

Board Structure and Risk-taking in the Extractive Industry in Kenya

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Abstract

The purpose of this paper is to investigate the relation between board structure and firm risk-taking in a sample of 8 extractive firms listed on the Nairobi Securities Exchange (NSE). The agency theory provided the theoretical foundation for this study. The study adopted a descriptive research design. It employed a purposive sampling technique to determine the sample size of extractive firms on the NSE from 2019-2023. The data was retrieved from annual reports of sampled firms. Further, Fixed Effect Model and Two-stage Least Squares (2SLS) methods supported data analysis and reliability check, respectively. Using 5 years of balanced panel data, the results show that board size and female gender diversity are statistically significant, negatively and positively associated with firm risk-taking (z-score), respectively. Additionally, evidence indicates that the interaction between independent directors and female gender terms is positively related to the z-score. In contrast, the findings on the relationship between independent directors and risk-taking are considerably mixed. Besides, the study highlights practical implications for policy reforms that require more extractive firms to list on stock exchanges and mandate female board representation. Finally, the study offers a literature review on the linkage between risk-taking and board structure in the extractive industry.

Keywords: Corporate Governance, Board structure, Risk-taking, Extractive Firms

1.0 INTRODUCTION

Over decades, corporate governance literature has devoted little effort to studying board structure and risk-taking, resulting in several gaps that require filling (Kaituko et al., 2023; Minh & Bich, 2023). Moreover, academic research associated with corporate governance and risk-taking in the extractive industry has captured less attention despite the vital contribution of the profuse mineral resources to the country's socio-economic development (Askarany et al., 2025; Younas et al., 2019). The underperformance of the extractive industry in socio-economic development was partly driven by weak corporate governance, lack of transparency, corruption, and greater risk-taking (Magoma & Ernest, 2023; Mumtaz et al., 2021; Tago & Sumawe, 2024). Therefore, the core objective in this study is to offer an understanding of the connection between board structure and risk-taking in the extractive industry. More importantly, the study attempted to answer the following fundamental research question: *Do corporate board characteristics influence firm risk-taking in Kenya?*

It is salient to empirically analyse the extractive industry for the following reasons: One, the tax revenues generated from and jobs created by the industry can promote sustainable economic and social development in a nation. Two, the extractive operations are exposed to assorted risks (Dewanta & Arifin, 2020). To safeguard equitably the interest of shareholders, excessive risks should be managed. The study is carried out in Kenya as an illustrative case for three reasons: First and very critical is the fact that many extractive firms have opened doors in this country, and Africa alone is largely the heart of the world's mineral reserves. Second, the guidelines on corporate governance practices in Kenya are deemed to be at the infant stage, and their execution is at a slow pace. In comparison, Davies et al. (2022) and Sumawe & Magoti (2025) conclude that the closed and risk-taking behaviour of opaque entities in the Russian extractive industry has considerably diminished because of the growing sound corporate governance. Finally, at first glance, the Kenyan government regime has unearthed several scandals in public-owned institutions - i.e. fraud, money laundering, office abuse, board incompetence and corruption.

The main findings show that board size and the firm risk are negatively associated, consistent with the principal-agent model. This implies that risk can be increased if firms have smaller board sizes. It is also indicated that board female gender diversity is positive and statistically significant in the z-score. The evidence may suggest that females in boards are more risk-averse; therefore, they have less incentive to pursue more risky strategic decisions. Furthermore, the interaction between independent directors and female gender terms is positively related to the z-score, suggesting the reduction of both insolvency risk and the

possibility of bankruptcy. It should, thus, be argued that the female board directors' enthusiasm outweighed the roles of independent managers in pursuing more risk. Contrastingly, the study has shown that the relationship between independent directors and risk considerably varied.

Subsequently, this study adds to extant literature in at least four important ways. First, to our knowledge, it offers the first empirical endeavour to link risk-taking and board structure in the extractive industry. Prior empirical evidence in the extractive industry found that board size is higher in Russian oil and gas producers than in South African gold producers (Dahiru Tahir et al., 2024; Fariska & Khaerunisa, 2024). Corporate governance has no economic effect on the petroleum firms in Pakistan (Nduati Kariuki, 2023). CEOs whose compensation is more sensitive to stock return volatility have an incentive to take more exploration risk and maintain lower hedge ratios in oil and gas producers (Musah et al., 2022), and consistent with agency theoretic predictions, risk management strategy helps to maximise shareholder value in the North American gold mining industry (Tufano, 1996). In this perspective, the study adds to the literature the understanding that corporate board characteristics are salient mechanisms in influencing firm risk-taking.

Second, the area of corporate governance literature inquiry on board attributes and firm risk-taking relation is limited and no consensus (Boadi et al., 2023; Migliori & Muhammad, 2023). Studies on this relation focus on the developed countries, and less interest is given to developing countries (i.e. Sub-Saharan Africa). Third, the study contributes to the existing literature by considering risk-taking and the interaction terms of independent directors and the board the female gender diversity on risk measures. This is new evidence. Previously, empirical studies focused on directly connecting risk-taking proxies and board structure parameters (Ulfa Subastian & Setiawan, 2022). Finally, this study contributes to the literature by highlighting policy reforms that require extractive firms to list and mandate female board representation.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework Background

Earlier studies have extensively empirically examined board structure and firm performance, and have focused less on risk-taking (Labija Amana et al., 2023), guided by the classic convergence of interest agency theory (Jensen and Meckling, 1976). The influence of board structure on firm risk-taking is investigated. In corporate firms, the separation of ownership from control creates an agency problem. The agency theory advances that managers (agents) are risk-averse and may not align their best interests with those of the owners (Jensen and

Meckling, 1976; Smith and Stulz, 1985). Following this, a strong and effective board of directors will mitigate agency conflicts to pursue their self-serving behaviour at the expense of shareholders. Because of the absence of a formal general economic theory of board structure, Jensen (1993) highlights three pertinent board monitoring characteristics to include board size, board independence and board leadership. The agency theory is applicable in this study, as extractive industries on NSE are run and managed by board members on behalf of owners and in turn, managers will be risk-averse, inconsiderate of shareholders' interests. Findings from extant research are consistent with the agency theory, advocating that the board of directors' role is to overcome managerial risk-aversion behaviour. As such, smaller boards are incentivised to pursue risky policy choices that converge with shareholders' interests. Prior researchers investigating corporate board structure, performance and risk-taking applied agency theory (Wang, 2022). It is reported that the same theory is relevant in research examining board structure and risk-taking in the extractive industry for least developed countries like Tanzania and Kenya.

The literature review is further anchored by the following three hypotheses:

2.1.1 Board size and firm risk-taking

The association between board size and firm risk-taking remains an unanswered question (Setiawan et al., 2023). Using US firms (Ulfa Subastian & Setiawan, 2022), find that board size and corporate performance variability are negatively related. The study by Rachdi and Ben Ameer (2021), who examined the relation between board size and corporate risk-taking in Japanese listed firms, shows identical results. They noted that a larger board does not necessarily result in lower risk-taking since many risky projects can be accepted during the screening stage. Yet, Nakano and Nguyen (2012) indicate the lower effect of board size on risk-taking in Japan than in the US, attributable to cultural and institutional environment differences. Other studies that look at the negative association between board size and risk taking include: in Chinese publicly traded firms (Ramly & Ramli, 2022); in the US banking industry (Yusuf et al., 2023); in UK firms (Mathew et al., 2016). Accordingly, evidence on this body of literature is consistent with Jensen's (1993) comment that smaller boards are preferable because they are more efficient and enhance risk-taking. Contrastingly, Assenga & Aly (2018) found board size to be insignificant and irrelevant to risk-taking in UK financial firms.

On the contrary, using the oil price collapse of the autumn and winter of 2014, (Chumba, 2015) provides that classified boards (significant and negative) and not board size (significant and positive) aggravated the impact of corporate risk-

taking on performance. More recently, (Muhammad et al., 2023) find that larger board size leads to greater leverage (financial risk), and the same is reduced by independent directors in Malaysian firms. They argued that a larger board size can be a firm's performance-destroyer. The positive sign suggests that larger boards may play a critical advisory role in the risk management practices, leading to firm value creation (Askarany et al., 2025; Wang, 2022).

To sum up, findings from this strand of research are consistent with the agency theory, advocating that the board of directors' role is to overcome managerial risk-aversion behaviour. As such, smaller boards are incentivised to pursue risky policy choices that converge with shareholders' interests. The arguments and discussion above suggest that the relevance of board size on firm risk-taking is unresolved, notwithstanding smaller board is recommended. Accordingly,

Hypothesis 1: A negative relationship will exist between board size and firm risk-taking.

2.1.2 Independent directors and firm risk-taking

Apparently, agency theory holds that independent directors are more objective and provide stronger monitoring for higher firm performance. Prior literature that examines the nexus of board independence and firm risk-taking has reported a negative, positive or no relation, suggesting mixed and contradicting evidence. Some empirical evidence shows that board independence and risk-taking are positively related; for instance, (Davies et al., 2022) European banks (Mathew et al., 2020); and Chinese firms (Huang and Wang, 2015). Evidence from this literature supports the conventional wisdom view that boards composed of majority of independent directors promote higher managerial risk-taking. Other researchers noted a negative link between board independence and firm risk-taking; US financial services firms (Davies et al., 2022; Lawal, 2018; Nyoni et al., 2021); Japanese firms (Musah et al., 2022); UK financial sector (Migliori & Muhammad, 2023), Chinese firms (Li, 2016) and Malaysian firms (Boadi et al., 2023). The evidence from this group implies that independent directors exhibit a higher degree of risk aversion. This could happen as follows: one, many executive compensation contracts make managerial compensation contingent on firm performance. Two, stringent governance can restrain managerial preferences from formulating corporate policies.

Finally, Kaituko et al. (2023b; Labija Amana et al., 2023) and Setiawan et al. (2023) find no relation between the two variables. Most recently, (Ulfa & Setiawan, 2022) and (Rachdi & Ben Ameer, 2021) (2020) report that well-connected bank CEOs and founders' leadership on the board are related to risk-

taking in Chilean listed family firms and US public banks, respectively. From the above discussion and the agency theorists' prediction, the link between independent directors and risk-taking is still controversial. Consequently,

Hypothesis 2: A positive relationship will exist between the proportion of independent directors and firm risk-taking.

2.1.3 Board gender diversity and firm risk-taking

Diversity is beneficial as people with different backgrounds provide varied health opinions in the decision-making process. It has been documented that females are different from males in their choices and preferences in terms of risk perceptions, desired exposure to competition, altruistic behaviour, monitoring intensity, and deceptive dimensions (Ramly & Ramli, 2022; Temitayo Odunsi et al., 2024; Yusuf et al., 2023). Consistent with the conjecture that males are more overconfident than their female counterparts, (Hesniati, 2024; Musah et al., 2022; Nodeh et al., 2015), to mention a few, show compelling evidence that female gender is negatively associated with firm risk-taking. They conclude that this is female gender risk aversion behaviour in the boardroom, highlighting females being less overconfident in risky corporate strategic decisions. Explicitly, (Minh & Bich, 2023; Mumtaz et al., 2021) establish that female directors pursue less aggressive acquisition strategies in acquisition bids by S&P 1,500 firms. Equally, in Compustat/CRSP and RiskMetrics databases, (Mathew et al., 2020) report that firms run by female CEOs have lower leverage (i.e. financing choice), less volatile earnings (i.e. investment choice) and higher survival probability.

Critics of the females who are less overconfident posit that as females become less risk-averse and more overconfident, their contributions in corporate boards positively influence decisions that are in shareholders' interests. With this position, (Dahiru Tahir et al., 2024; Fariska & Khaerunisa, 2024; Nduati Kariuki, 2023) exemplify a positive link between female gender diversity and firm risk-taking. On the same note, (Mathew et al., 2020) indicate that gender female representation in boards appears not to be an important trait for risk-taking. In this vein, it can be argued that the presence of females on the board in the decision-making process can lead to risk-taking actions. Based on the contentions above, it is predicted that the interaction of female gender diversity and board independence of directors' terms may enhance firm risk-taking.

Following the views above, the representation of both female and large independent directors is for shareholders. These arguments lead to:

Hypothesis 3a: A negative relationship will exist between female gender and firm risk-taking.

Hypothesis 3b: A positive relationship will exist between the interaction of female gender and independent directors, and firm risk-taking.

3.0 DATA AND METHODOLOGY

A research design is a plan that has details on how to find answers to the research objectives and research hypothesis, respectively, besides addressing any other challenges that were encountered during the study. The study adopted a descriptive research design. In addition, the study employed a purposive sampling technique to determine the sample size of extractive firms on the NSE from 2019-2023. The data was retrieved from annual reports of sampled firms. Further, Fixed Effect Model and Two-stage Least Squares (2SLS) methods supported data analysis and reliability check, respectively. Sample determination is explained as:

3.1 Sample Selection

Annual reports were obtained from the Nairobi Securities Exchange (NSE) website in Kenya. Consequently, an initial sample size of 64 publicly traded listed firms as of 31 December 2023 was selected. Both financial and board structure secondary data were hand-collected using consolidated balance sheets, and income and profit or loss and other comprehensive income statements. To arrive at the final sample, the following exclusion criteria were employed: One, every extractive firm in the sample was a gas, electricity, petroleum, or mining firm; otherwise, it was removed from the data sets. A total of 56 non-extractive firms were excluded. Two, each firm had data for the period 2019-2023. Accordingly, a minimum of three consecutive years of observation allows a robust check (Fosu et al., 2017). The critical motivation of the studied period was characterised by corporate governance practices, low accountability in boards, and hike in money laundering wave, and a higher economic sabotage level, thereby proposing that boards are indispensable to firm risk-taking. Therefore, the sample selection process resulted in the final sample with 8 extractive firms and spanning 40 usable observations. Variable construction is divided into two panels – variables associated with board structure and firm-level characteristics.

3.2 Measurements

3.2.1 Risk Measures

The primary dependent risk measures in the regression analysis are z-score and standard deviation of Tobin's Q. Z-score is defined as the inverse of the return on assets ratio (ROA) plus equity-assets ratio (E/A) divided by the standard deviation of return on assets $\delta(\text{ROA})$. Prior, Z-score has been widely used in empirical literature to measure the deviations from insolvency and as an indicator of financial fragility and the financial distress prediction of a firm (Askarany et

al., 2025; Dahiru Tahir et al., 2024; Lawal, 2018). The calculated z-score is transformed into positive values by taking absolute values. High z-score reflects low insolvency, and vice versa. The standard deviation of Tobin's Q is expressed as the standard deviation of the book value of assets minus the book value of equity, plus the market value of equity, scaled by the book value of assets (Migliori & Muhammad, 2023; Rachdi & Ben Ameer, 2021; Ramly & Ramli, 2022). To identify the underlying drivers of changes in the risk proxy, the study used board structure characteristics.

3.2.2 Empirical Specification

To test hypotheses developed on the connection between board structure and firm risk-taking, the multivariate structural model specification used is fixed effects, shown in equation (1). The application of the fixed effect framework over OLS is because it represents a common, unbiased estimator of controlling for omitted variables (unobservable heterogeneity) in a panel data (Hausman and Taylor, 1981). Thus, the Hausman test was also conducted, and the fixed effect model was chosen instead of the random effect model as the highest Prob>chi2 = 0.0215 across all regressions. If the p-value is small (less than 0.05), the null hypothesis is rejected. The fixed effects model has been broadly applied (Minh & Bich, 2023; Sumawe & Magoti, 2025) Yermack, 1996).

$$ZS_t = \alpha + \beta_1 BS + \beta_2 INDD + \beta_3 GENDER + \beta_4 INDD * GEN + \beta_5 LNSIZE + \beta_6 LEV + \beta_7 Time.Dummy + \varepsilon \dots \dots \dots (1)$$

$$SDTQ_{it} = \alpha + \beta_1 BS + \beta_2 INDD + \beta_3 GENDER + \beta_4 INDD * GEN + \beta_5 LNSIZE + \beta_6 LEV + \beta_7 Time.Dummy + \varepsilon \dots \dots \dots (2)$$

where Risk_{it} is represented by z-score (ZS) and standard deviation of Tobin's Q (SDTQ), and *i* and *t* represent the firm and time, respectively.

The centrality proxies as independent variables are on the coefficient estimates of board characteristics shown in Table 1 - Board Size (BS), Board Independence (INDD), female (GENDER-GEN) (Dahiru Tahir et al., 2024; Musah et al., 2022). Negative estimate BS on risk measures refers to the relevance of smaller boards in highlighting firm risk-taking, consistent with the hypothesis that strong boards positively affect managerial risk-taking behaviour. A positive coefficient estimate of INDD on insolvency score indicates independent directors' incentives to shape managerial risk-taking behaviour. Positive parameter estimate of GENDER on standard deviation of Tobin's Q and negative parameter estimate of GENDER on z-score imply the way females are less risk-averse regarding corporate investment decisions. This is true for the coefficient estimate of the

interaction of board independence and diversity independence board (β_4) on firm risk.

Table 1: Definitions of Variables

Variables	Measures
<i>Risk Measures</i>	
z-score	The return on assets plus equity assets ratio divided by the standard deviation of return on assets
Standard deviation of Tobin's Q	Standard deviation of the book value of assets minus the book value of equity, plus the market value of equity, scaled by the book value of assets.
<i>Board characteristics</i>	
Board size (BS)	The total number of board of directors on the board.
Percentage of independent directors (INDD)	The percentage of board seats held by non-employee, former executive, or relative of a current corporate executive of the firm, who does not have substantial business relationships with the firm, either personally or through his or her main employer, divided by the board size.
Gender	A dummy variable equals 1 when there is at least one female on the board, or otherwise 0.
Tenure	Measures the number of years served by the current CEO.
<i>Control Variables</i>	
Leverage	The total debt divided by the total assets' ratio
Return on assets (ROA)	Profit after tax divided by total assets
Natural log of total assets (LnTA)	Natural logarithm of total assets of a firm, a proxy for firm size
Year dummies	Year dummies - 2010-2014 capture inter-temporal variations in market conditions, tax effect and institutional framework effect

Next, coefficients β_5 - β_7 stand for control variables for firm size, leverage and time and country dummy variables, respectively. This is because these variables are aimed at controlling other sources of ex-ante heterogeneity and represent forces that influence risk-taking. And, time effects, which control for inter-temporal variations in country market conditions, tax effects and firm industry differences, are captured by the time dummy variable (β_7). Finally, to correct for heteroskedasticity and serial correlation, this study used White's (1980) heteroskedastic standard errors. The analysis of data was carried out by using STATA software.

4.0 EMPIRICAL RESULTS

4.1 Descriptive statistics and pair-wise correlation matrix

The definitions for variables used in this study are presented in Table 2. Dependent, independent and control variables are defined. Table 2 contains a descriptive statistics summary for the energy, petroleum and mining listed firms in the sample using year-end data over the period 2019-2023. It is interesting to

note that the z-score, a risk measure, ranges from -1.773 to 9.157. A higher z-score (distance from the default point) implies greater stability in extractive firms. In contrast, Pathan (2009) and Magoma & Ernest (2023) reported a distance from 2.24 to 211.31 and 1.56 to 5.14 z-score in banking firms, respectively. Tobin's Q values range from 0.892% to 5.42%.

Table 2: Descriptive statistics

Variable	N	Mean	Std. Dev.	Min	Max
z_score	40	3.854	2.931	-1.773	9.157
Tobin's Q (%)	40	0.892	1.222	0.084	5.418
Board size (#)	40	8.350	2.931	4.000	13.000
%ge of independent Directors	40	60.784	16.027	37.500	100.000
GENDER	40	0.550	0.504	0.000	1.000
Tenure (years)	40	3.275	2.298	1.000	10.000
Leverage (%)	40	10.250	13.973	0.000	48.889
Return on asset (%)	40	8.538	11.447	-37.860	26.130
LnTA (TZS Trillion)	40	27.160	1.617	23.978	29.286

The findings show that board size is between 4 and 13 directors, with a mean of 8 directors. The percentage of independent directors displays an average value of 61%. The mean value of female gender diversity made up 55% of the directors in the extractive firms. For other variables, the mean, standard deviation, minimum and maximum values are indicated in Table 2.

Table 3 lists a pair-wise correlation matrix between explanatory variables, at the 5% level of significance. This matrix is intended to identify multicollinearity concerns. The results show the largest correlations are between percentage of independent directors (INDD) and board size (BS) – (0.656); board size, and firm size (LnTA) and leverage (0.836 and 0.756) respectively; female gender diversity and firm size (0.530), therefore, making results interpretation difficult. Accordingly, the highly correlated regressors are orthogonalized or replaced. Post-estimation variance inflation.

Table 3: Correlation matrix

Variable	BS	INDD	GENDER	Tenure	LEV
INDD	-0.656	1.000			
GENDER	0.543*	-0.662	1.000		
Tenure	0.286	-0.028	0.110	1.000	
LEV	0.756*	-0.418	0.452*	0.506*	1.000
LnTa	0.836*	-0.596	0.530*	0.044	0.476*

Asterisk * indicates statistically significant at the level of 5%.

Variance Inflation Factor (VIF) test in every regression model is performed to confirm the variation from the benchmark of VIF=10.

4.2 Board attributes and firm risk

In this section, the empirical results for equation (1) testing for the extent to which board characteristics influence risk-taking in extractive firms are reported. Board attributes include board size, percentage of independent directors, and female gender diversity.

4.2.1 Board size, independent directors and female gender, and firm risk

Table 4 reports the estimates of the model specification in six (6) columns in the fixed effects estimator. For each risk measure, three columns are presented. Systematically, columns (2)-(3) show that firm risk-taking is explained by board size (BS). Specifically, in columns (2)-(3), the results consistently indicate that the estimated BS is statistically significant (at 5% and 1% levels) and negatively related to z-score, respectively. The negative association can be interpreted as that small board size led to higher managerial risk-taking behaviour, which in turn, increased the possibility of firm bankruptcy. In column (2), the percentage of independent directors (INDD), and in column (3), tenure and firm characteristics are controlled. In all columns (2)-(3), the results on the estimated BS remain with the earlier prediction as presented in column (1). Yet, in column (1), BS enters in z-score negatively, and it is insignificant.

Table 4: Analysis of z-score and standard deviation of Tobin's Q as a function of board structure

Dependent Variable			z-score (1/Z)	Standard deviation of Tobin's Q		
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
BS	-0.088 (-1.090)	-0.166** (-2.569)	-0.188*** (-4.047)	-0.083 (-1.202)	-0.117 (-1.644)	-0.137 (-1.358)
INDD		-0.021 (-1.731)	-0.018 (-1.556)		-0.009 (-1.750)	-0.009 (-1.764)
GENDER			0.619** (-2.426)			-0.110 (-0.662)
Tenure			-0.062 (-1.109)			0.082 (0.969)
Leverage	-0.022 (-0.819)	-0.037 (-1.414)	-0.056 (-1.642)	0.049 (1.142)	0.043 (1.036)	0.064 (1.033)
LnTA	0.257 (0.673)	0.137 (0.471)	0.264 (0.981)	-0.560 (-0.955)	-0.612 (-1.082)	-0.760 (-1.093)
Intercepts & year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	40	40	40	40	40	40
R ²	0.194	0.376	0.477	0.183	0.211	0.280

Robust t-statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01

Generally, the results on the link between board size and risk-taking are consistent with those reported by (Davies et al., 2022; Mathew et al., 2020; Wang, 2022), and Nakano and Nguyen (2012), and are explained by agency theorists' prediction. Conversely, the finding is not in line with (Lawal, 2018). Empirical evidence in publicly listed firms from Bursa Malaysia, shows that larger board size contributes to greater financial risk. The negative relationship goes with the notion that small boards may encourage management to execute risk-increasing projects, analogous to the principal-agent theoretical framework prediction.

In columns (4)-(6), the estimated coefficients on BS remain with the earlier negative prediction sign, but, insignificant on the standard deviation of Tobin's Q, the second measurement of firm risk, consistent with that in (Migliori & Muhammad, 2023). Hence, the results cannot be directly construed as board size is irrelevant in promoting managerial risk-taking behaviour in the extractive firms. The argument that can be advanced to this position is that the board size influence is not homogenous across all firms. Based on the results presented in columns (2)-(3), *Hypothesis 1* is accepted.

In Table 4, columns (2)-(3) and (5)-(6), the results on the percentage of independent directors (INDD) and risk measures are negatively related and insignificant. This finding contradicted (Boadi et al., 2023; Labija Amana et al., 2023), and (Rachdi & Ben Ameer, 2021) empirical work. Moreover, the result is inconsistent with positive direction evidence documented in (Nodeh et al., 2015; Yusuf et al., 2023), and (Setiawan et al., 2023). Consequently, this empirical evidence is unable to support *Hypothesis 2*.

Table 4 in column (3) connects female gender diversity (GENDER) and risk-taking. In this regard, it is found that z-score and female gender diversity are positively associated at 5% significance level. A significant positive coefficient estimate on the GENDER illustrates that with female gender diversity on boards, the firm's distance to default is higher. That is, the higher the distance to default, the greater the firm stability, and the lower the probability of firm insolvency risk. Additionally, consistent with a less overconfident view, female-female-positive sensitivity reflects that female board directors are more risk-averse in engaging in aggressive strategies. This result offers support to the existing empirical literature that documents females being more risk-averse in corporate decision-making (Kaituko et al., 2023; Mumtaz et al., 2021). Thus far, the result is contrary to the agency theory prediction and contradicts findings by (Mathew et al., 2020; Minh & Bich, 2023; Nduati Kariuki, 2023), among others, who show that board members are less risk-averse and positively influence firm risk. Accordingly, *hypothesis 3a* is supported. With this position on the *hypothesis*, further analysis is carried out in Section 5 to validate the results.

4.2.2 Independent directors and female gender interaction and firm risk

In this section, the percentage of independent directors and female directors is discussed. Next, the new main variable, INDD*GEND term is constructed and connected with firm risk measures. The findings from this analysis are shown in Table 5. In column (1), the estimated coefficient of INDD*GEND is statistically significant at 10% level, and with a positive sign in z-score. The result explains that the interaction of these two board characteristics reduced firm risk-taking that might have resulted in firm insolvency risk and bankruptcy possibilities. Therefore, *hypothesis 3b* is not accepted.

Table 5: Analysis of z-score and standard deviation of Tobin's Q as a function of the interaction of independent directors and gender diversity

Dependent Variable	z-score (1/Z)	Std of Tobin's Q
Independent variable	(1)	(2)
BS	-0.185*** (-3.610)	
Rbs		-0.137 (-1.323)
INDD	-0.054* (-2.034)	-0.011* (-2.218)
GENDER		-0.280 (-0.347)
INDD*GEND	0.105* (2.273)	0.030 (0.223)
Tenure	-0.063 (-1.067)	0.082 (0.95)
Leverage	-0.057 (-1.647)	0.064 (1.017)
RLnTA	0.427 (1.537)	
LnTA		-0.769 (-1.068)
Intercepts & Year dummies	Yes	Yes
N	40	40
R ²	0.480	0.281

Robust t-statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01

The above evidence translates that when boards are composed of independent directors and some females (at least one member), this firm's strategic mix negatively leads to risk-taking reduction in the extractive firms. With this finding, it may be logical to argue that female directors' interests outweighed independent directors' counterparts' interests, which, in turn, downsized the extent of firm risk-taking. The coefficient estimate of BS is negative in column (1), hence, comparable to that shown in Table 4. This evidence adds further support to *Hypothesis 1*.

Interestingly, in columns (1)–(2), the coefficient estimate of INDD is negative in both z-score and standard deviation of Tobin’s Q, at 10% significance level. That is, independent directors increased risk-taking in z-score directors (Boadi et al., 2023) and reduced the same in the standard deviation of Tobin’s Q. This evidence is somewhat contradictory, thus suggesting more enquiry on this linkage.

5.0 ENDOGENEITY CHECK

A cross-sectional regression of performance on board structure will be biased, as changes in the board of directors may arise from endogeneity concerns in prior firm performance (Ulfa & Setiawan, 2022). This could be true for past firm risk-taking. To control this concern, the system of equations of two-stage least squares (2SLS) is estimated, as in Agrawal and Knoeber (1996). In the system, standard deviation of Tobin’s Q, proxying firm risk, board size and percentage of independent directors are treated as endogenous variables. Firm size is replaced by total debt, and other variables like ROA are introduced in the system as instrumental variables. A test for validity and significance of total debt and ROA indicated $F(2, 37)=15.13$ at $p=0.000$. This is above the thumb rule of $F > 10$. The results from the 2SLS are shown in Table 6. BS retained the same negative pattern, but, is insignificant. This evidence adds little support to that presented in Table 4.

Table 6: Two stage least square (2SLS): Standard deviation of Tobin’s Q, board size and independent directors

Dependent Variable	sdQ	BS	INDD
Independent variable			
BS	-0.284 (-1.679)		-0.049 (-0.011)
sdQ		-3.524 (-1.679)	7.114 (0.481)
INDD	0.015 (0.220)	0.052 (0.198)	
GENDER	0.274 (0.236)	0.967 (0.216)	-15.384** (-2.632)
Tenure	0.114 (0.929)	0.403 (1.283)	0.395 (0.177)
Intercepts and year dummies	Yes	Yes	Yes
N	40	40	40
R ²	0.131	.	0.416

Robust t-statistics in parentheses * $p<0.10$, ** $p<0.05$, *** $p<0.01$

6.0 CONCLUSION AND IMPLICATIONS

The setting of this study is linked to agency theory that, board of directors' risk-averse behaviour would result in the reduction of shareholders' wealth and impair their interests. Using 8 listed extractive firms in Kenya over the period 2019-2023, the relationship between board structure and risk-taking is shown. The findings indicate that board size and risk-taking (z-score) are negatively associated. These findings are in line with (Dahiru Tahir et al., 2024; Kaituko et al., 2023) studies that found a negative result between board size and risk-taking. Further, a negative coefficient estimate of board size accentuates that a smaller board size increases firm risk-taking. The finding also indicates that the percentage of independent directors is negative in both z-score and standard deviation of Tobin's Q, entailing an increased risk for directors (Labija Amana et al., 2023; Rachdi & Ben Ameer, 2021) and decreased firm risk-taking, respectively.

Moreover, female-gender diversity and the interaction between independent directors and female gender are positively related to z-score, suggesting that female board members are more risk-averse and less overconfident in the corporate risk decision-making process. The study findings concur with (Hesniati, 2024; Temitayo Odunsi et al., 2024) studies that found risk-averse behaviour among women directors in corporate firms. Therefore, we conclude there is a significant association between board structure and risk-taking in extractive firms.

Turning attention to the contribution and implications of the study, the synthesised empirical literature on corporate governance and firm risk-taking is narrow, with several gaps to fill. Consequently, this study contributes understanding of the board structure's influence on risk-taking in extractive firms in developing countries. The study establishes that female gender directors are more risk-averse in pursuing the best interests that converge with their shareholders. In this perspective, it can be argued that reforms should be made that mandate more female board representatives in corporations. Also, the study advocates for other developing countries like Tanzania to list extractive firms on their stock exchange markets for diluted ownership and improved corporate governance. In addition, the study offers literature foundations on the linkage between risk-taking and board structure in the extractive industry.

Finally, the study had a few exceptional limitations. One, the listed extractive firms in NSE are few, which resulted in a small sample size; though studying the whole population of 8 firms by the current study reduced the bias. Secondly, future researchers can incorporate other variables like firm age, CEO ownership

and duality of the same person as a CEO and Chairperson of a firm in future studies.

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