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Sustainable finance: Predictive modeling of ESG indicators on Indian stock market

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ABSTRACT

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The global investment landscape has undergone a paradigm shift, focusing on Environmental, Social, and Governance (ESG) factors as the major determinants of financial sustainability in investment decisions worldwide. This study uses predictive modeling to analyze the complex link between ESG variables and investment decisions. Focusing on three key sectors: IT, FMCG, and BFS, the study adopts a predictive modeling approach, recognizing the distinct characteristics and challenges within each sector. The information depends on the data obtained from different places like ESG details, and previous financial performance pointers – EBITDA, EPS, ROE, and P/E for 2018 to 2022, inclusive of general investor behavior. We can do this by working with relevant sources of data together with machine learning methods which show what happens in the Indian market in terms of ESG influencing the market thus leading to sustainable investment outcomes. This article seeks to comprehend why investors may favor sustainability as opposed to their conventional monetary units.

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1. Introduction

Investments are no longer driven by traditional financial analysis alone since there has been awareness of Environmental Social Governance (ESG) worldwide (Dalal & Thaker, 2019). This consciousness alters how markets work globally and patterns of investment as well (Gawęda, 2022). According to De Souza et al. (2023), these ESG factors include measuring a company's environmental impact; social responsibility, or any other relevant factor such as corporate governance practices among others (Karlapudi & Reddy, 2022). This requires thinking beyond the balance sheet into what is known as Sustainable Finance – an approach that integrates non-financial considerations with financial analysis to evaluate whether an investment is viable over time and its effect on society at large (Al Amosh & Khatib, 2023). The Indian stock exchange is interesting because it brings together sustainable finance with the country's booming economy against a backdrop of ever-changing financial landscapes (Cunha et al., 2021; Le et al., 2023). Sustainable finance has resulted after taking into consideration the feedback from shareholders, corporations, governments, and Non-Governmental Organizations (NGOs) who recognize that there is a need to address global challenges. Consequently, ESG integration is becoming pervasive in financial markets globally as demand for sustainable investment products and strategies increases (Cerrato & Ferrando, 2020). As regards the Indian stock market, this is important, particularly for sustainable finance dynamics in developing countries. India's fast-

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paced economy and wide industrial base set it apart as being among those countries with conditions worth examining the connections between sustainability and financial markets (Pareek, 2022). The Indian market is made up of different modern and traditional industries that possess varying degrees of sustainability prospects (Varottil, 2024). The Indian economy provides a unique environment where many different market segments have cropped up within a short period; hence it can be used to determine how ESG indicators influence stock performance (Taliento et al., 2019; Chawla & Sharma, 2020).

In India's stock market, environmental factors have grown significantly as stakeholders realize that sustainability promotes long-term value creation, mitigates risks, and promotes ethical corporate behavior (Zhang, 2022). India is a fast-growing economy experiencing many environmental problems, including pollution, resource depletion, deforestation, and climate change. Its industrial base is also growing (Agarwal et al., 2023). Against this context, the Indian stock market's regulatory dynamics, company strategies, and investor views are significantly influenced by environmental factors (Monica, 2022; Sarkar, 2022). Due to industrialization, urbanization, and vehicle emissions, air and water pollution is one of India's most urgent environmental issues. Major Indian cities frequently have pollution levels over acceptable limits, which hurts public health, degrades the environment, and costs money. Investors increasingly consider environmental risks related to air and water pollution when assessing businesses engaged in highly polluting industries like manufacturing, power generation, and transportation. Businesses that perform poorly in the environmental arena risk regulatory attention, public outrage, and reputational harm, which can lower their stock values and make them less competitive in the market (Bernini, 2023). The Indian stock market considers climate change's effects on different economic sectors, which is a noteworthy environmental factor. Climate impact can potentially cause extreme weather, water scarcity, agricultural disruptions, and coastal erosion in India. Investors are becoming more aware of how exposed businesses are to climate risks, including transitional and physical hazards. Investors looking for sustainable investment options have a more favorable opinion of companies that proactively address climate risks by lowering carbon emissions, investing in renewable energy, and implementing climate adaptation strategies (Si, 2022).

Social aspects have become increasingly important in determining corporate behavior and investment decisions. This reflects the growing understanding of the significance of ethical business practices, stakeholder involvement, and social responsibility. India is a diversified country that is changing quickly. It faces many social issues, such as gender equality, labor rights, poverty, inequality, and access to healthcare and education. When making investment decisions, investors are increasingly looking at a company's social performance and influence on stakeholders such as consumers, employees, communities, and society (Latapi et al., 2019; Shaikh, 2022). Social factors about labor practices and workplace conditions hold significant importance in the Indian stock market, especially in manufacturing, textiles, and construction sectors. Investors closely examine a company's employment policies, including pay, hours worked, adherence to labor laws, and occupational health and safety standards, to evaluate the company's commitment to treating employees fairly and ethically. Investors looking for sustainable and ethical investment options are more likely to consider companies prioritizing employee well-being, diversity, inclusion, and talent development. Additionally, businesses with sound labor practices can better draw in and hold on to highly qualified employees, increase output, and cultivate a healthy workplace culture—all of which can improve stock prices and market performance (Davidescu, 2020). Corporate transparency, investor trust, and market integrity in the Indian stock market are all significantly influenced by governance factors. Transparency, accountability, and shareholder rights are the three main goals of the recent substantial improvements to India's corporate governance regulations. Board makeup, CEO compensation, audit quality, shareholder rights, and disclosure policies are important governance factors for investors to take into account. To evaluate the efficacy of supervision, risk management, and decision-making procedures, investors examine the governance structures and practices of organizations. This evaluation influences stock prices and investment decisions (Salehi, 2018).

In the Indian stock market, board independence and composition are two crucial aspects of governance. Investors prefer businesses with independent, diverse boards of directors with relevant experience, knowledge, and integrity in the industry. To protect shareholder interests and advance corporate responsibility, independent directors are essential in offering strategic direction, monitoring, and checks and balances on management decisions. Strong governance practices also increase a company's likelihood of implementing ethical standards, transparent procedures, and risk management systems that all work together to bolster investor trust, lower agency costs, and lessen risks associated with corporate governance. In the Indian stock market ecosystem, confidence, stability, and long-term sustainability depend on strong governance considerations (Garcia-Sanchez et al., 2015; Patel et al., 2015). Investors recognize that a company's commitment to sustainability and responsible business practices can significantly affect its long-term financial performance. As a result, ESG has evolved into a critical lens through which investors assess the potential of companies, impacting stock prices and influencing sustainable investment decisions (Zumente et al., 2021). In today's global investment landscape, ESG considerations have become integral to shaping the financial future while promoting ethical and responsible practices for making sustainable investment decisions (Ma, 2023). The impact and importance of ESG issues are examined in this study within the framework of the Indian stock market. It explores how ESG considerations impact investment decisions, financial performance, and corporate practices.

2. Key concepts and related works

ESG disclosure becomes even more important from a policy perspective as it becomes a key determinant of future financial success and risk mitigation tactics. Panel regression analysis covering 2011-2019 shows that ESG scores affect financial

performance metrics, albeit with time delays (Rupamanjari & Sandeep, 2023). Studies have indicated that companies possessing robust ESG credentials are frequently in a better position to reduce risks, improve the perception of their brand, and take advantage of new opportunities in developed countries such as the UK (Adrian, 2022). Zhou et al. (2022) understand that awareness is growing that ESG and CSR initiatives are less advanced in developing economies, where investors prioritize sustainability less in their portfolios than in developed markets. The lack of ESG awareness among Indian investors is a critical hurdle in the nascent ESG investing landscape. Additionally, the negative correlation between ESG indicators and stock returns during times of crisis emphasizes the significance of taking ESG variables into account. It shows how they may encourage more robust and sustainable investing strategies in developing nations such as India (Rao et al., 2023). Recently, the growing awareness of ESG indicators of companies has underscored the importance of being responsible for the social repercussions arising from their operations. Nevertheless, the investigation findings indicate that ESG screening has no appreciable impact on the organizations' risk profile or financial success indicator (Saxena & Singh, 2016). Hamdi et al. (2022) found multiple examples of a poor correlation between financial performance and sustainability. The authors find a negative correlation between CSR disclosure, ESG indices, and financial performance metrics. According to research findings, sustainable operations have no effect on volatility, and greater ESG ratings do not correlate with lower volatility levels. Contrary to expectations, there is little empirical evidence to support the claim that portfolios or companies with higher ESG scores typically outperform those with lower scores (Beloskar, 2023, Mahmut, 2022). According to Capelle-Blancard and Petit's (2019) research, stock prices are affected by ESG information only when it is unfavorable; good ESG information does not affect stock prices. ESG information will, however, induce investor reactions.

Chinese business research indicates a robust negative association, both statistically and economically significant, between ESG and stock prices (Feng et al., 2022). Using stock ownership and flow data from Chinese equity funds, researchers discovered a negative link between ESG performance and stock price fragility, implying that higher ESG performance reduces investor sensitivity to stock performance, lowering stock price fragility (Hu, 2023). Li (2022), looks at how the stock prices of Chinese listed firms fared during the COVID-19 outbreak and finds a strong positive association. ESG plays a critical role in crisis resilience and risk mitigation, with particularly strong effects seen in high-impact countries and in companies with inadequate human capital and a bad public image. Khan (2019) looks into how nonfinancial performance metrics, such as ESG measurements, and a company's financial success relate. These measures showed that ESG signals had inherent investment value by being able to forecast stock returns within a worldwide investable universe. Akkas (2023) discovered that the main factors influencing ESG performance in India are consumers and governmental laws. Conversely, poor data quality, inefficient human resources, and a dearth of corporate coordination are the primary barriers to ESG integration in Indian organizations. Saini (2022) employed regression analysis to investigate the impact of ESG risk on return on equity and return on assets within a sample of 57 Indian financial companies. The findings align with the stakeholder hypothesis, indicating a negative correlation between ESG risk and financial performance. De Souza et al. (2023) find that the performance of corporations in terms of sustainability is strengthened when ESG criteria are integrated and considered. Regression analysis is used in most articles in the sample under investigation, and company-level data is used in the analyses. Talento (2019) discovered that even though the individual ESG scores have no bearing, the distance from the industry average-normal numbers has a positive significance, which indirectly revisits the concept of competitive advantage in terms of sustainability. Responsible social, environmental, and governance practices are critical components of the modern firm's competitiveness. Supsermpol et al. (2023) employed a blend of statistical and machine-learning methodologies to evaluate the financial performance of stock market-listed companies, aiming to forecast their future financial performance. The result shows that the machine learning approach performs better than the statistical approach.

2.1 Objectives of the study

This study aims to explore the nuanced dynamics of sustainable finance within the context of the Indian stock market, with a specific focus on the IT, FMCG, and BFS sectors. The aim is to illustrate the extent to which sustainability variables affect investment decisions and market outcomes, thereby showcasing the predictive ability of ESG indicators on stock markets through the use of predictive modeling tools. Industry-specific perspectives will also be proposed based on our investigation, explaining various peculiarities and determinants that relate ESG to financial performance within each sector. The study seeks to achieve several main objectives.

➤ *To investigate the impact of Financial Performance Metrics and ESG scores on Stock Prices.*

This objective aims to determine how financial performance metrics and ESG scores affect stock prices. This is done through an assessment of the implications of conventional financial indicators and ESG issues on the valuation of tradable firms' shares. To review business financial indicators and ESG data, determine their effect on share prices, and establish if there are any relationships or trends between them; experts may use regression analysis among other statistical methods or machine learning algorithms for that matter. This objective also seeks to enlighten prospective shareholders and other well-wishers about the connection between earning money and sustainability in order to help them make informed decisions on investment locations.

➤ *To visualize and model Stock prices employing Python-based AI Predictive modeling.*

The main objective of Python-based AI predictive modeling for stock prices is to generate models that can predict future stock prices using the most advanced Artificial Intelligence (AI) algorithms existing today. This idea is to develop models that can learn from historical data about stock prices and other factors like economic indicators or corporate fundamentals. What these models do then is give an estimate about what could be expected as far as the value of stocks in future times and this helps people make better investment decisions based on their predictions. All this is done so that eventually more accurate forecasts can be made when it comes to investing in stocks by making use of Python tools powered by AI, with the hope being that they will result in a more enlightened approach towards investing which is backed up by information.

3. Hypothesis

H₀₁: *ESG score and financial performance metrics influence stock price.*

A quantitative research approach will be utilized to test the hypothesis that there exists a direct relationship between ESG scores and financial performance metrics in influencing stock price. First of all, five years' worth of historical ESG scores and financial data have been collected for companies in a sample. After taking into account other relevant factors, these characteristics were then assessed on their impact on the company's stock prices using multiple regression analysis. Ultimately, the examination of the data established whether or not ESG scores and financial success had a noteworthy impact on stock prices, supporting or contradicting the theory. Regression analysis using econometrics was used to determine how the stock prices of IT, FMCG, and BFS companies were affected by financial performance measurements and ESG scores.

H_{01a}: ESG score has an influence on stock price.

A sample of firms' stock prices and historical annual ESG scores are gathered. To determine the degree to which ESG scores affect stock prices, a regression analysis was performed while accounting for pertinent market and industry variables. The findings contributed to our growing understanding of the correlation between stock prices and ESG rankings.

4. Research Design

4.1 Data

The core source of data for this study comes from the Prowess database. The dataset encompasses the time frame from 2018 to 2022, and data is collected annually. Our research focuses on 57 publicly listed companies in the Indian market, specifically drawn from three distinct sectors: IT, FMCG, and BFS. Within our study, stock price is the dependent variable, while our independent variables encompass a range of financial performance metrics, including the ESG score (ESG), price-to-earnings ratio (P/E), Return on Equity (ROE), Earnings per Share (EPS), and Earnings before Interest, Tax, Depreciation, and Amortization (EBITDA). ESG scores are procured from the S&P Global website, while the remaining financial performance metrics are sourced from the Prowess database.

4.2 Measure of Variables

The stock price of the company, denominated in the local currency, represents the current valuation of its shares as determined by the market. It reflects investors' opinion of the firm's worth and is impacted by some variables, including market mood, industry dynamics, corporate performance, and economic circumstances. An organization's governance, social, and environmental performance is measured by its ESG score. Higher scores indicate better ESG performance, often composite scores calculated from various ESG indicators ranging from 0 to 100. A company's valuation is measured by the P/E, which provides information on how the company's earnings compare to the price of its shares and illustrates the price at which investors are ready to pay for every unit of the company's earnings. ROE is a measurement of profitability that shows net income as a percentage of shareholders' equity. This metric demonstrates how well a company uses money that shareholders have invested in it to generate profits. However, EPS shows what part of the profit has been allocated to each outstanding share of a company's common stock. On the other hand, EBITDA measures the profitability and efficiency of business before depreciation, amortization taxes, and interest. It is usually taken as an indication of the ability to conduct operations profitably; it often substitutes cash flow.

4.3 Model

A multiple regression model helps us understand how one or more independent variables affect the dependent variable. The method also allows for measuring the correlation between variables thus deepening the understanding of factors behind changes in dependent variables. Consequently, this is most helpful when making predictions or analyzing the effect of a particular factor(s) on target variables enabling evidence-based decisions within various fields such as marketing among others. The primary aims of this procedure are to predict the dependent variable and develop a multiple regression model shown below to ascertain whether there exists a relationship among several variables.

$$\text{Stock Price} = \alpha + \beta_1 \text{ESG} + \beta_2 \text{PE} + \beta_3 \text{ROE} + \beta_4 \text{EPS} + \beta_5 \text{EBITDA} + \zeta$$

where Stock Price is the dependent variable α is constant term ESG, PE, ROE, EPS, and EBITDA are independent variables while $\beta_1, \beta_2, \beta_3, \beta_4$ and β_5 are coefficients for independent variables, correspondingly.

5. Findings and interpretation

5.1 Descriptive statistics

The descriptive statistics for the variables of the studied Indian market are shown in the tables below. Key data for each variable are included in these tables. (Refer to Table 1,2,3)

Table 1
Descriptive statistics- IT sector

| Variables | Mean | Median | Standard deviation | Minimum | Maximum |
|-----------|---------|---------|--------------------|---------|---------|
| ESG | 42.03 | 42 | 29.79 | 0 | 89 |
| EBITDA | 9465.67 | 2920.16 | 12190.01 | 60.08 | 57075 |
| EPS | 82.73 | 60.05 | 97.65 | 0.24 | 555.88 |
| ROE | 22.05 | 22.03 | 7.18 | 0.96 | 42.99 |
| P/E | 36.89 | 24.15 | 30.94 | 3.31 | 209.58 |

As shown in Table 1, the mean and median ESG scores of the IT Sector are 42.03 and 42, respectively, and this sector has the highest ESG score of 89. Financial performance metrics statistics suggest that, on average, companies in the IT sector in India have positive EBITDA and EPS, indicating profitability. The ROE figures also show a decent average return on equity, and the P/E values indicate varying levels of investor confidence with a wide range of valuations. It is important to note that the maximum values for some variables are significantly higher than the mean, indicating potential outliers or highly performing companies within the sector.

Table 2
Descriptive statistics- FMCG sector

| Variables | Mean | Median | Standard deviation | Minimum | Maximum |
|-----------|---------|---------|--------------------|---------|----------|
| ESG | 25.67 | 17 | 21.39 | 0 | 76 |
| EBITDA | 2730.14 | 1204.62 | 4655.48 | 235.97 | 21760.86 |
| EPS | 42.21 | 9.83 | 88.27 | -7.81 | 481.03 |
| ROE | 27.48 | 21.61 | 24.75 | -25.43 | 103.12 |
| P/E | 55.24 | 46.08 | 63.62 | -182.74 | 428.02 |

According to the data in the table above, FMCG companies in this sector on average have moderate ESG scores. However, some are scored higher than others in terms of their ESG performance. This knowledge is highly significant for investors and stakeholders who wish to examine the sustainability and corporate responsibility practices at FMCG. The statistics indicate that the Indian FMCG sector shows remarkable heterogeneity in financial and market performance among the selected firms. Thus, it is evident when it comes to earnings (EBITDA and EPS), profitability (ROE), market valuation (P/E) as well as stock prices. It is well-known that standard deviations are high showing wide ranges of values, especially suggesting that there exist differences in firms' profitability or value among FMCGs.

Table 3
Descriptive statistics- BFS sector

| Variables | Mean | Median | Standard deviation | Minimum | Maximum |
|-----------|---------|---------|--------------------|----------|---------|
| ESG | 29.65 | 21 | 19.24 | 0 | 72 |
| EBITDA | 6852.23 | 3201.23 | 12497.02 | -20496.3 | 53429.9 |
| EPS | 30.31 | 18.3 | 37.14 | -59.4 | 116.67 |
| ROE | 8.42 | 11.88 | 12.73 | -75.74 | 26.52 |
| P/E | 24.81 | 15.58 | 45.42 | -46.8 | 394.1 |

According to Table 3, the BFS Sector's ESG data shows a mean score of 29.65, a maximum score of 72, and a standard deviation of 19.24. This indicates that the investigated companies' ESG performance varied, with some getting better scores than the norm and others falling below it. This variation illustrates the range in ESG commitment and performance among these organizations and suggests variations in environmental, social, and governance activities. The wide range of values and substantial variability in financial metrics within the BFS sector implies that individual companies may have different financial performance and valuation characteristics. This diversity could be attributed to varying business strategies, market conditions, and economic factors. Consequently, investors and analysts should exercise caution, thoroughly assess the sector's prospects, and consider a diversified approach to minimize risks and maximize potential returns.

5.2 Influence of ESG score and Financial performance metrics on stock price

The data provided in Table 4 presents the analysis on the relationship between ESG and various financial metrics with stock prices in three sectors: IT, FMCG, and BFS. The p-values signify the statistical significance of these relationships. In the

FMCG and BFS sectors, ESG demonstrates a weak influence on stock prices, compared with the IT sector, as indicated by relatively high p-values in the FMCG and BFS sectors. Similarly, EBITDA and PE Ratio also display weak connections with stock prices in all sectors, given their high p-values. However, EPS exhibits a robust and highly significant influence on stock prices across all sectors, and ROE exhibits a highly significant influence on stock prices in both IT and FMCG sectors, indicated by extremely low p-values. (Refer to Table 4)

Table 4
Consolidated sector-wise P-value and significance

| Variables | Sector-wise P-value | | |
|-----------------------|---------------------|--------------|--------------|
| | IT | FMCG | BFS |
| ESG | 0.092 | 0.732 | 0.921 |
| EBITDA | 0.072 | 0.802 | 0.829 |
| EPS | 0.000 | 0.000 | 0.000 |
| ROE | 0.000 | 0.013 | 0.296 |
| P/E | 0.128 | 0.327 | 0.131 |
| Significance F | 0.000 | 0.000 | 0.000 |

An association between ESG scores and stock prices is greater but still statistically insignificant when the p-values and mean ESG scores for each of the three sectors are compared. The lowest p-value is shown by the industry with the highest mean ESG score (IT). ESG scores and stock prices do not statistically significantly correlate, as seen by the sector with the lowest mean ESG score (FMCG), which also has the highest p-value. The intermediate mean ESG score in the BFS sector is associated with a moderately high p-value, suggesting a relatively weak and non-significant connection. The overall results show that the extremely low p-values for Significance F in all sectors indicate that H_01 can be accepted because the independent variables (EPS, ROE) have a statistically significant impact on stock prices in these sectors, even though a higher mean ESG score appears to correspond with a lower p-value.

5.3 Influence of ESG score on Stock price

Table 5
ESG score on stock price

| Sector | Year-wise ESG P-value | | | | |
|--------|-----------------------|-------|-------|-------|-------|
| | 2018 | 2019 | 2020 | 2021 | 2022 |
| IT | 0.714 | 0.631 | 0.486 | 0.426 | 0.175 |
| FMCG | 0.289 | 0.136 | 0.910 | 0.058 | 0.012 |
| BFS | 0.922 | 0.446 | 0.362 | 0.552 | 0.275 |

According to Table 5, In the IT sector, the consistently high p-values exceeding 0.05 indicate that H_01a is unsupported. This suggests a lack of statistically significant evidence for a relationship between ESG scores and stock prices over time. In the BFS sector, the p-values fluctuate but generally remain above the 0.05 threshold. This indicates a rejection of H_01a and suggests no statistically significant relationship between ESG factors and stock prices during the observed period. In the FMCG sector, the p-values vary widely across the years. From 2018 to 2021, the p-values are above 0.05, indicating no significant influence being H_01a is rejected. But in 2022, the p-value is incredibly low (0.012), indicating that H_01a is accepted and that stock prices and ESG ratings have a substantial relationship in that year.

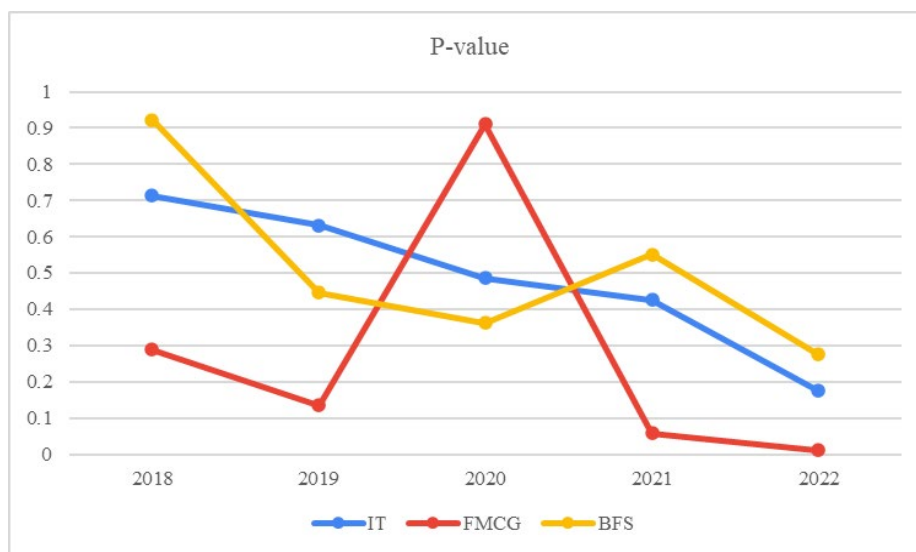
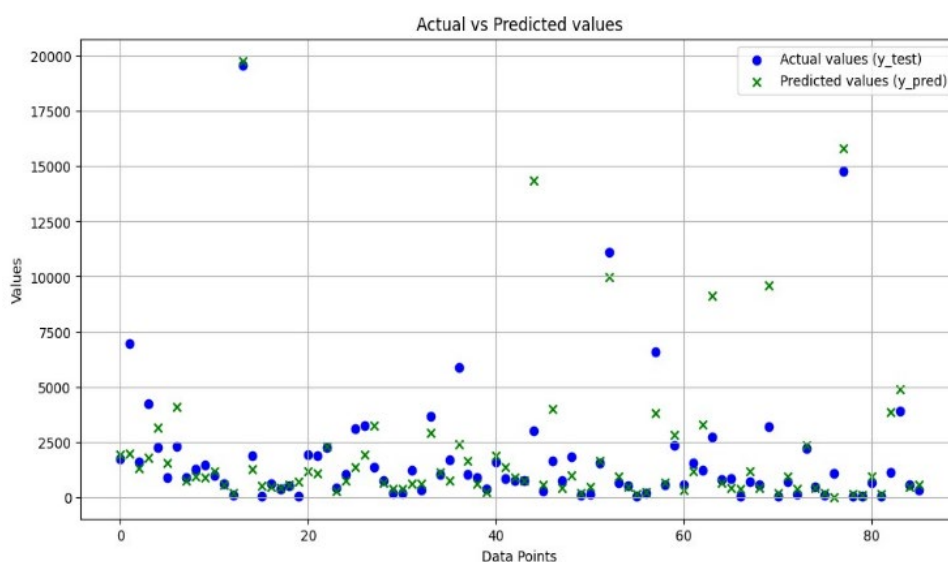


Fig. 1. Decreasing trend of the p-value of ESG scores on stock price

According to Fig. 1, a decreasing trend in p-values over the years suggests that the influence between ESG scores and stock prices in all sectors is becoming increasingly statistically significant. This means that over time, these sectors may observe more observable and consistent impacts of ESG scores on stock prices. Nevertheless, one has to be very careful while interpreting these tendencies and bear in mind other factors that also influence the results before drawing valid conclusions about the relationship between ESG and stock prices.

5.4 Stock price prediction using AI-predictive modeling

This AI-based Python predictive modeling model aims to predict stock prices for the year 2023 using data from IT, FMCG, and BFS companies. In this model, the key variables are classified as independent variables – ESG scores, EBITDA, EPS, ROE, and P/E. This is shown by historical stock price data up to 2022. Additionally, it plots a scatter plot that shows where data points are placed to see actual stock price data placement as well as predicted results till 2022 generated by the model (See Fig. 2). An Artificial Neural Network approach was utilized in developing this forecasting model. When given independent variable values such as ESG, EBITDA, EPS, ROE, and P/E ratios, etc., this model can be used to forecast for the year 2023. Fundamentally, the study has applied a portion of different monetary techniques that involve non-financial indicators to make predictions regarding upcoming share prices. This research therefore has implications for investors or financial analysts who want deep insights into how businesses perform within these sectors of specialization concerning their stocks' performance. Thus, it establishes that AI and predictive modeling can help decision-making based on data for making proper choices on investments in shares while emphasizing on significance of those variables identified as impacting the price movement of shares.

**Fig. 2.** Scatter plot: Actual vs. Predicted values

6. Conclusion

In essence, the research showed that for the calendar year 2018–2022, there is no discernible relationship between ESG indicators and stock prices in the Indian Stock market. However, an emerging trend shows that ESG factors have been growing steadily over time. This gradual rise in ESG relevance to stock prices indicates that these are becoming increasingly important to investors and might begin playing a prominent role in future sustainable investment decisions. One should recall that this observed trend may be influenced by several issues such as changing investor preferences, legal modifications, or an improved understanding of ESG principles. As the market becomes more aware of ethical and sustainable corporate practices, sustainability considerations will make it even more important when making sustainable investment decisions. However, there are challenges including a lack of knowledge about ESG among Indian shareholders which could stop the immediate effects on stock prices. On top of that, data fluctuations especially during external shocks such as the COVID-19 pandemic can impact on reliability and robustness of ESG-related data. The use of Artificial Neural Networks in the study reflects how much a data-driven approach holds promise for stock price prediction thereby giving insights to investors, financial analysts, and sector-specific enterprises. Model assessment can be enhanced using scatter plot visualization. Moreover, more accurate models and wider-ranging predictions can be investigated by further studies within the financial forecasting field particularly through model accuracy refinement and incorporation of more variables.

The implications from this reveal how much companies' practices are changing about environmental protection (ESG) in India's stock market. Despite having a slow effect on stock prices though, its increasing intensity demonstrates why ESG

factors must be part of investment plans as well as business processes. These two steps would therefore pave the way for solidifying ESG influence in shaping sustainable investment decisions within the Indian context because without any awareness among investors or reliable data; these aforementioned principles cannot ensure the desired results here.

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