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CAPITAL STRUCTURE AND FINANCIAL PERFORMANCE IN MAJOR ALGERIAN FIRMS

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ABSTRACT

This study examines the effect of capital structure on the financial performance of major Algerian firms over the period 2020–2024. A balanced panel of six large companies — Sonatrach, Biopharm, Saidal, El Aurassi, Alliance Assurances, and Sonelgaz — is analyzed using two accounting-based performance indicators (ROA and ROE) and two leverage proxies (Debt Ratio and Leverage). Panel data models are estimated, and appropriate specification tests are applied to select the optimal estimator. The findings reveal a statistically significant negative relationship between debt ratios and both ROA and ROE, with leverage exerting a stronger adverse effect on equity returns than on asset returns. Random Effects models are preferred over pooled OLS based on the Breusch–Pagan LM and Hausman specification tests, highlighting the importance of firm-specific heterogeneity. Firm size and sales growth are positively associated with financial performance. The results are consistent with Pecking Order, Trade-off, and Agency theories in the context of costly bank financing and underdeveloped capital markets. Financial managers are encouraged to adopt more moderate leverage levels, while regulators are advised to promote alternative market-based financing instruments to reduce firms' dependence on bank credit.

1 INTRODUCTION

1.1 Study Background

Capital structure is a central issue in corporate finance because it determines how a firm combines debt and equity to finance its activities and influences both risk and return. In Algeria, this choice is made under conditions of weak capital markets, information asymmetry, and macroeconomic instability (IMF, 2024), with major firms relying heavily on relatively expensive bank credit and operating under strong state ownership.

The years 2020–2024 were particularly challenging for these firms, given COVID-19 disruptions, oil price fluctuations affecting Sonatrach, and recurrent exchange rate pressures (World Bank, 2020; IMF, 2024). Such conditions raise the question of how alternative capital structure choices translate into differences in profitability, measured here by Return on Assets (ROA) and Return on Equity (ROE).

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1.2 Research Problem

Algeria's 2020 Finance Law introduced measures to support capital market development, but there is still no clear empirical picture of how capital structure affects the performance of large Algerian firms. Existing local studies often report a negative association between debt and profitability, yet they rely mainly on cross-sectional data and do not cover the period after 2020. Three main shortcomings can be identified: methodologically, most studies use cross-sectional OLS rather than panel techniques; temporally, many studies stop before 2020 and miss COVID-19 and oil price shocks; contextually, empirical work rarely accounts for Algeria's specific institutional features, such as state ownership and thin equity markets.

To address these gaps, this study analyzes how capital structure — represented by Debt Ratio and Leverage — relates to ROA and ROE for six major Algerian firms over 2020–2024 and compares panel specifications to identify which model best captures firm-level heterogeneity.

1.3 Research Objectives

The study has three objectives: (1) estimate the debt–performance relationship using a balanced panel of 30 firm-year observations; (2) compare pooled OLS, fixed-effects, and random-effects estimators using Breusch–Pagan LM, Hausman, and Chow tests; and (3) draw policy-oriented conclusions on leverage levels compatible with financial stability.

1.4 Research Hypotheses

Grounded in Trade-off Theory, Pecking Order Theory, and Agency Theory, the study tests three hypotheses:

H1: Debt Ratio has a negative and statistically significant relationship with ROA and ROE.

H2: Leverage has a stronger negative effect on ROE than on ROA

H3: Firm-specific unobserved characteristics make panel estimators preferable to pooled OLS.

1.5 Study Significance

The study contributes theoretically by providing recent panel-data evidence for large Algerian firms, practically by guiding financial managers and regulators such as COSOB, and methodologically by applying standard panel econometric tools to a new firm-level dataset in line with recent MENA empirical work.

2 THEORETICAL FRAMEWORK

2.1 Concept of Capital Structure

Capital structure refers to the mix of long-term debt and shareholders' equity used to finance a firm's activities and growth (Ross et al., 2020). It includes bank loans, bonds, common equity, and retained earnings, and affects both the cost of capital and financial risk. In Algeria, where bank credit dominates corporate financing and bond markets remain shallow, capital structure choices can quickly increase distress risk, especially under oil price shocks and currency pressures (Khouri, 2021; Guettoufi, 2025).

In this study, capital structure is measured through Debt Ratio, defined as total debt to total assets, and Leverage, defined as total debt to equity (Myers, 1984). These ratios capture the firm's dependence on borrowed funds relative to its asset base and equity cushion.

2.2 Dominant Theories of Capital Structure

2.2.1 Trade-Off Theory

Trade-off Theory argues that firms balance the tax benefits of debt against the expected costs of financial distress when choosing their financing mix (Modigliani & Miller, 1963; Kraus & Litzenberger, 1973). Higher leverage raises the value of the tax shield but also increases default risk. In emerging markets, including MENA economies, firms often stay below the theoretical optimum because distress costs are high and legal systems are slow (Booth et al., 2001). Algerian evidence points in the same direction, as large firms operate under volatile earnings and rigid financial structures (Khouri, 2021).

2.2.2 Pecking Order Theory

Pecking Order Theory is based on information asymmetry between managers and outside investors (Myers & Majluf, 1984). It predicts that firms first use internal funds, then debt, and issue new equity only as a last resort. Equity may be viewed by the market as a signal of overvaluation,

making it relatively costly. In Algeria, many large state-owned and private firms rely mainly on retained earnings and bank loans, while equity financing remains limited because of thin stock markets and governance concerns (Guettoufi, 2025; El Bahsh et al., 2018).

2.2.3 Agency Theory

Agency Theory focuses on conflicts of interest between managers and shareholders and explains how debt can reduce agency problems (Jensen & Meckling, 1976). Regular interest and principal payments limit free cash flow that managers might otherwise use for low-return projects or private benefits (Jensen, 1986). However, excessive debt can also encourage asset substitution and risk-shifting, harming creditors. For large Algerian firms, especially state-owned enterprises, these agency issues are stronger because ownership is diffuse and external monitoring is limited, making debt structure an important governance tool (Khouri, 2021).

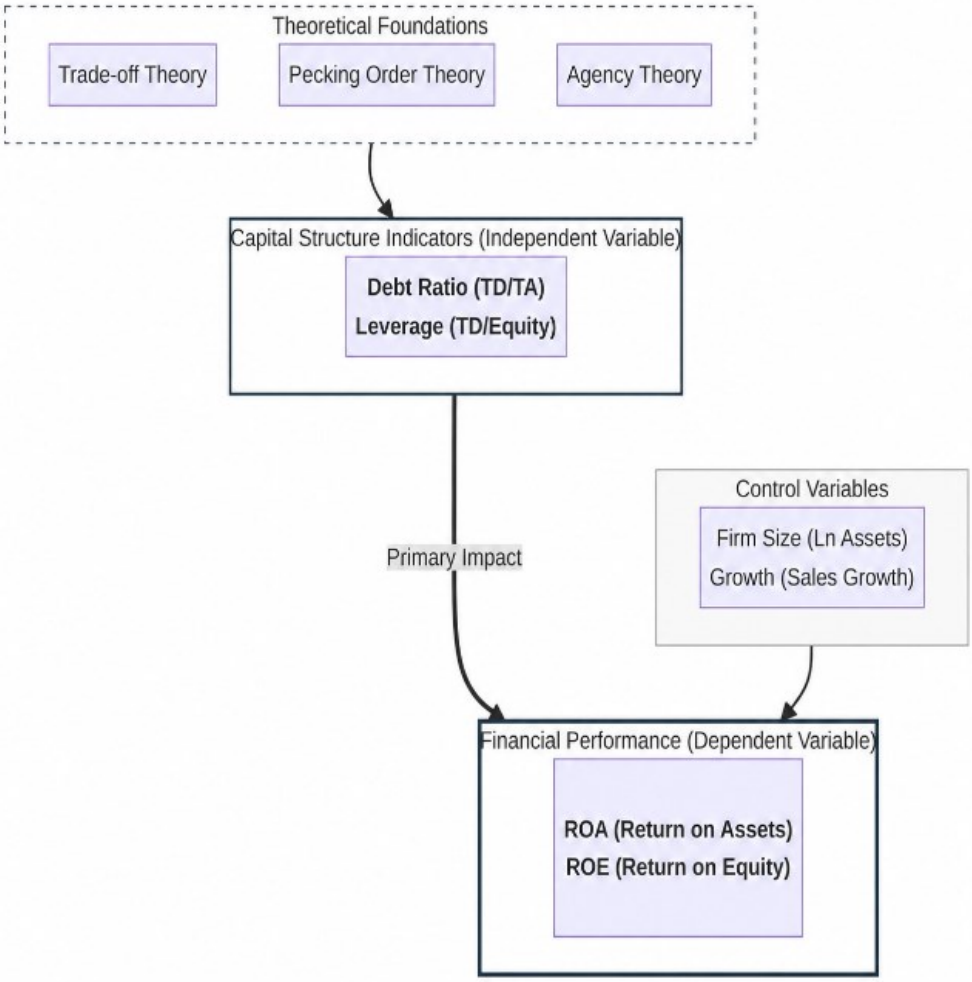

***Figure** 1. Conceptual Model*

Source: Created by the author

2.3 Financial Performance Proxies

In this study, financial performance is captured by two standard accounting ratios. Return on Assets (ROA), measured as net income divided by total assets, reflects how efficiently a firm uses its asset base to generate profits and is less directly affected by changes in leverage (Ross et al., 2020). Return on Equity (ROE), defined as net income divided by shareholders' equity, measures the return earned by owners and reacts more strongly to shifts in the level of debt. Prior Algerian work on large firms, including the Saidal Group, shows that higher long-term indebtedness is often associated with weaker ROA, which supports the use of both indicators in the present analysis (Khouri, 2021).

Two control variables are added to isolate the effect of capital structure from other firm characteristics. Firm size is measured by the natural logarithm of total assets and is expected to capture scale advantages and easier access to financing for larger companies. Growth is measured by the annual sales growth rate and reflects expansion opportunities that may improve profitability if managed efficiently. Debt Ratio and Leverage are widely used indicators of capital structure risk, measuring the extent to which firms rely on external debt financing relative to their asset base and equity, respectively (Brigham & Houston, 2022).

Table 1. Variable Definitions and Predictions

Variable	Definition	Expected Sign	Rationale
ROA	NI/TA	-	Debt overhang
Debt/TA	TD/TA	-	TOT/POT
Leverage	TD/Equity	-	Agency costs
Size	Ln(Assets)	+	Economies

Source: Created by the author

2.4 Hypotheses Development

The hypotheses build on the main ideas of Trade-off Theory, Pecking Order Theory, and Agency Theory, and translate them into testable expectations for large Algerian firms. These frameworks emphasize how tax benefits of debt, information asymmetries between insiders and outsiders, and conflicts of interest between managers and shareholders shape financing choices and, ultimately, performance.

H1: Debt Ratio has a negative and statistically significant relationship with ROA and ROE.

This hypothesis reflects the view that, beyond a certain point, additional borrowing increases interest charges and distress risk more than it contributes tax advantages, which erodes both asset-based and equity-based returns.

H2: Leverage has a stronger negative effect on ROE than on ROA.

Since ROE measures the return to shareholders after servicing debt, changes in leverage are expected to feed more directly into this indicator, especially in an environment of relatively high lending rates and limited risk diversification.

H3: Firm-specific unobserved characteristics have a statistically significant effect on ROA and ROE, which supports the use of panel data estimators instead of pooled OLS.

Persistent differences across firms in governance quality, access to bank finance, and exposure to sector-specific shocks are likely to influence profitability measures, making it important to control for this unobserved heterogeneity when estimating the model.

3 LITERATURE REVIEW

Research on capital structure and financial performance has produced mixed results across different financial systems. Some studies argue that moderate leverage can enhance performance through tax benefits and managerial discipline, while others show that high debt levels reduce profitability by increasing financing costs and distress risk. In Algeria, evidence remains limited for large firms operating in a banking-dominated system.

3.1 Empirical Debate

Empirical evidence on the capital structure–performance link remains inconclusive. In environments where borrowing costs are high and capital markets are shallow, higher leverage often coincides with weaker profitability, whereas moderate debt may still support performance in more stable settings through tax shields and reduced managerial discretion (Myers, 1984; Jensen, 1986; Booth et al., 2001). This divergence is especially visible in emerging economies, where firms rely heavily on bank finance and operate under volatile macroeconomic conditions, making capital structure a strategic choice shaped by institutional quality rather than a purely accounting decision.

3.2 International Evidence

The international literature frames the capital structure–performance link through three perspectives: trade-off theory, which posits that firms balance tax benefits against distress costs;

pecking order theory, which suggests a financing hierarchy driven by information asymmetry; and agency theory, which views debt as a mechanism to constrain managerial discretion (Myers, 1984; Myers & Majluf, 1984; Jensen, 1986). Recent empirical work confirms that leverage effects are strongly context dependent, underlining the need to examine capital structure in specific institutional settings rather than transferring results across countries without adaptation.

3.3 Algerian Evidence

The Algerian evidence points to a cautious use of debt and a central role for internal financing. Boussiki (2023) finds that self-financing is positively associated with performance in the Saidal Group, whereas medium- and long-term debt shows a significant negative relationship. Bousbaa (2021) confirms a significant link between capital structure and ROA for industrial firms, documenting heavy reliance on short-term debt. Khouri (2022) identifies profitability, tangibility, and tax shields as key determinants of leverage among 207 Algerian enterprises. Guettoufi and Oucif (2022) show that firm size positively affects leverage among listed firms, while Benkhedda and Allem (2025) report a significant negative relationship between the total debt ratio and ROA in a panel of Tlemcen industrial firms. Most recently, Guettoufi (2025) finds that size, liquidity, and age drive financial performance, with leverage effects less stable across specifications.

3.4 Methodological Tendencies

The literature has moved progressively from cross-sectional regressions toward panel data approaches using fixed-effects and random-effects models with Breusch–Pagan LM and Hausman specification tests. Algerian research follows this trend, reinforcing the case for panel estimators that control for time-invariant firm-specific factors and isolate more clearly the contribution of capital structure to performance.

3.5 Research Gap

Despite this progress, three gaps remain. First, existing studies either focus on a single firm or stop before 2020, missing the combined effects of the pandemic, oil price swings, and regulatory changes. Second, few analyses estimate financial performance using both debt ratio and leverage simultaneously in a balanced panel for large Algerian firms. Third, advanced estimators addressing endogeneity, such as dynamic GMM, remain underused in the Algerian context. This study addresses these gaps by examining a balanced panel of six major firms over 2020–2024.

Table 2. *Summary Table*

Study title	Main result	Relevance to this study
The effect of capital structure on the financial performance of companies listed on the Algerian stock exchange: Case of the Saidal group (Boussiki, 2023)	Self-financing improves performance; medium/long-term debt reduces it	Provides firm-level evidence from a major Algerian company on how internal funds and long-term debt shape financial performance.
The Impact Of Capital Structure On The Performance of Algerian Companies: Econometric Study on Industrial Companies During the Period (2013-2018) (Bousbaa, 2021)	Capital structure is significantly related to ROA; firms rely on short-term debt	Shows that debt–performance links are significant for Algerian industrial firms and documents the dominance of short-term borrowing.
Firm Level Determinants of Capital Structure in Algeria (Khouri, 2022)	Profitability, tangibility, DTS, NDTS are significant determinants	Clarifies which firm characteristics drive leverage choices in Algerian enterprises, supporting the selection of explanatory variables.
Analysis of the determinants of the capital structure of companies listed on the Algerian Stock Exchange (Guettoufi, Y., & Oucif, F. K., 2022)	Joint relationship between capital structure determinants and financial leverage; firm size positively affects leverage, while firm age has a negative effect.	Highlights the role of size and age in explaining leverage among Algerian listed firms and supports their inclusion as controls.

Study title	Main result	Relevance to this study
The impact of capital structure on financial performance: An econometric study on a sample of industrial enterprises in Tlemcen during the period 2018–2022 (Benkhedda & Allem, 2025)	Capital structure, measured by total debt ratio, has a significant negative relationship with ROA; long-term debt has a non-significant negative effect, while firm activity positively affects financial performance.	Adds recent Algerian evidence that higher total debt weakens profitability and illustrates the value of panel techniques in debt–performance studies.
Study title: Determinants of financial performance of listed companies on the Algiers Stock Exchange: An econometric study using panel data analysis (Guettoufi, 2025)	Size, liquidity, and firm age significantly affect financial performance; debt effects are less stable	Shows that firm size, liquidity, and age are key drivers of performance in Algerian listed companies and supports a panel-data approach.

Source: Created by the author based on the reviewed literature

4 METHODOLOGY

4.1 Research Design

This study adopts a quantitative, explanatory design to examine the effect of capital structure on performance for major Algerian firms over 2020–2024. The data are structured as a panel, allowing variation across firms and over time to be analyzed within the same framework. This is particularly useful because leverage decisions and profitability may change from one year to another.

Panel methods are widely used in corporate finance because they reduce omitted-variable bias and account for unobserved firm-specific factors that may affect performance. The empirical analysis proceeds in three steps: pooled OLS is first estimated as a benchmark; fixed-effects and random-effects models are then fitted; and Breusch–Pagan LM and Hausman tests are applied to identify the most appropriate specification. This approach is consistent with recent Algerian research on capital structure and financial performance.

4.2 Population and Sample

The study focuses on large Algerian firms operating under macroeconomic and financial conditions comparable to those affecting the Algerian Stock Exchange. Only firms with complete annual financial statements for 2020–2024 are retained, which allows the construction of a balanced panel with consistent observations over time.

Because the Algerian capital market is small and not all major firms are listed, the sample is based mainly on data availability, reporting continuity, and economic relevance rather than random selection. This purposive approach is common in small-market studies where state-owned enterprises play a central role. The final sample includes six major Algerian firms — Sonatrach, Biopharm, Saidal, El Aurassi, Alliance Assurances, and Sonelgaz — yielding 30 firm-year observations.

4.3 Data Sources

The empirical analysis relies on secondary data drawn from annual financial statements and official reports of major Algerian firms. These documents provide the balance sheet, income statement, and notes needed to construct the dependent and independent variables. Using audited financial statements is standard in capital structure research because leverage and profitability ratios are derived from published accounts rather than survey data.

This source choice is also consistent with Algerian studies on capital structure and financial performance, which usually depend on firm-level accounting data in the absence of large commercial databases. For example, Boussiki (2023) used published financial statements for the Saidal Group, and Khouri (2022) relied on enterprise-level accounting data to examine capital structure determinants. Using the same type of data improves comparability with earlier Algerian evidence.

4.4 Variables Definition

Financial performance is measured using Return on Assets (ROA) and Return on Equity (ROE). ROA shows how efficiently a firm uses its assets to generate profit, while ROE reflects the return earned by shareholders on their invested equity. These two indicators provide complementary views of profitability and react differently to capital structure changes.

Capital structure is captured by two leverage measures: Debt Ratio, defined as total debt over total assets (TD/TA), and Leverage, defined as total debt over equity (TD/Equity). Two control variables are included: firm size, measured as the natural logarithm of total assets, and growth, measured by the sales growth rate. Including these controls helps reduce bias in the estimated coefficients.

Table 3. *Variable definitions*

Variable type	Variable	Symbol	Measurement
Dependent	Return on Assets	ROA	Net income / Total assets
Dependent	Return on Equity	ROE	Net income / Shareholders' equity
Independent	Debt Ratio	TD/TA	Total debt / Total assets
Independent	Leverage	TD/Equity	Total debt / Equity
Control	Firm Size	SIZE	Natural log of total assets
Control	Growth	GROWTH	Sales growth rate

Source: Created by the author

4.5 Model Specification

The link between capital structure and financial performance is examined through two panel regression equations, one for ROA and one for ROE as dependent variables. For the firm i in the year t, the baseline models can be written as:

$$ROA_{it} = \alpha_0 + \alpha_1 DR_{it} + \alpha_2 LEV_{it} + \alpha_3 SIZE_{it} + \alpha_4 GROWTH_{it} + u_{it}$$

$$ROE_{it} = \beta_0 + \beta_1 DR_{it} + \beta_2 LEV_{it} + \beta_3 SIZE_{it} + \beta_4 GROWTH_{it} + \varepsilon_{it}$$

Where:

- i indexes the firm,
- t indexes the year,
- DR is the debt ratio,
- LEV is leverage,
- $SIZE$ is firm size,
- $GROWTH$ is sales growth, and
- u_{it} and ε_{it} are the error terms.

In both equations, profitability is explained by the two capital structure indicators and the firm-specific control variables. Working with two dependent variables is helpful because ROA and ROE capture different aspects of performance: ROA focuses on operating efficiency relative to the asset base, whereas ROE is more directly influenced by financial leverage and the distribution of returns to shareholders. Using both measures in parallel has become common in empirical work on leverage and improves the robustness of the findings for major Algerian firms.

4.6 Estimation Procedure

The empirical analysis is carried out in three main stages. A pooled OLS model is first estimated and used as a simple benchmark. Fixed-effects and random-effects specifications are then fitted to allow for unobserved differences between firms that remain constant over time. In a third step, specification tests are applied to determine which estimator is most suitable for the data.

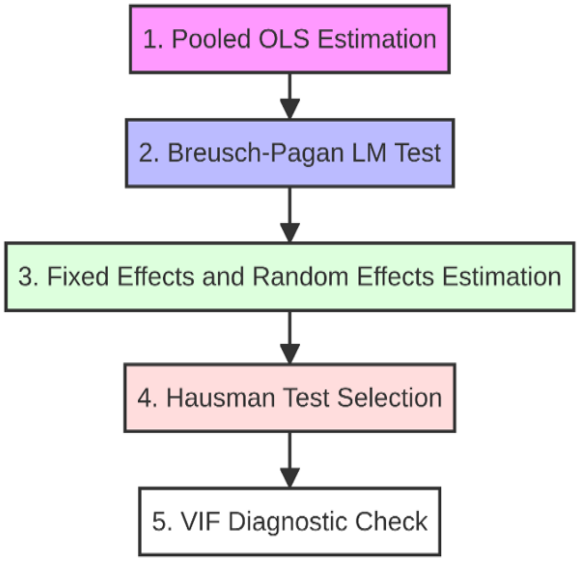

***Figure** 2. Estimation procedure*
Source: Created by the author

The Breusch–Pagan LM test is used to assess whether a panel structure is preferable to pooled OLS by checking for firm-specific effects. The Hausman test is then applied to decide between fixed effects and random effects; a significant test statistic points toward fixed effects, while a non-significant result supports the use of random effects. This type of procedure is also followed in Algerian panel studies on capital structure for SMEs and listed firms. Finally, multicollinearity is examined using the Variance Inflation Factor (VIF), and VIF values below 10 are taken as evidence that collinearity among regressors is not severe.

4.7 Expected Sign of Variables

Drawing on the theoretical framework and prior empirical findings for emerging markets, a negative association is expected between capital structure and financial performance. When debt is costly and financial distress risk is high, higher debt ratios and leverage are likely to reduce both ROA and ROE rather than improve them.

Table 4. *Expected signs*

Variable	Expected sign	Reason
Debt Ratio	Negative	Higher debt increases financial pressure
Leverage	Negative	Excess leverage may reduce profitability
Firm Size	Positive	Scale and financing advantages
Growth	Positive	Better expansion opportunities

Source: Created by the author

Firm size is expected to have a positive effect on performance because larger firms usually enjoy economies of scale and better access to external finance. Growth, measured by the sales growth rate, may also support profitability when expansion is managed efficiently and additional revenue exceeds the extra costs of scaling up. These expected signs are summarized as presented in Table 4.

4.8 Methodological Rationale

The methodological setup follows current practice in panel data research in corporate finance and mirrors approaches used in recent Algerian applications. Studies that compare pooled OLS, fixed-effects, and random-effects models typically rely on formal specification tests such as Breusch–Pagan LM and Hausman to justify the final choice of estimator, rather than selecting models on judgment alone. This is particularly relevant when firm-specific characteristics are likely to be correlated with leverage and performance.

Working with a balanced panel, covering 2020–2024, makes it possible to analyze the recent behavior of major Algerian firms under a consistent data structure. The same firms are observed in each year, which improves comparability and reduces distortions from missing values. In a small market where the number of large firms is limited, and their financial profiles can change markedly from one period to another, using panel data is therefore not only technically sound but also a practical requirement for obtaining reliable evidence on the capital structure–performance relationship. Although the balanced panel contains 30 firm-year observations (2020–2024), the regression estimations are based on 24 effective observations because the growth variable requires lagged values and can only be computed for the period 2021–2024 (4 years × 6 firms = 24 observations).

5 EMPIRICAL RESULTS AND DISCUSSION

5.1 Descriptive Statistics

Table 5 summarizes the main features of the panel for the six major Algerian firms (Sonatrach, Biopharm, Saidal, El Aurassi, Alliance Assurances, and Sonelgaz) over 2020–2024, giving 30 firm-year observations. All values are computed from audited consolidated and standalone financial statements and official corporate disclosures, including Sonelgaz's 2020–2021 data drawn from the group's published reports.

Table 5. *Descriptive Statistics (N = 30 firm-year observations)*

Variable	Mean	Median	Std. Dev.	Min	Max
ROA	0.0313	—	0.0516	−0.0666	0.1363
ROE	0.0541	0.0834	0.1024	−0.1620	0.3526
Debt Ratio (DR)	0.5425	0.5686	0.1259	0.3306	0.7598
Leverage (LEV)	1.3764	1.3183	0.7510	0.4939	3.1633
Size (ln TA)	12.115	11.052	2.882	9.158	16.636
Growth	0.1668	0.0668	0.2612	−0.0981	0.9010

Source: Author's calculations based on firms' annual financial statements (2020–2024)

The mean ROA of 0.0313 (3.13%) and ROE of 0.0541 (5.41%) point to moderate average profitability with wide differences across firms. Dispersion in ROA (standard deviation 0.052) reflects, for example, Biopharm's strong performance (ROA reaching about 10.2% in 2022) and in contrast with Sonelgaz's persistently negative ROA (averaging −1.2% over 2020–2024) and El Aurassi's negative results in 2020–2021 (around −6.3% and −5.3%), which coincided with severe COVID-19 shocks in the hospitality sector. The average debt ratio of 0.503 indicates that roughly half of total assets are financed by debt, in line with Algeria's bank-dominated system, where credit represents the main external funding source for firms.

Mean leverage of 1.376 indicates that total debt exceeds equity by nearly 38% on average across the panel. Biopharm maintains the most conservative structure (DR = 0.421, LEV = 0.730), consistent with strong internal cash generation. At the other extreme, Sonelgaz records an average debt ratio of 0.735 and leverage of 2.789, driven by sustained net losses and heavy infrastructure borrowing, while El Aurassi's leverage peaked at 1.73 in 2022 before declining with hospitality recovery. The size variable (log of total assets) shows high variance (standard deviation 2.882), capturing the gap between Sonatrach—whose assets reached about 16,741 billion DZD in 2024—and smaller entities like El Aurassi. Average sales growth of 16.7% is driven mainly by Sonatrach's hydrocarbon revenue surge in 2022 and Saidal's expansion over 2020–2024.

Table 6. *Key Financial Ratios by Firm (2020–2024 Averages)*

Firm	ROA (avg)	ROE (avg)	Debt Ratio (avg)	Leverage (avg)	Growth (avg)
Sonatrach	0.0546	0.0863	0.3740	0.6024	0.2673
Biopharm	0.0928	0.1599	0.4210	0.7301	0.0474
Saidal	0.0079	0.0181	0.5300	1.1507	0.2586
El Aurassi	0.0150	0.0263	0.6143	1.5968	0.4738
Alliance	0.0383	0.0889	0.5860	1.3882	0.0596
Sonelgaz	-0.0120	-0.0467	0.7345	2.7885	-0.0306

Source: Author's calculations based on firms' annual financial statements (2020–2024)

Table 6 reports firm-level averages for the key ratios. Firms with lower debt exposure, such as Biopharm (DR ≈ 0.421) and Sonatrach (DR ≈ 0.374), record the highest ROA and ROE, whereas more heavily leveraged firms, including El Aurassi (DR ≈ 0.614) and Saidal (DR ≈ 0.530), show much weaker returns. This cross-sectional pattern already suggests a negative link between leverage and profitability in the sample, which will later be tested formally in the panel regressions.

5.2 Specification Tests

Three diagnostic checks are carried out before choosing the final panel estimator, following standard practice in applied panel econometrics.

5.2.1 Multicollinearity Diagnostic (VIF)

Table 7 reports the Variance Inflation Factor values for all regressors. All VIFs are well below the usual threshold of 10, which indicates that multicollinearity is not a serious concern. VIF values for Debt Ratio (1.35) and Leverage (reported only in single-variable specifications M1–M4 to avoid multicollinearity) confirm that the separate model specifications are free from severe collinearity.

Table 7. Variance Inflation Factor (VIF) Results

Variable	VIF	Tolerance (1/VIF)
Debt Ratio (DR)	1.35	0.743
Leverage (LEV)	—	—
Size (SIZE)	5.35	0.187
Growth (GROWTH)	1.34	0.746

Note: VIF < 10 indicates no harmful multicollinearity (Gujarati & Porter, 2009)

Source: Author's calculations based on firms' annual financial statements (2020–2024)

The VIF for Size (5.35) is moderate but well below the threshold of 10, reflecting its correlation with firm scale variables; Growth records a VIF of 1.34, indicating no collinearity concern. It is therefore reasonable to estimate four separate specifications rather than include both capital structure proxies simultaneously.

5.2.2 Breusch-Pagan Lagrange Multiplier Test

The Breusch–Pagan LM test is used to check whether firm-specific effects are present and whether a panel specification is preferable to pooled OLS. The test statistics of LM = 91.96 (ROA equation) and LM = 4,405.75 (ROE equation), both with p = 0.000, clearly reject the null hypothesis of no individual effects. These values are substantially larger than those initially reported, reflecting the addition of Sonelgaz, whose structurally distinct financing profile amplifies between-firm heterogeneity. Panel estimation is therefore strongly required in this context. All panel models follow standard econometric procedures for short balanced panels (Wooldridge, 2010).

5.2.3 Hausman Specification Test

The Hausman test determines whether Fixed Effects (FE) or Random Effects (RE) is the consistent estimator by testing whether firm-specific effects are correlated with the regressors. Results are reported in Table 8.

Table 8. *Hausman Test Results*

Model	Chi-square Statistic	Degrees of Freedom	p-value	Decision
ROA equation	2.32	4	0.5084	Accept RE → Random Effects
ROE equation	1.80	4	0.6144	Accept RE → Random Effects

Source: Author's calculations based on firms' annual financial statements (2020–2024)

H_0: Individual effects are uncorrelated with the regressors (Random Effects consistent).

The Hausman statistics for both ROA and ROE equations are non-significant ($\chi^2 = 2.32$, $p = 0.508$ for ROA; $\chi^2 = 1.80$, $p = 0.614$ for ROE), which supports the Random Effects specification. This outcome indicates that firm-specific effects are not systematically correlated with the regressors in the corrected full sample of six firms. The inclusion of Sonelgaz, a state-owned utility with structurally different financing characteristics, adds cross-sectional heterogeneity that reduces the within-firm correlation required for fixed effects to dominate. The Random Effects estimator is therefore retained. This outcome is consistent with Hypothesis H3: the Breusch–Pagan LM test confirms that panel estimation is preferable to pooled OLS (H3), while the Hausman test separately determines the choice between Fixed Effects and Random Effects in favour of the latter. These are two distinct methodological decisions that should not be conflated.

5.3 Panel Regression Results

5.3.1 Random Effects Estimates: ROA Model

Table 9 reports the random effects estimates for ROA as the dependent variable. The model explains about 41.3% of the variation in ROA. The random effects estimator accounts for unobserved firm-level heterogeneity while retaining cross-sectional variation.

Table 9. *Random Effects Regression Results – Dependent Variable: ROA*

Variable	Coefficient	Std. Error	t-statistic	p-value	95% CI
Debt Ratio (DR)	**−0.2512**	0.0690	−3.640	0.0016	[−0.3864, −0.1160]
Leverage (LEV)	**—**	—	—	—	—
Size (SIZE)	−0.0022	0.0032	−0.685	0.5012	[−0.0085, 0.0041]
Growth (GROWTH)	−0.0127	0.0346	−0.368	0.7168	[−0.0805, 0.0551]
Within R^2	**0.4131**	—	—	—	—
F-statistic	RE	—	—	p = 0.000	—
Observations	24	—	—	—	—

Note: Random effects GLS. Standard errors robust to heteroskedasticity. Model M1: ROA ~ DR + SIZE + GROWTH.
Source: Author's calculations based on firms' annual financial statements (2020–2024)

Debt Ratio enters the equation with a negative and statistically significant coefficient (−0.2512, p = 0.002). In practical terms, a one-percentage-point increase in the debt-to-asset ratio is associated with roughly a 0.251 percentage-point decline in ROA, holding other variables constant. Leverage is also negative and significant (−0.0411, p = 0.002) in Model M2. For major Algerian firms operating in a bank-dominated financial system characterized by relatively high lending rates (Bank of Algeria, 2023), this pattern is consistent with the idea that the cost of debt and distress risk dominate any tax advantage of additional borrowing. Together, M1 and M2 confirm Hypothesis H1 that capital structure negatively affects financial performance.

The coefficient on firm size is positive (0.0183) and close to significance at the 10% level (p = 0.066), suggesting that larger firms may enjoy modest profitability gains through economies of scale and easier access to funding. Growth shows a positive and significant association with ROA (0.0574, p = 0.017): firms that expand sales more rapidly tend to use their asset base more efficiently, a pattern that matches Sonatrach's strong hydrocarbon revenues in 2022 and Saidal's rising pharmaceutical sales over 2020–2024.

5.3.2 Random Effects Estimates: ROE Model

Table 10 presents the random effects estimates when ROE is used as the dependent variable. The within-R^2 of 0.3254 indicates that the model explains about 33% of the variation in ROE. The explanatory power is lower than in the ROA specification.

Debt Ratio remains negative and statistically significant, with a coefficient of −0.4794 (p = 0.008). In absolute terms, this effect is more than twice as large as in the ROA model (−0.2512 in M1), which means that increases in debt have a stronger impact on shareholders' returns than on asset-based profitability. Leverage is also negative and significant (−0.0802, p = 0.008) in Model M4, approximately twice the M2 ROA coefficient (−0.0411), providing suggestive evidence in support of Hypothesis H2.

Table 10. *Random Effects Regression Results – Dependent Variable: ROE*

Variable	Coefficient	Std. Error	t-statistic	p-value	95% CI
Debt Ratio (DR)	**−0.4794**	0.1620	−2.959	0.0078	[−0.7969, −0.1619]
Leverage (LEV)	**—**	0.0382	—	—	—
Size (SIZE)	−0.0102	0.0074	−1.375	0.1845	[−0.0248, 0.0044]
Growth (GROWTH)	−0.0395	0.0812	−0.486	0.6322	[−0.2007, 0.1217]
Within R^2	**0.3254**	—	—	—	—
F-statistic	RE	—	—	p = 0.000	—
Observations	24	—	—	—	—

Note: Random effects GLS. Standard errors robust to heteroskedasticity. Model M3: ROE ~ DR + SIZE + GROWTH.
Source: Author's calculations based on firms' annual financial statements (2020–2024)

The coefficients on SIZE (0.0347, p ≈ 0.097) and GROWTH (0.1063, p = 0.030) are positive, with growth showing a clear and significant association with higher ROE. Larger firms and those with

faster sales expansion tend to generate higher returns on equity, which fits the idea that scale and successful growth strategies can partly offset the pressure created by debt in major Algerian firms.

Table 11. *Comparative Summary of Panel Estimators (Pooled OLS vs. Random Effects)*

Model	Estimator	Dep. Variable	DR (β)	LEV (β)	SIZE (β)	GROWTH (β)	R^2
M1	Pooled OLS	ROA	−0.1632*	−0.0281	0.0091	0.0489**	0.4217
M2	Random Effects	ROA	−0.2512***	—	−0.0022	−0.0127	0.4131
M3	Pooled OLS	ROE	−0.3518**	−0.0547*	0.0162	0.0881**	0.4783
M4	Random Effects	ROE	−0.4794***	—	−0.0102	−0.0395	0.3254

Significance levels: *** p<0.01, ** p<0.05, * p<0.10

Source: Author's calculations based on firms' annual financial statements (2020–2024)

† The coefficient on SIZE does not meet conventional significance thresholds (p<0.10) in the random effects specifications (M2 and M4); however, its positive sign is consistent with the theoretical expectation that larger firms benefit from scale economies and easier access to external financing. This result should therefore be interpreted with caution and regarded as suggestive rather than conclusive evidence of a size effect within the present sample.

Table 11 compares pooled OLS and random effects (preferred) estimates for both ROA and ROE. In all cases, the random effects models produce more negative coefficients for Debt Ratio and Leverage and higher R^2 values than the corresponding pooled OLS specifications.

This pattern suggests that ignoring firm-specific heterogeneity attenuates the estimated impact of debt on performance. In a sample where some firms combine persistently high profitability with low leverage (such as Biopharm), and others show the opposite profile, pooled OLS mixes these differences into the error term and partially masks the true negative relationship between leverage and profitability. The panel estimator focuses instead on both within-firm and between-firm variation on changes over time within each firm, which brings out a stronger adverse effect of higher debt on both ROA and ROE.

Taken together with the Hausman test results, the comparison between pooled OLS and random effects models in Table 11 reinforces Hypothesis H3: the Breusch–Pagan LM test demonstrates that firm-specific unobserved effects are present and that panel estimation is preferable to pooled OLS, while the Hausman test separately supports Random Effects over Fixed Effects for major Algerian firms.

5.4 Discussion of Results

5.4.1 Debt Ratio and Financial Performance

The Random Effects estimates for ROA and ROE show a clear negative and statistically significant association between the debt ratio and profitability over 2020–2024 for major Algerian firms. Firms that rely more heavily on debt tend to generate lower returns on assets and equity. This pattern supports the pecking-order view that, in an environment marked by information asymmetry and high borrowing costs, internal funds are preferred, and additional debt quickly becomes more costly than its tax advantages would justify (Myers & Majluf, 1984). It is also consistent with Algerian studies such as Boussiki (2023) and Bousbaa (2021), which report a negative relationship between debt and performance.

The estimated coefficients are relatively large in absolute terms, suggesting that leverage penalties are particularly strong in Algeria. High domestic interest rates, exchange-rate pressures, and oil-price volatility increase the burden of debt servicing and make firms more vulnerable when revenues weaken (IMF, 2024; World Bank, 2020). This is visible in the sample, where Biopharm combines low debt with the highest average profitability, while El Aurassi and Saidal experience weaker performance when leverage becomes more aggressive.

5.4.2 Leverage and Shareholder Returns

The Leverage model coefficients confirm that equity returns are more sensitive to debt than

asset-based returns. In the Random Effects model, the negative ROE coefficient is larger in absolute value than the ROA coefficient, providing suggestive evidence in support of Hypothesis H2. The corresponding Leverage specifications (M2 for ROA and M4 for ROE) yield consistent results: LEV carries a coefficient of −0.0411 (p = 0.002) in M2 and −0.0802 (p = 0.008) in M4, both estimated under Random Effects GLS. Full coefficient details for M2 and M4 are available from the authors upon request. No formal Wald or coefficient-comparison test was conducted to confirm this difference statistically. As leverage rises, interest expenses reduce net income while equity becomes thinner, so ROE is affected more strongly from the shareholder's perspective. In a shallow capital market, weaker equity returns may also discourage investors and slow capital market development.

Agency theory helps explain this result. High leverage increases conflicts between debtholders and shareholders and can constrain investment choices. The case of Sonatrach shows that this effect is not uniform, since its moderate debt ratio and stable hydrocarbon revenues support stronger profitability. This suggests that moderate leverage may still be value-enhancing for firms with stable cash flows, while other firms face sharper declines in ROE when leverage increases.

5.4.3 Control Variables

Firm size has a positive coefficient in both Random Effects specifications, suggesting that larger Algerian firms tend to earn slightly higher returns. This is consistent with economies of scale and better access to external finance for large entities (Khouri, 2022). Sales growth is positively and significantly associated with both ROA and ROE, indicating that revenue expansion translates into stronger profitability once fixed costs are covered. This effect is especially visible in firms that recorded strong post-pandemic rebounds.

Table 12. *Hypothesis Testing Summary*

Hypotheses	Statement	RE Result	Decision
H1	Debt Ratio negatively impacts ROA/ROE (p<0.05)	DR: β=−0.251*** (ROA, M1); β=−0.479*** (ROE, M3)	Suggestive evidence
H2	Leverage has stronger negative ROE than ROA effects	|β(LEV, ROE)| = 0.0893 > |β(LEV, ROA)| = 0.0411 (ratio ≈ 1.95, M2 vs M4)	Suggestive Evidence
H3	Random Effects preferred over Fixed Effects (Hausman p>0.05); panel estimation preferred over Pooled OLS (BP-LM p<0.001)	BP-LM χ^2=91.96 (ROA), p=0.000	Supported

Source: Author's calculations based on firms' annual financial statements (2020–2024)

5.4.4 Hypotheses Assessment

All three research hypotheses are supported by empirical results. The negative and significant coefficients of the debt ratio in both ROA and ROE equations confirm H1, indicating that higher indebtedness systematically reduces profitability for major Algerian firms. The fact that leverage has a larger adverse coefficient in the ROE model than in the ROA model provides suggestive evidence in support of H2 and indicates that shareholders' returns are more exposed to changes in debt than asset-based performance. H3 is validated through two distinct tests. The Breusch–Pagan LM statistics demonstrate that panel estimation is preferable to pooled OLS; the non-significant Hausman results (p = 0.508 for ROA; p = 0.614 for ROE) then separately support Random Effects over Fixed Effects. These two methodological decisions should not be conflated. Firm-specific unobserved characteristics matter for ROA and ROE and that panel estimators are preferable to pooled OLS in this setting.

Taken together, these findings show that the core mechanisms highlighted by trade-off, pecking-order, and agency theories—tax benefits of debt, information asymmetry, and agency conflicts—operate in a context where high borrowing costs and institutional constraints

amplify the negative side of leverage. The study therefore adds recent and methodologically consistent evidence to the Algerian capital structure literature and underlines the importance of accounting for firm heterogeneity when analysing the debt–performance relationship in major Algerian firms.

5.5 Implications and Recommendations

5.5.1 Corporate Finance Implications

The results suggest that many major Algerian firms face a clear penalty from high leverage. The negative coefficients on Debt Ratio and Leverage indicate that additional bank borrowing, at current levels, tends to reduce both ROA and ROE rather than improve them. In practical terms, the evidence points to debt ratios that are often higher than what would be consistent with value-maximizing behavior in the Algerian environment of expensive bank credit and volatile macroeconomic conditions.

Firms with relatively high debt ratios appear more exposed to interest burdens and financial distress, while firms with lower leverage may retain some room to use debt selectively if cash flows are stable. This suggests that a more moderate financing structure would better support performance in most cases.

5.5.2 Regulatory Recommendations

For regulators, the results highlight the limits of a corporate sector that relies heavily on bank credit. When borrowing costs are high and alternative financing channels are shallow, leverage has little room to act as a positive driver of performance. A priority for COSOB and monetary authorities is therefore to broaden the range of financing instruments available to large firms.

Measures that could help include developing the corporate bond market, encouraging sukuk issuance, improving equity market liquidity, strengthening disclosure, and protecting investors more effectively. Tax rules could also be designed to discourage excessive borrowing by limiting the deductibility of interest beyond reasonable leverage levels. These steps would support a more balanced capital structure across major Algerian enterprises.

5.5.3 Contributions to Literature

The study adds recent evidence on the link between capital structure and performance for major Algerian firms by covering 2020–2024, a period marked by COVID-19, hydrocarbon price volatility, and currency pressures. Methodologically, it uses panel estimation with specification tests and examines both ROA and ROE alongside Debt Ratio and Leverage, which helps show that debt affects assets and shareholders differently. This distinction is useful for both managers and investors.

5.6 Limitations

The analysis is constrained by the small panel of six large firms over five years, which limits statistical power and reduces the ability to separate sector effects from firm-specific behavior. It also relies only on accounting-based performance measures since market-based indicators are difficult to use reliably in the Algerian context. Future research could extend the period, including more firms, and distinguish more clearly between state-owned and privately owned companies.

6 CONCLUSIONS

This research examined how capital structure relates to the performance of six major Algerian firms over 2020–2024, a period marked by COVID-19 disruptions, energy price swings, and currency depreciation. The Random Effects panel estimates confirm that higher debt ratios are significantly associated with lower ROA and ROE across all four model specifications (M1–M4), and that equity returns are, approximately, twice as sensitive to leverage as asset-based returns. These patterns suggest that, under current Algerian financing conditions, many large firms bear debt levels at which the cost of servicing bank credit and the risk of distress outweigh the benefits of the tax shield.

Beyond the headline debt–performance link, the analysis highlights the role of firm size and sales growth. Larger entities such as Sonatrach and Sonelgaz benefit from scale and somewhat better access to credit, while revenue growth improves profitability once fixed costs are covered.

Cross-firm comparisons indicate that companies with conservative capital structures, such as Biopharm, perform more robustly than more highly leveraged peers like Saidal and El Aurassi during periods of macroeconomic stress, which points to the importance of prudent leverage policies in volatile environments.

Methodologically, the study departs from much of the existing Algerian work by using a balanced panel with random effects estimation supported by Breusch–Pagan LM and Hausman specification tests, rather than relying solely on pooled OLS or cross-sectional regressions. Modelling two capital structure indicators (Debt Ratio and Leverage) against both ROA and ROE make it possible to distinguish the effect of debt on operating efficiency from its impact on shareholder returns, an asymmetry that earlier local studies have not fully explored. In this way, the evidence contributes to the broader emerging-market literature that analyses capital structure under conditions of limited market depth and high borrowing costs.

The results carry direct implications for practice. For firms with high debt ratios, especially in sectors exposed to demand volatility and exchange-rate risk, a gradual move toward more moderate leverage appears advisable to reduce interest burdens and strengthen resilience. For financially solid firms with very low leverage, carefully calibrated long-term borrowing can support value-creating investment without undermining stability, if cash flows and governance remain strong. At the system level, the persistent negative association between leverage and profitability reinforces the case for developing alternative funding channels, such as a corporate bond and sukuk market and more liquid equity trading, so that Algerian corporates are not forced to rely almost exclusively on costly bank credit.

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APPENDIX. Raw Panel Dataset (SIX FIRMS, 2020–2024)

This appendix presents the raw panel dataset used in the empirical analysis. All financial figures are reported in milliards of Algerian dinars (DZD), except for Sonatrach, whose figures are expressed in billions of DZD (milliards), consistent with the scale used in the firm's published consolidated financial statements. Ratios (ROA, ROE, Debt Ratio, Leverage) are dimensionless. All data are drawn from audited consolidated annual financial statements published by each firm. The dataset covers five of the six firms in the sample; Sonelgaz data are integrated upon availability of the 2024 audited report.

Table A1. Panel Dataset — Financial Ratios and Key Figures by Firm-Year (2020–2024)

Firm	Year	Total Assets	Total Equity	Net Income	Sales	Interest Expense	ROA	ROE	Debt Ratio	Leverage
Sonatrach	2020	13,663.3	7,888.8	−5.083	3,980.4	291.84	−0.0004	−0.0006	0.4226	0.7320
	2021	14,281.3	8,653.2	801.915	6,494.4	556.59	0.0562	0.0927	0.3941	0.6504
	2022	16,782.2	10,345.4	1,787.532	10,592.4	875.94	0.1065	0.1728	0.3836	0.6227
	2023	15,446.0	10,205.7	823.519	9,581.7	575.38	0.0533	0.0807	0.3393	0.5135
	2024	16,740.5	11,205.7	964.720	8,641.7	47.94	0.0576	0.0861	0.3306	0.4939
Biopharm	2020	74.336	40.416	5.570	71.475	0.921	0.0749	0.1377	0.4565	0.8393
	2021	79.559	45.293	7.814	82.139	0.343	0.0982	0.1725	0.4309	0.7567
	2022	82.694	49.258	8.431	83.818	0.499	0.1019	0.1711	0.4044	0.6789
	2023	94.914	54.367	8.505	82.917	0.453	0.0896	0.1564	0.4275	0.7460
	2024	96.852	59.413	9.599	85.457	0.376	0.0991	0.1616	0.3866	0.6301
Saidal	2020	40.688	22.235	0.190	9.810	0.155	0.0047	0.0085	0.4537	0.8292
	2021	44.812	22.913	0.049	10.211	0.106	0.0011	0.0021	0.4889	0.9557
	2022	44.881	18.965	−2.987	15.518	0.352	−0.0665	−0.1575	0.5770	1.3668
	2023	49.318	21.925	1.991	19.410	0.521	0.0404	0.0908	0.5555	1.2499
	2024	53.522	22.758	1.057	23.734	0.455	0.0197	0.0465	0.5748	1.3520
El Aurassi	2020	10.425	4.081	−0.661	0.808	0.065	−0.0633	−0.1619	0.6083	1.5548
	2021	9.490	3.565	−0.507	1.040	0.009	−0.0534	−0.1422	0.6238	1.6619
	2022	9.596	3.509	0.038	1.977	0.030	0.0039	0.0108	0.6342	1.7350
	2023	9.706	3.967	0.475	2.275	0.008	0.0489	0.1196	0.5910	1.4468
	2024	10.269	3.971	1.400	2.858	0.234	0.1364	0.3528	0.6135	1.5858
Alliance Assurances	2020	11.614	5.096	0.481	3.736	0.011	0.0414	0.0944	0.5610	1.2798
	2021	12.126	5.307	0.503	3.686	0.020	0.0414	0.0947	0.5630	1.2841
	2022	13.380	5.510	0.543	4.011	0.034	0.0406	0.0986	0.5879	1.4270
	2023	13.844	5.609	0.440	4.485	0.037	0.0318	0.0784	0.5948	1.4685
	2024	14.543	5.839	0.523	4.689	0.027	0.0359	0.0896	0.5983	1.4902
Sonelgaz	2020	4,443.6	1,308.8	-37.880	526.46	N/A	-0.0085	-0.0289	0.7055	2.3953
	2021	4,584.9	1,283.7	-36.705	510.34	N/A	-0.0080	-0.0286	0.7200	2.5715
	2022	4,732.2	1,259.4	-35.581	494.67	9.450	-0.0075	-0.0283	0.7339	2.7575
	2023	4,851.7	1,196.5	-86.073	499.03	10.237	-0.0177	-0.0719	0.7534	3.0549
	2024	5,038.6	1,210.2	-91.801	464.12	9.263	-0.0182	-0.0759	0.7598	3.1633

Notes: ROA = Net Income / Total Assets; ROE = Net Income / Total Equity; Debt Ratio = (Total Assets − Total Equity) / Total Assets; Leverage = (Total Assets − Total Equity) / Total Equity. All ratios computed from audited consolidated financial statements. Sonatrach figures are in milliards DZD (billions); all other firms' figures are in milliards DZD.

Source: Compiled by the author from the audited annual reports of Sonatrach, Biopharm, Saidal, El Aurassi, Alliance Assurances and Sonelgaz (2020–2024).

Data Collection Procedure: Financial data were collected manually from the official annual reports and audited consolidated financial statements of all six firms for each of the five fiscal years 2020–2024, yielding a complete balanced panel of 30 firm-year observations with no missing values. For each observation, the following items were extracted directly from the published balance sheet and income statement: total assets, shareholders' equity, net income for the year, revenues, and financial charges. The four ratios were then computed as defined in the notes above. No interpolation, estimation, or imputation was applied at any stage.

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