |
| GMV EQ sin no-short CKs | 265 | 36 | 35 | 40 | 38 | 34 | 23 | 23 | 36 |
| GMV EQ ESG50 no-short CKs | 271 | 25 | 36 | 48 | 12 | 35 | 36 | 36 | 43 |
| GMV EQ ESG70 no-short CKs | 73 | 1 | 7 | 39 | 8 | 6 | 5 | 1 | 6 |
| GMV EQ ESG90 no-short CKs | 367 | 45 | 45 | 52 | 47 | 45 | 44 | 43 | 46 |
| GMV EQ no-short CKd | 357 | 42 | 46 | 50 | 45 | 44 | 40 | 40 | 50 |
| GMV EQ sin no-short CKd | 302 | 39 | 39 | 45 | 42 | 39 | 29 | 29 | 40 |
| GMV EQ ESG50 no-short CKd | 244 | 28 | 34 | 46 | 11 | 37 | 28 | 25 | 35 |
| GMV EQ ESG70 no-short CKd | 124 | 6 | 18 | 41 | 5 | 17 | 10 | 9 | 18 |
| GMV EQ ESG90 no-short CKd | 384 | 47 | 49 | 53 | 49 | 48 | 46 | 45 | 47 |
| GMV EQ bounds 1 | 81 | 12 | 12 | 9 | 21 | 11 | 2 | 3 | 11 |
| GMV EQ sin bounds 1 | 66 | 8 | 8 | 12 | 14 | 9 | 3 | 4 | 8 |
| GMV EQ ESG50 bounds 1 | 144 | 20 | 21 | 6 | 27 | 21 | 14 | 14 | 21 |
| GMV EQ ESG70 bounds 1 | 146 | 23 | 24 | 2 | 24 | 30 | 9 | 8 | 26 |
| GMV EQ ESG90 bounds 1 | 392 | 54 | 54 | 14 | 54 | 56 | 52 | 51 | 57 |
| GMV EQ bounds 1 CKs | 364 | 48 | 44 | 36 | 46 | 46 | 50 | 52 | 42 |
| GMV EQ sin bounds 1 CKs | 235 | 31 | 30 | 17 | 34 | 25 | 34 | 34 | 30 |
| GMV EQ ESG50 bounds 1 CKs | 143 | 16 | 14 | 26 | 4 | 15 | 27 | 28 | 13 |
| GMV EQ ESG70 bounds 1 CKs | 66 | 4 | 2 | 20 | 2 | 2 | 17 | 17 | 2 |
| GMV EQ ESG90 bounds 1 CKs | 449 | 56 | 56 | 57 | 57 | 54 | 58 | 58 | 53 |
| GMV EQ bounds 1 CKd | 337 | 44 | 41 | 34 | 43 | 42 | 47 | 47 | 39 |
| GMV EQ sin bounds 1 CKd | 362 | 50 | 47 | 33 | 48 | 49 | 48 | 49 | 38 |
| GMV EQ ESG50 bounds 1 CKd | 414 | 52 | 52 | 47 | 52 | 52 | 54 | 54 | 51 |
| GMV EQ ESG70 bounds 1 CKd | 314 | 40 | 42 | 23 | 37 | 40 | 43 | 44 | 45 |
| GMV EQ ESG90 bounds 1 CKd | 458 | 58 | 58 | 56 | 56 | 58 | 56 | 56 | 60 |
| GMV EQ bounds 5% | 115 | 14 | 16 | 7 | 23 | 16 | 11 | 12 | 16 |
| GMV EQ sin bounds 5% | 110 | 10 | 15 | 10 | 17 | 13 | 15 | 15 | 15 |
| GMV EQ ESG50 bounds 5% | 126 | 18 | 20 | 4 | 22 | 19 | 12 | 11 | 20 |
| GMV EQ ESG70 bounds 5% | 128 | 22 | 23 | 1 | 19 | 27 | 6 | 6 | 24 |
| GMV EQ ESG90 bounds 5% | 469 | 59 | 59 | 54 | 59 | 59 | 59 | 59 | 61 |
| GMV EQ bounds 5% CKs | 223 | 33 | 19 | 27 | 30 | 20 | 37 | 38 | 19 |
| GMV EQ sin bounds 5% CKs | 145 | 19 | 10 | 22 | 16 | 12 | 25 | 27 | 14 |
| GMV EQ ESG50 bounds 5% CKs | 108 | 11 | 6 | 24 | 9 | 5 | 24 | 24 | 5 |
| GMV EQ ESG70 bounds 5% CKs | 84 | 5 | 3 | 21 | 10 | 3 | 20 | 19 | 3 |
| GMV EQ ESG90 bounds 5% CKs | 482 | 61 | 61 | 61 | 61 | 61 | 61 | 60 | 56 |
| GMV EQ bounds 5% CKd | 248 | 35 | 32 | 29 | 26 | 33 | 30 | 31 | 32 |
| GMV EQ sin bounds 5% CKd | 343 | 46 | 43 | 43 | 44 | 43 | 41 | 42 | 41 |
| GMV EQ ESG50 bounds 5% CKd | 241 | 29 | 29 | 31 | 15 | 32 | 39 | 39 | 27 |
| GMV EQ ESG70 bounds 5% CKd | 102 | 7 | 4 | 28 | 18 | 4 | 19 | 18 | 4 |
| GMV EQ ESG90 bounds 5% CKd | 476 | 60 | 60 | 60 | 60 | 60 | 60 | 61 | 55 |
| GMV EQ unconstrained | 75 | 13 | 11 | 8 | 20 | 10 | 1 | 2 | 10 |
| GMV EQ sin unconstrained | 68 | 9 | 9 | 11 | 13 | 8 | 4 | 5 | 9 |
| GMV EQ ESG50 unconstrained | 146 | 21 | 22 | 5 | 28 | 22 | 13 | 13 | 22 |
| GMV EQ ESG70 unconstrained | 148 | 24 | 25 | 3 | 25 | 31 | 8 | 7 | 25 |
| GMV EQ ESG90 unconstrained | 386 | 53 | 53 | 13 | 53 | 55 | 51 | 50 | 58 |
| GMV EQ unconstrained CKs | 318 | 41 | 38 | 32 | 41 | 41 | 45 | 46 | 34 |
| GMV EQ sin unconstrained CKs | 243 | 32 | 31 | 18 | 35 | 26 | 35 | 35 | 31 |
| GMV EQ ESG50 unconstrained CKs | 134 | 15 | 13 | 25 | 3 | 14 | 26 | 26 | 12 |
| GMV EQ ESG70 unconstrained CKs | 58 | 3 | 1 | 19 | 1 | 1 | 16 | 16 | 1 |
| GMV EQ ESG90 unconstrained CKs | 447 | 55 | 55 | 58 | 58 | 53 | 57 | 57 | 54 |
| GMV EQ unconstrained CKd | 170 | 30 | 17 | 15 | 29 | 18 | 22 | 22 | 17 |
| GMV EQ sin unconstrained CKd | 227 | 34 | 28 | 16 | 33 | 28 | 33 | 32 | 23 |
| GMV EQ ESG50 unconstrained CKd | 335 | 43 | 48 | 30 | 36 | 47 | 42 | 41 | 48 |
| GMV EQ ESG70 unconstrained CKd | 405 | 51 | 50 | 49 | 50 | 50 | 53 | 53 | 49 |
| GMV EQ ESG90 unconstrained CKd | 450 | 57 | 57 | 55 | 55 | 57 | 55 | 55 | 59 |

### 5.5.1

*Table 5.5.1a: Performance Indicators, Michaud Approach and GMV*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.120 | 0.151 | 0.538 | 0.060 | 0.047 | 0.009 | 0.010 | 0.617 |
| GMV sample no-short | 0.172 | 0.212 | 1.462 | 0.102 | 0.075 | 0.018 | 0.019 | 0.669 |
| GMV sample sin no-short | 0.180 | 0.226 | 1.532 | 0.105 | 0.079 | 0.020 | 0.021 | 0.691 |
| GMV sample ESG50 no-short | 0.205 | 0.222 | 1.290 | 0.152 | 0.079 | 0.017 | 0.017 | 0.673 |
| GMV sample ESG70 no-short | 0.276 | 0.349 | 1.620 | 0.162 | 0.113 | 0.026 | 0.028 | 0.840 |
| GMV sample ESG90 no-short | 0.142 | 0.187 | 0.821 | 0.075 | 0.060 | 0.012 | 0.014 | 0.665 |
| GMV sample no-short MIC | 0.161 | 0.198 | 1.314 | 0.092 | 0.069 | 0.016 | 0.016 | 0.654 |
| GMV sample sin no-short MIC | 0.171 | 0.214 | 1.407 | 0.101 | 0.075 | 0.017 | 0.018 | 0.678 |
| GMV sample ESG50 no-short MIC | 0.197 | 0.217 | 1.215 | 0.144 | 0.075 | 0.015 | 0.016 | 0.667 |
| GMV sample ESG70 no-short MIC | 0.275 | 0.340 | 1.586 | 0.163 | 0.111 | 0.026 | 0.028 | 0.829 |
| GMV sample ESG90 no-short MIC | 0.157 | 0.204 | 0.904 | 0.083 | 0.066 | 0.015 | 0.016 | 0.678 |
| GMV sample unconstrained | 0.142 | 0.207 | 1.894 | 0.088 | 0.065 | 0.011 | 0.011 | 0.697 |
| GMV sample sin unconstrained | 0.186 | 0.259 | 2.550 | 0.108 | 0.086 | 0.016 | 0.017 | 0.742 |
| GMV sample ESG50 unconstrained | 0.216 | 0.326 | 2.253 | 0.172 | 0.102 | 0.018 | 0.019 | 0.818 |
| GMV sample ESG70 unconstrained | 0.256 | 0.362 | 2.388 | 0.169 | 0.119 | 0.021 | 0.022 | 0.855 |
| GMV sample ESG90 unconstrained | 0.078 | 0.103 | 0.683 | 0.039 | 0.032 | 0.007 | 0.007 | 0.588 |
| GMV sample unconstrained MIC | 0.129 | 0.178 | 1.631 | 0.079 | 0.057 | 0.010 | 0.010 | 0.662 |
| GMV sample sin unconstrained MIC | 0.170 | 0.232 | 2.121 | 0.104 | 0.076 | 0.014 | 0.014 | 0.714 |
| GMV sample ESG50 unconstrained MIC | 0.207 | 0.297 | 2.179 | 0.156 | 0.096 | 0.018 | 0.019 | 0.786 |
| GMV sample ESG70 unconstrained MIC | 0.249 | 0.336 | 2.253 | 0.166 | 0.111 | 0.021 | 0.022 | 0.823 |
| GMV sample ESG90 unconstrained MIC | 0.085 | 0.113 | 0.729 | 0.042 | 0.035 | 0.008 | 0.008 | 0.598 |
| GMV EQ no-short | 0.203 | 0.278 | 1.747 | 0.124 | 0.094 | 0.022 | 0.022 | 0.755 |
| GMV EQ sin no-short | 0.200 | 0.279 | 1.686 | 0.124 | 0.092 | 0.021 | 0.022 | 0.759 |
| GMV EQ ESG50 no-short | 0.221 | 0.253 | 1.457 | 0.169 | 0.087 | 0.018 | 0.018 | 0.714 |
| GMV EQ ESG70 no-short | 0.273 | 0.352 | 1.696 | 0.166 | 0.112 | 0.026 | 0.027 | 0.839 |
| GMV EQ ESG90 no-short | 0.174 | 0.221 | 1.098 | 0.102 | 0.072 | 0.016 | 0.018 | 0.692 |
| GMV EQ no-short MIC | 0.163 | 0.200 | 0.747 | 0.090 | 0.065 | 0.012 | 0.013 | 0.664 |
| GMV EQ sin no-short MIC | 0.155 | 0.190 | 0.710 | 0.085 | 0.062 | 0.012 | 0.013 | 0.653 |
| GMV EQ ESG50 no-short MIC | 0.166 | 0.204 | 0.758 | 0.092 | 0.066 | 0.013 | 0.014 | 0.669 |
| GMV EQ ESG70 no-short MIC | 0.157 | 0.195 | 0.715 | 0.085 | 0.063 | 0.012 | 0.013 | 0.660 |
| GMV EQ ESG90 no-short MIC | 0.110 | 0.142 | 0.512 | 0.066 | 0.044 | 0.008 | 0.009 | 0.617 |
| GMV EQ unconstrained | 0.229 | 0.332 | 4.938 | 0.141 | 0.108 | 0.027 | 0.028 | 0.820 |
| GMV EQ sin unconstrained | 0.236 | 0.341 | 4.623 | 0.152 | 0.110 | 0.027 | 0.028 | 0.826 |
| GMV EQ ESG50 unconstrained | 0.218 | 0.298 | 6.308 | 0.135 | 0.095 | 0.024 | 0.026 | 0.780 |
| GMV EQ ESG70 unconstrained | 0.209 | 0.279 | 6.964 | 0.137 | 0.087 | 0.025 | 0.027 | 0.762 |
| GMV EQ ESG90 unconstrained | 0.083 | 0.104 | 3.400 | 0.045 | 0.032 | 0.009 | 0.010 | 0.578 |
| GMV EQ unconstrained MIC | 0.164 | 0.200 | 0.750 | 0.091 | 0.065 | 0.012 | 0.013 | 0.665 |
| GMV EQ sin unconstrained MIC | 0.156 | 0.191 | 0.713 | 0.085 | 0.062 | 0.012 | 0.013 | 0.654 |
| GMV EQ ESG50 unconstrained MIC | 0.167 | 0.206 | 0.762 | 0.093 | 0.066 | 0.013 | 0.014 | 0.671 |
| GMV EQ ESG70 unconstrained MIC | 0.157 | 0.196 | 0.717 | 0.085 | 0.063 | 0.012 | 0.013 | 0.662 |
| GMV EQ ESG90 unconstrained MIC | 0.110 | 0.141 | 0.510 | 0.066 | 0.044 | 0.008 | 0.009 | 0.617 |

*Table 5.5.1b: Performance Indicators, Michaud Approach and GMV*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 294 | 36 | 36 | 39 | 38 | 36 | 36 | 35 | 38 |
| GMV sample no-short | 152 | 20 | 22 | 20 | 20 | 19 | 13 | 13 | 25 |
| GMV sample sin no-short | 131 | 18 | 17 | 19 | 18 | 16 | 12 | 12 | 19 |
| GMV sample ESG50 no-short | 140 | 13 | 18 | 24 | 9 | 17 | 18 | 19 | 22 |
| GMV sample ESG70 no-short | 36 | 1 | 3 | 17 | 7 | 2 | 3 | 1 | 2 |
| GMV sample ESG90 no-short | 247 | 34 | 34 | 28 | 35 | 34 | 28 | 27 | 27 |
| GMV sample no-short MIC | 202 | 27 | 29 | 23 | 24 | 23 | 21 | 21 | 34 |
| GMV sample sin no-short MIC | 162 | 21 | 21 | 22 | 22 | 21 | 17 | 17 | 21 |
| GMV sample ESG50 no-short MIC | 163 | 16 | 20 | 25 | 11 | 20 | 22 | 23 | 26 |
| GMV sample ESG70 no-short MIC | 47 | 2 | 5 | 18 | 6 | 4 | 5 | 3 | 4 |
| GMV sample ESG90 no-short MIC | 206 | 29 | 26 | 27 | 33 | 26 | 23 | 22 | 20 |
| GMV sample unconstrained | 209 | 33 | 23 | 12 | 28 | 28 | 34 | 34 | 17 |
| GMV sample sin unconstrained | 123 | 17 | 14 | 6 | 17 | 15 | 20 | 20 | 14 |
| GMV sample ESG50 unconstrained | 71 | 10 | 8 | 8 | 1 | 8 | 14 | 14 | 8 |
| GMV sample ESG70 unconstrained | 37 | 4 | 1 | 7 | 3 | 1 | 11 | 9 | 1 |
| GMV sample ESG90 unconstrained | 323 | 41 | 41 | 38 | 41 | 40 | 41 | 41 | 40 |
| GMV sample unconstrained MIC | 256 | 35 | 35 | 16 | 34 | 35 | 35 | 36 | 30 |
| GMV sample sin unconstrained MIC | 150 | 22 | 16 | 11 | 19 | 18 | 24 | 24 | 16 |
| GMV sample ESG50 unconstrained MIC | 89 | 12 | 10 | 10 | 8 | 9 | 16 | 15 | 9 |
| GMV sample ESG70 unconstrained MIC | 53 | 5 | 6 | 9 | 4 | 5 | 10 | 8 | 6 |
| GMV sample ESG90 unconstrained MIC | 309 | 39 | 39 | 33 | 40 | 39 | 40 | 40 | 39 |
| GMV EQ no-short | 99 | 14 | 13 | 13 | 16 | 11 | 8 | 11 | 13 |
| GMV EQ sin no-short | 100 | 15 | 12 | 15 | 15 | 12 | 9 | 10 | 12 |
| GMV EQ ESG50 no-short | 105 | 8 | 15 | 21 | 2 | 13 | 15 | 16 | 15 |
| GMV EQ ESG70 no-short | 40 | 3 | 2 | 14 | 5 | 3 | 4 | 6 | 3 |
| GMV EQ ESG90 no-short | 162 | 19 | 19 | 26 | 21 | 22 | 19 | 18 | 18 |
| GMV EQ no-short MIC | 229 | 26 | 28 | 32 | 27 | 29 | 29 | 29 | 29 |
| GMV EQ sin no-short MIC | 267 | 32 | 33 | 37 | 31 | 33 | 33 | 33 | 35 |
| GMV EQ ESG50 no-short MIC | 205 | 24 | 25 | 30 | 25 | 25 | 26 | 26 | 24 |
| GMV EQ ESG70 no-short MIC | 253 | 30 | 31 | 35 | 32 | 31 | 31 | 31 | 32 |
| GMV EQ ESG90 no-short MIC | 299 | 37 | 37 | 40 | 36 | 37 | 38 | 38 | 36 |
| GMV EQ unconstrained | 46 | 7 | 7 | 3 | 12 | 7 | 1 | 2 | 7 |
| GMV EQ sin unconstrained | 41 | 6 | 4 | 4 | 10 | 6 | 2 | 4 | 5 |
| GMV EQ ESG50 unconstrained | 68 | 9 | 9 | 2 | 14 | 10 | 7 | 7 | 10 |
| GMV EQ ESG70 unconstrained | 72 | 11 | 11 | 1 | 13 | 14 | 6 | 5 | 11 |
| GMV EQ ESG90 unconstrained | 280 | 40 | 40 | 5 | 39 | 41 | 37 | 37 | 41 |
| GMV EQ unconstrained MIC | 219 | 25 | 27 | 31 | 26 | 27 | 27 | 28 | 28 |
| GMV EQ sin unconstrained MIC | 257 | 31 | 32 | 36 | 29 | 32 | 32 | 32 | 33 |
| GMV EQ ESG50 unconstrained MIC | 196 | 23 | 24 | 29 | 23 | 24 | 25 | 25 | 23 |
| GMV EQ ESG70 unconstrained MIC | 243 | 28 | 30 | 34 | 30 | 30 | 30 | 30 | 31 |
| GMV EQ ESG90 unconstrained MIC | 307 | 38 | 38 | 41 | 37 | 38 | 39 | 39 | 37 |

### 5.5.2

*Table 5.5.2a: Performance Indicators, Michaud Approach and MS*

| Strategy | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|
| Market | 0.120 | 0.151 | 0.538 | 0.060 | 0.047 | 0.009 | 0.010 | 0.617 |
| MS sample no-short | 0.144 | 0.179 | 1.218 | 0.086 | 0.060 | 0.014 | 0.015 | 0.645 |
| MS sample sin no-short | 0.186 | 0.229 | 1.464 | 0.103 | 0.076 | 0.021 | 0.021 | 0.696 |
| MS sample ESG50 no-short | 0.223 | 0.239 | 1.377 | 0.173 | 0.088 | 0.020 | 0.021 | 0.699 |
| MS sample ESG70 no-short | 0.253 | 0.297 | 1.473 | 0.149 | 0.100 | 0.022 | 0.024 | 0.776 |
| MS sample ESG90 no-short | 0.157 | 0.187 | 0.916 | 0.116 | 0.060 | 0.013 | 0.013 | 0.650 |
| MS sample no-short MIC | 0.175 | 0.211 | 1.237 | 0.108 | 0.072 | 0.016 | 0.016 | 0.674 |
| MS sample sin no-short MIC | 0.205 | 0.248 | 1.411 | 0.118 | 0.083 | 0.019 | 0.020 | 0.718 |
| MS sample ESG50 no-short MIC | 0.212 | 0.221 | 1.169 | 0.146 | 0.079 | 0.016 | 0.017 | 0.673 |
| MS sample ESG70 no-short MIC | 0.263 | 0.293 | 1.366 | 0.153 | 0.098 | 0.021 | 0.023 | 0.770 |
| MS sample ESG90 no-short MIC | 0.168 | 0.192 | 0.894 | 0.113 | 0.062 | 0.014 | 0.014 | 0.649 |
| MS sample unconstrained | 0.072 | 0.101 | -1.429 | 0.053 | 0.031 | 0.014 | 0.014 | 0.577 |
| MS sample sin unconstrained | 0.098 | 0.130 | -2.129 | 0.070 | 0.041 | 0.019 | 0.019 | 0.596 |
| MS sample ESG50 unconstrained | 0.151 | 0.194 | -3.228 | 0.092 | 0.067 | 0.020 | 0.021 | 0.646 |
| MS sample ESG70 unconstrained | 0.079 | 0.086 | -1.376 | 0.062 | 0.033 | 0.006 | 0.006 | 0.497 |
| MS sample ESG90 unconstrained | -0.025 | -0.023 | -6.854 | -0.035 | -0.010 | -0.005 | -0.005 | 0.207 |
| MS sample unconstrained MIC | -0.050 | -0.043 | -3.167 | -0.120 | -0.021 | -0.004 | -0.005 | 0.123 |
| MS sample sin unconstrained MIC | 0.090 | 0.144 | -9.071 | 0.254 | 0.064 | 0.037 | 0.052 | 0.464 |
| MS sample ESG50 unconstrained MIC | -0.079 | -0.050 | 5.290 | -0.599 | -0.040 | -0.002 | -0.003 | 0.032 |
| MS sample ESG70 unconstrained MIC | 0.022 | 0.025 | -30.157 | 0.018 | 0.009 | 0.007 | 0.008 | 0.387 |
| MS sample ESG90 unconstrained MIC | 0.044 | 0.048 | 3.805 | 0.068 | 0.021 | 0.006 | 0.006 | 0.320 |
| MS EQ no-short | 0.132 | 0.167 | 0.605 | 0.071 | 0.054 | 0.011 | 0.012 | 0.631 |
| MS EQ sin no-short | 0.128 | 0.161 | 0.584 | 0.069 | 0.053 | 0.011 | 0.011 | 0.626 |
| MS EQ ESG50 no-short | 0.134 | 0.169 | 0.612 | 0.071 | 0.056 | 0.011 | 0.012 | 0.634 |
| MS EQ ESG70 no-short | 0.131 | 0.166 | 0.595 | 0.069 | 0.054 | 0.011 | 0.012 | 0.632 |
| MS EQ ESG90 no-short | 0.084 | 0.109 | 0.389 | 0.051 | 0.034 | 0.007 | 0.007 | 0.585 |
| MS EQ no-short MIC | 0.154 | 0.187 | 0.705 | 0.082 | 0.061 | 0.012 | 0.013 | 0.649 |
| MS EQ sin no-short MIC | 0.148 | 0.181 | 0.678 | 0.079 | 0.059 | 0.012 | 0.012 | 0.643 |
| MS EQ ESG50 no-short MIC | 0.157 | 0.192 | 0.717 | 0.084 | 0.063 | 0.013 | 0.013 | 0.655 |
| MS EQ ESG70 no-short MIC | 0.147 | 0.182 | 0.671 | 0.077 | 0.059 | 0.012 | 0.013 | 0.645 |
| MS EQ ESG90 no-short MIC | 0.106 | 0.140 | 0.493 | 0.060 | 0.044 | 0.008 | 0.009 | 0.616 |
| MS EQ unconstrained | 0.132 | 0.167 | 0.605 | 0.071 | 0.054 | 0.011 | 0.012 | 0.631 |
| MS EQ sin unconstrained | 0.128 | 0.161 | 0.583 | 0.069 | 0.053 | 0.011 | 0.011 | 0.626 |
| MS EQ ESG50 unconstrained | 0.134 | 0.169 | 0.612 | 0.071 | 0.056 | 0.011 | 0.012 | 0.634 |
| MS EQ ESG70 unconstrained | 0.131 | 0.166 | 0.595 | 0.069 | 0.054 | 0.011 | 0.012 | 0.632 |
| MS EQ ESG90 unconstrained | 0.084 | 0.109 | 0.389 | 0.051 | 0.034 | 0.007 | 0.007 | 0.585 |
| MS EQ unconstrained MIC | 0.161 | 0.924 | 5.123 | 0.627 | 0.329 | 0.095 | 0.106 | 1.565 |
| MS EQ sin unconstrained MIC | 0.212 | 0.382 | 1.272 | 0.166 | 0.125 | 0.029 | 0.033 | 0.876 |
| MS EQ ESG50 unconstrained MIC | 0.141 | 0.488 | 2.640 | 0.319 | 0.183 | 0.052 | 0.055 | 1.002 |
| MS EQ ESG70 unconstrained MIC | 0.065 | 0.096 | 1.146 | 0.066 | 0.034 | 0.013 | 0.013 | 0.482 |
| MS EQ ESG90 unconstrained MIC | -0.004 | -0.004 | -0.045 | -0.004 | -0.002 | -0.001 | -0.001 | 0.333 |

*Table 5.5.2b: Performance Indicators, Michaud Approach and MS*

| Strategy | CI | Sh | So | Tr | VaR | ES | Cal | Ste | FT |
|---|---|---|---|---|---|---|---|---|---|
| Market | 233 | 27 | 27 | 29 | 33 | 28 | 31 | 31 | 27 |
| MS sample no-short | 123 | 17 | 18 | 12 | 15 | 17 | 14 | 14 | 16 |
| MS sample sin no-short | 65 | 7 | 8 | 6 | 13 | 9 | 7 | 7 | 8 |
| MS sample ESG50 no-short | 52 | 3 | 7 | 8 | 4 | 6 | 9 | 8 | 7 |
| MS sample ESG70 no-short | 36 | 2 | 4 | 5 | 7 | 4 | 5 | 5 | 4 |
| MS sample ESG90 no-short | 114 | 11 | 15 | 15 | 10 | 16 | 17 | 18 | 12 |
| MS sample no-short MIC | 85 | 8 | 10 | 11 | 12 | 10 | 12 | 13 | 9 |
| MS sample sin no-short MIC | 61 | 6 | 6 | 7 | 9 | 7 | 10 | 10 | 6 |
| MS sample ESG50 no-short MIC | 77 | 4 | 9 | 13 | 8 | 8 | 13 | 12 | 10 |
| MS sample ESG70 no-short MIC | 43 | 1 | 5 | 9 | 6 | 5 | 6 | 6 | 5 |
| MS sample ESG90 no-short MIC | 106 | 9 | 13 | 16 | 11 | 14 | 15 | 15 | 13 |
| MS sample unconstrained | 235 | 34 | 33 | 35 | 34 | 35 | 16 | 16 | 32 |
| MS sample sin unconstrained | 200 | 29 | 30 | 36 | 24 | 30 | 11 | 11 | 29 |
| MS sample ESG50 unconstrained | 120 | 14 | 11 | 38 | 14 | 11 | 8 | 9 | 15 |
| MS sample ESG70 unconstrained | 272 | 33 | 35 | 34 | 31 | 34 | 36 | 36 | 33 |
| MS sample ESG90 unconstrained | 316 | 39 | 39 | 39 | 39 | 39 | 41 | 41 | 39 |
| MS sample unconstrained MIC | 317 | 40 | 40 | 37 | 40 | 40 | 40 | 40 | 40 |
| MS sample sin unconstrained MIC | 154 | 30 | 28 | 40 | 3 | 12 | 3 | 3 | 35 |
| MS sample ESG50 unconstrained MIC | 284 | 41 | 41 | 1 | 41 | 41 | 39 | 39 | 41 |
| MS sample ESG70 unconstrained MIC | 293 | 37 | 37 | 41 | 37 | 37 | 35 | 33 | 36 |
| MS sample ESG90 unconstrained MIC | 252 | 36 | 36 | 3 | 29 | 36 | 37 | 37 | 38 |
| MS EQ no-short | 190 | 21 | 22 | 23 | 21 | 23 | 28 | 28 | 24 |
| MS EQ sin no-short | 217 | 25 | 26 | 27 | 26 | 27 | 30 | 30 | 26 |
| MS EQ ESG50 no-short | 174 | 20 | 20 | 22 | 23 | 21 | 24 | 24 | 20 |
| MS EQ ESG70 no-short | 193 | 23 | 23 | 25 | 27 | 24 | 25 | 25 | 21 |
| MS EQ ESG90 no-short | 264 | 32 | 32 | 32 | 36 | 32 | 34 | 35 | 31 |
| MS EQ no-short MIC | 131 | 13 | 14 | 18 | 17 | 15 | 20 | 20 | 14 |
| MS EQ sin no-short MIC | 149 | 15 | 17 | 19 | 18 | 18 | 22 | 22 | 18 |
| MS EQ ESG50 no-short MIC | 117 | 12 | 12 | 17 | 16 | 13 | 19 | 17 | 11 |
| MS EQ ESG70 no-short MIC | 149 | 16 | 16 | 20 | 19 | 19 | 21 | 21 | 17 |
| MS EQ ESG90 no-short MIC | 240 | 28 | 29 | 30 | 32 | 29 | 32 | 32 | 28 |
| MS EQ unconstrained | 186 | 22 | 21 | 24 | 20 | 22 | 27 | 27 | 23 |
| MS EQ sin unconstrained | 213 | 26 | 25 | 28 | 25 | 26 | 29 | 29 | 25 |
| MS EQ ESG50 unconstrained | 166 | 19 | 19 | 21 | 22 | 20 | 23 | 23 | 19 |
| MS EQ ESG70 unconstrained | 201 | 24 | 24 | 26 | 28 | 25 | 26 | 26 | 22 |
| MS EQ ESG90 unconstrained | 256 | 31 | 31 | 31 | 35 | 31 | 33 | 34 | 30 |
| MS EQ unconstrained MIC | 18 | 10 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| MS EQ sin unconstrained MIC | 37 | 5 | 3 | 10 | 5 | 3 | 4 | 4 | 3 |
| MS EQ ESG50 unconstrained MIC | 34 | 18 | 2 | 4 | 2 | 2 | 2 | 2 | 2 |
| MS EQ ESG70 unconstrained MIC | 217 | 35 | 34 | 14 | 30 | 33 | 18 | 19 | 34 |
| MS EQ ESG90 unconstrained MIC | 298 | 38 | 38 | 33 | 38 | 38 | 38 | 38 | 37 |

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