

# Unraveling the Relationship Between ESG and Corporate Financial Performance - Logistic Regression Model with Evidence from China

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## Abstract

With growing awareness of sustainability, the field of Environmental, Social and Governance (ESG), has been attracting mainstream investors and researchers. Many previous studies have found inconclusive or mixed results on the relationship between ESG ratings and firms' financial performance, which are mainly attributed to their varied markets, time horizons, and sources of ESG rating. Based on evidence from an emerging market, namely China, this paper examines whether ESG is an adequate indicator for firms' future financial performance. Given the divergence in ESG rating methodologies, we use ESG data from two ESG rating agencies, one based in China (SynTao) and the other based in Switzerland (RepRisk), for robustness. Specifically, we investigate 377 China A-share companies covered by both agencies and find that ESG rating, albeit divergent due to disparate methodologies, is instrumental in predicting the trend of corporate financial performance (CFP). This work verifies that the forward-looking nature of ESG makes it crucial for firms' long-term valuation and financial performance in emerging markets. Throughout the research, we observe four issues in the current ESG rating process: the opacity and inaccessibility of source data, the obscurity of ESG rating methodologies adopted by rating agencies, the lack of automated pipeline, and the unannounced historical data rewriting. We believe that the public blockchain ecosystem is promising to address these issues, and we propose future research on the ESG framework for blockchain to call for sustainability focus on this emerging technology.

**JEL Classification:** G24, G30, M14, Q56

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# 1. Introduction

The growing awareness of sustainability in both investors and corporations has led to the latter shifting their focus beyond simply financial statements. Specifically, companies have been putting increasingly significant efforts to manage their environmental, social, and governance (ESG) profiles, as it attracts mainstream investors while potentially also leads to long-term profit. For corporations, good ESG practices provide them with competitive advantages such as lower tail risk, lower cost of capital, and higher valuation (Giese et al. 2019). For investors, ESG allows them to “zoom out” of financial statements and examine companies’ operations and long-term strategies through a complementary non-financial lens. Moreover, the importance of ESG has been amplified after China, the biggest player among the emerging markets, pledged to be carbon neutral by 2060, which is in line with its 14<sup>th</sup> five-year plan that specifically emphasized sustainable development including green finance. Thus, Chinese companies particularly have become more cautious of their ESG profile to align with the government’s strategy. Knowing how they may benefit financially is also one of the major incentives to improve ESG performance.

Increasing evidence suggests a link between firms’ ESG performance and corporate financial performance (CFP), thus making it a key concern for firms and other interested parties, including investors, policymakers, and scholars. However, evidence on the relationship between ESG and CFP has been mixed according to extant research on this topic and several meta-studies (Friede, Busch, and Bassen 2015). Existing literature found positive, negative, and nonexistent correlations between ESG and financial performance, although most researchers found a positive correlation. Such inconclusive results likely stem from the different ESG data used in previous research and the varied methodologies. Giese et al. (2019) study the underlying transmission channels between ESG and firms’ financial performance and reach the conclusion that better ESG characteristics can lead to firms’ better financial performance. Yoon, Lee, and Byun (2018) focus on the emerging market of Korea and found evidence that a positive ESG profile contributes to companies’ valuation. Lucia, Paziienza, and Bartlett (2020) utilize machine learning and logistic regression to show that good ESG does lead to better financial performance. Despite some of the studies stating ESG as a premature indicator for financial performance, the majority of relevant studies display a tendency of concluding that more sustainable firms are likely to have better long-term financial performance and lower systematic risk. For example, Friede, Busch, and Bassen (2015)

conduct a meta-analysis of over 2000 empirical studies on ESG and CFP, and most results show a positive relationship between ESG and CFP.

While existing literature provides exercisable research methodologies and insights for both investors and corporations, the results appear to be mixed or even contrasting. And it is hard to identify the source of this inconsistency as the studies differ in a range of key variables of assessment. For example, a variety of ESG rating sources are used. Several studies use the Thomson Reuters ASSET4/EIKON database whose coverage is mostly within Europe (Lucia, Paziienza, and Bartlett 2020). And studies that draw evidence from China tend to use China-based rating sources such as data provided by SynTao Green Finance (Broadstock et al. 2020). Besides, the time horizon is also a key variable that is not controlled. For instance, many of the former studies are event-oriented focused on times like financial crises and the pandemic. Event studies are suitable for verifying the relationship between ESG and financial resilience, but they might fail to give a generally conclusive relationship between ESG and CFP over a longer period. Further, literature on this topic mostly gathers evidence from developed markets like Europe and the US, while evidence from developing markets is limited. This may be because firms in emerging markets focus more on operating efficiency and profits, instead of intangible values such as environmental and social value added (Yoon, Lee, and Byun 2018). Other uncontrolled variables like market scope and selected CFP metrics might also contribute to the divergence of results.

This study contributes to the extant literature on ESG and financial performance by examining the predictive power of ESG ratings over financial performance trends. We address the aforementioned inconsistencies that current research poses by focusing on the China market, more specifically 377 China A-share companies that are covered by both rating agencies that are based in China and Switzerland, namely, SynTao and RepRisk. Using descriptive statistics, we first verify the significant ESG rating divergence between the two ESG sources based in China and the West. We then control the time horizons while having two different ratings for comparison. *Ceteris paribus*, we find that ESG can be viewed as an effective financial indicator as it helps predict the trend of future financial performance. By discovering ESG as a forward-looking indicator for companies' future financial performance, this study provides practical insights for Chinese companies, investors, and ESG researchers on the future development and applicability of ESG methodologies in China. Although one should not consider such relationship as causality, one can conclude that companies in emerging markets like China,

which lag in ESG management vis-à-vis their peers in developed markets, should devote more efforts to emphasize sustainability over multiple key issues, such as corporate governance, labor management, and carbon emission. In turn, they could expect an improved ESG profile and sustainable financial growth in the long run. Finally, we summarize the issues regarding ESG ratings we observed in this research and provide novel insights on how blockchain could be a promising solution. Taking the idea further, we innovatively propose that devising a sustainability measurement like the ESG framework could be crucial in driving sustainable development in the emerging blockchain field.

## 2. Methodology

### 2.1 Data

Data used in this research consists of ESG data and companies' historical CFP data. As mentioned earlier, we choose two ESG rating agencies, namely, SynTao Green Finance based in China, and RepRisk based in Switzerland. SynTao ESG data is accessed via WIND, a financial data provider in China, and RepRisk data is obtained from Wharton Research Data Service<sup>2</sup> via Duke Libraries (. The CFP data is also retrieved from WIND<sup>3</sup>.

We choose the time horizon from 2015/01/01 to 2021/03/14 for analysis. Note that although the granularity is daily, CFP metrics and ESG ratings are not originally daily since most companies disclose financial performance quarterly. Considering the disclosed financial data and ESG ratings capture the past performance, we therefore backfill the missing values of CFP and ESG using the nearest future data. After data cleaning, a panel dataset containing 2265 days and 377 companies is created for further analysis. Table 1 gives the metadata summary.

**Table 1.** Panel data summary.

Variable	Obs.	Description	Type
Stock code	2265	Stock code	string (e.g., 002128.SZ)
ROIC	2265	Return on invested capital	numerical

<sup>2</sup> Wharton Research Data Services provides business data source solutions. [Wharton Research Data Services](#)

<sup>3</sup> See more about Wind at their website. [Wind Financial Terminal](#)

ROA	2265	Return on asset	numerical
mkt_cap	2265	Market capitalization	numerical
ROE	2265	Return on equity	numerical
PE	2265	Price-Earning ratio	numerical
esg_rating	2265	Syntao ESG rating	numerical <sup>4</sup>
RRR	2265	RepRisk Rating	numerical
E_percentage <sup>5</sup>	2265	Environmental risk exposure (RepRisk)	numerical
S_percentage	2265	Social risk exposure (RepRisk)	numerical
G_percentage	2265	Governance risk exposure (RepRisk)	numerical

## 2.2 Descriptive statistics

The descriptive statistics in Table 2 below show that SynTao ESG rating indeed has a more centralized distribution.

**Table 2.** Panel data descriptive statistics.

Variable	Mean	Std. Dev.	Min.	Max.
ROE	6.93	9.59	-157.7	146.69
mkt_cap	599.17	1510.49	16.11	32673.7
ROA	3.31	4.72	-88.58	39.86
ROIC	5.39	6.57	-59.43	56.43
PE	54.16	165.63	-1940.81	5599.22
esg_rating	5.01	0.96	3	8
RRR	5.63	0.86	1	9
E_Percentage	0.08	0.22	0	1
S_Percentage	0.11	0.27	0	1
G_Percentage	0.28	0.42	0	1

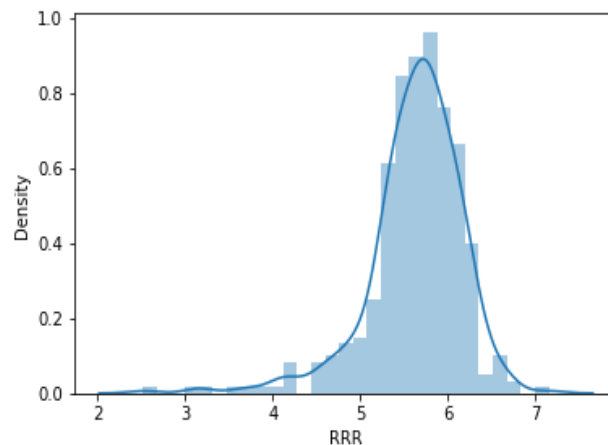
The distributions of SynTao and RepRisk ESG ratings are shown in Figure 1 and Figure 2. Both distributions appear to be normal. RepRisk rating is left-skewed while the Syntao rating has a more standard normal distribution with a mean at around 5. These distributions from a

<sup>4</sup> ESG ratings from SynTao and RepRisk are letter grades, which are then mapped to 1-10 integers.

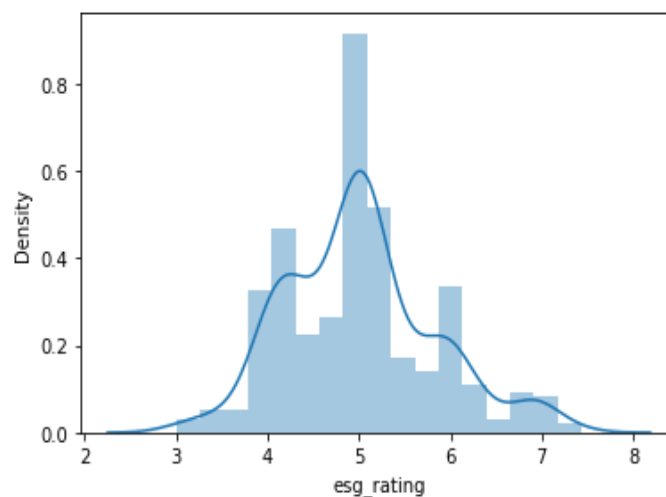
<sup>5</sup> The E, S, G percentages are essentially risk exposures, ranging from 0 to 1. A higher number means higher risk exposure

sample of 377 Chinese A-share companies may not be representative of their overall coverage, they can nonetheless display the general rating distributions in China market.

**Figure 1.** RepRisk rating distribution.



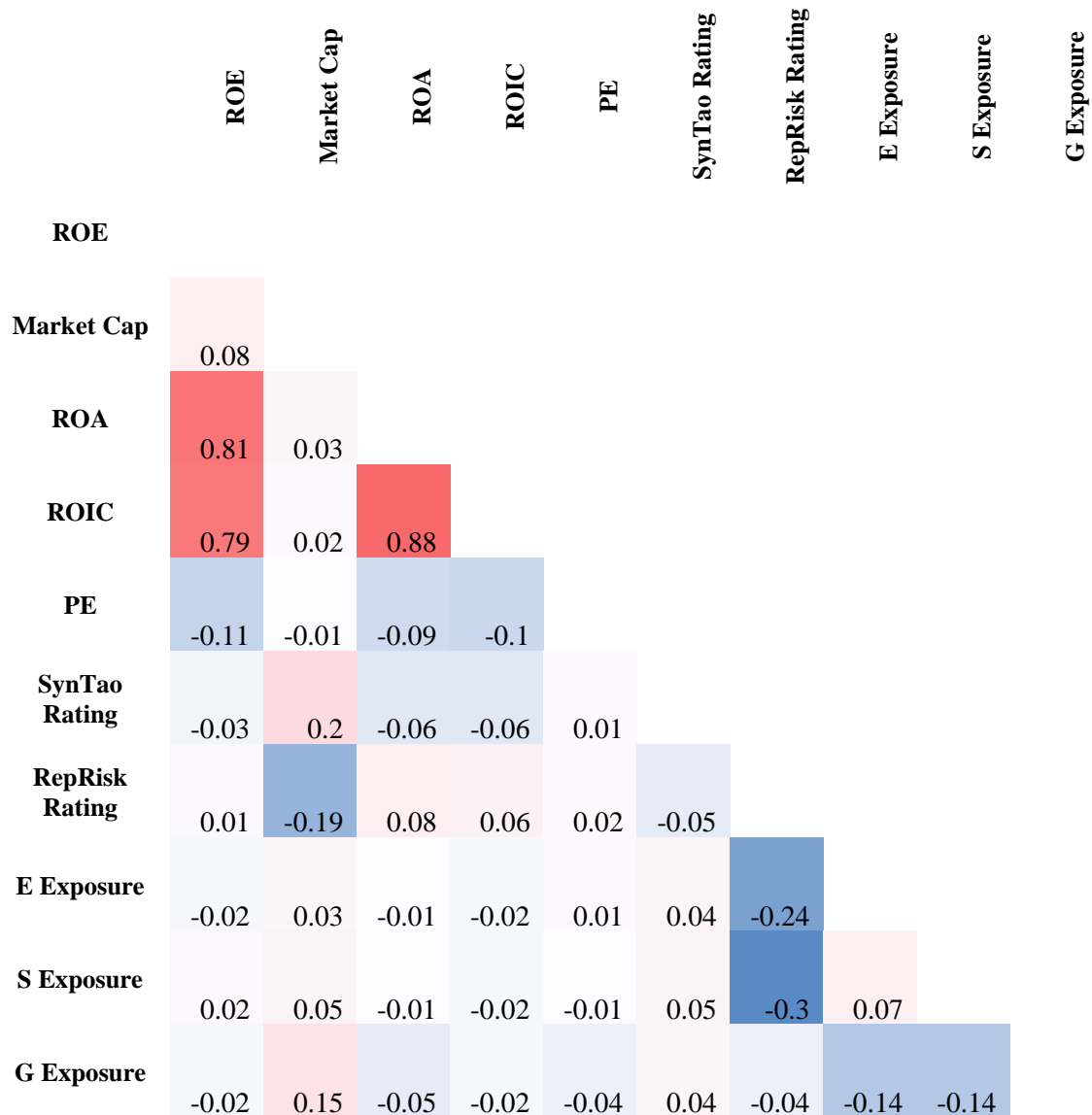
**Figure 2.** SynTao ESG rating distribution.



We think that the normal distribution of SynTao's ESG rating and its overly centralized distribution can be somewhat problematic for investors. Assuming investors would like to choose companies with higher ESG ratings, they might not find normally distributed ESG data helpful as most companies have a medium ESG rating. Besides, a normal distribution provides fewer high ESG rating options. If investors were to adopt a positive screening strategy<sup>6</sup>, it is unlikely for them to construct a well-diversified portfolio.

<sup>6</sup> Positive screening refers to the strategy where, rather than excluding companies, investors select companies that set positive examples of ESG practices, which tend to have high ESG ratings.

**Figure 3.** Correlation heatmap between variables (from 2020 cross-sectional data).



We plot the correlation heatmap using cross-sectional data from 2020 as Figure 3 shows. The ESG ratings appear to be uncorrelated with any CFP metric from the same year, which is sensible considering ESG should be forward-looking and give insights on future financial performance. Moreover, Syntao's ratings and RepRisk Ratings show a correlation coefficient of -0.05, meaning that they do not correlate at all despite the company coverage and time are controlled. This implies a notable divergence in ESG rating methodologies that is thoroughly studied by Berg, Kölbel, and Rigobon (2019). This slightly negative correlation is even lower than the average correlation of 0.54 between ESG ratings, which are provided by six prominent western ESG ratings (Berg, Kölbel, and Rigobon 2019). We can explain this divergence by assuming that Chinese rating agencies like SynTao may have completely different objectives for their ESG ratings, and therefore different rating methodologies from western rating

agencies that potentially focus more on financial materiality. Another possible explanation is that the rating methodologies include different sets of indicators of ESG information. For instance, SynTao's indicators might have indicators specific to China market while RepRisk's approach might include less such ESG information on Chinese firms.

Moreover, the correlation between (current) ESG and CFP metrics is close to 0, meaning that ESG ratings are not correlated with firms' current financial performance. Such a result could be attributed to the fact that ESG ratings are meant to evaluate the firms' sustainability level, which by nature takes time for it to be incorporated and reflected in firms' future financial performance.

## 2.3 Predicting CFP Trend Using Logistic Regression

The assumption that most ESG investors have is that it contains some degree of information that might be useful for predicting firms' future CFP. If true, it is certainly beneficial for investors to make better investment decisions, and for firms to manage their ESG profile.

This section utilizes a classic classification algorithm, logistic regression, to predict the trend of future CFP with the current CFP as input. Logistic regression is a supervised machine learning algorithm typically used for classification problems. It uses the sigmoid function as cost function, which maps any real value into another value between 0 and 1. A standard sigmoid function is defined as  $f(x) = \frac{1}{1+e^{-x}}$ , where  $f(x)$  is the predicted probability. For clarity, we denote  $f(x)$  as  $P(y^i = 1)$  where  $y$  is the target variable and 1 is the default class. Since the outcome variable, the trend of CFP, is binary (i.e., upward and downward), the algorithm produces labels by forcing the data point as the default class (in this case, upward) if as  $P(y^i = 1) \geq 0.5$ , as the other class (downward) if as  $P(y^i = 1) < 0.5$ . We can rewrite the logistic regression as  $P(y^i = 1) = \frac{1}{1+\exp(-(b_0+b_1x_1^i+\dots+b_nx_n^i))}$ , where  $y$  is our target variable, the trend of financial performance, and  $x_1$  to  $x_n$ , are the features which we will introduce next.

First, only the current CFP ( $x_1$ ) is given to predict the trend of future CFP ( $y$ ). Then we add the ESG ratings as an additional input ( $x_2$ ) to see if adding ESG ratings gives a statistically significant increase in prediction accuracy. If so, the increment indicates that ESG ratings contain valuable information for predicting the trend of future CFP. However, if the difference after adding ESG ratings is not statistically significant, the difference in prediction accuracy

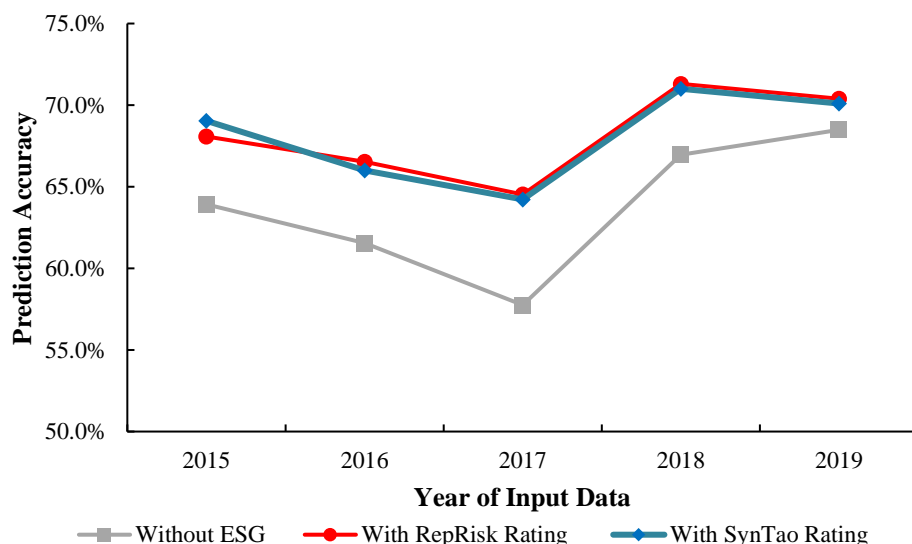


might simply be the contribution of (any) additional information rather than ESG ratings in particular.

We aggregate the dataset into quarterly data points in the modeling process and choose ROIC as the outcome variable. Taking the difference between the ROIC input of different years and CFP of 2020 gives a series of differences, which then yields the trend of ROIC by taking the signs. In other words, we predict the trend of future ROIC with varied time horizons.

Figure 4 shows that the prediction accuracies when having either one of the ESG ratings are consistently higher than those without the ESG information. To test if the prediction accuracy increase is statistically significant, the p values calculated using t scores are 0.034 for RepRisk rating and 0.048 for SynTao rating, both smaller than 0.05, indicating that the results are statistically significant. This proves our hypothesis that ESG ratings are an effective financial indicator for predicting the trend of future financial performance. We could then further conclude that ESG ratings have incorporated a certain degree of information that implies firms' future financial performance.

**Figure 4.** ROIC trend prediction accuracy as input year varies.



Moreover, it is worth noting that RepRisk Rating slightly outperforms SynTao's ESG rating in prediction accuracy and statistical significance, indicating the potential consequences of the aforementioned divergence in rating methodologies. However, there is no way for us to determine the source that leads to such difference because the rating algorithms are not fully disclosed and rather obscure in details.

In addition, Figure 5 shows how much prediction accuracy ESG ratings adds. We subtract the prediction accuracies with ESG rating by the accuracies without it. As the

**Figure 5.** ROIC trend prediction accuracy differences.

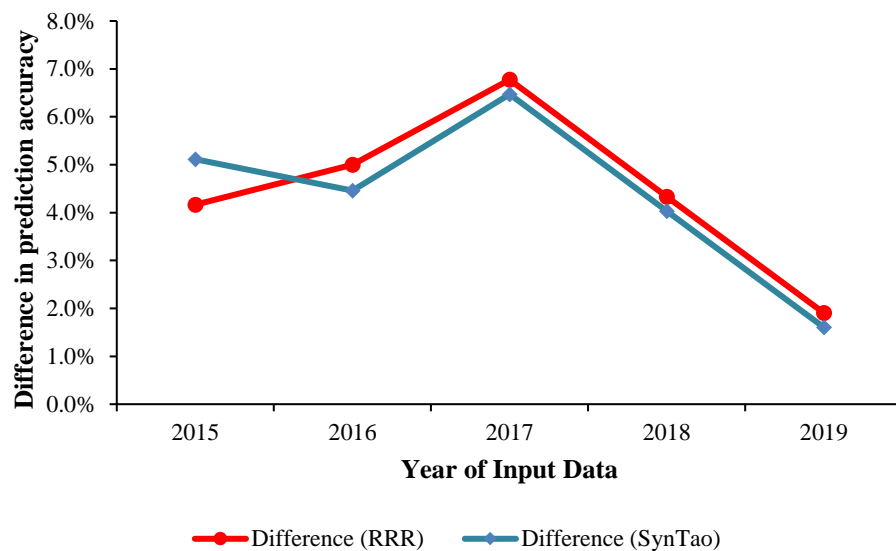


Figure 5 clearly shows that the effect of adding ESG information to the input declines as the year of input data gets closer to the year of outcome data that is 2020. In other words, the benefit of incorporating additional ESG information declines as the time horizon gets smaller. Therefore, conversely speaking, considering additional ESG information helps predict the trend of CFP metrics over a longer time horizon, demonstrating the potential value of ESG information in long-term valuation. Interestingly, the benefit of including additional ESG information seems to peak at the year 2017, which is equivalent to when the time horizon is 3 years (2017-2020). Such results could be attributed to the fact that ESG information might not necessarily be helpful for investors in an indefinite time horizon. In our case, due to the controlled time horizon and company scope, we are not able to take this discussion further, but this could be a starting point for studying and empirically examining how long the most suitable length for long-term ESG investing would be.

### 3. Conclusion

This preliminary study mainly adopts logistic regression to analyze the relationship between ESG and CFP, specifically ROIC as an example. First, the rating distributions from two ESG sources shed light on the divergence and a lack of a standardized framework of various ESG rating methodologies. Abhayawansa and Tyagi (2021) argue that ESG ratings are essentially a black box. Therefore, it is difficult for investors and firms to clearly understand how ratings are produced and exactly what sources they are based upon, which then causes ambiguities in their investment decisions and management strategy when considering ESG.

Second, using logistic regression, we find that incorporating ESG ratings in the input gives a statistically significant boost in prediction accuracy when predicting the trend of future financial performance. The prediction accuracy using RepRisk ratings slightly outperforms results using SynTao rating, indicating a potential effect of methodological divergence mentioned earlier. Such an increase in prediction accuracy shows that ESG ratings contain some degree of information that implies future financial performance. Besides, the prediction accuracy “bonus” with additional ESG information generally declines as the time horizon shrinks, demonstrating the long-term value of ESG.

Last but not least, our results show an interesting peak in prediction accuracy when the time horizon is three years, which motivates further research into the most suitable time horizon for ESG investing, or how the effectiveness of ESG information may change over time.

### 4. Discussion and Further Research

#### 4.1 Limitations

Objectively, our approach and results in this preliminary research are limited by the data acquired. For example, a longer time series could potentially give more insights into how ESG ratings are related to firms’ long-term value. Moreover, while this dataset includes 377 Chinese companies and over 5 years of CFP time series, we cannot group companies by their industries as there is no industry code. It might be insightful as well to see the relationship between CFP and ESG within the same industry (i.e., industry-neutral). Moreover, the statistical test is limited by the number of samples we have, and the results could benefit from a more robust statistical method.

## 4.2 Current issues with ESG ratings

While our results show that ESG ratings are instrumental for predicting future financial performance, the ESG rating itself has several issues that remain to be tackled. First, the data sources are often opaque. The lack of transparency about data sources contributes to difficulty in identifying a company's true ESG performance (Abhayawansa and Tyagi 2021). Besides, most ratings use self-disclosed data sources. Yoon, Lee, and Byun (2018) point out that relying on such data sources "has intrinsic shortcomings because of the self-reporting or -generation bias". Second, proliferating ESG rating methodologies have the common issue of obscurity. ESG ratings can be of more value to investors and firms if they understand what the raters (actually) measure. Unfortunately, rating agencies are only transparent about certain aspects or to a certain degree about their methodologies and how detailed scores are calculated (Hawley, 2017). And this issue of transparency is unlikely to be solved as the rating methodologies (e.g., ESG indicators and their respective weightings) are proprietary and considered intellectual property of the raters (Abhayawansa and Tyagi 2021). Third, the rating process lacks an automated pipeline. ESG ratings are evaluated based on a variety of data sources such as corporate disclosure and media reports. However, the dispersion and diversity of data sources result in a gap between the data input and the evaluation process, meaning it is necessary for analyst to review all the available data before giving the final rating. Human insights are undoubtedly crucial to make the ratings interpretable and reliable, nonetheless, the degree of automation in the rating process can be improved if an automated pipeline is formed with human on the loop. Worse still, the critical part of data input, company's disclosure, is beyond the control of any rating agency, which can hardly be incorporated into the rating pipeline. In other words, the starting point of the current pipeline is broken due to the dependence on company's voluntary disclosure (not all disclosures are voluntary, see 4.3.1 for elaboration). The lack of automation not only delays rating updates but also increases the chance of information of smaller companies not fully accounted for. Forth, historical ESG data might be overwritten secretly. As historical records of firms' ESG performance, ESG data should not be overwritten unless sometimes correction is necessary. Surprisingly, however, Berg, Fabisik, and Sautner (2020) look into ESG data provided by Thomson Reuters ASSET4 from 2018 and 2020 and find that the data has been rewritten. The unannounced "changes might have been 'data-mined'", meaning that firms that performed better (as in stock returns) in a given year were then given "ex-post upgrade in their E and S score" in the next year. Astonishingly still, such rewriting of ESG data is conducted on a

continuous and ongoing basis (Berg, Fabisik, and Sautner 2020). Given the growing reliance on ESG data providers due to the proliferation of relevant research, such unannounced rewritings of ESG data have implications for investors and researchers, for instance, unintended deviations in results and extra data verification efforts to check if the data has been rewritten, etc.

## **4.3 The Future of ESG**

### **4.3.1 Public blockchain for ESG**

With the above issues, we propose the public blockchain as a promising solution. Blockchain, by definition, is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way (Yaga et al. 2018). With public blockchains, we can envision a business world in which coded smart contracts are stored in transparent and shared databases, where they are resistant to deletion, tampering, and revision.

The first issue of data source transparency is solved at ease with the nature of public blockchain, which guarantees the transparency and validity of data. The second issue of methodology transparency can be solved with rule-based smart contracts on the public blockchain, where the rating algorithm is coded into an open-source smart contract. Such smart contracts provide transparency on exactly what data sources are fed into the algorithm as well as how the ratings are generated. The third issue of a lack of automation in the rating process can be solved with the decentralized application (dApps) ecosystem that runs on public blockchains. Decentralized applications offer certain services and functions on blockchains. Currently, Ethereum is native to many popular dApps across diverse industries, such as Uniswap, a decentralized cryptocurrency exchange, and PooTogether, a protocol for no-loss lottery. In essence, those dApps can be viewed as “companies” operating on the blockchain, enjoying unique benefits such as decentralization and interoperability. They have grown rapidly over the past years in both quantity and quality. Within the ecosystem, data collection, rating, analysis, and later processes can form an automated pipeline. The rating process can utilize the rating algorithm mentioned previously as it automatically collects available information of firms in the ecosystem and updates their ratings. Similar to the solution to the first issue, the last issue of unannounced score changes would be eliminated for the immutability of (historical) records on blockchain and any activities like score updates would be entirely transparent.

We should also point out, however, that the fundamental issue with current ESG measurement still lies within ESG disclosures. As mentioned earlier, most ESG ratings take companies' self-disclosed ESG reporting as a key data source, which in some cases is complemented by alternative data verification (see MSCI ESG rating methodology<sup>7</sup> for example). However, reliable ESG disclosures require regulatory initiatives by government bodies or stock exchanges. While regulations such as SFDR are effective in the EU to certain companies, most markets are yet to have regulations on mandatory ESG disclosure. Therefore, although blockchain can potentially bring more transparency to the current ESG rating framework, it is incapable of improving raw data quality from ESG disclosures, at least without enormous regulatory efforts. Still, we believe that the potential benefits of integrating blockchain as the backbone of the current ESG rating process should be valued, despite potential challenges.

### **4.3.2 ESG for Blockchain Economy**

The above-discussed fundamental issue with ESG disclosure would be solved naturally if we were to apply the ESG framework entirely in the blockchain economy, where all financial activities are transparent and immutable. Therefore, as innovative as empowering the current ESG rating with blockchain, we think it would be more impactful and feasible to build an ESG framework tailored to the blockchain economy and its participants. The evolving blockchain space lacks research on sustainability. While the energy concerns for Bitcoin have been escalating, there is little research that has empirically measured its environmental impact, let alone the sustainability of blockchains in general. Jiang et al. (2021) conclude that “the annual energy consumption of the Bitcoin blockchain in China is expected to peak in 2024 at 296.59 Twh” if without intervention and generate the carbon emission equivalent to the emission of Qatar. Their results along with the lack of research in this area motivate our novel idea of developing a sustainability framework for the rapidly expanding blockchain space.

There is no doubt that the disruptive power of blockchain can revolutionize the world as we know, including areas like finance and art, etc. Its massive potential to create and innovate is yet to be fully unveiled. With a sustainability measurement framework, quantitative or qualitative, blockchain technology can advance even further. Hence, we will focus on designing a sustainability measurement for blockchains in the next phase of research.

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<sup>7</sup> Learn more about MSCI ESG Methodology at their [website](#)

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