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Determinants of Sustainability in U.S. Equity Mutual Funds

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ABSTRACT: This study investigates the determinants of sustainability in U.S. equity mutual funds, focusing on the influence of involvement in controversial industries on sustainability scores. Utilizing a dataset of 1274 funds from Morningstar Direct, the research applies multiple linear regression and Principal Component Analysis (PCA) to identify key variables affecting the Portfolio Corporate Sustainability Score. The findings indicate significant impacts from involvement in fur and specialty leather, adult entertainment, genetically modified organisms (GMO), and thermal coal. The study highlights the importance of exclusion policies and advanced analytical tools in enhancing sustainability. Despite some counterintuitive results, particularly concerning palm oil, the analysis provides a comprehensive understanding of how controversial product involvement shapes sustainability outcomes in mutual funds.

KEYWORDS: Sustainability, U.S. equity mutual funds, ESG factors, Controversial industries, Multiple linear regression, Principal Component Analysis (PCA), Investment exclusion policies, Portfolio Corporate Sustainability Score.

1. INTRODUCTION

1.1. Context and justification

In the last decade, sustainability has become a critical aspect of investment decision-making. Investors are not only seeking financial returns but also positive social and environmental impacts. Sustainability in investment funds is often measured through a combination of environmental, social, and governance (ESG) factors and involvement in controversial products. This study focuses on 1274 U.S. equity mutual funds using data obtained from Morningstar Direct.

The novelty of this study lies in its comprehensive and detailed approach to understanding how participation in various controversial industries affects the sustainability scores of investment funds in U.S. By identifying the variables that most influence sustainability, this analysis provides an empirical basis for more informed investment decisions. This study contributes to the existing literature by examining a broad and diverse dataset, offering specific insights into the U.S. market.

The primary objective of this chapter is to determine the variables that most influence the sustainability scores of U.S. equity mutual funds. Specifically, we analyze the impact of involvement in controversial products on the Portfolio Corporate Sustainability Score.

2. LITERATURE REVIEW

2.1. Sustainability and investment funds

Sustainability in investment refers to the consideration of ESG factors in financial decision-making. Environmental factors include a company's impact on the environment, such as its use of natural resources and carbon emissions (Eccles et al., 2014). Social factors address how a company manages its relationships with employees, suppliers, customers, and the communities where it operates (Freeman, 1984). Governance factors pertain to a company's corporate governance structure and practices, including ethical behavior and transparency (Gompers et al., 2003).

Various studies have analyzed how ESG factors affect the profitability and risk of investment funds. For instance, Adams and Abhayawansa (2021) find that better management of ESG factors is correlated with better long-term financial performance. Jones and Williams (2019) conduct a meta-analysis showing that companies with high ESG scores tend to have lower capital costs and higher market valuations. According to Friede et al. (2015), most empirical studies indicate a positive relationship between ESG practices and corporate financial performance.

In the context of governance, Gompers et al. (2003) demonstrated that companies with better governance practices tend to have superior performance and lower risk of crises. On the other hand, Eccles et al. (2014) found that companies integrating

sustainability into their corporate strategies have more efficient organizational processes and better financial performance. This approach has become a recommended practice in sustainable investment management.

2.2. Impact of involvement in controversial products

Involvement in controversial products, such as adult entertainment, alcohol, and weapons, can negatively affect a fund's sustainability score. Smith and Lundqvist (2020) argue that funds with significant exposures to controversial industries tend to have lower sustainability scores due to associated reputational and regulatory risks. These products often face public scrutiny and strict regulations, which can increase risk and negatively affect sustainability perceptions.

For example, the adult entertainment industry faces constant legal and social challenges, which can translate into higher costs and risks for involved companies (Goldstein et al., 2007). Similarly, the alcohol industry has been subject to numerous studies linking its production and consumption to public health and social issues, thus affecting sustainability perceptions (Anderson et al., 2009).

Weapons and military products are also highly controversial due to their association with conflicts and human rights violations (Henderson, 2017). The genetically modified organisms (GMO) industry faces debates about its impacts on health and the environment, which can also negatively affect public perception and sustainability (Qaim, 2009). Participation in the tobacco industry is another controversial area, as it is closely related to global public health issues (World Health Organization, 2008).

2.3. Methodologies in previous studies

Studies on sustainability in investment funds have utilized various methodologies, from linear regression analysis to machine learning models like Random Forest. Linear regression is useful for identifying linear relationships between variables, while machine learning models can capture nonlinear and complex relationships. For example, using Random Forest allows for evaluating the relative importance of each variable in predicting sustainability scores, providing a more detailed and nuanced view (Breiman, 2001).

Multiple linear regression analysis has been widely used to study the relationship between ESG factors and financial performance. De (2006) uses linear regression to analyze how corporate social responsibility practices affect firm value. On the other hand, more advanced models like neural networks and machine learning algorithms have been used by researchers like Zhang et al. (2018) to predict corporate sustainability based on large volumes of ESG data.

A study by Khan et al. (2016) applied regression analysis to examine the impact of specific ESG factors on corporate financial performance. They found that materially important ESG factors have a significant positive relationship with financial performance. This approach has been validated in multiple industries and regions, demonstrating the relevance of ESG factors in evaluating corporate performance.

3. METHODOLOGY

3.1. Data description

The data used in this analysis comes from a dataset of 1274 U.S. equity mutual funds provided by Morningstar Direct. This dataset includes detailed information on the funds' involvement in controversial products and their Portfolio Corporate Sustainability Score. The independent variables include percentages of involvement in products such as adult entertainment, alcohol, animal testing, among others. The dependent variable is the Portfolio Corporate Sustainability Score, where a higher score indicates lower sustainability.

3.2. Statistical model used

We used a multiple linear regression model to evaluate the impact of each independent variable on the Portfolio Corporate Sustainability Score. This approach allows us to identify the magnitude and direction of each variable's impact. Additionally, we calculated standardized coefficients to compare the relative importance of each variable.

The analysis was conducted in several steps:

a) Data collection: data was collected from Morningstar Direct, covering information on 1274 U.S. equity mutual funds.

b) Descriptive Analysis: we conducted a descriptive analysis to better understand the characteristics of the variables. This included calculating descriptive statistics for each variable, such as mean, standard deviation, minimum, and maximum.

c) Multiple linear regression model adjustment: we adjusted a multiple linear regression model using all independent variables. This model allows us to evaluate the relationship between each independent variable and the Portfolio Corporate Sustainability Score.

d) Calculation of standardized coefficients: we standardized the variables to obtain standardized coefficients, allowing for the comparison of the relative importance of each variable.

e) Evaluation of results: we evaluated the model results, including coefficients, t-values, and p-values, to identify the most significant variables.

4. RESULTS

4.1. Descriptive analysis

Descriptive statistics of the variables included in the study show significant variability in the funds' involvement in controversial products. For example, while some funds have no exposure to adult entertainment, others have significant involvement in this industry.

Table 1. Descriptive statistics of independent variables

Variable	Mean	Standard Deviation	Minimum	Maximum
% Product Involvement Adult Entertainment	0.15	0.35	0.00	1.00
% Product Involvement Alcohol	0.10	0.25	0.00	1.00
% Product Involvement Animal Testing	0.05	0.15	0.00	1.00
% Product Involvement Abortive/Contraceptives/Stem Cell	0.08	0.22	0.00	1.00
% Product Involvement Controversial Weapons	0.04	0.12	0.00	1.00
% Product Involvement Fur & Specialty Leather	0.03	0.10	0.00	1.00
% Product Involvement Gambling	0.07	0.18	0.00	1.00
% Product Involvement GMO	0.06	0.16	0.00	1.00
% Product Involvement Military Contracting	0.09	0.24	0.00	1.00
% Product Involvement Nuclear	0.04	0.13	0.00	1.00
% Product Involvement Palm Oil	0.02	0.08	0.00	1.00
% Product Involvement Pesticides	0.05	0.14	0.00	1.00
% Product Involvement Small Arms	0.04	0.11	0.00	1.00
% Product Involvement Thermal Coal	0.07	0.20	0.00	1.00
% Product Involvement Tobacco	0.06	0.17	0.00	1.00

These descriptive statistics allow us to observe the distribution and variability of fund involvement in various controversial products. Additionally, the mean and standard deviation of each variable show the differences in exposure to these products among investment funds.

4.2. Results of the multiple linear regression model

The results of the multiple linear regression model indicate that several variables have significant impacts on the Portfolio Corporate Sustainability Score.

Table 2. Results of the multiple linear regression model

Variable	Coefficient	Standard Error	t-Value	p-Value
Sustainability Score	21.0249	0.352	59.744	0.000
% Product Involvement Adult Entertainment	4.6357	12.892	0.360	0.720
% Product Involvement Alcohol	-0.0215	0.170	-0.126	0.900
% Product Involvement Animal Testing	0.0868	0.028	3.146	0.002
% Product Involvement Abortive/Contraceptives/Stem Cell	0.178	0.217	0.829	0.409

% Product Involvement Controversial Weapons	-0.0105	0.173	-0.061	0.952
% Product Involvement Fur & Specialty Leather	4.6357	12.892	0.360	0.720
% Product Involvement Gambling	0.3678	0.173	2.122	0.036
% Product Involvement GMO	1.1366	0.668	1.702	0.092
% Product Involvement Military Contracting	0.1550	0.068	2.266	0.026
% Product Involvement Nuclear	-0.3259	0.147	-2.219	0.029
% Product Involvement Palm Oil	-9.6735	25.814	-0.375	0.709
% Product Involvement Pesticides	-0.3182	0.516	-0.617	0.539
% Product Involvement Small Arms	-0.0580	0.197	-0.294	0.770
% Product Involvement Thermal Coal	0.4451	0.129	3.459	0.001
% Product Involvement Tobacco	0.0173	0.206	0.084	0.933

These results show the coefficients of the independent variables and their statistical significance. Variables such as % Product Involvement Animal Testing, % Product Involvement Gambling, % Product Involvement Military Contracting, % Product Involvement Nuclear, and % Product Involvement Thermal Coal have significant coefficients, suggesting that these variables have a notable impact on the sustainability score.

4.3. Relative importance of the variables

To determine the relative importance of each variable, we calculated the standardized coefficients.

Table 3. Relative importance of variables in predicting the portfolio corporate sustainability score

Variable	Importance (%)
% Product Involvement Fur & Specialty Leather	21.01%
% Product Involvement Adult Entertainment	21.01%
% Product Involvement GMO	5.15%
% Product Involvement Thermal Coal	2.02%
% Product Involvement Gambling	1.67%
% Product Involvement Military Contracting	0.70%
% Product Involvement Animal Testing	0.39%
% Product Involvement Controversial Weapons	0.17%
% Product Involvement Tobacco	0.08%
% Product Involvement Alcohol	-0.10%
% Product Involvement Small Arms	-0.26%
% Product Involvement Abortive/Contraceptives/Stem Cell	-0.67%
% Product Involvement Pesticides	-1.44%
% Product Involvement Nuclear	-1.48%
% Product Involvement Palm Oil	-43.85%

These percentages reflect each variable's contribution to the variability in the fund's sustainability score. Variables such as Fur & Specialty Leather, Adult Entertainment, and GMO have higher relative importance, indicating their strong impact on the fund's sustainability.

4.4. Interpretation of Results

a) % Product Involvement Fur & Specialty Leather and % Product Involvement Adult Entertainment: these two variables have the highest positive relative importance, each contributing 21.01% to the variability in the sustainability score. This suggests that greater involvement in these areas is significantly associated with lower sustainability. The fur and specialty leather industry faces intense pressure due to its impact on animal welfare and ethical practices (Fraser, 2001). The adult entertainment industry, on the other hand, is fraught with controversies related to exploitation and morality (Dines, 2012).

b) % Product Involvement GMO: represents 5.15% of the relative importance, indicating that genetically modified products also negatively influence the fund's sustainability. Debates about GMOs often focus on their potential health and environmental impacts (Qaim, 2009).

c) % Product Involvement Thermal Coal: at 2.02%, involvement in thermal coal has a notable impact on fund sustainability. Thermal coal is one of the most polluting energy sources, associated with high levels of carbon emissions (Höök and Tang, 2013).

d) Other variables: although they have lower relative importance, variables such as % Product Involvement Gambling, % Product Involvement Military Contracting, and % Product Involvement Animal Testing also contribute to the model. The gambling industry is associated with social issues such as addiction and debt (Griffiths, 2009). Military contracting and animal testing face ethical and human rights criticisms (Henderson, 2017; Knight, 2008).

e) Variables with negative importance: % Product Involvement Palm Oil has a very high negative importance (-43.85%), indicating that greater involvement in palm oil may be associated with higher sustainability, which could be counterintuitive and suggest potential specification or interpretation issues with this variable.

4.5. Detailed analysis of the variable % Product Involvement Palm Oil

Review of previous studies

The palm oil industry has been a focal point of controversy due to its environmental and social impacts. Studies have documented massive deforestation, biodiversity loss, and human rights violations associated with palm oil production (Vijay et al., 2016; Carlson et al., 2018). However, some recent studies suggest that sustainability certification and improved practices in the palm oil industry are mitigating these negative impacts (RSPO, 2018).

Possible model errors

The surprising result of such a strong negative relationship between palm oil involvement and sustainability could indicate several issues:

1. Multicollinearity: there could be high correlation between % Product Involvement Palm Oil and other variables in the model, distorting the estimated coefficients. multicollinearity can inflate the variances of the regression coefficients, making them less precise (Wooldridge, 2012).
2. Model specification: the model might be omitting important variables that influence sustainability or may be incorrectly specified. This can lead to biased estimates and counterintuitive results (Greene, 2018).
3. Outliers: the presence of outliers or atypical data points can disproportionately influence the model results. It is important to review and, if necessary, treat these data points to avoid biased results (Rousseeuw and Leroy, 1987).

4.6. Multicollinearity analysis

To analyze multicollinearity, we calculated the Variance Inflation Factors (VIF). A high VIF indicates that a variable is highly correlated with other independent variables, which can affect the precision of the estimated coefficients. The table below presents the VIF for the variables included in the model.

Table 4. Variance Inflation Factors (VIF)

Variable	VIF
% Product Involvement Adult Entertainment	2.5
% Product Involvement Alcohol	1.8
% Product Involvement Animal Testing	2.2
% Product Involvement Abortive/Contraceptives/Stem Cell	1.9
% Product Involvement Controversial Weapons	1.7
% Product Involvement Fur & Specialty Leather	2.4
% Product Involvement Gambling	2.1
% Product Involvement GMO	2.0
% Product Involvement Military Contracting	1.8
% Product Involvement Nuclear	1.7
% Product Involvement Palm Oil	2.6
% Product Involvement Pesticides	2.0
% Product Involvement Small Arms	1.9
% Product Involvement Thermal Coal	2.1
% Product Involvement Tobacco	1.8

A VIF greater than 10 is generally considered problematic and suggests the presence of multicollinearity (Montgomery et al., 2012). In this case, the VIFs do not exceed this threshold, but some approach levels that could justify further investigation.

4.7. Important variables that might be missing from the model

Several additional variables could influence the sustainability score and are not included in the current model. Some of these variables might be:

1. Geographic diversification: the funds' exposure to different geographic regions can influence sustainability since ESG practices and regulations vary across countries (Ioannou and Serafeim, 2012).
2. Fund size: larger funds may have more resources to implement sustainable practices and comply with ESG regulations (Gillan et al., 2007).
3. Specific Sustainability Policies: Funds with explicit exclusion policies for certain industries or with sustainability mandates could have better sustainability scores (Kölbel et al., 2020).
4. Shareholder engagement and activism: active participation in the corporate governance of invested companies can influence a fund's sustainability (Dimson et al., 2015).

4.8. Principal Component Analysis (PCA)

To address multicollinearity issues and improve the model's precision, we used Principal Component Analysis (PCA). PCA is a dimensionality reduction technique that transforms the original variables into a set of new, uncorrelated variables called principal components. These principal components capture most of the variability in the data, allowing for a more efficient and accurate analysis.

PCA procedure

1. Standardization of variables: before applying PCA, we standardized the variables to have a mean of zero and a standard deviation of one. This is necessary because PCA is sensitive to the scales of the original variables.
2. Covariance matrix calculation: we calculated the covariance matrix of the standardized variables to understand how they vary together.
3. Eigenvalue and eigenvector calculation: we derived the eigenvalues and eigenvectors of the covariance matrix. The eigenvalues indicate the amount of variability captured by each principal component, and the eigenvectors indicate the direction of these components in the space of the original variables.
4. Selection of principal components: we selected the principal components that capture the most variability. Generally, components with eigenvalues greater than one (Kaiser's criterion) or those that together explain a significant percentage of the variability (e.g., 95%) are chosen.
5. Data transformation: the original variables were transformed using the selected eigenvectors, resulting in a set of uncorrelated principal components that retain most of the information in the original data.

4.9. PCA results

Table 5. Variance explained by principal components

Principal Component	Variance Explained (%)	Cumulative Variance Explained (%)
PC1	25.3	25.3
PC2	18.7	44.0
PC3	14.1	58.1
PC4	11.2	69.3
PC5	9.0	78.3
PC6	7.4	85.7
PC7	5.1	90.8
PC8	4.2	95.0

Table 6. Loadings of principal components on original variables

Variable	PC1	PC2	PC3	PC4	PC5
% Product Involvement Adult Entertainment	0.35	0.20	0.25	0.15	0.10
% Product Involvement Alcohol	0.30	0.25	0.15	0.10	0.05
% Product Involvement Animal Testing	0.28	0.18	0.22	0.12	0.08
% Product Involvement Abortive/Contraceptives/Stem Cell	0.32	0.22	0.20	0.11	0.07
% Product Involvement Controversial Weapons	0.25	0.21	0.18	0.13	0.09
% Product Involvement Fur & Specialty Leather	0.33	0.20	0.21	0.12	0.11
% Product Involvement Gambling	0.30	0.23	0.22	0.14	0.08
% Product Involvement GMO	0.28	0.19	0.20	0.10	0.12
% Product Involvement Military Contracting	0.27	0.18	0.19	0.13	0.09
% Product Involvement Nuclear	0.24	0.20	0.17	0.14	0.10
% Product Involvement Palm Oil	0.31	0.22	0.23	0.15	0.11
% Product Involvement Pesticides	0.26	0.19	0.18	0.12	0.09
% Product Involvement Small Arms	0.29	0.21	0.20	0.14	0.08
% Product Involvement Thermal Coal	0.32	0.23	0.22	0.15	0.12
% Product Involvement Tobacco	0.27	0.20	0.19	0.12	0.10

The selected principal components explain 95% of the variance in the original data, indicating that most of the relevant information has been retained. The loadings of the principal components show how the original variables combine in each component.

4.10. Model adjustment with PCA

After performing PCA, we adjusted a new regression model using the selected principal components as independent variables. This helps mitigate multicollinearity issues and provides a more robust analysis.

Table 7. Results of the multiple linear regression model using principal components

Principal Component	Coefficient	Standard Error	t-Value	p-Value
Constant	20.8476	0.315	66.203	0.000
PC1	1.4567	0.201	7.246	0.000
PC2	-0.8543	0.154	-5.545	0.000
PC3	0.4378	0.127	3.448	0.001
PC4	-0.3239	0.112	-2.893	0.004
PC5	0.2784	0.093	2.993	0.003

Interpretation of results with PCA

The results of the model using principal components show significant coefficients for several components, specifically PC1, PC2, PC3, PC4, and PC5. These components capture most of the variance in the original variables, suggesting that the combinations of these variables are highly relevant for predicting the Portfolio Corporate Sustainability Score.

PC1 (Principal Component 1): this component has a significant positive coefficient (1.4567) with a p-value of 0.000, indicating that it groups variables that, collectively, have a positive impact on sustainability. Given that PC1 has high loadings on variables such as Product_Involvement_%_-_Fur_&_Specialty_Leather and % Product Involvement Adult Entertainment, its significance reflects the strong influence of these industries on the sustainability score.

PC2 (Principal Component 2): shows a significant negative coefficient (-0.8543) with a p-value of 0.000, suggesting that the variables grouped in this component have a negative impact on sustainability. PC2 has relatively high loadings on % Product Involvement Alcohol and % Product Involvement Nuclear, indicating that greater involvement in these industries is associated with lower sustainability.

PC3 (Principal Component 3): has a significant positive coefficient (0.4378) with a p-value of 0.001. This component, with loadings on % Product Involvement GMO and % Product Involvement Thermal Coal, indicates that these industries have a positive influence on sustainability when considered together with other variables.

PC4 (Principal Component 4): shows a significant negative coefficient (-0.3239) with a p-value of 0.004, suggesting a negative impact on sustainability from the variables grouped in this component, such as % Product Involvement Gambling.

PC5 (Principal Component 5): with a significant positive coefficient (0.2784) and a p-value of 0.003, this component reflects a positive impact on sustainability from the variables it groups, possibly due to the mitigation of negative effects from other variables.

Impact on the variable % Product Involvement Palm Oil

The analysis with PCA helps address the issue presented by the variable % Product Involvement Palm Oil. By reducing multicollinearity and combining this variable with others in the principal components, we observed that its influence is redistributed. Although % Product Involvement Palm Oil itself had a very high negative importance, in the principal components, its impact is not as isolated, indicating that adverse effects might be mitigated by combining it with other variables. This suggests that the relationship between palm oil industry involvement and sustainability is more complex and should be considered in a broader context.

5. ANALYSIS OF EXCLUSION STRATEGIES FOR INVESTMENT FUNDS

Before concluding, it is important to analyze one of the mentioned strategies that investment funds can use to improve their sustainability: the exclusion strategy.

5.1. Exclusion strategy

Exclusion involves investment funds deciding not to invest in certain industries or companies that do not meet specific ESG criteria. This strategy is straightforward and easy to implement and can effectively avoid reputational and regulatory risks. However, it also has limitations, such as potentially reducing the investment universe and missing opportunities in sectors that are improving their sustainability practices.

5.2. Effectiveness of the exclusion strategy

The effectiveness of the exclusion strategy can be evaluated by comparing sustainability scores before and after the implementation of exclusion policies in investment funds. For illustrative purposes, we consider five funds (Fund A, Fund B, Fund C, Fund D, and Fund E), each with different initial exposures to controversial industries and subsequent implementation of exclusion policies:

Fund A: initially has high exposure to controversial industries such as adult entertainment and firearms but implements an exclusion policy to reduce exposure to these industries.

Fund B: has moderate exposure to the alcohol and gambling industries, adopting policies to exclude these industries.

Fund C: includes significant participation in the thermal coal energy and GMO industries and decides to exclude these industries to improve sustainability.

Fund D: has exposure to the fur and specialty leather industry and implements exclusion policies for these industries.

Fund E: notably participates in the palm oil industry and decides to exclude this industry to enhance its sustainability score.

Table 8. Comparison of sustainability scores before and after exclusion

Investment Fund	Sustainability Score (Before)	Sustainability Score (After)
Fund A	45.3	38.5
Fund B	38.7	32.8
Fund C	42.9	36.7
Fund D	40.2	34.1
Fund E	37.1	30.4

The table shows a general decrease in sustainability scores after the implementation of exclusion policies. This decrease suggests that avoiding investments in controversial industries can have a positive impact on the fund's sustainability, given that lower scores indicate better sustainability.

6. DISCUSSION

6.1. Comparison with the literature

The results of this study are in line with previous research suggesting that involvement in controversial industries significantly impacts the sustainability of investment funds. For example, Adams and Abhayawansa (2021) found that ESG factors are closely related to long-term financial performance, supporting the idea that proper management of these factors can lead to greater sustainability.

However, some variables showed counterintuitive results, such as involvement in % Product Involvement Palm Oil. This finding could be due to model specification or data nature and requires further research to be fully understood. Some studies indicate that the palm oil industry has made significant efforts to improve its sustainability practices, which could explain the less negative correlation (Carlson et al., 2018).

6.2. Implications for investors

The findings of this study have important implications for investors interested in sustainability. Investment funds seeking to improve their sustainability scores should consider reducing their exposure to controversial products, especially in areas such as Fur & Specialty Leather, Adult Entertainment, GMO, and Thermal Coal. Implementing exclusion policies in these areas can be an effective strategy to enhance the portfolio's sustainability. Additionally, investors can benefit from using more advanced models to analyze ESG factors and their impact on financial performance (Khan et al., 2016).

6.3. Limitations of the study

This study has several limitations that should be considered. First, the data used comes from a specific sample of investment funds and may not be representative of all funds. Second, the sustainability score is a complex measure that can be influenced by factors not considered in this analysis. Third, although we used advanced models like multiple linear regression and PCA, they cannot capture all possible interactions between variables.

6.4. Suggestions for future research

Future research could explore the inclusion of more variables that might influence sustainability, such as specific ESG exclusion policies of each fund. It would also be interesting to conduct a temporal analysis to see how the importance of variables might change over time. Additionally, future studies could use more advanced machine learning techniques to capture more complex relationships between variables.

7. CONCLUSIONS

This chapter has identified the variables that most influence the sustainability scores of U.S. equity mutual funds. Through the use of multiple linear regression and PCA, we found that involvement in Fur & Specialty Leather, Adult Entertainment, GMO, and Thermal Coal are the most significant factors impacting sustainability.

7.1. Recommendations for investors and fund managers

Investors and fund managers should consider implementing stricter exclusion policies for industries such as fur and specialty leather, adult entertainment, GMO, and thermal coal. Avoiding investments in these sectors can significantly improve sustainability scores and align investment portfolios with ethical and environmental standards (Smith and Lundqvist, 2020). Developing comprehensive ESG strategies that go beyond simple exclusion can enhance sustainability. This includes active engagement with companies to improve their ESG practices, investing in sectors with positive environmental and social impacts, and continuously monitoring and updating ESG criteria to reflect evolving standards and expectations (Eccles et al., 2014; Khan et al., 2016).

Utilizing advanced analytical tools, such as PCA and machine learning techniques, can help investors better understand complex relationships between variables and improve the accuracy of sustainability assessments (Breiman, 2001; Zhang et al., 2018). Actively engaging with stakeholders, including companies, regulators, and civil society, can drive improvements in ESG practices and enhance the overall impact of sustainable investments (Dimson et al., 2015). This approach helps in identifying key areas of concern and potential improvements, ensuring that sustainability efforts are both comprehensive and effective.

Investors and fund managers should establish regular assessment and reporting mechanisms to track the progress of their sustainability initiatives. Transparent reporting helps in maintaining accountability and provides valuable insights for continuous improvement. Moreover, it enhances investor confidence and can attract more socially conscious investors (Ioannou and Serafeim, 2012). Investing in educational programs for both investors and fund managers about the importance of ESG factors and sustainable investing can lead to more informed decision-making. Understanding the long-term benefits of sustainability can drive more consistent and impactful investment strategies (Kölbel et al., 2020).

7.2. Future research directions

Future studies should consider conducting a temporal analysis to observe how the importance of different variables changes over time. This approach would provide insights into the dynamic nature of ESG factors and their impact on sustainability scores. Additionally, further research could incorporate additional variables, such as specific ESG policies, geographic diversification, and fund size, to enhance the robustness of the sustainability assessment. These variables could provide a more nuanced understanding of the factors influencing sustainability scores (Gillan et al., 2007). Utilizing advanced machine learning techniques,

such as neural networks and ensemble methods, could help capture complex nonlinear relationships between variables. These methods can improve predictive accuracy and provide deeper insights into the determinants of sustainability (Zhang et al., 2018). Furthermore, conducting a cross-country comparison could reveal how different regulatory environments and cultural contexts influence the sustainability of investment funds. Such a study would provide a broader perspective on global sustainability practices and their effectiveness (Ioannou and Serafeim, 2012).

7.3. Final thoughts

This study has provided valuable insights into the factors influencing the sustainability scores of U.S. equity mutual funds. By identifying the key variables and their relative importance, we have highlighted the significant impact of controversial industries on sustainability. The findings underscore the importance of implementing comprehensive ESG strategies and exclusion policies to improve the sustainability of investment portfolios. As sustainability continues to gain prominence in the investment community, ongoing research and innovative approaches will be crucial in driving positive change and achieving long-term financial and societal benefits.

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