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The Importance of ESG Integration for Financial Stability: A Study of Energy-Intensive Companies in Saudi Arabia

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Abstract: This study assesses the financial strength and ESG (Environmental, Social, and Governance) commitments of a selected group of energy-intensive companies listed on the Saudi Stock Exchange (Tadawul). Altman's Z-score is employed to identify firms with minimal or no bankruptcy risk. ESG-related activities are evaluated through a manual review of each company's annual board reports, in accordance with the guidelines issued by the Saudi Capital Market Authority (CMA). We utilize human experience and AI applications to search board annual reports for companies under analysis. We identify and score ESG activities under each factor. The results indicate a weak positive correlation between financial stability and ESG integration. We used visual inspection, Spearman's correlation, and robust checks to understand this relationship better. Based on further investigation, we apply a scatter plot to visualize the relationship, which illustrates clusters rather than a distinctive correlation pattern. As a result, we apply hierarchal clustering analysis that suggests three different data clusters that we could link to the company's efforts for financial stability and ESG integration. These findings provide valuable insights for investors and risk managers in evaluating risk-return trade-offs. Moreover, the results can support policymakers and stakeholders in formulating environmentally responsible, sustainable strategies by introducing effective regulatory frameworks and fostering public trust.
Keywords: energy sector, environment, financial, governance, hierarchical clustering, social.

أهمية تكامل المعايير البيئية والاجتماعية والحوكمة لتحقيق الاستقرار المالي: دراسة للشركات السعودية كثيفة الاستهلاك للطاقة

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المستخلص: تُقيّم هذه الدراسة الوضع المالي، ومدى علاقته بالالتزام بمعايير البيئة والمجتمع والحوكمة (ESG) في عددٍ من الشركات المدرجة ضمن القطاعات كثيفة الاستهلاك للطاقة بسوق الأسهم السعودي (تداول)، وقد تم استخدام نموذج "ألتمن Z-Score" لتحديد الشركات الأقل عرضة للإفلاس، كما تم قياس الالتزام بالمعايير المعتمدة من هيئة السوق المالية من خلال تحليل تقارير مجالس الإدارات باستخدام مزيج من الخبرة البشرية وتقنيات الذكاء الاصطناعي، مع تصنيف الأنشطة والمبادرات المرتبطة بمعايير أعلاه، وقد أظهرت النتائج عبر التحليل البصري، ومعامل ارتباط سبيرمان، واختبار النشاط، وجود علاقة طردية ضعيفة. ولتفسير طبيعة العلاقة بعمق، تم استخدام مخطط الانتشار، الذي كشف عن تجمعات بدلاً من علاقة خطية؛ مما أتاح تطبيق نموذج تحليل هرمي بيّن انقسام العينة إلى ثلاث مجموعات، وفقًا لدرجات السعي نحو الاستقرار المالي والالتزام البيئي. تشير النتائج إلى أن الالتزام بمعايير ESG قد يرتبط بأنماط متباينة من الأداء المالي، ما يساعد المستثمرين، ومديري المخاطر، على فهم العلاقة بين العائد والمخاطر، ويدعم صانعي السياسات في تعزيز الممارسات المستدامة، وبناء الثقة المجتمعية.
الكلمات المفتاحية: قطاع الطاقة، بيئة، مالية، حوكمة، تحليل هرمي، اجتماعي.

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1. Introduction

Many investors and stakeholders now expect corporate performance to extend beyond traditional financial results, placing increasing emphasis on long-term environmental, social, and governance (ESG) goals. While corporate social responsibility (CSR) is a well-established concept among publicly traded companies and often considered a subset of the broader ESG framework, the full integration of ESG factors into corporate strategy and operations remains limited. Despite ongoing skepticism among some executives regarding the tangible benefits of ESG adoption, the potential for positive, transformative impact is becoming increasingly evident. In the 2019 annual meeting of Berkshire Hathaway, legendary investor Warren Buffet expressed his view on ESG, "We'll Never Waste Time and Money on ESG Reporting." However, many stockholders and stakeholders increasingly value plans and decisions regarding long-term sustainability. For instance, in recent years, Larry Fink, Chairman and CEO of BlackRock, the world's largest asset manager, stated that the ESG matrix would play a significant role in valuing a company, thereby underlining the crucial role of ESG in corporate valuation. BlackRock is embracing transition investing and focusing on transitioning to a low-carbon economy[1]. Given the investment community's increasing awareness, we observe the growing significance of ESG in the financial world, a trend that our research aims to analyze. We assess the financial strength and ESG commitment of a selected group of energy-intensive companies listed on the Saudi Stock Exchange by estimating each company's financial stability and ESG scores.

This analysis is particularly relevant in the context of energy-intensive companies, where the intersection of financial stability and ESG integration is becoming increasingly critical. The transition to a low-carbon economy refers to the global shift towards reducing carbon emissions and adopting sustainable energy practices and consumptions. This growing trend of ESG integration is becoming more urgent, emphasizing the need for companies to adapt to this change and gain the potential benefits of a more sustainable financial future, such as improved brand reputation, reduced risk, and increased investor interest. Our research aims to uncover the tangible benefits of ESG integration, offering reassurance to investors, risk managers, policymakers, and other stakeholders regarding the value of investing in ESG-oriented firms. It also encourages broader ESG adoption across industries.

The energy sector serves as a prime example of how businesses must focus on the collective expectations of stakeholders to guide future projects. With the global shift toward green and renewable energy, energy-intensive firms are under increasing pressure to integrate ESG factors into their strategic planning. As a result, these companies must assess and forecast the impact of ESG integration on their long-term financial health. The trend toward green and renewable energy is not just a passing phenomenon but a global movement driven by growing awareness and concerns about climate change and the need for sustainable energy solutions. This movement presents an opportunity for energy companies to be part of a more significant, positive change and contribute to a more sustainable future. For instance, traditional project-based financing models may soon be supplanted by mechanisms such as energy performance contracts (EPCs), which promote investments in energy efficiency (Ning et al 2023).

As a newly developed financing mechanism, green finance serves, in addition to its financing role, as an additional means of diversification to an investment portfolio. Hence, a class of assets attracts impacts-seeking investors and a growing number of traditional investors. They would be keen to tap into a new class of assets with a unique set of unsystematic risks to offset other traditional unsystematic risks. The urgency of this global movement is visible, and companies need to act swiftly to adapt. International investors have committed billions of dollars to investments in green and low-carbon initiatives announced in recent years. The alignment of financial portfolios with targeted and sustainable goals, consisting of buying and holding green assets and selling brown assets[2], aligns with the European Union (EU) Sustainable Finance Taxonomy and Sustainable Finance Action Plan (Caldecott et al., 2024).

[1] *https://www.blackrock.com/sg/en/investment-strategies/sustainable-transition-investing.*
[2] *Brown assets: Investment that could potentially be harmful to the empowerment.*

The successful implementation of green finance projects such as concessional loans, green bonds, Energy Saving Insurance (ESI), contingent grants, and performance contracts heavily relies on the role of financial intermediaries. These intermediaries are crucial in developing, underwriting, and marketing financial products/arrangements that accommodate a business's long-term sustainable financial needs. They also need to evaluate and mitigate expected risks within the venture. Given that green energy projects operate in an environment with particular risks and expectations, financial intermediaries must alter the risk and reward paradox accordingly to account more accurately for these risks. Grishunin et al. (2023) specify that the top three most severe risks expected globally are environment-related: climate action failure, extreme weather, and biodiversity loss. This function of risk adjustment underscores the vital role of financial intermediaries in achieving long-term sustainability, providing a solid support system for these ventures, and reassuring stakeholders about the sustainability of these projects.

For companies to participate in green finance, several criteria and conditions must be met (e.g., successfully launching a green bond). The International Finance Corporation (IFC) has developed a green bond issuing framework for issuing social, sustainability, and sustainability-linked bonds. The framework consists of four principles: 1) Use of Proceeds, 2) Project Evaluation and Selection, 3) Management of Proceeds, and 4) Reporting. It also emphasizes the role of external examiners and evaluators in ensuring long-term sustainability throughout the life of the green-financed project. Although these principles are voluntary, 95% of global issuers apply them (see page 5 of the referenced report). The international trend can be recognized by the share numbers and performance of multi-national indexes, as shown in Table 1.

Table 1: Multi-national indexes and their respected annual performance as of July 29, 2024:

Index	Target	Performance (%)
Bloomberg Barclays MSCI Green Bond Index	Fixed-income securities issued to fund projects of direct environmental benefits	4.5
S&P Green Bond Select Index	Global green bonds.	3.8
Solactive Green Bond Index	Green bonds that meet specific criteria	4.2
MSCI Global Bond Index	Global green bonds issued by sovereign, quasi-sovereign, and corporate issuers	4.0
Source: Bloomberg Professional Services		

Nationally, and in alignment with Saudi Arabia's Vision 2030, the Saudi Ministry of Finance has taken a significant step by issuing a Green Financing Framework. This framework, developed following the Green Bond Principles of the IFC, highlights the Saudi government's commitment to sustainable finance. It consists of the four abovementioned principles and a fifth External Review principle. Notably, it specified that these principles also apply to issuing Sukuk, a bond-like financial instrument aligned with Islamic principles. The Saudi Capital Market Authority (CMA) launched the Sukuk/Bonds Market index on June 19, 2011. As of July 29, 2024, the index closed at 895.59 points, and the Sukuk issuance by the end of 2023 amounted to SAR 758.8 billion, equivalent to US$ 202.34 billion. The Saudi Stock Exchange has also launched two specialized indexes: the Corporate Sukuk/Bonds Index and the Government Sukuk /Bond Index. Internationally, On the international front, in September 2021, FTSE Russell announced the inclusion of the local currency Saudi Arabian government Sukuk, in the FTSE Emerging Markets Government Bond Index (EMGBI)[3].

In a 2023 report, the International Renewable Energy Agency (IRENA) estimates that energy infrastructure investment that would contribute to achieving the target of limiting global temperature increase to below 1.5 degrees, as specified by the Paris Climate Agreement, would reach US$ 150 trillion for the period from 2023-2050. Furthermore, investments must exceed US$ 5 trillion annually

[3] *Ministry of Finance, Saudi Arabia and Tadawul.*

between 2023 and 2030 to meet the expected target[4]. Thus, major international stock exchanges have launched trading on green finance products. Table 2 lists international financial markets that list and trade green financial products and the launching date for each.

Table 2: Global Stock Exchanges that have launched sections of green or sustainable bonds

Name of Stock Exchange	Type of Dedicated Section	Launch Date
Oslo Stock Exchange	Green bonds	2015-01-01
Stockholm Stock Exchange	Sustainable bonds	2015-06-01
London Stock Exchange	Green bonds	2015-07-01
Shanghai Stock Exchange	Green bonds	2016-03-01
Mexico Stock Exchange	Green Bond	2016-08-01
Luxembourg Stock Exchange	Luxembourg Green Exchange	2016-09-01
Borsa Italiana	Borsa Italiana	2017-03-01
Taipei Exchange	Sustainable bonds	2017-05-01
Johannesburg Stock Exchange	Green bonds	2017-10-01
Japan Exchange Group	Green and Social bonds	2018-01-01
Vienna Exchange	Green and Social bonds	2018-03-01
Nasdaq (Multiple stock exchanges	Sustainable bonds	2018-05-01
Swiss Stock Exchange	Green and Sustainability bonds	2018-07-01
The International Stock Exchange	Sustainable bonds	2018-11-01
Frankfurt Stock Exchange	Green bonds	2018-11-01
Santiago Stock Exchange	Green and social bonds	2019-07-01
Euronext (Multiple stock exchanges)	Green, Sustainable, and Social bonds	2019-11-01
Bombay Stock Exchange	Green bonds	2019-06-01
Argentina Stock Exchange BYMA	Green, Sustainable, and Social bonds	2019-07-01
Brazil Stock Exchange	Green bond	2019-06-01
Nigerian Stock Exchange	Sustainable bonds	2019-10-01
Hong Kong Exchange	Green, Sustainable, and Social bonds	2020-06-01
Korea Exchange	Green, Sustainable, and Social bonds	2020-06-01
Toronto Stock Exchange	Sustainable bonds	2020-11-01
Singapore Stock Exchange	Green, Sustainable, and Social bonds	2020-06-01
Bolsas y Mercados Espaȯles (BME)	Green, Sustainable, and Social bonds	2022-11-01
Astana International Exchange (AIX)	ESG bonds	2022-12-01
	Source: Climate Bonds Initiative	

As of 2023, the global green debt issuance market reached a record high of US$870 billion, with the potential to grow strongly in 2024. This growth is a testament to the increasing importance

[4] *The Global Landscape of Renewable Energy Finance, IRENA, 2023.*

and potential of green finance in the global market, providing a promising outlook for the future of sustainable finance. Grishunin et al. (2023) estimate that financial institutions account for 45% of green issues, followed by utilities and industrials, with 30% and 10%, respectively. In terms of countries issuing green bonds, China is in the first place, issuing almost US$ 85 billion, followed by Germany and the US, issuing US$ 68 and US$ 60 billion, respectively.

Emerging markets also have seen an unprecedented %45 growth in green, social, sustainability, and sustainability-linked (GSSS) bonds to a record high of US$ 209 billion. GSSS bonds fund projects with a positive social or environmental impact and are regularly re-evaluated to ensure meeting these intended targets. In the case of the GCC countries, we can group green debt issuance into the following two categories: First is sovereign bond issuance, in which Saudi Arabia has a considerable lead in green bond issuance. As of the end of 2023, Saudi Arabia issued US$ 16 billion, followed by the UAE, which raised over US$ 3.6 billion. Next, Qatar and Bahrain issued US$ 2.5 and US$ 2 billion each. Second is corporate bond ESG-related issuance, which reached US$ 14.7 billion. The leading issuer is the Saudi Public Investment Fund (PIF), which totaled US$ 9 billion—followed by Masdar, Abu Dhabi's clean energy company, which raised US$1 billion[5].

Energy investment is expected to surpass US$ 3 trillion globally by the end of 2024, with about US$ 2 trillion projected toward clean energy investment. In Saudi Arabia, energy investment is expected to exceed US$ 175 billion by the end of 2024, with increasing funding demand for clean energy projects[6]. Such high demand for funding and investment puts Saudi energy-related companies under increasing pressure to be financially and technically well-equipped to contribute to achieving several ambitious Saudi Vision 2030 goals. These goals include specific targets such as achieving net zero emissions, protecting land by planting 600 million trees, and using renewable energy to produce 50% of local energy needs. In addition, the energy-intensive industries are significant participants in four critical programs of the vision: Saudi Green Initiative (SGI), National Industry Development and Logistics Program, Renewable Energy Projects, and Technological and Economic Strategies.

The study assesses the financial strength and ESG commitments of a selected group of energy-intensive companies listed on the Saudi Stock Exchange (Tadawul). The companies are selected based on the specifications issued by EU Energy-intensive industries' Masterplan of Competitive Transformation[7]. According to the masterplan plan, energy-intensive industries are characterized by high energy consumption, significant carbon emissions, infrastructure dependency, technological pathways for reduction, global competitive pressure, long-term investment, and Circular Economy Integration. Hence, the masterplan has identified 33 industries as energy-intensive. To compile our sample, we cross-reference these industries to their counterparts in the Saudi Stock Exchange.

We apply the Altman (1968) Z-score to measure the financial health of 63 publicly traded Saudi companies across six energy-related sectors. Next, we utilize human/AI interaction to measure the ESG-related rating by reviewing these companies' board annual reports. Our sample of companies is classified as follows: Energy sector: 7 companies, Materials/Industrial: 18 companies, Materials/Petrochemical: 11 companies, Materials/Cement: 14 companies, Transportation: 7 companies, and Utilities: 6 companies. Our data set consists of companies' financial statements for the last four years (2020 - 2021- 2022- 2023). The Altman Z-score helps us assess the financial stability of these companies by answering the question of whether a particular company is facing financial distress or not. At the same time, the ESG-related rating provides insights into their commitment to environmental, social, and governance principles. We organized the remainder of the paper: Section 2 provides a literature review. Section 3 introduces the methodology, including model specifications, and states hypotheses. Section 4 provides results and discussion. Finally, section 5 presents the conclusion and future research recommendations.

[5] *Sources: Abu Dhabi Commercial Bank and Qatar National Bank*
[6] *Source: International Energy Association, www.iea.org*
[7] *Report by the High-Level Group on Energy-intensive Industries, European Union, 2019*

2. Literature review

A growing body of literature has investigated the interplay between ESG practices and corporate financial performance, highlighting how sustainability efforts can affect both operational efficiency and financial resilience. Researchers across various sectors and regions have employed varied methodologies to evaluate how ESG integration affects investment decisions, firm value, and risk management. The following studies provide insights into how ESG considerations are increasingly shaping financial strategies and outcomes.

Iazzolino et al. (2023) explore the influence of ESG factors on companies' financial efficiency across several European sectors by applying Data Envelopment Analysis (DEA). Results suggest ESG factors are affecting financial efficiency across different sectors. Furthermore, the study gives potential investors insights into constructing efficient and sustainable portfolios. Lisian et al. (2022) studied the impact of ESG-related policies on the financial performance of 691 companies in North America. They apply regression models and the Pearson correlation coefficients.

MacNeil and Esser (2022) examine how ESG investing evolved from Corporate Social Responsibility (CSR). The main idea investigated is that the risk and return business model has limitations. Thus, they propose an alternative "entity" model to emphasize corporate governance and board decision-making in promoting sustainability. They argue that investors' focus, through capital allocation, has shifted from ethical responsibility to financial performance.

Lupu et al. (2024) examine the impact of ESG factors on the financial stability of several European banks using a cross-quantilogram statistical method. They explore the dependencies of various distribution levels of ESG scores on financial stability measures such as Marginal Expected Shortfall (MES) and Value-at-risk (Var). the study reveals a significant but varied impact of ESG components on financial resilience.

Ben Abdallah, S. (2020) investigates the relationship between sustainability practices and financial stability in 61 European banks using a panel vector autoregressive (PVAR) model and a Granger causality test. The results indicate the possible existence of a bidirectional causality between sustainability and bank stability. It shows that sustainability positively impacts banks' stability but not vice versa.

Several recent studies have focused on ESG practices and financial sustainability within the Saudi market, reflecting the region's growing interest in aligning with global sustainability standards. Almubarak et al. (2023) examine the relationship between ESG corporate practices and financial sustainability in local companies. They examine how companies reformed governance during the COVID-19 pandemic and its influence on this relationship.

By using publicly available historical prices from the Saudi Stock Exchange, which spans 2013 and 2021, the study found a positive relationship between financial sustainability and ESG disclosure. Chebbi et al. (2022) examine the association between board composition (i.e., terms of size, gender, and independence) and ESG disclosure. It suggests that board size and independence positively impact ESG disclosure.

On the other hand, gender diversity has a positive but insignificant relationship with ESG disclosure. Qasem et al. (2024) examine the relationship between institutional investors' ownership and its impact on the ESG reporting of 206 publicly listed Saudi companies. The study applies ordinary least squares regression (OLS) on data spans from 2010 to 2019. It finds a positive relationship between intuitional ownership and ESG reporting. Furthermore, the significance of this relationship varies with each of the three pillars of ESG. Conversely, they found no significant positive relationship between private ownership and ESG reporting.

In the context of financial development within the GCC countries, several recent studies have examined the interplay between environmental factors and financial systems. Hasanov et al. (2023) utilized a panel data time series analysis to investigate the effects of carbon emissions, alongside other economic factors, on financial development. They conclude that the authorities in the GCC countries should jointly work on climate initiatives to boost financial development. Studies are not limited to empirical analysis; in a comprehensive literature review and semi-structured interviews,

Alhejaili (2024) examines the integration of climate change risk and sustainable goals in the Saudi financial markets. He identified several mechanisms for promoting sustainability in the Saudi financial sector. Radhi et al. (2024) examine the transformative impact of ESG disclosures on conventional and Islamic banks' financial and operational performance in GCC countries. By conducting literature reviews, they can identify the complex relationship between ESG disclosures and financial performance, indicating that some banks negatively impact while others positively correlate.

This study contributes to the growing body of literature on ESG integration by exploring its impact on corporate financial performance and long-term sustainability. Specifically, it examines the relationship between financial stability and ESG factor integration in a sample of 63 Saudi energy-intensive companies. We measure financial stability using the Altman Z-score. On the other hand, given that most of the companies under study have yet to publish ESG reports formally, and only a handful of ESG reports and sections appear in annual board reports, we utilize a human/AI technology approach. We apply this human/AI interaction to search and rate ESG-related initiatives and programs for each company. To our knowledge, this is the first study to apply a human-AI interaction model to assess ESG integration within the context of the Saudi market. By generating ESG scores through empirical analysis of publicly available data, this research enhances our understanding of how both financially stable and unstable companies are engaging with ESG principles. The findings offer valuable insights for investors, policymakers, and corporate leaders aiming to evaluate sustainability practices within the framework of financial resilience.

3. Methodology

This section outlines the methodological approach employed to examine the relationship between financial stability and ESG integration in Saudi energy-intensive companies. Our goal is to estimate whether there is a correlation between the two scores or not. We state that financially stable firms' management and corporate culture are more likely to integrate ESG factors in their strategic planning and operational activities. In other words, we are testing the null hypothesis that there is no significant correlation between financial stability (i.e., measured by Z-score) and the integration of ESG factors:

H0: ESG integration is not correlated with the firm's financial stability

Ha: ESG integration is correlated with the firm's financial stability

We identify companies with high Z-scores and ESG-related scores, which suggest higher chances of successfully obtaining green finance funds. Combining Z-score and ESG-related scores would provide empirical evidence of the degree of correlation between financial stability and environmental, social, and governance factors. Therefore, we divide our study into three stages. First, by reviewing financial statements, we obtain the Z-score of 63 energy-intensive companies using Altman's Z-score. The Z-score has eight inputs: Total Assets, Total Liabilities, Current Assets, Current Liabilities, EBIT, Retained Earnings, Net Sales, and Market capitalization. Altman (1968) states the Z-score equation as follows:

$$Altman\ Z\text{-}score = 1.2a + 1.4b + 3.3c + 0.6d + 0.99e \qquad (1)$$

a = Working capital / Total Assets

b = Returned Earning / Total Assets

c = Earnings Before Interest and Taxes (EBIT) / Total Assets

d = Market Value of Equity / Total Assets

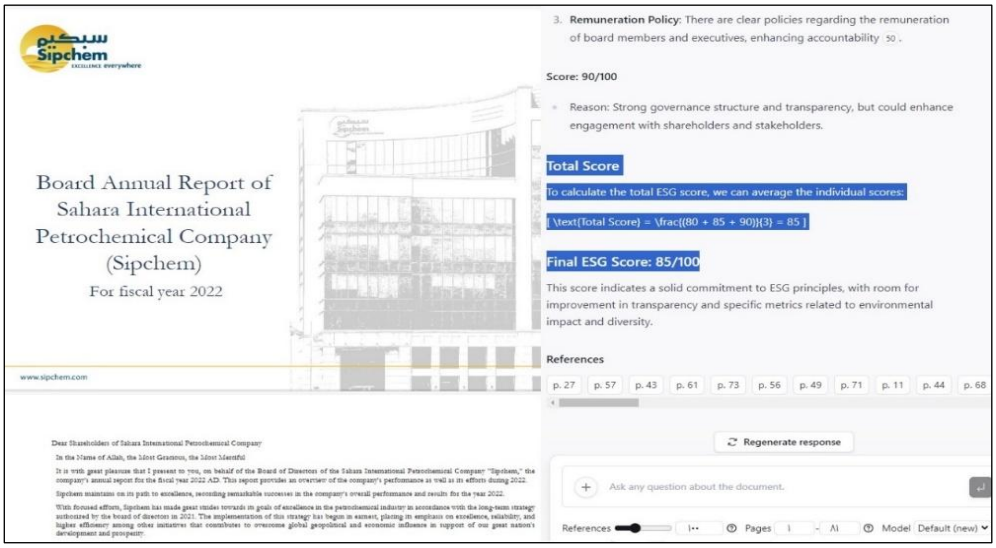
e = Sales / Total Assets

Second, through a partnership with the UN Sustainable Stock Exchange Initiatives, CMA has issued ESG Disclosure Guidelines to help issuers (and underwriters) navigate through promoting the ESG framework and its impact on sustainable investment. For the most part, listed companies still

need to do better in publishing ESG reports on the Saudi Stock Exchange website. They may need help adopting and integrating ESG, mainly concerning data availability, resource constraints, and sector-specific factors. Nevertheless, by reviewing annual board reports, we could still find initiatives and programs and categorize them into one or more ESG factors. We have encountered several professional ESG rating agencies, but they cover only major Saudi companies. As a result, to avoid any bias in treatment, we disregard external ratings for major companies in our sample and rely on human/AI interaction to subject all companies to the exact steps of analysis and treatment.

To ensure the accuracy and relevance of ESG-related activities, we reviewed outputs generated by AI applications in alignment with internationally recognized standards, specifically the MSCI ESG Ratings and the Sustainability Accounting Standards Board (SASB) frameworks.[8] Once we establish a company's financial strength, we identify its level of ESG commitment through joint hybrid efforts between human expertise and AI applications. We start by developing an evaluation form for each company, consisting of the company's name, Tadawul's trading symbol, industry, and sector. Then, we divide the evaluation form into four columns corresponding to 2020 to 2023. In each column, we specify three sections representing ESG's three pillars. Finally, we manually review annual reports for our sample of companies to identify ESG's and ESG-related activities. Once we have completed the evaluation forms, we utilize the Coral AI application to upload four annual reports for each company. The AI application goes through four stages of processing: First, scanning and extracting related ESG information by reviewing environmental, social responsibility, and governance sections. Second, analyzing text using Natural Language Processing (NLP) to identify key terms and phrases to measure each against ESG factors. Third, benchmarking and scoring each item against industry standards specified by MSCI ESG Ratings and SASB Standers. Finally, the AI application generates a full report with detailed scoring for each factor and a total grade. Figure 1: Provide a screenshot of the inputs (Sipchem for the fiscal year 2022 and the following two questions: "Can you review ESG-related activities and score each out of 100? and a total score out of 100?") and outputs of the Coral AI application on the left side of the image stating detailed analysis for ESG activities and a total score of 85 out of 100.

Figure 1: Outputs of the Coral AI application.



Finally, we combined the Z-score and ESG scores for each company. Given that the minimum Z-score for a safe financial position is > 2.99 and the minimal risk of bankruptcy is a Z-score between 1.8 and 2.99, we decided to accept companies of Z-score 1.8 and above, which means companies of no or minimum bankruptcy risk are potential candidates for pairing. In the case of ESG scores, we use rating criteria specified by MSCI in which the highest rating is AAA, equal to a score of 100;

[8] *MSCI ESG Ratings and SASB Standers are two leading ESG frameworks for evaluating and ranking corporate ESG activities.*

AA, equal to 90; A, equal to 80; and the lowest acceptable rating of BBB, equal to 70 is "passing grade." These thresholds can vary according to industry standards and economic conditions.

4. Results and discussion

This section presents the findings of our empirical analysis, focusing on the relationship between financial stability, as measured by Altman's Z-score, and ESG integration scores derived from hybrid human-AI evaluation. By categorizing firms based on their financial health and ESG performance, we aim to identify companies that are both financially sound and committed to long-term sustainability. In calculating Z-scores, we obtained 34 out of the 63 companies' samples with a Z-score of 2.99 and above, indicating a safe financial position, and we expect no risk of bankruptcy. In addition, 12 companies out of the total sample exabit Z-scores between 1.8 and 2.99, which we classified as having minimal risk of bankruptcy. These two groups account for 65.62% of the sample and are to be cross-matched with the ESG ratings of at least BBB, equivalent to 0.70 and above. For ESG ratings, we have rated 55 companies as having the acceptable rating of BBB equal to the passing grade of 70 or above. Next, we paired Z-scores of 1.8 and above with ESG ratings of 0.70 and above to identify companies that exhibit financial soundness and have the potential for long-term sustainability. Table 2 provides Z-scores and ESG ratings organized by sector, firm name, Tadawul's trading symbol, and Z-scores and ESG ratings, respectively. We highlight firms that meet the two criteria of Z-scores of at least 1.8 and ESG rating of 0.70 by a gray background.

Table 2: Firms included in the study, including their trading symbols, calculated Z-score, and ESG score.

Sect.	Firm	Symbol	Z-Score	ESG	Sect.	Firm	Symbol	Z-Score	ESG
Energy	SARCO (1)	2030	0.48	0.58	Materials Cement	NAJRAN CEMENT (37)	3002	3.55	0.85
	SAUDI ARAMCO (2)	2222	8.62	0.88		CITY CEMENT (38)	3003	17.63	0.83
	PETRO RABIGH (3)	2380	0.44	0.85		NORTHERN CEMENT (39)	3004	0.74	0.80
	ARABIAN DRILL (4)	2381	3.47	0.80		SAUDI CEMENT (40)	3030	5.91	0.85
	ADES (5)	2382	1.21	0.85		QACCO (41)	3040	18.92	0.83
	BAHRI (6)	4030	1.06	0.86		SPCC (42)	3050	7.23	0.82
	ALDREES (7)	4200	2.80	0.85		YCC (43)	3060	6.19	0.80
Materials Industrial	TAKWEEN (8)	1201	0.43	0.70		EPCCO (44)	3080	6.21	0.80
	MEPCO (9)	1202	3.18	0.80		TCC (45)	3090	2.38	0.80
	MA'ADEN (10)	1211	2.30	0.90		JOUF CEMENT (46)	3091	1.04	0.80
	ASLAK (11)	1301	8.79	0.75		RIYADH CEM (47)	3092	13.30	0.85
	ALYAMAMAH (12)	1304	2.33	0.85		YANBU CEMENT (48)	3020	2.70	0.85
	SSP (13)	1320	4.16	0.80		ACC (49)	3010	4.91	0.87
	EAST PIPES (14)	1321	4.90	0.80		UACC (50)	3005	2.24	0.78
	AMAK (15)	1322	6.52	0.82	Trans	SISCO HOLD (51)	2190	0.84	0.83
	TASNEE (16)	2060	0.95	0.80		SGS (52)	4031	2.45	0.85
	NGC (17)	2090	12.92	0.78		SAPTCO (53)	4040	0.81	0.57
	ZOUJAJ (18)	2150	7.99	0.88		BUDGET SAUDI (54)	4260	4.43	0.82
	ALUJAIN (19)	2170	2.75	0.50		THEEB (55)	4261	2.08	0.85
	FIPCO (20)	2180	3.43	0.50		LUMI (56)	4262	0.95	0.70
	APC (21)	2200	0.99	0.77		SAL (57)	4263	5.62	0.75
	MAADANIYAH (22)	2220	4.22	0.63	Utilities	GASCO (58)	2080	4.92	0.85
	ZAMIL INDUST (23)	2240	0.76	0.85		AWPT (59)	2081	4.54	0.85
	SIIG (24)	2250	17.98	0.85		ACWA POWER (60)	2082	2.98	0.82
	SVCP (25)	2360	16.51	0.60		MARAFIQ (61)	2083	6.20	0.86
Materials Petrochemical	CHEMANOL (26)	2001	2.33	0.83		MIAHONA (62)	2084	5.82	0.50
	SABIC (27)	2010	2.96	0.81		SAUDI ELECTRICITY (63)	5110	0.51	0.83
	SABIC AGRI-NU (28)	2020	9.38	0.85					
	NAMA CHEMIC (29)	2210	0.88	0.83					
	LUBEREF (30)	2223	4.39	0.85					
	YANSAB (31)	2290	5.41	0.85					
	SPM (32)	2300	1.86	0.75					
	SIPCHEM (33)	2310	3.09	0.85					
	ADVANCED (34)	2330	1.96	0.87					
	SAUDI KAYAN (35)	2350	1.09	0.85					
	BCI (36)	1210	2.31	0.80					

Note: *Numbers in parentheses are in clusters in Figure 3.*

By examining the results in Table 2, we find that all six sectors have shown pass and no pass of the two-threshold criteria. Thus, we suspect no particular sector is immune to the impact of ESG integration and that selection bias is less likely. However, the energy sector has shown less passing of the two criteria than the other sectors. Only three companies acquired high Z and ESG scores, which is 42.86% of the companies in the energy sector, showing evidence of a degree of correlation between ESG integration and financial stability. On the other hand, the Materials/Cement sector has shown the highest degree of correlation between a high Z-score and a high ESG score. Twelve out of fourteen companies have passed the two-threshold criteria, which is 85.71% of the total companies in the sector. Passing percentages for other sectors are as follows: Materials/Industrial is 55.56%, Materials/Petrochemicals 81.82%, transportation is 57,14%, and finally, Utilities is 66.67%.

Additionally, we grouped the results of combining pairs of Z-scores and ESG ratings into the following: First, a group of High Z-scores and high ESG ratings. Second, a group of high Z-scores and low ESG ratings. Third, a group of low Z-scores and high ESG ratings. Finally, a group of low Z-scores and low ESG ratings. Table 3. shows the allocation of these Z-score and ESG-rating pairs among the four specified groups. We apply three methods of examination: visual inspection, Spearman's correlation, and robustness checks to determine the statistical significance of the results. To revisit these statistical tools, see Smith and Johnson (2018) and Ronchetti (2020).

Through visual inspection, we clearly show that in the first group (high Z-score and high ESG ratings), 42 companies out of the 63 met the two criteria of Z-scores of at least 1.8 and ESG rating of 0.70, which represents 66.67% of the total sample. Hence, these numbers may indicate a degree of correlation between the Z-score and ESG score.

Table 3: Results of the allocation of the pairs of Z-score and ESG score listed by trading symbols.

	High	**Z-score**	**Low**
High ESG	2222 2381 4200 1202 1211 1301 1304 1320 1321 1322 2090 2150 2250 2001 2010 2020 2223 2290 2300 2310 2330 1210 3002 3003 3030 3040 3050 3060 3080 3090 3092 3020 3010 3005 4031 4260 4261 4263 2080 2081 2082 2083		2060 2380 2382 4030 2350 3091 2190 2200 2240 2350 3004 4262 5110
Low	2170 2180 2220 2360 2084		2030 1201 2210 4040

Subsequently, we check for robustness to validate the stability of results by testing two scenarios. First, we increase thresholds by 10%, the Z-score increases from 1.8 to 1.98, and the ESG score increases from 0.70 to 0.77. Second, we decrease the thresholds by 10%, the Z-scorer from 1.8 to 1.62, and the ESG score from 0.70 to 0.63. In the case of the first scenario, we found out that tightening the threshold causes the number of passing companies to decrease. Thus, companies with high Z-scores and ESG scores decreased from 42 to 39 (down %7.14). Likewise, in the second scenario, loosening thresholds by 10% causes the number of passing companies to go from 42 to 43 (up % 4.76). We examine the sensitivity of results by varying thresholds and provide supporting evidence of a positive relationship between ESG integration and financial stability. We summarize the robustness check results in Table 4.

Table 4: Results of robust checks:

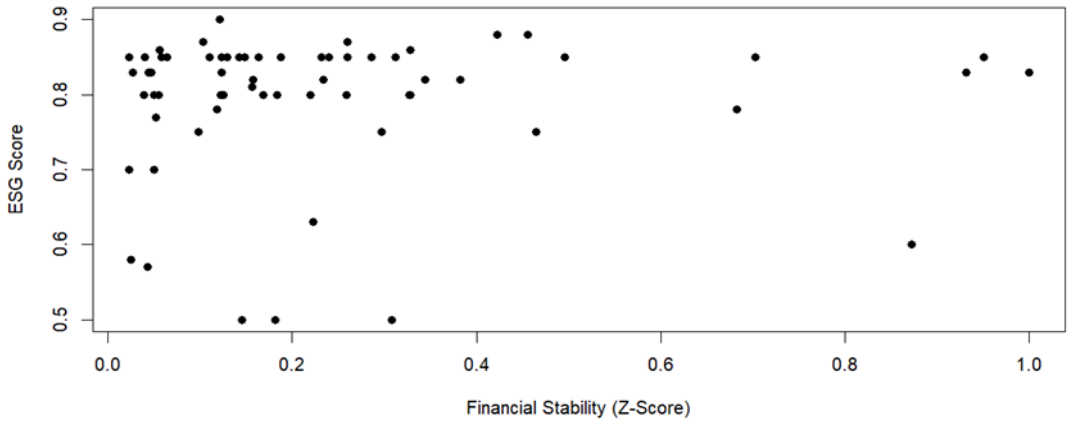
	Z-score	**ESG-score**	**Result**
Scenario 1	1.98	0.77	39 Decreased by 7.14 %
Scenario 2	1.62	0.63	43 Increased by 4.76 %
Base	1.8	0.70	Passing companies (42 out of 63)

Furthermore, we ran Spearman's correlation between Z-scores and ESG scores of companies in the first group and obtained a value of 0.26, which suggests a weak positive relationship. Therefore, a correlation value of 0.26 is insufficient to assume a moderate correlation; however,

considering the relatively large number of pairs in the High Z-score/High ESG score category (i.e., as indicated in Table 3), we further investigate all pairs of scores using a scatter plot. Given that the Z-scores in the X-axis are open-ended and have no ceiling and the ESG scores in the Y-axis scaled from 0.01 to 0.99, we have to normalize the Z-score by using the min-max normalization method to make both sides comparable. Hence, we divide each Z-score by the maximum Z-value of 18.92 obtained for QACC (see Appendix 1).

By looking into the spread of pairs in the scatter, as illustrated in Figure 2, we suspect the relationship is a cluster rather than a recognizable correlation. The scatter plot suggests that the relationship between Z-scores and ESG scores spreads across the graph without forming any apparent pattern or trend (i.e., we could not identify a solid linear relationship). Since we did not identify upward or downward sloping, we take a closer inspection and see that a higher density of observations located between scaled Z-scores of 0.01 to 0.5 and ESG scores of 0.7 to 0.9, indicating the possibility of most companies seeking to achieve the highest possible ESG scores using financial resources sufficient to achieve financial stability. Thus, we applied hierarchical clustering analysis to identify companies with similar clustering patterns, analyze sector-related patterns, and detect any possible outliers.

Figure 2: Scatter Plot of pairs of Z and EESG scores.

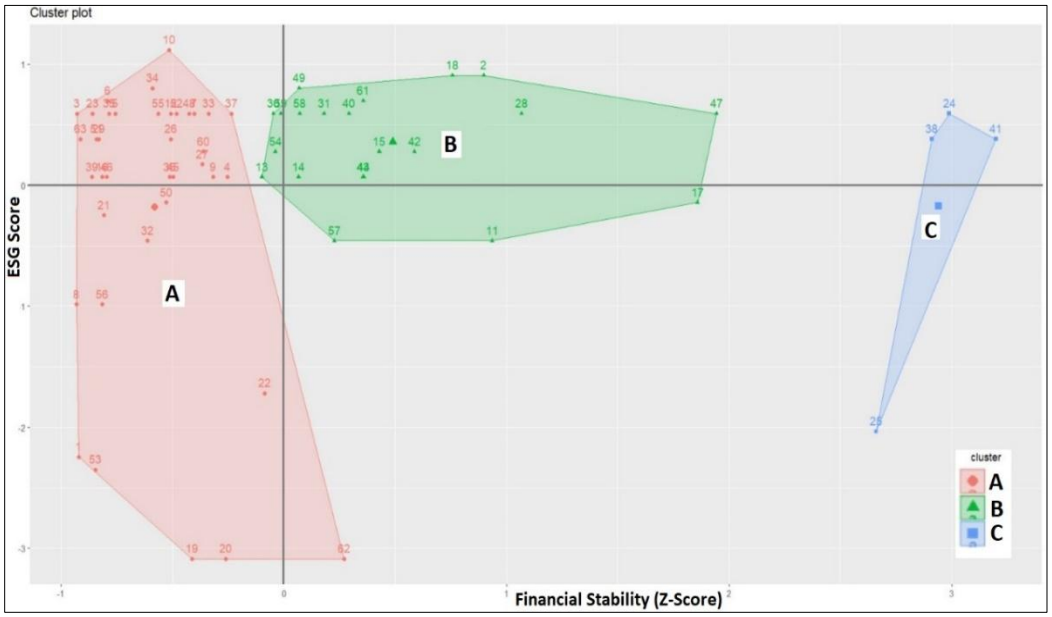


We applied a plotting dendrogram to identify the number of clusters we suspect in Figure 2. We draw a line at 0.75 (four clusters) and another line at 1 (three clusters) in the Height axis[9] of the clustering dendrogram to compare and contrast significant gaps (Appendix 2). Next, we calculate the silhouette average width for both lines, which ranges from -1 to 1, with the optimal size being as close to 1 as possible. In practical terms, a width above 0.5 is considered good, and anything above 0.7 is considered very strong. In our two cases, we received 0.57 and 0.64, respectively, suggesting that three clusters would be a more meaningful level of clustering than four clusters, as illustrated in Figure 3. Then, we map how far each cluster is from the passing scores of both axes. By dividing Figure 3 into four quadrants, each represents combinations of Z-scores and ESG scores. The clusters are color-coded by the programming[10]. However, we decided to code clusters (A, B, and C) to ensure easier identification, given that color printers are not always available.

[9] *Height is the y-axis in the Hierarchical Clustering Dendrogram, which measures the distance (or dissimilarity) between clusters at the merge points*

[10] *language R, and packages are available upon request.*

Figure 3: Scatter Plot of pairs of Z and ESG scores.



Note 1: *In the x and y-axes, the zero value represents the passing Z-score of 1.8 and the passing score of 0.70 for ESG scores; we adjusted other scores accordingly.*

Note 2: *Numbers in clusters represent companies in Table 2.*

We analyze clusters and recognize that no specific cluster is sector-specific; in other words, no sector can be identified as dominant in one of the following clusters. First, the red cluster (A) is in the two right quadrants, with all 36 companies (except one) not achieving the minimum passing score of financial stability (1.80). In this cluster, companies have low Z-scores and varying ESG scores (25 out of 36 companies are above the ESG threshold of 0.70). Companies in this cluster are likely facing financial hardship. Long-term survival is in question; thus, ESG integration may not be a priority. In other words, a company in this category may need more funds and resources to achieve (or sustain) ESG integration. In addition, companies in this cluster may need help attracting new investments or meeting sustainable growth requirements.

Second, the green cluster (B) at the top between the right and left quadrants contains 21 companies. Most companies surpass the passing score on the Z-score and ESG score, except four companies that did not pass the Z-score threshold and three that did not pass the ESG threshold score. However, these companies are close to the passing thresholds in both cases. This cluster of companies suggests that companies are looking to reach a particular level of considerable financial stability but would not be eager to increase their financial stability beyond a certain level. Any additional financial stability beyond what is required to cope with market and industry conditions would likely cause missing out on future profits.

These results are in line with the findings of several other studies, such as Kim et al. (2021), which found a positive correlation between ESG factors and corporate financial performance, and MacNeil and Esser (2022), who argue that ESG has shifted the focus of investors and capital allocation from corporate ethical responsibility toward financial performance. However, we further claim that the green cluster (B) offers an optimal area for companies to achieve and stay on. Given that any additional investment in financial stability and ESG would likely have diminishing returns (see Atz et al., (2021).

Third, the purple cluster (C) is mainly in the upper left quadrant above the ESG, with three companies passing the threshold and only one company below the threshold in the middle of the lower left quadrant. Companies in this cluster would look like outliers; however, the R package used "factoextra" is programmed to perform a silhouette plot but does not identify outliers. Nevertheless, the cluster under investigation (i.e., cluster C) produces an even higher silhouette average width of 0.67, as shown in Appendix 2.

In many cases, the direction of causality is straightforward and obvious and can easily be deducted (i.e., prices and sales). These are clear-cut examples of cause and effect (unidirectional). However, in the case of financial strength causing ESG commitment, a company with vast financial resources can invest generously in ESG initiatives. Additionally, enhanced financial resources provide top executives with the mindset to foster the implementation of ESG. In the case of ESG integration causing financial strength, companies with robust ESG implementation may enhance their financial stability by improving operational efficiency and risk management. They can also tap into a relatively less costly green finance market. For instance, debt holders would lower interest rates on loans for environmentally friendly projects. We perceive the possibility of a bidirectional relationship between ESG integration and financial strength. However, given that we have small-size observations, our choices of empirical causality tests are limited.

Nevertheless, we apply the Bayesian model, one of the few capable of handling small samples. In both cases (i.e., financial stability causes ESG integration and vice versa), we find neither has significant causal effects on the other, even though the model converged well. The estimates are checked for reliability, but the most likely explanation is that other factors significantly influence the relationship, laying the foundation for future research.

Long-term sustainable goals significantly affect corporate financial decisions (i.e., capital budgeting). An environment-friendly operation would benefit from relatively low-cost debt provided or supported by formal and informal bodies. For instance, two-thirds of the green bonds issued by the Association of Southeast Asian Nations are used for financing renewable energy and energy efficiency projects (SU et al., 2022). Furthermore, in 2023, the EU countries and the UK's collective issuance of green bonds reached US$190 billion, in addition to 135 billion for social bonds[11]. In addition, concessional loans, Energy Saving Insurance (ESI), contingent grants, and performance contracts are examples of financing mechanisms that promote funding clean energy projects and decrease their weighted average cost of capital[12]. Hence, investors and fund managers would value companies in terms of current and future financial performance (i.e., sustainability), ensuring the company's long-term economic, social, and environmental health. A project, or an asset maintained by the owner and operated correctly and up to standard, is expected to serve longer and more efficiently. This logic would be the driving force behind convincing potential lenders and investors to fund environmentally friendly projects.

Our results would help policymakers and stakeholders make environmentally friendly and sustainable decisions. ESG integration drives community awareness and encourages policymakers to introduce regulations to achieve long-term economic, social, and environmental goals. Once regulations are implemented, the investment community generally values how transparency and reporting standards are disclosed. Free access to such information would help build public trust and maintain continuous investments in green projects.

5. Conclusion:

This section summarizes the key findings of our study and reflects on the implications of our analysis. By employing various statistical techniques, we sought to explore the relationship between financial stability and ESG integration in Saudi energy-intensive companies. The findings provide valuable insights, and we conclude by suggesting potential areas for further investigation.

We employed a combination of visual inspection, Spearman's correlation, and robust checks to explore the relationship between financial stability and ESG scores. Spearman's correlation indicated a weak positive relationship, prompting further investigation into this connection. To better understand the distribution of the data, we created a scatter plot, which revealed clusters rather than a clear linear correlation. Following this, we performed hierarchical clustering analysis using a dendrogram to determine the optimal number of clusters.

[11] *Bloomberg Professional Services, (2024).*
[12] *Deloitte. Financing the Green Energy Transition: A US$ 50 trillion catch, November, 2023*

In addition, we apply the Bayesian model to test for a bidirectional relationship between financial stability and ESG scores. We find neither has a significant causal effect on the other, even though the model converges well. We suspect that other factors significantly influence the relationship. In future research, once we obtain additional financial data, we could use regression models, time series analysis, or structural equations to empirically test the impact of financial strength on ESG integration and vice versa.

Integrating ESG factors provides significant benefits for investors, mutual fund managers, and risk managers, enabling them to enhance risk-adjusted returns and better estimate risk-reward trade-offs. In the context of portfolio management, especially within international finance, ESG considerations serve as a valuable tool to filter investment options and offer guidelines for optimizing portfolio performance.

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Appendixes:

Appendix 1: Z-score calculations:

	Company	Symb	Z-	Sales	Mkt. V.	T. Liab	EBIT	R.	W. Cap	T. Assets
Energy	SARCO	2030	0.48	19,864	1,458	6,620	15,522	34,957	39,108	474,610
	SAUDI ARAMCO	2222	8.62	1,609,595,	7,653,988,	802,093,	892,262,	1,259,773,	394,480,	2,338,174,
	PETRO RABIGH	2380	0.44	45,941,97	16,249,12	55,618,3	-	-3,493,786	-	66,696,57
	ARABIAN	2381	3.47	2,886,589	13,867,01	3,865,61	550,170	3,894,581	1,741,25	9,254,561
	ADES	2382	1.21	3,586,022	18,078,96	13,084,4	504,965	1,553,808	-662,694	17,454,00
	BAHRI	4030	1.06	7,995,289	4,340,152	11,119,0	1,363,44	3,174,866	1,422,15	22,552,38
	ALDREES	4200	2.80	11,959,77	8,484,750	5,327,97	238,336	258,706	-936,661	6,443,421
Mat_Ind	TAKWEEN	1201	0.43	900,198	729,220	1,193,03	-46,350	-229,986	-253,373	1,726,377
	MEPCO	1202	3.18	986,751	2,106,880	622,394	100,799	308,128	349,380	1,888,087
	MAADEN	1211	2.30	31,003,69	143,770,8	56,504,8	6,257,50	12,148,13	13,256,1	108,566,5
	ASLAK	1301	8.79	887,057	868,259	87,929	49,139	14,935	321,491	505,864
	ALYAMAMAH	1304	2.33	1,573,853	2,027,982	1,008,78	-2,536	47,020	298,890	1,751,159
	SSP	1320	4.16	880,356	1,401,032	763,692	1,023,30	63,925	43,992	1,434,753
	EAST PIPES	1321	4.90	1,261,904	1,881,600	471,829	169,465	343,957	493,796	1,151,986
	AMAK	1322	6.52	524,834	3,088,323	334,153	115,811	28,011	324,625	1,363,190
	TASNEE	2060	0.95	3,553,443	9,383,527	10,440,8	1,053,27	1,500,239	837,572	24,778,12
	NGC	2090	12.92	64,665	881,473	39,309	11,103	-319,354	95,936	432,075
	ZOUJAJ	2150	7.99	119,980	1,209,733	102,407	65,366	255,524	13,087	785,631
	ALUJAIN	2170	2.75	1,237,345	2,898,096	1,402,87	388,322	2,095,588	678,263	4,150,839
	FIPCO	2180	3.43	236,078	562,407	157,996	8,853	34,198	56,649	292,455
	APC	2200	0.99	354,852	785,610	635,815	24,168	-68,539	-115,656	797,219
	MAADANIYAH	2220	4.22	235,018	787,296	129,416	-29,096	-68,330	171,628	434,970
	ZAMIL INDUST	2240	0.76	4,094,686	1,373,000	4,996,60	-187,267	42,332	4,613	5,903,397
	SIIG	2250	17.98	336,390	16,397,16	563,176	604,157	940,955	1,753,19	11,204,11
	SVCP	2360	16.51	83,254	847,500	31,899	-24,834	22,971	106,334	279,870
Mat_Petro	CHEMANOL	2001	2.33	865,714	1,698,148	682,431	23,962	183,232	224,059	1,746,701
	SABIC	2010	2.96	158,209,4	275,400,0	99,729,9	16,488,4	27,939,02	52,697,2	241,302,8
	SABIC AGRI-	2020	9.38	11,575,45	60,713,50	5,163,52	6,337,55	6,820,658	10,058,9	23,195,75
	NAMA	2210	0.88	506,042	764,870	700,812	-41,439	60,093	-167,221	1,100,832
	LUBEREF	2223	4.39	8,650,468	19,507,50	3,847,70	348,479	1,023,615	298,840	8,540,134
	YANSAB	2290	5.41	5,905,346	26,305,31	3,847,70	440,784	6,053,956	4,634,10	16,272,20
	SPM	2300	1.86	702,961	903,342	670,009	80,698	76,179	16,965	1,031,838
	SIPCHEM	2310	3.09	8,651,913	24,219,14	7,016,83	2,766,76	2,309,265	2,270,79	23,129,52
	ADVANCED	2330	1.96	2,679,346	11,786,63	4,973,02	395,848	320,654	198,837	8,633,623
	SAUDI KAYAN	2350	1.09	10,112,38	20,520,00	13,399,3	-	-1,434,638	238,221	29,276,95
	BCI	1210	2.31	651,542	960,162	516,950	66,011	241,696	177,833	1,179,790
Mat_Cemt	NAJRAN CEMENT	3002	3.55	478,997	2,279,020	461,721	124,332	143,016	306,481	2,459,169
	CITY CEMENT	3003	17.63	428,621	2,990,960	107,374	132,674	207,389	509,230	1,914,103
	NORTHERN	3004	0.74	638,739	204,084	1,174,61	128,336	282,880	-79,338	2,138,232
	SAUDI CEMENT	3030	5.91	1,449,556	8,177,850	1,009,20	401,289	314,236	215,592	3,315,169
	QACCO	3040	18.92	437,195	7,412,980	256,193	219,975	492,181	947,042	1,915,370
	SPCC	3050	7.23	1,228,009	7,667,800	764,656	323,039	1,152,851	798,304	4,010,286
	YCC	3060	6.19	887,372	5,703,075	632,604	186,942	387,530	503,580	3,392,313
	EPCCO	3080	6.21	854,879	3,683,380	437,742	213,050	516,841	862,379	2,837,362
	TCC	3090	2.38	268,649	1,371,960	400,388	28,080	26,816	118,906	1,683,835
	JOUF CEMENT	3091	1.04	266,657	1,363,273	833,996	3,542	-60,991	-64,250	2,005,584
	RIYADH CEMENT	3092	13.30	629,997	3,981,600	193,184	208,912	118,369	230,529	1,871,554
	YC	3020	2.70	919,278	6,057,787	1,703,50	317,514	1,031,332	124,785	6,242,323
	ACC	3010	4.91	935,421	3,517,500	545,360	190,136	710,003	726,475	3,288,875
	UACC	3005	2.24	223,043	1,081,575	446,072	44,310	176,489	270,059	1,191,903
Trans	SISCO HOLDING	2190	0.84	1,238,691	2,263,891	3,102,23	130,401	184,048	218,325	5,353,218
	SGS	4031	2.45	2,023,436	5,664,816	2,148,72	-513	-121,417	1,652,93	4,414,793
	SAPTCO	4040	0.81	1,332,783	2,362,500	3,454,73	-109,063	-268,117	984,514	4,442,690
	BUDGET SAUDI	4260	4.43	1,152,915	4,145,814	763,441	258,206	798,946	-146,203	2,513,091
	THEEB	4261	2.08	961,021	2,801,880	1,236,81	154,979	186,114	-306,630	1,889,765
	LUMI	4262	0.95	976,398	5,302,000	1,488,90	158,549	249,441	-	2,685,571
	SAL	4263	5.62	1,250,755	15,552,00	2,146,74	419,520	232,369	993,007	3,256,566
	GASCO	2080	4.92	2,178,853	3,894,750	668,620	223,807	272,575	128,470	2,414,196

Utilities	AWPT	2081	4.54	1,096,209	3,795,750	806,807	130,878	148,096	341,230	1,241,822
	ACWA POWER	2082	2.98	13,184,57	127,597,1	31,532,8	1,430,21	2,303,272	5,345,81	49,428,94
	MARAFIQ	2083	6.20	6,354,875	144,100,0	15,758,4	657,551	5,082,092	1,086,93	23,722,06
	MIAHONA	2084	5.82	286,595	3,482,257	619,953	500,296	181,328	150,238	968,428
	SAUDI ELECTRIC	5110	0.51	72,494,19	88,248,45	232,937,	12,203,4	37,084,47	21.21,92	487,681,5

Appendix 2: Determining the number of clusters using Hierarchical Clustering Dendrogram: