Moderating Effect of Board Characteristics on the Relationship Between Renewable Energy Investment and Firm Performance among Oil & Gas Firms in Sub Saharan Africa

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ABSTRACT

Several factors affect the firm performance of oil and gas firms due to their potential relevance to a company's profitability and sustainability. Renewable energy investment includes the factors that represent an enormous challenge to the oil and gas firm's survival. This study examines the moderating effect of board characteristics on the relationship between renewable energy investment and firm financial performance among oil and gas firms in sub-Saharan Africa. The sample population of fifty (50) oil and gas firms was selected using the purposive sampling method. Data were collected from secondary sources comprising an audited annual financial statement of sampled firms and the LSEG data stream. The period of the study was ten (10) years (2014–2023). Data were analysed using a linear multiple regression technique in the STATA software package. The result of the study reveals a significant negative effect of renewable energy investment on Return on Assets (ROA) and a significant positive effect on Net Profit Margin (NPM). Similarly, board independence and board tenure have an insignificant moderating effect on the relationship between renewable energy investment, ROA and NPM. While board expertise has a positive moderating effect on the relationship between renewable energy investment and NPM. Gender diversity has a positive moderating effect on the relationship between renewable energy investment and ROA of oil and firms of sub-Saharan Africa. The study concludes that while renewable energy investments temporarily decrease return on assets, it has a long-term profitability benefit, create value for investors' confidence and firms' sustainability among the oil and gas firms, especially when complemented by an effective corporate governance mechanism. Therefore, this study suggests for effective corporate governance compliance, specifically boards with expert members and more female directors are in better positioned to guide, evaluate and contribute to good oversight and innovative investment decisions in renewable energy, also a collaboration of oil and gas firms with governments, development banks and private investors to provide incentives in terms of concessional funds, subsidies and tax reliefs to encouraged the firms to invest more on renewable energy projects beyond the current average investment level to strengthen long-term competitiveness and resilience against oil price volatility and improved firm performance.

Keywords: Firm performance, Investment, Renewable energy, Board characteristics, Oil & Gas.

INTRODUCTION

Oil and gas businesses are facing new challenges and new pressures related to their sustainability, which may have a critical and long-term effect on investors and stakeholders in the industry (Rahi et al., 2023). The sector faces the possibility of losing investment fund opportunities, which might result in negative consequences on their financial performance and development plans, unless they incorporate sustainability measures into their strategy (Grosu et al., 2023). Firm performance of the oil and gas industry is traditionally measured by financial metrics, including profitability, return on assets, return on equity, return on investment, and market valuation (Bajwa et al., 2023). However, in the context of sustainability performance, other indicators such as environmental impact, social contribution, governance quality and investment in renewable energy have gained prominence (Shaikh, 2022). Investors are more concerned about the accurate assessment of the company's performance, as they strive to make investments that will not only yield return but also bring significant increase

in income with the lowest level of risk (Borodin et al., 2023). Investors use firm performance as a yardstick for investment and decision-making because it guarantees that the business organisation has successfully met its desired results and will remain competitive in the markets in the foreseeable future (Journal et al., 2022). Among these challenges, renewable energy investment has gained significant attention due to its potential contribution to companies' profitability and sustainability (IEA, 2023). This is also evident in the increased involvement of investors in oil and gas companies' climate-related issues and restrictions in some areas on access to finance (IEA, 2023). In addition, oil and gas firms require social legitimacy to build their projects and operate in their business environment (García-Amate et al., 2023). In this regard, the global energy landscape driven by increasing concerns about climate change, energy security, investment in renewable energy, is seen as an essential channel to satisfy the yearning, needs, and expectations of all stakeholders to improve firm's performance, firm's reputation and attract more investors in the industry (Herzog-hawelka & Gupta, 2023; Ramírez-orellana et al., 2023; Abel et al., 2023). The pressing need for sustainable energy solutions has highlighted the implications of renewable energy investments, especially in energy-intensive industries like oil and gas (Hartmann et al., 2022). Investments in renewable energy have become a critical component of the industry's sustainability strategy, although usually much smaller than the investments in the core oil and gas business projects; renewable energy investment can be viewed as buying the right to expand in the future (World Energy Investment 2023). In Africa, the oil and gas industry will be increasingly measured by its ability to reduce environmental footprint, engage with local populations in supply and distribution value chains, safety development and diversify into new energy resources (International Energy Agency (IEA), 2023). Board characteristics, including size, gender diversity, tenure, independence and expertise, play a critical role in shaping strategic directions and ensuring accountability (Makpotche et al., 2023). In particular, a board's characteristics can moderate the relationship between renewable energy investments and firm performance. For instance, boards with diverse expertise may more effectively drive renewable energy investments, influence the extent and effectiveness of renewable energy projects and potentially enhance firm performance (Nepal & Deb, 2022). Conversely, boards lacking diversity or independence and expertise might prioritise traditional, short-term profit motives over sustainable investments, limiting the potential positive impact on firm performance (Saleh & Islam, 2020). Although there is an extensive body of literature that investigates the nature and extent of energy transition, climate change sustainability (environmental, social and governance) practices in African countries, for example (Bajwa et al., 2023; Mohammed et al., 2023; Obiso I. Evans, Maendo Densford, 2023; Nwanwu et al., 2022; Okudo & Amahalu, 2023; Kwame et al., 2023; Adams et al., 2022; Bui & Nguyen,2021; Ofoegbu & Onyebuenyi, 2022; Fabian et al., 2022; Ozdemir, 2021). None of these empirical studies examined the relationship between board characteristics, renewable energy investment and firm performance of Africa's oil and gas firms. Therefore, the purpose of this study is to investigate the relationship between board characteristics, renewable energy investment and firm performance among oil and gas firms of sub-Saharan Africa. Legitimacy and Resource dependence theories were used to guide the relationship.

LITERATURE REVIEW

Firm performance

The concept of a firm's performance is generic. A company's performance is determined by how well it meets its market and financial objectives. Firm performance includes the firm's level of economic success (Alagbe et al., 2021). The definition of a firm's performance theoretically centres on the economic view of the organisation's profit maximisation and the stakeholders' approach to satisfying the needs of a group or individuals affected by the business organisation's activities. Also, firm performance is a subjective measure of how effectively and efficiently a firm uses its assets to generate resources (Aiyesan, 2023). The financial performance of an organisation is classified into subsets of Accounting or profitability performance measure (return on assets (ROA), return on equity (ROE), return on investment (ROI), economic value added (EVA), net income/revenue and earnings before interest, tax, depreciation, and amortisation margin (EBTIDA) and Net profit margin (NPM) or market based measure of firm performance (earnings per share (EPS), change in stock price, dividend yield, stock price volatility, market value added (MVA), and Tobin Q).

Transition to Renewable Energy

The energy transition is a gradual and lasting change in the composition of the worldwide energy system (Tjcd et al., 2022). The energy transition is also referred to as the process of shifting from one dominant energy source

to another (Fouquet & Pearson, 2012). Energy transitions were necessitated by various unavoidable global forces. The first notable significant energy transition occurred between the 17th and the late 19th centuries, when biomass energy (wood) gave way to fossil fuels. The necessity and acceleration of the transition process were brought about by the discovery of new fossil fuel reserves, technological breakthroughs, and urbanisation (Solomon & Krishna, 2011). Consequently, fossil fuels have emerged as the predominant source of worldwide energy consumption. The world is currently going through its second major energy shift, which is defined as a move away from fossil fuels like coal and oil and towards renewable energy sources such as solar, gas, geothermal energy, and bioenergy. The goal of the transition to renewable energy is to lessen the negative effects of using fossil fuels (Of & Sciences, 2020). The adverse impacts, such as climate change and air pollution, play an important role in driving the global shift towards sustainable energy transition. Therefore, implementing an energy transition is a very necessary and essential option to reduce greenhouse gas emissions (GHG), address climate change, transition to a low-carbon energy system, and establish a sustainable socio-economic global system (Tjcd- et al., 2022)

Renewable Energy Investment

The transition to low-carbon energy will mark the start of a new, environmentally friendly era (Pearson & Foxon, 2012). The environment, the world economy and society at large will all be greatly affected by the energy shift. Oil and gas firms have been greatly impacted during this period. The demand for oil and gas is challenged by the transition to renewable energy in the energy sector. Price of oil and gas is directly impacted by political decisions and thus directly affects the financial performance of oil and gas firms (Of & Sciences, 2020). Hence, the corporation should broaden its commercial scope by allocating resources towards the renewable energy shift. Furthermore, the environmental measures outlined in the Paris Agreement, aimed at reducing global climate change, have the potential to pose a significant risk to the financial stability and survival of oil and gas firms. The implementation of the agreement's obligations is anticipated to result for reduction in future demand of hydrocarbon energy, a growth in operational expenses due to rising taxes on CO2 emissions, and a negative impact on the public image of oil and gas companies (Zhong & Bazilian, 2018). The investors' prioritisation of environmental, social, and governance (ESG) metrics also contributes to the growing demand and shift to renewable energy by oil and gas firms to diversify their business towards renewable energy projects (Marthinsen et al., 2021). Therefore, in order to ensure economic stability and remain competitive in the energy market, it is imperative for oil and gas corporations to actively invest more resources in the process of transitioning to alternative renewable energy projects (Of & Sciences, 2020).

Board Characteristics

The board of directors (BOD) is a highly important internal governance body that plays a critical role in monitoring and supervising organisational management, as well as protecting the interests of stakeholders. It is used to supervise the company's strategic plans and verify that management is actively working towards accomplishing the organisation's objective (Cheung & Lai, 2022). The literature emphasises that the board of directors is a central and highly efficient internal mechanism of corporate governance (Shao, 2019). It serves two significant functions in companies: monitoring executive management on behalf of the shareholders and providing business resources and evaluation (Cheung & Lai, 2022). The boards fulfil their supervisory function by dedicating their time and expertise in monitoring the performance of the firm and the conduct of the firm’s executive managers (María & Isabel, 2019). As such, it is essential to comprehend the characteristics of the board of directors (BOD) and also to assess their potential effect on firm performance. For example, oil and gas firms should explicitly consider mechanism such as board gender diversity, board independence, board size, board meetings, board financial knowledge or board expertise and board tenure for effective monitoring strategies (Saleh & Islam, 2020; Mlay et al., 2023; Andrew O O, 2021).

Theoretical foundation

Legitimacy Theory

The legitimacy theory, developed by Davis (1973), posits that business is granted legitimacy and authority by society (Meditari Accountancy Research Article Information, 2018). Any organisation that fails to exercise power in a manner that is considered legitimate by society is likely to gradually forfeit that power. The view of

legitimacy posits that organisations continually endeavour to adhere to the boundaries and societal norms of their unique environments. Legitimacy theory posits that firms must exhibit environmental and social responsibility and be answerable to society as a necessary condition for legitimate operations (Simnett et al., 2009; Cong & Freedman, 2011).

Resource dependence Theory

Resource dependence theory was developed by Barney (1991). According to Wernerfelt (1984) and Remelt (1984), the resource-based view (RBV) asserts that a firm's competitive advantage is essentially derived from effectively using its collection of valuable resources. The core objectives of this theory are to explain the relationship between a company's success and its possession of costly, scarce, inimitable, and non-substitutable resources, which are acquired to attain a competitive advantage (Kountriasova, 2022). Based on theory, external resources can influence the behaviour of an organisation, and various components of the corporate governance system can facilitate the connection between the organisation and these external resources, hence enhancing the organisation's performance (Pervin & Rashid, 2019). Growing sustainability concerns have, in recent years, received significant and in-depth attention from investors and stakeholders across the globe. In this study, board characteristics is expected to moderate significantly the relationship between renewable energy investment and the firm performance of listed oil and gas firms in sub-Saharan Africa.

THEORETICAL FRAMEWORK

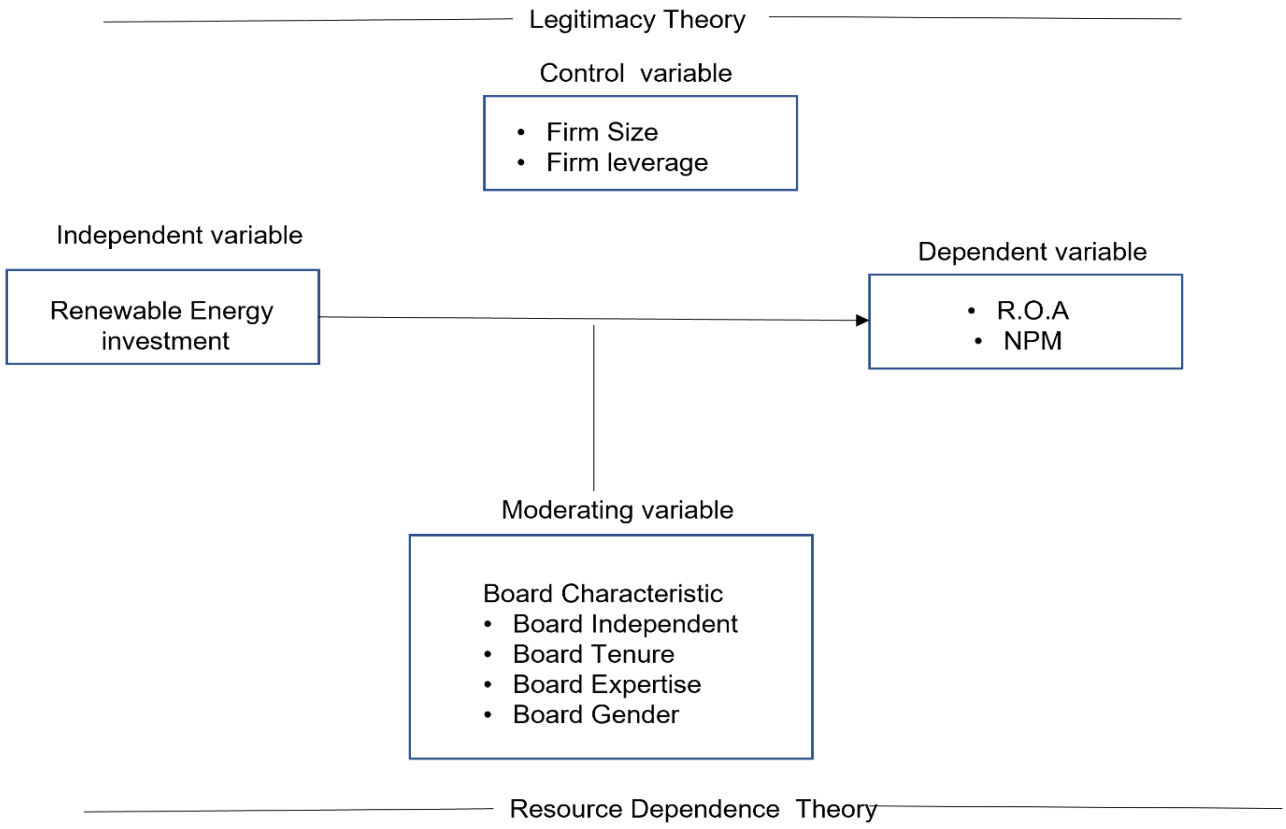

Figure 1Theoretical framework

Hypothesis Development

Relationship between Renewable energy investment and Firm financial performance

According to legitimacy theory, a company has an implied social contract within the society it operates (Velte, 2021). This social contract can motivate the board of directors to be in line with societal specific norms and values. The boundary helps in implementing adequate investment decision-making processes (Velte, 2021). The firm green investment increased societal support within the community it operates and hence gained acceptance and legitimacy for future growth and development (Ofoegbu & Onyebuenyi, 2022); (Mahmood et al., 2019).

Research has consistently indicated that firm performance is positively affected by a higher rate of investment in green energy projects for example (Daferighe & Etim, 2023), (Marthinsen et al., 2021) investigates the effect of green innovation on financial performance, (Zhong & Bazilian, 2018) study sustainable investment in international oil and gas companies, the study finding indicates feasible technologies, and acquiring technical capabilities to operate renewable power facilities has a positive significant effect on firm performance (Nchofoung, 2023) examines the effect of oil price shocks on Africa's energy transition, the findings show a strong effect between rural and urban contexts of energy transition and firm performance (Kwame et al., 2023) studied the safety practices and performance of critical sector in Ghana's oil, gas and allied energy industry, analysis of the result show that safety training and renewable investment has a significant contribution to safety and firm performance. In contrast, (Rezende et al., 2019) examines how green innovation influence financial performance in multinationals oil and gas firms, the study finding indicates insignificant relationship between green innovation's and firm financial performance, (Marthinsen et al., 2021) investigates the effect of green innovation on financial performance of oil and gas companies, the study indicates crude oil prices negatively moderate the relationship between green innovation score and financial performance, (Hermundsdottir & Aspelund, 2022) examines how sustainability practice such as investment in renewable energy, social and environmental innovations influence firm performance of the manufacturing firms. The result indicates environmental innovations has negative effect on all measures of firm performance, social innovations show a mixed result, while investment in renewable energy resources show an insignificant positive effect on a company's economic returns and performance. The various previous studies indicated mixed findings between renewable energy investment and financial performance. However, a strong relationship is needed to achieve greater corporate sustainability. It is in line with this framework that the relationship between renewable energy investment and the financial performance of oil and gas firms in sub-Saharan Africa is introduced in this research study. Thus, the following hypothesis is developed to be tested.

Hypothesis 1 (H1): Renewable energy investment has a positive relationship on firm financial performance of oil and gas firms in sub–Saharan Africa:

Board independence moderate the relationship between renewable energy investment and firm performance.

Resource dependence theory argues that one of the main functions of the board is to provide effective response and efficient advice toward acquiring new resources (Shyamanthi, 2018). The argument of advocates of resource dependence theory is that, independent directors bring outside relationships that help the board with relationships to overseas networks and bring new resources (Shyamanthi, 2018). Similarly, the robust presence of board independent directors can reduce the rate of agency conflicts and attract more resources (Muniandy & Hillier, 2015; Shao, 2019). Increasing managers monitoring on their role in environmental, social and governance related policies and investment in renewable energy, which have a significant positive effect on firm sustainability (Fooladi, 2012). In the same direction, an independent board is always associated with diversity in skills, experience and expertise (Cheung & Lai, 2022; Doni et al., 2022), independent board may address the conflict of interest between different stakeholder's interest group which thereby help to maintain the balance between the financial and non-financial objectives of companies (Cheung & Lai, 2022). Hence, from the perspective of legitimacy theory, independent directors' ore likely to put greater pressure on top managers to carry out sustainability-related programs in order to demonstrate firms' obligation to the diverse interest groups within its operating environment. In this regard, independent board are expected to be positively related with sustainable investment, because independent directors are believed to be more determine as compared to non-independent directors in terms of pressure from executives and shareholders (Kwarteng et al., 2023; Makpotche et al., 2023; Lee, 2019; Shyamanthi, 2018; Bajwa et al., 2023; Rossi et al., 2021). However, some studies results indicate a significant negative correlation between board independence and sustainability performance metrics (Kwarteng et al., 2023; Hussain et al., 2018; Dong et al., 2023; Shyamanthi, 2018; Cormier & Beauchamp, 2021; Murtaza, 2020). Despite the mixed findings from the previous studies, increasing the proportion of independent directors on the board is considered a positive development that may put pressure on companies to engage in sustainability friendly practice (Bui & Nguyen,2021). Thus, the following hypotheses of the study are developed to be tested:

Hypothesis (H2): Board independence moderate positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa:

Board of directors' tenure moderate the relationship between renewable energy investment and firm performance.

Board tenure is viewed as a measure of firm stability, since longer board tenure signals that the shareholders have appointed and maintained a board with the relevant number of experience members (Livnat & Suslava, 2021). Similarly, Boards with the composition of directors with long tenure would monitor management and help to provide additional resources to the firm (Livnat & Suslava, 2021). Further, previous empirical studies (Kwarteng et al., 2023; Bui & Nguyen,2021; Cheung & Lai, 2022; Livnat & Suslava, 2021; Ozdemir, 2021; Calgary, 2020) argue that if board members stay on the board for long period are likely to become satisfied with the firms' operations, particularly those concerning investment in new energy projects and sustainability practice (Cheung & Lai, 2022). In contrast, corporate board are likely to suffer from long tenure, resulting in reducing firm value and subsequently influence firms' overall performance adversely (Jia et al., (2021). Similarly, a board with long tenure is associated with an increase in familiarity among board members and company's management. This tries to undermine board independence and by implication, the firm's sustainability becomes questionable (Huang et al., 2018). This serves as our motivation to carry out this study in the context of the sub-Saharan Africa (SSA) oil and gas sector, the sector is considered to be susceptible to the effects of global shift to new energy dimension. Thus, the following hypothesis is developed to be tested.

Hypothesis (H3): Board tenure moderate positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa:

Board of directors' expertise moderate the relationship between renewable energy investment and firm performance.

Based on the legitimacy and resource dependence theories, the company board are encouraged to implement firms plan accordingly to achieve firms' objectives in the long run (Kwarteng et al., 2023). This is because the company board members' skills and knowledge or expertise influences the firm's overall objectives and ensure improved firm's performance (Nugraha, 2023). This suggests that different or diversity of board members especially, board expertise generally improves the quality of decisions making which in turn enables firm managers to address numerous stakeholders' interests, which subsequently increases firm value (Harun et al., 2020; Kwarteng et al., 2023; Ojo et al., 2021; Lee, 2019; Dong et al., 2023; Mlay et al., 2023) studies finds that board's expertise has a positive effect on a firm's performance. Similarly, (Makpotche et al., 2023; Kwarteng et al., 2023; Bajwa et al., 2023; Miotto, 2020; Martín, 2019; Cheung & Lai, 2022) studies finds that board members with a higher level of education or expert and skill members, including with wider experience have a positive and significant effect on firms' investment decision, particularly on new energy resources, corporate environmental, social and governance performance. None of the existing studies has investigated the relationship between board expertise, investment in renewable energy and firm performance in the context of sub-Saharan Africa (S)SA oil and gas firms. Thus, the following hypothesis is developed to be tested:

Hypothesis (H4): Board expertise moderate positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa

Board gender diversity moderate the relationship between renewable energy investment, and firm performance.

The composition of corporate boards has been given diverse interpretations, which generally relate to gender diversity and female percentage of executive as against non-executive directors. This is extensively perceived as a significant mechanism to influence management efficiency and impact board decisions making (Mlay et al., 2023). Increasing the proportion of women directors is a vital and critical internal board mechanism that is often connected to the promotion of sound and good corporate governance mechanism, which controls management opportunistic interests (Kwarteng et al., 2023; Makpotche et al., 2023; Saleh & Islam, 2020; Pervin & Rashid, 2019; Dong et al., 2023; Mlay et al., 2023; Cheung & Lai, 2022; Mohammed et al., 2023; Martín, 2019; Lee, 2019; Assenga et al., 2018) studies potentially indicate female directors to be more sensitive to humanitarian concerned like sustainability matters like investment in renewable energy projects, which can positively influence firms' financial performance (Saleh & Islam, 2020). None of the prior previous empirical studies

investigate the effect of board gender diversity, renewable energy investment and firm performance in sub–Saharan Africa oil and gas firms, to the best of our knowledge. Therefore, this study investigated the relationship between renewable energy investment and firm performance of oil and gas firms in sub–Saharan Africa. Thus, the following hypothesis is developed to be tested:

Hypothesis (H5): Board gender diversity moderate positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa:

RESEARCH METHODOLOGY

Research Design

To identify the statistical relationship between the moderating effect of board characteristics, renewable energy investment and firm performance of oil and gas firms in sub–Saharan Africa, a correlation research design is used in this study. It is considered to be the most appropriate research design for the study, since it allows for the testing of anticipated relationships between variables as well as the deduction of logical inferences about those relationships (Park et al., 2020)**.**

Population, Sampling and Method of data collection

The study employed a secondary source of data to test the above study stated hypothesis by collecting the data from LSEG data stream and published audited annual reports and accounts of sample oil and gas firms in sub-Saharan Africa from the period 2014 to 2023. The population of the study comprise of fifty (50) oil and gas firms operating in Nigeria, Ghana, Angola, Namibia, Kenya, Uganda and Egypt.

Techniques of Data Analysis.

A panel data linear multiple regression analysis technique is used to test the moderating effect of board characteristics on the relationship between renewable energy investment and the firm's financial performance among oil and gas firms in sub-Saharan Africa, with the aid of the STATA statistical software package.

Control variables

Firm Size

Firm size is a firm characteristic usually determined by the natural logarithm of assets, net sales, or employees. As indicated by (Nicholson, 2007). The size of the company matters and can influence performance. It is related to overall profitability and incurred costs for the industry. Energy sector, i.e. oil & gas firms, is more likely to have numerous departments managed by line managers, who are more qualified or unqualified in terms of skills and knowledge and thus have much bureaucracy; this will significantly affect the firm performance (Akuno, 2018).

Firm Leverage

Leverage is an investment technique that requires borrowing funds. It involves utilising a range of financial instruments or borrowed capital to improve the potential return on investment (A. Ali & Fatima, 2023). Leverage is the term commonly used to describe the level of debt that a company uses to fund its assets. When a firm determine to increase its asset base and generate profits from invested capital, it can source funding from borrowed capital in the financial markets (James & A, 2023). The use of debt (borrowed capital) to finance a business or task is known as leverage. Hence, the potential returns of the project are increased (Asika, 2022). Simultaneously, leverage increases the downside firm risk, but if the business does not produce any results leverage can be used to provide financial support for a company's assets (Asika, 2022). In contrast to issuing shares for capital raising, businesses have the option to use debt financing to invest in their operations and increase shareholder value. In this situation, investors apply leverage to increase their potential returns on investment (Asika, 2022).

Table 3.1 Model Variable Description and Measurement

Variable	Mnemonics	Definition	Role	Measurement
ROA	ROA_{it}	Return on assert	Dependent variable	% of Net income to Total asset
NPM	NPM_{it}	Net profit margin	Dependent variable	% of Net income to Total revenue
REI	REI_{it}	Renewable energy investment	Independent variable	Amount invested
BOIND	$BOIND_{it}$	Board Independence	Moderating variable	Number of directors in the board
BOT	BOT_{it}	Board Tenure	Moderating variable	Average number of years
BOEXP	$BOEXP_{it}$	Board Expertise	Moderating variable	Number of directors in the board
BOGND	$BOGND_{it}$	Board Gender	Moderating variable	Number of women presents on the board
FL	FS_{it}	Firm Leverage	Control variable	log of the total assets
FS	$LEVit$	Firm Size	Control variable	Total debt to total assets
	$\beta 0$	Constant		
	$\beta 1\text{-}5$	Coefficient of independent variables		
	ε_{it}	Error Term		
	I	Firm under consideration		
	T	Time period in a year		

In this study, the regression models equation (1a and 1b) is used to measure the direct relationship between renewable energy investment and firm financial performance.

Regression Models

$$ROA_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 FL_{it} + \beta_3 FS_{it} + \varepsilon_{it}. \quad (1a)$$

$$NPM_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 FL_{it} + \beta_3 FS_{it} + \varepsilon_{it} \quad (1b)$$

The Regression models used to measure the moderating effect of board characteristics are stated in equation 2,3,4 and 5.

$$ROA_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOIND_{it} + \beta_3 REI_{it} \times BOIND_{it} + \beta_{14} FL_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (2a)$$

$$NPM_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOIND_{it} + \beta_3 REI_{it} \times BOIND_{it} + \beta_4 FL_{it} + {}_5\beta 5 FS_{it} + \varepsilon_{it} \quad (2b)$$

$$ROA_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOT_{it} + \beta_3 REI_{it} \times BOT_{it} + \beta_4 FL_{it} + \beta_5 FS_{it} \varepsilon_{it} \quad (3a)$$

$$NPM_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOT_{it} + \beta_3 REI_{it} \times BOT_{it} + + \beta_4 FL_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (3b)$$

$$ROA_{it} = \beta_0 + \beta_1 REI_{it} \_ + \beta_2 BOEXP_{it} + \beta_3 REI_{it} \times BOEXP_{it} + \beta_4 FL_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (4a)$$

$$NPM_{it} = \beta_0 + \beta_1 REI_{it} \_ + \beta_2 BOEXP_{it} + \beta_3 REI_{it} \times BOEXP_{it} + \beta_4 FL_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (4b)$$

$$ROA_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOGND_{it} + \beta_3 REI_{it} \times BOGND_{it} + \beta_4 FL_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (5a)$$

$$NPM_{it} = \beta_0 + \beta_1 REI_{it} + \beta_2 BOGND_{it} + \beta_3 REI_{it} \times BOGND_{it} + \beta_4 FL_{it} + \beta_{15} FS_{it} + \varepsilon_{it} \quad (5b)$$

Diagnostics Test

In this study, the relationship between board characteristics, renewable energy investment and firm performance among oil and gas firms in sub-Saharan Africa, the study conducted the following Diagnostic tests:

The skewness and kurtosis test that shows the data is normally distributed across the cross-section, statistics suggest that independent and dependent variables are acceptably close to being normally distributed (Ojo et al., 2021). Skewness is a measure of the normal distribution's symmetry, or more accurately, its lack of symmetry. Kurtosis is a measure of the peakiness of a distribution. Sometimes the term "kurtosis" (proper) refers to the

initial kurtosis value. If a distribution or data set appears the same to the left and right of the centre point, it is said to be symmetric. A symmetric distribution is one in which the mean, median, and mode all match i.e, skewness = 0, and kurtosis (excess) = 0. A distribution is considered approximately normal if the skewness or kurtosis (excess) of the data falls between 1 and +1 (Mishra et al., 2019).

Multicollinearity tests were also carried out to determine the correlation among the study's independent variables. However, the VIF result indicates the non-existence of multicollinearity. Multicollinearity put simply, if there is a strong and consistent linear relationship between the predictor variables, then it suggests the presence of multicollinearity. The regression analysis might present a problem in determining the unique individual impact of each independent variable on the dependent variable. Multicollinearity can result in imprecise and unstable coefficient estimates, rendering the interpretation of results and the attainment of a meaningful conclusion from the model. Observing and addressing multicollinearity is required for the validity and reliability of regression models (Mishra et al., 2019).

Homoskedasticity is one of the assumptions of multiple linear regression models that states the variance of the errors must be constant. If the data do not have a constant variance, the data are said to be heteroskedastic (Gujarati & Porter 2009). Therefore, a Hausman specification test was conducted using the White Heteroskedasticity-Consistent Standard Errors & Covariance test. Because of the presence of heteroskedasticity in the data set, the pooled OLS model cannot stand for generalisation. The study conducted an Autocorrelation test to determine the serial correlation. Serial correlation is a statistical term used to describe the situation when the residual is correlated with lagged values of itself, which is not desirable (Nepal & Deb, 2022). In this study, the Breusch-Woodridge test has been applied to check the serial autocorrelation. Therefore, due to the presence of heteroskedasticity among the sample firms and the existence of autocorrelation issues in the data set, the study further conducted a panel corrected standard error to overcome both the heteroskedasticity and serial autocorrelation in the data set

RESULT AND DISCUSSION.

Table 4.1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Roa	500	0.066	0.058	0.001	0.310
Npm	500	3.868	2.839	0.190	13.800
Rei	500	3.701	3.008	0.000	7.350
Boi	500	0.589	0.216	0.200	0.990
Bot	500	5.340	2.038	2.000	8.000
Boe	500	0.377	0.157	0.100	0.890
Bog	500	0.234	0.134	0.000	0.8000
Fse	500	7.052	0.807	5.530	10.320
Lev	500	1.098	0.981	0.080	4.720

Table 4.2 Matrix of correlations

Variables	-1	-2	-3	-4	-5	-6	-7	-8	-9
(1) roa	1								
(2) npm	0.081*	1							
(3) rei	-0.143***	0.116*	1						
(4) boi	0.128***	0.090**	0.113**	1					
(5) bot	0.041	0.011	0.132***	0.038	1				
(6) boe	-0.122***	0.237***	0.114**	-0.021	-0.139***	1			
(7) bog	-0.007	0.250***	0.200***	0.210***	-0.079*	0.447***	1		
(8) fse	0.104**	-0.002	-0.287***	-0.012	-0.094**	0.022	0.105***	1	
(9) lev	-0.096**	-0.276***	-0.01	-0.06	0.091**	-0.272***	-0.25	0.056	1
*** p<.01, ** p<.05, * p<.1									

Table 4.3 Summary of Linear regression, correlated panels corrected standard errors (PCSEs)

	(1) roa	(2) Npm	(3) roa	(4) Npm
VARIABLES	model	Model2	Model3	Model4
Rei	-0.00249***	0.0658**	-0.00794**	-0.333***
	(0.000929)	(0.0294)	(0.00403)	(0.109)
Boi	0.0339***	0.600	0.0248	0.590
	(0.00865)	(0.402)	(0.0187)	(0.662)
Bot	0.00155	0.0673	0.000434	0.0266
	(0.00119)	(0.0454)	(0.00203)	(0.0912)
Boe	-0.0528***	2.265***	-0.0130	-0.905
	(0.0136)	(0.776)	(0.0320)	(1.546)
Bog	0.00823	2.516**	-0.108***	1.557
	(0.0183)	(1.182)	(0.0233)	(1.612)
Reixboi			0.000889	0.0179
			(0.00362)	(0.140)
Reixbot			0.000214	0.0129
			(0.000331)	(0.0200)
Reixboe			-0.00915	0.689***
			(0.00628)	(0.260)
Reixbog			0.0317***	0.305
			(0.00651)	(0.314)
Fse	0.00594**	0.0694	0.00450	0.0736
	(0.00266)	(0.118)	(0.00286)	(0.123)
Lev	-0.00787***	-0.620***	-0.00740***	-0.635***
	(0.00276)	(0.167)	(0.00265)	(0.186)
Constant	0.0316	1.659	0.0617**	3.171**
	(0.0225)	(1.248)	(0.0272)	(1.455)
Observations	500	500	500	500
R-squared	0.075	0.131	0.111	0.147
Number of company code	50	50	50	50

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Relationship between Renewable energy investment and Firm financial performance

In hypothesis one (H1), it is assumed that renewable energy investment has a positive relationship with firm performance of oil and gas firms in sub–Saharan Africa, whereas the finding, specifically, indicates renewable energy investment shows a significant negative relationship with ROA ($\beta = –0.00249$, $p < 0.01$). This finding is not unusual because it is in line with the previous studies of (Kaupke & K, 2023; Ganda & Milondzo, 2018), suggesting a potential decrease in return on assets due to capital intensiveness of renewable energy investment for oil and gas firms in sub–Saharan Africa. However, the same investment in renewable energy indicates a strongly significant positive impact on net profit margin ($\beta = 0.0658$, $p < 0.05$). This finding is in line with the studies of (Daferighe & Etim, 2023; Marthinsen et al., 2021; Kwame et al., 2023 and Mahmood et al., 2019), indicating improved profitability relative to revenue. This implies that while renewable energy initiatives may initially burden asset returns, they contribute positively to long-term profitability, likely through operational efficiencies, reputational gains, or cost savings. Thus, hypothesis H1 is therefore accepted. Consequently, renewable investment appears to be a strategically right decision for oil and gas firms in sub-Saharan Africa, particularly when long-term performance is prioritised.

Moderating role of Board Independence on the relationship between Renewable energy investment and Firm financial performance.

The empirical result reported in Table 4.8.2 above indicates the regression results of moderating effects of board independence on the relationship between renewable energy investment and firm performance of oil and gas firms in sub–Saharan Africa. Specifically, before the interaction, board Independence (BOIND) with (β = 0.000889 and β = 0.0179) indicates board independence has an insignificant relationship with ROA and NPM; the study result is consistent with the studies of (Nepal & Deb, 2022; Muniandy & Hillier, 2015 and Murtaza, 2020). The positive insignificant relationship means that as the board has many independences directors, ROA and NPM are not affected, implying that oil and gas firms in sub–Saharan Africa, independent directors focus more on compliance, monitoring, and risk control rather than aggressive profit-maximisation motives. The result of the regression after the interaction indicates a positive, insignificant relationship between the moderating effect of BOIND and REI on ROA and NPM with (β = 0.00362 and β = 0.140), which is consistent with the study of (Makpotche et al., 2023; Murtaza, 2020 and Bezawada & Adavelli, 2020).

Moderating role of Board Tenure on the relationship between Renewable energy investment and Firm financial performance

The hypothesis four (H4) of the research study where it is anticipated that Board tenure moderate positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa: The result on table 4.8.3 above indicate the regression results of the moderating effects of board tenure on the relationship between renewable energy investment and firm performance of oil gas firms in sub–Saharan Africa. Specifically, before the interaction, board tenure (BOT) with (β = 0.000434, 0.0266) has a positive, insignificant relationship on ROA and NPM, which is consistent with the studies of (Huang et al., 2018; Jiao Jia, Hongfeng Peng∗b, Hanwen Sunc, 2021; Livnat & Suslava, 2021 and Livnat & Suslava, 2021). This implies that longer board tenure is not associated with a substantial decrease or increase in profitability margins (NPM) and return on assets. The result of the regression after the interaction also indicates a positive, insignificant relationship between the moderating effect of BOT and REI on ROA and NPM with (β = 0.000214, 0.0129). These findings are in line with the previous research study of (Livnat & Suslava, 2021). This implies that board independence does not influence renewable energy investment to increase or decrease either return on assets or profitability of oil and gas firms in Sub-Saharan Africa.

Moderating role of Board Expertise on the relationship between Renewable energy investment and Firm financial performance.

The empirical result reported in Table 4.8.4 above shows the regression results of the moderating effects of board expertise on the relationship between renewable energy investment and firm performance of oil and gas firms in sub–Saharan Africa. The finding shows before the interaction, board expertise (BOE) has a negative insignificant relationship on ROA and NPM with (β = -0.0130, -0.905), the study is in consistent with the previous studies of (Kwarteng et al., 2023; Mlay et al., 2023; Nugraha, 2023; Shyamanthi, 2018 and Assenga et al., 2018), this indicates that while expertise is expected to enhance decision-making, the result shows that oil and gas firms board with expertise may instead not reduce profitability and eturn on asset of oil and gas firms in sub-Saharan Africa, because expert may prioritize compliance, risk control, and sustainability over aggressive profit-seeking. The regression result after the interaction indicates a negative and insignificant relationship between the moderating effect of BOE and REI on ROA wβ = -0.00915), which is usual and in line with the studies of (Bajwa et al., 2023), (Miotto, 2020), (Martín, 2019) and (Cheung & Lai, 2022). While the finding further shows board expertise moderately positively the relationship between REI and NPM and statistically significant at 1% level with (β = 0.689, $p < 0.01$). This finding is in line with the previous studies of (Calgary, 2020; Makpotche et al., 2023 and Cheung & Lai, 2022), implying that board expertise does not seem to reduce the ROA of firms, with which renewable energy investments translate into returns on assets. This could be because renewable energy investments are long-term strategic projects, and their financial benefits do not immediately reflect on ROA. Similarly, oil and gas firms with more expert boards can utilise renewable energy investments into higher profits, which helps boards evaluate, guide, and oversee renewable energy projects in ways that improve cost efficiency, attract renewable energy-focused investors, and open up revenue opportunities (e.g., carbon credits, cleaner production advantages).

Moderating role of Board Gender Diversity on the relationship between Renewable energy investment and Firm financial performance

Based on the empirical result in Table 4.8.5 above, hypothesis six (H6) where it is expected that board gender diversity moderates positively the relationship between renewable energy investment and firm financial performance of oil and gas firms in sub–Saharan Africa. The hypothesis six (H6) is accepted, because the study result indicates, specifically, before the interaction, board gender diversity (BOG) has a negative relationship and statistically significant at 1% level of significance on ROA ($\beta = -0.108$, $p < 0.01$) this finding is in line with the previous studies of (Saeed & Sameer, 2017), (A. M. Ali & Aminu, 2021) similarly from the results board gender diversity has a positive and insignificant relationship on NPM with ($\beta = 1.557$), the result is in consistent with the studies of (Saleh & Islam, 2020), (Asikhia et al., 2023; Governance, 2018) this implies that increasing board gender diversity is associated with a decrease in return on assets (ROA), which means gender diversity may be more symbolic than functional and lack influence in decision-making in oil and gas firms in sub Saharan Africa. Similarly, gender diversity does not increase the profitability of oil and gas firms in the region. But the regression result after the interaction indicates gender diversity moderates positively and has a significant relationship between REI and ROA of oil and gas firms in sub–Saharan Africa, with ($\beta = 0.0317$, $p < 0.01$), and the moderating effect of gender diversity has an insignificant positive relationship between REI and NPM with ($\beta = 0.305$). The result is in consistent with the findings of the previous studies of (Makpotche et al., 2023; Muhammad et al., 2020; Saleh & Islam, 2020 and Calgary, 2020), this implies that when firms have more gender-diverse boards, their renewable energy investments initiative are more likely to improve asset returns, which means female directors may bring new perspectives, stakeholder-oriented thinking, and renewable energy commitment, which help align renewable energy projects with operational and financial efficiency. Similarly, while board gender diversity also may not enhance the effect of renewable energy investment on profitability margins (NPM), the effect on margins is less consistent, which is likely due to high costs of renewable energy projects or the long payback period typical in the oil & gas sector of sub-Saharan Africa.

CONCLUSION

The findings show the financial effect of renewable energy investment among oil and gas firms in sub-Saharan Africa. In the short term, investment in renewable projects decreases returns on assets, largely due to high capital requirements and long payback periods. However, in the long run, renewable energy investments improve firms' profitability, as firms benefit from increased energy efficiency, enhanced corporate reputation, and limited exposure to environmental and regulatory-related risks. The study concludes that board independence does not moderate the relationship between renewable energy investment and firm performance of oil and gas firms in sub–Saharan Africa, implying that, while board independence strengthens governance credibility, independent directors may not be actively engaged in bringing or facilitating renewable energy projects that could improve firms' financial performance. The study concludes that board tenure does not significantly moderate the relationship between renewable energy investment and firm financial performance among the oil and gas firms in sub-Saharan Africa. Although directors with longer tenure may contribute valuable experience, bring stability, excessive long tenures may reduce directors' motivation to pursue innovative or high-risk sustainable investments that can enhance long-term profitability in the oil and gas industry. The result further concludes that board expertise plays a different moderating effect in the relationship between renewable energy investment and firm performance among oil and gas firms in sub-Saharan Africa. Specifically, board expertise is better positioned to guide investment in renewable energy projects in a way to improves long-term financial stability and market competitiveness, rather than immediate asset returns. The study also concludes that board gender diversity moderates the relationship between renewable energy investment and firm performance of oil and gas companies in sub–Saharan Africa. Female directors on the board contribute to better evaluation, good oversight and innovative investment decisions in renewable energy projects with sustainability and financial objectives.

Policy Implications

Governments in sub-Saharan Africa should design financial incentives, for example, tax reliefs, subsidies, and low-interest green financing, to mitigate the high costs of renewable energy projects. This will encourage greater adoption among oil and gas firms in the region.

The oil and gas firms in sub–Saharan Africa should diversify their energy portfolios to gradually shift from carbon-intensive activities toward renewable energy projects for long-term stability and compliance with global decarbonization sustainable goals.

The firms should give emphasis to board training, capacity development for directors to deepen their knowledge on the implications of renewable energy initiatives within the oil and gas sector. Also, policymakers should review and enhance corporate governance codes to ensure that directors not only perform oversight roles but also contribute to strategic innovation, energy transition planning, and performance evaluation.

SUGGESTION

This study is limited to only one factor, i.e renewable energy investment. Future studies could extend the model to include social and environmental performance metrics to provide a more holistic understanding of how board characteristics influence the relationship between other factors on the financial performance of oil and gas companies.

Another limitation is that this study limited itself to one sector. Therefore, comparative studies across different sectors (e.g., manufacturing, utilities, or mining) could also reveal whether the moderating effects result are unique to the oil and gas sector only.

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