Industry-Level Impact of Environmental, Social and Governance (ESG) Factors for Alternative Investment

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Abstract: This study takes S&P500 companies' ESG disclosure score and Environmental，Social and Governance disclosure score separately and using SVD algorithm to get the industry-level ESG score graphs. Through analyzing the graphs, we found that the leisure products, tobacco, automobiles industries occupied the top behaviour under the total ESG disclosure score, which deserves to mention that the tobacco, which is normally regarded as the sin stock and shunned by the investors, ranks second among all the industries. For Environmental, Social and Governance disclosure score separately, leisure products, real estate management & devel, tobacco industries occupy the first place respectively, and the disclosure score for Governance for all industries is overall higher than Social and Environmental. In conclusion, this study provides guidance on stock recommendation for ESG investors.

1. Introduction

In the wake of the high-speed economic progress, investors are increasingly concerned about not just the monetary value of the objects but the external environment of the companies they invest in, for example, the environment, social, and governance, which is called ESG. As a result, companies' share prices are now influenced by the ESG index. To enable companies to increase the value of their stocks and investors better to use the ESG index as an investment reference, the impact of ESG on investment has its research significance and can provide valuable references for future generations of financial markets. We select the industry category data, downloaded from Bloomberg Terminal, and choose the SP500 ticker data, which contains the total ESG score, and Environmental, Social, and Governance score separately. Due to the large amount of data studied, this study has a relatively accurate reference significance. In this research, we will use the Singular value decomposition algorithm to help reduce the data's dimension to reach the researchable degree. Because we have 500 companies, the dimensions of the data are also beyond the scope of what can be studied, so we use the SVD algorithm to help us research the impact of the ESG score on how investors invest the stocks.

In the literature review section, we present the current research achievements of the SVD algorithm and the reason we choose this model to reduce the data dimensions. In the method section, we use the SVD algorithm to reduce the data dimensions first, then cross-validate the data after dimension reduction and overfit the data. In the experimental analysis section, we conduct the experiments and analyze the results. This will include the resource of the data, the application of the arithmetic, and the indication of the data chart. In the conclusion section, we will explain this research's value and predict the investment market's future development.

2. Literature Review

There are some kinds of literature stating the use of the SVD algorithm. The singular value decomposition (SVD) algorithm is a numerical technique used in diagonalizing matrices in numerical analysis. SVD can unfold the distributions measured in high-energy physics experiences that are usually distorted and transformed by various detector effects [1]. It is also applied to images in an attempt to achieve data compression, developed for multiple applications, including matrix diagonalization, regression, and pseudo-inversion [2]. This algorithm has been proposed for image coding and provides essential insights for the optimal decomposition of images into their unique feature images [2].

Over the past few decades, there is a huge trend of companies engaging in sustainability strategies and disclosing data about Environmental, Social and Governance (e.g., carbon emissions(environmental), employee makeup(social), board diversity(governance)). According to Amel-Zadeh, nearly 9000 companies issuing ESG related reports by 2016[3], and investors also respond quickly to ESG investing with 1400 signatories ($60 trillion total assets under management) to the UN Principles for Responsible Investment, which requires to committed to take ESG issue into consideration during analysis and practices by 2016 [4]. Previous studies show that the ESG investing is related to affect the value of the investor's portfolio, since high ESG rating exhibit high future returns especially since 2012[5], therefore it is also the top reasons investors take ESG into consideration during investment followed by client demand, product strategy ethical concerns [3]. This study will provide suggestions for ESG investors based on the analyse of the industry level ESG disclosure score.

3. Methodology

To get more reliable predictions about the influences of the environment, society, and government (ESG) on alternative investment, some technologies and algorithms are used. Data can be better analysed by using the SVD algorithm, RMSE, and MAE. Before performing the algorithm, the dimension of techniques data needs to be reduced by the SVD algorithm to achieve the purpose of data compression and noise reduction.

3.1. Singular Value Decomposition (SVD)

SVD performs matrix decomposition but is different from the eigendecomposition, SVD does not require that the matrix be decomposed into a square matrix. A singular value decomposition (SVD) of a real m x n matrix A is its factorization of the form [1]

$$A = USV^T \tag{1}$$

Where U is an m x m orthogonal matric, V is an n x n orthogonal matrix, while S is an m x n diagonal matrix with non-negative diagonal elements:

$$UU^T = U^TU = I, VV^T = V^TV = I \tag{2}$$

$$S_{ij} = 0 \; for \; i \neq j, S_{ii} = s_i \geq 0 \qquad (3)$$

The quantities S_i are called singular values of the matrix A, and columns of U and V are called the left and right singular vectors [1].

It is a valuable dimension-reduction tool that can be used to approximate matrices and extract essential features from them. By reserving 80%-90% of the energy of the matrix or only reserving the first 2,000-3,000 singular values, an important feature can be obtained, and the remaining noise can be removed.

4. Empirical Analysis

The data set comprises S&P500 ticker data, which contains the 500 companies' total ESG disclosure score and Environmental disclosure score (with data of Direct CO_2 Emissions, Total CO2 Emissions, CO2 Intensity per Energy, Total GHG Emissions, NOx Emissions, Total Energy Consumption, Total Water Use, Hazardous Waste, Total Wastes, and Environmental Fines), Social disclosure score (with data of Number of Employees%, Women in Workforce%, Women in Mgt, Workforce Accidents, Fatalities – Employees, and Community Spending) and Governance disclosure score (with data of Size of Board, Indep Directors%, Indep Directors, Board Duration (Years)#, Board Meetings, Board Mtg Attendance and Political Donations) separately in 2018.

We then collected the industry category data from the Bloomberg terminal and use the industry sector and GICS industry classification to classify the 500 companies into different industries such as Chemicals, Oil&Gas, Transportations. After merging two datasets based on 'company name', we got the dataset for analysis using SVD algorithm on an industry basis.

4.1. Annually Data Analysis

Total ESG histogram plots are used to review how the data changes from year to year. Helps us to recognize how does ESG disclosure score change from 2009 to 2018.
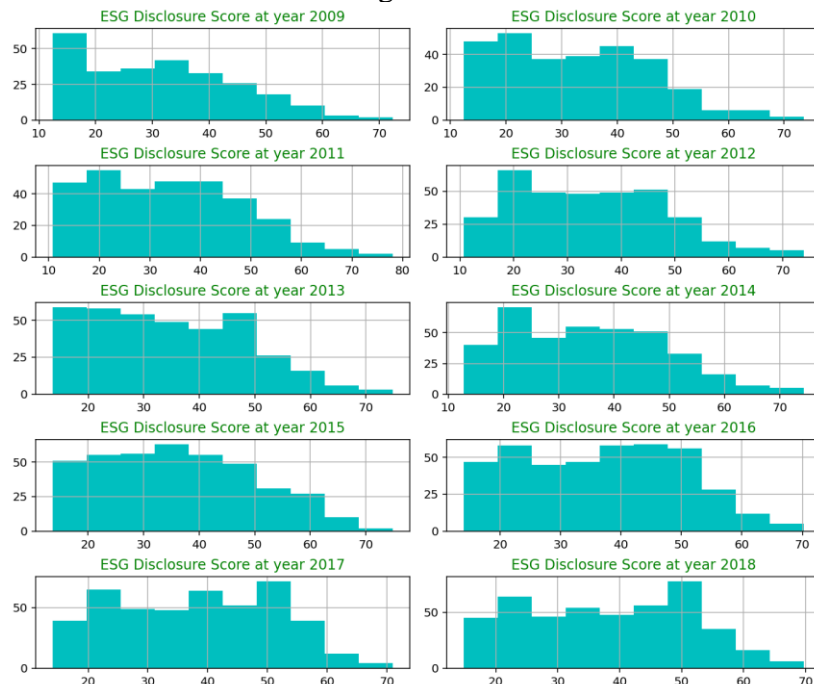

Figure 1: Annually Data Analysis

The above Figure 1 data describes the ESG disclosure sore change every year. The figure shows

that the ESG disclosure score increased from 2009 to 2019.

4.2. RMSE

RMSE is used as a standard statistical metric to measure the best fold in SVD [6]. If RMSE is less, then the Error is less. Here, we examine 5-fold cross-validate and apply RMSE for that.

$$\sqrt{\frac{1}{N}\sum_{i=1}^{n}(Y_i - f(x_i))^2} \qquad (4)$$

Table 1: RMSE Test

	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Mean	Std
RMSE	30.3926	28.9126	28.5209	29.5384	28.7572	29.2243	0.6743

From Table 1, it shows that the best RMSE score is 29.22994 for this data set.

4.3. MAE

MAE is another helpful way that used to access model performance.

$$\left(\frac{1}{n}\right) * \sum |y_i - x_i| \qquad (5)$$

Table 2: MAE Test

	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Mean	Std
MAE	25.7067	24.1478	24.0743	24.7856	24.3472	24.6123	0.6005

From Table 2, it shows that the mean value is 24.6123 for this data set.

4.4. Industry-level ESG Disclosure Score Graph Analysis

The popularity of ESG investing and potential return and sustainable investment on high ESG score companies make it useful to plot the industry ranking of ESG scores for the reference of the investor.
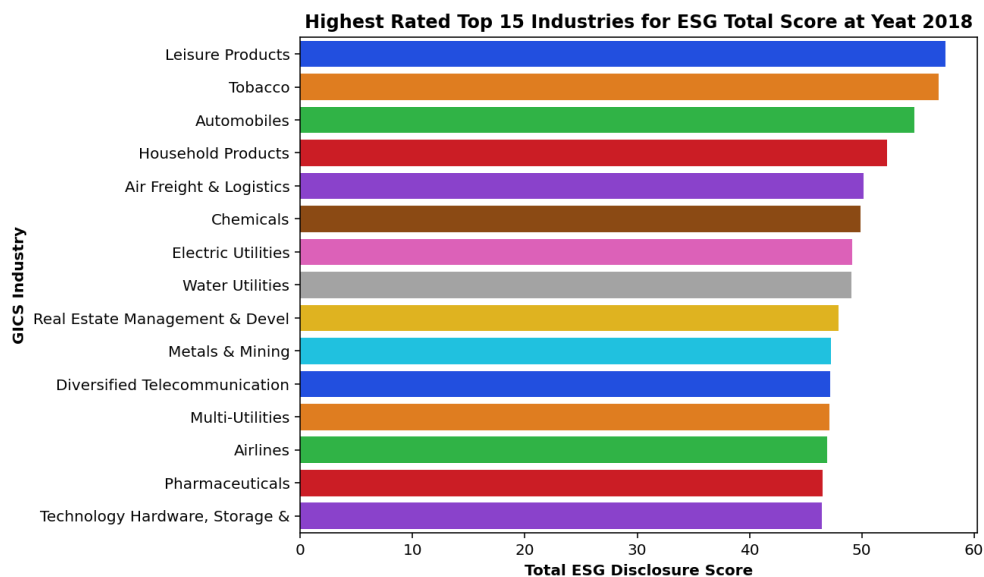

Figure 2: Total ESG Disclosure Score

Figure 2 illustrates the highest-rated top 15 industries for ESG total score in 2018. It can be seen

that leisure products occupied the first place, followed by Tobacco and automobile, which made it a top recommendation for ESG investors if only considering the total ESG score.

The second-highest score obtained by Tobacco may contradict our normal perception that the sin industry shouldn't get a high ESG score. If we look at the Environmental, Social, and Governance score separately in Figure 3,4, and 5, we can find that the Tobacco industry gets the highest score in Governance and get third place in both social and environmental factors, which implies the tobacco company makes great effort in the management of the company, considering and respecting people, and the conservation of the natural world, which reveal the compensation the tobacco companies made due to its harm to the general interests of the society. In mainstream investing, the sin industry is always shunned by the investor, however, under the ESG score-based stock recommendation, the high ESG score ranking caused the contradiction which required the investors' careful consideration.

It is also obvious and reasonable that utility industries including water utilities, electric utilities, and multi-utilities obtained a high ESG score and deserve to be invested. Apart from leisure products and tobacco, all the industries remaining seems to link with people's daily necessities to some degree.

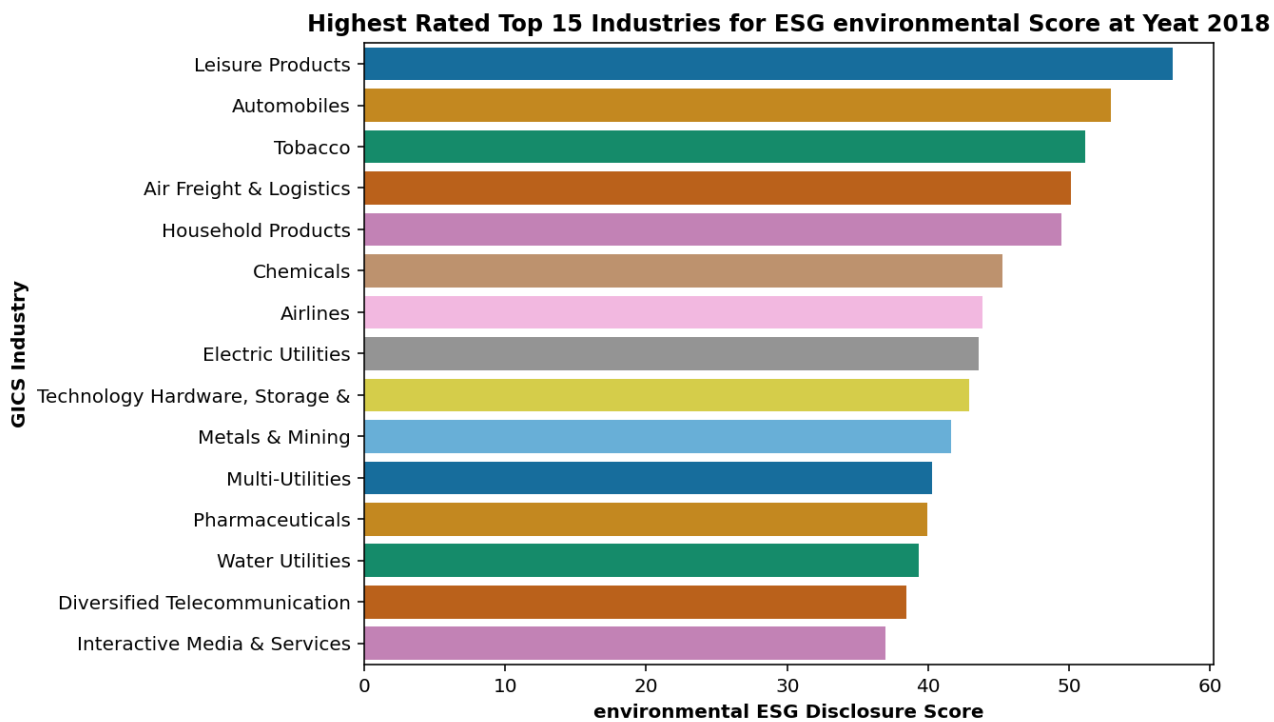The separated Environmental, Social, and Governance scores also have significant meaning for ESG investor.

Figure 3: Environmental ESG Disclosure Score

In Figure 3, we can see the top 15 highest environmental score industries, with leisure products occupying the first place still, exceeding tobacco by a great amount. Automobiles obtained higher environmental scores than tobacco and they are still top 3 under environmental factor. However, real estate management & devel has poor performance, which is replaced by the interactive media & services industry.
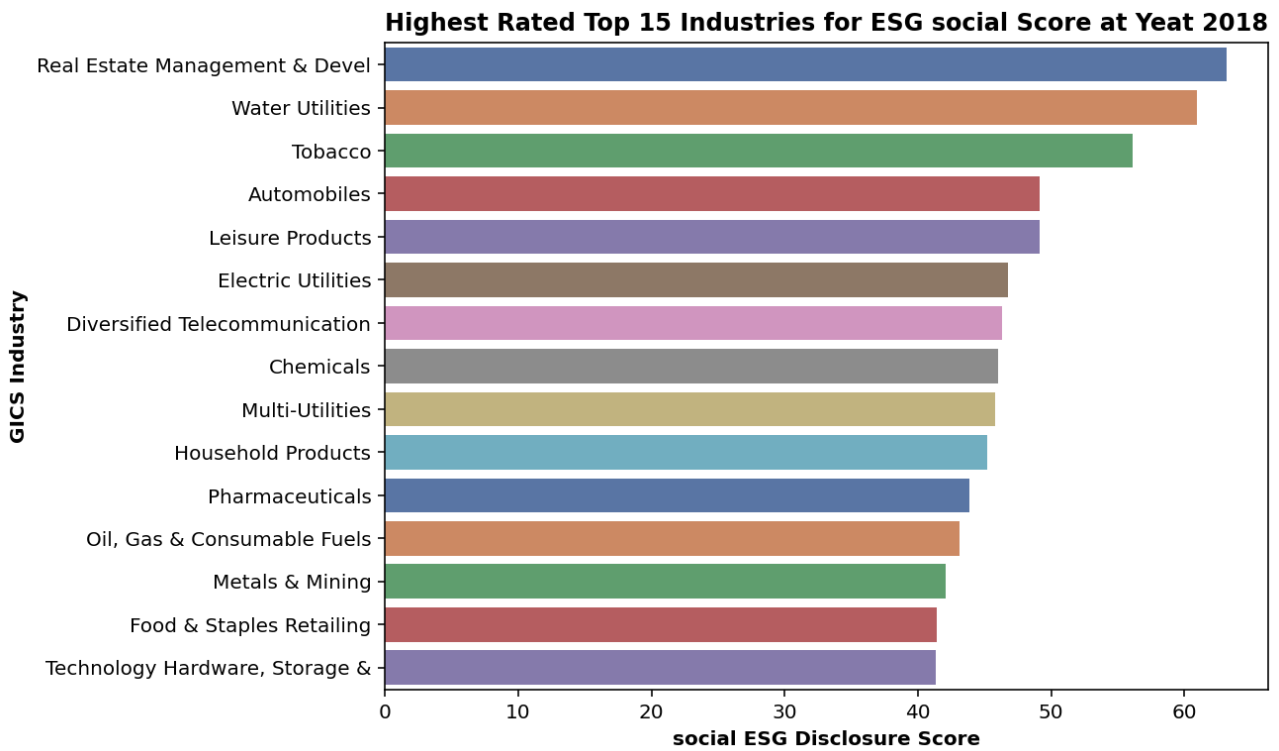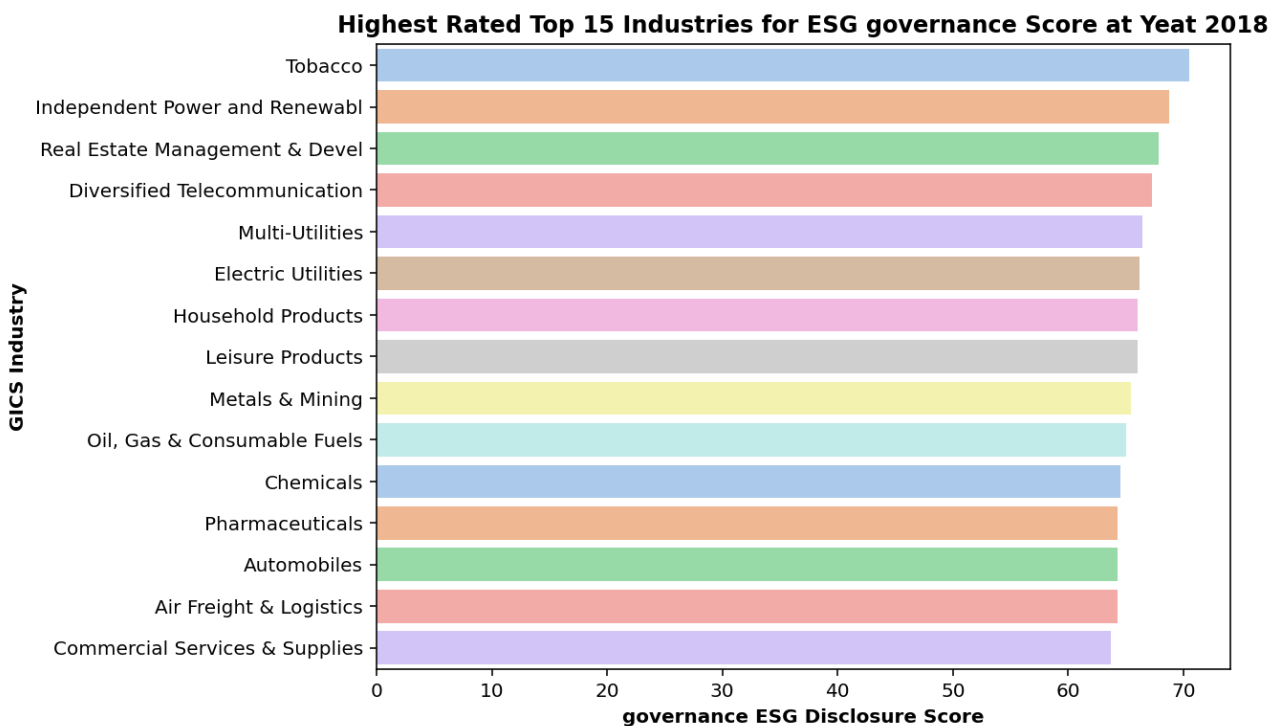
Figure 4: Social ESG Disclosure Score

Figure 5: Governance ESG Disclosure Score

In Figure 4, for the social ESG disclosure score, real estate management & devel, water utilities, and tobacco took the leading position and exceed other industries by a large margin. For Governance in Figure 5, each industry got a comparatively close score at more than 60, which in all exceeds the environmental at around 40 and social score at 50 approximately.

Generally speaking, if we consider the asset allocation at industry levels, investors will have industry preferences for separate environmental, social, or governance factors. Investors are willing to choose more stocks following their investment logic, which means stock recommendation based on ESG is helpful for investment decisions. In this section, we focus on how to recommend a similar stock given a certain industry based on the stocks we have already chosen. It provides a guidance for investors to better take advantage of ESG investing.

5. Conclusions

This study has selected S&P500 companies' ESG score and after analysing using the SVD algorithm, we got the score based on the GICS industry level. We concluded from the graph that for the total ESG disclosure score, leisure products, tobacco, automobiles occupied the top 3 positions, and for sin industry like tobacco, it's high ESG score shows its effort in making up for its damages, which also makes ESG investors swing at whether to invest in such high ESG scores sin industry. Since the sin stocks usually exhibit outperformance [7], therefore, this study perhaps provides legitimate reasons for investors to invest in the tobacco industry. The utilities industry deserves investment confirmed with its high ESG score. And for Environmental, Social, and Governance score separately, the industries show an overall better performance at Governance than Social and Environment. This study analysing the ESG score on the industry level will provide guidance for ESG investors to choose stocks more wisely based on investment logic and preferences.

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