References with abstracts for QWIM project: ESG, impact and climate-based investing in quantitative wealth and investment management

Cristian Homescu

December 2022

Abstract

This document includes the list of references (including abstracts) for this QWIM project

Contents

1 Motivation for the project

Investors throughout the world are increasingly interested in environmental, social, and governance (ESG) investing. The 2021 Global Sustainable Investment Report indicated a significant increase for sustainable and responsible investments, bringing the total to USD 35.3 trillion.

Many investors have social or ethical reasons for ESG investing, and academic and practitioner surveys indicate that majority of surveyed investment professionals believe that incorporating ESG information into an investment evaluation process is relevant to investment performance.

1.1 ESG-based portfolio construction

ESG identifies factors that reflect environmental considerations (E), societal preferences (S), and governance of the firm (G) and may complement, or compete with, classical portfolio construction methods. It is complementary if the ESG factors enhance alpha. It is competitive if the factors detract from alpha.

1.2 ESG ratings and scores

Billio et al. ("Inside the ESG Ratings: (Dis)agreement and Performance," 2021): Analysis the ESG rating criteria used by prominent agencies indicate a lack of a commonality in the definition of ESG (i) characteristics, (ii) attributes and (iii) standards in defining E, S and G components. Such heterogeneity in rating criteria can lead agencies to have opposite opinions on the same evaluated companies and that agreement across those providers was found to be substantially low in many cases.

1.3 Climate-based investing

Climate risk is denitively back on the agenda of investors and goes beyond ESG ratings. However, climate risk assessment methodologies have not reached maturity. Nevertheless, the development of climate risk measures and their sophistication have an increasing impact on portfolio construction and management. While first developed on the side of passive management and low-carbon equity indices, these approaches are now gaining a lot of traction in active management.

1.4 Portfolio diversification and tail risk protection through ESG investing

Diversification is one of the most important concepts in the financial world. It is often said that diversification is the only free lunch in finance. From a qualitative point of view, the concept of diversification is quite clear: a portfolio is well-diversified if shocks in the individual components do not heavily impact on the overall portfolio. Relatively simple to understand then but profoundly difficult to define. Indeed, there is no broadly accepted precise and quantitative definition of diversification.

One of the most vexing problems in investment management is that diversification seems to disappear when investors need it the most. A key challenge in the construction of diversified multi-asset portfolio strategies is that even a seemingly well-balanced allocation to many asset classes can eventually translate into a portfolio with a very concentrated set of underlying risk exposures.

Incorporating ESG into portfolios may also improve their diversification behavior.

1.5 Practical challenges with ESG investing

Practical challenges include

- inconsistent ESG metrics and ratings
- particularly noisy data
- entanglement of ESG factors with standard risk factors

The lack of standardized ESG metrics creates opportunities for greenwashing by companies less interested in pursuing legitimate ESG objectives, than in building brand by meeting minimum criteria for metrics that may be somewhat easy to game.

ESG data typically are deficient in the following areas:

- Quantity: Not enough data are available.
- Consistency: Companies often report different ESG data items.
- Quality: Methodologies used to derive or compute the reported ESG data mayvary across companies.

2 Relevant references

2.1 Main references

List of references:

Alessandrini and Jondeau ("Optimal Strategies for ESG Portfolios," 2021)

Alessandrini et al. ("ESG Screening in the Fixed-Income Universe," 2021)

Alford ("Some considerations for investors exploring ESG strategies," 2019)

Amon et al. ("Passive ESG Portfolio Management – The Benchmark Strategy for Socially Responsible Investors," 2021)

Antoncic et al. ("Sustainable Investment - Exploring the Linkage between Alpha, ESG, and SDG's," 2020)

Apostolou and Papaioannou ("Integration of Environmental Factors into Portfolio Risk Assessment," 2021)

Ascioglu et al. ("Integration of ESG Metrics into a Student-Managed Fund:Creating Sustainable Student-Managed Funds," 2017)

Avramov et al. ("Investment and Asset Pricing with ESG Disagreement," 2021)

Bauer et al. ("Get Real! Individuals Prefer More Sustainable Investments," 2021)

Baz et al. ("Climate Regulatory Exposure: Evidence from Stock Returns," 2021)

Becker et al. ("Fostering the Power of ESG Transparency: The Effect of Sustainability Labels on Mutual Funds and Individual Investors," 2021)

Benedetti et al. ("Climate change investment risk: optimal portfolio construction ahead of the transition to a lower-carbon economy," 2021)

Berg et al. ("ESG Confusion and Stock Returns: Tackling the Problem of Noise," 2021)

Billio et al. ("Inside the ESG Ratings: (Dis)agreement and Performance," 2021)

Bingler et al. ("Cheap Talk and Cherry-Picking: What ClimateBert has to say on Corporate Climate Risk Disclosures," 2021)

Bohn et al. ("Sustainable Investing From a Practitioner's Viewpoint: What's in Your ESG Portfolio?" 2022)

Branch et al. ("A guide to ESG portfolio construction," 2019)

Breedt et al. ("Is ESG an Equity Factor or Just an Investment Guide?" 2019)

Bruder et al. ("Integration of ESG in asset allocation," 2019)

Bruno et al. (""Honey, I Shrunk the ESG Alpha": Risk-Adjusting ESG Portfolio Returns," 2022)

Cai et al. ("Socially Responsible Investing and Factor Investing, Is There an Opportunity Cost?" 2022)

Cesarone et al. ("Does ESG impact really enhances portfolio profitability?" 2022)

Chava et al. ("Doing Well by Doing Good? Risk, Return, and Environmental and Social Ratings," 2021)

Chen and Mussalli ("An integrated approach to quantitative ESG investing," 2020)

Coqueret ("Perspectives in ESG equity investing," 2021)

Coqueret et al. ("ESG Equity Investing: A Short Survey," 2021)

Coqueret et al. ("Boosting ESG-Based Optimization With Asset Pricing Characteristics," 2021)

Coqueret (*Perspectives in sustainable equity investing (website version)*, 2022)

Cornell ("ESG Investing: Conceptual Issues," 2020)

Cosemans et al. ("Climate Change and Long-Horizon Portfolio Choice: Combining Theory and Empirics," 2021)

De Franco et al. ("Sustainable Investing: ESG versus SDG," 2021)

De Spiegeleer et al. ("ESG: A New Dimension in Portfolio Allocation," 2020)

Dimson et al. ("Divergent ESG Ratings," 2020)

Dumitrescu et al. ("Defining Greenwashing," 2022)

Geczy and Guerard ("ESG and Expected Returns on Equities: The Case of Environmental Ratings," 2021)

Geczy et al. ("Investing in Socially Responsible Mutual Funds," 2021)

Gibson Brandon et al. ("ESG Rating Disagreement and Stock Returns," 2021)

Giese et al. ("Performance and Risk Analysis of Index-Based ESG Portfolios," 2019)

Giese et al. ("Consistent ESG through ESG Benchmarks," 2019)

Giese et al. ("Deconstructing ESG Ratings Performance: Risk and Return for E, S, and G by Time Horizon, Sector, and Weighting," 2021)

Giese et al. ("Foundations of Climate Investing: How Equity Markets Have Priced Climate-Transition Risks," 2021)

Grim and Berkowitz ("ESG, SRI, and Impact Investing: A Primer for Decision-Making," 2020)

Hays and McCabe ("Sustainable and Impact Investing: A Taxonomy of Approaches and Considerations for Fiduciaries," 2021)
Henriksson et al. ("Integrating ESG in portfolio construction," 2019)
Hubel and Scholz ("Integrating sustainability risks in asset management: the role of ESG exposures and ESG ratings," 2020)
Jacobsen et al. ("The alpha, beta, and sigma of ESG: better beta, additional alpha?" 2019)
Jacobsen et al. ("Climate Change and Asset Allocation: A Distinction That Makes a Difference," 2021)
Kaiser ("ESG integration: value, growth and momentum," 2020)
Kazdin et al. ("Climate Alpha with Predictors Also Improving Company Efficiency," 2021)
Kilmurray et al. ("Integrating Impact Funds into Mainstream Portfolios," 2021)
Krappel et al. ("Heterogeneous Ensemble for ESG Ratings Prediction," 2021)
Lanza et al. ("Mind the gap! Machine Learning, ESG Metrics and Sustainable Investment," 2020)
Lee et al. ("Combining E, S, and G Scores: An Exploration of Alternative Weighting Schemes," 2020)
Le Guenedal and Roncalli (*Portfolio Construction with Climate Risk Measures*, 2022)
Lepetit et al. (*The Recent Performance of ESG Investing, the COVID-19 Catalyst and the Biden Effect*, 2021)
Lindeman ("ESG Score Design And Portfolio Construction," 2022)
Lioui and Tarelli ("Chasing The ESG Factor," 2021)
Lo and Zhang ("Quantifying the Impact of Impact Investing," 2022)
Macpherson et al. ("Artificial Intelligence and FinTech Technologies for ESG Data and Analysis," 2021)
Madhavan et al. ("Toward ESG Alpha: Analyzing ESG Exposures through a Factor Lens," 2021)
Margot et al. ("ESG Investments: Filtering versus Machine Learning Approaches," 2021)
Martin ("Impact Investing. A Practitioner Perspective," 2021)
Mercereau and Melin ("Optimizing Portfolios across Risk, Return, and Climate," 2020)
Naffa and Fain ("A factor approach to the performance of ESG leaders and laggards," 2022)
Ouchen ("Is the ESG portfolio less turbulent than a market benchmark portfolio?" 2021)
Parker ("Achieving Goals While Making an Impact: Balancing Financial Goals with Impact Investing," 2021)
Pedersen et al. ("Responsible investing: The ESG-efficient frontier," 2021)
Roncalli et al. ("Measuring and Managing Carbon Risk in Investment Portfolios," 2020)
Roncalli ("Advanced Course in Asset Management," 2021)
Roncalli ("Green and Sustainable Finance, ESG Investing and Climate Risk," 2021)
Rubbaniy et al. ("Are ESG Stocks Safe-Haven during COVID-19?" 2021)
Sahin-et-al-2021
Schmidt and Zhang ("Optimal ESG Portfolios: Which ESG Ratings to Use?" 2021)
Simpson et al. ("The ESG Mirage," 2021)
Sokolov et al. ("Weak Supervision and Black-Litterman for Automated ESG Portfolio Construction," 2021)
Sokolov et al. ("Building Machine Learning Systems for Automated ESG Scoring," 2021)
Sorensen et al. ("The Quantitative Approach for Sustainable Investing," 2021)
Stotz ("Expected and realized returns on stocks with high- and low-ESG exposure," 2021)
Tokat-Acikel et al. ("Top-Down Portfolio Implications of Climate Change," 2021)
Varmaz et al. ("Portfolio optimization for sustainable investments," 2021)
Venturini ("Climate change, risk factors and stock returns: A review of the literature," 2022)
Yeh et al. ("SustainBench: Benchmarks for Monitoring the Sustainable Development Goals with Machine Learning," 2021)
Yoshino and Yuyama ("Studies of Applied Economics," 2021)

2.2 Comprehensive set of references

2.2.1 ESG investing and risk

List of references:
Alessandrini and Jondeau ("ESG investing: from sin stocks to smart beta," 2020)
Alessandrini and Jondeau ("Optimal Strategies for ESG Portfolios," 2021)
Alessandrini et al. ("ESG Screening in the Fixed-Income Universe," 2021)
Amon et al. ("Passive ESG Portfolio Management – The Benchmark Strategy for Socially Responsible Investors," 2021)

Andersson et al. ("Portfolio Construction and New Energy Infrastructure Investing," 2021)
Antoncic et al. ("Sustainable Investment - Exploring the Linkage between Alpha, ESG, and SDG's," 2020)
Apostolou and Papaioannou ("Integration of Environmental Factors into Portfolio Risk Assessment," 2021)
Areal et al. ("The conditional performance of US mutual funds over different market regimes: do different types of ethical screens matter?" 2013)
Austmo and Eikeland ("Exploiting ESG Information by Extending Conventional Smart Beta Strategies: An Empirical Analysis of Portfolio Performances through the Booms and Busts in the European Equity Market," 2021)
Avramov et al. ("Investment and Asset Pricing with ESG Disagreement," 2021)
Avramov et al. ("Dynamic ESG Equilibrium," 2021)
Aw et al. ("A Morality Tale of ESG: Assessing Socially Responsible Investing," 2017)
Azevedo et al. ("Investor sentiment and the time-varying sustainability premium," 2021)
Baeza-Sampere et al. ("A fuzzy data envelopment analysis model for evaluating the efficiency of socially responsible and conventional mutual funds," 2016)
Bag and Mohanty ("Impact of ESG Factors on Emerging Market Stock Returns," 2021)
Bahra and Thukral ("ESG in Global Corporate Bonds: The Analysis Behind the Hype," 2020)
Balcilar et al. ("Do Sustainable Stocks Offer Diversification Benefits for Conventional Portfolios? An Empirical Analysis of Risk Spillovers and Dynamic Correlations," 2017)
Bauer et al. ("Get Real! Individuals Prefer More Sustainable Investments," 2021)
Bax et al. ("ESG, Risk, and (tail) dependence," 2021)
Becker et al. ("Fostering the Power of ESG Transparency: The Effect of Sustainability Labels on Mutual Funds and Individual Investors," 2021)
Benedetti et al. ("Climate change investment risk: optimal portfolio construction ahead of the transition to a lower-carbon economy," 2021)
Bender et al. ("Thematic Indexing, Meet Smart Beta! Merging ESG into Factor Portfolios," 2017)
Bennani et al. ("How ESG investing has impacted the asset pricing in the equity market," 2019)
Ben Slimane et al. ("ESG Investing in Fixed Income: It's Time to Cross the Rubicon," 2020)
Berg et al. ("ESG Confusion and Stock Returns: Tackling the Problem of Noise," 2021)
Blank et al. ("Best Practices in ESG Investing," 2016)
Bohn et al. ("Sustainable Investing From a Practitioner's Viewpoint: What's in Your ESG Portfolio?" 2022)
Branch et al. ("A guide to ESG portfolio construction," 2019)
Breedt et al. ("Is ESG an Equity Factor or Just an Investment Guide?" 2019)
Briere et al. ("Do Social Responsibility Screens Really Matter When Assessing Mutual Fund Performance?" 2017)
Bruder et al. ("Integration of ESG in asset allocation," 2019)
Bruno et al. (""Honey, I Shrunk the ESG Alpha": Risk-Adjusting ESG Portfolio Returns," 2022)
Bush et al. ("E, S, or G - Analyzing Global ESG Performance," 2020)
Cai et al. ("Socially Responsible Investing and Factor Investing, Is There an Opportunity Cost?" 2022)
Cao et al. ("Unlocking ESG Premium from Options," 2021)
Chan et al. ("ESG in Factors," 2020)
Chang et al. ("How Interpretable and Trustworthy are GAMs?" 2021)
Chava et al. ("Doing Well by Doing Good? Risk, Return, and Environmental and Social Ratings," 2021)
Chen and Mussalli ("An integrated approach to quantitative ESG investing," 2020)
Chen et al. ("The Unreasonable Attractiveness of More ESG Data," 2021)
Chen et al. ("NLP for SDGs: Measuring Corporate Alignment with the Sustainable Development Goals," 2022)
Choi et al. ("Measuring the carbon exposure of institutional investors," 2020)
Chong and Phillips ("ESG Investing: A Simple Approach," 2016)
Climent et al. ("ESG Disclosure and Portfolio Performance," 2021)
Coqueret ("Perspectives in ESG equity investing," 2021)
Coqueret et al. ("Boosting ESG-Based Optimization With Asset Pricing Characteristics," 2021)
Coqueret et al. ("ESG Equity Investing: A Short Survey," 2021)
Coqueret (*Perspectives in sustainable equity investing*, 2022)
Cornell ("ESG Investing: Conceptual Issues," 2020)
Cornell ("ESG preferences, risk and return," 2021)

Cornell and Damodaran ("Valuing ESG: Doing Good or Sounding Good?" 2020)
Dash and Kajiji ("Behavioral Portfolio Management with Layered ESG Goals and AI Estimation of Asset Returns," 2021)
De and Clayman ("The Benefits of Socially Responsible Investing: An Active Manager's Perspective," 2015)
De Franco et al. ("ESG investments: Filtering versus machine learning approaches," 2020)
De Franco et al. ("Sustainable Investing: ESG versus SDG," 2021)
De Spiegeleer et al. ("ESG: A New Dimension in Portfolio Allocation," 2020)
Díaz et al. ("Reconsidering systematic factors during the Covid-19 pandemic – The rising importance of ESG," 2021)
Drei et al. ("ESG Investing in Recent Years: New Insights from Old Challenges," 2019)
Dumitrescu et al. ("Defining Greenwashing," 2022)
Fish et al. ("The ESG Sacrifice," 2019)
Fridson et al. ("ESG Impact on High-Yield Returns," 2021)
Gao et al. ("Styles through a convergent/divergent lens: the curious case of ESG," 2020)
Garefalakis and Dimitras ("Looking back and forging ahead: the weighting of ESG factors," 2020)
Geczy et al. ("Efficient SRI / ESG portfolios," 2019)
Gaussel and Le Saint ("ESG Risk Rating of Alternative Portfolios," 2021)
Geczy and Guerard ("ESG and Expected Returns on Equities: The Case of Environmental Ratings," 2021)
Geczy et al. ("Contracts with (Social) benefits: The implementation of impact investing," 2021)
Geczy et al. ("Investing in Socially Responsible Mutual Funds," 2021)
Gerard ("ESG and socially responsible investment: A critical review," 2018)
Gidwani ("Some Issues with Using ESG Ratings in an Investment Process," 2020)
Giese et al. ("ESG as a performance factor for smart beta indexes," 2016)
Giese et al. ("Performance and Risk Analysis of Index-Based ESG Portfolios," 2019)
Giese et al. ("Consistent ESG through ESG Benchmarks," 2019)
Giese et al. ("Foundations of ESG investing: how ESG affects equity valuation, risk, and performance," 2019)
Gougler and Utz ("Factor exposures and diversification: Are sustainably screened portfolios any different?" 2020)
Gregory ("Market Efficiency in ESG Indexes: Trading Opportunities," 2021)
Grim and Berkowitz ("ESG, SRI, and Impact Investing: A Primer for Decision-Making," 2020)
Hanna ("The Impact of ESG-Related Industry Exclusions in Minimum-Volatility Portfolios," 2020)
Harper ("One Institutional Investor Approach to Integrating ESG in the Investment Process," 2020)
Hays and McCabe ("Sustainable and Impact Investing: A Taxonomy of Approaches and Considerations for Fiduciaries," 2021)
Henriksson et al. ("Integrating ESG in portfolio construction," 2019)
Hsu et al. ("Outperformance through Investing in ESG in Need," 2018)
Hubel and Scholz ("Integrating sustainability risks in asset management: the role of ESG exposures and ESG ratings," 2020)
Husse and Pippo ("Responsible Minus Irresponsible - a determinant of equity risk premia?" 2022)
Jacob and Wilkens ("What drives sustainable indices? A framework for analyzing the sustainable index landscape," 2021)
Jacobsen et al. ("The alpha, beta, and sigma of ESG: better beta, additional alpha?" 2019)
Jin ("Is ESG a systematic risk factor for US equity mutual funds?" 2018)
Jin ("Systematic ESG Risk and Decision Criteria for Optimal Portfolio Selection," 2021)
Kaiser and Schaller ("Environmentally (Un-)Friendly Portfolio Construction," 2019)
Kaiser ("ESG integration: value, growth and momentum," 2020)
Kanuri ("Risk and Return Characteristics of Environmental, Social, and Governance (ESG) Equity ETFs," 2020)
Khan ("Corporate Governance, ESG, and Stock Returns around the World," 2019)
Klement ("Does ESG matter for asset allocation?" 2018)
Kumar ("ESG: Alpha or Duty?" 2019)
Kumar and Khasnis ("Fallen Angels with ESG Wings," 2020)
Lanza et al. ("Mind the gap! Machine Learning, ESG Metrics and Sustainable Investment," 2020)

Lee ("What Does ESG Investing Really Mean? Implications for Investors of Separating Financial Materiality and Social Objectives," 2021)
Lepetit et al. (*The Recent Performance of ESG Investing, the COVID-19 Catalyst and the Biden Effect*, 2021)
Li et al. ("Robust enhanced indexation with ESG: An empirical study in the Chinese Stock Market," 2022)
Lindeman ("ESG Score Design And Portfolio Construction," 2022)
Lindsey et al. ("The Cost of ESG Investing," 2021)
Lioui ("ESG Factor Investing: Myth or Reality ?" 2018)
Lioui and Tarelli ("Chasing The ESG Factor," 2021)
Macpherson et al. ("Artificial Intelligence and FinTech Technologies for ESG Data and Analysis," 2021)
Madhavan et al. ("Toward ESG Alpha: Analyzing ESG Exposures through a Factor Lens," 2021)
Maiti ("Is ESG the succeeding risk factor?" 2021)
Margot et al. ("ESG Investments: Filtering versus Machine Learning Approaches," 2021)
Matos ("ESG and Responsible Institutional Investing Around the World: A Critical Review," 2020)
Mendiratta et al. ("How ESG Affected Corporate Credit Risk and Performance," 2021)
Mercereau and Melin ("Optimizing Portfolios across Risk, Return, and Climate," 2020)
Miralles-Quiros et al. ("Sustainable Development Goals and Investment Strategies: The Profitability of Using Five-Factor Fama-French Alphas," 2020)
Mohanty et al. ("Alpha enhancement in global equity markets with ESG overlay on factor-based investment strategies," 2021)
Morgenstern et al. ("Tuning Trend-Following Strategies with Macro ESG Data," 2021)
Naffa and Fain ("A factor approach to the performance of ESG leaders and laggards," 2022)
Nagy et al. ("Can ESG Add Alpha? An Analysis of ESG Tilt and Momentum Strategies," 2016)
Ocal and Kamil ("The impact of risk indicators on sustainability (ESG) and broad-based indices: an empirical analysis from Germany, France, Indonesia and Turkey," 2021)
Oikonomou et al. ("Socially Responsible Investment Portfolios: Does the Optimization Process Matter?" 2017)
Ouchen ("Is the ESG portfolio less turbulent than a market benchmark portfolio?" 2021)
Pan ("Demystifying ESG investing considerations for institutional cash investors," 2020)
Pastor et al. ("Dissecting Green Returns," 2021)
Pedersen et al. ("Responsible investing: The ESG-efficient frontier," 2021)
Pham and Nguyen ("Asymmetric tail dependence between green bonds and other asset classes," 2021)
Porage ("Sustainability in Portfolio Optimization," 2021)
Roncalli ("Advanced Course in Asset Management," 2021)
Rubbaniy et al. ("Are ESG Stocks Safe-Haven during COVID-19?" 2021)
Sautner and Starks ("ESG and Downside Risks: Implications for Pension Funds," 2021)
Schanzenbach and Sitkoff ("ESG Investing: Theory, Evidence, and Fiduciary Principles," 2021)
Schmidt ("Optimal ESG portfolios: an example for the Dow Jones index," 2020)
Schmidt ("The ESG Conundrum: An Outsider's View," 2021)
Serafeim ("ESG: Hyperboles and Reality," 2021)
Shafer and Szado ("Environmental, social, and governance practices and perceived tail risk," 2020)
Sherwood and Pollard ("The risk-adjusted return potential of integrating ESG strategies into emerging market equities," 2018)
Silva et al. ("ESG Integration Strategy for Stocks Portfolios Based on a Resampling Methodology with a Multivariate Normal Distribution," 2021)
Simpson et al. ("The ESG Mirage," 2021)
Sokolov et al. ("Weak Supervision and Black-Litterman for Automated ESG Portfolio Construction," 2021)
Sorensen et al. ("The Quantitative Approach for Sustainable Investing," 2021)
Stotz ("Expected and realized returns on stocks with high- and low-ESG exposure," 2021)
Swedroe ("ESG Investing Means Lower Bond Yields," 2021)
Swedroe ("Socially Responsible Funds Do Not Deliver Excess Returns," 2021)
van der Meulen ("Assessment of SRI portfolio performance with particular attention to crisis periods," 2021)
Varmaz et al. ("Portfolio optimization for sustainable investments," 2021)
Vojtko and Padysak ("Quant look on ESG investing strategies," 2020)
von Ditfurth et al. ("Low volatility and ESG investing combined: Invesco's holistic approach," 2021)

Wilhelmsen and Woods ("ESG ratings and stock performance : an empirical investigation of the link between ESG ratings and stock performance of European large cap firms," 2021)

Xiong ("The Impact of ESG Risk on Stocks," 2021)

Yoshino and Yuyama ("Studies of Applied Economics," 2021)

2.2.2 ESG-based portfolio construction and investment strategies

List of references:

Alessandrini and Jondeau ("ESG investing: from sin stocks to smart beta," 2020)

Alessandrini and Jondeau ("Optimal Strategies for ESG Portfolios," 2021)

Alford ("Some considerations for investors exploring ESG strategies," 2019)

Amon et al. ("Passive ESG Portfolio Management – The Benchmark Strategy for Socially Responsible Investors," 2021)

Andersson et al. ("Portfolio Construction and New Energy Infrastructure Investing," 2021)

Antoncic et al. ("Sustainable Investment - Exploring the Linkage between Alpha, ESG, and SDG's," 2020)

Ascioglu et al. ("Integration of ESG Metrics into a Student-Managed Fund:Creating Sustainable Student-Managed Funds," 2017)

Austmo and Eikeland ("Exploiting ESG Information by Extending Conventional Smart Beta Strategies: An Empirical Analysis of Portfolio Performances through the Booms and Busts in the European Equity Market," 2021)

Bahra and Thukral ("ESG in Global Corporate Bonds: The Analysis Behind the Hype," 2020)

Benedetti et al. ("Climate change investment risk: optimal portfolio construction ahead of the transition to a lower-carbon economy," 2021)

Bennani et al. ("How ESG investing has impacted the asset pricing in the equity market," 2019)

Bengo et al. ("Preserving the Integrity of Social Impact Investing: Towards a Distinctive Implementation Strategy," 2021)

Ben Slimane et al. ("ESG Investing in Fixed Income: It's Time to Cross the Rubicon," 2020)

Blitz and Hoogteijling ("Carbon-Tax-Adjusted Value," 2021)

Bohn et al. ("Sustainable Investing From a Practitioner's Viewpoint: What's in Your ESG Portfolio?" 2022)

Branch et al. ("A guide to ESG portfolio construction," 2019)

Bruno et al. (""Honey, I Shrunk the ESG Alpha": Risk-Adjusting ESG Portfolio Returns," 2022)

Bruder et al. ("Integration of ESG in asset allocation," 2019)

Caldeira ("Impact of ESG on financial performance on the most capitalized stock markets : evidence from the USA Europe and Asia," 2021)

Cesarone et al. ("Does ESG impact really enhances portfolio profitability?" 2022)

Chan et al. ("ESG in Factors," 2020)

Cheema-Fox et al. ("Decarbonization Factors," 2021)

Chen and Mussalli ("An integrated approach to quantitative ESG investing," 2020)

Chong and Phillips ("ESG Investing: A Simple Approach," 2016)

Coqueret et al. ("Boosting ESG-Based Optimization With Asset Pricing Characteristics," 2021)

Coqueret et al. ("ESG Equity Investing: A Short Survey," 2021)

Coqueret (*Perspectives in sustainable equity investing (website version)*, 2022)

Cornell ("ESG Investing: Conceptual Issues," 2020)

Cornell ("Is the Stock Market Worried About Climate Change? Lessons from the 2010s," 2021)

Cornell ("ESG preferences, risk and return," 2021)

Cosemans et al. ("Climate Change and Long-Horizon Portfolio Choice: Combining Theory and Empirics," 2021)

De Spiegeleer et al. ("ESG: A New Dimension in Portfolio Allocation," 2020)

Dumitrescu et al. ("Defining Greenwashing," 2022)

Fiordelisi et al. ("An ESG Ratings Free Assessment of Socially Responsible Investment Strategies," 2021)

Giese et al. ("Consistent ESG through ESG Benchmarks," 2019)

Giese et al. ("Foundations of ESG investing: how ESG affects equity valuation, risk, and performance," 2019)

Gueant et al. ("Environmental transition alignment and portfolio performance," 2021)

Hanicova and Vojtko ("Backtesting ESG Factor Investing Strategies," 2020)

Harper ("One Institutional Investor Approach to Integrating ESG in the Investment Process," 2020)

Henriksson et al. ("Integrating ESG in portfolio construction," 2019)
Hsu et al. ("Outperformance through Investing in ESG in Need," 2018)
Ielasi et al. ("Integrating ESG Analysis into Smart Beta Strategies," 2020)
Jacobsen et al. ("The alpha, beta, and sigma of ESG: better beta, additional alpha?" 2019)
Juddoo et al. ("An Investment Strategy Based on Impact," 2021)
Kaiser ("ESG integration: value, growth and momentum," 2020)
Kaiser and Schaller ("Environmentally (Un-)Friendly Portfolio Construction," 2019)
Kanuri ("Risk and Return Characteristics of Environmental, Social, and Governance (ESG) Equity ETFs," 2020)
Klement ("Does ESG matter for asset allocation?" 2018)
Kumar ("ESG: Alpha or Duty?" 2019)
Lanza et al. ("Mind the gap! Machine Learning, ESG Metrics and Sustainable Investment," 2020)
Lee et al. ("Combining E, S, and G Scores: An Exploration of Alternative Weighting Schemes," 2020)
Le Guenedal and Roncalli (*Portfolio Construction with Climate Risk Measures*, 2022)
Lindeman ("ESG Score Design And Portfolio Construction," 2022)
Madhavan and Sobczyk ("On the Factor Implications of Sustainable Investing in Fixed-Income Active Funds," 2020)
Margot et al. ("ESG Investments: Filtering versus Machine Learning Approaches," 2021)
Mercereau and Melin ("Optimizing Portfolios across Risk, Return, and Climate," 2020)
Miralles-Quiros et al. ("Sustainable Development Goals and Investment Strategies: The Profitability of Using Five-Factor Fama-French Alphas," 2020)
Mohanty et al. ("Alpha enhancement in global equity markets with ESG overlay on factor-based investment strategies," 2021)
Morgenstern et al. ("Tuning Trend-Following Strategies with Macro ESG Data," 2021)
Nagy et al. ("Can ESG Add Alpha? An Analysis of ESG Tilt and Momentum Strategies," 2016)
Owadally et al. ("Long-Term Sustainable Investment for Retirement," 2021)
Pedersen et al. ("Responsible investing: The ESG-efficient frontier," 2021)
Pisani and Russo ("Sustainable Finance and COVID-19: The Reaction of ESG Funds to the 2020 Crisis," 2021)
Raynaud et al. ("Portfolio Alignment to a 2°C Trajectory: Science or Art?" 2020)
Roncalli ("Green and Sustainable Finance, ESG Investing and Climate Risk," 2021)
Ruf et al. ("Investments in ESG-Rated Mutual Funds: Is Good Better than Great?" 2019)
Sahin et al. ("The pitfalls of (non-definitive) Environmental, Social, and Governance scoring methodology," 2022)
Sahin et al. ("ESGM: ESG scores and the Missing pillar," 2022)
Schmidt ("Optimal ESG portfolios: an example for the Dow Jones index," 2020)
Schmidt and Zhang ("Optimal ESG Portfolios: Which ESG Ratings to Use?" 2021)
Sherwood and Pollard ("The risk-adjusted return potential of integrating ESG strategies into emerging market equities," 2018)
Silva et al. ("ESG Integration Strategy for Stocks Portfolios Based on a Resampling Methodology with a Multivariate Normal Distribution," 2021)
Sokolov et al. ("Weak Supervision and Black-Litterman for Automated ESG Portfolio Construction," 2021)
Sorensen et al. ("The Quantitative Approach for Sustainable Investing," 2021)
Varmaz et al. ("Portfolio optimization for sustainable investments," 2021)
Vojtko and Padysak ("Quant look on ESG investing strategies," 2020)

2.2.3 Portfolio diversification and tail risk protection through ESG investing

List of references:
Balcilar et al. ("Do Sustainable Stocks Offer Diversification Benefits for Conventional Portfolios? An Empirical Analysis of Risk Spillovers and Dynamic Correlations," 2017)
Bax et al. ("ESG, Risk, and (tail) dependence," 2021)
Broadstock et al. ("The Role of ESG Performance During Times of Financial Crisis: Evidence from COVID-19 in China," 2020)
Chan et al. ("ESG in Factors," 2020)

De and Clayman ("The Benefits of Socially Responsible Investing: An Active Manager's Perspective," 2015)
Giese et al. ("Foundations of ESG investing: how ESG affects equity valuation, risk, and performance," 2019)
Gougler and Utz ("Factor exposures and diversification: Are sustainably screened portfolios any different?" 2020)
Gueant et al. ("Environmental transition alignment and portfolio performance," 2021)
Hambel et al. ("Asset Pricing and Decarbonization: Diversification versus Climate Action," 2021)
Kilmurray et al. ("Integrating Impact Funds into Mainstream Portfolios," 2021)
Lepetit et al. (*The Recent Performance of ESG Investing, the COVID-19 Catalyst and the Biden Effect*, 2021)
Lioui ("ESG Factor Investing: Myth or Reality ?" 2018)
Lioui and Tarelli ("Chasing The ESG Factor," 2021)
Mohanty et al. ("Alpha enhancement in global equity markets with ESG overlay on factor-based investment strategies," 2021)
Ouchen ("Is the ESG portfolio less turbulent than a market benchmark portfolio?" 2021)
Pham and Nguyen ("Asymmetric tail dependence between green bonds and other asset classes," 2021)
Rubbaniy et al. ("Are ESG Stocks Safe-Haven during COVID-19?" 2021)
Shafer and Szado ("Environmental, social, and governance practices and perceived tail risk," 2020)
Xiong ("The Impact of ESG Risk on Stocks," 2021)

2.2.4 ESG ratings and scores

List of references:
Akgun et al. ("How Company Size Bias in ESG Scores Impacts the Small Cap Investor," 2021)
Angelova et al. ("Sovereign rating methodologies, ESG and climate change risk: an overview," 2021)
Avramov et al. ("Sustainable investing with ESG rating uncertainty," 2022)
Berg et al. ("ESG Confusion and Stock Returns: Tackling the Problem of Noise," 2022)
Berg et al. ("Aggregate Confusion: The Divergence of ESG Ratings," 2022)
Berg et al. ("Rewriting History II: The (Un)Predictable Past of ESG Ratings," 2021)
Bettin ("Sustainable finance and ESG scores: A portfolio analysis a la Fama and French," 2021)
Billio et al. ("Inside the ESG Ratings: (Dis)agreement and Performance," 2021)
Boucher et al. (*Backtesting ESG Ratings*, 2021)
Cakici and Zaremba ("Responsible Investing: ESG Ratings and the Cross-Section of International Stock Returns," 2021)
Caldeira ("Impact of ESG on financial performance on the most capitalized stock markets : evidence from the USA Europe and Asia," 2021)
Cornell ("ESG preferences, risk and return," 2021)
D'Amato et al. ("Fundamental ratios as predictors of ESG scores: a machine learning approach," 2021)
Dimson et al. ("Divergent ESG Ratings," 2020)
Fiordelisi et al. ("An ESG Ratings Free Assessment of Socially Responsible Investment Strategies," 2021)
Geczy and Guerard ("ESG and Expected Returns on Equities: The Case of Environmental Ratings," 2021)
Gibson Brandon et al. ("ESG Rating Disagreement and Stock Returns," 2021)
Gidwani ("Some Issues with Using ESG Ratings in an Investment Process," 2020)
Giese et al. ("Deconstructing ESG Ratings Performance: Risk and Return for E, S, and G by Time Horizon, Sector, and Weighting," 2021)
Gregory ("The Response of the S&P 1500 during the COVID-19 Pandemic and ESG Scores," 2021)
Gyonyorova et al. ("ESG ratings: relevant information or misleading clue? Evidence from the S&P Global 1200," 2022)
Ielasi et al. ("Integrating ESG Analysis into Smart Beta Strategies," 2020)
Kaurissaari ("Markowitz Revisited: Is there trade-off between return and responsibility?" 2021)
Kapri ("Implications of mutual funds' ESG score on performance," 2021)
Krappel et al. ("Heterogeneous Ensemble for ESG Ratings Prediction," 2021)
Lee et al. ("Combining E, S, and G Scores: An Exploration of Alternative Weighting Schemes," 2020)
Lindeman ("ESG Score Design And Portfolio Construction," 2022)
Lopez et al. ("ESG Ratings: The Road Ahead," 2020)
Mannix ("Investors turn to raw data over ratings in ESG alpha hunt," 2020)

Martin ("Impact Investing. A Practitioner Perspective," 2021)
Oude Veldhuis ("Corporate Social Responsibility and the effect of ESG scores on stock returns," 2021)
Polbennikov et al. ("ESG Ratings and Performance of Corporate Bonds," 2016)
Pyles ("Examining Portfolios Created by Bloomberg ESG Scores: Is Disclosure an Alpha Factor?" 2020)
Rzenik et al. ("The Salience of ESG Ratings for Stock Pricing: Evidence From (Potentially) Confused Investors," 2021)
Sahin et al. ("The pitfalls of (non-definitive) Environmental, Social, and Governance scoring methodology," 2022)
Sahin et al. ("ESGM: ESG scores and the Missing pillar," 2022)
Schmidt and Zhang ("Optimal ESG Portfolios: Which ESG Ratings to Use?" 2021)
Semet et al. ("ESG and Sovereign Risk: What is Priced in by the Bond Market and Credit Rating Agencies?" 2021)
Shanaev and Ghimire ("When ESG meets AAA: The effect of ESG rating changes on stock returns," 2021)
Sokolov et al. ("Building Machine Learning Systems for Automated ESG Scoring," 2021)
Swedroe ("Do Wide Divergences in ESG Ratings Doom Investors?" 2021)
Swedroe ("Revisionist History in ESG Ratings," 2021)
Tang et al. ("The Determinants of ESG Ratings: Rater Ownership Matters," 2021)
Tharavanij ("ESG Rating and Financial Performance: A Review Article," 2021)
Wang et al. ("Does ESG Screening Enhance or Destroy Stock Portfolio Value? Evidence from China," 2022)
Zhang ("ESG Rating Divergence: Beauty Is in the Eye of the Beholder," 2021)

2.2.5 Impact Investing

List of references:
Barber et al. ("Impact investing," 2021)
Bengo et al. ("Preserving the Integrity of Social Impact Investing: Towards a Distinctive Implementation Strategy," 2021)
Berk and van Binsbergen ("The Impact of Impact Investing," 2021)
Geczy et al. ("Contracts with (Social) benefits: The implementation of impact investing," 2021)
Grim and Berkowitz ("ESG, SRI, and Impact Investing: A Primer for Decision-Making," 2020)
Gutterman ("Impact Investment Tools, Structures and Instruments," 2020)
Hays and McCabe ("Sustainable and Impact Investing: A Taxonomy of Approaches and Considerations for Fiduciaries," 2021)
Juddoo et al. ("An Investment Strategy Based on Impact," 2021)
Kilmurray et al. ("Integrating Impact Funds into Mainstream Portfolios," 2021)
Lo and Zhang ("Quantifying the Impact of Impact Investing," 2022)
Parker ("Achieving Goals While Making an Impact: Balancing Financial Goals with Impact Investing," 2021)
Jeffers et al. ("The Risk and Return of Impact Investing Funds," 2021)

2.2.6 Climate based investing and risk

List of references:
Amel-Zadeh ("The Materiality of Climate Risk," 2021)
Andersson et al. ("Portfolio Construction and New Energy Infrastructure Investing," 2021)
Barnett et al. ("Pricing uncertainty induced by climate change," 2020)
Bajic et al. ("Handle with Care: Challenges and Opportunities of using Company-Level Emissions Data for Assessing Financial Risks from Climate Change," 2021)
Baz et al. ("Climate Regulatory Exposure: Evidence from Stock Returns," 2021)
Bender et al. ("Reducing the carbon intensity of low volatility portfolios," 2020)
Benedetti et al. ("Climate change investment risk: optimal portfolio construction ahead of the transition to a lower-carbon economy," 2021)
Bingler et al. ("Cheap Talk and Cherry-Picking: What ClimateBert has to say on Corporate Climate Risk Disclosures," 2021)
Bingler et al. ("Cheap Talk in Corporate Climate Commitments: The Role of Active Institutional Ownership, Signaling, Materiality, and Sentiment," 2022)

Blitz and Hoogteijling ("Carbon-Tax-Adjusted Value," 2021)
Bolliger and Cornilly ("Sustainability Attribution: The Case of Carbon Intensity," 2021)
Bolton and Kacperczyk ("Do investors care about carbon risk?" 2021)
Chan et al. ("ESG in Factors," 2020)
Cheema-Fox et al. ("Decarbonization Factors," 2021)
Chen and Bowler ("Constructing and Validating Climate Risk Factors from ESG Data: an Empirical Comparison," 2021)
Choi et al. ("Measuring the carbon exposure of institutional investors," 2020)
Cosemans et al. ("Climate Change and Long-Horizon Portfolio Choice: Combining Theory and Empirics," 2021)
Duan et al. ("Is Carbon Risk Priced in the Cross Section of Corporate Bond Returns?" 2021)
Engle et al. ("Hedging climate change news," 2020)
Faccini et al. ("Dissecting Climate Risks: Are they Reflected in Stock Prices?" 2021)
Focardi and Fabozzi ("Climate change and asset management," 2020)
Friederich et al. ("Automated Identification of Climate Risk Disclosures in Annual Corporate Reports," 2021)
Garnier ("The Climate Extended Risk Model (CERM)," 2022)
Giese et al. ("Foundations of Climate Investing: How Equity Markets Have Priced Climate-Transition Risks," 2021)
Gorgen et al. ("Get Green or Die Trying? Carbon Risk Integration into Portfolio Management," 2021)
Heeb et al. ("Do Investors Care About Impact?" 2022)
Hain et al. ("Let's get physical: Comparing metrics of physical climate risk," 2021)
Hambel et al. ("Asset Pricing and Decarbonization: Diversification versus Climate Action," 2021)
Hodges et al. ("Net Zero Investing for Multi-Asset Portfolios seeking to satisfy Paris Aligned Benchmark Requirements with Climate Alpha Signals," 2022)
Immel et al. ("Green bonds: shades of green and brown," 2021)
Jacobsen et al. ("Climate Change and Asset Allocation: A Distinction That Makes a Difference," 2021)
Jondeau et al. ("Building Benchmarks Portfolios with Decreasing Carbon Footprints," 2021)
Kaustia and Yu ("Greenwashing in Mutual Funds," 2021)
Kazdin et al. ("Climate Alpha with Predictors Also Improving Company Efficiency," 2021)
Krueger et al. ("The importance of climate risks for institutional investors," 2020)
Le Guenedal and Roncalli (*Portfolio Construction with Climate Risk Measures*, 2022)
Lo and Zhang ("Quantifying the Impact of Impact Investing," 2022)
Mercereau and Melin ("Optimizing Portfolios across Risk, Return, and Climate," 2020)
Nofsinger and Varma ("Keeping Promises? Carbon Risk Disclosure and Mutual Fund Portfolios," 2021)
Raynaud et al. ("Portfolio Alignment to a 2°C Trajectory: Science or Art?" 2020)
Reboredo and Otero ("Are investors aware of climate-related transition risks? Evidence from mutual fund flows," 2021)
Roncalli et al. ("Measuring and Managing Carbon Risk in Investment Portfolios," 2020)
Roncalli ("Green and Sustainable Finance, ESG Investing and Climate Risk," 2021)
Semet et al. ("ESG and Sovereign Risk: What is Priced in by the Bond Market and Credit Rating Agencies?" 2021)
Shen et al. ("Strategic asset allocation with climate change," 2019)
Swinkels ("Allocating to green bonds," 2021)
Terpstra ("ESG ratings and stock performance: Do high ESG portfolios perform differently within and between industries?" 2021)
Tokat-Acikel et al. ("Top-Down Portfolio Implications of Climate Change," 2021)
Venturini ("Climate change, risk factors and stock returns: A review of the literature," 2022)
van Tilborg ("(Ir)responsible Investing: Revisiting the Effects of ESG Performance on Portfolio Returns," 2021)
Webersinke et al. ("ClimateBert: A Pretrained Language Model for Climate-Related Text," 2021)
Westcott et al. ("Be Prepared: Exploring Future Climate-Related Risk for Residential and Commercial Real Estate Portfolios," 2020)

2.2.7 Metrics, performance and benchmarks for ESG-based investing

List of references:

Alessandrini and Jondeau ("Optimal Strategies for ESG Portfolios," 2021)

Amon et al. ("Passive ESG Portfolio Management – The Benchmark Strategy for Socially Responsible Investors," 2021)

Antoncic et al. ("Sustainable Investment - Exploring the Linkage between Alpha, ESG, and SDG's," 2020)

Ascioglu et al. ("Integration of ESG Metrics into a Student-Managed Fund:Creating Sustainable Student-Managed Funds," 2017)

Austmo and Eikeland ("Exploiting ESG Information by Extending Conventional Smart Beta Strategies: An Empirical Analysis of Portfolio Performances through the Booms and Busts in the European Equity Market," 2021)

Aw et al. ("A Morality Tale of ESG: Assessing Socially Responsible Investing," 2017)

Baeza-Sampere et al. ("A fuzzy data envelopment analysis model for evaluating the efficiency of socially responsible and conventional mutual funds," 2016)

Bahra and Thukral ("ESG in Global Corporate Bonds: The Analysis Behind the Hype," 2020)

Billio et al. ("Inside the ESG Ratings: (Dis)agreement and Performance," 2021)

Bolliger and Cornilly ("Sustainability Attribution: The Case of Carbon Intensity," 2021)

Boucher et al. (*Backtesting ESG Ratings*, 2021)

Broadstock et al. ("The Role of ESG Performance During Times of Financial Crisis: Evidence from COVID-19 in China," 2020)

Bush et al. ("E, S, or G - Analyzing Global ESG Performance," 2020)

Cai et al. ("Socially Responsible Investing and Factor Investing, Is There an Opportunity Cost?" 2022)

Calvo et al. ("Finding socially responsible portfolios close to conventional ones," 2015)

Chang et al. ("How Interpretable and Trustworthy are GAMs?" 2021)

Chen and Bowler ("Constructing and Validating Climate Risk Factors from ESG Data: an Empirical Comparison," 2021)

Chen and Deleon ("Financial Quality Metrics and ESG Factor Interactions in Equity Markets," 2020)

Coqueret et al. ("Boosting ESG-Based Optimization With Asset Pricing Characteristics," 2021)

Coqueret et al. ("ESG Equity Investing: A Short Survey," 2021)

Cornell ("ESG preferences, risk and return," 2021)

Cosemans et al. ("Climate Change and Long-Horizon Portfolio Choice: Combining Theory and Empirics," 2021)

De Franco ("ESG Controversies and Their Impact on Performance," 2019)

Dumitrescu et al. ("Defining Greenwashing," 2022)

Filbeck et al. ("Performance assessment of firms following sustainalytics ESG principles," 2019)

Fridson et al. ("ESG Impact on High-Yield Returns," 2021)

Giese et al. ("Consistent ESG through ESG Benchmarks," 2019)

Giese et al. ("Consistent ESG through ESG Benchmarks," 2019)

Giese et al. ("Foundations of ESG investing: how ESG affects equity valuation, risk, and performance," 2019)

Gueant et al. ("Environmental transition alignment and portfolio performance," 2021)

Hain et al. ("Let's get physical: Comparing metrics of physical climate risk," 2021)

Hanicova and Vojtko ("Backtesting ESG Factor Investing Strategies," 2020)

Hodges et al. ("Net Zero Investing for Multi-Asset Portfolios seeking to satisfy Paris Aligned Benchmark Requirements with Climate Alpha Signals," 2022)

Hsu et al. ("Outperformance through Investing in ESG in Need," 2018)

Jondeau et al. ("Building Benchmarks Portfolios with Decreasing Carbon Footprints," 2021)

Khan ("Corporate Governance, ESG, and Stock Returns around the World," 2019)

Lanza et al. ("Mind the gap! Machine Learning, ESG Metrics and Sustainable Investment," 2020)

Le Guenedal and Roncalli (*Portfolio Construction with Climate Risk Measures*, 2022)

Li et al. ("Robust enhanced indexation with ESG: An empirical study in the Chinese Stock Market," 2022)

Lindeman ("ESG Score Design And Portfolio Construction," 2022)

Lo and Zhang ("Quantifying the Impact of Impact Investing," 2022)

Ouchen ("Is the ESG portfolio less turbulent than a market benchmark portfolio?" 2021)

Plagge and Grim ("Have investors paid a performance price? examining the behavior of ESG equity funds," 2020)

Polbennikov et al. ("ESG Ratings and Performance of Corporate Bonds," 2016)
Roncalli ("Advanced Course in Asset Management," 2021)
Ruf et al. ("Investments in ESG-Rated Mutual Funds: Is Good Better than Great?" 2019)
Sorensen et al. ("The Quantitative Approach for Sustainable Investing," 2021)
Statman and Glushkov ("Classifying and Measuring the Performance of Socially Responsible Mutual Funds," 2016)
Tharavanij ("ESG Rating and Financial Performance: A Review Article," 2021)
Walkshausl ("Dissecting the performance of socially responsible firms," 2018)
Yeh et al. ("SustainBench: Benchmarks for Monitoring the Sustainable Development Goals with Machine Learning," 2021)

2.2.8 NLP, text, topic and sentiment analysis within context of ESG investing

List of references:
Ascioglu et al. ("Analysis of Sustainability Reports for Top 20 Companies in the S&P 500 Index," 2022)
Azevedo et al. ("Investor sentiment and the time-varying sustainability premium," 2021)
Ballinari and Mahmoud ("From Chatter to Action: An Index of Sustainability Sentiment," 2021)
Ben Dor et al. ("ESG and Alternative Data: Capturing Corporates' Sustainability-Related Activities with Job Postings," 2021)
Bingler et al. ("Cheap Talk and Cherry-Picking: What ClimateBert has to say on Corporate Climate Risk Disclosures," 2021)
Bingler et al. ("Cheap Talk in Corporate Climate Commitments: The Role of Active Institutional Ownership, Signaling, Materiality, and Sentiment," 2022)
Bonaparte ("The ESG Investor Sentiment Index: A Cross Sectional and Time Series Analyses," 2021)
Borms et al. ("Semi-supervised Text Mining for Monitoring the News About the ESG Performance of Companies," 2021)
Chava et al. ("Doing Well by Doing Good? Risk, Return, and Environmental and Social Ratings," 2021)
Chen et al. ("NLP for SDGs: Measuring Corporate Alignment with the Sustainable Development Goals," 2022)
Coqueret and Tran ("ESG news spillovers to (and from) the supply chain," 2022)
D'Amato et al. ("Fundamental ratios as predictors of ESG scores: a machine learning approach," 2021)
Engle et al. ("Hedging climate change news," 2020)
Faccini et al. ("Dissecting Climate Risks: Are they Reflected in Stock Prices?" 2021)
Friederich et al. ("Automated Identification of Climate Risk Disclosures in Annual Corporate Reports," 2021)
Guo et al. ("ESG2Risk: A Deep Learning Framework from ESG News to Stock Volatility Prediction," 2020)
Hakala ("Can ESG controversies predict medium- to long-term stock performance? Evidence from global markets," 2021)
Luccioni et al. ("Analyzing Sustainability Reports Using Natural Language Processing," 2020)
Nugent et al. ("Detecting ESG topics using domain-specific language models and data augmentation approaches," 2020)
Serafeim ("Public sentiment and the price of corporate sustainability," 2020)
Sokolov et al. ("Building Machine Learning Systems for Automated ESG Scoring," 2021)
Taleb et al. ("Corporate ESG News and The Stock Market," 2020)
Webersinke et al. ("ClimateBert: A Pretrained Language Model for Climate-Related Text," 2021)

2.2.9 Testing and comparison procedures for investment portfolios

References:
Adcock et al. ("Portfolio Performance Measurement: Monotonicity with Respect to the Sharpe Ratio and Multivariate Tests of Correlation," 2017)
Arnott et al. ("A backtesting protocol in the era of machine learning," 2019)
Bailey et al. ("Stock Portfolio Design and Backtest Overfitting," 2017)
Bessler and Wolff ("Portfolio Optimization with Industry Return Prediction Models," 2017)
Bessler et al. ("Multi-asset portfolio optimization and out-of-sample performance: an evaluation of Black Litterman, mean-variance, and naive diversification approaches," 2017)
Bjerring et al. ("Feature selection for portfolio optimization," 2017)

Bruni et al. ("On exact and approximate stochastic dominance strategies for portfolio selection," 2017)
Bruni et al. ("Real-world datasets for portfolio selection and solutions of some stochastic dominance portfolio models," 2016)
Bryzgalova et al. ("Bayesian solutions for the factor zoo: we just ran two quadrillion models," 2021)
Cesarone et al. ("On the stability of portfolio selection models," 2019)
Cesarone et al. ("Why Small Portfolios Are Preferable and How to Choose Them," 2018)
Chaudhuri and Lo ("Dynamic Alpha: A Spectral Decomposition of Investment Performance Across Time Horizons," 2019)
Diris et al. ("Long-Term Strategic Asset Allocation: An Out-of-Sample Evaluation," 2015)
Fabozzi and Lopez de Prado ("Being Honest in Backtest Reporting: A Template for Disclosing Multiple Tests," 2018)
Greiner and Stoyanov ("Portfolio scoring by expected risk premium," 2019)
Guidolin et al. ("Portfolio performance of linear SDF models: an out-of-sample assessment," 2018)
Guo ("A Statistical Response to Challenges in Vast Portfolio Selection," 2019)
Guo et al. ("When Does The 1/N Rule Work?" 2019)
Haley ("K-fold cross validation performance comparisons of six naive portfolio selection rules: how naive can you be and still have successful out-of-sample portfolio performance?" 2017)
Harvey et al. ("An Evaluation of Alternative Multiple Testing Methods for Finance Applications," 2020)
Hens et al. ("Escaping the backtesting illusion," 2020)
Hsu et al. (*Do Cross-Sectional Stock Return Predictors Pass the Test without Data-Snooping Bias?* 2017)
Hsu et al. ("Asset allocation strategies, data snooping, and the 1 / N rule," 2018)
Huang and Yu ("A new procedure for resampled portfolio with shrinkaged covariance matrix," 2020)
Hwang et al. ("Naive versus optimal diversification: Tail risk and performance," 2018)
Ielpo et al. (*Engineering Investment Process: Making Value Creation Repeatable*, 2017)
Jaeger et al. ("Understanding machine learning for diversified portfolio construction by explainable AI," 2020)
Kazak and Pohlmeier ("Testing out-of-sample portfolio performance," 2019)
Kazak and Pohlmeier (*Portfolio Pretesting with Machine Learning*, 2020)
Kuntz ("Portfolio Strategies with Classical and Alternative Benchmarks," 2018)
Lohre et al. ("Hierarchical Risk Parity: Accounting for Tail Dependencies in Multi-asset Multi-factor Allocations," 2020)
Lopez de Prado ("A Data Science Solution to the Multiple-Testing Crisis in Financial Research," 2019)
Lopez de Prado and Lewis ("Detection of false investment strategies using unsupervised learning methods," 2019)
Malavasi et al. ("Second order of stochastic dominance efficiency vs mean variance efficiency," 2021)
Mooney et al. ("Dynamic Regime Strategy for Stress Testing and Optimizing Institutional Investor Portfolios," 2020)
Platanakis et al. ("Horses for Courses: Mean-Variance for Asset Allocation and 1/N for Stock Selection," 2021)
Radovanov and Marcikic ("Testing The Performance Of The Investment Portfolio Using Block Bootstrap Method," 2014)
Rebonato ("A financially justifiable and practically implementable approach to coherent stress testing," 2019)
Schumann ("Backtesting," 2019)
Seymour et al. ("Dynamic portfolio management strategies: A framework for historical analysis," 2018)
Suhonen et al. ("Quantifying Backtest Overfitting in Alternative Beta Strategies," 2017)
Taljaard and Maré ("Why has the equal weight portfolio underperformed and what can we do about it?" 2021)
Tayali ("A novel backtesting methodology for clustering in mean–variance portfolio optimization," 2020)
Traccucci et al. ("A Triptych Approach for Reverse Stress Testing of Complex Portfolios," 2019)
Valentine et al. ("Beyond p values: utilizing multiple methods to evaluate evidence," 2019)
Vincent et al. ("Analyzing the Performance of Multifactor Investment Strategies under a Multiple Testing Framework," 2018)
Vovk and Wang ("True and false discoveries with e-values," 2020)
Vovk and Wang ("E-values: Calibration, combination, and applications," 2021)
Wiecki et al. ("All That Glitters Is Not Gold: Comparing Backtest and Out-of-Sample Performance on a Large Cohort of Trading Algorithms," 2016)

Yu ("Comparing Classical Portfolio Optimization and Robust Portfolio Optimization on Black Swan Events," 2021)

Zhang et al. ("DoubleEnsemble: A New Ensemble Method Based on Sample Reweighting and Feature Selection for Financial Data Analysis," 2020)

Zhang et al. ("Information Coefficient as a Performance Measure of Stock Selection Models," 2020)

Zhang et al. ("Deep Learning for Portfolio Optimization," 2020)

References

Adcock, C., Areal, N., Armada, M. R., Cortez, M. C., Oliveira, B., and Silva, F. (2017). "Portfolio Performance Measurement: Monotonicity with Respect to the Sharpe Ratio and Multivariate Tests of Correlation." In: *SSRN e-Print*.

This paper reports an investigation into methods of portfolio performance measurement. The work is motivated first by equivocal empirical evidence reported by several authors about the correlation of performance measures with the Sharpe ratio. Secondly it is motivated by recent work which specifies that performance measures will be monotone functions of the Sharpe ratio if portfolio returns follow the same location-scale distribution. The paper demonstrates that the class of location-scale distributions is broader than previously reported. It presents conditions under which monotonicity with respect to the Sharpe ratio will fail. The paper shows that for large sample sizes the correlation between pairs of performance measures that are functions of the Sharpe ratio is unity. The correct null hypothesis for tests of correlation is therefore rho=1. Two multivariate tests of this null hypothesis are presented. The new tests are used to carry out of a comprehensive study of performance measurement for a set over ninety UK investment trusts.

Akgun, O. T., Mudge, T. J., and Townsend, B. (2021). "How Company Size Bias in ESG Scores Impacts the Small Cap Investor." In: *The Journal of Impact and ESG Investing* 1(4), pp. 31–44.

The rising popularity of socially responsible investing (SRI) has increased interest in the relationship between traditional measures of corporate financial performance (CFP) and the emerging field of corporate social performance (CSP). SRI investors have tended to have a large capitalization (cap) stock focus that has served them well in the past, but that may be suboptimal in the future if we return to a period of small cap outperformance. Using environmental, social, and governance (ESG) scores as a proxy for CSP, our research supports past studies showing a large cap bias in measures of CSP. Narrowing our focus, we find that within the US small cap stock universe, the correlation between firm size and ESG scores is greatly reduced. We construct small cap ESG leaders and laggards portfolios and test their performance. We demonstrate that performance was not affected by neutralizing these portfolios with respect to firm size. Our results reinforce the idea that CSP proxies such as ESG scores have the potential to practically enhance portfolio performance in US small cap stocks.

Alessandrini, F., Balula, D. B., and Jondeau, E. (2021). "ESG Screening in the Fixed-Income Universe." In: *SSRN e-Print*.

This paper evaluates the impact of a screening process based on Environment, Social, and Governance (ESG) scores for an otherwise passive portfolio of investment-grade corporate bonds. The main result is that this filtering leads to a substantial improvement of the targeted ESG score without reducing the risk-adjusted performance but with significant biases in regional, sectoral, and risk factor exposures. We find that screening is very often associated with a substantial improvement in the risk profile. In particular, ESG-tilted portfolios lead to large negative exposure (i.e., protection) to credit risk. Screening based on the Environment score is where most of the reduction in risk takes place, making this criterion particularly relevant in moving the portfolio toward a more defensive composition. We demonstrate that screening at the regional and sectoral levels allows investors to eliminate undesirable regional and sectoral exposures while delivering similar ESG scores and risk-adjusted performances.

Alessandrini, F. and Jondeau, E. (2020). "ESG investing: from sin stocks to smart beta." In: *The Journal of Portfolio Management* 46(3), pp. 75–94.

Research on socially responsible investment in equity markets initially focused on sin stocks. Since then, the availability of data has been extended substantially and now covers environmental, social, and governance (ESG) criteria. Using ESG scores of firms belonging to the MSCI World universe, the authors measure the impact of score-based exclusion on both otherwise passive investment and smart beta strategies. They find that exclusion leads to improved scores of initially standard portfolios without deterioration of the risk-adjusted performance. Smart beta strategies exhibit a similar pattern, often in a more pronounced way. Moreover, the results demonstrate that exclusion also implies regional and sectoral tilts as well as (possibly undesirable) risk exposures of the portfolios.

Alessandrini, F. and Jondeau, E. (2021). "Optimal Strategies for ESG Portfolios." In: *The Journal of Portfolio Management* 47(6), pp. 114–138.

Previous research has provided evidence that in the last decade, investing according to screening based on environmental, social, and governance (ESG) criteria would have allowed investors to considerably improve the ESG quality of their portfolio without deterioration of its financial performance. However, a drawback of such a

screening process is that it may generate undesirable regional, sectoral, and risk factor exposures. In this article, the authors propose an investment strategy that maximizes the ESG quality of the portfolio while maintaining regional, sectoral, and risk factor exposures within stated limits. They provide evidence that such a portfolio would have produced risk-adjusted performance at least as high as the standard MSCI benchmark for a wide range of ESG criteria and regions over the 2007-2018 investment period.

Alford, A. W. (2019). "Some considerations for investors exploring ESG strategies." In: *The Journal of Investing* 28(2), pp. 21–31.
Investors who are concerned about environmental, social, and governance (ESG) factors face numerous questions. In the author opinion, investors need to determine which ESG issues are important for them, and how these issues should be reflected in a portfolio. For some strategies, ESG factors are integral to the investment process, whereas for other strategies, ESG factors are best captured via simple and transparent rules (screens and/or tilts). Investors also face several practical implementation choices. Should each company be evaluated on the basis of its current ESG profile, or is the trend more relevant? Should a company be analyzed on a stand-alone basis or relative to its industry peers? And for the strategy, what is the appropriate level of active risk (tracking error) relative to the policy benchmark? In addition, investors need to determine how to monitor any ESG strategy over time, which will help ensure the strategy is performing as expected. In the author opinion, perhaps the biggest challenge facing investors is articulating an investment thesis for an ESG strategy. Which ESG factors are already reflected in security prices, and which ESG factors have the potential to drive outperformance? Finally, the article identifies some differences between equity and fixed income strategies as they relate to ESG.

Amel-Zadeh, A. (2021). "The Materiality of Climate Risk." In: *SSRN e-Print*.
Evidence from a global survey of nearly 700 investors and companies shows that investors consider climate risk to be financially material and to represent regulatory and litigation risk, whereas far fewer companies believe they are exposed to climate risks, diverge in their perspectives on the types of risks and consequently few make any disclosures about it. Investors state difficulties with identifying and quantifying risks due to the lack of disclosures as the main challenge in assessing the impact of climate change. The findings suggest that current disclosure practices do not provide investors with adequate information about climate-related financial risks.

Amon, J., Rammerstorfer, M., and Weinmayer, K. (2021). "Passive ESG Portfolio Management – The Benchmark Strategy for Socially Responsible Investors." In: *Sustainability* 13(16), p. 9388.
In this article, we investigate the notion of doing well while doing good from the perspective of passive portfolio strategies. We analyze a number of asset allocation strategies based on ESG-weighting and compare their financial and ESG performance for the US and Europe. We find no significant difference in the financial performance but superior ESG performance of ESG-based strategies. It can be concluded that, compared to a naive strategy, socially responsible investors are willing to pay a small premium for the impact of the portfolio via transaction costs when rebalancing the portfolio according to their preferences for social responsibility. In addition, when comparing the ESG-based strategies to a value-weighted strategy, we observe no significant difference in ESG performance but a high degree of significance in the superior financial performance of the ESG-based strategy. We also analyze the strategies with regards to the factor loadings given by the Fama-French five-factor model and a sixth factor denoted GMB (Good minus Bad) and find significant differences across the regions and strategies. Overall, the results show strong support of ESG-based strategies being preferred by socially responsible investors but also suggest that such strategies might be preferred by conventional investors looking for a passively managed alternative compared to a value-weighted index. Furthermore, it seems that such a strategy might be a more adequate benchmark for active SRI funds.

Andersson, C., Broberg, C., Kaskal, K., and Sonesson, M. (2021). "Portfolio Construction and New Energy Infrastructure Investing." In: *The Journal of Impact and ESG Investing* 2(2), pp. 57–76.
In light of the increasingly severe consequences of climate change, an increasing number of institutional investors want their investments to replicate their ethical values. This article identifies the decarbonization of global power generation as an opportunity for those investors requiring sustainable impact while enhancing the risk-adjusted returns for, and future-proofing of, their portfolios. After analyzing the worsening state of financial markets, with high equity valuations and record-low bond yields, the authors demonstrate the added benefit of economic resilience of sustainable infrastructure assets. A move into sustainable infrastructure is bolstered by global political tailwinds earmarking fiscal stimulus to upgrade existing and new green infrastructure, as well as regulators increasingly enforcing disclosure of progress. Finally, by delving deeper into portfolio construction, the authors argue for the benefits of diversifying into the adjacent renewable-energy technologies needed to sustain the forthcoming renewable-power networks to optimize the risk-return profile of portfolios.

Angelova, D., Bosello, F., Bigano, A., and Giove, S. (2021). "Sovereign rating methodologies, ESG and climate change risk: an overview." In: *SSRN e-Print*.
We review the sovereign credit rating methodologies of three credit rating agencies (Moody's, S&P and Fitch) and analyze how they currently accommodate climate change risk and ESG considerations. We elaborate on the differences between the three rating methodologies and critically evaluate their suitability and limitations. We propose lines of improvement with respect to the indicator selection, normalization, aggregation and weighting procedures as well as the use of the sovereign rating indicator in connection with climate change scenarios.

Antoncic, M., Bekaert, G., Rothenberg, R. V., and Noguer, M. (2020). "Sustainable Investment - Exploring the Linkage between Alpha, ESG, and SDG's." In: *SSRN e-Print*.
Environmental, Social and Governance (ESG) investing has been one of the most important trends in the asset management industry over the past decade. Previously institutional asset owners believed that ESG issues, also known as nonfinancial risks and opportunities, were not relevant to portfolio value and therefore were nonessential, or even in conflict with their fiduciary duties to act in the best interest of their beneficiaries. In this paper, we analyze the relationship between alpha generation and ESG metrics. We also measure whether companies have an either positive or negative net influence on the U.N.'s Sustainable Development Goals (SDG's) which are emerging as the new, broader standard to measure sustainability. First, we explore whether utilizing ESG factors can improve performance vis a vis the MSCI US index. By constructing a sector-neutral portfolio using MSCI ESG momentum scores from 2013 to 2018, we determine that it is feasible to generate positive alpha from an ESG momentum strategy. Second, we utilize structured and unstructured data to determine a company's net influence on the SDGs, or what we call its SDG 'footprint.' Our research shows that an ESG momentum portfolio not only outperforms the MSCI US index but has a relatively better SDG footprint than that of the index. Third, we establish a positive contemporaneous connection between the sample portfolio's ESG ratings change (its momentum) and its coinciding SDG footprint over the sample period. We conclude that a positive linkage exists between ESG, alpha, and the SDG's.

Apostolou, A. and Papaioannou, M. G. (2021). "Integration of Environmental Factors into Portfolio Risk Assessment." In: *The Journal of Impact and ESG Investing* 2(1), pp. 74–91.
The financial sector collectively cannot hedge all climate-related risks, and investors individually are unlikely to affect climate developments significantly. However, the financial sector can help channel savings into green projects and thus facilitate divestment from heavy-carbon-footprint producers. This article provides a novel framework for understanding climate-related adaptation, mitigation, and transition risks and outlines a method for valuing these risks in institutional investor portfolios. The authors' proposed setup serves as a continuous call to action to long-term institutional investors to obtain accurate information on climate-related risks and develop appropriate frameworks for understanding these risks, regularly valuing them, and properly incorporating them into their investment decisions.

Areal, N., Cortez, M. C., and Silva, F. (2013). "The conditional performance of US mutual funds over different market regimes: do different types of ethical screens matter?" In: *Financial Markets and Portfolio Management volume* 27 (397-429).
We investigate the performance of US mutual funds that employ different ethical criteria: religious, socially responsible, and irresponsible. Performance is evaluated over different market regimes using a Markov-switching conditional CAPM approach that endogenously defines different states of the market. This model is also extended to a multifactor context. The results show that estimates of performance vary across different market regimes. The Vice Fund, which invests in unethical firms, outperforms in low-volatility regimes, but underperforms in high-volatility regimes. These results contradict the Vice Fund's claim that it constitutes a "solid investment during recessionary periods". Our results show that socially responsible and morally responsible funds exhibit different performance across different market conditions, thereby supporting the use of performance evaluation models that take into account different market regimes. Overall, different types of ethical screens seem to lead to different performance patterns across different market regimes.

Arnott, R. D., Harvey, C. R., and Markowitz, H. (2019). "A backtesting protocol in the era of machine learning." In: *The Journal of Financial Data Science* 1(1), pp. 64–74.
Machine learning offers a set of powerful tools that holds considerable promise for investment management. As with most quantitative applications in finance, the danger of misapplying these techniques can lead to disappointment. One crucial limitation involves data availability. Many of machine learning early successes originated in the physical and biological sciences, in which truly vast amounts of data are available. Machine learning applications often require far more data than are available in finance, which is of particular concern in longer-

horizon investing. Hence, choosing the right applications before applying the tools is important. In addition, capital markets reflect the actions of people, which may be influenced by others actions and by the findings of past research. In many ways, the challenges that affect machine learning are merely a continuation of the long-standing issues researchers have always faced in quantitative finance. While investors need to be cautious, more cautious than in past applications of quantitative methods new tools offer many potential applications in finance. In this article, the authors develop a research protocol that pertains both to the application of machine learning techniques and to quantitative finance in general.

Ascioglu, A., Gonzalez, J., and Zbib, L. (2022). "Analysis of Sustainability Reports for Top 20 Companies in the S&P 500 Index." In: *The Journal of Impact and ESG Investing* 2(2).
An increasing number of companies are voluntarily issuing sustainability reports as investors are putting more emphasis on the sustainability and the environmental, social and governance (ESG) ratings of the companies in their investment decisions. We analyze the sustainability reports from the top 20 companies in the S&P 500. We find that these reports differ significantly based on their length and their word and number count. We also apply Benford's law to the numbers reported in sustainability reports. We examine the distributions of the first and the second digits of the numbers and find that there is a rounding of numbers especially with the second digit in the reports. We also find that the distributions of the first and second digits significantly deviate from the expected distribution according to Benford's law. Our results support the current push from regulators for the standardization of sustainability reports to provide better ESG information to investors.

Ascioglu, A., Saatcioglu, K., and Smith, A. (2017). "Integration of ESG Metrics into a Student-Managed Fund:Creating Sustainable Student-Managed Funds." In: *The Journal of Trading* 13(1), pp. 59–71.
In this article, the authors evaluate a student-managed fund, Bryant University Archway Investment Fund (AIF), from an environmental, social, and governance (ESG) perspective and develop a framework for integration of ESG metrics for the fund. The authors explain why ESG issues are especially relevant to a student-managed fund and describe efforts to move the AIF toward becoming ESG conscious. ESG integration begins with the ESG assessment of the fund holdings followed by an analysis of each sector of the fund. They then offer several ways to improve the ESG standing of each sector compared with various benchmarks.

Austmo, J. H. and Eikeland, H. M. (2021). "Exploiting ESG Information by Extending Conventional Smart Beta Strategies: An Empirical Analysis of Portfolio Performances through the Booms and Busts in the European Equity Market." MA thesis. Copenhagen Business School.
This study investigates how portfolio construction- and investment principles, such as incorporation of ESG information in decision making, can be applied to enhance stock portfolio performances in the European Equity markets. The authors find that portfolios constructed with equal weights in combination with a buy and hold strategy yield better result relative to a benchmark, while incorporation of ESG growth information further enhances performances. On a more granular level, the authors confirm the notion that small-cap stock portfolios outperform large-cap stock portfolios in periods of economic prosperity, while there is no evidence to suggest the opposite during periods of economic hardship. The authors also find that the extension of the Fama-French three-factor model with an ESG growth risk factor improves its ability to explain portfolio returns, especially towards the end of the investment period. Evidence from conventional and extended models source more of the experienced overperformance in small-cap portfolios to the size effect anomaly, while large-cap portfolio returns are more prominently captured by the ESG growth risk factor.

Avramov, D., Cheng, S., Lioui, A., and Tarelli, A. (2021a). "Investment and Asset Pricing with ESG Disagreement." In: *SSRN e-Print*.
This paper analyzes the asset pricing and portfolio implications of an important barrier to sustainable investing—uncertainty about the corporate ESG profile. In equilibrium, the market premium increases and demand for stocks declines under ESG uncertainty. In addition, the CAPM alpha and effective beta both rise with ESG uncertainty and the negative ESG-alpha relation weakens. Employing the standard deviation of ESG ratings from six major providers as a proxy for ESG uncertainty, we provide supporting evidence for the model predictions. Our findings help reconcile the mixed evidence on the cross-sectional ESG-alpha relation and suggest that ESG uncertainty affects the risk-return trade-off, social impact, and economic welfare.

Avramov, D., Cheng, S., Lioui, A., and Tarelli, A. (2022). "Sustainable investing with ESG rating uncertainty." In: *Journal of Financial Economics*.
This paper analyzes the asset pricing and portfolio implications of an important barrier to sustainable investing: uncertainty about the corporate ESG profile. In equilibrium, the market premium increases and demand for stocks declines under ESG uncertainty. In addition, the CAPM alpha and effective beta both rise with ESG

uncertainty and the negative ESG-alpha relation weakens. Employing the standard deviation of ESG ratings from six major providers as a proxy for ESG uncertainty, we provide supporting evidence for the model predictions. Our findings help reconcile the mixed evidence on the cross-sectional ESG-alpha relation and suggest that ESG uncertainty affects the risk-return trade-off, social impact, and economic welfare.

Avramov, D., Lioui, A., Liu, Y., and Tarelli, A. (2021b). "Dynamic ESG Equilibrium." In: *SSRN e-Print*.
This paper develops and applies an equilibrium model that accounts for ESG demand and supply dynamics. In equilibrium, ESG preference shocks represent a novel risk source characterized by diminishing marginal utility and positive premium. Expected green asset returns are negatively associated with time-varying convenience yield, while exposures to ESG preference shocks lead to positive green premium. Augmenting these conflicting forces with positive contemporaneous effects of preference shocks on realized returns, the green-minus-brown portfolio delivers large positive payoffs for reasonably long horizons. Nonpecuniary benefits from ESG investing account for a nontrivial and increasing fraction of total consumption.

Aw, E. N. W., LaPerla, S. J., and Sivin, G. Y. (2017). "A Morality Tale of ESG: Assessing Socially Responsible Investing." In: *The Journal of Wealth Management* 19(4), pp. 14–23.
A review of academic literature suggests a lack of consensus on positive and negative abnormal returns associated with socially responsible investing/environmental, social, and governance (SRI/ESG) factors. This article examines the benefit of incorporating ESG factors during a more recent period to acknowledge the ongoing investment trend toward ESG. The authors find that the topquintile (most compliant) stocks ranked by ESG score underperform the outsample research universe. They present evidence that indicates incorporating ESG into a robust quantitative investment process can mitigate the adverse effect, however, thus providing investors with a portfolio that outperforms a benchmark while allowing investors to embrace ESG.

Azevedo, V., Kaserer, C., and Campos, L. M. S. (2021). "Investor sentiment and the time-varying sustainability premium." In: *Journal of Asset Management* 22, pp. 600–621.
Studies show the inconclusive results regarding the relation between corporate social and environmental responsibility (CSR and CER) and expected returns. We argue that the reason for these mixed results is that the sustainability premium (i.e., the return difference of high-intensity minus low-intensity CSR/CER firms) is time-varying and correlated with investor sentiment. We find that high-intensity CSR (CER) firms have a monthly excess return that is 0.70 (0.88) p.p. higher following periods of low investor sentiment as compared to periods of high sentiment. Given that standard pricing factors cannot fully explain the abnormal returns caused by investor sentiment on the sustainability premium, we propose a sustainability pricing factor, estimated as the second principal component of portfolios sorted based on environmental and social variables, which corrects this mispricing.

Baeza-Sampere, I., Coll-Serrano, V., M, B., and Mendez-Rodriguez, P. (2016). "A fuzzy data envelopment analysis model for evaluating the efficiency of socially responsible and conventional mutual funds." In: *Journal of Risk* 19(1), pp. 77–90.
Although several data envelopment analysis (DEA) models have been proposed in the literature for mutual funds' performance evaluation, few of them incorporate nonfinancial criteria. In this paper a fuzzy DEA model is used, allowing mutual funds relative performance evaluation in a more realistic and flexible way. We examine the efficiency of forty US large cap equity mutual funds based not only on financial variables but also on nonfinancial ones. To achieve this aim, we extend Basso and Funari's mutual funds' ethical level proposing a more reliable fuzzy measure of the social environmental responsibility degree of equity mutual funds. It relies on the corporate social performance of the companies invested in by the mutual funds and on the quality of the management in terms of the transparency and credibility degree of the nonfinancial information provided by the mutual funds. We can conclude that socially responsible mutual funds show better behavior in terms of efficiency than conventional funds.

Bag, D. and Mohanty, S. (2021). "Impact of ESG Factors on Emerging Market Stock Returns." In: *The Journal of Impact and ESG Investing* 2(2), pp. 138–147.
Empirical evidence indicates that environmental, social, and governance (ESG) practices are associated with a company's financial performance, but little has been mentioned about investors' attention toward stock performance. In this article, the authors conduct a test of the relationship between ESG performance disclosures and a company's financial or capital market performance. They choose a stratified sample of large-cap companies across eight sectors drawn from the S&P 100 from 2016-2021. The changes in ESG ratings-namely, for governance and the environment-exhibit a small but significant impact on the stock's performance. Their results show that a few ESG disclosures are positively related and dominate over the usual company-level determinants of re-

turn on assets. They find corporate governance practices to be more significant than climate change disclosures. These outcomes are robustly demonstrated on use cases of top stocks with investor safety recommendations. The results could have useful implications for investors, fund managers, and regulators.

Bahra, B. and Thukral, L. (2020). "ESG in Global Corporate Bonds: The Analysis Behind the Hype." In: *The Journal of Portfolio Management* 46(8), pp. 133–147.
Both large institutional and individual retail investors are increasingly demanding that the stewards of their savings demonstrate consideration of environmental, social, and governance (ESG) externalities in their decision making. This study asks how different ESG scores are from traditional agency credit ratings. Are E, S, and G scores correlated? Most importantly, can ESG scores enhance the investment process? Can an active, ESG-tilted corporate bond portfolio strategy generate superior performance versus a relevant benchmark that does not explicitly take ESG scores into account? The authors conclude that ESG scores can be used to enhance portfolio outcomes via lower drawdowns, reduced portfolio volatility, and, in some cases, even marginally increased risk-adjusted returns. Their backtesting suggests that E, S, and G scores are not related to one another and that ESG scores are additive to traditional credit ratings; the contingent liabilities related to ESG issues are not necessarily factored into rating agencies' assigned credit ratings.

Bailey, D. H., Borwein, J. M., and Lopez de Prado, M. (2017). "Stock Portfolio Design and Backtest Overfitting." In: *Journal of Investment Management* 15(1), pp. 75–87.
In mathematical finance, backtest overfitting connotes the usage of historical market data to develop an investment strategy, where too many variations of the strategy are tried, relative to the amount of data available. Backtest overfitting is now thought to be a primary reason why investment models and strategies that look good on paper often disappoint in practice. Models and strategies suffering from overfitting typically target the specific idiosyncrasies of a limited dataset, rather than any general behavior, and, as a result, often perform erratically when presented with new data. In this study, we address overfitting in the context of designing a mutual fund or investment portfolio as a weighted collection of stocks. Very often a newly minted equity-based fund of this type has been designed by an exhaustive computer-based search of some sort to obtain an optimal weighting that exhibits excellent performance based, say, on the past 10 or 20 years' historical market data, and the fund often highlights this backtest performance.

Bajic, A., Kiesel, R., and Hellmich, M. (2021). "Handle with Care: Challenges and Opportunities of using Company-Level Emissions Data for Assessing Financial Risks from Climate Change." In: *SSRN e-Print*.
By now climate change has a substantial impact on financial markets and risks related to it have to be analysed. Besides the physical risk imposed by extreme weather conditions, companies face transition risks as economies are rebuilding on a low-carbon basis. To assess the impact on individual companies reliable data are necessary. Currently, by far most-used data relate to the carbon emissions of firms. By analysing a large data set on company-level carbon emissions we identify several sources of data fault which have to be considered in any data-intensive analysis. We show that year-by-year analysis of company emission consistency is best to find data flaws. Also, we find that economic and carbon data are not perfectly synchronized. Our analysis indicates that the widespread use of winsorizing is not enough to remove data flaws. Also, alternative emission measures do not provide robustness of results as they tend to suffer from the same flaws. As providers update carbon data on an ad-hoc basis, the previous analysis may not be repeated unless the data set on which it was based is saved. Our findings serve as a warning for the reliability of (academic) analysis and highlight the possible impact of bad data quality on algorithmic approaches to company-level emission data.

Balcilar, M., Demirer, R., and Gupta, R. (2017). "Do Sustainable Stocks Offer Diversification Benefits for Conventional Portfolios? An Empirical Analysis of Risk Spillovers and Dynamic Correlations." In: *Sustainability* 9(10), p. 1799.
This paper explores the potential diversification benefits of socially responsible investments for conventional stock portfolios by examining the risk spillovers and dynamic correlations between conventional and sustainability stock indexes from a number of regions. We observe significant unidirectional volatility transmissions from conventional to sustainable equities, suggesting that the criteria applied for socially responsible investments do not necessarily shield these securities from common market shocks. While significant dynamic correlations are observed between sustainable and conventional stocks, particularly in Europe, the analysis of both in- and out-of-sample dynamic portfolios suggests that supplementing conventional stock portfolios with sustainable counterparts improves the risk/return profile of stock portfolios in all regions. The findings overall suggest that sustainable investments can indeed provide diversification gains for conventional stock portfolios globally.

Ballinari, D. and Mahmoud, O. (2021). "From Chatter to Action: An Index of Sustainability Sentiment." In: *SSRN e-Print*.
Investments in sustainable assets have grown at a rapid pace over the last decade. Theory partially attributes this increase to changes in investor taste for sustainability. We develop a novel and direct measure of market-wide aggregate investor sentiment for sustainability and present evidence that it has a significant impact on asset prices. Using microblogging data from a social media investing platform, we construct a daily index capturing investor taste for environmental-, social-, and governance issues. We find that (i) sustainability sentiment temporarily increases during market downturns; (ii) positive sentiment shocks drive prices of sustainable stocks above their fundamental value, which is corrected in the long run, whereas negative shocks predict long-term asset price decreases for sustainable stocks; and (iii) sentiment forecasts flows into sustainable mutual funds.

Barber, B. M., Morse, A., and Yasuda, A. (2021). "Impact investing." In: *Journal of Financial Economics* 139(1), pp. 162–185.
We show that investors derive nonpecuniary utility from investing in dual-objective Venture Capital (VC) funds, thus sacrificing returns. Impact funds earn 4.7 percentage points (ppts) lower internal rates of return (IRRs) ex-post than traditional VC funds. In random utility/willingness-to-pay (WTP) models investors accept 2.5-3.7 ppts lower IRRs ex ante for impact funds. The positive WTP result is robust to fund access rationing and investor heterogeneity in fund expected returns. Development organizations, foundations, financial institutions, public pensions, Europeans, and United Nations Principles of Responsible Investment signatories have high WTP. Investors with mission objectives and/or facing political pressure exhibit high WTP; those subject to legal restrictions (e.g., Employee Retirement Income Security Act) exhibit low WTP.

Barnett, M., Brock, W., and Hansen, L. P. (2020). "Pricing uncertainty induced by climate change." In: *The Review of Financial Studies* 33(3), pp. 1024–1066.
Geophysicists examine and document the repercussions for the earth climate induced by alternative emission scenarios and model specifications. Using simplified approximations, they produce tractable characterizations of the associated uncertainty. Meanwhile, economists write highly stylized damage functions to speculate about how climate change alters macroeconomic and growth opportunities. How can we assess both climate and emissions impacts, as well as uncertainty in the broadest sense, in social decision-making? We provide a framework for answering this question by embracing recent decision theory and tools from asset pricing, and we apply this structure with its interacting components to a revealing quantitative illustration.

Bauer, R., Ruof, T., and Smeets, P. (2021). "Get Real! Individuals Prefer More Sustainable Investments." In: *The Review of Financial Studies* 34(8). Ed. by S. V. Nieuwerburgh, pp. 3976–4043.
The United Nations' Sustainable Development Goals (SDGs) have created societal and political pressure for pension funds to address sustainable investing. We run two field surveys (n = 1,669, n = 3,186) with a pension fund that grants its members a real vote on its sustainable-investment policy. Two-thirds of participants are willing to expand the fund's engagement with companies based on selected SDGs, even when they expect engagement to hurt financial performance. Support remains strong after the fund implements the choice. A key reason is participants' strong social preferences.

Bax, K., Sahin, O., Czado, C., and Paterlini, S. (2021). "ESG, Risk, and (tail) dependence." In: *arXiv e-Print*.
While environmental, social, and governance (ESG) trading activity has been a distinctive feature of financial markets, the debate if ESG scores can also convey information regarding a company's riskiness remains open. Regulatory authorities, such as the European Banking Authority (EBA), have acknowledged that ESG factors can contribute to risk. Therefore, it is important to model such risks and quantify what part of a company's riskiness can be attributed to the ESG ratings. This paper aims to question whether ESG scores can be used to provide information on (tail) riskiness. By analyzing the (tail) dependence structure of companies with a range of ESG scores, using high-dimensional vine copula modelling, we are able to show that risk can also depend on and be directly associated with a specific ESG rating class. Empirical findings on real-world data show positive not negligible dependencies between clusters determined by ESG scores, especially during the 2008 crisis.

Baz, S., Cathcart, L., Michaelides, A., and Zhang, Y. (2021). "Climate Regulatory Exposure: Evidence from Stock Returns." In: *SSRN e-Print*.
We propose a new measure of firm-level climate regulatory exposure based on 10-K filings. Using the 2016 Trump election as an exogenous shock to perceived climate regulatory risks, we identify a positive effect on stock returns for firms with higher climate regulatory exposures; they experience 240 to 270 basis points higher cumulative returns post-election. For firms with higher climate regulatory exposure, investor attention falls and carbon emissions rise in the year following the election, consistent with the hypothesis that investors become

less concerned with climate regulatory risks after the election. Results are robust to trade, tax and oil price exposures.

Becker, M. G., Martin, F., and Walter, A. (2021). "Fostering the Power of ESG Transparency: The Effect of Sustainability Labels on Mutual Funds and Individual Investors." In: *SSRN e-Print*.
This paper analyses the effect of the Sustainable Finance Disclosure Regulation (SFDR) on mutual funds and individual investors in the EU. First, we study whether affected funds increase their sustainability compared to a control group. Second, we examine if the regulation makes individual investors allocate more capital into more sustainable funds. In a difference-in-differences setting, we analyse the influence of the regulation on ESG fund scores and fund net inflows. Our results show that affected funds increase their sustainability rating after the policy intervention. Additionally, we find that a better ESG label leads to larger fund net inflows.

Ben Dor, A., Guan, J., Kelleher, A., Lauretig, A., Preclaw, R., and Zeng, X. (2021). "ESG and Alternative Data: Capturing Corporates' Sustainability-Related Activities with Job Postings." In: *The Journal of Impact and ESG Investing* 1(2), pp. 16–25.
The emergence of environmental, social, and governance (ESG) investing resulted in a flurry of studies examining the effects of incorporating ESG considerations on portfolio performance. Limited attention, however, was given to analyzing corporate activities related to ESG and sustainability. The authors employ a novel dataset of over 200 million job postings by US firms since 2014 and use natural language processing to identify ESG-related openings and assess companies' planned ESG activities. Using the job postings data allows one to learn about and monitor planned sustainability-related corporate activities based on firms' actions, rather than relying solely on their announcements (i.e., what firms do as opposed to what firms say they do). The authors find that ESG job posting data can serve as a leading indicator of future changes in firms' ESG ratings. Firms with higher abnormal ESG hiring posting intensity were more likely to experience subsequent rating improvements and enjoyed better stock performance 2-3 years following the posting date.

Ben Slimane, M., Brard, E., Le Guenedal, T., Roncalli, T., and Sekine, T. (2020). "ESG Investing in Fixed Income: It's Time to Cross the Rubicon." In: *SSRN e-Print*.
his research is the companion study of three previous research projects conducted at Amundi that address the issue of ESG (Berg et al., 2014; Bennani et al., 2018; Drei et al., 2019). These studies, which were focused on the stock market, showed that 2014 marks a turning point for ESG screening and the performance of active and passive management in developed equities. Indeed, ESG investing tended to penalize both passive and active investors between 2010 and 2013. Contrastingly, ESG investing has been a source of outperformance since 2014 in Europe and North America. Moreover, it appears that ESG investing and factor investing are increasingly connected. In particular, Bennani et al. (2018) and Drei et al. (2019) concluded that ESG is a new risk factor in the Eurozone. The case of fixed income is particular since it has been little studied by academics and professionals. It is true that implementing an ESG investment policy in the bond market is less obvious than in the stock market. For example, in the case of sovereign bonds using ESG filters may dramatically change the profile of the bond portfolio, particularly in terms of liquidity. In fact, it seems that ESG investors pursue two different goals when they consider equities and bonds. They invest in stocks with good ESG ratings in order to avoid extra-financial longterm risks, whereas they consider that fixed income is the field of impact investing. This explains the high demand for green and social bonds, and this also explains why ESG screening is less widely implemented in fixed income markets than in equity markets. The objective of this new study is to explore the impact of ESG investing on asset pricing in the corporate bond market. For that, we apply the methodologies that have been used by Bennani et al. (2018) for testing ESG screening in active and passive management. In particular, we consider the sorted portfolio approach of Fama and French (1992), and the index optimization method that consists in minimizing the active risk with respect to the benchmark while controlling for the ESG excess score. Three investment universes are analyzed: euro-denominated investment grade bonds, dollar-denominated investment grade bonds, and high-yield bonds. Results differ from one universe to another. In the case of EUR IG bonds, we retrieve some common patterns observed by Bennani et al. (2018) in the case of equities. Indeed, from 2010 to 2013, ESG screening has produced a negative alpha, whereas we observe an outperformance since 2014 when we implement ESG scoring in active and passive management. In the case of USD IG bonds, the results are disappointing since ESG screening produces negative alpha for the entire period. Results on high-yield bonds are difficult to interpret since ESG coverage of this market is not satisfactory. We also test how ESG has impacted the cost of corporate debt. Our results show that there is a positive correlation between ESG and credit ratings. This is normal since credit rating agencies also incorporate extra-financial risks in their default risk models. Using the approach developed by Crifo et al. (2017), we propose an integrated

credit-ESG model in order to understand the marginal effects of ESG on the cost of capital. We find that there is a negative relationship between ESG scores and yield spreads. The better the ESG rating, the lower the yield spread. For instance, we estimate that the cost of capital difference is equal to 31 bps between a worst-in-class corporate and a best-in-class corporate in the case of EUR IG corporate bonds. In the case of USD IG corporate bonds, the difference is lower but remains significant at 15 bps. Moreover, the impact of ESG is more pronounced for some sectors, for instance Banking and Utility and Energy. These results are important because ESG investing and ESG financing are two sides of the same coin. In order to tackle environmental and social issues, ESG must be a winning bet for both investors and issuers.

Bender, J., He, C., Ooi, C., and Sun, X. (2020). "Reducing the carbon intensity of low volatility portfolios." In: *The Journal of Portfolio Management* 46(3), pp. 108–122.
In recent years, interest has heightened in ESG, particularly regarding the integration of climate risk metrics such as carbon intensity in institutional portfolios. This article focuses on low volatility equity strategies, which are a natural candidate for examining the impact of incorporating climate risk as both forms of investing focus on risk. The authors find that meaningful levels of carbon reduction can be achieved across a range of low-volatility-type portfolios without compromising the volatility reduction objectives of the portfolio. There is also a point at which further reducing carbon has an increasingly negative impact on volatility reduction. Based on the authors historical simulations, between 30% and 70% is the range in which this tipping point occurs.

Bender, J., Sun, X., and Wang, T. (2017). "Thematic Indexing, Meet Smart Beta! Merging ESG into Factor Portfolios." In: *The Journal of Index Investing* 8(3), pp. 89–101.
Many investors are starting to explore ways to integrate environmental, social, and governance (ESG) considerations into their portfolios. Factor portfolios and indexes that integrate ESG allow investors to capture both the long-term durable factor premiums while allowing them to invest in companies with attractive ESG attributes. Traditional factors and ESG both have strong investment rationale for investors with long horizons, but how should blended ESG-factor portfolios be constructed? This article discusses several ways to integrate ESG into factor portfolios. The authors show that the approach chosen depends on the investor's investment rationale behind integrating ESG, desired exposure, performance expectations, and preference for conceptual consistency.

Benedetti, D., Biffis, E., Chatzimichalakis, F., Fedele, L. L., and Simm, I. (2021). "Climate change investment risk: optimal portfolio construction ahead of the transition to a lower-carbon economy." In: *Annals of Operations Research* 299(1-2), pp. 847–871.
There is an increasing likelihood that governments of major economies will act within the next decade to reduce greenhouse gas emissions, probably by intervening in the fossil fuel markets through taxation or cap & trade mechanisms (collectively "carbon pricing"). We develop a model to capture the potential impact of carbon pricing on fossil fuel stocks, and use it to inform Bayesian portfolio construction methodologies, which are then used to create what we call Smart Carbon Portfolios. We find that investors could reduce ex-post risk by lowering the weightings of some fossil fuel stocks with corresponding higher weightings in lower-risk fossil fuel stocks and/or in the stocks of companies active in energy efficiency markets. The financial costs of such de-risking strategy are found to be statistically negligible in risk-return space. Robustness of the results is explored with alternative approaches.

Bengo, I., Borrello, A., and Chiodo, V. (2021). "Preserving the Integrity of Social Impact Investing: Towards a Distinctive Implementation Strategy." In: *Sustainability* 13(5), p. 2852.
Social impact investing (SII) is a strategy of asset allocation that aims to generate social and environmental impact alongside a financial return. Compared to other approaches of sustainable finance it holds an enormous potential of generating solutions to societal challenges. However, scholars have claimed that social impact often just employs logic upheld by the mainstream investment approach. Therefore, the paper investigates the assumption that SII has not developed a distinctive implementation strategy able to translate the prioritization of social impact into practice and how to overcome this issue. The thematic analysis of data collected through 105 interviews with Italian SII financiers and the top managers of social ventures allowed us to identify three features of an SII tailored practice: promoting a cultural shift of intermediaries, adopting a coopetition approach, and integrating the social impact in the terms of the financial transaction. Lastly, the paper drafts a research agenda to enhance the proper theorization of SII focusing on the definition of social risk, social return, and governance mechanisms. The key contribution of this article is confirming the lack of an SII-specific practice able to endogenize the intent of prioritizing social impact and providing suggestions to prevent the risk of impact washing.

Bennani, L., Le Guenedal, T., Lepetit, F., Ly, L., Mortier, V., Roncalli, T., and Sekine, T. (2019). "How ESG investing has impacted the asset pricing in the equity market." In: *SSRN e-Print*.
ESG investing has gained considerable traction over the past few years and, alongside smart beta, factor investing and alternative risk premia, is one of the current hot topics for the asset management industry. Nevertheless, even though large institutions such as insurance companies, pension funds and sovereign wealth funds have invested significantly in ESG strategies over recent years and we are observing a substantial and increasing interest from other investors such as wealth management or retail investors, the question of performance remains a controversial issue and a puzzle for the financial community. Indeed, academic findings have been mixed and have revealed a U-shape pricing of stocks in the equity market, meaning that both best-in-class and worst-in-class ESG stocks have been rewarded by the equity market in the past.In this research, we analyze the relationship between ESG and performance in the recent years (2010 - 2017) since ESG was more an anecdotal and explanatory investment idea before the Global Financial Crisis. For that, we consider different regions (North America, Europe, Japan, World) and different investment styles (passive management, active management and factor investing). We show that ESG investing has been rewarded since 2014, but not before. Across the three ESG pillars, the Environment factor in North America and the Governance factor in the Eurozone performed the strongest. Overall, the study reveals that ESG does not impact all stocks, but tends to impact best-in-class and worst-in-class assets.Contrary to common beliefs, we also observe that ESG had little impact on volatility and drawdown management during the 2010-2017 period. In the case of passive management, implementing an ESG strategy helps to improve the information ratio if the investor accepts to take a tracking error risk. Finally, we show that ESG investing is related to factor investing. In particular, we conclude that ESG investing remains an alpha strategy in North America, whereas it has become a beta strategy in the Eurozone.

Berg, F., Fabisik, K., and Sautner, Z. (2021a). "Rewriting History II: The (Un)Predictable Past of ESG Ratings." In: *SSRN e-Print*.
The explosion in ESG research has led to a strong reliance on ESG rating providers. We document widespread changes to the historical ratings of a key rating provider, Refinitiv ESG (formerly ASSET4). Depending on whether the original or rewritten data are used, ESG-based classifications of firms into ESG quantiles and tests that relate ESG scores to returns change. While there is a positive link between ESG scores and firms' stock market performance in the rewritten data, we fail to observe such a relationship in the initial data. The ESG data rewriting is an ongoing rather than a one-off phenomenon.

Berg, F., Kolbel, J., Pavlova, A., and Rigobon, R. (2021b). "ESG Confusion and Stock Returns: Tackling the Problem of Noise." In: *SSRN e-Print*.
How strongly does ESG (environmental, social and governance) performance affect stock returns? Answering this question is difficult because existing measures of performance, ESG ratings, are noisy. To tackle the bias, we propose a noise correction procedure, in which we instrument ESG ratings with ratings of other ESG rating agencies, as in the classical errors-in-variables problem. The corrected estimates demonstrate that the effect of ESG performance on stock returns is stronger than previously estimated; the standard regression estimates of ESG ratings' impact on stock returns are biased downward by about 60%. Our dataset includes scores of eight ESG rating agencies for firms located in North America, Europe, and Japan. We determine which agencies' scores are valid instruments (not all of them are) and estimate the noise-to-signal ratio for each ESG rating agency (some of which are very large). Overall, our results suggest that it is advantageous to rely on several complementary ratings. In our sample, stocks with higher ESG performance have higher expected returns. Our model provides several explanations for this finding.

Berg, F., Kolbel, J., Pavlova, A., and Rigobon, R. (2022a). "ESG Confusion and Stock Returns: Tackling the Problem of Noise." In: *American Finance Association Annual Meeting*.
How strongly does ESG (environmental, social and governance) performance affect stock returns? Answering this question is difficult because existing measures of performance, ESG ratings, are noisy. To tackle the bias, we propose a noise correction procedure, in which we instrument ESG ratings with ratings of other ESG rating agencies, as in the classical errors-in-variables problem. The corrected estimates demonstrate that the effect of ESG performance on stock returns is stronger than previously estimated; the standard regression estimates of ESG ratings' impact on stock returns are biased downward by about 60%. Our dataset includes scores of eight ESG rating agencies for firms located in North America, Europe, and Japan. We determine which agencies' scores are valid instruments (not all of them are) and estimate the noise-to-signal ratio for each ESG rating agency (some of which are very large). Overall, our results suggest that it is advantageous to rely on several

complementary ratings. In our sample, stocks with higher ESG performance have higher expected returns. Our model provides several explanations for this finding.

Berg, F., Kolbel, J. F., and Rigobon, R. (2022b). "Aggregate Confusion: The Divergence of ESG Ratings." In: *Review of Finance*.

This paper investigates the divergence of environmental, social, and governance (ESG) ratings based on data from six prominent ESG rating agencies: Kinder, Lydenberg, and Domini (KLD), Sustainalytics, Moody's ESG (Vigeo-Eiris), S&P Global (RobecoSAM), Refinitiv (Asset4), and MSCI. We document the rating divergence and map the different methodologies onto a common taxonomy of categories. Using this taxonomy, we decompose the divergence into contributions of scope, measurement, and weight. Measurement contributes 56% of the divergence, scope 38%, and weight 6%. Further analyzing the reasons for measurement divergence, we detect a rater effect where a rater's overall view of a firm influences the measurement of specific categories. The results call for greater attention to how the data underlying ESG ratings are generated.

Berk, J. B. and van Binsbergen, J. H. (2021). "The Impact of Impact Investing." In: *SSRN e-Print*.

We evaluate the quantitative impact of ESG divestitures. For divestitures to have impact they must change the cost of capital of affected firms. We derive a simple expression for the change in the cost of capital as a function of three inputs: (1) the fraction of socially conscious capital, (2) the fraction of targeted firms in the economy and (3) the correlation between the targeted firms and the rest of the stock market. Given the current state of ESG investment we find that the impact on the cost of capital is too small to meaningfully affect real investment decisions. We empirically corroborate these small estimates by studying firm changes in ESG status. When firms are either included or excluded from the leading socially conscious US index (FTSE USA 4Good) we find no detectable effect on the cost of capital. We conclude that current ESG divesture strategies have had little impact and will likely have little impact in the future. Our results suggest that to have impact, instead of divesting, socially conscious investors should invest and exercise their rights of control to change corporate policy.

Bessler, W., Opfer, H., and Wolff, D. (2017). "Multi-asset portfolio optimization and out-of-sample performance: an evaluation of Black Litterman, mean-variance, and naive diversification approaches." In: *The European Journal of Finance* 23(1), pp. 1–30.

The Black Litterman model aims to enhance asset allocation decisions by overcoming the problems of mean-variance portfolio optimization. We propose a sample-based version of the Black Litterman model and implement it on a multi-asset portfolio consisting of global stocks, bonds, and commodity indices, covering the period from January 1993 to December 2011. We test its out-of-sample performance relative to other asset allocation models and find that Black Litterman optimized portfolios significantly outperform na ive-diversified portfolios (1/N rule and strategic weights), and consistently perform better than mean-variance, Bayes Stein, and minimum-variance strategies in terms of out-of-sample Sharpe ratios, even after controlling for different levels of risk aversion, investment constraints, and transaction costs. The BL model generates portfolios with lower risk, less extreme asset allocations, and higher diversification across asset classes. Sensitivity analyses indicate that these advantages are due to more stable mixed return estimates that incorporate the reliability of return predictions, smaller estimation errors, and lower turnover.

Bessler, W. and Wolff, D. (2017). "Portfolio Optimization with Industry Return Prediction Models." In: *SSRN e-Print*.

We postulate that utilizing return prediction models with fundamental, macroeconomic, and technical indicators instead of using historical averages should result in superior asset allocation decisions. We investigate the predictive power of individual variables for forecasting industry returns in-sample and out-of-sample and then analyze multivariate predictive regression models including OLS, a regularization technique, principal components, a target-relevant latent factor approach, and forecast combinations. The gains from using industry return predictions are evaluated in an out-of-sample Black-Litterman portfolio optimization framework. We provide empirical evidence that portfolio optimization utilizing industry return prediction models significantly outperform portfolios using historical averages and those being passively managed.

Bettin, G. (2021). "Sustainable finance and ESG scores: A portfolio analysis a la Fama and French." MA thesis. Universita Ca Foscari Venezia.

In recent years, people around the world have expressed their concerns regarding the environment and society and the concept of sustainable development has expanded considerably. One way to contribute to sustainable development is to encourage individuals and institutional investors to make investment choices aimed at rewarding companies engaged in the management of environmental and social impact and committed to improving

their corporate governance. For this reason, sustainable finance has born. The prevailing approach to Sustainable and Responsible Investing (SRI) is the integration of Environmental, Social and Governance (ESG) factors into financial analysis, which can improve the risk-return profile of investments. This master thesis is a further contribution to the existing studies on the performance of ESG portfolios. First, companies included in the S&P 100 were ranked based on their ESG scores, which were provided by Refinitiv, one of the largest providers of financial data. The next step was the creation of "bottom" portfolios, consisting of the 20 low-ranked stocks and "top" portfolios, composed by the 20 high-ranked stocks. Then, long-short portfolios were constructed, by holding a long position in high-rated portfolios and a short position in low-rated portfolios. The analysis was carried out using the multi-factor models of Fama and French and discusses the possible significant differences in the performance and risk exposure between low-rated and high-rated portfolios. Thanks to this research, it has been possible to identify which portfolios perform best in the timeframe July 2003-June 2020, offering a brief insight into the effects of the COVID-19 pandemic on the financial performance of sustainable and responsible investments too.

Billio, M., Costola, M., Hristova, I., Latino, C., and Pelizzon, L. (2021). "Inside the ESG Ratings: (Dis)agreement and Performance." In: *SSRN e-Print*.
We analyze the ESG rating criteria used by prominent agencies and show that there is a lack of a commonality in the definition of ESG (i) characteristics, (ii) attributes and (iii) standards in defining E, S and G components. We provide evidence that heterogeneity in rating criteria can lead agencies to have opposite opinions on the same evaluated companies and that agreement across those providers is substantially low. Those alternative definitions of ESG also affect sustainable investments leading to the identification of different investment universes and consequently to the creation of different benchmarks. This implies that in the asset management industry it is extremely difficult to measure the ability of a fund manager if financial performances are strongly conditioned by the chosen ESG benchmark. Finally, we find that the disagreement in the scores provided by the rating agencies disperses the effect of preferences of ESG investors on asset prices, to the point that even when there is agreement, it has no impact on financial performances.

Bingler, J. A., Kraus, M., and Leippold, M. (2021). "Cheap Talk and Cherry-Picking: What ClimateBert has to say on Corporate Climate Risk Disclosures." In: *SSRN e-Print*.
Disclosure of climate-related financial risks greatly helps investors assess companies' preparedness for climate change. Voluntary disclosures such as those based on the recommendations of the Task Force for Climate-related Financial Disclosures (TCFD) are being hailed as an effective measure for better climate risk management. We ask whether this expectation is justified. We do so with the help of a deep neural language model, which we christen ClimateBert. We train ClimateBert on thousands of sentences related to climate-risk disclosures aligned with the TCFD recommendations. In analyzing the disclosures of TCFD-supporting firms, ClimateBert comes to the sobering conclusion that the firms' TCFD support is mostly cheap talk and that firms cherry-pick to report primarily non-material climate risk information. From our analysis, we conclude that the only way out of this dilemma is to turn voluntary reporting into regulatory disclosures.

Bingler, J. A., Kraus, M., Leippold, M., and Webersinke, N. (2022). "Cheap Talk in Corporate Climate Commitments: The Role of Active Institutional Ownership, Signaling, Materiality, and Sentiment." In: *SSRN e-Print*.
Corporate climate disclosures based on the TCFD recommendations are considered an important prerequisite to managing climate-related financial risks. At the same time, current disclosures are imprecise, inaccurate, and greenwashing-prone. Yet, existing research on this matter suffers from small samples or inaccuracies. Therefore, we introduce a scalable deep learning approach to enable comprehensive climate disclosure analyses of large samples by fine-tuning the ClimateBert model. Our model significantly outperforms previous approaches. We then extract the amount of cheap talk, defined as the share of precise versus imprecise climate commitments, of 14,584 annual reports of the MSCI World index firms from 2010 to 2020. Finally, we use this data to test various hypotheses on the drivers of cheap talk. We find that institutional ownership, targeted institutional investor engagement, materiality and downside risk disclosures are associated with less cheap talk. Signaling by publicly supporting the TCFD is associated with more cheap talk.

Bjerring, T., Ross, O., and Weissensteiner, A. (2017). "Feature selection for portfolio optimization." In: *Annals of Operations Research* 256, pp. 21–40.
Most portfolio selection rules based on the sample mean and covariance matrix perform poorly out-of-sample. Moreover, there is a growing body of evidence that such optimization rules are not able to beat simple rules of thumb, such as 1/N. Parameter uncertainty has been identified as one major reason for these findings. A strand of literature addresses this problem by improving the parameter estimation and/or by relying on more

robust portfolio selection methods. Independent of the chosen portfolio selection rule, we propose using feature selection first in order to reduce the asset menu. While most of the diversification benefits are preserved, the parameter estimation problem is alleviated. We conduct out-of-sample back-tests to show that in most cases different well-established portfolio selection rules applied on the reduced asset universe are able to improve alpha relative to different prominent factor models.

Blank, H., Sgambati, G., and Truelson, Z. (2016). "Best Practices in ESG Investing." In: *The Journal of Investing* 25(2), pp. 103–112.
This article examines the journey from value-based or ethical investing programs to more mainstream approaches integrating socially responsible corporate behaviors into investment processes. This trend has led to a differentiation between negative screening and best-practice ratings for environmental, social, and corporate governance (ESG) performance. The authors detail the methodology behind the Thomson Reuters corporate responsibility ratings, which provide objective and comparable quantifications of ESG performance for some 5,000 companies. They also provide a context for the usefulness of the ratings and the associated benchmarks in research and investing, for both current and future directions.

Blitz, D. and Hoogteijling, T. (2021). "Carbon-Tax-Adjusted Value." In: *SSRN e-Print*.
We examine the effects of incorporating a potential tax on carbon emissions into a value investment strategy. We show that in a portfolio optimization problem, a carbon tax at the stock level is mathematically equivalent to a carbon constraint at the portfolio level. Using this insight we derive a value-carbon efficient frontier that reflects the trade-off between a high value exposure and a low carbon footprint. Empirically we find that carbon taxes up to $100, corresponding to a portfolio carbon footprint reduction of about 50%, have little effect on the characteristics and the performance of the long side of a value strategy. Much more aggressive footprint reduction levels seem unreasonable, as they correspond to extremely high carbon tax levels and performance starts to decay.

Bohn, J., Goldberg, L. R., and Ulucam, S. (2022). "Sustainable Investing From a Practitioner's Viewpoint: What's in Your ESG Portfolio?" In: *Journal of Investment Management* 20(2).
Many investors have shifted their asset allocations to account for Environmental, Social, and Governance (ESG) issues. While we welcome this shift from an ethical perspective, the financial and non-financial benefits of ESG investing as well as best practices for portfolio construction are subjects of heated debate. We look at aspects of the debate through a series of practical examples. First, we illustrate the trade-off between risk control and unwanted exposures in energy and "vice" stock exclusions, which have exhibited inconsistent performance at a ten-year horizon. Next, we show how recent underperformance of a gender lens portfolio has been confounded by technology stocks. Finally, we explore how ESG score disparities lead to important differences in portfolios constructed with these scores. In aggregate, our examples point to the inherent complexity of ESG investing, which will benefit from better data, transparency, customization, and an acknowledgement that doing good does not necessarily lead to doing well. An important theme throughout this paper is that everything should be made as simple as possible, but no simpler.

Bolliger, G. and Cornilly, D. (2021). "Sustainability Attribution: The Case of Carbon Intensity." In: *The Journal of Impact and ESG Investing* 2(1), pp. 93–99.
This article proposes a method to decompose the carbon intensity of a portfolio with respect to a benchmark into an allocation and a selection component. The carbon-intensity decomposition allows for a better understanding of the sources of the difference between the carbon footprint of a portfolio and that of its benchmark. As such, it prevents greenwashing by analyzing whether the carbon exposure of a portfolio results from active stock selection choices on the part of the manager or from passive sector exclusion decisions. The authors' approach is based on methods developed for traditional performance attribution. They discuss an equity example using the MSCI ACWI Sustainable Impact Index and a fixed-income example around the ICE BofA Global Corporate Green Bond Index. In the latter example, they show that a higher portfolio carbon intensity does not necessarily contradict the portfolio's stated environmental, social, and governance (ESG) or impact objectives. Their methodology can easily be extended to any other sustainability or impact metric that is constructed as a weighted average of asset scores, thus providing greater precision in analyzing the sources and implications of incorporating ESG into portfolio construction.

Bolton, P. and Kacperczyk, M. (2021). "Do investors care about carbon risk?" In: *Journal of Financial Economics* 142(2), pp. 517–549.
We study whether carbon emissions affect the cross-section of US stock returns. We find that stocks of firms with higher total carbon dioxide emissions (and changes in emissions) earn higher returns, controlling for size,

book-to-market, and other return predictors. We cannot explain this carbon premium through differences in unexpected profitability or other known risk factors. We also find that institutional investors implement exclusionary screening based on direct emission intensity (the ratio of total emissions to sales) in a few salient industries. Overall, our results are consistent with an interpretation that investors are already demanding compensation for their exposure to carbon emission risk.

Bonaparte, Y. (2021). "The ESG Investor Sentiment Index: A Cross Sectional and Time Series Analyses." In: *SSRN e-Print*.

We constructed an ESG investors' sentiment Index (ESG-ISX) that reflects four key components: (1) governance: gap between women and men in labor participation and pay; (2) sustainability: renewable energy production; (3) environment: global warming index; and (4) ESG google search sentiment. Applying the ESG-ISX monthly index data between 1/2004 and 7/2021, we find it is increasing with a convex fashion, and comoves with key financial indicators, such as, companies' cost of capital. The raise of ESG investors' sentiment has implication at the household and stock market levels. At the household level, it increases the stock market participation; causes households to allocate more in risky assets, and mitigate this additional risk by increasing the number of stocks in their portfolio, hence, more diversification. At the stock market level, we show that the overall impact in equity prices is diminishing in recent years, and the raise of ESG-ISX increases the consensus and agreement among investors, as such, we suggest it has implication on the stock market volatility.

Borms, S., Boudt, K., Holle, F. V., and Willems, J. (2021). "Semi-supervised Text Mining for Monitoring the News About the ESG Performance of Companies." In: *Data Science for Economics and Finance*. Springer International Publishing, pp. 217–239.

We present a general monitoring methodology to summarize news about predefined entities and topics into tractable time-varying indices. The approach embeds text mining techniques to transform news data into numerical data, which entails the querying and selection of relevant news articles and the construction of frequency- and sentiment-based indicators. Word embeddings are used to achieve maximally informative news selection and scoring. We apply the methodology from the viewpoint of a sustainable asset manager wanting to actively follow news covering environmental, social, and governance (ESG) aspects. In an empirical analysis, using a Dutch-written news corpus, we create news-based ESG signals for a large list of companies and compare these to scores from an external data provider. We find preliminary evidence of abnormal news dynamics leading up to downward score adjustments and of efficient portfolio screening.

Boucher, C., Le Lann, W., Matton, S., and Tokpavis, S. (2021). *Backtesting ESG Ratings*. Tech. rep. University of Orleans.

Sustainable investing is growing fast and investors are increasingly integrating environmental, social and governance (ESG) criteria. However, ESG ratings are derived using heterogeneous data and non-standardised methodologies and so are quite divergent across providers, and this suggests that a formal statistical procedure is needed to evaluate the accuracy of any given ESG rating system. This paper develops a backtesting procedure that evaluates how well these extra-financial metrics help in predicting whether ESG risks will materialise, as given by increased idiosyncratic volatility. Technically, the inference is based on extending the conditional predictive ability test of Giacomini and White (2006) to a panel data setting. We apply our methodology to two ESG rating systems from Sustainalytics and Asset4 for Europe, North America and the Asia-Pacific region. The results show that the null hypothesis of lacking informational content of ESG ratings is rejected in Europe and North America, where there is less disagreement between the two ratings, while the results are mixed for the Asia-Pacific region, where there is more disagreement. Furthermore, applying the test only to firms with convergent ESG ratings leads to the null hypothesis being rejected for all three regions. Beyond providing insights into the accuracy of each of the ESG rating systems, these results suggest that information gathered from several ESG rating providers should be cross-checked before ESG is integrated into investment processes.

Branch, M., Goldberg, L. R., and Hand, P. (2019). "A guide to ESG portfolio construction." In: *The Journal of Portfolio Management* 45(4), pp. 61–66.

In this article, the authors explore six quantitative environmental (E), social (S), and governance (G) strategies to provide insights into best practices for ESG portfolio construction. These strategies offer different approaches to the trade-off between desired ESG attributes and investment performance. They conclude that fully understanding the dynamics of these trade-offs will allow investors to select the strategy that best matches their ethical and financial views.

Breedt, A., Ciliberti, S., Gualdi, S., and Seager, P. (2019). "Is ESG an Equity Factor or Just an Investment Guide?" In: *The Journal of Investing* 28(2), pp. 32–42.

Environmental, social, and governance (ESG) information demands attention within the asset management industry since it has become widely accepted that making an allowance for ESG criteria within an equity portfolio enhances returns. The authors test this proposition by incorporating ESG criteria into a worldwide market neutral portfolio using an "off-the-shelf" third-party database of individual security ratings. Our results show that incorporating ESG information into a worldwide equity-market-neutral portfolio yields no additional return because any benefits from tilting toward a better-rated ESG portfolio is already wholly captured by other well-known equity factors. Doing so, however, does not hurt returns. They conclude that ESG should not be considered as a unique equity factor.

Briere, M., Peillex, J., and Ureche, L. (2017). "Do Social Responsibility Screens Really Matter When Assessing Mutual Fund Performance?" In: *SSRN e-Print*.
This paper questions the contribution that socially responsible (SR) screening makes to mutual fund performance. We propose a new decomposition of the variability of SR mutual fund returns making it possible to isolate the contribution of SR screening and compare it with the other traditional sources of performance: market movements, asset allocation choices and active management. Our results, based on a sample of SR equity mutual funds show that SR screening does contribute to the variability of mutual fund performance, alongside other portfolio choices such as asset allocation decisions and active management. This contribution is rather modest on average (between 4% and 10%), roughly two times lower than that made by active portfolio choices.

Broadstock, D., Chan, K., Cheng, L. T. W., and Wang, X. W. (2020). "The Role of ESG Performance During Times of Financial Crisis: Evidence from COVID-19 in China." In: *SSRN e-Print*.
We examine the role of ESG performance during market-wide financial crisis, triggered in response to physical and economic lockdowns arising from the COVID-19 global pandemic. These unique circumstances create an inimitable opportunity to question if investors interpret ESG performance as a signal of future stock performance and/or risk mitigation. Using a novel dataset covering China's CSI300 constituents, we illustrate that (i) high ESG portfolios tend to outperform low ESG portfolios (ii) that ESG performance mitigates financial risk during financial crisis and (iii) the role of ESG performance is attenuated in 'normal' times, confirming their incremental importance during crisis. We phrase the results in the context of ESG investment practices.

Bruder, B., Cheikh, Y., Deixonne, F., and Zheng, B. (2019). "Integration of ESG in asset allocation." In: *SSRN e-Print*.
In this paper, we try to identify the relationship between the ESG scores and stocks' performance and risk measures. Using the ESG database of MSCI, we split the global investment universe into three regions: Europe, North America and Asia-Paci c. The investment universe of each region is de ned by the components of the corresponding MSCI index which is rebalanced every month. A simple statistical check allows us to verify the integrity of the database. For the portfolio construction of E/S/G/ESG factors, the ESG scores are normalized for all stocks in the same sector such that the sectorial bias is minimized. We nd that Governance score can signi cantly improve the portfolio's performance both in Europe and North America, meanwhile, the market of Asia-Paci c is not sensitive to E/S/G/ESG scores. It is interesting to remark that the Governance factor in Europe can be explained by traditional Quality factor, meaning that there is some equivalence between Governance score and Quality indicators. In terms of risk measures, we observe that stocks with higher Governance and Environmental scores are exposed to lower risks measured by maximum drawdown or volatility, for Europe and North America. In Asia-Paci c, it is difficult to make any conclusion on the relationship between risk measures and ESG scores.

Bruni, R., Cesarone, F., Scozzari, A., and Tardella, F. (2016). "Real-world datasets for portfolio selection and solutions of some stochastic dominance portfolio models." In: *Data in Brief* 8, pp. 858–862.
A large number of portfolio selection models have appeared in the literature since the pioneering work of Markowitz. However, even when computational and empirical results are described, they are often hard to replicate and compare due to the unavailability of the datasets used in the experiments. We provide here several datasets for portfolio selection generated using real-world price values from several major stock markets. The datasets contain weekly return values, adjusted for dividends and for stock splits, which are cleaned from errors as much as possible. The datasets are available in different formats, and can be used as benchmarks for testing the performances of portfolio selection models and for comparing the efficiency of the algorithms used to solve them. We also provide, for these datasets, the portfolios obtained by several selection strategies based on Stochastic Dominance models (see "On Exact and Approximate Stochastic Dominance Strategies for Portfolio Selection" (Bruni et al. [2])). We believe that testing portfolio models on publicly available datasets greatly simplifies the comparison of the different portfolio selection strategies.

Bruni, R., Cesarone, F., Scozzari, A., and Tardella, F. (2017). "On exact and approximate stochastic dominance strategies for portfolio selection." In: *European Journal of Operational Research* 259(1), pp. 322–329.
New type of approximate stochastic dominance designed for portfolio selection. Equivalent to minimizing the expected shortfall of the portfolio below the benchmark. An easily solvable LP model for the practical implementation of our approach. Extensive empirical comparison of stochastic dominance models for portfolio selection. One recent and promising strategy for Enhanced Indexation is the selection of portfolios that stochastically dominate the benchmark. We propose here a new type of approximate stochastic dominance rule which implies other existing approximate stochastic dominance rules. We then use it to find the portfolio that approximately stochastically dominates a given benchmark with the best possible approximation. Our model is initially formulated as a Linear Program with exponentially many constraints, and then reformulated in a more compact manner so that it can be very efficiently solved in practice. This reformulation also reveals an interesting financial interpretation. We compare our approach with several exact and approximate stochastic dominance models for portfolio selection. An extensive empirical analysis on real and publicly available datasets shows very good out-of-sample performances of our model.

Bruno, G., Esakia, M., and Goltz, F. (2022). ""Honey, I Shrunk the ESG Alpha": Risk-Adjusting ESG Portfolio Returns." In: *The Journal of Investing* 31(3), pp. 45–61.
The authors construct ESG strategies that have been shown to outperform in popular articles. They assess performance benefits to investors when accounting for sector and factor exposures. They find that most of the outperformance of these strategies can be explained by their exposure to equity style factors that are mechanically constructed from balance sheet information. This result is robust across different multifactor models. Furthermore, the ESG strategies tested show large sector biases. Removing these biases also removes outperformance. They conclude that claims on ESG outperformance in popular articles are not valid.

Bryzgalova, S., Huang, J., and Julliard, C. (2021). "Bayesian solutions for the factor zoo: we just ran two quadrillion models." In: *SSRN e-Print*.
We propose a novel, and simple, Bayesian estimation and model selection procedure for cross-sectional asset pricing. Our approach, that allows for both tradable and non-tradable factors, and is applicable to high dimensional cases, has several desirable properties. First, weak and spurious factors lead to diffuse, and centered at zero, posteriors for their market price of risk, making such factors easily detectable. Second, posterior inference is robust to the presence of such factors. Third, we show that flat priors for risk premia lead to improper marginal likelihoods, rendering model selection invalid. Therefore, we provide a novel prior, that is diffuse for strong factors but shrinks away useless ones, under which posterior probabilities are well behaved, and can be used for factor and (non necessarily nested) model selection, as well as model averaging, in large scale problems. We apply our method to a very large set of factors proposed in the literature, and analyse 2.25 quadrillion possible models, gaining novel insights on the empirical drivers of asset returns.

Bush, R., Chen, J., and Legunn, E. (2020). "E, S, or G - Analyzing Global ESG Performance." In: *The Journal of Impact and ESG Investing* 1(2), pp. 16–25.
The authors propose a framework for analyzing the risk and return impact of environmental, social, and governance (ESG) investing across regional equity markets. By examining the performance of ESG through passive index exposure via the MSCI ESG Leaders methodology, we seek to determine: 1) whether an ESG investment has generated meaningful, statistically significant alpha in the single-index model, 2) if any such alpha does exist, whether it is simply explained by known risk premia 3) in regions where ESG has empirically added meaningful alpha, which of the three pillars, E, S, or G, has been the main determinant of this alpha, and whether the sensitivity to each of the three pillars has changed over time, and 4) the extent to which any ESG alphas are correlated across regions.

Cai, L., Cooper, R., and He, D. (2022). "Socially Responsible Investing and Factor Investing, Is There an Opportunity Cost?" In: *The Journal of Portfolio Management* 48(2), pp. 181–197.
This article examines factor investing in the presence of an environment, social, and governance (ESG) screening overlay. The authors find that virtually no degradation in performance or turnover costs occur when using a negative-based ESG screen (i.e., removing only companies that have an actively bad ESG score). However, there are severe risk-induced performance issues and high transactions costs involved when the screening process becomes more active and includes only companies that are ESG-forward. The authors find that this is true for individually constructed factor portfolios, a composite benchmark of factor portfolios, and a stock selection model constructed from factor scores. Interestingly, they find that both screening methodologies produce significant improvement in ESG portfolio scores. They find very modest increases in turnover with the ESG screening of

bad companies and significant costs with the more aggressive ESG screening techniques. In general, the authors conclude that ESG screening of negative companies is a positive way forward for agents who wish to add ESG to their factor-based investment portfolios and that the method of implementing ESG makes a large difference in outcomes.

Cakici, N. and Zaremba, A. (2021). "Responsible Investing: ESG Ratings and the Cross-Section of International Stock Returns." In: *SSRN e-Print*.
Does socially responsible investing pay off? The investigation of 49 developed and emerging markets indicates that environmental, social, and governance ratings negatively predict future stock returns. A decile of global stocks with the highest ESG scores underperforms their low-rated counterparts by 4.68% per year. However, the superior returns on irresponsible companies are driven by the small firm effect. By buying unethical stocks, investors harvest the size premium. Once its role is isolated, the ESG companies no longer differ from their peers.

Caldeira, J. N. M. d. J. M. (2021). "Impact of ESG on financial performance on the most capitalized stock markets : evidence from the USA Europe and Asia." MA thesis. Universidade Catolica Portuguesa.
This paper analyzes the relationship between the corporate Environmental, Social, and Governance (ESG) score and stock returns. Contrary to previous literature, this study covers two recent time frames, 2010-2018 and 2015-2018, in three different regions: USA, Europe, and Asia. To predict each ESG pillar's effect on excess stock returns, a regression model was used. This paper finds a negative impact of the Environmental score on excess returns on the US, a positive impact of the Social score on the US and Asia and a positive impact of the ESG score on stock returns in Asia. Additionally, resourcing to a portfolio construction method, this paper shows evidence that portfolios containing the top ESG score stocks can outperform those containing the bottom ones. Between 2010 and 2018, there was evidence that a portfolio that buys (shorts) the best (worst) Governance score achieved positive abnormal returns in Europe. In the 2015-2018 period, in the USA and Europe, a portfolio that buys (shorts) the best (worst) ESG score stocks achieved positive abnormal returns. In Asia, there was no evidence of positive abnormal returns. Although the relationship between ESG and stock returns will depend heavily on the time frame and region, this paper showed clear benefits in adopting a socially responsible investment approach. Furthermore, an ethical dilemma arises where investors must acknowledge that the returns obtained by a less socially responsible portfolio with stocks linked with the production/distribution of tobacco, alcohol, firearms, and fuels lead to higher returns comparing to ESG rich portfolios.

Calvo, C., Ivorra, C., and Liern, V. (2015). "Finding socially responsible portfolios close to conventional ones." In: *International Review of Financial Analysis* 40, pp. 52–63.
An increasing number of investors are interested in sustainable, responsible and impact investment (SRI). However, there is a concern about the possible financial sacrifice associated to this kind of investments. The design of Decision Support Systems assisting socially responsible investors in their investment decisions can contribute to stimulate SRI. In this paper the financial content of a portfolio selection model is discussed in order to justify that it can be integrated into a Decision Support System designed for investors interested in socially responsible investment but initially reluctant to pay a financial cost in exchange for increasing the social responsibility of their portfolios. Investor's preferences are incorporated by means of adequate parameters of a utility function designed for handling subjective criteria in a reliable way. We show that these parameters can be determined by means of a non-technical questionnaire addressed to the investor, and that they can faithfully reflect his/her preferences about achieving an SRI performance as good as possible without going too far from the financial efficient frontier or even from an initial choice of an efficient pair of financial risk and return. The proposed procedure is illustrated by means of two examples. A first small example illustrates the decision making process followed in order to obtain the required parameters from the investor. The second example is intended to show how the proposed procedure can be applied to real world problems including financial constraints which are hard from a computational point of view.

Cao, J., Goyal, A., Zhan, X., and Zhang, W. E. (2021). "Unlocking ESG Premium from Options." In: *SSRN e-Print*.
We find that option expensiveness, as measured by implied volatility, is higher for low-ESG stocks, showing that investors pay a premium in the option market to hedge ESG-related uncertainty. Using delta-hedged option returns, we estimate this ESG premium to be about 0.3% per month. All three components of ESG contribute to option pricing. The effect of ESG performance heightens after the announcement of Paris Agreement, after speeches of Greta Thunberg, and in the aftermath of Me-Too movement. We find that investors pay ESG premium to hedge volatility, jump, and other higher moment risks. The influence of ESG on option premia is

stronger for firms that are closer to end-consumers, facing severer product competition, with higher investors' ESG awareness, and without corporate hedging activity.

Cesarone, F., Martino, M. L., and Carleo, A. (2022). "Does ESG impact really enhances portfolio profitability?" In: *SSRN e-Print*.

Over the last few decades, a growing attention to the Social Responsibility (SR) topic has affected financial markets and institutional authorities. Indeed, recent environmental, social and financial crises have inevitably led regulators and investors to take into account the sustainable investing issue. However, the question of how Environmental, Social and Governance (ESG) criteria impact financial portfolio performances, is still open. In this work, we examine a multi-objective optimization model for portfolio selection, where we add to the classical Mean-Variance analysis, a third non-financial goal represented by the ESG scores. The resulting optimization problem, formulated as a (convex) Quadratic Programming (QP), consists in minimizing the portfolio variance with parametric lower bounds on the levels of the portfolio expected return and ESG. We provide here an extensive empirical analysis on five datasets involving real-world capital market indices from major stock markets. Our empirical findings typically reveal the presence of two behavioral patterns for the 16 Mean-Variance-ESG portfolios analyzed. Indeed, over the last fifteen years we can distinguish two non-overlapping time windows on which the inclusion of portfolio ESG targets leads to different regimes in terms of portfolio profitability. Furthermore, on the most recent time window we observe that, for the US markets, imposing a high ESG target tends to select portfolios that show better financial performances than the other strategies, whereas for the European markets the ESG constraint does not seem to improve the portfolio profitability.

Cesarone, F., Moretti, J., and Tardella, F. (2018). "Why Small Portfolios Are Preferable and How to Choose Them." In: *SSRN e-Print*.

One of the fundamental principles in portfolio selection models is minimization of risk through diversification of the investment. However, this principle does not necessarily translate into a request for investing in all the assets of the investment universe. Indeed, following a line of research started by Evans and Archer almost 50 years ago, we provide here further evidence that small portfolios are sufficient to achieve almost optimal in-sample risk reduction with respect to variance and to some other popular risk measures, and very good out-of-sample performances. While leading to similar results, our approach is significantly different from the classical one pioneered by Evans and Archer. Indeed, we describe models for choosing the portfolio of a prescribed size with the smallest possible risk, as opposed to the random portfolio choice investigated in most of the previous works. We find that the smallest risk portfolios generally require no more than 15 assets. Furthermore, it is almost always possible to find portfolios that are just 1% more risky than the smallest risk portfolios and contain no more than 10 assets. The preference for small optimal portfolios is also justified by recent theoretical results on the estimation errors for the parameters required by portfolio selection models. Our empirical analysis is based on some new and on some publicly available benchmark data sets often used in the literature.

Cesarone, F., Mottura, C., Ricci, J. M., and Tardella, F. (2019). "On the stability of portfolio selection models." In: *SSRN e-Print*.

One of the main issues in portfolio selection models consists in assessing the effect of the estimation errors of the parameters required by the models on the quality of the selected portfolios. Several studies have been devoted to this topic for the minimum variance and for several other minimum risk models. However, no sensitivity analysis seems to have been reported for the recent popular Risk Parity diversification approach, nor for other portfolio selection models requiring maximum gain-risk ratios.Based on artificial and real-world data, we provide here empirical evidence showing that the Risk Parity model is always the most stable one in all the cases analyzed. Furthermore, the minimum risk models are typically more stable than the maximum gain-risk models, with the minimum variance model often being the preferable one.

Chan, Y., Hogan, K., Schwaiger, K., and Ang, A. (2020). "ESG in Factors." In: *The Journal of Impact and ESG Investing* 1(1), pp. 26–45.

Environmental, social, and governance (ESG) signals are an important part of factor-based investing strategies as they can stem from the same economic rationales as general factor premiums. Because factors are broad and diversified, building portfolios by jointly optimizing factor exposures with ESG and carbon outcomes can result in similar historical performance as benchmark factor portfolios that do not include those considerations. We show how sustainable signals, which often involve alternative data, can be integrated in the definitions of factors themselves: We offer two examples on green intangible value and corporate culture quality which enhance traditional financial value and quality factors, respectively.

Chang, C.-H., Tan, S., Lengerich, B., Goldenberg, A., and Caruana, R. (2021). "How Interpretable and Trustworthy

are GAMs?" In: *Proceedings of the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining*. ACM.
Generalized additive models (GAMs) have become a leading model class for interpretable machine learning. However, there are many algorithms for training GAMs, and these can learn different or even contradictory models, while being equally accurate. Which GAM should we trust? In this paper, we quantitatively and qualitatively investigate a variety of GAM algorithms on real and simulated datasets. We find that GAMs with high feature sparsity (only using a few variables to make predictions) can miss patterns in the data and be unfair to rare subpopulations. Our results suggest that inductive bias plays a crucial role in what interpretable models learn and that tree-based GAMs represent the best balance of sparsity, fidelity and accuracy and thus appear to be the most trustworthy GAM models.

Chaudhuri, S. E. and Lo, A. W. (2019). "Dynamic Alpha: A Spectral Decomposition of Investment Performance Across Time Horizons." In: *Management Science* 65(9), pp. 4440–4450.
The value added by an active investor is traditionally measured using alpha, tracking error, and the information ratio. However, these measures do not characterize the dynamic component of investor activity, nor do they consider the time horizons over which weights are changed. In this paper, we propose a technique to measure the value of active investment that captures both the static and dynamic contributions of an investment process. This dynamic alpha is based on the decomposition of a portfolio's expected return into its frequency components using spectral analysis. The result is a static component that measures the portion of a portfolio's expected return resulting from passive investments and security selection and a dynamic component that captures the manager's timing ability across a range of time horizons. Our framework can be universally applied to any portfolio and is a useful method for comparing the forecast power of different investment processes. Several analytical and empirical examples are provided to illustrate the practical relevance of this decomposition.

Chava, S., Kim, J. H. (, and Lee, J. (2021). "Doing Well by Doing Good? Risk, Return, and Environmental and Social Ratings." In: *SSRN e-Print*.
We analyze the risk and return characteristics across firms sorted by their environmental and social (ES) ratings. We document that ES ratings have no significant relationship with average stock returns or unconditional market risk. Stocks of firms with higher ES ratings do have significantly lower systematic downside risk. Such reduction in downside risk delivers modest, yet non-trivial, gain in long-term returns of around 0.96% per annum. Realized firm news sentiment and institutional trading patterns are also consistent with these results. Our evidence suggests that investors who derive non-pecuniary benefits from ES investing need not sacrifice performance in the stock market.

Cheema-Fox, A., LaPerla, B. R., Serafeim, G., Turkington, D., and Wang, H. ((2021). "Decarbonization Factors." In: *The Journal of Impact and ESG Investing* 2(1), pp. 47–73.
In the face of accelerating climate change, investors are making capital allocations seeking to decarbonize portfolios by reducing the carbon intensity of their holdings. To understand the performance of portfolio decarbonization strategies and investor behavior toward decarbonization, the authors construct decarbonization factors that go long low-carbon-intensity and short high-carbon-intensity sectors, industries, or companies. They consider several portfolio formation strategies and find that strategies that lowered carbon emissions more aggressively performed better. Decarbonization factor returns are associated with contemporaneous institutional flows into the factors. Buying decarbonization factors when coincident flows are positive while selling when they are negative produces significantly positive alphas. Combining decarbonization factors that have positive contemporaneous flows would provide investors with significantly superior returns and continuous exposure to low-carbon portfolios. The results are more pronounced in Europe relative to the United States. The results suggest that institutional investor flows contain information about anticipated fundamentals related to climate change developments.

Chen, M. and Mussalli, G. (2020). "An integrated approach to quantitative ESG investing." In: *The Journal of Portfolio Management* 46(3), pp. 65–74.
ESG investing is an area of active interest for both the investment and academic communities. Despite the intense interest, there currently is no agreed upon definition of ESG investing, or how to best build investment portfolios that incorporate both return and sustainability dimensions. (Both are important for sustainability-minded investors.) In this article, the authors categorize the broad types of ESG investing currently in the market and introduce an ESG investment framework. This results in a portfolio that optimally combines the dual objectives of alpha and sustainability outperformance.

Chen, M., Mussalli, G., Amel-Zadeh, A., and Weinberg, M. O. (2022). "NLP for SDGs: Measuring Corporate Alignment with the Sustainable Development Goals." In: *The Journal of Impact and ESG Investing* 2(2).
This article uses advanced natural language processing NLP methods to identify companies that are aligned with the UN Sustainable Development Goals SDGs based on the text in their sustainability disclosures. Using the Corporate Social Responsibility (CSR) reports of Russell 1000 companies between 2010-2019, we apply a logistic classifier, support vector machines (SVM), and a fully connected neural network to predict alignment with the SDGs. Specifically, we use word embeddings to augment dictionary-based input features, as well as the embeddings as features themselves, based on Word2Vec and Doc2Vec models to classify companies' alignment with the SDGs over time. Notably, the Doc2Vec embedding inputs to the SVM classifier result in high average accuracy of above 80% for predicting alignment.

Chen, M., von Behren, R., and Mussalli, G. (2021). "The Unreasonable Attractiveness of More ESG Data." In: *The Journal of Portfolio Management* 48(1), pp. 147–162.
Sustainable investing is of tremendous interest in both academia and the investment industry. However, despite the interest and the surge in assets under management (AUM) inflow, environment, social, and governance (ESG) data currently remain a fundamental challenge because they are deficient in quantity, consistency, and quality. In light of this data challenge, many investors and academics have come to rely on commercial ESG raters to assess the ESG quality of various corporations. However, the commercial ESG ratings still suffer some notable biases. This article documents one possible bias, termed quantity bias. The authors find that the amount of ESG data available for a given company is positively correlated with the commercial ESG rating of that company and the weighted average cost of its capital. The implication for investors is that they should do their homework and examine what the ESG data actually say rather than simply check the box. For corporations, it implies that they will get favorable treatment in the capital market if they publish more ESG data.

Chen, S. and Bowler, M. (2021). "Constructing and Validating Climate Risk Factors from ESG Data: an Empirical Comparison." In: *SSRN e-Print*.
Increased concern about climate change has led many investors to focus on its effects on portfolio returns. ESG metrics used for analyzing climate risks, however, have been shown to be inconsistent. What would happen if they were used in analyzing the climate risks of portfolios and making climate-aligned investments? In this paper, we look at different ways to incorporate ESG metrics into the investment process by creating climate factors for use with multi-factor equity returns models. We found that different ESG metrics do indeed lead to very different, sometimes even opposite, investment recommendations. At the same time, it was possible to create at least one climate factor from Exchange Traded Funds which could be used to identify investment opportunities and monitor climate risks in the Energy industry. This suggests that the market is trading to a systematic climate factor in at least one industry. The methodologies in this paper for validating the climate factors created from ESG metrics could be used to develop climate factors for other industries. It could also be used to test the validity of ESG metrics and of the integration of climate risk analysis into managers' investment processes.

Chen, Y. and Deleon, A. (2020). "Financial Quality Metrics and ESG Factor Interactions in Equity Markets." In: *The Journal of Impact and ESG Investing* 1(2), pp. 7–15.
As investor's interests in indexes tilt toward quality factors grow, many of them mistakenly conflate ESG (environmental, social, and governance) factors with quality factors when they seek to integrate ESG data into their investment process. This article offers a different perspective on the relationship between quality factors and ESG factors, as well as the financial materiality of different multifactor combinations of quality and ESG factors across six-year monthly rebalanced in-sample backtests (June 28, 2013 to April 30, 2019) on the Russell 1000 Index, Russell 2000 Index, and MSCI EAFE Index. The authors compare the return streams and correlations of ROE, ROA, ROIC, MSCI IVA Score, and their corresponding equal-weighted multifactor combinations. The ESG and financial quality factors are uncorrelated, suggesting that well-rated ESG companies are not always high-quality companies. In some cases, the combination of quality and ESG is a stronger predictor for high returns than either quality factor or ESG factor alone.

Choi, D., Gao, Z., and Jiang, W. (2020). "Measuring the carbon exposure of institutional investors." In: *The Journal of Alternative Investments* 23(1), pp. 12–23.
The authors introduce a simple definition of carbon-intensive firms to measure institutional investors exposure to the emission intensities of portfolio companies. The definition is based on major emission industry sectors identified by the Intergovernmental Panel on Climate Change (IPCC). All firms in these industries are classified as carbon-intensive. The authors show that 13F institutions, on average, gradually reduce their carbon exposure

relative to the US value-weighted market portfolio, from overweighting stocks of high-emission firms by 0.5% in 2001 to underweighting by 0.2%-0.7% since 2015, consistent with the view that investors have become more concerned about the financial implications of climate change. Compared with firm-level emission data obtained from vendors, the authors measure is free from selection issues and can be extended to early periods and to international markets, as it only depends on industry classifications and covers all stocks. The authors do not find the same divestment trend before 2000, when climate risks were less eminent.

Chong, J. and Phillips, G. M. (2016). "ESG Investing: A Simple Approach." In: *The Journal of Wealth Management* 19(2), pp. 73–88.
Socially conscious individual investors face a host of challenges, not least of which are a stock buy list screened by environmental, social, and governance (ESG) criteria, and investment strategies that are easily implementable. In this study, we addressed these issues by utilizing a publicly available ESG stock list (100 Best Corporate Citizens) with investment strategies involving low-volatility investing, mean-variance optimization, and equally weighted approach, and introducing an innovative method in estimating the return premium due to survivorship bias. Over the period under review, the various strategies and shortlisted ESG stock mutual funds outperformed the SandP 500 index.

Climent, R. B., Garrigues, I. F.-F., Paraskevopoulos, I., and Santos, A. (2021). "ESG Disclosure and Portfolio Performance." In: *Risks* 9(10), p. 172.
This paper illustrates the impact of Environmental Social and Governance (ESG) disclosure on European corporate equity performance. In this study, we use an extensive data set of European ESG ratings provided by Bloomberg to demonstrate that ESG disclosure is associated with improved return growth, with the Governance pillar exhibiting the strongest effect on corporate performance. The impact of ESG disclosure on volatility is changing over time, suggesting that the existence of opaque ratings limits the transmission of information disclosure into corporate performance.

Coqueret, G. (2021). "Perspectives in ESG equity investing." In: *SSRN e-Print*.
The research on sustainable finance has intensified in the past decade. In this survey, we synthesize recent academic results and models on socially responsible investing (SRI) in equity markets. We split our review into six thematic parts: data issues, investor preferences, link with financial performance, portfolio integration, climate change risk, and theoretical models.

Coqueret, G. (2022a). *Perspectives in sustainable equity investing*. Boca Raton: CRC Press. 140 pp.
Sustainable investing has recently gained traction throughout the world. This trend has multiple sources, which span from genuine ethical concerns to hopes of performance boosting, and also encompass risk mitigation. The resulting appetite for green assets is impacting the decisions of many investors. Perspectives in Sustainable Equity Investing is an up-to-date review of the academic literature on sustainable equity investing. It covers more than 800 academic sources grouped into six thematic chapters. Designed for corporate sustainability and financial management professionals, this is an ideal reference for ESG-driven financiers (both retail and institutional). Students majoring in finance or economics with some background or interest in ESG concerns would also find this compact overview useful.

Coqueret, G. (2022b). *Perspectives in sustainable equity investing (website version)*.
This website is periodically updated. The printed version of the book is published by CRC Press, This short book is a large-scale literature review on the topic of sustainable equity investing. It covers more than 900 academic sources (research articles, overwhelmingly), grouped into six thematic chapters. As such, it can serve as reference for analysts and researchers who work on environmental, social or governance (ESG)-driven portfolios. The book assumes no prior knowledge of this field, but some parts, especially the last chapter, can be rather technical mathematically. While the sheer number of references may seem exhaustive, the survey only scratches the surface of the topic because the amount of contributions is daunting. The best round estimate on the pace of the development of the literature is roughly two serious papers per day (based on one year of compiling research output). The intellectual production on this matter is such that surveying a narrow subfield thereof can take weeks. In addition, all facets of the issue are interconnected, so that it does not make any sense to consider them separately. Focusing on pure ESG integration without notions in climate change risk is ill-advised. The big picture matters. Briefly, we outline the chapters of the book below.

- Chapter 2 introduces a large number of terms to make sure the reader familiarizes with the jargon and nomenclature.
- In Chapter 3, we cover the broad theme of green investors, including their beliefs, preferences, and practices, as well as the topic of impact investing.

- Chapter 4, which is the core of the book, is dedicated to the very complex relationship between ESG investing and financial performance.
- Technical details on how to integrate sustainable criteria in complex portfolio optimization are provided in Chapter 5.
- The subject of climate change (its measurement, impact, and how to tackle it) is treated in Chapter 6.
- Finally, Chapter 7 is dedicated to theoretical models related to ESG investing and to the push for sustainability more broadly in the economy.

The review is compact, meaning that we favored concision to in-depth treatment. The monograph is intended as a thematic compass, pointing towards some relevant directions. For many topics, the interested reader will have to satisfy his or her curiosity by examining the mentioned references.

Coqueret, G., Stiernegrip, S., Morgenstern, C., Kelly, J., Frey-Skott, J., and Osterberg, B. (2021a). "Boosting ESG-Based Optimization With Asset Pricing Characteristics." In: *SSRN e-Print*.
This article investigates the usefulness of combining traditional factors with ESG data when building optimal equity portfolios. Our contribution departs from the traditional literature by focusing on allocations designed to adjust benchmark policies. We allow compositions to be embedded in a general factor framework in which firm characteristics are the main drivers of the portfolio weights. In line with much of the literature, our results suggest that it is feasible to improve the ESG score of a portfolio without it being detrimental to its out-of-sample performance. However, pure sustainable attributes alone do not allow to fulfil this objective: they need to be boosted by non-ESG predictors to deliver their full potential.

Coqueret, G., Stiernegrip, S., Morgenstern, C., Kelly, J., Frey-Skott, J., and Osterberg, B. (2021b). "ESG Equity Investing: A Short Survey." In: *SSRN e-Print*.
This article investigates the usefulness of combining traditional factors with ESG data when building optimal equity portfolios. Our contribution departs from the traditional literature by focusing on allocations designed to adjust benchmark policies. We allow compositions to be embedded in a general factor framework in which firm characteristics are the main drivers of the portfolio weights. In line with much of the literature, our results suggest that it is feasible to improve the ESG score of a portfolio without it being detrimental to its out-of-sample performance. However, pure sustainable attributes alone do not allow to fulfil this objective: they need to be boosted by non-ESG predictors to deliver their full potential.

Coqueret, G. and Tran, V. L. (2022). "ESG news spillovers to (and from) the supply chain." In: *SSRN e-Print*.
In this article, we document the impact of ESG shocks on the returns of suppliers and clients of affected firms. Our equilibrium model suggests that this impact is contingent not only on the sign and magnitude of the shock, but also on the product between the shock and the level of the ESG score. An empirical analysis of US stocks, along with their global clients and suppliers, reveals that ESG shocks are integrated into prices intra-daily and that the cross-effect between shocks and ESG levels is statistically significant. The indirect diffusion of ESG shocks to customers' and suppliers' returns is also significant, but takes more time (a few days) and is less pronounced.

Cornell, B. (2020). "ESG Investing: Conceptual Issues." In: *The Journal of Wealth Management* 23(3), pp. 61–69.
Using criteria based on environmental, social, and governance (ESG) considerations has become an increasingly important aspect of investment decision making, particularly for high-profile institutional investors. As of 2019, sustainable assets under management were estimated to be 30 trillio USDn worldwide. The claim here is that the enthusiasm for ESG investing has been exaggerated for three reasons. First, it is not clear what constitutes an ESG investment in the context of a complex, integrated economy. Second, the impact on investment performance of a preference for ESG investments has not been sufficiently recognized outside academic circles. Finally, many leading practitioners have stated that the importance of ESG considerations implies that the corporate objective of maximizing shareholder value, which lies at the core of much of finance theory, is outdated and needs to be replaced by a more comprehensive stakeholder model. The conclusion is that both the benefits of the traditional model and the dangers of a broader stakeholder model have not be adequately appreciated.

Cornell, B. (2021a). "ESG preferences, risk and return." In: *European Financial Management* 27(1), pp. 12–19.
There are two primary factors that affect expected returns for companies with high ESG (environmental, social and governance) ratings-investor preferences and risk. Although investor preferences for highly rated ESG companies can lower the cost of capital, the flip side of the coin is lower expected returns for investors. Regarding risk, the jury remains out on whether there is an ESG-related risk factor. However, to the extent, ESG is a risk

factor it also points towards lower expected returns for investments in highly rated companies. Though ESG investing may have social benefits, higher expected returns for investors are not among them.

Cornell, B. (2021b). "Is the Stock Market Worried About Climate Change? Lessons from the 2010s." In: *The Journal of Impact and ESG Investing* 1(3), pp. 51–58.
On Christmas Eve 2019, the MIT Technology Review published an article entitled "The 2010s Were Another Lost Decade on Climate Change." On New Year's Day, the Washington Post published a longer article with the same title. Both pieces told basically the same story, one repeated by many environmentalists and climate experts, the failure to take meaningful action on climate change in the 2010s had dramatically exacerbated the problem. This article investigates how the stock market reacted to the negative climate-related news that emerged during the 2010s. The results suggest that at an aggregate level the stock market was unconcerned about the climate news, implying that the market believed that climate change would not have a major impact on future macroeconomic growth. There is evidence, however, that the market concluded that climate issues would be a significant problem for fossil fuel companies.

Cornell, B. and Damodaran, A. (2020). "Valuing ESG: Doing Good or Sounding Good?" In: *SSRN e-Print*.
In the last decade, companies have come under pressure to be socially conscious and environmentally responsible, with the pressure coming sometimes from politicians, regulators and interest groups, and sometimes from investors. The argument that corporate managers should replace their singular focus on shareholders with a broader vision, where they also serve other stakeholders, including customers, employees and society, has found a receptive audience with corporate CEOs and institutional investors. The pitch that companies should focus on "doing good" is sweetened with the promise that it will also be good for their bottom line and for shareholders. In this paper, we build a framework for value that will allow us to examine how being socially responsible can manifest in the tangible ingredients of value and look at the evidence for whether being socially responsible is creating value for companies and for investors.

Cosemans, M., Hut, X., and Dijk, M. A. V. (2021). "Climate Change and Long-Horizon Portfolio Choice: Combining Theory and Empirics." In: *SSRN e-Print*.
We propose a novel approach for measuring the impact of climate change on long-horizon equity risk and optimal portfolio choice. Our method combines historical data about the impact of climate change on return dynamics with prior beliefs elicited from the temperature long-run risk (LRR-T) model of Bansal, Kiku, and Ochoa (2019). Our Bayesian framework incorporates this prior information to obtain more precise estimates of long-term climate risks than existing methods that solely rely on historical data. Compared to the benchmark investor without climate change, we document that the LRR-T Bayesian investor predicts higher equity premia for all investment horizons, with per period variance increasing considerably over the horizon. This results in relatively (high) low allocations to equities in the (short) long run. Investors that optimize between portfolios that are vulnerable and non-vulnerable to climate change only diversify in the long run.

D'Amato, V., D'Ecclesia, R., and Levantesi, S. (2021). "Fundamental ratios as predictors of ESG scores: a machine learning approach." In: *Decisions in Economics and Finance* 44(2), pp. 1087–1110.
Sustainable and responsible finance incorporates Environmental, Social, and Governance (ESG) principles into business decisions and investment strategies. In recent years, investors have rushed to Sustainable and Responsible Investments in response to growing concerns about the risks of climate change. Asset managers look for some assessment of sustainability for guidance and benchmarking, for instance, USD30 trillion of assets are invested using some ESG ratings. Several studies argue that good ESG ratings helped to prop up stock returns during the 2008 Global Financial Crisis. The ESG score represents a benchmark of disclosures on public and private firms, it is based on different characteristics which are not directly related to the financial performance (Harvard Law School Forum on Corporate Governance, ESG reports and ratings:what they are, why they matter). The role of ESG ratings and their reliability have been widely discussed (Berg et al. Aggregate confusion: the divergence of ESG ratings, MIT Sloan Research Paper No. 5822-19, 2019). Sustainable investment professionals are unsatisfied with publicly traded companies' climate-related disclosure. This negative sentiment is particularly strong in the USA, and within asset managers who do not believe that markets are consistently and correctly pricing climate risks into company and sector valuations. We believe that ESG ratings, when available, still affect business and finance strategies and may represent a crucial element in the company's fundraising process and on shares returns. We aim to assess how structural data as balance sheet items and income statements items for traded companies affect ESG scores. Using the Bloomberg ESG scores, we investigate the role of structural variables adopting a machine learning approach, in particular, the Random Forest algorithm. We use balance sheet data for a sample of the constituents of the Euro Stoxx 600 index, referred to the last decade, and investigate how

these explain the ESG Bloomberg ratings. We find that financial statements items represent a powerful tool to explain the ESG score.

Dash, G. H. and Kajiji, N. (2021). "Behavioral Portfolio Management with Layered ESG Goals and AI Estimation of Asset Returns." In: *SSRN e-Print*.
Portfolio managers and individual investors alike are in quest of efficient asset allocation models that simultaneously express environmental, social, and governance (ESG) considerations along with investor behavioral biases. The current study presents a novel approach to optimize the behavioral portfolio management model in the presence of investor biases for ESG sustainability, loss aversion, and cognitive dissonance. We extend the factor pricing literature by implementing a factor extraction protocol to identify three unique and pervasive ESG factors. Upon examining the interconnectedness of the factors, machine learning methods are applied to a production-theoretic six-factor Fama and French model to predict individual asset returns. Enumeration of efficient asset allocations is obtained by solving a hierarchical multiobjective portfolio optimization model. simulation results from solving alternate specifications of the layered goal ESG-driven model corroborate and extend emergent research on portfolio sustainability, network theory, and the interconnectedness of financial returns. Additionally, we provide results to amplify the existence of a hump-shaped ESG efficiency frontier. The results provide new information about the trade-offs available for resolving cognitive dissonance when investors are conflicted between holding 'green' versus 'brown' asset diversification plans.

De, I. and Clayman, M. R. (2015). "The Benefits of Socially Responsible Investing: An Active Manager's Perspective." In: *The Journal of Investing* 24(4), pp. 49–72.
There has been a lot of research on the predictive power of environmental, social, and governance (ESG) ratings, the relationship between ESG ratings and subsequent stock performance, and whether using ESG data in stock analysis and portfolio management was value-additive or valuedetracting. In this article, the authors examine the relationship between the ESG ratings of a company and its stock returns, volatility, and risk-adjusted returns in the post-2008 financial crisis era. They explore the negative relationship between ESG and volatility in greater depth, given the well-documented low-volatility anomaly (outperformance of low-volatility stocks). Both (high) ESG rating and (low) volatility positively impact stock returns, but the ESG effect is independent of the low-volatility effect, and ESG is a positive contributor in its own right. Given the controversy surrounding the effect of ESG-based investment restrictions, the authors test the effect of restricting the investible universe by deleting the lower tail of ESG companies on portfolio performance. Asset managers can thus actively use the association between corporate ESG ratings and stock return, volatility, and risk-adjusted return to enhance their stock-picking and portfolio-construction abilities.

De Franco, C. (2019). "ESG Controversies and Their Impact on Performance." In: *The Journal of Investing* 29(2), pp. 33–45.
This article introduces an aggregated controversy metric-derived from environmental, social, and governance (ESG) data-that targets specific issues companies face in the environmental, social, or governance fields. By building portfolios based on this controversy measure, the study shows that in Europe and the US, stocks that undergo severe controversies significantly underperform both their benchmarks and other portfolios consisting of stocks with low controversy or no controversy at all. The main reason for this result is that, in both cases, markets tend to react strongly to changes in controversy levels, penalizing stocks that experience ESG downgrades. These results make a clear case for the potential benefits of excluding stocks with high controversy levels from investment universes. However, these findings are not confirmed for the Asia-Pacific region, where the portfolios consisting of highly controversial stocks outperform their benchmarks, although the number of such portfolios is lower compared to the number in Europe and the US.

De Franco, C., Geissler, C., Margot, V., and Monnier, B. (2020). "ESG investments: Filtering versus machine learning approaches." In: *arXiv e-Print*.
We designed a machine learning algorithm that identifies patterns between ESG profiles and financial performances for companies in a large investment universe. The algorithm consists of regularly updated sets of rules that map regions into the high-dimensional space of ESG features to excess return predictions. The final aggregated predictions are transformed into scores which allow us to design simple strategies that screen the investment universe for stocks with positive scores. By linking the ESG features with financial performances in a non-linear way, our strategy based upon our machine learning algorithm turns out to be an efficient stock picking tool, which outperforms classic strategies that screen stocks according to their ESG ratings, as the popular best-in-class approach. Our paper brings new ideas in the growing field of financial literature that investigates the links between ESG behavior and the economy. We show indeed that there is clearly some form of alpha in

the ESG profile of a company, but that this alpha can be accessed only with powerful, non-linear techniques such as machine learning.

De Franco, C., Nicolle, J., and Tran, L.-A. (2021). "Sustainable Investing: ESG versus SDG." In: *The Journal of Impact and ESG Investing* 1(4), pp. 45–62.
In this article, we compare the established ESG-oriented to the more recent SDG-driven investment strategies in the United States and Europe. We have built cap-weighted portfolios based on ESG scores (Low, Mid, High) and comparable portfolios based on SDG scores. In the observed period, we show that most of the SDG premium is driven by the sector allocation effect: Technology in the United States and Healthcare in Europe. Thus, we have built sector-adjusted ESG and SDG portfolios to cope with the sector bias. This entails the reduction of the structural sector differences in SDG ratings. Interestingly, although the premium between high- and low-rated SDG stocks vanishes in the US case, the European case exhibits a strong positive premium. Finally, integrating SDG components in investment decisions will certainly be the standard in the years to come, but investors should be aware of the potential undesired bias implied by such an approach.

De Spiegeleer, J., Hocht, S., Jakubowski, D., Reyners, S., and Schoutens, W. (2020). "ESG: A New Dimension in Portfolio Allocation." In: *SSRN e-Print*.
In this paper, we examine the impact of including environmental, social and governance (ESG) criteria in the allocation of equity portfolios. We focus on the risk and return characteristics of the resulting ESG portfolios and investment strategies. Two specific measures are considered to quantify the ESG performance of a company; the ESG rating and the greenhouse gas (GHG) emission intensity. For both measures, we carry out empirical portfolio analyses with assets in either the STOXX Europe 600 or the Russell 1000 index. The ESG rating data analysis does not provide clear-cut evidence for enhanced performance of portfolios with either high or low ESG scores. We moreover illustrate that the choice of rating agency has a significant impact on the performance of the resulting ESG-constrained portfolios. Secondly, we study the impact of GHG emission reductions and increases. We show that emission reductions do not necessarily lead to increased risk or diminished returns, which gives confidence in a smooth transition towards the green economy pursued by the European Green Deal.

Dimson, E., Marsh, P., and Staunton, M. (2020). "Divergent ESG Ratings." In: *The Journal of Portfolio Management* 47(1), pp. 75–87.
Responsible investors require data to underpin their stock and sector selections. Regardless of the rating agency, bond ratings for a particular issuer are broadly similar. This is not the case for ESG ratings. Companies with a high score from one rater often receive a middling or low score from another rater. This article examines the extent of, and reasons for, disagreement among the leading suppliers of ESG ratings. The weightings given to each pillar of an ESG rating also vary across agencies. Many asset managers contend that ESG ratings can help investors to select assets with superior financial prospects, and the authors therefore review the investment performance of portfolios and of indexes screened for their ESG credentials. In the authors' opinion, ESG ratings, used in isolation, are unlikely to make a material contribution to portfolio returns.

Diris, B., Palm, F., and Schotman, P. (2015). "Long-Term Strategic Asset Allocation: An Out-of-Sample Evaluation." In: *Management Science* 61(9), pp. 2185–2202.
We evaluate the out-of-sample performance of a long-term investor who follows an optimized dynamic trading strategy. Although the dynamic strategy is able to benefit from predictability out-of-sample, a short-term investor using a single-period market timing strategy would have realized an almost identical performance. The value of intertemporal hedge demands in strategic asset allocation appears negligible. The result is caused by the estimation error in predicting the predictors. A myopic investor only needs to predict one-period-ahead expected returns, but hedge demands also require accurate predictions of the predictor variables. To reduce the problem of errors in optimized portfolio weights, we consider Bayesian procedures. Myopic and dynamic portfolios are similarly affected by such modifications, and differences in performance become even smaller.

Díaz, V., Ibrushi, D., and Zhao, J. (2021). "Reconsidering systematic factors during the Covid-19 pandemic – The rising importance of ESG." In: *Finance Research Letters* 38 (101870).
We investigate the importance of Environmental, Social and Governance (ESG) ratings in explaining different industry returns during the Covid-19 window. We build our ESG factor as the spread in returns between firms in the top ESG quartile and those in the bottom ESG quartile. The ESG factor shows to significantly explain industry returns in addition to the Fama-French factors. We also analyze the individual Environmental, Social, and Governance components of ESG. Environmental and Social dimensions are the main drivers of the ESG impact on different industries.

Drei, A., Le Guenedal, T., Lepetit, F., Mortier, V., Roncalli, T., and Sekine, T. (2019). "ESG Investing in Recent Years: New Insights from Old Challenges." In: *SSRN e-Print*.
This research is an update of the study that we published last year (Bennani et al., 2018) and that explored the impact of ESG investing on asset pricing in the stock market. It extends the original period 2010-2017 by adding eighteen months from January 2018 to June 2019. These new results confirm the previous results as we reach the same essential conclusions once again. ESG investing tended to penalize both passive and active ESG investors between 2010 and 2013. Contrastingly, ESG investing was a source of outperformance from 2014 to 2019 in Europe and North America. Moreover, ESG can be considered as a risk factor in the Eurozone, while it continues to be an alpha strategy in North America. However, the last 18 months exhibit new interesting patterns. First, we observe a transatlantic divide since the results for North America and the Eurozone are different for the recent period. Second, we document a partial ordering between ESG ratings and performance that can be explained by a shift from a static to a dynamic approach to ESG investing. Third, we note some discrepancies between active and passive management. Fourth, the social pillar seems to have gained traction these last years, and is no longer the laggard pillar. Fifth, factor investing and ESG investing are more and more connected. In what follows, we develop and explain these five key findings.

Duan, T., Li, F. W., and Wen, Q. (2021). "Is Carbon Risk Priced in the Cross Section of Corporate Bond Returns?" In: *SSRN e-Print*.
This paper examines the pricing of a firm's carbon risk, measured by its carbon emissions intensity, in the cross section of corporate bond returns. Contrary to the "carbon risk premium" hypothesis, we find bonds of firms with higher carbon emissions intensity earn significantly lower returns. This effect cannot be explained by a comprehensive list of bond characteristics and exposure to known risk factors. Investigating sources of the low carbon premium, we find the underperformance of bonds issued by carbon-intensive firms cannot be fully explained by divestment from institutional investors. Instead, our evidence is most consistent with investor underreaction to carbon risk, as carbon emissions intensity is predictive of lower future cash flow news, deteriorating firm creditworthiness, more environmental incidents, and elevated downside risks.

Dumitrescu, A., Gil-Bazo, J., and Zhou, F. (2022). "Defining Greenwashing." In: *SSRN e-Print*.
We propose a precise definition of greenwashing by mutual funds that combines ESG self-labels, sustainability scores of portfolio holdings, and funds' voting behavior. Armed with this definition, we are able to quantify the prevalence of greenwashing in the US mutual fund industry. Although self labeled ESG funds dominate non-ESG funds in terms of ESG ratings and voting support for ESG proposals, 24% of them are greenwashers according to our definition. Greenwashers are more likely to belong to larger and older fund families and less likely to be offered by signatories of the United Nations Principles for Responsible Investment. Importantly, while retail investors do not distinguish between greenwashers and true ESG funds, institutional investors are not deceived by the former. Our results suggest that accusations of ubiquitous greenwashing in asset management exaggerate the true extent of the problem. However, there is room for regulation aimed at enhanced ESG disclosure, at least for those funds that target retail investors.

Engle, R. F., Giglio, S., Kelly, B., Lee, H., and Stroebel, J. (2020). "Hedging climate change news." In: *The Review of Financial Studies* 33(3), pp. 1184–1216.
We propose and implement a procedure to dynamically hedge climate change risk. We extract innovations from climate news series that we construct through textual analysis of newspapers. We then use a mimicking portfolio approach to build climate change hedge portfolios. We discipline the exercise by using third-party ESG scores of firms to model their climate risk exposures. We show that this approach yields parsimonious and industry-balanced portfolios that perform well in hedging innovations in climate news both in sample and out of sample. We discuss multiple directions for future research on financial approaches to managing climate risk.

Fabozzi, F. J. and Lopez de Prado, M. (2018). "Being Honest in Backtest Reporting: A Template for Disclosing Multiple Tests." In: *The Journal of Portfolio Management* 45(1), pp. 141–147.
Selection bias under multiple testing is a serious problem. From a practitioner perspective, failure to disclose the impact of multiple tests of a proposed investment strategy to clients and senior management can lead to the adoption of a false discovery. Clients will lose money, senior management will misallocate resources, and the firm may be exposed to reputational, legal, and regulatory risks. From the perspective of academic journals that publish evidence supporting an investment strategy, the failure to address selection bias under multiple testing threatens to invalidate large portions of the literature in empirical finance. In this article, the authors propose a template that practitioners should use to fairly disclose multiple tests involved in an alleged discovery when pitching strategies to clients and senior management. The same template could be used by contributors to

academic journals so that referees, and ultimately readers, can assess the strategy. By disclosing this information, those who are charged with making the final decision about a discovery can evaluate the probability that the purported discovery is false.

Faccini, R., Matin, R., and Skiadopoulos, G. (2021). "Dissecting Climate Risks: Are they Reflected in Stock Prices?" In: *SSRN e-Print*.
We provide first-time evidence on whether market-wide physical or transition climate risks are priced in U.S. stocks. Textual and narrative analysis of Reuters climate-change news over 2000-2018, uncovers four novel risk factors related to natural disasters, global warming, international summits, and U.S. climate policy, respectively. Only the climate-policy factor is priced, especially post-2012. The documented risk premium is consistent with investors hedging the imminent transition risks from government intervention, rather than the direct risks from climate change itself. Firms that are most exposed to transition risks tend to be polluting businesses which show no strong intention of becoming greener.

Filbeck, A., Filbeck, G., and Zhao, X. (2019). "Performance assessment of firms following sustainalytics ESG principles." In: *The Journal of Investing* 28(2), pp. 7–20.
The authors explore whether firms rated highly by Sustainalytics based on ESG criteria are rewarded with superior long-term stock price performance. They find that firms with the highest ESG ratings statistically outperform the SandP 500 index, although not on a risk-adjusted basis. Firms with higher governance and social scores also statistically outperform those firms with corresponding lower scores. Firms with better (worse) governance scores produce statistically significant positive (negative) alpha values. Firms less likely to adhere to strong governance principles are penalized in the market, while firms more likely following strong social and environmental principles are negatively assessed. Improved governance scores and to a lesser extent improved social scores produce statistically significant positive alpha values whereas negative changes in environmental scores are positively received by the market. Overall, investors are not hurt by following an ESG philosophy with the market rewarding firms for good governance, penalizing those with strong environmental records, and meeting with ambivalence those with strong social records.

Fiordelisi, F., Galloppo, G., Lattanzio, G., and Paimanova, V. (2021). "An ESG Ratings Free Assessment of Socially Responsible Investment Strategies." In: *SSRN e-Print*.
Environmental, Social, and Governance (ESG) ratings feature statistical and economic problems undermining their reliability as valid proxies for corporates' social performance. To overcome this ratings providers specific bias, we focus on global sample of ESG-oriented Exchange Traded Funds (ETFs). Studying passive and pre-committed strategies provide us with several economic and econometric advantages, allowing us to document that Socially Responsible Investments (SRI)-oriented strategies generate significantly higher average stock market returns and liquidity. However, the identified overperformance is concentrated in months of extreme climate activity, while the effect reverses during financial crisis. These findings confirm that investors react to non-pecuniary shocks by increasing the weights assigned to SRI investments in their portfolio, but their preference shifts back towards traditional strategies during economic downturns.

Fish, A., Kim, D. H., and Venkatraman, S. (2019). "The ESG Sacrifice." In: *SSRN e-Print*.
Socially Responsible investing has become a key point of discussion within the past few years as society gravitates towards producing positive externalities. The topic remains greatly contested especially when considering the perspectives of Milton Friedman, who claimed the sole focus of any publicly-traded company is to generate positive growth and performance for its shareholders. One of the key questions this paper sought to explore was whether or not an investor would sacrifice a portfolio performance in order to achieve a socially responsible portfolio. ESG (Environmental, Social, and Governance) Scores from Bloomberg and historical performance on various securities in both the United States and Europe were collected in order to construct various portfolios. For some portfolios, the returns were adjusted based on ESG Scores in order for companies with better ESG scores to receive more weight when portfolio optimization techniques were applied. In addition, given that the returns of companies with better ESG scores tended to have highly correlated returns, alternative portfolio optimization techniques beyond the traditional Mean-Variance Optimization were used to enhance the portfolio performance. Ultimately, it was shown that minimal difference existed between the returns of the ESG-weighted portfolios and the non-weighted portfolios indicating an investor does not have to sacrifice financial performance to achieve a socially responsible investment portfolio.

Focardi, S. M. and Fabozzi, F. J. (2020). "Climate change and asset management." In: *The Journal of Portfolio Management* 46(3), pp. 95–107.

In this article, the authors explain how asset owners and asset managers should behave to cope with new regulations and risks related to climate change. By optimizing portfolios with constraints on the global portfolio carbon footprint, it is possible to construct equity portfolios and indexes with a low carbon footprint without penalizing returns. In the future, there will be costs and opportunities as a result of the process of transitioning to a low-carbon-emission economy. The authors explain how building future scenarios for assessing the climate consequences of more- or less- stringent actions and regulations will be challenging because doing so requires integrated assessment models that integrate climate science with economic data and predictions. According to the authors, bond investors offer more promise in forcing corporations to adopt policies to reduce carbon emissions than do equity investors by affecting funding costs. This can be done through carbon emission reduction covenants in corporate bond indentures and carbon policy performance bonds; the latter can be used to control government performance as well as corporate performance. On the financing side, green bonds can be used to fund carbon emission reduction projects.

Fridson, M., Jiang, L., Mei, Z., and Navaei, D. (2021). "ESG Impact on High-Yield Returns." In: *The Journal of Fixed Income* 30(4), pp. 53–63.

High-yield bond investors who adopt an environmental, social, and governance (ESG) discipline must consider the potential impact on returns. Recently introduced high-yield benchmarks for ESG-conscious portfolios make it possible to quantify these effects. ESG-based high-yield indexes produced higher historical returns than a standard high-index, but those differences are not statistically significant. The apparently superior downside protection provided by ESG-oriented funds in down markets is explained by two major confounding factors: the ESG-based indexes' underweighting in Energy bonds and lowest-rated issues. High-yield investors cannot reliably cushion their returns during selloffs by avoiding issuers involved in controversial weapons or with poor scores in other ESG categories. Energy companies with good ESG scores show no tendency to provide or to not provide superior downside protection in a high-yield bear market. The overall evidence to date on relative performance confirms neither a bonus nor a penalty for adhering to ESG principles within a high-yield portfolio. The growth of investing with attention to ESG factors has generated considerable controversy. Both proponents and critics are keen to answer this question: Must ESG-conscious investors sacrifice return for the sake of their principles, or do good ESG corporate citizens achieve higher profits with less risk, and actually outperform standard indexes? We address this question by comparing the returns of recently introduced ESG high-yield indexes and a standard index of the asset class.

Friederich, D., Kaack, L. H., Luccioni, A., and Steffen, B. (2021). "Automated Identification of Climate Risk Disclosures in Annual Corporate Reports." In: *arXiv e-Print*.

It is important for policymakers to understand which financial policies are effective in increasing climate risk disclosure in corporate reporting. We use machine learning to automatically identify disclosures of five different types of climate-related risks. For this purpose, we have created a dataset of over 120 manually-annotated annual reports by European firms. Applying our approach to reporting of 337 firms over the last 20 years, we find that risk disclosure is increasing. Disclosure of transition risks grows more dynamically than physical risks, and there are marked differences across industries. Country-specific dynamics indicate that regulatory environments potentially have an important role to play for increasing disclosure.

Gao, Y., Satchell, S., and Srivastava, N. (2020). "Styles through a convergent/divergent lens: the curious case of ESG." In: *Journal of Asset Management* 21, pp. 4–12.

We look at a technique of classification, based on convergent and divergent patterns of returns that has been applied to hedge funds and alternative investments, and apply it to US equity investment styles with a particular interest in ESG. We extend the technique by looking at the impact of price changes on factor-mimicking portfolio weights. This analysis leads to powerful insights into style return dynamics. In particular, an ESG-ranked long-short portfolio looks more like momentum than value.

Garefalakis, A. and Dimitras, A. (2020). "Looking back and forging ahead: the weighting of ESG factors." In: *Annals of Operations Research* 294, pp. 151–189.

The research for the investigation of the quality of the Corporate Annual Reports (CAR) and particularly the part of the narrative information contained in it has long been underestimated, mainly due to the lack of tools that allow an objective measurement and analysis of the narrative disclosed information of each company. The concept of narrative portion is extremely difficult and multidimensional, most studies use ESG composite scores to measure the CSP. The studies which investigate this issue are facing two major problems. The first problem related with the aggregation number of Key Performance Indicators while the second problem is that all ESG factors are not equal importance. This research focuses on the detailed presentation of a new method of reliable

measurement of the quality of the narrative part of the CARs, which is greatly enhanced by using two composite indices, the unweighted index Ma.Co.I and the weighted one Ma.Co.Iw. These specific indices, for the first time, offer a comprehensive and coded checklist (for the measurement of the quality of the narrative information) which follows the guidelines set by the International Accounting Standards Board in 2010. Finally, this article proposes a novel weighting scheme of narrative portion and suggest specific minimum and maximum weights per ESG factors with purpose to contribute to a better understanding of the complexity of composite scores and to improve the quality of their outputs.

Garnier, J. (2022). "The Climate Extended Risk Model (CERM)." In: *arXiv e-Print*.
This paper is directed to the financial community and focuses on the financial risks associated with climate change. It, specifically, addresses the estimate of climate risk embedded within a bank loan portfolio. During the 21st century, man-made carbon dioxide emissions in the atmosphere will raise global temperatures, resulting in severe and unpredictable physical damage across the globe. Another uncertainty associated with climate, known as the energy transition risk, comes from the unpredictable pace of political and legal actions to limit its impact. The Climate Extended Risk Model (CERM) adapts well known credit risk models. It proposes a method to calculate incremental credit losses on a loan portfolio that are rooted into physical and transition risks. The document provides detailed description of the model hypothesis and steps. This work was initiated by the association Green RWA (Risk Weighted Assets). It was written in collaboration with Jean-Baptiste Gaudemet, Anne Gruz, and Olivier Vinciguerra (cerm@greenrwa.org), who contributed their financial and risk expertise, taking care of its application to a pilot-portfolio. It extends the model proposed in a first white paper published by Green RWA `https://www.greenrwa.org/`.

Gaussel, N. and Le Saint, L. (2021). "ESG Risk Rating of Alternative Portfolios." In: *SSRN e-Print*.
Our aim is to propose a methodology to derive an ESG risk rating for any alternative portfolio, from the ESG ratings of its constituents. To do so, we introduce the notion of ESG risk and define the ESG rating as the ratio between the portfolio's ESG risk and its total risk. We show how both ESG and total risk can be computed with a variance-based formula. The empirical correlation matrix has to go through a prior shrinkage procedure to ensure that the ESG risk cannot be larger than the total risk. An important consequence of our methodology is that a fund trading an investment universe of poorly (resp. highly) ESG-rated instruments, should have a poor (resp. good) ESG rating. We test this methodology on the Lyxor Epsilon Global Trend Fund and observe that results are consistent with qualitative expectations.

Geczy, C., Jeffers, J. S., Musto, D. K., and Tucker, A. M. (2021a). "Contracts with (Social) benefits: The implementation of impact investing." In: *Journal of Financial Economics* 142(2), pp. 697–718.
We draw on new data and theory to examine how private market contracts adapt to serve multiple goals, particularly the social-benefit goals that impact funds add to their financial goals. Counter to the intuition from multitasking models (Holmstrom and Milgrom, 1991), few impact funds tie compensation directly to impact, and most retain traditional financial incentives. However, funds contract directly on impact in other ways and adjust aspects of the contracts such as governance. In the cross-section of impact funds, those with higher profit goals contract more tightly around both goals.

Geczy, C. C., Stambaugh, R. F., and Levin, D. (2021b). "Investing in Socially Responsible Mutual Funds." In: *The Review of Asset Pricing Studies* 11(2), pp. 309–351.
We construct optimal portfolios of mutual funds whose objectives include socially responsible investment (SRI). Comparing portfolios of these funds to those constructed from the broader fund universe reveals the cost of imposing the SRI constraint on investors seeking the highest Sharpe ratio. This SRI cost crucially depends on the investor's views about asset pricing models and stock-picking skill by fund managers. To an investor who strongly believes in the CAPM and rules out managerial skill, that is, a market index investor, the cost of the SRI constraint is typically just a few basis points per month, measured in certainty-equivalent loss. To an investor who still disallows skill but instead believes to some degree in pricing models that associate higher returns with exposures to size, value, and momentum factors, the SRI constraint is much costlier, typically by at least 30 basis points per month. The SRI constraint imposes large costs on investors whose beliefs allow a substantial amount of fund-manager skill, that is, investors who heavily rely on individual funds' track records to predict future performance.

Geczy, C. C. and Guerard, J. (2021). "ESG and Expected Returns on Equities: The Case of Environmental Ratings." In: *SSRN e-Print*.
Using long-standing models for expected returns of US equities, we show that firm environmental ratings interact with those forecasted returns and produce excess returns both unconditionally and conditionally. Well-known

factor models subsume neither environmental-related return differentials nor expected return premia from those scores and models. In addition, combining information from both inputs – expected return models and economic, social, and governance (ESG) information – may provide an advantage in selecting investments. For financial fiduciaries, this notion shifts the conversation about ESG reflecting only constraints to one of an expanded information and possibly investment opportunity set.

Geczy, C. C., Guerard, J., and Samonov, M. (2019). "Efficient SRI / ESG portfolios." In: *SSRN e-Print*.
Using an earnings forecasting model has been shown to be useful and highly statistically significant in U.S. stock selection. We find that incorporation of ESG criteria can enhance stockholder returns holding risk constant under reasonable assumptions. The novel approach here uses a normalization of ESG strengths and weaknesses ratings, applied in both robust simply-weighted and realistic optimized portfolio settings. In part, it confirms a now classical -cost result for certain SRI/ESG investment constraints and, with Diversity, Human Rights, and Governance criteria, shows that SRI/ESG information can enhance portfolio returns. Thus, SRI/ESG investors may not have to expect lower portfolio returns and Sharpe Ratios.

Gerard, B. (2018). "ESG and socially responsible investment: A critical review." In: *SSRN e-Print*.
We review the literature on ESG and Socially Responsible Investment with a special focus on fixed income investments. Most of the academic research is focused on the link between corporate CSR and ESG activities, investors SR engagement and stock returns and firm value. Very few studies examine the link between firm ESG policies and bond prices, risks and returns, and the performance of SR FI funds. The studies linking CSR to firm value suggest that higher CSR leads to higher corporate value, higher equity returns and lower risk, enhancing the general collateral value of the firm. The FI income studies provide mixed evidence about the link between issuer ESG scores and bond prices and return characteristics: the bonds of issuers with both excellent and very poor ESG behavior tend to under-perform the bonds of issuer with neither very strong or very poor ESG scores. Lastly while issuers ESG excellence may have led to both their equity and debt outperforming those of poorer ESG issuers in the 90, this out-performance halved in the first part of the 2000 and completely disappeared after the financial crisis. Markets seem now to largely price ESG performance in equity and bond prices.

Gibson Brandon, R., Krueger, P., and Schmidt, P. S. (2021). "ESG Rating Disagreement and Stock Returns." In: *Financial Analysts Journal* 77(4), pp. 104–127.
Using environmental, social, and governance (ESG) ratings from seven different data providers for a sample of firms in the S&P 500 Index between 2010 and 2017, we studied the relationship between ESG rating disagreement and stock returns. We found that stock returns are positively related to ESG rating disagreement, suggesting a risk premium for firms with higher ESG rating disagreement. The relationship is primarily driven by disagreement about the environmental dimension. We discuss the practical implications of our findings for firms' equity cost of capital as well as for investment managers and asset owners who use ESG investment strategies.

Gidwani, B. (2020). "Some Issues with Using ESG Ratings in an Investment Process." In: *The Journal of Investing* 29(6), pp. 76–84.
A growing number of investors want to integrate information about company sustainability into their investment decision processes to avoid risk, satisfy an asset owner's needs, or find a new alpha-generating factor. Few new users of environment, social, and governance (ESG) data understand how ESG ratings behave over time. We use the CSRHub data set to show that ESG ratings regress strongly toward the mean. These ratings include both data from most commercial ESG ratings firms and another 640 sources. The observed regression persists within the ratings data across nine years, for a sample set of more than 8,000 companies. Newly-rated companies show even more reversion than "seasoned" companies. It is rare that a company maintains an especially high or low ESG rating. Investors and company managers should both realize that ESG ratings are likely to change toward the mean and that this pattern does not necessarily mean that a good company is getting worse or a bad one is getting better.

Giese, G., Lee, L.-E., Melas, D., Nagy, Z., and Nishikawa, L. (2019a). "Consistent ESG through ESG Benchmarks." In: *The Journal of Index Investing* 10(2), pp. 24–42.
There has been a wide range of research in academia and the asset management industry about the financial benefits of ESG investing. However, the equally important question about how to achieve consistency when integrating ESG and what methodologies to use has not received the same level of attention. As a result, ESG integration is often applied inconsistently and incompletely across portfolios. The authors provide a framework for the integration of ESG into benchmarks at various strategic levels the top policy benchmark level to the performance benchmark of individual allocations. In addition, they highlight the different investment objectives that asset owners may pursue when integrating ESG and how they can reflect these in their choice of ESG

benchmarks. They find that integrating ESG into benchmarks makes sense as a framework to achieve consistency because benchmarks are not only used at different strategic levels but also across all areas of asset management-index-based, factor-based, and active management-to define the underlying investable universe and to provide a yardstick for performance.

Giese, G., Lee, L.-E., Melas, D., Nagy, Z., and Nishikawa, L. (2019b). "Foundations of ESG investing: how ESG affects equity valuation, risk, and performance." In: *The Journal of Portfolio Management* 45(5), pp. 69–83.
Many studies have focused on the relationship between companies with strong environmental, social, and governance (ESG) characteristics and corporate financial performance. However, these have often struggled to show that positive correlations produced in fact explain the behavior. The authors of this article provide a link between ESG information and the valuation and performance of companies, by examining three transmission channels within a standard discounted cash flow model they call the cash-flow channel, the idiosyncratic risk channel, and the valuation channel. They tested each of these transmission channels using MSCI ESG Ratings data and financial variables. This showed that companies ESG information was transmitted to their valuation and performance, both through their systematic risk profile (lower costs of capital and higher valuations) and their idiosyncratic risk profile (higher profitability and lower exposures to tail risk). The research suggests that changes in a company ESG characteristics may be a useful financial indicator. ESG ratings may also be suitable for integration into policy benchmarks and financial analyses.

Giese, G., Lee, L.-E., Melas, D., Nagy, Z., and Nishikawa, L. (2019c). "Performance and Risk Analysis of Index-Based ESG Portfolios." In: *The Journal of Index Investing* 9(4), pp. 46–57.
There has been a wide range of research in academia and the asset management industry about the financial benefits of ESG investing. However, the question of how to achieve consistency when integrating ESG has not obtained the same level of attention. As a result, ESG integration currently is often applied inconsistently and incompletely across asset owners portfolios. The authors of this article focus on how asset owners can implement ESG integration through index-based allocations to portfolios that seek to replicate ESG indexes. Index-based approaches offer consistency, transparency, and replicability and are generally cost-effective. Over a seven-year study period, global and regional versions of the MSCI ESG Leaders Indexes (as proxies for regional allocations) resulted in significant variations in their respective ESG profiles and performance, but in all instances, there was a clear reduction in all key risk measures.

Giese, G., Nagy, Z., and Lee, L.-E. (2021a). "Deconstructing ESG Ratings Performance: Risk and Return for E, S, and G by Time Horizon, Sector, and Weighting." In: *The Journal of Portfolio Management* 47(3), pp. 94–111.
There are many ways to construct a company's environmental, social, and governance (ESG) score or rating, involving different combinations of financial and nonfinancial inputs. Determining the most influential criteria for firm performance may be overlooked in the rush to "do some ESG." In this study, the authors deconstruct ESG ratings performance at the E, S, and G pillar levels and use the most common key issues indicators that underlie ESG scores. They find that the time horizon used has an important bearing on the indicators' significance. In the short term, they find that governance is the dominant pillar because it strongly reflects event risks, such as fraud. In the long term, however, environmental and social indicators became more important because issues such as carbon emissions tended to be more cumulative, presenting erosion risks to long-term performance. The authors also find that a more balanced and industry-specific weighting of E, S, and G issues showed better long-term relevance than the individual pillar indicators alone.

Giese, G., Nagy, Z., and Rauis, B. (2021b). "Foundations of Climate Investing: How Equity Markets Have Priced Climate-Transition Risks." In: *The Journal of Portfolio Management* 47(9), pp. 35–53.
Countries have set varying targets to reduce greenhouse gas emissions in line with the Paris Agreement's goal of keeping the increase in global average temperatures to well below 2 degrees C. In this article, the authors examine to what extent climate risk has been priced into equity markets and whether climate change can be modeled using a typical risk model structure. They develop the fundamental economic transmission channels to explain the potential impact of climate change on equity prices, including empirical evidence for climate policies and green technology as financial risk drivers. They also study the impact of climate-transition risk on valuation levels and trends. They conclude with a discussion of how to measure and categorize companies' climate-risk exposures and how to integrate climate-transition risks into risk models.

Giese, G., Ossen, A., and Bacon, S. (2016). "ESG as a performance factor for smart beta indexes." In: *The Journal of Index Investing* 7(3), pp. 7–20.
Although traditional financial factors, such as value, growth, and momentum, have become common practice in the construction of smart beta indexes, the question whether environmental, social, and governance (ESG) data

can be used as a performance factor in a similar way is a controversial topic in the asset management community. In this article, the authors develop a methodology to extract an unbiased standalone ESG performance factor from a broad database of ESG indicators and apply this ESG factor in different smart beta type of index methodologies. The results show that this ESG factor can add financial value in portfolios and financial indexes and can be used the same way as or in addition to traditional common performance factors.

Gorgen, M., Jacob, A., and Nerlinger, M. (2021). "Get Green or Die Trying? Carbon Risk Integration into Portfolio Management." In: *The Journal of Portfolio Management* 47(3), pp. 77–93.
Portfolio management is confronting climate change more strongly and rapidly than expected. Risks arising from the transition from a brown, carbon-based to a green, low-carbon economy need to be integrated into portfolio and risk management. The authors show how to quantify these carbon risks by using a capital markets-based approach. Their measure of carbon risk, the carbon beta, can serve as an integral part of portfolio management practices in a more comprehensive way than fundamental carbon risk measures. Apart from other studies, the authors demonstrate that both green and brown stocks are risky per se, but there is no adequate remuneration in the financial market. In addition, carbon risk exposure is correlated with exposures to other common risk factors. This requires due diligence when integrating carbon risk in investment practices. By implementing carbon risk screening and best-in-class approaches, the authors find that investors can gain a desired level of carbon risk exposure, but this does not come without well-hidden costs.

Gougler, A. and Utz, S. (2020). "Factor exposures and diversification: Are sustainably screened portfolios any different?" In: *Financial Markets and Portfolio Management* 34, pp. 221–249.
We analyze the performance, risk, and diversification characteristics of global screened and best-in-class equity portfolios constructed according to Inrate's sustainability ratings. The financial performance of sustainably high-rated portfolios is similar to the risk-adjusted market performance in terms of abnormal returns of a five-factor market model. In contrast, low-rated portfolios exhibit negative abnormal returns. Firms with high sustainability ratings show lower idiosyncratic risk and higher exposure toward the high-minus-low and the conservative-minus-aggressive factor.

Gregory, R. P. (2021a). "Market Efficiency in ESG Indexes: Trading Opportunities." In: *The Journal of Impact and ESG Investing* 1(4), pp. 72–82.
Examining the returns of 16 ESG indexes, we found evidence that a few violate the conditions of weak-form efficiency and that all violate conditions for semi-strong form efficiency. Given previous research on market efficiency in the ESG market, this points to profitable trading opportunities in this market using public information. We also discuss why these results are not subject to previous criticisms of testing of market efficiency.

Gregory, R. P. (2021b). "The Response of the S&P 1500 during the COVID-19 Pandemic and ESG Scores." In: *SSRN e-Print*.
Examining the S&P 1500 stocks, the responses of the stocks to fiscal and monetary policy are found to differ due to E, S and G scores by the type of legislation. Non-Financial firms that manage environmental and governance risks better performed better over the pandemic Part of this was due to their high environmental and governance scores allowing them to hedge the negative effects of the announcements of fiscal policies during the pandemic.

Greiner, S. P. and Stoyanov, S. V. (2019). "Portfolio scoring by expected risk premium." In: *The Journal of Portfolio Management* 45(4), pp. 83–90.
In this article, the authors discuss a general method for ranking portfolios that places few limitations on the portfolio constituents other than using publicly traded assets. The ranking scores reflect the expected reward investors would require for accepting the risks of the portfolio in the context of an asset pricing framework. The scores are computed through a factor model that acknowledges the factor return correlations. The authors illustrate the approach with a large universe of exchange-traded funds assuming a linear model with Fama-French-Carhart factors wherein factor premiums (i.e., expected returns) are proportional to factor volatilities. The empirical analysis implies that the most significant factors from the Fama-French-Carhart factor set driving the premiums are the market and the momentum factors.

Grim, D. M. and Berkowitz, D. B. (2020). "ESG, SRI, and Impact Investing: A Primer for Decision-Making." In: *The Journal of Impact and ESG Investing* 1(1), pp. 47–65.
Investors throughout the world are increasingly interested in environmental, social, and governance (ESG) issues. However, they may be puzzled by the growing assortment of acronyms and terminology on the subject, leading to challenges in determining what-if any – action they should take. ESG investing is an investment-related activity that accounts for some type of ESG consideration. It is not a separate asset class, a single strategy, or even a single type of action, and importantly, the appropriate approach is not the same for all investors. The authors

believe that specific forms of ESG investing can be prudent for investors with particular preferences, beliefs, resources, and circumstances. As with any other form of investing, investors must establish their goals and weigh the potential benefits of the various approaches against any relevant risks and costs to give themselves the best chance of achieving their desired outcome. In this article, the authors clarify the terms and trends and provide investors with an objective, practical framework for making informed decisions. Their four-step process helps investors establish specific goals, evaluate potential options, and decide on an ESG investing approach based on personalized criteria and trade-off considerations.

Gueant, O., Peladan, J.-G., Robert-Dautun, A., and Tankov, P. (2021). "Environmental transition alignment and portfolio performance." In: *SSRN e-Print*.
We contribute to the debate on whether using ESG/SRI criteria in investment decisions improves portfolio performance. The choice of a specific ESG metric being crucial, we focus on the Net Environmental Contribution, a robust open-source measure of environmental transition alignment. From a universe of 752 European stocks, we select subsets of stocks with high and low NEC scores, and compare the performance of equal-weighted and capitalization-weighted portfolios constructed from these subsets over the 2015-2020 period. The high-NEC portfolios outperform the low-NEC ones consistently throughout the period, and particularly during 18 months starting mid-2019, both before and during the COVID crisis.

Guidolin, M., Hansen, E., and Lozano-Banda, M. (2018). "Portfolio performance of linear SDF models: an out-of-sample assessment." In: *Quantitative Finance* 18(8), pp. 1425–1436.
We evaluate linear stochastic discount factor models using an ex-post portfolio metric: the realized out-of-sample Sharpe ratio of mean-variance portfolios backed by alternative linear factor models. Using a sample of monthly US portfolio returns spanning the period 1968-2016, we find evidence that multifactor linear models have better empirical properties than the CAPM, not only when the cross-section of expected returns is evaluated in-sample, but also when they are used to inform one-month ahead portfolio selection. When we compare portfolios associated to multifactor models with mean-variance decisions implied by the single-factor CAPM, we document statistically significant differences in Sharpe ratios of up to 10 percent. Linear multifactor models that provide the best in-sample fit also yield the highest realized Sharpe ratios.

Guo, D. (2019). "A Statistical Response to Challenges in Vast Portfolio Selection." PhD thesis. University of Waterloo.
The thesis is written in response to emerging issues brought about by an increasing number of assets allocated in a portfolio and seeks answers to puzzling empirical findings in the portfolio management area. Over the years, researchers and practitioners working in the portfolio optimization area have been concerned with estimation errors in the first two moments of asset returns. The thesis comprises several related chapters on our statistical inquiry into this subject. Chapter 1 of the thesis contains an introduction to what will be reported in the remaining chapters. A few well-known covariance matrix estimation methods in the literature involve adjustment of sample eigenvalues. Chapter 2 of the thesis examines the effects of sample eigenvalue adjustment on the out-of-sample performance of a portfolio constructed from the sample covariance matrix.

Guo, D., Boyle, P. P., Weng, C., and Wirjanto, T. S. (2019). "When Does The 1/N Rule Work?" In: *SSRN e-Print*.
We propose a "1/N favorability index" to measure how favorable a market is to holding a 1/N portfolio. This index reflects the extent of difficulty for an optimized portfolio to outperform the 1/N portfolio in a specific market. A single-factor model predicts that bull markets are accompanied by a high 1/N favorability index and vice versa. We validate the model implication that the 1/N portfolio is more difficult to beat in bull markets using stock return datasets from a number of countries as well as the classic datasets used by DeMiguel et al. (2009). Our results imply that the reported good performance of the 1/N portfolio in the US equity market can be partially attributed to the long-run bullish trend in the market which gives rise to the high favorability of the market to the 1/N portfolio.

Guo, T., Jamet, N., Betrix, V., Piquet, L.-A., and Hauptmann, E. (2020). "ESG2Risk: A Deep Learning Framework from ESG News to Stock Volatility Prediction." In: *arXiv e-Print*.
Incorporating environmental, social, and governance (ESG) considerations into systematic investments has drawn numerous attention recently. In this paper, we focus on the ESG events in financial news flow and exploring the predictive power of ESG related financial news on stock volatility. In particular, we develop a pipeline of ESG news extraction, news representations, and Bayesian inference of deep learning models. Experimental evaluation on real data and different markets demonstrates the superior predicting performance as well as the relation of high volatility prediction to stocks with potential high risk and low return. It also shows the prospect of the proposed pipeline as a flexible predicting framework for various textual data and target variables.

Gutterman, A. (2020). "Impact Investment Tools, Structures and Instruments." In: *SSRN e-Print*.
This chapter described tools, structures and instruments used by impact investors to effectively apply their theories of environmental and/or social change. Impact tools are actions that impact investors can take to create a portfolio that is aligned with the investor's investment and impact goals. Each impact investment needs to be structured properly to optimize impact while fitting within the investor's overarching impact investment goals and policies. Impact structures are a function of decisions made regarding the investor, intermediary and enterprise vehicles and the use of certain transactional tools that are intended to drive specific impact outcomes. The selection of the investment instrument that will be used by the investor or the intermediary to provide capital to the enterprise depends on a number of factors including the investment goals and risk tolerances of the investor/intermediary; the legal structure of the enterprise; the instruments that the enterprise have previously issued to other investors, since the relative priorities of different groups of investors with respect to return of capital and their rights to the assets of the enterprise as collateral for their investment must always be clear; the relative cost of the financing to the business and the existing owners; the risks associated with the instrument and the degree of flexibility associated with any payment obligations under the terms of the instrument.

Gyonyorova, L., Stachoň, M., and Stašek, D. (2022). "ESG ratings: relevant information or misleading clue? Evidence from the S&P Global 1200." In: *Journal of Sustainable Finance & Investment*, pp. 1–35.
Environmental, social, and corporate governance (ESG) scores are frequently involved in investment-related decision-making, e.g. for red-flagging or to manage risks. The increasing interest in ESG data raises the question about their validity from various sources. Therefore, we explore the consistency and convergent validity of the well recognized ESG data providers. Exploratory factor analysis of S&P Global 1200 index demonstrates considerable uncertainty across extracted latent factors. Further factor analyses show that the consistency and convergent validity across ESG data significantly depend on the industry type and the country of domicile. These findings are supported by confirmatory factor analyses. Thus, the stakeholders are encouraged to incorporate the company sector and domicile aspects into their decisions. Otherwise, naive use of primary ESG scores may provide a misleading clue.

Hain, L. I., Kolbel, J. F., and Leippold, M. (2021). "Let's get physical: Comparing metrics of physical climate risk." In: *Finance Research Letters*, p. 102406.
Investors and regulators require reliable estimates of physical climate risks for decision-making. While assessing these risks is challenging, several commercial data providers and academics have started to develop firm-level physical risk scores. We compare six physical risk scores. We find a substantial divergence between these scores, also among those based on similar methodologies. We show how this divergence could cause problems when testing whether financial markets are pricing physical risks. Hence, financial markets may not adequately account for the physical risk exposure of corporations using available risk scores. Finally, we identify key sources of uncertainty for further investigation.

Hakala, E.-E. (2021). "Can ESG controversies predict medium- to long-term stock performance? Evidence from global markets." MA thesis. Aalto University.
I study the relationship between CSR media publicity, measured by changes in companies' ESG Con- troversies Score, and medium- to long-term stock performance. Using a global dataset between 2004 and 2020, I find that a portfolio of companies with improving ESG public image generates risk-adjusted excess returns of up to 0.4% per month. However, betting against firms with deteriorating ESG public image overweighs the positive returns, the effect being most notable in non-developed markets. The results are robust over time, but the performance of low ESG performers seems to be driven by large firms whereas the opposite is found for high ESG performers. In addition, I show that "offsetting ESG", meaning improving ESG performance as means of compensating for past low performance, seems to be more valued than improving ESG performance overall.

Haley, M. R. (2017). "K-fold cross validation performance comparisons of six naive portfolio selection rules: how naive can you be and still have successful out-of-sample portfolio performance?" In: *Annals of Finance* 13, pp. 341–353.
Recent research reports that optimal portfolio selection models often perform worse than equal-weight naive diversification in out-of-sample testing. This paper extends this line of inquiry by comparing the out-of-sample performance of the equal-weight naive strategy to the out-of-sample performance of five alternative naive strategies, each of which derives from a simple heuristic that does not require any optimization. Out-of-sample portfolio performance is assessed by mean, standard deviation, skewness, and Sharpe ratio; k-fold cross validation is used as the out-of-sample testing mechanism. The results indicate that the proposed naive heuristic rules exhibit

strong out-of-sample performance, in most cases superior to the equal-weight naive strategy. These findings are consequential for at least two reasons: first, if these simple heuristic-based rules outperform the equal-weight naive strategy, then by transitivity they can outperform the mean-variance- and shortfall-optimal portfolio rules that have been shown in the literature to be inferior to the equal-weight naive rule, which further emphasizes the out-of-sample fragility of "optimal"methods; and second, among naive diversification strategies, some appear more robust in out-of-sample testing than others, hence the proposed methods may be useful when forming mixed portfolio selection models wherein a naive strategy is combined with an optimal strategy to improve performance.

Hambel, C., Kraft, H., and Ploeg, R. van der (2021). "Asset Pricing and Decarbonization: Diversification versus Climate Action." In: *SSRN e-Print*.

Asset pricing and climate policy are analyzed in a global economy where consumption goods are produced by both a green and a carbon-intensive sector. We allow for two types of damages from global warming. Given that the economy is initially heavily dependent on carbon-intensive capital, the desire to diversify assets complements the attempt to mitigate economic damages from climate change. In the longer run, however, a trade-off between diversification and climate action emerges. We derive the optimal carbon price, the equilibrium risk-free rate, and risk premia. Climate disasters, which are more likely to occur sooner as temperature rises, significantly increase risk premia on financial assets.

Hanicova, D. and Vojtko, R. (2020). "Backtesting ESG Factor Investing Strategies." In: *SSRN e-Print*.

This paper takes an in-depth look at socially responsible investing and problems associated with it. One of the main problems with ESG factor investing is caused by data. Firstly, we obtained unfiltered ESG data from OWL Analytics. Secondly, we reviewed two strategies based on ESG Factor investing: ESG Factor Momentum Strategy and ESG Level Factor Strategy. After we tested both of these strategies on our data, we concluded factor strategies based on ESG scoring seem to be profitable during the last several years. Our findings confirm the broader trend of recent outperformance of strategies based on ESG. Unexpectedly ESG level had better performance than the ESG momentum. Performance of the momentum was positive, although low; compared to the notable performance of ESG level. ESG scoring seems to be applicable to use in the portfolio as an addition to other better-known factors. Nonetheless, we still recommend caution because of the inconsistency of the ESG data among data providers.

Hanna, M. (2020). "The Impact of ESG-Related Industry Exclusions in Minimum-Volatility Portfolios." In: *The Journal of Impact and ESG Investing* 1(2), pp. 87–103.

Can an investor combine minimum volatility and ESG (environmental, social, and governance) investing without sacrificing the advantage of the low-volatility factor? Defensive and ESG investing are two of the fastest growing segments in the investing world. This article seeks to determine whether defensive investors, through low-volatility or minimum-volatility portfolios (MVPs), can maintain strong results if the portfolios include an ESG industry restriction overlay. The implication of this study is that investors face no statistically significant loss of investment return or increased risk by imposing ESG industry exclusions on minimum-volatility portfolios. The author excludes 25 different sub-industries categorized as industries with environmental or social issues and determines that the exclusions, individually and collective, do not cause any significant deviation in long-term minimum-volatility investor experience. Ultimately ESG and minimum-volatility equity investors can have their cake and eat it too. They can maintain a minimum-volatility experience while also improving the ESG profile of their portfolio.

Harper, H. (2020). "One Institutional Investor Approach to Integrating ESG in the Investment Process." In: *The Journal of Portfolio Management* 46(4), pp. 110–123.

This article intends to share one institutional investor approach to integrating environmental, social, and governance (ESG) factors in managing and overseeing the assets of the United Automobile Workers Retiree Medical Benefits Trust. This approach takes a comprehensive view of material, ESG-related factors that influence corporate financial results, which ultimately influence the investment performance of the Trust portfolio. Over the past couple of decades, the number of investors integrating some form of responsible investing has grown significantly. Nevertheless, a portion of the investment community still does not pursue ESG as part of the investment process. As with any decision in managing a pool of assets, one must be clear on governance structure, investment beliefs, investment objectives, risk tolerances, regulatory environment, and other considerations in designing an investment strategy. All of these important elements and dynamics are critical in designing and implementing an investment policy and strategy that best fits the asset owner circumstances. Hopefully, by

sharing one investor perspective, this will prove useful for all investors as a data point for considering the role and approach of responsible investing in an investment program.

Harvey, C. R., Liu, Y., and Saretto, A. (2020). "An Evaluation of Alternative Multiple Testing Methods for Finance Applications." In: *The Review of Asset Pricing Studies* 10(2), pp. 199–248.
In almost every area of empirical finance, researchers confront multiple tests. One high-profile example is the identification of outperforming investment managers, many of whom beat their benchmarks purely by luck. Multiple testing methods are designed to control for luck. Factor selection is another glaring case in which multiple tests are performed, but numerous other applications do not receive as much attention. One important example is a simple regression model testing five variables. In this case, because five variables are tried, a t-statistic of 2.0 is not enough to establish significance. Our paper provides a guide to various multiple testing methods and details a number of applications. We provide simulation evidence on the relative performance of different methods across a variety of testing environments. The goal of our paper is to provide a menu that researchers can choose from to improve inference in financial economics.

Hays, M. and McCabe, J. (2021). "Sustainable and Impact Investing: A Taxonomy of Approaches and Considerations for Fiduciaries." In: *The Journal of Wealth Management* 24(2), pp. 10–24.
The application of sustainable and impact investing approaches to the management of investment portfolios has risen dramatically over the past three years due to a convergence of factors, including increased cross-generational interest and the enhanced ability of asset managers to utilize these approaches when seeking strong risk-adjusted returns. But two key challenges hold many asset owners and managers back from taking action: 1) confusion over the differences among the vast array of sustainable and impact investing disciplines and 2) lack of clarity on whether and how investors who serve in a fiduciary capacity can incorporate these disciplines. In this article, the authors introduce a taxonomy of sustainable and impact investing approaches, mapped to a set of guidelines for fiduciaries to consider in practice. This framework, based on a mix of market, legal, academic, and internal risk/return research, provides investors with guidance on applicability by ESG approach by account type, ranging from investment management accounts (both nondiscretionary and discretionary) to revocable and irrevocable trusts, to ERISA accounts. The sustainable and impact investing industry is at an inflection point where further growth will need to be supported by clear and well-supported frameworks-and this article serves to provide them.

Heeb, F., Kolbel, J., Paetzold, F., and Zeisberger, S. (2022). "Do Investors Care About Impact?" In: *SSRN e-Print*.
We assess how investors' willingness-to-pay (WTP) for sustainable investments responds to the impact of those investments, using a framed field experiment. Although investors have a substantial WTP for sustainable investments, they do not pay more for investments with more impact. This also holds for dedicated impact investors. When investors compare several sustainable investments, their WTP increases with impact, but depends strongly on the choice set. Investors experience positive emotions when choosing a sustainable investment, irrespective of the investment's impact. These findings suggest that the WTP for sustainable investments is driven by "warm glow" and not by deliberate evaluations of impact.

Henriksson, R., Livnat, J., Pfeifer, P., and Stumpp, M. (2019). "Integrating ESG in portfolio construction." In: *The Journal of Portfolio Management* 45(4), pp. 67–81.
In this article, the authors recommend an approach to integrate environmental, social, and governance (ESG) issues into portfolios that is based on two premises. The first is that classification of firms as good or bad ESG companies should be performed using ESG items that are material in that industry. The second premise is that it is possible to overcome the sparse voluntary ESG data reported by firms by constructing an ESG good minus bad (GMB) factor and then finding those firms whose returns load significantly on this factor. The authors provide evidence that shows the superiority of using material, industry-specific ESG items and the merits of expanding the ESG classification using the ESG GMB loadings. Their approach is particularly suitable for quantitative investment approaches that invest in portfolios with large number of positions and many small active exposures, wherein vendor ESG data can be used in portfolio construction efficiently without the need to employ detailed ESG analyses of many individual firms. With such portfolios, it is less about the ESG classification of an individual company than about the aggregate portfolio tilt toward good ESG and away from bad ESG at the portfolio level.

Hens, T., Schenk-Hoppe, K. R., and Woesthoff, M.-H. (2020). "Escaping the backtesting illusion." In: *The Journal of Portfolio Management* 46(4), pp. 81–93.
Two tests can help asset managers to develop more robust investment strategies: an impact test and a survival test. Both tests complement the backtest, in which one checks how a proposed investment strategy would have

performed in the past. The impact test considers the performance of the strategy when assets under management grow (crowdedness), and it checks the impact that growth in assets under management in competing strategies has on the proposed strategy (cross impact). The survival test considers the effect of the long-term evolution of assets under management in competition for market capital. Using Shiller S&P 500 index and bond market data, we show that time-series momentum (relative strength) performs best in the backtest and the impact test but that an expected relative cash-flow rule (relative dividend yield) has the best long-term survival properties.

Hodges, P., Ren, H., Schwaiger, K., and Ang, A. (2022). "Net Zero Investing for Multi-Asset Portfolios seeking to satisfy Paris Aligned Benchmark Requirements with Climate Alpha Signals." In: *SSRN e-Print*.
The authors embed Paris Aligned Benchmark (PAB) requirements in an illustrative multi-asset portfolio containing developed and emerging market equities, sovereign bonds, corporate bonds, listed real estate, and commodities. By being PAB compliant, the immediate reduction and ongoing reductions in carbon emissions for each asset class are designed to limit average global temperature rises to 1.5 degrees C, do not disinvest from any sectors, and build in forward-looking data on emissions for issuers for both corporations and governments with certain exclusions of poor climate performers. The authors show comparable performance in historical data of the multi-asset PAB portfolio to a balanced multi-asset portfolio without climate considerations. The outperformance is enhanced by alpha signals based on climate-related metrics and non-climate data.

Hsu, Y.-C., Lin, H.-W., and Vincent, K. (2017). *Do Cross-Sectional Stock Return Predictors Pass the Test without Data-Snooping Bias?* Tech. rep. Institute of Economics Academia Sinica.
This study examines the possible data-snooping bias as a competing explanation for the anomalies in the cross-section of stock returns. We posit that the exhaustive standalone searches for profitable strategies could lead to recommending spuriously predictive variables. In order to explore the severity of this problem, we use a multiple testing method to evaluate the profitability of portfolios constructed by these predictors. Our empirical analyses suggest that over half of the findings based on individual testing method are no longer statistically significant after we adjust for data-snooping bias. Excluding the micro-cap stocks before portfolios construction and applying the notion of economic significance in this study further weaken the evidence for predictability.

Hsu, P.-H., Han, Q., Wu, W., and Cao, Z. (2018a). "Asset allocation strategies, data snooping, and the 1 / N rule." In: *Journal of Banking & Finance* 97, pp. 257–269.
Using a series of advanced tests from White's (2000) Check to correct for data-snooping bias, we assess the out-of-sample performance of various portfolio strategies relative to the naive 1/N rule. When we analyze 16 basic portfolio strategies, 126 learning strategies, and nearly 2,000 extended strategies, we find that some strategies outperform the 1/N rule in conventional tests that do not account for data-snooping bias. However, after we use the new tests that control for such bias, we find that none or very few of these strategies outperform the 1/N rule. Thus, our finding underscores the necessity to control for data-snooping bias when making asset allocation decisions.

Hsu, J., Liu, X., Shen, K., Viswanathan, V., and Zhao, Y. (2018b). "Outperformance through Investing in ESG in Need." In: *The Journal of Index Investing* 9(2), pp. 18–26.
To maximize their effectiveness, environmental, social, and governance (ESG) strategies should target those ESG firms that are most capital constrained. Inherently, this involves seeking ESG firms that have irrationally high costs of capital and thus high expected return. We replicate results that find returns among ESG firms that are similar to those among non-ESG firms. In addition, we find that sorting stocks based on cost of equity capital generates significant positive return for both ESG and non-ESG firms. Investing in an ESG in Need index, which contains only high-ESG companies and tilts toward firms with high cost of capital, thus generates both higher social value and better return than investing in traditional capitalization-weighted ESG indexes.

Huang, M. and Yu, S. (2020). "A new procedure for resampled portfolio with shrinkaged covariance matrix." In: *Journal of Applied Statistics* 47(44), pp. 642–652.
Dealing with estimation error is an important issue when we implement the mean-variance paradigm for portfolio construction. To tackle the problem, two approaches are proposed in literature, the portfolio resampling technique introduced by Michuad and the well-known shrinkaged covariance matrix method. There are certain evidences on the advantages of shrinkaged covariance over portfolio resampling, however, it is unclear whether a combination of the two approaches could produce a better performance compared with using shrinkaged covariance alone. In this paper, we propose a new algorithm to integrated linear or nonlinear shrinkage estimation with resampled portfolio to achieve a further improvement. Our method are demonstrated via extensive simulation and application in active portfolio management process.

Hubel, B. and Scholz, H. (2020). "Integrating sustainability risks in asset management: the role of ESG exposures and ESG ratings." In: *Journal of Asset Management* 21, pp. 52–69.
The rising sustainability awareness among regulators, consumers and investors results in major sustainability risks for firms. We construct three ESG risk factors (Environmental, Social, and Governance) to quantify the ESG risk exposures of firms. Taking these factors into account significantly enhances the explanatory power of standard asset pricing models. We find that portfolios with pronounced ESG risk exposures exhibit substantially higher risks, but investors can compose portfolios with lower ESG risks without harming risk-adjusted performance. Moreover, investors can measure the ESG risk exposures of all firms in their portfolios using only stock returns, so that even stocks without qualitative ESG information can be easily considered in the management of ESG risks. Indeed, strategically managing ESG risks may result in potential benefits for investors.

Husse, T. and Pippo, F. (2022). "Responsible Minus Irresponsible - a determinant of equity risk premia?" In: *Journal of Sustainable Finance & Investment*, pp. 1–23.
This study attempts to explain the relationship between ESG and financial performance. It utilises a new method for constructing an ESG portfolio with a high exposure towards ESG that eliminates the inherent correlation between size and ESG. In that perspective, a zero initial investment portfolio that goes long in responsible companies and short in irresponsible companies is adopted; hence, developing a 'Responsible Minus Irresponsible' (RMI) factor mimicking portfolio. A pricing anomaly test on this portfolio suggests that ESG exerts superior financial performance, mostly as a result of a significant lower market risk. Performing a cross-sectional analysis of different factor models on an international set of company returns indicates a negative effect of ESG on expected returns. However, the ESG factor becomes insignificant once multiple factors are introduced as explanatory variables. Consequently, ESG represents a pricing anomaly but does not act as an independent risk factor.

Hwang, I., Xu, S., and In, F. (2018). "Naive versus optimal diversification: Tail risk and performance." In: *European Journal of Operational Research* 265(1), pp. 372–388.
It is well documented in portfolio optimization that naive diversification outperforms optimal mean-variance diversification because the latter is subject to severe estimation error. Our study provides an alternative explanation for the outperformance of naive diversification by examining the tail risk of naive diversification relative to optimal mean-variance diversification. We utilize a rolling-sample approach and compare the out-of-sample performance and tail risk of various optimal strategies to that of the naive diversification strategy. Using portfolios consisting of individual stocks, we show that for portfolios containing relatively small number of stocks, naive diversification outperforms optimal mean-variance diversification and is less exposed to tail risk. However, for relatively large number of stocks in the portfolio, naive diversification maintains its superior performance but increases tail risk and results in more concave portfolio returns. These results imply that the outperformance of naive diversification acts as compensation for the increase in tail risk and concavity.

Ielasi, F., Ceccherini, P., and Zito, P. (2020). "Integrating ESG Analysis into Smart Beta Strategies." In: *Sustainability* 12(22), p. 9351.
Smart beta strategy is an increasingly frequent approach to investment analysis for portfolio selection and optimization and it can be combined with environmental, social, and governance (ESG) considerations. In order to verify the impact of the integration between ESG and smart beta analysis, first we apply a portfolio rebalancing based on ESG scores on securities selected according to different smart beta strategies (ex-post ESG rebalancing approach). Secondly, we apply different smart beta approaches to sustainable portfolios, screened according to the issuers' ESG scores (ex-ante ESG screening approach). We find that ESG rebalancing and screening are able to impact both on return and risk statistics, but with a different level of efficiency for each smart beta strategy. ESG rebalancing proves to be particularly efficient when it is applied to a "Value" portfolio. On the other hand, when smart beta is applied to ESG-screened portfolios, "Growth" is the strategy which shows the highest increase in risk-adjusted performance, particularly in the US. Minimum volatility proves to be the most efficient smart beta strategy for sustainable portfolios. In general, the increase in the level of sustainability does not deteriorate the risk-adjusted performances of most smart beta strategies.

Ielpo, F., Merhy, C., and Simon, G. (2017). *Engineering Investment Process: Making Value Creation Repeatable*. Elsevier. 430 pp.
The book explores the quantitative steps of a financial investment process. The authors study how these steps are articulated in order to make any value creation, whatever the asset class, consistent and robust. The discussion includes factors, portfolio allocation, statistical and economic backtesting, but also the influence of negative rates, dynamical trading, state-space models, stylized facts, liquidity issues, or data biases. Besides the quantitative

concepts detailed here, the reader will find useful references to other works to develop an in-depth understanding of an investment process.

Immel, M., Hachenberg, B., Kiesel, F., and Schiereck, D. (2021). "Green bonds: shades of green and brown." In: *Journal of Asset Management* 22, pp. 96–109.
We analyse the existence of a green bond premium and find a negative premium of 8 to 14 basis points. We are further interested in the influence of ESG ratings on green bonds to determine if investors differentiate between the shade of green. Examining a unique dataset of green bonds, we find a statistically significant influence of ESG ratings on bond spreads. A one-point increase in the weighted average ESG score leads to a decrease in the spread of 6 to 13 basis points. Interestingly, the results are not driven by the environmental friendliness of the green bond issuer, but through the company's governance.

Jacob, A. and Wilkens, M. (2021). "What drives sustainable indices? A framework for analyzing the sustainable index landscape." In: *SSRN e-Print*.
This article presents an encompassing four-step customizable framework for analyzing the heterogeneous sustainable index landscape. Compared to previous studies, we present means and methods to move the measurement and impact of sustainability performance in the center of attention and emphasize the often neglected aim of sustainable indices: incorporating sustainability into investment tools. Besides traditional comparisons of return and risk indicators (step one), we analyze the sustainability profile of sustainable indices while actively managing the presence of ESG rating disagreement (step two). For the determination of index-specific return and risk sources, we integrate sustainability factors in factor analyses and risk decomposition approaches (step three). A performance attribution analysis based on sustainability classes increases the transparency on the composition strategies of sustainable indices (step four). Our framework facilitates the analyses of sustainable investment tools and thus supports investors in making more meaningful and forward-looking investment decisions in line with their sustainability-related preferences.

Jacobsen, B., Cheng, E., and Lee, W. (2021). "Climate Change and Asset Allocation: A Distinction That Makes a Difference." In: *The Journal of Portfolio Management* 47(4), pp. 123–134.
It has become generally accepted that climate change affects economic variables such as growth and inflation. Via these economic channels, it is likely that climate change will also affect asset returns and risks. The authors provide evidence-based estimates of what these effects are and discuss how to incorporate climate change to build portfolios that are robust to a variety of climate change scenarios.

Jacobsen, B., Lee, W., and Ma, C. (2019). "The alpha, beta, and sigma of ESG: better beta, additional alpha?" In: *The Journal of Portfolio Management* 45(6), pp. 6–15.
Rather than treat investments as statistical objects to be optimally combined into portfolios, investors are increasingly interested in the environmental, social, and corporate governance (ESG) dimensions of their investments. Analysts traditionally evaluated these dimensions in qualitative ways, but many data providers are attempting to score these dimensions, effectively quantifying what was qualitative. For developed market equities, on the basis of one popular data provider ESG assessment, we evaluate the evidence on whether portfolios of highly rated ESG stocks are materially different from their complements (non-ESG stocks) in their investment opportunity sets. It is obvious that ESG stocks differ from non-ESG stocks in their ESG dimensions, but we show that ESG stocks returns are also different. Although the total return-to-total risk of ESG stocks may be lower than that for non-ESG stocks, after factor-adjusting the returns and risks, portfolios of ESG stocks with positive alpha have return-to-risk features comparable to those of portfolios of non-ESG stocks with positive alpha. For portfolios without statistically significant alpha, the portfolios of ESG stocks have lower residual volatility than portfolios of non-ESG stocks. It should be possible, by factor-neutralizing portfolios, to build better beta with comparable alpha portfolios by using ESG factors.

Jaeger, M., Krugel, S., Marinelli, D., Papenbrock, J., and Schwendner, P. (2020). "Understanding machine learning for diversified portfolio construction by explainable AI." In: *SSRN e-Print*.
In this paper, we construct a pipeline to investigate heuristic diversification strategies in asset allocation. We use machine learning concepts ("explainable AI") to compare the robustness of different strategies and back out implicit rules for decision making.In a first step, we augment the asset universe (the empirical dataset) with a range of scenarios generated with a block bootstrap from the empirical dataset.Second, we backtest the candidate strategies over a long period of time, checking their performance variability. Third, we use XGBoost as a regression model to connect the difference between the measured performances between two strategies to a pool of statistical features of the portfolio universe tailored to the investigated strategy. Finally, we employ the concept of Shapley values to extract the relationships that the model could identify between the portfolio

characteristics and the statistical properties of the asset universe. We test this pipeline for studying risk-parity strategies with a volatility target, and in particular, comparing the machine learning-driven Hierarchical Risk Parity (HRP) to the classical Equal Risk Contribution (ERC) strategy.In the augmented dataset built from a multi-asset investment universe of commodities, equities and fixed income futures, we find that HRP better matches the volatility target, and shows better risk-adjusted performances. Finally, we train XGBoost to learn the difference between the realized Calmar ratios of HRP and ERC and extract explanations.The explanations provide fruitful ex-post indications of the connection between the statistical properties of the universe and the strategy performance in the training set. For example, the model confirms that features addressing the hierarchical properties of the universe are connected to the relative performance of HRP respect to ERC.

Jeffers, J., Lyu, T., and Posenau, K. (2021). "The Risk and Return of Impact Investing Funds." In: *SSRN e-Print*.
We provide the first analysis of the risk exposure and consequent risk-adjusted performance of impact investing funds, private market funds with dual financial and social goals. We introduce a new dataset of impact fund cash flows constructed from financial statements. When accounting for market risk exposure, impact funds underperform the market, though not more so that comparable private market strategies. We exploit known distortions in measures of VC performance to characterize the risk profile of impact funds. Impact funds have substantially lower market beta than VC funds, contradicting the idea of sustainability as a "luxury good." We find that impact fund cash flows do not exhibit positive correlation with a public market sustainability factor, consistent with the idea that private and public market sustainability strategies capture distinct exposures.

Jin, I. (2018). "Is ESG a systematic risk factor for US equity mutual funds?" In: *Journal of Sustainable Finance & Investment* 8(1), pp. 72–93.
On the outperformance of responsible investing (RI) which incorporates environmental, social, and governance (ESG) into investment decisions, the empirical evidence to date is inconsistent from the viewpoint of ex-post performance. This paper tries to explain the nature of return differential between RI and conventional investing within the well-known risk-return paradigm. From the viewpoint of ex-ante equity risk premium, the five factor model of Fama and French [2015. Five-factor Asset Pricing Model. Journal of Financial Economics 116: 1-22] combined with a ESG-related factor applies to returns on 1,425 US open-end equity funds for the period from April 2009 to December 2016. Empirical findings include that US open-end equity funds tend to hedge the ESG-related systematic risk, and that the exposure to ESG-related systematic risk is significantly priced in the market. The result implies that RI provides the downside protection against ESG-related systematic risk which is not reduced even through extensive diversification.

Jin, I. (2021). "Systematic ESG Risk and Decision Criteria for Optimal Portfolio Selection." In: *SSRN e-Print*.
As institutional investors utilize passive ESG investing, ESG indices may account for joint movement in security prices and act as systematic risk factors. We identify the ESG risk factor through the orthogonal spread between a broad market and an ESG screened index. We suggest the double-index model and extended decision criteria for optimal portfolio selection. Applying the decision criteria to US equity mutual funds shows that ESG integration to portfolio optimization could enhance the portfolio's ESG quality and marginally improve the portfolio's risk-adjusted return. We also suggest interpreting individual funds' responsiveness to the ESG risk factor as returns-based ESG scores.

Jondeau, E., Mojon, B., and da Silva, L. A. P. (2021). "Building Benchmarks Portfolios with Decreasing Carbon Footprints." In: *SSRN e-Print*.
In this paper, we build portfolios with decreasing carbon footprint, which passive investors can use as new Paris-consistent (PC) benchmarks and have the same risk- adjusted returns as business as usual (BAU) benchmarks. As the distribution of firms' carbon intensity is very skewed, excluding a small fraction of highly polluting firms can massively reduce the carbon footprint of a portfolio of corporate stocks. We identify the worst polluters globally, exclude them from the portfolio, and re- allocate the proceeds so as to keep sectoral and regional exposures similar to those of the business as usual (BAU) benchmark. This approach limits divestment from corporates in Emerging Countries that would result from implementing exclusions and reinvestment without the objective of preserving regional exposures. We show that reducing the carbon footprint of the portfolio by 64% in 10 years would be obtained by excluding sequentially up to 11% of the corporates, which together amount to less than 6% of the global market portfolio. While this reallocation preserves regional and sectoral exposures similar to those of the BAU benchmark, it does not change its risk-adjusted return. We define PC benchmark portfolios at the global level, for Emerging Countries, Europe, North America, and the Pacific.

Juddoo, K., Malki, I., Mathew, S., and Sivaprasad, S. (2021). "An Investment Strategy Based on Impact." In: *SSRN e-Print*.

Impact investing is based on using the ESG framework as a tool to evaluate firms that engage in generating positive impact. Most impact investors and fund managers now integrate the ESG framework in their investment and stock-picking process. However, due to lack of standardisation of ESG reporting, it remains a challenge for investors and the public to identify the truly sustainable companies. We propose an additional measure of tax avoidance to identify firms that are socially responsible. When firms indulge in excessive tax avoidance behaviour, it may be viewed as unethical or socially irresponsible. We integrate the empirical association between corporate social responsibility (CSR) and tax avoidance into an investment strategy based on impact. We adopt an investment strategy based on firm level ESG ratings and tax avoidance practices. In a 'pure' impact investment strategy based on ESG and tax avoidance, we find that investing in high ESG rated firms and low tax avoidance firms yield a buy and hold abnormal return of 2.6% per annum and 14.3% in a three-year investment horizon. Next, if impact investors were to combine traditional investment strategies based on risk with impact measures, we find that portfolios of high ESG and high price-to-book-ratio firms earn a buy and hold abnormal return of 25.5%, while a portfolio of low tax avoidance and high price-to-book portfolios earn 33.1% in the long run. Collectively, our results suggest that whilst impact investing do provide investors a return, it does not necessarily outperform traditional investment strategies. Our results are robust to other risk factors and the sector of the firm.

Kaiser, L. (2020). "ESG integration: value, growth and momentum." In: *Journal of Asset Management* 21(1), pp. 32–51.

This study provides finer-grained results on the financial effectiveness of ESG integration for mainstream active investment styles. We account for firm size, industry and country effects within ESG scores and introduce the concept of ESG risk materiality. Empirical evidence shows that US and European investors can raise their portfolio's ESG level and increase risk-adjusted performance at the same time. Therefore, we add to the growing demand for sustainable products in the traditional investment industry and overcome the notion of ESG integration being a burden to traditional investment strategies.

Kaiser, L. and Schaller, F. (2019). "Environmentally (Un-)Friendly Portfolio Construction." In: *Journal of Investment Consulting* 19(1), pp. 43–52.

This study sheds light on a new type of sustainable investment approach, namelyenvironmental, social, and governance (ESG) momentum. We provide both a theoretical discussion and an empirical comparison of this new approach and put it in perspective to traditional weighting schemes considered by sustainable portfolio managers. In order to provide a clear basis for our argumentation and avoid any conflicting effects, we solely focus on the environmental aspect of ESG ratings in Europe and pay particular attention to strategies' carbon footprint as a central measure of a portfolio's environmental friendliness. Although the empirical results demonstrate inferior environmental ratings for ESG-momentum portfolios and mixed results in respect to risk-adjusted returns across alternative rating components, there might still be a case for investing in sustainable momentum stocks.

Kanuri, S. (2020). "Risk and Return Characteristics of Environmental, Social, and Governance (ESG) Equity ETFs." In: *The Journal of Index Investing* 11(2), pp. 66–75.

Environmental, social, and governance (ESG) ETFs attract investors who are driven by their personal values in investing, but also by investors who believe that ESG investing will produce a favorable return-risk tradeoff. This article looks at the risk and return characteristics of ESG ETFs since their inception (February 2005) through July 2019 and compares them with investable proxies for US (Russell 3000 ETF-IWV) and global (SPDR Global Dow ETF-DGT) equity markets. Using absolute and risk-adjusted performance measures, the author finds that equal- and value-weighted ESG portfolios outperformed the IWV and DGT in some periods and underperformed in others. However, during the entire period, IWV and DGT outperformed ESG portfolios and had higher absolute- and risk-adjusted performance.

Kapri, T. (2021). "Implications of mutual funds' ESG score on performance." MA thesis. University of Vaasa.

There are conflicting economic theories on the implication of ESG criteria on fund perfor-mance. Previous academic research has mostly mixed returns in portfolio level studies on the relationship of ESG and performance. The mutual fund industry and ESG investing have both seen rapid growth in the recent years, increasing the importance to better understand the effects of ESG profile of mutual funds. Therefore, this thesis investigates impact of fund ESG ratings on the performance of the funds. The thesis uses ESG rating data from Morningstar and factor data from Kenneth R. French's database. The data sample of the thesis consist of US based equity mutual funds that have received ESG rating from Morningstar between Jan-uary 1999 and October 2020. After excluding duplicate funds and deploying best-in-class and worst-in-class approach on top and bottom 20% funds based on Morningstar historic ESG rating, the sample consist of 326 mutual funds.

To investigate risk-adjusted returns of high and low ESG fund portfolios, the monthly returns of the portfolios are analysed with the CAPM, Fama and French (1993) three-factor model, Fama and French (2015) five-factor model and Fama and French (2018) six-factor model. Mul-tiple factor models are considered to minimize the possibility of p-hacking which is argued by Revelli and Viviani (2015) to be one of the drivers of previous mixed results in the SRI portfo-lio performance literature. Moreover, to investigate previous evidence and theory on ESG implication during market downturns dummy variable depicting 10% of lowest market re-turns is introduced to the factor models.

This thesis finds that low ESG rated funds have statistically significant negative abnormal re-turns during 1999 to 2020. The found significant negative abnormal return for the low ESG funds is monthly return of -0.282% For the high ESG rated funds statistically significant ab-normal returns cannot be found. Moreover, this thesis finds that high ESG funds outperform low ESG portfolios during the sample period. When introducing market downturn dummy variables, the models find positive alphas for high ESG and low ESG fund portfolios. However, the alphas are not statistically significant. Furthermore, the spread of high minus low ESG return with the dummy variable is positive and not statistically significant.

Kaurissaari, M. (2021). "Markowitz Revisited: Is there trade-off between return and responsibility?" MA thesis. University of Helsinki.

The aim of this thesis is to investigate whether investors face a trade-off between the responsibility and return when they invest with interest in only one or the other. In addition, the research asks whether it is more worth to invest in responsible funds, or can investors build their own portfolios and hence avoid the fund fees. The thesis uses Standard Portfolio Theory to build portfolios, and the stocks are selected within Swedish Large Cap companies. The first portfolio is built to maximize Sharpe ratio, that is the return-to-risk-ratio. Moreover, in line with an older study, the model is extended to include preference for a responsible portfolio. The responsible portfolio is called the Delta portfolio. Thus, the second portfolio is built by maximizing the portfolio's ESG score to its risk. A third portfolio is built with similar fashion to how funds are often constructed. The portfolio includes only stocks with a minimum ESG score of 0.583 and then the stocks are picked by optimizing the Sharpe ratio. The results show that by building a portfolio that only aims to maximize the responsibility to risk ratio, the investor faces a decrease in risk but only a modest decrease in returns. Investors, who do not care about responsibility, but optimize Sharpe ratio of portfolio face a decrease in ESG score, but the score seemed to have been increasing since 2016. However, the increase in ESG score was associated with relatively lower returns. Thus, Sharpe portfolio faced a more severe trade-off than the responsible portfolio. Moreover, the ESG portfolio showed underperformance to the funds, in addition to lower ESG scores and higher risk. Delta portfolio was found to be less risky and having relatively similar returns to funds. In conclusion, the results of the study show that there is only a modest trade-off between responsibility and return for a responsible investor but a more severe for conventional one. The study also shows a negative relationship between ESG score and risk. Secondly, the results indicate that investors should not consider creating their own responsible portfolio by following the screening for stocks and then using Sharpe ratio optimization, but instead try maximizing the Delta ratio, or invest in a well rated ESG-fund.

Kaustia, M. and Yu, W. (2021). "Greenwashing in Mutual Funds." In: *SSRN e-Print*.

This paper investigates mutual funds' potential "greenwashing" behavior. Funds profiled as ESG- based receive higher inflows compared to other similar funds. Importantly, we show this is true also for ESG labeled funds having inferior objective ESG profiles, as based on Morningstar sustainability ratings, applying to both retail and institutional funds. An analysis of mutual funds repurposing into ESG focus shows that fund families especially tend to convert such funds whose ability to attract in-flows has been lagging behind. Documenting and uncovering the motives for greenwashing is vital in terms of trust in the emerging and rapidly growing market of green financial products, with high hopes for its pivotal role in combating climate change.

Kazak, E. and Pohlmeier, W. (2019). "Testing out-of-sample portfolio performance." In: *International Journal of Forecasting* 35(2), pp. 540–554.

This paper studies the quality of portfolio performance tests based on out-of-sample returns. By disentangling the components of the out-of-sample performance, we show that the observed differences are driven largely by the differences in estimation risk. Our Monte Carlo study reveals that the puzzling empirical findings of inferior performances of theoretically superior strategies result mainly from the low power of these tests. Thus, our results provide an explanation as to why the null hypothesis of equal performance of the simple equally-weighted portfolio compared to many theoretically-superior alternative strategies cannot be rejected in many out-of-sample horse races. Our findings turn out to be robust with respect to different designs and the implementation

strategies of the tests. For the applied researcher, we provide some guidance as to how to cope with the problem of low power. In particular, we make use of a novel pretest-based portfolio strategy to show how the information regarding performance tests can be used optimally.

Kazak, E. and Pohlmeier, W. (2020). *Portfolio Pretesting with Machine Learning*. Tech. rep. University of Lancaster.
This paper exploits the idea of pretesting to choose between competing portfolio strategies. We propose an estimator for a portfolio weight vector, which optimally trades off between Type I and Type II errors when choosing the best investment strategy. Furthermore we accommodate the idea of bagging in the portfolio testing problems, which helps to avoid sharp thresholding and reduces the amount of portfolio turnover. Our approach borrows from both shrinkage and forecast combination literature. The portfolio weights of our strategy are weighted averages of the portfolio weights from a set of stand-alone strategies. More specifically, the weights are generated from a pseudo out-of-sample portfolio pretesting, such that they reflect the probability that a given strategy will be overall best performing. Contrary to previous approaches, the shrinkage intensity is continuously updated to incorporate the most recent information in the rolling window forecasting set-up. We show that the bagged pretest estimator performs exceptionally well, especially when combined with adaptive smoothing. The resulting strategy allows for a flexible and smooth switch between the underlying strategies and is shown to outperform the corresponding stand-alone strategies.

Kazdin, J., Schwaiger, K., Wendt, V.-S., and Ang, A. (2021). "Climate Alpha with Predictors Also Improving Company Efficiency." In: *The Journal of Impact and ESG Investing* 2(2), pp. 25–56.
Characteristics of companies associated with climate change predict excess equity returns. This article shows that companies with low-carbon-emission intensities-with carbon emissions being a key component of the Paris Agreement-have high excess returns. The authors present evidence that companies with low carbon emissions have high productivity and that low carbon intensities may reflect greater company efficiencies. A portfolio of companies with a high proportion of Leadership in Energy and Environmental Design (LEED)-certified buildings also exhibits high excess returns. Such companies also contemporaneously exhibit high return on assets. Portfolios constructed with carbon emission intensity and LEED-certified building signals are only weakly correlated with a traditional quality factor. The authors further discuss how climate change-themed measures of company efficiency may drive value for sustainably focused investors.

Khan, M. (2019). "Corporate Governance, ESG, and Stock Returns around the World." In: *Financial Analysts Journal* 75(4), pp. 103–123.
Nonfinancial performance measures, such as environmental, social, and governance (ESG) measures, are potentially leading indicators of companies financial performance. In the study reported here, I drew on prior academic literature and the concept of ESG materiality to develop new corporate governance and ESG metrics. The new metrics predicted stock returns in a global investable universe over the tested period, which suggests potential investment value in the ESG signals.

Kilmurray, D., Melin, L., and Mercereau, B. (2021). "Integrating Impact Funds into Mainstream Portfolios." In: *The Journal of Impact and ESG Investing* 1(4), pp. 103–119.
Interest in impact investing is growing, but investors typically allocate to impact funds and traditional assets independently from one another. We develop an optimizer that brings both types of assets together. Doing so allows investors to maximize impact for a certain level of risk-adjusted returns. For example, we find that investors can allocate 18% more to impact funds on average while keeping risk-adjusted returns constant. Intuitively, analyzing how impact funds and traditional assets interact should allow for better portfolio diversification. As interest in impact investing broadens, tools integrating impact funds into mainstream finance should become more widespread.

Klement, J. (2018). "Does ESG matter for asset allocation?" In: *SSRN e-Print*.
The integration of ESG factors into the investment process is increasingly becoming mainstream for institutional investors. However, investors struggle with how to incorporate ESG criteria into their top-down asset allocation decisions. In this report we show how ESG criteria can be systematically and consistently integrated into the asset allocation process. Our approach can be used for almost any multi-asset portfolio without materially reducing return expectations or increasing portfolio risk.

Krappel, T., Bogun, A., and Borth, D. (2021). "Heterogeneous Ensemble for ESG Ratings Prediction." In: *arXiv e-Print*.
Over the past years, topics ranging from climate change to human rights have seen increasing importance for investment decisions. Hence, investors (asset managers and asset owners) who wanted to incorporate these issues started to assess companies based on how they handle such topics. For this assessment, investors rely on

specialized rating agencies that issue ratings along the environmental, social and governance (ESG) dimensions. Such ratings allow them to make investment decisions in favor of sustainability. However, rating agencies base their analysis on subjective assessment of sustainability reports, not provided by every company. Furthermore, due to human labor involved, rating agencies are currently facing the challenge to scale up the coverage in a timely manner. In order to alleviate these challenges and contribute to the overall goal of supporting sustainability, we propose a heterogeneous ensemble model to predict ESG ratings using fundamental data. This model is based on feedforward neural network, CatBoost and XGBoost ensemble members. Given the public availability of fundamental data, the proposed method would allow cost-efficient and scalable creation of initial ESG ratings (also for companies without sustainability reporting). Using our approach we are able to explain 54% of the variation in ratings R2 using fundamental data and outperform prior work in this area.

Krueger, P., Sautner, Z., and Starks, L. T. (2020). "The importance of climate risks for institutional investors." In: *The Review of Financial Studies* 33(3), pp. 1067–1111.
According to our survey about climate risk perceptions, institutional investors believe climate risks have financial implications for their portfolio firms and that these risks, particularly regulatory risks, already have begun to materialize. Many of the investors, especially the long-term, larger, and ESG-oriented ones, consider risk management and engagement, rather than divestment, to be the better approach for addressing climate risks. Although surveyed investors believe that some equity valuations do not fully reflect climate risks, their perceived overvaluations are not large.

Kumar, R. (2019). "ESG: Alpha or Duty?" In: *The Journal of Index Investing* 9(4), pp. 58–66.
The paper examines information content of Environment, Social and Governance (ESG) from factor exposure perspective. We use integration approach of ESG in portfolio construction by using four broader MSCI USA ESG indices. The analyses have been done using risk-return, CAPM, Fama-French three factors, Fama-French-Carhart four factors, Fama-French five factors and Fama-French-Carhart six factors asset pricing models since the inception of each of the four ESG indices. We find that most of the returns of these four indices are explained by CAPM market factor and different asset pricing factors are significantly associated with returns of these ESG indices. The analyses show that there is no information content in ESG overall score in constructing a portfolio instead asset managers should incorporate relevant parameters forming part of overall ESG score in their portfolio construction. The institutional investors should perform their duty of helping poorly ESG ranked companies in changing their structural framework and thereby improving overall ESG score and then gaining through ESG momentum.

Kumar, R. and Khasnis, A. (2020). "Fallen Angels with ESG Wings." In: *The Journal of Impact and ESG Investing* 1(2), pp. 26–38.
This study examines the effect of environment, social, and governance (ESG) factors on fallen angel (FA) bonds, which are rated investment grade at issue but are subsequently downgraded to high yield. FAs are characterized by price pressure, higher yields, lower coupons, weaker covenants, higher probability of bankruptcy, higher durations, and higher concentration in sectors subject to a recent specific shock as compared with investment-grade bonds. The authors show the ESG-tilted FA portfolio negates some of the negative characteristics and increases the risk-adjusted return of the portfolio. The authors also examine the effect of the separate components of ESG'environmental (E), social (S), and governance (G)'separately on portfolio performance. They find that the impact of a governance-tilted portfolio has better risk-adjusted return than the other two components during the period of analysis. The conclusions are relevant for both active and passive institutional investors in constructing investment-grade as well as high-yield strategies.

Kuntz, L.-C. (2018). "Portfolio Strategies with Classical and Alternative Benchmarks." PhD thesis. Georg August University of Gottingen.
This dissertation addresses different key elements in portfolio management. It intends to improve and analyze influences on portfolio strategies and their performance. Likewise, it aims at the systematization and extension of benchmark specifications as well as their effect on portfolio strategies. Each chapter focuses on a different aspect of developing and implementing portfolio strategies. The dissertation seeks to contribute to the advancement of portfolio strategies by making the performance generating process and influences on it more comprehensible and transparent. In doing so, it attempts to strengthen the awareness of the impact of the exact design of portfolio strategies and benchmarks on the resulting portfolio and its performance. The key findings of this dissertation can be summarized as follows: The benchmark specification, especially in terms of the investible universe and the inherent risk conception, has substantial influence on the explicit design and performance of portfolio strategies. In general, the specification of the benchmark and design of portfolio strategies should be carefully considered

and the implementation should be well thought out. Alternative risk conceptions, such as regret risk, can be applied to portfolio selection and lead to clearly different portfolio compositions. Moreover, timing strategies can be improved by choosing a careful investment approach on the basis of distributional regressions. All empirical work 3 of this thesis has in common that it pursues different ideas to set up portfolio strategies while explicitly addressing the benchmark specification used for the implementation and evaluation of said strategies.

Lanza, A., Bernardini, E., and Faiella, I. (2020). "Mind the gap! Machine Learning, ESG Metrics and Sustainable Investment." In: *SSRN e-Print*.

This work proposes a novel approach for overcoming the current inconsistencies in ESG scores by using Machine Learning (ML) techniques to identify those indicators that better contribute to the construction of efficient portfolios. ML can achieve this result without needing a model-based methodology, typical of the modern portfolio theory approaches. The ESG indicators identified by our approach show a discriminatory power that also holds after accounting for the contribution of the style factors identified by the Fama-French five-factor model and the macroeconomic factors of the BIRR model. The novelty of the paper is threefold: a) the large array of ESG metrics analysed, b) the model-free methodology ensured by ML and c) the disentangling of the contribution of ESG-specific metrics to the portfolio performance from both the traditional style and macroeconomic factors. According to our results, more information content may be extracted from the available raw ESG data for portfolio construction purposes and half of the ESG indicators identified using our approach are environmental. Among the environmental indicators, some refer to companies' exposure and ability to manage climate change risk, namely the transition risk.

Le Guenedal, T. and Roncalli, T. (2022). *Portfolio Construction with Climate Risk Measures*. Tech. rep. Amundi Asset Management.

Because of the 2015 Paris Agreement, the development of ESG investing and the emergence of net zero emission policies, climate risk is certainly the most important topic and challenge for asset owners and managers now and will remain so over the next five years. It considerably changes portfolio allocation and the investment framework of both passive and active investors. The goal of this paper is to conduct a survey of the various climate risk measures that are available in the asset management industry and the practices of portfolio construction that use these metrics.

Therefore, the first part of this paper lists the different climate risk metrics - e.g., carbon footprint, carbon transition pathway, carbon transition and physical risks. The second part is dedicated to portfolio optimization, in particular portfolio decarbonization and portfolio alignment (Paris-based benchmarks and net zero carbon objective). Among the different findings, two are of great importance for investors. First, portfolio decarbonization is more difficult when we include scope 3 carbon emissions. Indeed, optimizing using the sum of scopes 1, 2 and 3 emissions leads to a portfolio with more tracking error risk than using direct plus first tier indirect carbon emissions. Second, portfolio alignment is more complex than portfolio decarbonization. Since aligning portfolios with scope 3 is becoming the standard approach to climate portfolio construction, the impact on portfolio management may be substantial, and the divergence between carbon investing and traditional investing will increase.

Lee, L.-E. (2021). "What Does ESG Investing Really Mean? Implications for Investors of Separating Financial Materiality and Social Objectives." In: *SSRN e-Print*.

Interest in measuring companies' behavior along economic, social, and governance (ESG) criteria reflects two important objectives: social values and financial performance. Nevertheless, measuring these has been difficulty, leading to confusion about ESG investing's effectiveness. New data and analytical innovations have supported efforts to separate material factors driving investment risk and return from those relevant primarily to social objectives. This paper reviews evidence on the effectiveness of social value-based versus financially relevant measures and identifies financially material factors, so as to guide pension fiduciaries and other investors on using ESG factors to meet investment objectives.

Lee, L.-E., Giese, G., and Nagy, Z. (2020). "Combining E, S, and G Scores: An Exploration of Alternative Weighting Schemes." In: *The Journal of Impact and ESG Investing* 1(1), pp. 94–103.

How an overall rating is constructed can have a significant impact on its usefulness to investors. In this study, we tested two approaches: equal weighting and backward optimization. Equally weighting E, S, and G pillar scores across sectors showed less financial significance than the stand-alone G pillar score -that is, without E and S scores - over the 13-year study period. Although backward optimization showed greater significance than the stand-alone G scores, this approach may underestimate the importance of ESG indicators to financial results over longer periods of time. These results suggest that investors seeking to combine E, S, and G into an aggregate

ESG score should proceed with caution. A naive approach such as equal weighting could introduce noise that decreases financial significance and a backward-optimized approach may ignore the importance of different time frames in how ESG risks unfold. Our findings illustrate the historical value in prospectively adjusting the selection and weighting of ESG Key Issues industry by industry to capture companies' exposure to dynamic and emerging risks.

Lepetit, F., Le Guenedal, T., Ben Slimane, M., Cherief, A., Mortier, V., Sekine, T., and Stagnol, L. (2021). *The Recent Performance of ESG Investing, the COVID-19 Catalyst and the Biden Effect*. Tech. rep. Amundi Asset Management.

This paper marks the latest update in our series exploring the impact of ESG investment on asset pricing in stock markets. The previous papers, covering the periods 2010-2019, found that:

1) ESG investing tended to penalize both passive and active ESG investors between 2010 and 2013.
2) In contrast, ESG investing was a source of outperformance from 2014 to 2017 in Europe and North America, and was even becoming a beta strategy in the Eurozone.
3) More recently the trends between North America and the Eurozone have somewhat diverged with ESG performance in North America lagging the sustained advances made in the Eurozone.
4) In 2018-2019, a move became apparent from bestin-class selection policies to the implementation of more active strategies to integrate a dynamic view of ESG scores.
5) The social pillar came to the fore in 2018-2019 after lagging from 2014-2017, likely due to growing concern for social themes such as rising inequalities.

The purpose of this paper is to appraise recent ESG trends in global equity markets. It contributes to a broader research project started at Amundi in 2014 on the relevance of ESG. Since the latest update in 2019, we have lived through a global pandemic that profoundly reshaped the global economy and society, and an eventful change of leadership in the United States. The aim of this paper is to analyze the changes in ESG trends since our latest update in June 2019. We work on the North American and EMU universes and, for the first time in our research series, also shed the light on Emerging Asia market. We identify that a presumed "Biden effect", assumed to be supportive for ESG performance in North America, was actually anticipated earlier by investors and rooted in the fertile ground of rising ESG awareness. This being said, Joe Biden's election may have fueled some momentum for the Emissions & Energy component of the Environmental pillar on both sides of the Atlantic at the end of 2020. In addition, we previously showed that the Social pillar in North America had already caught ESG investors' attention following the market stress caused by the COVID-19 outbreak. Our results also demonstrate the Social pillar's strong performance in North America since the end of 2020. Additionally, we show that companies with better Governance have been the most resilient in terms of performance during the pandemic's troublesome market environment, independently of the region considered. In North America, employing credit market data, we demonstrate that these firms also benefited from a lower corporate cost of debt. In Emerging Asia, we have witnessed strong ESG performance since the end of 2020. Finally, employing a predictive non-linear framework, our results support ESG as a serious candidate risk factor not only in the EMU, but also in North America since 2019.

Li, X., Xu, F., and Jing, K. (2022). "Robust enhanced indexation with ESG: An empirical study in the Chinese Stock Market." In: *Economic Modelling* 107, p. 105711.

The enhanced indexation constructs tracking portfolios to outperform the benchmark index without incurring additional downside risk. Previous studies only consider optimizing the tracking portfolios return and risk measures derived from historical price data. As environmental, social and governance (ESG) topics advance in the capital markets, this paper quantifies the uncertainty behind ESG data and proposes a robust enhanced indexation model with real-life constraints. Using ESG ratings from three of China's mainstream raters over a period 2015-2020, we conduct empirical studies to compare portfolios constructed by our model and previous works. Numerical results demonstrate that embedding ESG in the enhanced indexation leads to higher returns and lower risks. Moreover, the superiorities of the robust tracking portfolio are reducing the share of assets with high ESG uncertainty and capturing the upward returns of ESG investment. Therefore, our tracking portfolio is suitable for conservative and green investors who are suspicious of ESG data.

Lindeman, A. J. (2022). "ESG Score Design And Portfolio Construction." In: *The Journal of Impact and ESG Investing* 2(3), pp. 42–60.

Many investors are striving to incorporate granular ESG data into their decision-making. The use of scores themselves can be questioned-do they accurately reflect one's views, or are too many decisions being delegated? Or should one integrate ESG metrics directly into portfolio construction? We take the view of an index provider serving various clients who are looking to systematize their views. The paper naturally has two arcs, the first being score design from the ground up. The second part concerns the use of these scores (and sub-scores) in portfolio construction, wherein both the investing hypothesis and practicalities of data availability are discussed. We recommend that ESG portfolios be checked for unintended factor exposures, ESG metrics performance, as well as traditional backtest measures. In order to focus on techniques, we limit the scope of data and companies being included in this expository survey.

Lindsey, L. A., Pruitt, S., and Schiller, C. (2021). "The Cost of ESG Investing." In: *SSRN e-Print*.
Even against increasing interest in socially responsible investing mandates, we find that implementing ESG strategies can cost nothing. Modifying optimal portfolio weights to achieve an ESG-investing tilt negligibly affects portfolio performance across a broad range of ESG measures and thresholds. This is because those ESG measures do not provide information about future stock performance, either in relation to risk or mispricing, beyond what is provided by other observable firm characteristics. That the stock market does not reflect significant equilibrium pricing of ESG information is rationalized in a model of responsible investing wherein investors differ in which ESG-related criteria are used to weight their portfolios.

Lioui, A. (2018). "ESG Factor Investing: Myth or Reality ?" In: *SSRN e-Print*.
When treated as a characteristic, there seems to be an ESG anomaly. A real time investor is better off when augmenting an otherwise standard investment universe with two ESG portfolios of irresponsible and responsible firms. Out of sample, the optimal portfolio including the ESG portfolios outperforms one ignoring them. This added value shows up in the last decade and ESG Factor is a nascent anomaly which became a reality after the Great Financial Crisis. To harvest the ESG premium, the investor goes long irresponsible firms and short responsible ones. In sample evidence based on a long sample fails to show any potential gain from ESG investing. Moreover, long only investors with or without portfolio concentration constraints cannot harvest the ESG premium. Small stocks magnify the potential gains from ESG Factor investing although big stocks already deliver a respectable ESG diversification gain.

Lioui, A. and Tarelli, A. (2021). "Chasing The ESG Factor." In: *SSRN e-Print*.
In the time-series (ordinal ESG) or the cross-section (cardinal ESG)? We show analytically that, when proper adjustment to guarantee identical ESG ratings is implemented, the return spread of the factors produced by the two methods is merely noise. We provide a protocol to construct a cross-sectional ESG factor with a targeted ESG rating without screening stocks, hence without harming ex ante diversification (Sharpe ratio). The cross-sectional ESG factor neutralizes the exposure to other firm characteristics. Using ratings from several ESG data vendors, we document strong variations in the ESG factor's alpha in the time series and across data vendors. The alpha filtered from realized returns is negatively related to the level of an ESG sentiment variable based on media attention, while it is positively related to unexpected variations of the sentiment.

Lo, A. W. and Zhang, R. (2022). "Quantifying the Impact of Impact Investing." In: *American Finance Association Annual Meeting*.
We propose a quantitative framework for assessing the financial impact of any form of impact investing, including socially responsible investing (SRI), environmental, social, and governance (ESG) objectives, and other non-financial investment criteria. We derive conditions under which impact investing detracts from, improves on, or is neutral to the performance of traditional mean-variance optimal portfolios, which depends on whether the correlations between the impact factor and unobserved excess returns are negative, positive, or zero, respectively. Using Treynor-Black portfolios to maximize the risk-adjusted returns of impact portfolios, we propose a quantitative measure for the financial reward, or cost, of impact investing compared to passive index benchmarks. We illustrate our approach with applications to biotech venture philanthropy, divesting from "sin" stocks, investing in ESG, and "meme" stock rallies such as GameStop in 2021.

Lohre, H., Rother, C., and Schafer, K. A. (2020). "Hierarchical Risk Parity: Accounting for Tail Dependencies in Multi-asset Multi-factor Allocations." In: *Machine Learning for Asset Management: New Developments and Financial Applications*. Ed. by E. Jurczenko. Wiley, pp. 329–368.
This chapter examines the use and merits of hierarchical clustering techniques in the context of multi-asset multi-factor investing. In particular, it contrasts these techniques with several competing risk-based allocation paradigms, such as 1/N, minimum-variance, standard risk parity and diversified risk parity. The chapter introduces hierarchical risk parity (HRP) strategies based on the Pearson correlation coefficient and also introduces

hierarchical clustering based on the lower tail dependence coefficient. The chapter provides an overview of traditional risk-based allocation strategies and outlines a framework to measure and manage portfolio diversification. It examines the performance of the introduced HRP strategies relative to the traditional alternatives. The chapter discusses Meucci's approach to managing diversification, which serves to construct a diversified risk parity strategy based on economic factors.

Lopez, C., Contreras, O., and Bendix, J. (2020). "ESG Ratings: The Road Ahead." In: *SSRN e-Print*.
In this report, we show that a standard set of variables would partially resolveinconsistencies and lack of uniform standards among rating providers, which often confuses investors. Furthermore, we dissociate the impact of the rating agencies' different focus on E, S, or G from that of using non-standardized data. While the former, if properly disclosed, can be useful as it allows investors to choose what rating will align more with their preferences, the latter necessarily requires harmonization of the data.

Lopez de Prado, M. (2019). "A Data Science Solution to the Multiple-Testing Crisis in Financial Research." In: *The Journal of Financial Data Science* 1(1), pp. 99–110.
Most discoveries in empirical finance are false, as a consequence of selection bias under multiple testing. Although many researchers are aware of this problem, the solutions proposed in the literature tend to be complex and hard to implement. In this article, the author reduces the problem of selection bias in the context of investment strategy development to two sub-problems: determining the number of essentially independent trials and determining the variance across those trials. The author explains what data researchers need to report to allow others to evaluate the effect that multiple testing has had on reported performance. He applies his method to a real case of strategy development and estimates the probability that a discovered strategy is false.

Lopez de Prado, M. and Lewis, M. J. (2019). "Detection of false investment strategies using unsupervised learning methods." In: *Quantitative Finance* 19(9), pp. 1555–1565.
In this paper we address the problem of selection bias under multiple testing in the context of investment strategies. We introduce an unsupervised learning algorithm that determines the number of effectively uncorrelated trials carried out in the context of a discovery. This estimate is critical for computing the familywise false positive probability, and for filtering out false investment strategies.

Luccioni, A., Baylor, E., and Duchene, N. (2020). "Analyzing Sustainability Reports Using Natural Language Processing." In: *arXiv e-Print*.
Climate change is a far-reaching, global phenomenon that will impact many aspects of our society, including the global stock market dietz2016climate. In recent years, companies have increasingly been aiming to both mitigate their environmental impact and adapt to the changing climate context. This is reported via increasingly exhaustive reports, which cover many types of climate risks and exposures under the umbrella of Environmental, Social, and Governance (ESG). However, given this abundance of data, sustainability analysts are obliged to comb through hundreds of pages of reports in order to find relevant information. We leveraged recent progress in Natural Language Processing (NLP) to create a custom model, ClimateQA, which allows the analysis of financial reports in order to identify climate-relevant sections based on a question answering approach. We present this tool and the methodology that we used to develop it in the present article.

Macpherson, M., Gasperini, A., and Bosco, M. (2021). "Artificial Intelligence and FinTech Technologies for ESG Data and Analysis." In: *SSRN e-Print*.
AI AND Fintech-powered ESG screening and analysis solutions have become "strategic enablers" that can address some of the inherent ESG information biases and potentially even ESG rating divergences arising from corporate self-reporting, and annualised, backward looking reporting of information. Moreover, corporate disclosures can vary by region, with companies in developed economies in general disclosing more information than companies in emerging economies. In such cases, the "alternative data" is key to endeavour for capturing more information from these "black-box" companies for extra disclosures. Latest AI- and Fintech-led developments and innovation-centred collaboration efforts between regulators, standards setters, assurance, and innovation providers can provide a meaningful approach for ESG data complexity management.

Madhavan, A. and Sobczyk, A. (2020). "On the Factor Implications of Sustainable Investing in Fixed-Income Active Funds." In: *The Journal of Portfolio Management*, jpm.46.3.141.
Interest in sustainable investing in fixed income has grown tremendously. A natural question concerns how environmental, social, and governance (ESG) attributes affect expected return and risk. Most evidence has focused on equities. In this article, the authors use quarterly holdings data for a broad sample of US fixed-income active mutual funds to attribute active returns to 1. the returns to static factor exposures; 2. time-varying factor exposures; 3. security selection. They find that funds with strong ESG attributes derive a significant fraction of

their alpha from static factor exposures, which reflects a tilt toward higher-quality bonds that are less volatile. This fact explains the strong negative relation between a fund total return and its holdings-based ESG score.

Madhavan, A., Sobczyk, A., and Ang, A. (2021). "Toward ESG Alpha: Analyzing ESG Exposures through a Factor Lens." In: *Financial Analysts Journal* 77(1), pp. 69–88.
Using data on 1,312 active US equity mutual funds with 3.9 USD trillion in assets under management, we analyzed the link between funds' bottom-up, holdings-based environmental, social, and governance (ESG) scores and funds' active returns, style factor loadings, and alphas. We found that funds with high ESG scores have profiles of factor loadings that are different from those of low-scoring ESG funds. In particular, funds with high environmental scores tend to have high quality and momentum factor loadings. In partitioning the ESG scores into components that are related to factors and idiosyncratic components, we found strong positive relationships between fund alphas and factor ESG scores.

Maiti, M. (2021). "Is ESG the succeeding risk factor?" In: *Journal of Sustainable Finance & Investment* 11(3), pp. 199–213.
The present study addresses three questions: 1. Whether ESG is the succeeding risk factor? 2. To study the relevance of each component of ESG in investment decision? 3. To develop a new more robust asset pricing model with ESG. This study finds that three-factor models with market, size and ESG factors perform better than the Fama-French three-factor model. Higher Sharpe ratios for ESG, environment, social and governance factors indicate that portfolios formed on these factors show better investment performance over traditional size and value-based portfolios for all cases. The main message of the study is that ESG, environment, social and governance factors play an important role in predicting returns hence they should not be ignored while considering investment decision.

Malavasi, M., Lozza, S. O., and Truck, S. (2021). "Second order of stochastic dominance efficiency vs mean variance efficiency." In: *European Journal of Operational Research* 290(3), pp. 1192–1206.
In this paper, we compare two of the main paradigms of portfolio theory: mean variance analysis and expected utility. In particular, we show empirically that mean variance efficient portfolios are typically sub-optimal for non satiable and risk averse investors. We illustrate that the second order stochastic dominance (SSD) efficient set is the solution of a multi-objective optimization problem. We further show that the market portfolio is not necessarily a solution to this optimization problem. We also conduct an empirical analysis, examining the ex ante and ex post performance of SSD and mean variance efficient portfolios, using a bootstrap approach. In an ex ante analysis, we compare empirical moments, the level of diversification and set distances of mean variance and SSD efficient sets. We also show that the global minimum variance (GMV) portfolio and the part of the mean variance efficient frontier (MVEF) composed of highly diversified portfolios is second order stochastically dominated. This result also provides a possible alternative explanation for the diversification puzzle. Conducting an ex post analysis, we construct second order stochastic dominating strategies that outperform the GMV portfolio in terms of wealth and various other performance measures, producing a positive ex post opportunity cost.

Mannix, R. (2020). "Investors turn to raw data over ratings in ESG alpha hunt." In: *Risk*.
Firms are using data on product returns and employee welfare to pick winners.

Margot, V., Geissler, C., Franco, C. D., and Monnier, B. (2021). "ESG Investments: Filtering versus Machine Learning Approaches." In: *Applied Economics and Finance* 8(2), p. 1.
We designed a machine learning algorithm that identifies patterns between ESG profiles and financial performances for companies in a large investment universe. The algorithm consists of regularly updated sets of rules that map regions into the high-dimensional space of ESG features to excess return predictions. The final aggregated predictions are transformed into scores which allow us to design simple strategies that screen the investment universe for stocks with positive scores. By linking the ESG features with financial performances in a non-linear way, our strategy based upon our machine learning algorithm turns out to be an efficient stock picking tool, which outperforms classic strategies that screen stocks according to their ESG ratings, as the popular best-in-class approach. Our paper brings new ideas in the growing field of financial literature that investigates the links between ESG behavior and the economy. We show indeed that there is clearly some form of alpha in the ESG profile of a company, but that this alpha can be accessed only with powerful, non-linear techniques such as machine learning.

Martin, S. M. (2021). "Impact Investing. A Practitioner Perspective." In: *Studies of Applied Economics* 39(3).
This paper aims to briefly explore some of the most relevant and practical issues around "Impact investment" proposals from the perspective of a due diligence analyst or consultant. Measurement challenges, implementation

issues, the risk of Impact washing and the availability of Impact investments across various asset classes are among the topics analyzed.

Matos, P. (2020). "ESG and Responsible Institutional Investing Around the World: A Critical Review." In: *SSRN e-Print*.
This survey examines the vibrant academic literature on environmental, social, and governance (ESG) investing. While there is no consensus on the exact list of ESG issues, responsible investors increasingly assess stocks in their portfolios based on nonfinancial data on environmental impact (e.g., carbon emissions), social impact (e.g., employee satisfaction), and governance attributes (e.g., board structure). The objective is to reduce exposure to investments that pose greater ESG risks or to influence companies to become more sustainable. One active area of research at present involves assessing portfolio risk exposure to climate change. This literature review focuses on institutional investors, which have grown in importance such that they have now become the largest holders of shares in public companies globally. Historically, institutional investors tended to concentrate their ESG efforts mostly on corporate governance (the "G" in ESG). These efforts included seeking to eliminate provisions that restrict shareholder rights and enhance managerial power, such as staggered boards, supermajority rules, golden parachutes, and poison pills.

Mendiratta, R., Varsani, H. D., and Giese, G. (2021). "How ESG Affected Corporate Credit Risk and Performance." In: *The Journal of Impact and ESG Investing* 2(2), pp. 101–116.
This article extends the authors' research on how environmental, social, and governance (ESG) characteristics have affected equity investing and corporate bonds. Unlike with equities-where MSCI's previous research shows that MSCI ESG Ratings had positive effects on stocks' risk and return characteristics-the authors find that a corporate bondholder's main ESG focus could be mitigating downside risk, rather than capturing upside. They also examine whether ESG added value beyond credit ratings-a significant point of interest for bondholders. In short, ESG complemented credit ratings. ESG ratings had characteristics distinct from credit ratings and delivered additional insights into risk and performance. ESG was in general more financially relevant in high-yield (HY) bonds than in investment-grade (IG) bonds and more relevant in IG bonds with longer, rather than shorter, maturities. Higher-ESG-rated issuers tended to have stronger cash flow metrics, lower levels of ex ante risk, and less-frequent severe incidents than lower-rated-ESG issuers.

Mercereau, B. and Melin, L. (2020). "Optimizing Portfolios across Risk, Return, and Climate." In: *The Journal of Impact and ESG Investing* 1(1), pp. 115–131.
Climate concerns have grown dramatically. Investment tools to fight climate change are still lacking, though. We develop portfolio optimizers that minimize climate impact while maximizing expected returns and minimizing risk. Global equity investors can lower their portfolio's climate alignment temperature to 2.5 deg C without hurting its Sharpe ratio. Lowering its temperature further is more costly. Investors willing to forego 1pp in expected returns to shave 1 deg C off their portfolio would invest in firms aligned with a sub 2 degC climate scenario on average. Hence, investors factoring climate alignment in would benefit "colder" assets and hurt "hotter" ones. In practice, asset allocators could use three-dimensional optimizers to design the best risk, return, and climate impact trade-off for each client. Being able to diversify across asset classes means that the trade-off between risk-adjusted returns and climate alignment is moderate.

Miralles-Quiros, J. L., Miralles-Quiros, M. M., and Nogueira, J. M. (2020). "Sustainable Development Goals and Investment Strategies: The Profitability of Using Five-Factor Fama-French Alphas." In: *Sustainability* 12(5), p. 1842.
This study focuses on assets related to Sustainable Development Goals (SDGs), which are the most recent aspect of the Socially Responsible Investment framework and have caught the attention of investors due to their investment opportunities as well as the global challenges that can be achieved. The profitability of developing an investment strategy is shown based on the value of the alphas obtained from the estimation of the Fama-French five-factor model when compared to an equally weighted portfolio, even when transaction costs are taken into consideration. In addition, it is proven that investors should focus their investments on two main SDGs: Good health and well-being (Goal 3) and Industry, innovation and infrastructure (Goal 9).

Mohanty, S. S., Mohanty, O., and Ivanof, M. (2021). "Alpha enhancement in global equity markets with ESG overlay on factor-based investment strategies." In: *Risk Management* 23(3), pp. 213–242.
Studies show that companies with a strong Environment, Social and Governance (ESG) profile are more competitive than their peers, as they use resources, human capital and innovation more efficiently. High ESG-rated companies have lower exposure to systematic risk factors and low expected cost of capital, leading to higher valuations in a DCF model framework. They are typically more transparent, particularly with respect to their

risk exposures, risk management and governance standards and have better long-term vision. The paper finds that higher Alpha can be harvested by restricting investment exposure to the ESG theme combined with various style characteristics, as they display low systematic and idiosyncratic tail risks. It shows that an ESG overlay on such factor-based strategies, particularly on 'multi-factor', 'value' and 'low volatility' in that order, reduces both systematic and idiosyncratic risks further. ESG overlay on 'quality' factor provides the highest return among ESG target indices, however, the underlying 'quality' factor provides even higher excess return. These findings can provide some insight on return enhancement to investors investing in the global equity markets.

Mooney, T., Rapaka, R., and Vera, T. (2020). "Dynamic Regime Strategy for Stress Testing and Optimizing Institutional Investor Portfolios." In: *SSRN e-Print*.
Our work aims to develop a stand-alone trading system to construct portfolios that show the benefits of value and momentum style integration and presents the effectiveness of alternative integration methods for long-only absolute return funds, which seeks absolute returns that are not highly correlated to traditional assets such as stocks and bonds. Our approach uses the CRoss Industry Standard Process for Data Mining (CRISP-DM) model to guide the necessary steps, processes, and workflows for executing our project.

Morgenstern, C., Coqueret, G., and Kelly, J. (2021). "Tuning Trend-Following Strategies with Macro ESG Data." In: *The Journal of Impact and ESG Investing* 2(2), pp. 117–136.
This article seeks to tilt traditional macro trend-following strategies toward countries with high Environmental, Social, and Governance (ESG) scores. The integration incorporates both ESG levels and changes (improvements or deteriorations in sustainability). Notably, the authors find that the international ESG exposure of the macro portfolios can be substantially increased without any cost in performance for both long-only and long-short portfolios. In some cases, transaction cost-adjusted Sharpe ratios can even benefit from a minor shift toward more ESG exposure.

Naffa, H. and Fain, M. (2022). "A factor approach to the performance of ESG leaders and laggards." In: *Finance Research Letters* 44 (102073), p. 102073.
We introduce a factor approach to performance measurement of global ESG equity investments. We construct ESG pure factor portfolios (PFP) following Fama-MacBeth; then, applying Fama-French (FF) spanning regressions that simultaneously test performance and the validity of adding new ESG factors to the FF 5-factor model. To address endogeneity, we use a GMM-IV estimator. Our ESG portfolios do not generate significant alphas during 2015-2019, corroborating the literature's neutrality argument. We find no sufficient evidence for ESG factors to complement FF5. PFPs, nevertheless, may serve as ESG indices to quantify investment portfolio sustainability risks via performance attribution of the ESG factor tilt.

Nagy, Z., Kassam, A., and Lee, L.-E. (2016). "Can ESG Add Alpha? An Analysis of ESG Tilt and Momentum Strategies." In: *The Journal of Investing* 25(2), pp. 113–124.
Do institutional investors sacrifice risk-adjusted returns by incorporating environmental, social, and corporate governance (ESG) considerations? The authors analyze two relatively hightracking-error global strategies constructed using ESG data-a tilt strategy and a momentum strategy and find that both model portfolios outperformed the MSCI World Index over the past eight years, while also improving the ESG profile of the portfolios. These backtested model portfolios provide an example of how institutional investors with the tolerance to take some active risk, while at the same time looking to improve the ESG profile of their portfolios on a systematic basis, can incorporate such strategies in their investment processes.

Nofsinger, J. R. and Varma, A. (2021). "Keeping Promises? Carbon Risk Disclosure and Mutual Fund Portfolios." In: *SSRN e-Print*.
Morningstar's disclosure of carbon risk (CR) scores in May 2018 showed that (environmentally) sustainable mutual funds in the US had lower CR scores before the disclosure and a greater reduction in their portfolio CR scores after the announcement relative to convention funds. The observed causal impact of disclosures is consistent with funds' primary investment objectives. Conventional funds that are signatories to UN's Principles for Responsible Investment (PRI) or those with secondary sustainability mandates behave more like other conventional funds rather than sustainable funds. Such funds appear insensitive to disclosures as their sustainability considerations are superseded by other primary investment criteria. Sustainable funds lower their CR score by reducing exposure to fossil fuels, not by increasing exposure to renewables.

Nugent, T., Stelea, N., and Leidner, J. L. (2020). "Detecting ESG topics using domain-specific language models and data augmentation approaches." In: *arXiv e-Print*.
Despite recent advances in deep learning-based language modelling, many natural language processing (NLP) tasks in the financial domain remain challenging due to the paucity of appropriately labelled data. Other issues

that can limit task performance are differences in word distribution between the general corpora - typically used to pre-train language models - and financial corpora, which often exhibit specialized language and symbology. Here, we investigate two approaches that may help to mitigate these issues. Firstly, we experiment with further language model pre-training using large amounts of in-domain data from business and financial news. We then apply augmentation approaches to increase the size of our dataset for model fine-tuning. We report our findings on an Environmental, Social and Governance (ESG) controversies dataset and demonstrate that both approaches are beneficial to accuracy in classification tasks.

Ocal, H. and Kamil, A. A. (2021). "The impact of risk indicators on sustainability (ESG) and broad-based indices: an empirical analysis from Germany, France, Indonesia and Turkey." In: *International Journal of Sustainable Economy* 13(1), p. 18.
This study aims to provide empirical insights into how sustainability (ESG) and broad-based indices are affected by risk indicators such as VIX, CDS, and FX volatility index. Germany ESG-X, CDAX, France ESG-X, CAC All, Indonesia SRI-KEHATI, IDX Composite, BIST (Borsa Istanbul) Sustainability, and BIST All price indices have been examined. The daily data between November 4, 2014, and December 5, 2019 are used. Vector autoregression (VAR), Granger causality and impulse response test are employed in the analysis. The results of the study revealed that companies which are included in the Germany ESG-X, France ESG-X, and SRI-KEHATI are affected by shocks less than the companies included in broad-based indices of each country. In contrast to this result, BIST Sustainability is affected more by the shocks than BIST All. Stocks with higher ESG exposure in terms of quantity, quality, and credibility tend to have a lower risk. Causality test results revealed that VIX causes broad-based and ESG indices more than any other risk indicators.

Oikonomou, I., Platanakis, E., and Sutcliffe, C. (2017). "Socially Responsible Investment Portfolios: Does the Optimization Process Matter?" In: *SSRN e-Print*.
This study investigates the impact of the choice of optimization technique when constructing Socially Responsible Investment (SRI) portfolios. Corporate Social Performance (CSP) scores are price sensitive information that is subject to considerable estimation risk. Therefore, uncertainty in the input parameters is greater for SRI portfolios than conventional portfolios, and this affects the selection of the appropriate optimization method. We form SRI portfolios based on six different approaches and compare their performance along the dimensions of risk, risk-return trade-off, diversification and stability. Our results for SRI portfolios contradict those of the conventional portfolio optimization literature. We find that the more "formal" optimization approaches (Black-Litterman, Markowitz and robust estimation) lead to SRI portfolios that are both less risky and have superior risk-return trade-offs than do more simplistic approaches; although they also have more unstable asset allocations and lower diversification. Our conclusions are robust to a series of tests, including the use of different estimation windows and stricter screening criteria.

Ouchen, A. (2021). "Is the ESG portfolio less turbulent than a market benchmark portfolio?" In: *Risk Management* 24, pp. 1–33.
Given that there is no consensus on the fact that ESG portfolios are characterized by very high returns and very low risks compared to conventional portfolios, this study aims to empirically verify whether the series of returns of an ESG portfolio is less volatile than the returns of a benchmark market portfolio. To verify this hypothesis, we used the Markov-switching GARCH models in order to model the process of the series of daily returns of the ESG portfolio "MSCI USA ESG Select," as well as those of the market benchmark portfolio daily returns series "S&P 500," during the period June 01, 2005 to December 31, 2020 as well as that excluding the COVID19 crisis and from June 1, 2005 to October 29, 2019. It can be concluded that the ESG portfolio "MSCI USA ESG Select" is relatively less turbulent compared to the market benchmark portfolio "S&P 500.".

Oude Veldhuis, N. (2021). "Corporate Social Responsibility and the effect of ESG scores on stock returns." MA thesis. University of Groningen.
This study investigates whether the ESG score, as well as, the individual dimensions, i.e., environmental, social and governance score, affect the stock returns. Based on a sample of 6514 firms from 23 developed countries over the years 2002 to 2020, evidence suggests that ESG score does not affect stock returns. Moreover, at the dimension-specific level, we can see that a portfolio of stocks with the highest governance scores achieves a return of 40 basis points higher than their lowest counterpart. Meanwhile, a portfolio of stocks with the lowest environmental scores achieves a higher return of 60 basis points than their highest counterpart. Lastly, evidence suggests that the social score does not affect stock returns.

Owadally, I., Mwizere, J.-R., Kalidas, N., Murugesu, K., and Kashif, M. (2021). "Long-Term Sustainable Investment for Retirement." In: *Sustainability* 13(9), p. 5000.

We consider whether sustainable investment can deliver performance comparable to conventional investment in investors' long-term retirement plans. On the capital markets, sustainable investment can be achieved through various instruments and strategies, one of them being investment in mutual funds that subscribe to ESG (environmental, social, and governance) principles. First, we compare the investment performance of ESG funds with matched conventional funds over the period 1994-2020, in Europe and the U.S. We find no significant evidence of differing performance (at 5% level) despite using a number of investment performance metrics. Second, we perform a historical backtest to model a UK personal retirement plan from 2000 till 2020, taking full account of investment management fees and transaction costs. We find that investing in an index-tracker fund overlaid with ESG screening delivers a pension which is 10.4% larger than is achieved if the index-tracker fund is used without screening. This is also 20.2% larger than is achieved by investing in a collection of actively managed funds with a sustainable purpose. We conclude that an ESG-screened long-term passive investment approach for retirement plans is likely to be successful in satisfying the twin objectives of a secure retirement income and of sustainability.

Pan, L. (2020). "Demystifying ESG investing considerations for institutional cash investors." In: *The Journal of Portfolio Management* 46(3), pp. 153–156.
The popularity of responsible investing has extended to the fixed-income and liquidity-management fields in recent years. Incorporating environmental, social, and governance (ESG) issues in cash investment decisions makes sense as part of overall credit risk management. In addition to challenges related to disclosure, criteria, measure, and verification, liquidity portfolios face unique challenges in the areas of relevance, concentration, short-termism, and transparency. In this article, the author describes ESG considerations for institutional liquidity investors and explains that rather than buying into a strategy with an ESG label, institutional liquidity investors should engage their managers to include ESG issues in general credit evaluation and monitoring to improve risk management.

Parker, F. J. (2021). "Achieving Goals While Making an Impact: Balancing Financial Goals with Impact Investing." In: *The Journal of Impact and ESG Investing* 1(3), pp. 27–38.
For investors who wish to engage in impact investing and who have specific goals to achieve, there exists the potential for a trade-off. When impact investments yield lower returns than nonimpact portfolios, how much return should an investor be willing to give up to incorporate it? Using recent advances in goals-based utility theory, this article explores an answer to that question and offers practical and concrete advice for advisors to individual investors and fiduciaries of trusts. Using the goals-based framework, the author shows how an investor's willingness to sacrifice return for an impact investing mandate changes in response to market and portfolio conditions.

Pastor, L., Stambaugh, R. F., and Taylor, L. A. (2021). "Dissecting Green Returns." In: *SSRN e-Print*.
Green assets delivered high returns in recent years. This performance reflects unexpectedly strong increases in environmental concerns, not high expected returns. German green bonds outperformed their higher-yielding non-green twins as the "greenium" widened, and U.S. green stocks outperformed brown as climate concerns strengthened. To show the latter, we construct a theoretically motivated green factor—a return spread between environmentally friendly and unfriendly stocks—and find that its positive performance disappears without climate-concern shocks. A theory-driven two-factor model featuring the green factor explains much of the recent underperformance of value stocks. Our evidence also suggests small stocks underreact to climate news.

Pedersen, L. H., Fitzgibbons, S., and Pomorski, L. (2021). "Responsible investing: The ESG-efficient frontier." In: *Journal of Financial Economics* 142(2), pp. 572–597.
We propose a theory in which each stock's environmental, social, and governance (ESG) score plays two roles: (1) providing information about firm fundamentals and (2) affecting investor preferences. The solution to the investor's portfolio problem is characterized by an ESG-efficient frontier, showing the highest attainable Sharpe ratio for each ESG level. The corresponding portfolios satisfy four-fund separation. Equilibrium asset prices are determined by an ESG-adjusted capital asset pricing model, showing when ESG raises or lowers the required return. Combining several large data sets, we compute the empirical ESG-efficient frontier and show the costs and benefits of responsible investing. Finally, we test our theory's predictions using proxies for E (carbon emissions), S, G, and overall ESG.

Pham, L. and Nguyen, C. P. (2021). "Asymmetric tail dependence between green bonds and other asset classes." In: *Global Finance Journal* 50, p. 100669.
This study analyzes the tail-dependence between green bonds and other asset classes including energy markets, stock markets, and conventional bonds. The study employs the cross- quantilogram method to identify the cross-

quantile dependence between green bonds and other assets. Our data set covers the U.S. and European asset markets between October 2014 and February 2021. The empirical results show that the spillovers between asset classes and green bonds vary widely across the quantiles, indicating that the hedging benefits of green bonds against conventional asset classes differ across extreme and normal market conditions.

Pisani, F. and Russo, G. (2021). "Sustainable Finance and COVID-19: The Reaction of ESG Funds to the 2020 Crisis." In: *Sustainability* 13(23), p. 13253.
We investigated the financial performance of a sample of sustainable investment funds in terms of returns, volatility, and contagion risk during the financial crisis caused by the COVID-19 pandemic. In order to conduct a more reliable analysis, we considered a homogenous sample composed of 30 funds declaring the same benchmark (the MSCI Europe index). The Morningstar Sustainability ESG rating was used to determine the level of sustainability of each fund. Both the GARCH models and the event study suggest that funds with a higher ESG rating were able to outperform other funds during the COVID-19 period. These funds had a greater level of resilience and exhibited a lower level of risk contagion during the pandemic. These instruments appear to assume the role of risk protection and should be considered a means of both promoting sustainable growth and minimizing portfolio risk.

Plagge, J.-C. and Grim, D. M. (2020). "Have investors paid a performance price? examining the behavior of ESG equity funds." In: *The Journal of Portfolio Management* 46(3), pp. 123–140.
The academic and practitioner literature provides a variety of contradicting theories as to expected consequences of environmental, social, and governance (ESG)-related factors on the risk and return of equity securities. In light of these heterogeneous expectations, this article sets out to empirically investigate the performance characteristics of investable ESG equity funds to assess whether support for a particular direction in performance impact can be found. The dataset comprises index and active equity mutual funds and exchange-traded funds with a US investment focus that indicate the use of ESG factors in their investment process and extends over a period of 15 years (2004-2018). The empirical results are rather mixed. The authors find substantial cross-sectional dispersion in performance among funds. After controlling for style factor exposures, the majority of funds in any of the tested ESG categories does not produce statistically significant positive or negative gross alpha. An industry-based performance contribution analysis reveals that systematic differences in allocations relative to the broad market exist. However, their median contribution to performance is close to zero over time. Overall, return and risk differences of ESG funds can be significant but appear to be mainly driven by fund-specific criteria rather than by a homogeneous ESG factor. As a result, investors would be better served by assessing investment implications on a fund-by-fund basis.

Platanakis, E., Sutcliffe, C. M., and Ye, X. (2021). "Horses for Courses: Mean-Variance for Asset Allocation and 1/N for Stock Selection." In: *European Journal of Operational Research* 288(1), pp. 302–317.
For various organizational reasons, large investors typically split their portfolio decision into two stages - asset allocation and stock selection. We hypothesise that mean-variance models are superior to equal weighting for asset allocation, while the reverse applies for stock selection, as estimation errors are less of a problem for mean-variance models when used for asset allocation than for stock selection. We confirm this hypothesis in separate analyses of US and international equities using four different types of mean-variance model (Bayes-Stein, Black-Litterman, Bayesian diffuse prior and Markowitz), a range of parameter settings, and a simulation analysis calibrated to US data.

Polbennikov, S., Desclee, A., Dynkin, L., and Maitra, A. (2016). "ESG Ratings and Performance of Corporate Bonds." In: *The Journal of Fixed Income* 26(1), pp. 21–41.
The authors study the historical relationship between environmental, social, and governance (ESG) ratings and corporate bond spread and performance, finding that corporate bonds with high composite ESG ratings have slightly lower spreads, all else being equal. They also find that bonds with high ESG ratings have modestly outperformed their lowerrated peers when controlling for various risk exposures. They provide details on the effects of individual E, S, and G scores on performance. The outperformance of low-ESG issuers by their high-ESG peers through the past eight years has not been accompanied by increasing relative valuation. This suggests that the ESG performance gain is not a consequence of buying pressure and therefore might be retained.

Porage, C. (2021). "Sustainability in Portfolio Optimization." MA thesis. Orebro University.
Sustainability has become a global trend due to the remarkable growth of the demand for sustainable practices when controlling the risks associated with ESG (Environmental, Social and Governance) aspects worldwide. Hence, the socially responsible investors (or ESG investors) are curious to know whether investing in portfolios containing sustainable assets would create better investment opportunities compared to the portfolios consisted

of both sustainable and nonsustainable assets. In this study, mean-variance spanning tests that are based on classical optimal portfolio theory, are performed to examine whether there is a statistically significant difference between the minimum variance frontier of sustainable stocks and the minimum variance frontier comprising both the sustainable and non-sustainable stocks in OMXC25 index. For the analysis, weekly returns of fifteen stocks of OMXC25 index are used over a three year period from 2017 to 2019. Statistically significant results of the performed meanvariance spanning tests suggest that inclusion of unsustainable stocks will statistically significantly improve the performance of the portfolio compared with a portfolio of sustainable stocks solely in the OMXC25 index of the Danish capital market.

Pyles, M. K. (2020). "Examining Portfolios Created by Bloomberg ESG Scores: Is Disclosure an Alpha Factor?" In: *The Journal of Impact and ESG Investing* 1(2), pp. 39–52.
This article uses Bloomberg's ESG disclosure data to create portfolios of high- and low-ESG firms over the recent market run of 2011-2017. The primary purpose is to determine whether disclosure is an alpha factor related to portfolio creation and management. We find that abnormal returns are generally higher for portfolios of lower-scoring firms. The author further documents that larger firms, with lower profitability, and higher dividend yields tend to have higher Bloomberg ESG disclosure scores. These variables also tend to inhibit market gains. Further, once controlling for firm characteristics, the author finds no significant influence on buy-and-hold abnormal returns from any of the ESG scoring variables. The results suggest positive screening based upon ESG disclosure to be a non-value-enhancing strategy, while also recognizing the strong relationship between disclosure and underlying firm characteristics that drive performance results.

Radovanov, B. and Marcikic, A. (2014). "Testing The Performance Of The Investment Portfolio Using Block Bootstrap Method." In: *Economic Themes* 52(2).
The aim of this paper is to create a stable model of investment portfolio optimization through a high degree of diversification and reduction of sudden changes in the allocation with monitoring of the dynamics of the impact factor. In this sense, there is bootstrap application procedure, which, without an excessive number of constraints involved in the optimization process provides solutions based on uncertain information. Thus defined, the optimization method has been patented by Michaud (1999) entitled re-sampled efficiency. Accordingly, this paper offers a comparison of the performance block bootstrap optimization models and traditional Markowitz's model inside and outside of the sample by applying the most frequently traded stocks on the BSE. The results show a better performance out of the sample and the presence of a larger number of shares forming the portfolio through bootstrap methodology. However, only through the traditional optimization process could be attained optimum according to the required limits. Such effects can be observed by comparing the limits of efficiency obtained through these optimization models. However, optimization-based methods bootstrap finds its place in reducing errors of assessment resulting from the limited sample size.

Raynaud, J., Tankov, P., and Voisin, S. (2020). "Portfolio Alignment to a 2°C Trajectory: Science or Art?" In: *SSRN e-Print*.
The concept of portfolio alignment to a temperature trajectory has gained momentum among investors and regulators since the 2015 Paris Agreement recognized the importance of the financial sector for the low carbon energy transition. Yet, a clear definition and a transparent methodological framework for alignment assessment with a temperature trajectory, or portfolio temperature alignment, are presently lacking and few academic studies have addressed this question. This paper provides a definition of portfolio temperature alignment, reviews the key methodological steps in computing alignment measures, and highlights the main scientific challenges, with the aim to stimulate further research on this topic. We review, analyze and place in context the main findings of the recent technical review of portfolio temperature alignment assessment methodologies by Institut Louis Bachelier.

Rebonato, R. (2019). "A financially justifiable and practically implementable approach to coherent stress testing." In: *Quantitative Finance* 19(5), pp. 827–842.
We present an approach to stress testing that is both practically implementable and solidly rooted in well-established financial theory. We present our results in a Bayesian-net context, but the approach can be extended to different settings. We show (i) how the consistency and continuity conditions are satisfied; (ii) how the result of a scenario can be consistently cascaded from a small number of macrofinancial variables to the constituents of a granular portfolio; and (iii) how an approximate but robust estimate of the likelihood of a given scenario can be estimated. This is particularly important for regulatory and capital-adequacy applications.

Reboredo, J. C. and Otero, L. A. (2021). "Are investors aware of climate-related transition risks? Evidence from mutual fund flows." In: *Ecological Economics* 189, p. 107148.

Using information on climate transition risks embedded in US equity mutual fund portfolios, we report evidence that mutual fund investors consider climate-related transition risk to be an undesirable fund feature and accordingly allocate more money to funds with lower climate-related transition risk. The size of the impact of this risk on fund flows differs depending on the performance expectations of investors and the socially responsible focus and sustainability of the fund. Our results suggest that mutual fund investors are aware of climate-related transition risks as evidenced by their investment decisions.

Roncalli, T., Le Guenedal, T., Lepetit, F., Roncalli, T., and Sekine, T. (2020). "Measuring and Managing Carbon Risk in Investment Portfolios." In: *SSRN e-Print*.

This article studies the impact of carbon risk on stock pricing. To address this, we consider the seminal approach of Gorgen et al. (2019), who proposed estimating the carbon financial risk of equities by their carbon beta. To achieve this, the primary task is to develop a brown-minus-green (or BMG) risk factor, similar to Fama and French (1992). Secondly, we must estimate the carbon beta using a multi-factor model. While Gorgen et al. (2019) considered that the carbon beta is constant, we propose a time-varying estimation model to assess the dynamics of the carbon risk. Moreover, we test several specifications of the BMG factor to understand which climate change-related dimensions are priced in by the stock market. In the second part of the article, we focus on the carbon risk management of investment portfolios. First, we analyze how carbon risk impacts the construction of a minimum variance portfolio. As the goal of this portfolio is to reduce unrewarded financial risks of an investment, incorporating the carbon risk into this approach fulfills this objective. Second, we propose a new framework for building enhanced index portfolios with a lower exposure to carbon risk than capitalization-weighted stock indices. Finally, we explore how carbon sensitivities can improve the robustness of factor investing portfolios.

Roncalli, T. (2021a). "Advanced Course in Asset Management." In: *SSRN e-Print*.

These presentation slides have been written for the Advanced Course in Asset Management (theory and applications) given at the University of Paris-Saclay. They contain 15 tutorial exercises and 5 main lectures:

1) Portfolio Optimization
2) Risk Budgeting
3) Smart Beta, Factor Investing and Alternative Risk Premia
4) Green and Sustainable Finance, ESG Investing and Climate Risk
5) Machine Learning in Asset Management

The Table of contents is the following:

Part 1. Portfolio Optimization 1. Theory of portfolio optimization 1.a. The Markowitz framework 1.b. Capital asset pricing model (CAPM) 1.c. Portfolio optimization in the presence of a benchmark 1.d. Black-Litterman model 2. Practice of portfolio optimization 2.a. Covariance matrix 2.b. Expected returns 2.c. Regularization of optimized portfolios 2.d. Adding constraints 3. Tutorial exercises 3.a. Variations on the efficient frontier 3.b. Beta coefficient 3.c. Black-Litterman model

Part 2. Risk Budgeting 1. The ERC portfolio 1.a. Definition 1.b. Special cases 1.c. Properties 1.d. Numerical solution 2. Extensions to risk budgeting portfolios 2.a. Definition of RB portfolios 2.b. Properties of RB portfolios 2.c. Diversification measures 2.d. Using risk factors instead of assets 3. Risk budgeting, risk premia and the risk parity strategy 3.a. Diversified funds 3.b. Risk premium 3.c. Risk parity strategies 3.d. Performance budgeting portfolios 4. Tutorial exercises 4.a. Variation on the ERC portfolio 4.b. Weight concentration of a portfolio 4.c. The optimization problem of the ERC portfolio 4.d. Risk parity funds

Part 3. Smart Beta, Factor Investing and Alternative Risk Premia 1. Risk-based indexation 1.a. Capitalization-weighted indexation 1.b. Risk-based portfolios 1.c. Comparison of the four risk-based portfolios 1.d. The case of bonds 2. Factor investing 2.a. Factor investing in equities 2.b. How many risk factors? 2.c. Construction of risk factors 2.d. Risk factors in other asset classes 3. Alternative risk premia 3.a. Definition 3.b. Carry, value, momentum and liquidity 3.c. Portfolio allocation with ARP 4. Tutorial exercises 4.a. Equally-weighted portfolio 4.b. Most diversified portfolio 4.c. Computation of risk-based portfolios 4.d. Building a carry trade exposure

Part 4. Green and Sustainable Finance, ESG Investing and Climate Risk 1. ESG investing 1.a. Introduction to sustainable finance 1.b. ESG scoring 1.c. Performance in the stock market 1.d. Performance in the corporate bond market 2. Climate risk 2.a. Introduction to climate risk 2.b. Climate risk modeling 2.c. Regulation of climate risk 2.d. Portfolio management with climate risk 3. Sustainable financing products 3.a. SRI Investment funds 3.b. Green bonds 3.c. Social bonds 3.d. Other sustainability-linked strategies 4. Impact investing 4.a. Definition 4.b. Sustainable development goals (SDG) 4.c. Voting policy, shareholder activism and engagement

4.d. The challenge of reporting 5. Tutorial exercises 5.a. Probability distribution of an ESG score 5.b. Enhanced ESG score and tracking error control
Part 5. Machine Learning in Asset Management 1. Portfolio optimization 1.a. Standard optimization algorithms 1.b. Machine learning optimization algorithms 1.c. Application to portfolio allocation 2. Pattern learning and self-automated strategies 3. Market generators 4. Tutorial exercises 4.a. Portfolio optimization with CCD and ADMM algorithms 4.b. Regularized portfolio optimization.

Roncalli, T. (2021b). "Green and Sustainable Finance, ESG Investing and Climate Risk." In: *SSRN e-Print*.
These lectures notes cover the following topics:

- ESG Investing (definition, ESG scoring and rating systems, ESG performance in stock and bond markets);
- Climate Risk (definition, modeling, regulation, portfolio management);
- Sustainable financing products (SRI strategies, green and social bonds, sustainability-linked securities);
- Impact Investing (definition, SDG, voting policy and engagement, reporting) 5
- Tutorial Exercises (probability distribution of an ESG score, optimal design of ESG rating systems, enhanced ESG score and tracking error control).

These lectures notes have been written for the advanced course in Asset Management given at the University of Paris-Sacla.

Rubbaniy, G., Khalid, A. A., Ali, S., and Naveed, M. (2021). "Are ESG Stocks Safe-Haven during COVID-19?" In: *SSRN e-Print*.
This study contributes to the debate on safe-haven characteristics of environmental, social, and governance (ESG) stocks during COVID-19 pandemic. Using wavelet coherence framework on four major ESG stock indices from global and emerging stock markets, and two proxies of COVID-19 fear over the period from February 5th, 2020, to March 18th, 2021, we find a strong and positive co-movement between health fear index of COVID-19 and returns on ESG stocks suggesting the existence of safe-haven properties in ESG stocks. However, we also observe a negative co-movement between stock market base proxy of COVID-19 and returns on ESG indices, suggesting that safe-haven properties of ESG stocks are contingent upon the proxy of COVID-19 pandemic. Our findings are of particular interest for the investors and asset managers who may use ESG stocks to diversify their portfolios during health crisis due to COVID-19 pandemic.

Ruf, B. M., Das, N., Chatterjee, S., and Sunder, A. (2019). "Investments in ESG-Rated Mutual Funds: Is Good Better than Great?" In: *The Journal of Wealth Management* 22(1), pp. 49–55.
Socially responsible mandated mutual funds are a popular class of funds characterized by strategies that address sustainability, responsibility, and impact. The dramatic growth of socially responsible mandated mutual funds during the last decade, makes it important to understand how their social metrics (environmental, social and governance; ESG) relates to their financial performance. The current study compares the risk-adjusted returns of socially responsible mutual funds (SRMF) with funds rated by Morningstar Portfolio ESG Score grouped into low, medium, and high ratings. We find that during the period of pre-recession boom, the funds with high-ESG ratings had a significantly higher risk-adjusted performance than did funds with a low-ESG or mid-ESG rating. This trend continued during the early parts of the Great Recession. During periods of economic recovery and growth, SRMF rated low on ESG performed significantly better than highly rated SRMFs. For medium rated SRMFs, other than prior to the Great Recession, fund performance was not consistently significantly different from highly rated SRMFs.

Rzenik, A., Hanley, K. W., and Pelizzon, L. (2021). "The Salience of ESG Ratings for Stock Pricing: Evidence From (Potentially) Confused Investors." In: *SSRN e-Print*.
We exploit the a modification to Sustainanlytics' environmental, social, and governance (ESG) rating methodology, which is subsequently adopted by Morningstar, to study whether ESG ratings are salient for stock pricing. We show that the inversion of the rating scale but not new information leads some investors to make incorrect assessments about the meaning of the change in ESG ratings. They buy (sell) stocks they misconceive as ESG upgraded (downgraded) even when the opposite is true. This trading behavior exerts transitory price pressure on affected stocks. Our paper highlights the importance of ESG ratings for investors and consequently for asset prices.

Sahin, O., Bax, K., Czado, C., and Paterlini, S. (2022a). "ESGM: ESG scores and the Missing pillar." In: *arXiv e-Print*.

Environmental, Social, and Governance (ESG) scores measure companies' performance concerning sustainability and societal impact and are organized on three pillars: Environmental (E), Social (S), and Governance (G). These complementary non-financial ESG scores should provide information about the ESG performance and risks of different companies. However, the extent of not yet published ESG information makes the reliability of ESG scores questionable. To explicitly denote the not yet published information on ESG category scores, a new pillar, the so-called Missing (M) pillar, is formulated. Environmental, Social, Governance, and Missing (ESGM) scores are introduced to consider the potential release of new information in the future. Furthermore, an optimization scheme is proposed to compute ESGM scores, linking them to the companies' riskiness. By relying on the data provided by Refinitiv, we show that the ESGM scores strengthen the companies' risk relationship. These new scores could benefit investors and practitioners as ESG exclusion strategies using only ESG scores might exclude assets with a low score solely because of their missing information and not necessarily because of a low ESG merit.

Sahin, O., Bax, K., Paterlini, S., and Czado, C. (2022b). "The pitfalls of (non-definitive) Environmental, Social, and Governance scoring methodology." In: *SSRN e-Print*.
Evaluating companies' sustainability embraces environmental, social, and governance (ESG) activities. Data providers assign companies ESG scores as a quantitative measure based on available information. Refinitiv (previously ASSET4) is a key data provider whose scores are used extensively by researchers. However, their ESG scoring methodology allows the ESG scores of the five most recent years to change post-publication without any announcements. Such ESG scores are called non-definitive. Then, ESG research findings using the data from the same data provider might be inconsistent. By optimization and exploratory data-mining approaches, we show that it is possible to change ESG scores to exhibit stronger risk dependence. Additionally, we discuss that the initial disclosure of ESG information and an update in the published ESG information alter how ESG scores are computed in a given industry group, impacting ESG research findings greatly. Finally, our work points out the criticality that should be addressed to improve comparability within research studies relying on the same data providers.

Sautner, Z. and Starks, L. T. (2021). "ESG and Downside Risks: Implications for Pension Funds." In: *SSRN e-Print*.
Due to their long-term horizons, pension funds face enhanced exposures to the long-lived effects of many ESG risks. Moreover, given the potential consequences of being underfunded, pension funds are particularly exposed to ESG-related downside risks, especially those related to climate change. We discuss the implications of these risks and provide evidence on institutional investors' perspectives on climate-related downside risks and how these risks are priced in financial markets. We also document how institutional investors address climate risks in the investment process, with a focus on the role of engagement versus divestment.

Schanzenbach, M. M. and Sitkoff, R. H. (2021). "ESG Investing: Theory, Evidence, and Fiduciary Principles." In: *SSRN e-Print*.
Trustees and other investment fiduciaries of pensions, charities, and personal trusts, and those who advise them, face increasing pressure to rely on ESG factors in the investment management of tens of trillions of dollars of other people's money. At the same time, however, confusion abounds about the intersection of fiduciary principles and ESG investing. This article cuts through that confusion to provide guidance about when and how ESG investing by trustees and investment fiduciaries is permissible. We make four interrelated points: (1) we provide a clarifying taxonomy on the meaning of ESG investing, differentiating between risk-return ESG (i.e., using ESG factors to improve risk-adjusted returns) and collateral benefits ESG (i.e., using ESG factors for third-party effects); (2) we discuss the subjectivity inherent to identifying and applying ESG factors, which complicates assessment of ESG investing strategies; (3) we summarize the current theory and evidence on whether ESG investing can improve risk-adjusted returns, finding the results to be mixed and contextual; and (4) we show that American trust fiduciary law generally prohibits collateral benefits ESG, but risk-return ESG can be permissible if supported by a reasoned and documented analysis that is updated periodically.

Schmidt, A. B. (2020). "Optimal ESG portfolios: an example for the Dow Jones index." In: *SSRN e-Print*.
Mean variance portfolio theory is expanded to accommodate investors preferences for the portfolio ESG value (PESGV). Namely, PESGV is added to the minimizing objective function so that portfolio weights are simultaneously optimized in terms of returns, risk (volatility), and PESGV. PESGV is assumed proportional to the sum of portfolio constituents weighted ESG scores and is controlled by the ESG strength parameter. A portfolio formed with 29 constituents of the Dow Jones Index in 2015 - 2019 is considered as an example. The MSCI ESG ratings are chosen for estimating PESGV. It is found that higher PESGVs yield more concentrated portfolios

and lower Sharpe ratios. Partial correlations based portfolios are more diversified and have higher PESGVs than the Pearson correlations based portfolios.

Schmidt, A. B. (2021). "The ESG Conundrum: An Outsider's View." In: *SSRN e-Print*.
Two suggestions are offered to address growing criticism of the ESG-based investing. First, socially responsible investors need to use portfolio performance measure that is explicitly sensitive to the portfolio ESG value. Second, since the corporate ESG ratings are not regulated and are vaguely defined, the ratings agencies should provide detailed information on how their ratings are calculated and allow their clients to implement the customized ratings of their choice.

Schmidt, A. B. and Zhang, X. (2021). "Optimal ESG Portfolios: Which ESG Ratings to Use?" In: *SSRN e-Print*.
The idea behind the optimal ESG portfolio (OESGP) is to expand the mean variance theory by adding the portfolio ESG value (PESGV) multiplied by the ESG strength parameter gamma (which is investor's choice) to the minimizing objective function (Pederson et al., 2019; Schmidt, 2020). PESGV is assumed to be the sum of portfolio constituents' weighted ESG ratings that are offered by several providers. In this work we analyze the sensitivity of the OESGP based on the constituents of the Dow Jones Index to the ESG ratings provided by MSCI, S&P Global, and Sustainalytics. We describe discrepancies among various ESG ratings for the same securities and their effects on the OESGP performance. We found that the OESGP diversity decreases with growing gamma. The dependence of the ESG tilted Sharpe ratio on gamma may have two maximums. The 1st maximum exists at moderate values of gamma and yields a moderately diversified OESGP. The 2nd maximum at large gamma corresponds to a highly concentrated OESGP. It appears if portfolio has one or two securities with lucky combinations of high returns and high ESG ratings.

Schumann, E. (2019). "Backtesting." In: *SSRN e-Print*.
We discuss the backtesting of investment and trading strategies. We start with the challenges and pitfalls: overfitting, data preparation, and the effects of randomness. Then, we introduce and describe R software for backtesting. We demonstrate how to use the software for univariate and multivariate strategies (i.e. portfolio strategies) for two equity data sets. Specifically, we discuss the implementation and testing of momentum and portfolio optimization models. Throughout, we stress the analysis of sensitivity and robustness checks. Since such analyses require to run many backtests, we also discuss how backtests can be run in parallel.

Semet, R., Roncalli, T., and Stagnol, L. (2021). "ESG and Sovereign Risk: What is Priced in by the Bond Market and Credit Rating Agencies?" In: *arXiv e-Print*.
In this paper, we examine the materiality of ESG on country creditworthiness from a credit risk and fundamental analysis viewpoint. We first determine the ESG indicators that are most relevant when it comes to explaining the sovereign bond yield, after controlling the effects of traditional fundamental variables such as economic strength and credit rating. We also emphasize the major themes that are directly useful for investors when assessing the country risk premium. At the global level, we notice that these themes mainly belong to the E and G pillars. Those results confirm that extra-financial criteria are integrated into bond pricing. However, we also identify a clear difference between high-and middle-income countries. Indeed, whereas the S pillar is lagging for the highest income countries, it is nearly as important as the G pillar for the middle-income ones. Second, we determine which ESG metrics are indirectly valuable for assessing a country's solvency. More precisely, we attempt to infer credit rating solely from extra-financial criteria, that is the ESG indicators that are priced in by credit rating agencies. We find that there is no overlap between the set of indicators that predict credit ratings and those that directly explain sovereign bond yields. The results also highlight the importance of the G and S pillars when predicting credit ratings. The E pillar is lagging, suggesting that credit rating agencies are undermining the impact of climate change and environmental topics on country creditworthiness. This is consistent with the traditional view that social and governance issues are the main drivers of the sovereign risk, because they are more specific and less global than environmental issues. Finally, taking these different results together, this research shows that opposing extra-financial and fundamental analysis does not make a lot of sense.

Serafeim, G. (2020). "Public sentiment and the price of corporate sustainability." In: *Financial Analysts Journal* 76(2), pp. 26–46.
Combining environmental, social, and governance (ESG) data with big data measuring public sentiment about corporate sustainability performance, I found that the valuation premium for strong sustainability performance increases as a function of positive momentum in public sentiment. An ESG factor long (short) on companies with superior (inferior) sustainability performance and negative (positive) ESG sentiment momentum delivered significant positive alpha. In contrast, the high-sentiment ESG factor delivered insignificant alpha and was negatively correlated with the value factor. The evidence suggests that public sentiment influences investor

views about the value of sustainability activities and that big ESG data can be useful in identifying value ESG stocks.

Serafeim, G. (2021). "ESG: Hyperboles and Reality." In: *SSRN e-Print*.
ESG has rapidly become a household name leading to both confusion about what it means and creating unrealistic expectations about its effects. In this paper, I draw on more than a decade of research to dispel several myths about ESG and provide answers to important questions around theories of influence, the relation between ESG and corporate value, and the usefulness of ESG assessments and ratings.

Seymour, A., Flint, E. J., and Chikurunhe, F. (2018). "Dynamic portfolio management strategies: A framework for historical analysis." In: *SSRN e-Print*.
The performance of dynamic trading and investment strategies can be difficult to predict. Although not without its problems, analysis of the historical performance of a strategy can provide valuable insight into its general risk and return properties. Furthermore, historical analysis allows one to compare variations of a strategy and examine the impact of various parameter choices and implementation rules. Dynamic strategy applications in three areas are considered, namely derivatives, asset allocation and equity factor portfolios. Firstly, the analysis of a strategy involving single-stock derivatives is examined in which call options on certain constituents of an index portfolio are sold as an alternative method of under-weighting the underlying. Secondly, the historical performance of an optimization-based asset allocation strategy is considered. The assumed aim of the strategy is to outperform a benchmark of CPI 5 via dynamic trading in a portfolio of domestic equities, bonds, property and cash, as well as international equities and bonds. Finally, the effects of portfolio construction on factor performance are studied via an historical analysis in which portfolios corresponding to a selection of fundamental factors are managed according to a range of weighting schemes, rebalance frequencies and portfolio sizes.

Shafer, M. and Szado, E. (2020). "Environmental, social, and governance practices and perceived tail risk." In: *Accounting & Finance* 60(4), pp. 4195–4224.
Using the implied volatility smirk on individual equity securities to measure perceived tail risk, we find that better environmental, social and governance (ESG) practices significantly reduce ex-ante expectations of a left-tail event. Our findings are robust to using multiple model specifications and to adjusting for potential endogeneity concerns. We also show that, while practices in each ESG pillar are important in reducing perceived tail risk, the environmental pillar plays the most important role. Our results indicate that investors consider strong ESG practices to be insurance against left-tail events rather than wasteful investment borne out of managers' own values or self-interest.

Shanaev, S. and Ghimire, B. (2021). "When ESG meets AAA: The effect of ESG rating changes on stock returns." In: *Finance Research Letters*, p. 102302.
This study is the first to employ calendar-time portfolio methodology to investigate the impact of 748 ESG rating changes on stock returns of US firms over 2016-2021. While ESG rating upgrades lead to positive yet inconsistently significant abnormal returns of 0.5% per month, downgrades are detrimental to stock performance, leading to statistically significant monthly risk-adjusted returns of -1.2% on average. These findings are more pronounced for ESG leaders than laggards and are robust to various asset-pricing model specifications. The effects of ESG rating levels are modest, with ESG laggards underperforming in risk-adjusted terms.

Shen, S., LaPlante, A., and Rubtsov, A. (2019). "Strategic asset allocation with climate change." In: *SSRN e-Print*.
We investigate the impact of climate change over a large universe of asset classes including stocks, bonds, alternatives and a list of green assets which have low-carbon emission, in terms of their time-varying risk-return trade-offs. We extend the strategic asset allocation framework of Hoevenaars et al. (2008) by adding the climate risk as an additional state variable to the vector autoregression (VAR) model driving expected returns, beyond the traditional macroeconomic variables. Green assets are in general resilient against temperature shocks, while the others are negatively related to the risk of warming. The optimal portfolio weight on green assets is low, due to the very high risk of green assets and an underestimated temperature projection implied by the VAR model. We impose a temperature beta towards the return dynamics of each asset to correct the temperature exposure on each asset class. We find that both temperature beta and short-selling constraint can help enhance the demand for green assets, while their opportunity costs are much larger than the cost of ignoring green assets.

Sherwood, M. W. and Pollard, J. L. (2018). "The risk-adjusted return potential of integrating ESG strategies into emerging market equities." In: *Journal of Sustainable Finance & Investment* 8(1), pp. 26–44.
This study purposed to quantify the performance potential of integrating ESG research within emerging market investment strategies, as well as the potential for risk diversification through investments in emerging markets. This study evaluated literature on investing in both emerging markets and integrating environmental, social,

and governance (ESG) research-based strategies. This study examines real data on ESG and non-ESG integrated emerging market indices, both region-specific and country-specific. This examination includes measuring historical returns, beta, the Sharpe ratio, the Sortino ratio, the Conditional Value at Risk, skewness, and the Omega ratio for ESG and non-ESG integrated emerging market indices. Paired t-test analysis is incorporated in the measurement of the data. The results of the study indicate significant outperformance based on ESG integration. The implications of this study indicate that integrating ESG emerging market equities into institutional portfolios could provide ...

Silva, A. F. A., Lôpo, R., and Lofiego, P. (2021). "ESG Integration Strategy for Stocks Portfolios Based on a Resampling Methodology with a Multivariate Normal Distribution." In: *SSRN e-Print*.
The objective of this paper is to present a framework for ESG integration and analyze the consequences of considering environmental, social and governance (ESG) factors in the optimization of investment portfolios. We use a multivariate normal distribution of returns and we generate portfolios by an optimization process combined with a Monte Carlo simulation,. After applying an ESG filtering strategy to portfolios, we show that the ex-ante costs (optimization process) of the ESG integration strategy may be very low. The methodology presented in this paper avoid complexity of some papers since it includes a new objective and it does not need to optimize portfolios by modifying the utility function.

Simpson, C., Rathi, A., and Kishan, S. (2021). "The ESG Mirage." In: *Bloomberg Businessweek*.
MSCI, the largest ESG rating company, does not even try to measure the impact of a corporation on the world. It's all about whether the world might mess with the bottom line.

Sokolov, A., Caverly, K., Mostovoy, J., Fahoum, T., and Seco, L. (2021a). "Weak Supervision and Black-Litterman for Automated ESG Portfolio Construction." In: *The Journal of Financial Data Science* 3(3), pp. 129–138.
The authors propose an approach that combines modern machine learning techniques in natural language processing with portfolio optimization to incorporate views of companies' environment, social, and governance (ESG) performance. This is automatically done through curating and subsequently converting large-scale news data into portfolio management decisions. They train a machine learning news data classifier to automatically identify several key ESG issues in news data over time. They then aggregate these issues over time to generate a views vector under the Black-Litterman portfolio framework and finally compare the performance of an ESG-tilted portfolio against a standard Black-Litterman portfolio. They also show how this can be achieved at scale, in a fully automated manner, and with consistency over large periods of time. Their methodology thus demonstrates a reasonable and agile method for asset managers to incorporate ESG considerations into their portfolios free of any exclusionary frameworks and without sacrificing performance.

Sokolov, A., Mostovoy, J., Ding, J., and Seco, L. (2021b). "Building Machine Learning Systems for Automated ESG Scoring." In: *The Journal of Impact and ESG Investing* 1(3), pp. 39–50.
Although investing in environment, social, and governance (ESG)-driven portfolios is already a large and growing portion of global assets under management, applications of quantitative techniques to improve and standardize ESG scoring and the construction of ESG portfolios are underutilized. In this article, the authors propose an approach to automatically convert unstructured text data into ESG scores by using the latest advances in deep learning for natural language processing (NLP). They also show how a state-of-the-art NLP technique, BERT, can be incorporated to improve the accuracy of assessing relevance and content of documents in an ESG context using social media data as an example and discuss the relevance of this approach to automating ESG scoring and constructing ESG portfolios.

Sorensen, E., Chen, M., and Mussalli, G. (2021). "The Quantitative Approach for Sustainable Investing." In: *The Journal of Portfolio Management* 47(8), pp. 38–49.
Sustainable (also known as environment, social, and governance [ESG]) investing is currently of intense interest in the investment world. In this article, the authors consider the salient challenges associated with ESG investing and how quantitative approaches may address them. Compared to fundamental methods of sustainable investing, the authors see quantitative methods as having several advantages: These methods can build on and extend the vast analytical toolbox of modern portfolio theory to incorporate investor preference in portfolio construction; they can leverage the recent data explosion to obtain insights on many intangible sustainability metrics; and they do not have the black box label. Instead, subjective judgement applied to building the quantitative system is essential. A thoughtful analytical system can be applied to a large universe of stocks, and quantitative methods may also be leveraged to predict popular ESG vendor ratings. Although it is in the early days of quantitative sustainable investing, the authors believe these advantages will prove the quantitative method's worth in sustainable investing.

Statman, M. and Glushkov, D. (2016). "Classifying and Measuring the Performance of Socially Responsible Mutual Funds." In: *The Journal of Portfolio Management* 42(2), pp. 140–151.
This article offers a factor model for classifying socially responsible mutual funds and measuring their performance. The authors provide a factor model that consists of six factors: the four widely used factors of market, smalllarge (SMB), value-growth (HML), and momentum, and two social responsibility factors, reflecting the criteria most widely used by socially responsible funds. The first social responsibility factor is the top-bottom factor (TMB), consisting of the difference between the returns of stocks of companies ranked in the top third and the bottom third by five social responsibility criteria: employee relations, community relations, environmental protection, diversity, and products. The second is the accepted-shunned factor (AMS), consisting of the difference between the returns of stocks of companies commonly accepted by socially responsible investors and the returns of stocks of companies they commonly shun. Shunned stocks are stocks of companies in the alcohol, tobacco, gambling, firearms, military, and nuclear industries. A factor's coefficient is its loading, tilt, or beta; the authors use the term beta. TMB and AMS factors' betas effectively capture the social responsibility features of indices and mutual funds, and the TMB and AMS betas of indices and mutual funds generally reflect the social responsibility scores of the companies whose stocks they contain. The classification of socially responsible mutual funds by betas and contents differs from classification by Morningstar and other classifying services. Mutual funds' measured performance when the authors consider TMB and AMS factors differs from their measured performance when these factors are overlooked.

Stotz, O. (2021). "Expected and realized returns on stocks with high- and low-ESG exposure." In: *Journal of Asset Management* 22, pp. 133–150.
Empirically, stocks with a good environmental, social, or governance (ESG) rating tend to earn higher returns than stocks with a low rating. In contrast, the expected returns of high-ESG stocks are primarily lower than those of low-ESG stocks. The difference between realized and expected returns in the ESG domain constitutes a puzzle which we will address in this paper. Applying a return decomposition, we find that the puzzle can be explained by discount rate news. We find that discount rates of high-ESG stocks have fallen relative to low-ESG stocks. However, discount rate news does not reflect changes in risk; rather, discount rate news is systematically related to the demand of investors who have ESG preferences.

Suhonen, A., Lennkh, M., and Perez, F. (2017). "Quantifying Backtest Overfitting in Alternative Beta Strategies." In: *The Journal of Portfolio Management* 43 (2), pp. 90–104.
The authors investigate the biases in the backtested performance of "alternative beta"strategies using a unique sample of 215 trading strategies developed and promoted by global investment banks. Their results lend support to the cautions in the recent literature regarding backtest overfitting and lack of robustness in trading strategy performance during the "live"period (out of sample). The authors report a median 73 percent deterioration in Sharpe ratios between backtested and live performance periods for the strategies, and they establish a link between performance deterioration and strategy complexity, with the realized reduction in live versus backtested Sharpe ratios of the most complex strategies exceeding those of the simplest ones by over 30 percentage points. The robustness of strategy exposure to risk factors varies between asset classes and strategies; it appears reasonable in equity volatility and FX carry strategies but quite weak in the equity value strategy in particular.

Swedroe, L. (2021a). "Do Wide Divergences in ESG Ratings Doom Investors?" In: *Advisor Perspectives*.
Six competing vendors rate how companies perform along environmental, social and governance (ESG) standards. But because those ratings differ widely across vendors, investors cannot reliably construct portfolios that meet their personal criteria.

Swedroe, L. (2021b). "ESG Investing Means Lower Bond Yields." In: *Advisor Perspectives*.
There has been an explosion in academic research on the impact of implementing environmental, social and governance (ESG) on the risk and returns of equity portfolios. Research on fixed income, which has received less attention, shows that positive ESG scores correlate with lower yield spreads, decreasing future returns for bond investors.

Swedroe, L. (2021c). "Revisionist History in ESG Ratings." In: *Advisor Perspectives*.
Investors following an environmental, social and governance (ESG) mandate can achieve their goals only if they can accurately and consistently identify stocks that meet their criteria. But new research shows that those criteria have been subject to arbitrary revisions and that there are wide discrepancies among the vendors providing the data.

Swedroe, L. (2021d). "Socially Responsible Funds Do Not Deliver Excess Returns." In: *Advisor Perspectives*.

Funds with a socially responsible or environmental, social and governance (ESG) mandate may allow clients to feel good about their investments. But new research shows that they should not expect excess returns.

Swinkels, L. (2021). "Allocating to green bonds." In: *SSRN e-Print*.
Green bonds are about a decade old financial instrument with cash flows earmarked to improve the environment or combat climate change. We show the spectacular growth of the asset class over time, but note that it is currently still less than 1% of the entire fixed income market. The composition of the asset class has changed considerably over time. At the start, it were mainly very safe supranational institutions issuing in a variety of currencies with relatively short maturities. They were followed by corporates, especially utilities, and more recently also governments have started issuing green bonds. This change of composition leads us to conclude that historical data from before 2015 is less representative for the future. Our returns- and characteristics-based analyses show that an investor allocating to green bonds should finance this from an aggregate fixed income allocation to reduce the impact on the risk and return characteristics of the existing portfolio.

Taleb, W., Le Guenedal, T., Lepetit, F., Mortier, V., Sekine, T., and Stagnol, L. (2020). "Corporate ESG News and The Stock Market." In: *SSRN e-Print*.
ESG investing's popularity has continually increased in the past five years. ESG data is increasingly integrated into investment processes. However, the information contained in ESG-related news for corporates has not been entirely exploited by institutional and long-only investors. The objective of this paper is to identify the benefits of ESG news information for active and factor-based investors. Indeed, one of the issues with ESG is the low frequency of score updates. For active management, we analyze ESG-sorted portfolios in investment universes filtered by ESG news volume. Metrics of ESG-related news are sourced from Truvalue Labs, a provider of Artificial Intelligence-powered ESG insights and analytics. We find that the approach of a universe focused on ESG news of corporates has been efficient in the early 2010s on the lower ESG-ranked side of the universe, but also on the higher ESG rank. More recently, it has positively contributed to more dynamic approaches of ESG investing. Finally, increasing the sensitivity to the highly visible SDGs significantly improves the return of ESG long-short portfolios.

Taljaard, B. H. and Maré, E. (2021). "Why has the equal weight portfolio underperformed and what can we do about it?" In: *Quantitative Finance* 21(11), pp. 1855–1868.
It is widely noted that market capitalisation weighted portfolios are inefficient and underperform an equal weighted portfolio over the long-term. However, at least since 2016, an equal weighted portfolio of stocks in the S&P500 has significantly underperformed the market capitalisation weighted portfolio. In this paper, we analyse this underperformance using stochastic portfolio theory. We show that the equal weighted portfolio does appear to outperform the market capitalisation weighted portfolio over the long-term but with periods of significant short-term underperformance. In addition, we find that concentration in the market capitalisation weighted portfolio has increased in recent years and has contributed to the recent underperformance together with a significantly lower level of diversification benefits. Furthermore, we highlight an approach to improve the performance of a portfolio by dynamically selecting a market cap or an equal weighting using a rudimentary linear regression model.

Tang, D. Y., Yan, J., and Yao, Y. (2021). "The Determinants of ESG Ratings: Rater Ownership Matters." In: *SSRN e-Print*.
Environmental, social, and governance (ESG) ratings are increasingly popular in financial markets and for policy making. We show that firms held by the same investors who own the rater ("sister firms") receive higher ESG ratings. Exogenously created sister firms through acquisitions provide causal inference for the ownership effect. Sister firms receive higher ratings when the common owners have larger stakes in the ESG rater. Notwithstanding their initial higher ratings, sister firms have poorer future ESG outcomes. These findings suggest that the quality of ESG ratings can be undermined by conflicts of interest and have important implications for practitioners and regulators.

Tayali, S. T. (2020). "A novel backtesting methodology for clustering in mean–variance portfolio optimization." In: *Knowledge-Based Systems* 209, p. 106454.
The decisions of asset selection and allocation lie at the heart of financial portfolio management. For these challenging tasks, the mathematical programming model of the mean-variance optimization problem proposes to use the concept of diversification. The novel methodology in this article is a representation of the accumulated knowledge of this model from the modern portfolio theory. It is a practical application for portfolio managers to help synthesize the available historical data and to infer rational decisions. The state-of-the-art backtesting methodology integrates the unsupervised machine learning method of clustering analysis into the mean-variance

portfolio optimization model. The test results from the proposed novel methodology show that clustering with Euclidean distance measures outperform the results of the benchmark and other specified clustering methods for different datasets, backtesting periods, and temporal scales of major stock indices.

Terpstra, M. (2021). "ESG ratings and stock performance: Do high ESG portfolios perform differently within and between industries?" MA thesis. University of Groningen.
In this study, I investigate whether twenty industry portfolios consisting of the best ESG performers within an industry perform differently compared to the industry and other industries by estimating the alpha in the Fama French 5-factor model. In the main model, I find that the ESG portfolio performs significantly worse than the industry within two industries. However, after considering different criteria, I only find a significantly negative alpha in the Healthcare Services industry. Furthermore, two industry portfolios perform significantly different from the market ESG portfolio in the main regression. Nevertheless, this finding is not consistent when different criteria are considered. Therefore, in specific situations the relative ESG performance and industry can be considered for investment decisions. However, given the size of the alphas, the effect on performance will be marginal.

Tharavanij, P. (2021). "ESG Rating and Financial Performance: A Review Article." In: *SSRN e-Print*.
This paper provides the updated reviews on the relationships between a firm's ESG (Environmental, Social and Governance) performance and its financial performance. The survey includes both theories and empirical studies. It addresses three main issues. Firstly, it investigates relationships between ESG and financial performance. Secondly, it examines the effect of firm's ESG performance on its cost of equity. The effect of each component (E/S/G) is studied. Thirdly, it investigates the effect of ESG performance on a firm's value. Based on a standard Discounted Cash Flow (DCF) model, value creation could come from the cash-flow channel or the cost-of-capital channel. The cash-flow channel can be separated further into short-term profitability and long-term growth.

Tokat-Acikel, Y., Aiolfi, M., Johnson, L., Hall, J., and Jin, J. ((2021). "Top-Down Portfolio Implications of Climate Change." In: *The Journal of Portfolio Management* 47(9), pp. 69–91.
This article reviews the significant progress in academic research on economic impact of climate change and explores the implications for expected returns and strategic portfolio allocation across major public asset classes. There have been numerous efforts to measure the environmental impact within a broader environment, social, and governance framework with a focus on microeconomic and firm-level implications. In this article, the authors assess the impact of climate change on long-term expected returns across asset classes from a top-down macroeconomic perspective. They use well-accepted climate risk scenarios to assess the potential impact of alternative climate scenarios on economic growth, inflation, and asset returns for major asset classes. Finally, they design hypothetical portfolios given these top-down assumptions and explore portfolio allocation implications.

Traccucci, P., Dumontier, L., Garchery, G., and Jacot, B. (2019). "A Triptych Approach for Reverse Stress Testing of Complex Portfolios." In: *Risk (Cutting Edge)*.
Pascal Traccucci, Luc Dumontier, Guillaume Garchery and Benjamin Jacot present an extended reverse stress test (ERST) triptych approach with three variables: level of plausibility, level of loss and scenario. Any two of these variables can be derived, provided the third is given as input. A new version of the Levenberg-Marquardt optimisation algorithm is introduced to derive the ERST in certain complex cases.

Valentine, K. D., Buchanan, E. M., Scofield, J. E., and Beauchamp, M. T. (2019). "Beyond p values: utilizing multiple methods to evaluate evidence." In: *Behaviormetrika* 46(1), pp. 121–144.
Null hypothesis significance testing is cited as a threat to validity and reproducibility. While many individuals suggest that we focus on altering the p value at which we deem an effect significant, we believe this suggestion is short-sighted. Alternative procedures (i.e., Bayesian analyses and observation-oriented modeling: OOM) can be more powerful and meaningful to our discipline. However, these methodologies are less frequently utilized and are rarely discussed in combination with NHST. Herein, we discuss three methodologies (NHST, Bayesian Model comparison, and OOM), then compare the possible interpretations of three analyses (ANOVA, Bayes Factor, and an Ordinal Pattern Analysis) in various data environments using a frequentist simulation study. We found that changing significance thresholds had little effect on conclusions. Furthermore, we suggest that evaluating multiple estimates as evidence of an effect allows for more robust and nuanced interpretations of results and implies the need to redefine evidentiary value and reporting practices. Recent events in psychological science have prompted concerns within the discipline regarding research practices and ultimately, the validity and reproducibility of published reports (Etz and Vandekerckhove 2016; Lindsay 2015, Open Science Collaboration 2015; van Elk et al. 2015). One often discussed matter is over-reliance, abuse, and potential hacking of p values produced by frequentist null hypothesis significance testing (NHST), as well as misinterpretations of NHST

results (Gigerenzer 2004; Ioannidis 2005; Simmons et al. 2011). We agree with these concerns and believe that many before us have voiced sound, generally accepted opinions on potential remedies, such as an increased focus on effect sizes (Cumming 2008; Lakens 2013; Maxwell et al. 2015; Nosek et al. 2012). However, other suggestions have been met with less enthusiasm, including an article by Benjamin et al. (2018) advocating that researchers should begin thinking only of p values less than .005 as "statistically significant", thus changing alpha levels to control Type I error rates. Alternatively, Pericchi and Pereira (2016) promote the use of fluctuating alpha levels as a function of sample size to assist with these errors. Trafimow et al. (2018) critiques this suggestion to broadly lower the alpha level to .005 and suggested that findings should be weighted on the basis of evidence accumulation from multiple studies. We argue that alpha should not be the sole focus of our attention, but rather, we should wonder if a p value should be utilized at all, and, if so, what that p value can tell us in relation with other indicators. While NHST and p values may have merit, researchers have a wealth of other statistical tools available to them. We believe that improvements may be made to the sciences as a whole when individuals become aware of these tools and how these methods may be used, either alone or in combination, to strengthen understanding of data and conclusions. These sentiments have been shared by the American Statistical Association who recently held a conference focusing on going beyond NHST, expanding their previous stance on p values (Wasserstein and Lazar 2016). Therefore, the main goal of this project was to show researchers how two alternative paradigms compare to NHST in terms of their methodological design, statistical interpretations, and comparative robustness. Herein, we will discuss the following methodologies: NHST, Bayes factor comparisons, and observation-oriented modeling. To compare their methodological designs, we first provide historical backgrounds, procedural steps, and limitations for each paradigm. We then simulated data using a three timepoint repeated measures design with a Likert-type scale as the outcome variable to be able to compare the statistical interpretations and comparative robustness. By simulating possible data sets and analyzing them with each of the three paradigms, we will be able to discuss the conclusions these three methods reach given the same data and to compare how often these methodologies agree within different data environments (i.e., given varying sample sizes and effect sizes). Beyond simply comparing methodologies, we also sought to identify how changing the alpha criteria within the NHST framework may alter conclusions. Although previous work has already compared Frequentist NHST to Bayesian approaches (Goodman 1999; Rouder et al. 2012; Wetzels et al. 2011), this manuscript adds a novel contribution: observation-oriented modeling. By introducing social scientists to observation-oriented modeling (OOM), a relatively new paradigm that is readily interpretable, we will show both how useful this paradigm can be in these contexts, and how it compares to two well-known methods. We hope that by discussing these methodologies in terms of a simple statistical analysis researchers will be able to easily compare and contrast methodologies.

van der Meulen, W. (2021). "Assessment of SRI portfolio performance with particular attention to crisis periods." MA thesis. University of Groningen.

This paper examines the risk-adjusted performance of SRI portfolios with particular attention to crisis periods. The equally weighted SRI portfolios are created using the positive and best-in-class screening technique based on ESG scores and the single dimension environmental, social and governance scores. A sample of 10216 companies operating in both developed and emerging markets is used over the sampling period 2003 - 2020. The main finding is that SRI portfolios do indeed pay a hedging cost over the full sample period to mitigate downside risk during the crisis periods. This result is relevant for investors since it supports previous findings of the strong performance of SRI portfolios in times of crisis.

van Tilborg, N. P. . (2021). "(Ir)responsible Investing: Revisiting the Effects of ESG Performance on Portfolio Returns." MA thesis. University of Groningen.

The sin stock anomaly where stocks belonging to "sin" industries such as alcohol, tobacco, gambling and weapons yield abnormal returns above the market return was observed decades ago. Presently, this anomaly fits into the broader focus of investors on factors besides returns, such as ESG, and indications exist that high ESG might result in excess returns. In this paper we investigate if ESG and returns are related. In order to investigate this, we create decile portfolios based on the Refinitiv ESG Combined Scores of the individual stocks and test for the presence of alpha in these portfolios using different models in the period 2003-2019. Throughout the models and after robustness checks, it seems that actually the lowest ESG portfolio is the only one to yield a significantly positive alpha.

Varmaz, A., Fieberg, C., and Poddig, T. (2021). "Portfolio optimization for sustainable investments." In: *SSRN e-Print*.

Investments in firms related to environment, social responsibility and corporate governance (ESG) aspects have recently grown, attracting interest from both academic research and investment fund practice. This paper develops a simple new portfolio optimization approach to include ESG in portfolio formation. In addition to technical and practical advantages over a traditional mean–variance approach that incorporates ESG preferences, our approach allows us to follow competing explanations of the relation among risk, return and ESG. An extension of our portfolio optimization approach can even help distinguish competing explanations from the literature, i.e., between the preferences of investors for ESG firm characteristics and exposure to a common ESG risk factor. The proposed portfolio optimization approach is flexible enough to include additional risk factors and/or characteristics. We demonstrate the application of our approach to empirical data.

Venturini, A. (2022). "Climate change, risk factors and stock returns: A review of the literature." In: *International Review of Financial Analysis* 79, p. 101934.
This article reviews how climate change could be considered an additional source of market risk. I discuss the types of data needed to analyse the climate risk drivers that shape the dynamics of the equity market. I present empirical evidence at both the macro and micro-level, analysing whether and to what extent the equity market prices climate change and related risks. Top-down and bottom-up approaches are compared to understand which climate risk is more likely to affect the cross-section of stock returns, both within and across sectors. Emphasis is also placed on investors' beliefs about climate change risks, and the related asset pricing implications are analysed. I conclude by illustrating further directions for both empirical and theoretical research in the field of climate finance.

Vincent, K., Hsu, Y.-C., and Lin, H.-W. (2018). "Analyzing the Performance of Multifactor Investment Strategies under a Multiple Testing Framework." In: *The Journal of Portfolio Management* 44(4), pp. 113–126.
Evaluating portfolios based on numerous combinations of factors using the individual backtesting method could suffer from serious data mining bias and lead to spurious significant findings. Accordingly, the authors employ a multiple hypothesis testing method to examine the multifactor portfolio performance. Their empirical results show that even after they adjust for the multiple comparisons bias, stock-picking strategies with certain combined firm characteristics could generate significantly better liquidity risk-adjusted returns. In addition, the outperforming multifactor strategies that the authors report are robust to alternative definitions of factors. However, they observe that the number of significantly profitable multifactor portfolios has decreased substantially in the era of increased liquidity and trading activity in the U.S. stock market.

Vojtko, R. and Padysak, M. (2020). "Quant look on ESG investing strategies." In: *SSRN e-Print*.
This paper reviews academic research about ESG factors and socially responsible investing. Probably the main issue with ESG investing is caused by the ESG data. ESG scores vary across various datasets, which makes all analyses complicated for academics, practitioners, and companies as well. We examine the literature to find the correlation between datasets and the reasons for such dispersion among scores. Secondly, we are interested in applying strategies based on the ESG scores. We conclude that ESG scores can be successfully used in practice, utilized in negative screening, level, or momentum strategies. However, academic research must be examined with attention to the ESG dataset, approach for the strategy construction, and time period. Otherwise, there may be some dangerous generalizations.

von Ditfurth, M., Paarmann, T., and Radatz, E. (2021). "Low volatility and ESG investing combined: Invesco's holistic approach." In: *SSRN e-Print*.
The low volatility factor in conjunction with the style factors Quality, Value and Momentum, has empirically proven to be able to moderate market risks and improve a portfolio's overall risk-return profile. By integrating ESG into such a factor portfolio, future risks may be mitigated. We present a proprietary approach to managing ESG risks that can maximize sensitivities to the desired multi-factor characteristics, and we calculate Climate VaR under different global warming scenarios.

Vovk, V. and Wang, R. (2020). "True and false discoveries with e-values." In: *arXiv e-Print*.
The topic of this paper is multiple hypothesis testing based on e-values, which are Bayes factors stripped of their Bayesian content. Using e-values instead of p-values, which are standard in this area, leads to simple and efficient procedures that control the number of false discoveries under arbitrary dependence of the base e-values. We prove an optimality result for our main procedure and demonstrate advantages of our methods over standard methods using simulated and real-world datasets.

Vovk, V. and Wang, R. (2021). "E-values: Calibration, combination, and applications." In: *Annals of Statistics* 49(3), pp. 1736–1753.

Multiple testing of a single hypothesis and testing multiple hypotheses are usually done in terms of p-values. In this paper we replace p-values with their natural competitor, e-values, which are closely related to betting, Bayes factors, and likelihood ratios. We demonstrate that e-values are often mathematically more tractable; in particular, in multiple testing of a single hypothesis, e-values can be merged simply by averaging them. This allows us to develop efficient procedures using e-values for testing multiple hypotheses.

Walkshausl, C. (2018). "Dissecting the performance of socially responsible firms." In: *The Journal of Investing* 27(2), pp. 29–40.
High-rated ESG (environmental, social, governance) firms do not outperform low-rated ESG firms in international markets. However, ESG-rated firms in general outperform unrated firms after controlling for firm size, book-to-market ratio, momentum, operating profitability, and investment. The following explanations are provided for these observations. First, though higher ESG ratings predict higher operating profitability and lower investments, these positive return-generating firm characteristics are not priced within the universe of ESG-rated firms, causing the insignificant return difference between high-rated and low-rated ESG firms. Second, the positive excess returns of ESG-rated firms over unrated firms reflect price corrections arising from the reversal of investors expectation errors concerning the impact of ESG characteristics on the firm future fundamental performance and are therefore the outcome of mispricing.

Wang, Z., Liao, K., and Zhang, Y. (2022). "Does ESG Screening Enhance or Destroy Stock Portfolio Value? Evidence from China." In: *Emerging Markets Finance and Trade*, pp. 1–15.
This article investigates the impact of ESG screening on the portfolio value of four risk weighting models in the Chinese stock market from July 2012 to June 2019. Using a novel ESG rating data of CSI 300 composite stock, we show that: (i) ESG screening undermines the portfolio value of the equal-weighted (EW), value-weighted (VW), minimum variance (MVP), and reward-to-return (RRT) model. Portfolio models in the High-ESG group have the lowest out-of-sample return, Sharpe ratio, and cumulative wealth. (ii) After adjusting for asset pricing models, portfolio models in the High-ESG group generally produce the lowest out-of-sample risk-adjusted return per IVOL. (iii) ESG screening harms portfolio value by excluding stocks with favorable risk-return characteristics, leading to a conservative investment style, which is costly both for non-ESG-motivated and ESG-motivated investors. Our findings reveal that although ESG investment is becoming a significant trend, portfolio managers should be aware of the opportunity cost to apply ESG screening in emerging markets.

Webersinke, N., Kraus, M., Bingler, J. A., and Leippold, M. (2021). "ClimateBert: A Pretrained Language Model for Climate-Related Text." In: *arXiv e-Print*.
Over the recent years, large pretrained language models (LM) have revolutionized the field of natural language processing (NLP). However, while pretraining on general language has been shown to work very well for common language, it has been observed that niche language poses problems. In particular, climate-related texts include specific language that common LMs can not represent accurately. We argue that this shortcoming of today's LMs limits the applicability of modern NLP to the broad field of text processing of climate-related texts. As a remedy, we propose ClimateBert, a transformer-based language model that is further pretrained on over 1.6 million paragraphs of climate-related texts, crawled from various sources such as common news, research articles, and climate reporting of companies. We find that ClimateBertleads to a 46% improvement on a masked language model objective which, in turn, leads to lowering error rates by 3.57% to 35.71% for various climate-related downstream tasks like text classification, sentiment analysis, and fact-checking.

Westcott, M., Ward, J., Surminski, S., Sayers, P., Bresch, D. N., and Claire, B. (2020). "Be Prepared: Exploring Future Climate-Related Risk for Residential and Commercial Real Estate Portfolios." In: *The Journal of Alternative Investments* 23(1), pp. 24–34.
This article explores how real estate investors and lenders can assess and manage the physical risks of climate change through well-established risk models and climate scenarios. The authors propose a methodology that real estate investors and lenders can use to improve their understanding and management of these risks. The methodology is applied to a sample of 12 real estate portfolios with a total market value in excess of GBP2 trillion, spread across Europe, North and South America, and Asia, investigating the impacts of climate change on losses from floods and winter storms (UK) as well as tropical cyclones (North America and the Pacific Rim). The estimated changes in risk, especially in the climate scenario most aligned with the current warming trajectory, raises important questions for investors, lenders, insurers, and policymakers as to how these new levels of risk can be managed in the most cost-effective manner.

Wiecki, T., Campbell, A., Lent, J., and Stauth, J. (2016). "All That Glitters Is Not Gold: Comparing Backtest

and Out-of-Sample Performance on a Large Cohort of Trading Algorithms." In: *The Journal of Investing* 25(3), pp. 69–80.
When automated trading strategies are developed and evaluated using backtests on historical pricing data, there exists a tendency to overfit to the past. Using a unique dataset of 888 algorithmic trading strategies developed and backtested on the Quantopian platform, with at least six months of out-of-sample performance, this article studies the prevalence and impact of backtest overfitting. Specifically, the authors find that commonly reported backtest evaluation metrics, such as the Sharpe ratio, offer little value in predicting out-of-sample performance ($R2 < 0.025$). In contrast, higher-order moments, such as volatility and maximum drawdown, as well as portfolio construction features (e.g., hedging), show significant predictive value of relevance to quantitative finance practitioners. Moreover, in line with prior theoretical considerations, the authors find empirical evidence of overfitting-the more backtesting a quant has done for a strategy, the larger the discrepancy between backtest and out-of-sample performance. Finally, they show that by training nonlinear, machine-learning classifiers on a variety of features that describe backtest behavior, out-of-sample performance can be predicted with much greater accuracy ($R2 = 0.17$) on hold-out data than when using linear, univariate features. A portfolio constructed by using predictions on hold-out data performed significantly better out-of-sample than one constructed from algorithms with the highest backtest Sharpe ratios.

Wilhelmsen, E. B. and Woods, E. (2021). "ESG ratings and stock performance : an empirical investigation of the link between ESG ratings and stock performance of European large cap firms." MA thesis. Norwegian School of Economics.
This thesis investigates the link between ESG ratings and stock performance of European large capitalization firms. Using ESG ratings from three independent providers - Thomson Reuters, Bloomberg and Sustainalytics - we examine differences in returns of zero-investment portfolios with a long position in the quartile consisting of top ESG-rated firms and a short position the quartile consisting of low ESG-rated firms. We find differences in return based on the choice of rating provider. Only Thomson Reuters portfolios earn negative annual abnormal returns of 6.0%-8.4%, suggesting that investors pay a premium for better ESG-rated firms. Given the observed differences in return and composition of the constructed providers' portfolios, our findings suggest ESG ratings are subjective and may cause confusion when implementing ESG features in a portfolio.

Xiong, J. X. (2021). "The Impact of ESG Risk on Stocks." In: *The Journal of Impact and ESG Investing* 2(1), pp. 7–18.
This article examines the impact of environmental, social, and governance (ESG) risk on US stocks through the lens of Sustainalytics' ESG risk-rating measure over the past decade. The author finds that stocks with low ESG risk ratings (green stocks) not only have higher realized returns but also provide better tail-risk protection than stocks with high ESG risk ratings (brown stocks), especially during the COVID-19 crisis. The tail-risk protection provided by green stocks is robust within sectors and styles. Green funds and exchange-traded funds (ETFs) that hold green stocks have attracted significantly more fund flow than their counterparts, which is associated with the outperformance for both green funds and stocks.

Yeh, C., Meng, C., Wang, S., Driscoll, A., Rozi, E., Liu, P., Lee, J., Burke, M., Lobell, D. B., and Ermon, S. (2021). "SustainBench: Benchmarks for Monitoring the Sustainable Development Goals with Machine Learning." In: *arXiv e-Print*.
Progress toward the United Nations Sustainable Development Goals (SDGs) has been hindered by a lack of data on key environmental and socioeconomic indicators, which historically have come from ground surveys with sparse temporal and spatial coverage. Recent advances in machine learning have made it possible to utilize abundant, frequently-updated, and globally available data, such as from satellites or social media, to provide insights into progress toward SDGs. Despite promising early results, approaches to using such data for SDG measurement thus far have largely evaluated on different datasets or used inconsistent evaluation metrics, making it hard to understand whether performance is improving and where additional research would be most fruitful. Furthermore, processing satellite and ground survey data requires domain knowledge that many in the machine learning community lack. In this paper, we introduce SustainBench, a collection of 15 benchmark tasks across 7 SDGs, including tasks related to economic development, agriculture, health, education, water and sanitation, climate action, and life on land. Datasets for 11 of the 15 tasks are released publicly for the first time. Our goals for SustainBench are to (1) lower the barriers to entry for the machine learning community to contribute to measuring and achieving the SDGs; (2) provide standard benchmarks for evaluating machine learning models on tasks across a variety of SDGs; and (3) encourage the development of novel machine learning methods where improved model performance facilitates progress towards the SDGs.

Yoshino, N. and Yuyama, T. (2021). "Studies of Applied Economics." In: *ESG/Green Investment and Allocation of Portfolio Assets* 39(3).
This article examines the current portfolio allocation in ESG and Green projects. Traditional investments focus on rates of return and risks associated with investment. Environmental, Social and Governance (ESG) or Green factors are additional components that investors have to pay attention to. Environmental protection is very important. However, as we see the current different definitions of ESG or Green factors lead to distorted allocations in portfolio investments. In order to bring portfolio allocations to a desirable direction, global taxation on pollution or creation of an accurate Green credit rating based on emissions of various pollutants are recommended.

Yu, L. (2021). "Comparing Classical Portfolio Optimization and Robust Portfolio Optimization on Black Swan Events." MA thesis. University of Waterloo.
Black swan events, such as natural catastrophes and manmade market crashes, historically have a drastic negative influence on investments; and there is a discrepancy on losses caused by these two types of disasters. In general, there is a recovery and it is of interest to understand what type of investment strategies lead to better performance for investors. In this thesis we study classical portfolio optimization, robust portfolio optimization and some historical black swan events. We compare two main strategies: mean variance optimization vs robust portfolio optimization on two types of black swan events: natural vs anthropogenic. The comparison illustrates that robust portfolio optimization is much more conservative, and has a shorter recovery time than classical portfolio optimization. Moreover, the losses in the stock investment resulted from a natural disaster are very minor compared to the losses resulted from an anthropogenic market crash.

Zhang, C., Li, Y., Chen, X., Jin, Y., Tang, P., and Li, J. (2020a). "DoubleEnsemble: A New Ensemble Method Based on Sample Reweighting and Feature Selection for Financial Data Analysis." In: *IEEE International Conference on Data Mining (ICDM)*. IEEE.
Modern machine learning models (such as deep neural networks and boosting decision tree models) have become increasingly popular in financial market prediction, due to their superior capacity to extract complex non-linear patterns. However, since financial datasets have very low signal-to-noise ratio and are non-stationary, complex models are often very prone to overfitting and suffer from instability issues. Moreover, as various machine learning and data mining tools become more widely used in quantitative trading, many trading firms have been producing an increasing number of features (aka factors). Therefore, how to automatically select effective features becomes an imminent problem. To address these issues, we propose DoubleEnsemble, an ensemble framework leveraging learning trajectory based sample reweighting and shuffling based feature selection. Specifically, we identify the key samples based on the training dynamics on each sample and elicit key features based on the ablation impact of each feature via shuffling. Our model is applicable to a wide range of base models, capable of extracting complex patterns, while mitigating the overfitting and instability issues for financial market prediction. We conduct extensive experiments, including price prediction for cryptocurrencies and stock trading, using both DNN and gradient boosting decision tree as base models. Our experiment results demonstrate that DoubleEnsemble achieves a superior performance compared with several baseline methods.

Zhang, F., Guo, R., and Cao, H. (2020b). "Information Coefficient as a Performance Measure of Stock Selection Models." In: *arXiv e-Print*.
Information coefficient (IC) is a widely used metric for measuring investment managers' skills in selecting stocks. However, its adequacy and effectiveness for evaluating stock selection models has not been clearly understood, as IC from a realistic stock selection model can hardly be materially different from zero and is often accompanies with high volatility. In this paper, we investigate the behavior of IC as a performance measure of stick selection models. Through simulation and simple statistical modeling, we examine the IC behavior both statically and dynamically. The examination helps us propose two practical procedures that one may use for IC-based ongoing performance monitoring of stock selection models.

Zhang, L. (2021). "ESG Rating Divergence: Beauty Is in the Eye of the Beholder." In: *The Journal of Index Investing* 12(3), pp. 53–63.
Investments aligned with environmental, social, and governance (ESG) principles are rapidly growing globally. In the exchange traded fund (ETF) industry, this gives rise to the power of ESG rating firms that have the influence to direct capital flows into ETFs tracking the indexes. This article examines the issues of substantial ESG rating divergence across rating firms, the impact on investors' choices, and the influence on the ETF industry. The divergence appears to be the greatest in social and governance components, and is often qualitative in nature. The author found that certain economic sectors are more prone to ESG rating divergence than others. She

presents a case study about two ESG ETFs that are viewed quite differently under various rating lenses, and offers suggestions to investors, advisors, and analysts on how to research ESG ETFs, given the major rating divergence. The article concludes with ways the ETF industry could improve its practices collectively to better serve investors with clarity and to sustain the growth of ESG impact investments.

Zhang, Z., Zohren, S., and Roberts, S. (2020c). "Deep Learning for Portfolio Optimization." In: *The Journal of Financial Data Science* 22(4), pp. 8–20.

In this article, the authors adopt deep learning models to directly optimize the portfolio Sharpe ratio. The framework they present circumvents the requirements for forecasting expected returns and allows them to directly optimize portfolio weights by updating model parameters. Instead of selecting individual assets, they trade exchange-traded funds of market indexes to form a portfolio. Indexes of different asset classes show robust correlations, and trading them substantially reduces the spectrum of available assets from which to choose. The authors compare their method with a wide range of algorithms, with results showing that the model obtains the best performance over the testing period of 2011 to the end of April 2020, including the financial instabilities of the first quarter of 2020. A sensitivity analysis is included to clarify the relevance of input features, and the authors further study the performance of their approach under different cost rates and different risk levels via volatility scaling.