ESG Decomposition & Factor Reconstruction

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Abstract

This project aims to decompose the iShares ESG Aware MSCI USA ETF (ESGU) into distinct Environmental (E), Social (S), and Governance (G) factor portfolios to determine if any factor is the primary driver of performance and risk of assets, via Arbitrage Pricing Theory and Fama-MacBeth models.

Data

We used the Bloomberg Terminal to extract ESG and holdings data for the ESGU from 2020 to 2024. For each company, we gathered E, S, and G scores, along with their ESG weight in the ETF. These inputs helped us construct E, S, and G factor portfolios to assess performance and risk. To ensure fair comparison, we normalized ESG scores by industry, considering scoring methodology differences. This allowed us to build industry-weighted portfolios and track how ESG factor contributions evolved over time.

Factor Construction

Our goal when creating factors was picking stocks that outperformed in the respective factor while underperforming in the other two, with the goal of making each factor portfolio as "true" to each individual factor as possible. To construct our various factors, we solved the following programming problem:

Given stocks Z_i for i = 1,...,N, each stock has three scores E_i, S_i, G_i. We can create our E-Portfolio,

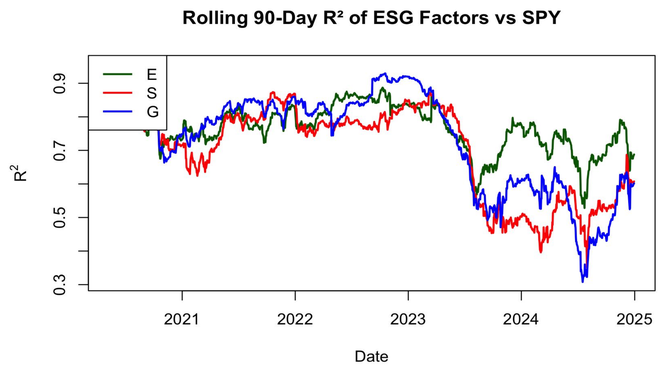
$$\max_{k\in\{0,1\}^n} \quad \frac{1}{e^T k} k^T E$$

$$\text{s.t.} \quad \frac{1}{e^T k} k^T S \le \frac{1}{N} e^T S,$$

$$\frac{1}{e^T k} k^T G \le \frac{1}{N} e^T G,$$

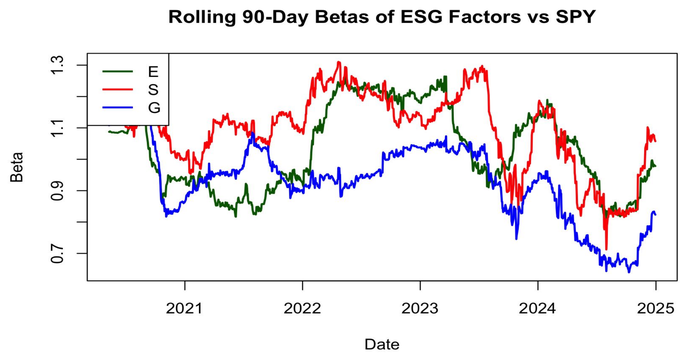
$$a \le e^T k \le b.$$

Arbitrage Pricing Theory Model Results



The left chart plots the three ESG-factor portfolios' correlation (R^2) to the SPY from 2020 through the end of 2024. All factors track SPY closely, with R^2 generally between 0.70 and 0.90. Early on, G (blue) and S (red) slightly lead, but after mid-2023 E (green) pulls ahead, maintaining the highest R^2 into 2025.

To the right, we see each factor's sensitivity to market movement (beta) over the same period. All three betas cluster tightly around 1.0, occasionally nudging above or below in unison. E, S, and G each show similar patterns of amplification and diminishment relative to SPY, confirming that none of the ESG portfolios stand out as significantly more or less market-aligned than the others.



Fama-MacBeth Model Results

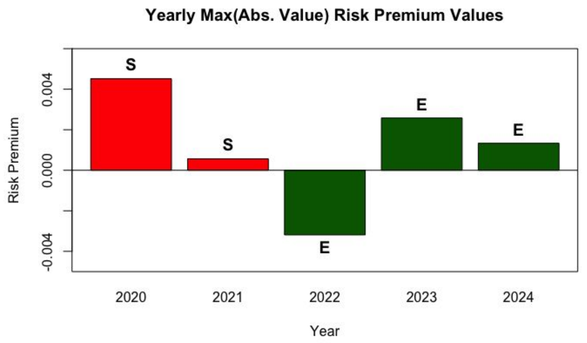
To further assess our factors effects on risk and performance, we utilized the Fama-MacBeth regression to calculate risk premiums. These premiums represent the given exposure to the factor and if that results in higher or lower returns on average for an investor. To find these premiums, we ran a regression of the assets' returns against factor returns to determine exposure of the assets to each factor. Then, we ran a cross-sectional regression to "price" the exposure to these different factors. This gives us a metric to understand each factor's impact on performance.

Regress each asset return on the m factors to estimate its betas:

$$R_{1,t} = \alpha_1 + \beta_{1,F_1} F_{1,t} + \beta_{1,F_2} F_{2,t} + \cdots + \beta_{1,F_m} F_{m,t} + \epsilon_{1,t},$$
$$R_{2,t} = \alpha_2 + \beta_{2,F_1} F_{1,t} + \beta_{2,F_2} F_{2,t} + \cdots + \beta_{2,F_m} F_{m,t} + \epsilon_{2,t},$$
$$\vdots$$
$$R_{n,t} = \alpha_n + \beta_{n,F_1} F_{1,t} + \cdots + \beta_{n,F_m} F_{m,t} + \epsilon_{n,t}.$$

Regress cross-sectional returns on the fitted betas to estimate factor premia:

$$R_{i,1} = \gamma_{1,0} + \gamma_{1,1} \hat{\beta}_{i,F_1} + \gamma_{1,2} \hat{\beta}_{i,F_2} + \cdots + \gamma_{1,m} \hat{\beta}_{i,F_m} + \epsilon_{i,1},$$
$$R_{i,2} = \gamma_{2,0} + \gamma_{2,1} \hat{\beta}_{i,F_1} + \gamma_{2,2} \hat{\beta}_{i,F_2} + \cdots + \gamma_{2,m} \hat{\beta}_{i,F_m} + \epsilon_{i,2},$$
$$\vdots$$
$$R_{i,T} = \gamma_{T,0} + \gamma_{T,1} \hat{\beta}_{i,F_1} + \cdots + \gamma_{T,m} \hat{\beta}_{i,F_m} + \epsilon_{i,T}.$$



Cap Weight

Blackrock's Model:

1) Involvement Screen
   - "Sin Stocks"
2) Controversy Screen
3) Portfolio Constraints
   - Preserves risk/return of the parent index
4) Optimization
   - Maximize ESG score

Industry Weight

Let:

- S_i = ESG-weighted score of stock i
- $\mathcal{I}(i)$ = industry of stock i

Then:

$$\text{IndustryScore}_k = \sum_{i \in k} S_i$$

$$T = \sum_k \text{IndustryScore}_k$$

$$w_i = \frac{\text{IndustryScore}_{\mathcal{I}(i)}}{T}$$

Each stock is assigned a weight (wi) based on its industry's relative ESG contribution.

Factor Composition 2024

Portfolio Weights (2024)

Environmental (E)			Social (S)			Governance (G)		
Ticker	Industry Weight	Cap Weight	Ticker	Industry Weight	Cap Weight	Ticker	Industry Weight	Cap Weight
ECL	3.54%	1.07%	A	9.21%	3.07%	BG	5.57%	0.75%
J	5.55%	0.27%	PNC	7.42%	6.08%	ISRG	2.85%	13.06%
LULU	6.69%	0.76%	KKR	7.42%	10.69%	PNR	9.46%	1.14%
HUBS	6.72%	0.58%	HUM	9.21%	2.42%	WY	2.50%	1.40%
TGT	2.34%	1.00%	HWM	2.48%	4.20%	INTU	4.80%	12.21%
META	2.27%	24.49%	KR	2.30%	3.58%	GWW	9.46%	3.53%
AMZN	6.69%	37.89%	SYK	9.21%	10.88%	LDOS	9.46%	1.32%
RCL	6.69%	1.00%	KEYS	3.58%	2.24%	MSI	4.80%	5.31%
WDAY	6.72%	1.08%	PSX	1.66%	3.75%	ADP	9.46%	8.20%
GE	5.55%	2.91%	SNPS	3.58%	5.95%	FI	2.46%	8.13%
FIS	2.73%	0.70%	PHM	1.01%	1.81%	KHC	5.57%	2.52%
JPM	2.73%	10.92%	AMP	7.42%	4.09%	FANG	3.04%	3.28%
COR	4.02%	0.70%	SCHW	7.42%	10.74%	LOW	1.11%	9.58%
VEEV	4.02%	0.56%	HBAN	7.42%	1.87%	DIS	1.04%	13.89%
ORCL	6.72%	7.68%	AVTR	9.21%	1.14%	SYY	5.57%	2.58%
AMGN	4.02%	2.26%	TXN	3.58%	13.56%	TRV	2.46%	3.81%
ODFL	5.55%	0.61%	PLD	0.34%	7.73%	OVV	3.04%	1.04%
TWLO	6.72%	0.27%	BKR	1.66%	3.20%	URI	9.46%	3.18%
JNPR	6.72%	0.20%	MDB	3.58%	1.37%	OKE	3.04%	4.03%
ABBV	4.02%	5.06%	MKC	2.30%	1.62%	FFIV	4.80%	1.01%

Conclusion

After implementing our two models to assess the effects of E, S, and G factors on asset performance, our preliminary results show the factor the ETF is most exposed to varies, and that exposure to these factors doesn't have a significant effect on asset prices. While ESG investing in general still holds value when investing ethically, performance in a particular E, S, or G pillar doesn't have a significant effect on performance.