AALBORG UNIVERSITET

Capital Structure, Ownership Structure and Firm Performance: Evidence from European Listed Energy Firms

A Panel Data Analysis

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Abstract

This thesis examines the relationship between capital structure, ownership structure and firm performance among publicly listed European energy firms. The study draws on a panel dataset comprising 104 firms across 23 European countries over the period 2014 to 2024, resulting in 1,139 firm-year observations spanning three energy sectors; conventional, mixed and renewable energy. The theoretical framework is grounded in Trade-off Theory and Agency Theory, which provide competing predictions regarding the optimal use of debt financing and the role of ownership in firm governance.

The empirical analysis is structured around four hypotheses examining leverage, earnings volatility, ownership type and ownership concentration as variables associated with firm performance, measured by return on assets and Tobin's Q. Two-way Random Effects panel regression with firm-clustered standard errors is employed as the primary estimation method. Driscoll-Kraay standard errors are additionally reported as a robustness check to account for the simultaneous presence of heteroscedasticity, autocorrelation, and cross-sectional dependence confirmed across all model specifications.

The results provide evidence of a non-linear inverted-U shaped relationship between leverage and firm performance measured by ROA, consistent with the predictions of Trade-Off Theory. Earnings volatility does not significantly moderate the leverage-performance relationship across any specification, and H2 is not supported. Ownership type analysis reveals no significant effects in the full sample for ROA, while family ownership is negatively associated with Tobin's Q relative to strategic ownership, particularly in conventional energy firms. Ownership concentration is positively and significantly associated with operational performance measured by ROA in the full sample, with the squared term negatively significant, providing support for a non-linear monitoring hypothesis. All findings are interpreted as conditional associations rather than causal effects, as a valid causal identification strategy could not be implemented due to sample size constraints.

The findings contribute to capital structure and corporate governance literature by providing empirical evidence from the European energy sector during a period of significant energy transition, offering insights for managers, investors and stakeholders involved in the financing and governance of listed energy companies.

Abbreviations

AABUS	Aalborg University Business School
BP	Breusch-Pagan
CD	Cross-Sectional Dependence
DK	Driscoll-Kraay
DWH	Durbin-Wu-Hausman
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EU	European Union
FE	Fixed Effects
HHI	Herfindahl-Hirschman Index
GMM	Generalised Method of Moments
HC	Heteroscedasticity Consistent
OLS	Ordinary Least Squares
PLM	Panel Linear Models
POLS	Pooled Ordinary Least Squares
PPE	Property, Plant and Equipment
RE	Random Effects
ROA	Return on Assets
ROE	Return on Equity
SE	Standard Errors
2SLS	Two-Stage Least Squares
VIF	Variance Inflation Factor
TQ	Tobin's Q
SD	Standard Deviation

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This thesis concludes the master's program in Economics and Business Administration with a specialization in Finance at Aalborg University Business School (AABUS). The process has been both challenging and rewarding, providing us with valuable insight into the capital structure and ownership dynamics of European energy firms during a period of significant energy transition. We hope that our findings capture the reader's interest and contribute to greater understanding of capital structure and corporate governance in the energy sector.

Chapter 1: Introduction

1.1 Background and Motivation

Two of the most fundamental decisions in corporate finance are how firms choose to finance their operations, and who has control of them. The mix of debt and equity used to fund assets determines not only the cost of capital but also the incentives of managers, the risks borne by shareholders, and ultimately the financial performance of the firm. The decision on ownership structure, which concerns the allocation of shares and their related voting powers, is associated with company performance through its influence on governance processes. These two dimensions of corporate organization are deeply interconnected, yet the literature examining their joint effects on firm performance remains fragmented. Most of the studies treat them as separate research questions rather than as mutually conditioning aspects of the same governance problem.

The European energy sector offers an exceptionally compelling setting in which to examine these questions jointly. Energy firms are among the most capital-intensive companies in the world. They invest substantial capital upfront on the construction of power generation facilities, pipelines, refineries, wind farms, and power grids, resulting in substantial cash flows over many years in the future amidst much uncertainty. All these factors lead to significant implications for capital structure choices; whether to finance through debt or equity which directly impact a firm's level of flexibility, its ability to endure difficult times, and its capability to develop long term investment strategies. On the other hand, ownership within the European energy industry comes in many forms, including state-owned shares as part of privatization, increasing institutional ownership because of sustainability demands, strategic corporate ownership, and even family or personal ownership in some instances. This diversity of owner types, each with distinct governance priorities and investment horizons, creates meaningful variation in ownership structure that is expected to influence both capital structure decisions and performance outcomes in ways that cross-sector studies cannot fully capture.

The interest in the topic grew from observing real-world anomalies. In early 2022, several large European energy companies reported high debt levels even as their earnings became more volatile, a pattern that appeared to contradict the traditional trade-off theory prediction that volatile earnings should reduce optimal debt (International Energy Agency, 2022). This puzzle led us to ask: does earnings volatility alter the well-known leverage-performance relationship? And are state or concentrated ownership associated with different borrowing behavior? By

answering these questions, this study aims to provide both academic insights and practical guidance for managers, investors, and policymakers.

The motivation for focusing specifically on the period 2014 to 2024 is both institutional and empirical. Post-2014 marks the beginning of the European Union's 2030 Climate and Energy Framework, which established binding renewable energy targets and initiated the policy driven structural transformation of the European energy sector that has accelerated throughout the sample period. The Paris Agreement of 2015, the EU Green Deal of 2019, the post-COVID commodity price surge of 2021 and 2022, and the energy security crisis triggered by the Russian invasion of Ukraine in February 2022 each introduced notable shifts in the operating environment facing European energy firms. These events influenced investment priorities, financing conditions, valuation levels, and the strategic calculus of both corporate managers and controlling shareholders. Examining capital structure and ownership effects on performance over this period therefore captures firms navigating one of the most challenging and consequential decades in the history of the European energy industry, making the findings particularly relevant for both academic research and policy debate.

1.2 Research Questions and Objectives

Despite the importance of the European energy sector and the richness of this institutional period, empirical research examining the joint effects of capital structure and ownership structure on firm performance specifically among listed energy firms over the post-2014 period remains limited. This study addresses this gap by investigating the following primary research question:

How do capital structure and ownership structure jointly influence the financial performance of European listed energy firms over the period 2014 to 2024?

This primary question is addressed through four specific research objectives:

Objective 1: To examine whether the relationship between leverage and firm performance is non-linear among European listed energy firms, such that moderate leverage is associated with stronger performance while excessive leverage reduces it resulting in an inverted-U shaped relationship, consistent with the trade-off theory prediction of an optimal capital structure.

Objective 2: To investigate whether earnings volatility moderates the leverage-performance relationship, such that firms exhibiting more volatile earnings experience a systematically

different effect of leverage on performance; an exploratory objective given the limited direct empirical precedent for this interaction in the existing literature.

Objective 3: To examine whether different ownership types specifically, state, strategic, family, and institutional ownership have significantly different effects on firm performance, and to determine whether the identity of the controlling shareholder influences both accounting and market-based performance outcomes.

Objective 4: To examine whether ownership concentration measured by the voting percentage of the largest controlling shareholder exhibits a non-linear association with firm performance and to assess whether the monitoring hypothesis holds in the context of the European energy sector.

1.3 Sample and Empirical Approach

The empirical analysis is based on a sample of 104 European listed energy firms over the period 2014 to 2024, yielding an unbalanced panel of 1,139 firm-year observations. Firms were identified using the FactSet database through the Revere Business Industry Classification System, encompassing companies operating across upstream energy, integrated oil and gas, downstream and midstream activities, and renewable energy sub-categories within the broader energy classification.

Each firm was subsequently manually verified through its corporate website and annual reports to confirm its primary business model, resulting in a final classification of 71 conventional energy firms, 19 renewable energy firms, and 14 firms with mixed energy operations. This classification captures the full structural heterogeneity of the European energy sector, encompassing both fossil fuel intensive operators and clean energy developers navigating the energy transition. Further details regarding data sources and sample selection criteria are provided in the data section Chapter 3: Data.

Financial data were collected from the FactSet database while ownership data including the voting rights and cash flow rights of the five largest controlling shareholders for each firm-year were collected manually from company annual reports. The voting percentage of the largest controlling shareholder is used as the primary measure of ownership concentration, and the ownership category of the largest controlling shareholder is used to classify firm-year observations by ownership type into strategic, state, family, institutional, and undisclosed categories.

Cash flow rights data were additionally collected for all five largest controlling shareholders with the intention of examining potential wedges between voting rights and economic ownership, which are particularly relevant in the European energy sector given the widespread use of control-enhancing mechanisms by state and strategic shareholders. However, upon inspection only 12 firms in the sample exhibited a meaningful divergence between voting rights and cash flow rights, representing insufficient variation for reliable econometric analysis. The cash flow rights data are therefore not used in the hypothesis testing, and the analysis focuses exclusively on voting rights as the measure of ownership structure.

The empirical methodology employs two-way Random Effects panel regression to account for unobserved firm-specific heterogeneity and common time variation simultaneously. The selection of Random Effects over Fixed Effects is guided by the Hausman test, which yields insignificant results across all four model specifications, confirming that Random Effects is the consistent and efficient estimator in this context. Four regression models are estimated corresponding to the four research objectives. The non-linear leverage association between leverage and firm performance is examined by including both linear and a squared leverage term in the regression model. The moderating role of earnings volatility is examined through an interaction term between leverage and earnings volatility, where earnings volatility is measured as the rolling three-year standard deviation of ROA. Associations between ownership type and firm performance are examined through binary dummy[1] variables representing state, family, and institutional ownership, with strategic ownership serving as the reference category. The association between ownership concentration and firm performance is examined using the mean-centered voting percentage of the largest controlling shareholder and its squared term to capture potential non-linearity. All models include firm size, asset tangibility, cash holdings, and capital expenditure ratio as control variables. Prior to estimation, variance inflation factor analysis and mean centering[2] are applied to address multicollinearity in the quadratic

[1] A dummy variable is a binary indicator that takes the value of one if an observation belongs to a particular category and zero otherwise. In this study, four mutually exclusive ownership type categories are identified as strategic, state, family, and institutional based on the identity of the largest controlling shareholder for each firm-year observation. Three dummy variables are constructed, one each for state, family, and institutional ownership, with strategic ownership designated as the reference category and therefore excluded from the regression to avoid perfect multicollinearity.

[2] Mean centering subtracts the sample mean from each observation of a variable before squaring it to construct the quadratic term. This reduces the mathematical correlation between the linear and quadratic terms, which would otherwise produce variance inflation factor values exceeding conventional thresholds, without altering the shape or interpretation of the estimated non-linear relationship.

specifications. Diagnostic tests including the Breusch-Pagan Lagrange Multiplier test, the Hausman test, the Breusch-Pagan heteroscedasticity test, the Breusch-Godfrey serial correlation test, and the Pesaran cross-sectional dependence test are conducted to assess the validity of the estimation approach and to determine the appropriate correction for standard errors. Firm-clustered standard errors are applied as the primary correction and Driscoll-Kraay standard errors are reported as a robustness check.

1.4 The European Energy Market

1.4.1 Market Structure and Sector Composition

Energy in Europe is a sector that includes a wide variety of business operations which are very different from each other regarding financial characteristics such as capital requirements, cash flow uncertainty, sources of income and ownership structures. Upstream exploration and production firms focus on the discovery and extraction of oil and natural gas reserves, typically requiring large capital-intensive investments with long lead times and highly uncertain cash flows that are directly exposed to commodity price volatility. The integrated oil and gas companies are involved in the full scope of activities associated with the energy chain from exploration and production through refining and retailing. They tend to generate more stable cash flows and are therefore associated with a broader range of capital structure choices. Downstream and midstream firms focusing on refining and transportation operate in regulated and/or contract environments and can also afford stable cash flows and high leverage ratios. The growing segment of renewable energy generation firms like those involved in wind, solar, hydro, or biomass production tend to face upfront project financing requirements and are often heavily dependent on premium prices or subsidies during the project development phase. They increasingly access green finance and institutional capital facilitated by the EU sustainable finance agenda, with revenues progressively secured through long-term power purchase agreements.

This structural heterogeneity has important implications for capital structure and performance research. Pooling firms across these diverse subsectors without controlling energy type risks obscuring meaningful differences in the leverage-performance relationship, the role of state ownership, and the governance effects of ownership concentration. This study addresses this concern by conducting sub-sector analyses for conventional and renewable energy firms separately throughout the empirical investigation.

1.4.2 Historical Legacy of State Ownership

The current ownership structure of European energy companies cannot be understood without considering the historical legacy of state ownership. For much of the twentieth century, most European energy companies operated as vertically integrated state monopolies, exercising exclusive control over the entire energy chain from generation to distribution within national markets. These monopolies emerged not only because of the strategic importance of energy security, but also because of the political economy of post-war European economic management, in which governments took direct ownership of sectors deemed essential to national welfare.

The wave of privatization experienced throughout Europe between the late 1980s and the early 2000s led to a transfer of formal ownership rights of many of these utilities to private owners. Nonetheless, as is detailed by Bortolotti and Faccio (2009), the privatization process carried out within strategic sectors in Europe has often been incomplete. Residual ownership stakes were kept by governments, the exercise of golden shares that allowed the exercise of special veto rights was common, and board membership by government institutions has ensured state control over corporate governance even post-privatization. Within the specific context of the energy industry, which Bortolotti and Faccio (2009) refer to as one of the sectors in which state control remains common even after privatization, the issue of incomplete privatization stands out clearly. Many of the biggest energy companies listed in Europe retain government-owned institutions among their largest stockholders.

1.4.3 Key Regulatory Developments 2014 to 2024

The sample period of this study coincides with a decade of exceptional regulatory and geopolitical change in European energy markets. Understanding these developments is essential for contextualizing the capital structure and performance dynamics examined in empirical analysis.

2014-EU 2030 Climate and Energy Framework: The European Council adopted binding targets for at least 40 percent reduction in greenhouse gas emissions, at least 27 percent renewable energy share, and at least 27 percent improvement in energy efficiency by 2030 (European Council, 2014). This framework fundamentally altered long term investment incentives across the sector, directing capital toward renewable technologies and creating mounting stranded asset risks for fossil-fuel intensive operators dependent on coal, oil, and natural gas revenues.

2015-Paris Agreement: The adoption of the Paris Agreement committed European governments to progressively ambitious decarbonization pathways that further reinforced the structural shift away from fossil fuels (Paris Agreement, 2015). For European energy firms the Paris Agreement increased regulatory uncertainty around the long-term viability of fossil fuel assets and accelerated investor pressure for climate aligned capital allocation dynamics that influenced both financing decisions and market valuations throughout the remainder of the sample period.

2019-EU Green Deal: The European Green Deal significantly raised policy ambition, targeting climate neutrality for the European Union by 2050 (European Commission, 2019) and introducing the European Climate Law that made this target legally binding (European Parliament and Council of the European Union, 2021). The Green Deal triggered a wave of regulatory initiatives including the EU Taxonomy for Sustainable Finance, the Corporate Sustainability Reporting Directive, and the revision of the EU Emissions Trading System that materially affected the financing conditions, valuation levels, and strategic positioning of European energy firms.

2020-COVID-19 Pandemic: The pandemic caused an unprecedented collapse in energy demand, driving oil prices briefly into negative territory in April 2020 and creating severe short term financial stress for energy firms with high leverage and limited liquidity buffers (International Energy Agency, 2020). The pandemic period provides a particularly sharp test of the leverage-performance relationship examined in the first hypothesis, firms with excessive leverage entering the crisis faced amplified financial distress costs relative to more conservatively financed peers.

2021 to 2022-Commodity Price Surge and Energy Crisis: The post-pandemic recovery of 2021 and the energy security shock triggered by the Russian invasion of Ukraine in February 2022 drove European energy prices to historically elevated levels (International Energy Agency, 2022). Natural gas prices in Europe surged from below €20/MWh in 2020 to a peak of over €340/MWh in August 2022, creating windfall revenues for fossil fuel producers while simultaneously accelerating policy momentum toward energy security, domestic renewable capacity expansion, and reduced dependence on Russian energy imports. The energy crisis reinforced the strategic importance of state ownership in the sector as governments across Europe intervened directly to stabilize energy markets and protect consumers further blurring the boundary between state and corporate governance in the energy sector.

These structural breaks in the operating environment of European energy firms are controlled throughout the empirical analysis through the inclusion of year fixed effects in all regression models, which absorb the common time varying effects of these macroeconomic and regulatory shocks on firm performance and capital structure across the sample.

1.4.4 Ownership Landscape

The ownership structure of European listed energy firms reflects the intersection of privatization history, institutional investor growth, and the increasing role of sustainability mandates in capital allocation. State entities remain significant shareholders in many of the largest European energy companies, particularly among incumbent electricity utilities and integrated oil and gas operators with roots in former national monopolies retaining influence over financing and governance decisions that persist long after formal privatization. Alongside state shareholders, large institutional investors including pension funds, sovereign wealth funds, asset managers, and insurance companies have increased their presence in European energy firms, driven by the growing demand for infrastructure assets offering stable long-term returns and by the expansion of ESG mandated investment strategies prioritizing aligned energy transition companies.

The importance of state ownership has become even more pronounced during the European energy transition period. Following the Paris Agreement and the European Green Deal, governments have increasingly supported renewable energy investment through subsidies, public financing, and state-backed participation in strategic energy projects. As a result, state shareholders may influence performance outcomes, governance structures, and long-term investment strategies differently from purely private investors, particularly within renewable energy firms where policy alignment and long-term infrastructure investment play central roles.

Family and individual shareholders also retain significant positions in a number of smaller and mid-sized European energy firms, particularly in Southern and Eastern European markets where founding family influence is more persistent. Strategic corporate shareholders, including other energy companies holding cross-participation, represent a further important owner category in integrated markets where vertical ownership relationships are common. This diversity of owner types with distinct investment horizons and governance priorities creates the empirical variation in ownership structure that enables this study to examine the

performance implications of ownership concentration and state ownership across the full spectrum of European listed energy firms.

1.5 Structure of the Thesis

The remainder of this thesis is organized as follows. Chapter 2 presents the theoretical and empirical literature review, covering capital structure theories including trade-off theory and agency theory, firm performance measures, ownership structure theories, and the formal development of the four research hypotheses. Chapter 3 describes the data collection procedure, sample construction, and variable definitions, and presents descriptive statistics and correlation analysis for all variables included in the empirical models. Chapter 4 presents the empirical methodology, covering the panel data framework, regression estimation methods including pooled OLS, fixed effects, and random effects models, followed by a comprehensive set of diagnostic tests addressing multicollinearity, panel effects, model selection, heteroscedasticity, serial correlation, and cross-sectional dependence. The chapter concludes with a discussion of endogeneity concerns and the limitations of the identification strategy employed. Chapter 5 presents and discusses the empirical results for each of the four hypotheses, supported by regression tables, sub-sector analyses, and robustness checks including crisis period sensitivity analysis. Chapter 6 concludes the thesis by summarizing the main findings, discussing their theoretical and practical implications, acknowledging the limitations of the study, and suggesting directions for future research.

Chapter 2: Literature Review

2.1 Capital Structure Theories

Capital structure refers to the specific mix of debt and equity used to finance firms for their operations and investment. It is a major part of corporate finance that determines a company's risk, profitability, and the total value of the firm. To understand how businesses might modify their financing mix to maximize firm value, optimal capital structure has been studied for several decades. This section will provide major theories regarding capital structure.

Table 2.1: Overview of Capital Structure Theory

Theory/Author	Summary/ Mechanism	Expected Leverage-Performance Implication
Modigliani & Miller (1958)	Under perfect capital markets, financing choices do not affect firm value.	Neutral benchmark
Modigliani & Miller (1963)	Corporate tax deductibility of interest creates a debt tax shield.	Positive, if distress costs are ignored.
Trade-off Theory: Kraus & Litzenberger (1973)	Firms balance tax benefits of debt against expected financial distress costs.	Non-linear/ Inverted-U
Agency Theory: Jensen & Meckling (1976)	Debt can discipline managers, but excessive debt can create shareholder-creditor conflicts.	Mixed/ potentially non-linear
Pecking Order Theory: Donaldson (1961); Myers & Majluf (1984)	Firms prefer internal funds, then debt, then equity because of information asymmetry.	Often negative association between profitability and leverage
Earnings volatility: Titman & Wessels (1988); Frank & Goyal (2009)	Volatile earnings increase expected distress risk and reduce debt capacity.	More negative leverage effect for volatile firms

As shown in Table 2.1, capital structure theories provide differing predictions regarding the relationship between leverage and firm performance. While early theories suggest irrelevance, more advanced frameworks such as the trade-off and agency theories highlight the existence of an optimal leverage level, supporting the hypothesis of a non-linear relationship.

2.1.1 The Modigliani-Miller Irrelevance Proposition

The foundation of modern capital structure theory originates from the seminal work of Franco Modigliani and Merton Miller, who introduced the irrelevance proposition in 1958.

The Modigliani-Miller (MM) theorem states that, under perfect capital market conditions3, the value of a firm is independent of its capital structure. This implies that the proportion of debt and equity used by a firm does not affect its overall market value, as investors can replicate leverage on their own through personal borrowing or lending (Modigliani & Miller, 1958).

Proposition I: Capital Structure Irrelevance

The first proposition of the MM theorem states that in a frictionless market, characterized by no taxes, no bankruptcy costs, symmetric information, and efficient markets, the value of a leveraged firm is identical to that of an unleveraged firm. In other words, firm value is determined solely by its underlying assets and investment decisions rather than financing choices (Modigliani & Miller, 1958).

Formally, MM proposition I states that:

$$\boldsymbol{V_U = V_L} \tag{1}$$

Where,

VU is the value of an unlevered firm

VL is the value of a levered firm.

This implies that any increase in return from higher leverage is exactly offset by an increase in financial risk, leaving the total firm value unchanged. Investors, therefore, are indifferent between firms with different capital structures because they can construct "homemade leverage" to achieve the same payoff structure (Brealey et al., 2020).

However, this proposition relies heavily on strong assumptions that are not held in real-world markets. In practice, taxes, bankruptcy costs, and agency conflicts create significant deviations from this theoretical irrelevance.

Proposition II: Cost of Equity and Financial Leverage

[3] According to the paper, the assumptions of perfect capital market include: (1) No taxes, (2) No transaction or bankruptcy costs, (3) Symmetric information between firms and investors, (4) Borrowing and lending at same risk-free rate, (5) Rational investors and efficient markets, (6) No agency conflicts, and (7) A fixed investment policy (Modigliani & Miller, The Cost of Capital, Corporation Finance and the Theory of Investment, 1958)

The second proposition of the MM framework introduces the relationship between financial leverage and the cost of equity. While proposition I focuses on firm value, proposition II explains how leverage affects the required return on equity.

According to MM Proposition II, the cost of equity increases linearly with the debt-to-equity ratio because equity holders demand higher returns to compensate for increased financial risk. (Modigliani & Miller, 1958)

The relationship is expressed as:

$$r_E = r_0 + \frac{D}{E}(r_0 - R_D) \quad (2)$$

Where,

r_E: is the cost of equity for a levered firm,
r_0: is the cost of equity for an unlevered firm,
R_D: is the cost of debt.
D: Market value of debt
E: Market value of equity

This equation implies that as firms increase leverage, the risk borne by equity holders rises, leading to higher expected returns. However, the overall weighted average cost of capital (WACC) remains constant under the original MM assumptions, because the cheaper cost of debt is exactly offset by the increasing cost of equity (Modigliani & Miller, 1958). Thus, while leverage redistributes risk between debt and equity holders, it does not reduce or increase total firm value in a perfect market setting.

Although the MM theorem provides a powerful theoretical benchmark, its assumptions are highly restrictive. Subsequent literature has shown that introducing taxes alters the irrelevance result significantly. With corporate taxes, interest payments on debt become tax-deductible, creating a "tax shield" that is associated with higher firm value at greater leverage levels (Modigliani & Miller, 1963).

Furthermore, later research highlights the importance of bankruptcy costs and financial distress, which rise with excessive leverage and are associated with lower firm value. This leads to the development of the trade-off theory, which suggests that firms choose an optimal capital structure by balancing tax benefits of debt against bankruptcy and agency costs (Kraus & Litzenberger, 1973).

Information asymmetry also weakens MM assumptions. Managers typically possess better information about firm value than external investors, leading to financing preferences described in the pecking order theory, where firms prefer internal financing over debt and equity issuance (Myers & Majluf, 1984).

The Modigliani–Miller propositions laid a basis for modern capital structure theory by proving that under perfect market conditions, financing decisions are irrelevant to firm value. However, the MM framework is essentially a theoretical benchmark as it does not consider factors like taxes, bankruptcy costs, agency conflicts, information asymmetry, etc. So, various theories have been developed by relaxing these assumptions and looking at how market imperfections motivate firms to make financing decisions. For instance, trade-off theory, agency theory, and pecking order theory are some of the major theoretical developments that have been motivated by the limitations of MM theory and thus provide an alternative view to the leverage impact on firm performance.

2.1.2 Trade-Off Theory

The trade-off theory emerged as a response to the restrictive assumptions of the Modigliani–Miller irrelevance proposition. While the original MM framework assumed perfect capital markets, later studies incorporated real-world market imperfections such as taxes, bankruptcy costs, and agency conflicts into capital structure decisions. The trade-off theory suggests that firms determine an optimal leverage ratio by balancing the benefits of debt financing against the associated costs of financial distress (Kraus & Litzenberger, 1973).

The central idea behind the theory is that by using debt to finance their operations, companies can avail tax advantages as the interest paid on the debt is tax-deductible. Conversely, excessive reliance on borrowing can increase a company's risk of financial distress and bankruptcy, which not only may cause a loss in the value of the firm but also reduce its profit-making potential. Therefore, businesses aim to maintain a suitable mix of capital where the additional advantage derived from borrowing is just balanced by the additional disadvantage of financial distress.

Static Trade-Off Model

The static trade-off theory of capital structure posits that a firm determines its optimal leverage by balancing the marginal benefits of debt against its marginal costs within a single-period framework, assuming that managers make financing decisions with a fixed target in mind (Kraus & Litzenberger, 1973). The primary benefit is the corporate tax shield from deductible interest payments, while the primary cost is the expected present value of financial distress and bankruptcy expenses that increase with leverage (Myers & Majluf, 1984). The optimum occurs where the incremental tax benefit of an additional unit of debt exactly equals the incremental distress cost; beyond this point, the costs outweigh the benefits(Bradley et al., 1984).

Dynamic Trade-Off Theory

While the static trade-off theory assumes immediate adjustment toward an optimal capital structure, the dynamic trade-off model recognizes that firms face adjustment costs when changing leverage levels. As a result, firms may temporarily deviate from their target capital structure and gradually adjust over time(Fischer et al., 1989). The trade-off model with dynamics posits that firms reallocate their capital composition constantly as they react to changes in profitability, new investment opportunities, macroeconomic environment, and stock market valuations. The costs of change might be transaction costs, issuance costs, and information costs related to getting external finance. Thus, firms are not capable of reaching the optimal leverage ratio immediately but instead rely on gradual consecutive steps toward it.

2.1.3 Agency Theory

Agency theory was developed by (Jensen & Meckling, 1976) to explain conflicts of interest among managers, shareholders, and debt holders. The central argument is that managers, acting as agents on behalf of shareholders as principals, may pursue personal objectives such as empire building, excessive compensation, or risk avoidance rather than maximizing shareholder value. (Jensen, 1986) extends agency theory through the free cash flow hypothesis, arguing that managers in firms with substantial free cash flow face particularly acute incentive problems. When internal funds are abundant, managers may allocate resources to value-destroying projects or acquisitions that expand their sphere of control rather than returning cash to shareholders.

Free Cash Flow Theory

One important extension of agency theory is the free cash flow hypothesis proposed by Michael Jensen in 1986. According to this theory, managers in firms with substantial free cash flow may invest in unprofitable projects to maximize their own benefits, prestige, or control. Debt financing can reduce this problem by committing firms to fixed interest obligations, thereby reducing excess cash available to managers (Jensen, 1986).

Debt financing may help reduce these agency conflicts by limiting managerial discretion and forcing managers to make regular interest payments. However, excessive leverage may also generate conflicts between shareholders and creditors, particularly when shareholders undertake risky investment projects that shift risk to debt holders.

Agency Cost of Debt model

Agency theory also highlights conflicts between shareholders and creditors. Highly leveraged firms may encourage shareholders to pursue excessively risky projects because gains accrue primarily to equity holders while losses are partly borne by debt holders (Jensen & Meckling, 1976)

This conflict may increase borrowing costs and reduce investment efficiency, ultimately lowering firm performance. Consequently, agency theory predicts both positive and negative effects of leverage depending on the level of debt and the governance structure of the firm.

2.1.4 Pecking Order Theory

The pecking order theory was initially introduced by (Donaldson, 1961) and later formalized by Stewart Myers and Nicolas Majluf (1984). The theory argues that firms do not target a specific leverage ratio. Instead, financing decisions are driven primarily by information asymmetry between managers and external investors.

Managers possess better information about the firm's true value and future prospects than outside investors. As a result, external financing may send signals to the market regarding firm valuation.

Information Asymmetry Model

The information asymmetry model suggests that issuing new equity may signal that managers believe the firm is overvalued, leading to negative market reactions. Consequently, firms prefer financing methods that minimize information costs (Myers & Majluf, 1984). This explains why firms prioritize internally generated funds before seeking external finance. When external financing becomes necessary, firms generally prefer debt over equity because debt issuance involves lower information sensitivity.

Financing Hierarchy Model

The financing hierarchy model represents the practical application of the pecking order theory. According to this model, firms follow a sequential financing order: (1) Internal funds (retained earnings), (2) Debt financing & (3) Equity Financing. The model suggests that companies with higher profits might actually have less debt because they tend to use their own cash for financing more than others. This finding is quite different from the trade-off theory that usually assumes profitable companies to have higher debt levels so that they can enjoy the tax advantages of debt.

2.1.5 Market Timing Theory

While trade-off theory and pecking order theory explain leverage through tax shields, distress costs, and information asymmetry, market timing theory (Baker & Wurgler, 2002) offers a complementary perspective. Market timing theory suggests that firms' financing choices are influenced by equity market conditions: managers issue equity when they perceive their stock to be overvalued and rely on debt when equity is undervalued or when market conditions are unfavorable. This implies that capital structure is the cumulative outcome of past attempts to time the equity market rather than the result of a deliberate target adjustment.

(Baker & Wurgler, 2002) present evidence that shows market-to-book ratios from the past had a significant negative impact on leverage; companies that raised equity when valuation was high maintained low leverage for many years to come due to market timing, which means that such decisions have lasting effects on capital structure and cannot be explained by either trade-off or pecking order theory. It follows that capital structures are not only the outcome of past opportunistic decisions but also do not reflect the optimal leverages.

This perspective is particularly relevant for the European energy sector during the sample period (2014–2024). The decade witnessed dramatic swings in renewable-energy valuations,

commodity price shocks (oil price collapse in 2014-2016, the COVID-19 demand shock in 2020, and the energy crisis following the Russian invasion of Ukraine in 2022), and shifting investor sentiment toward clean energy. Energy firms may have timed their debt or equity issuance based on these market conditions. For example, renewable energy firms might have issued equity during periods of high green-energy valuations, while conventional energy firms might have increased debt when oil prices rebounded. Incorporating market timing theory provides a more complete framework for interpreting financing choices in a rapidly changing industry.

2.1.6 Institutional Theory and the Political Economy of State Ownership

While agency theory focuses on internal conflicts between principals and agents, a broader understanding of ownership structure requires considering the institutional environment and the political objectives of the state as an owner legitimacy to regulators, investors, and the public. Institutional theory suggests that firm behavior is shaped not only by economic efficiency considerations but also by the institutional environment in which firms operate. Organizations are influenced by formal regulations, government policies, social expectations, and industry norms that create pressures for firms to adopt certain structures and strategies in order to gain legitimacy and access to resources (Bortolotti & Faccio, 2009; DiMaggio & Powell, 1983). In highly regulated industries such as energy, institutional forces may significantly affect financing decisions, governance structures, and firm performance.

In the case of the energy industry in Europe, it is possible to consider how institutional theory can apply to the situation, as energy companies have to deal with strong regulatory control and are affected by various national energy policies, climate transition goals, and issues regarding public interest. In this context, governments are actively involved in creating markets via various measures such as environmental legislation, renewable energy subsidies, infrastructure creation, and energy security. This institutional perspective is closely related to the political economy of state ownership. Unlike private shareholders whose primary objective is typically shareholder-value maximization, state owners may pursue broader economic and social objectives including energy security, employment protection, price stability, industrial policy, and support for renewable-energy investment (Bortolotti & Faccio, 2009). Consequently, state ownership can have both positive and negative implications for firm performance.

Positive effects include the fact that state ownership can grant companies favorable financing opportunities, regulatory and governmental backing, and stable investments in the long run.

These are especially useful in such an industry as renewable energy, where projects usually demand large sums for their implementation and rely significantly on government assistance. Lower risks of default by government companies may also improve access to outside financing.

Nonetheless, there is always the risk that state ownership might undermine business discipline when the government's agenda is more about politics than maximizing profits. The government can compel businesses to focus on socio-political considerations at the expense of efficiency, resulting in over-investment, misallocation of resources, or lack of business incentives (Shleifer & Vishny, 1997). Consequently, it becomes uncertain whether state ownership positively impacts business performance or not.

The state ownership issue is very relevant to the energy industry in Europe because most big energy firms began their operations as former state-owned monopolies, which still retain significant state ownership despite the subsequent privatizations. This generates a context where political motives often blend with economic motives in determining management policies, hence the relevance of institutional and political economy theories in the study of performance-ownership relationships.

2.1.7 Resource Dependence Theory

The resource dependency theory suggests that businesses require reliance on others for acquiring vital resources, which help them survive and succeed in the long run (Pfeffer & Salancik, 1978). As not all resources could be produced by the organizations themselves, the firms would have to develop links with other entities that can help them secure financing, expertise, political clout, legitimacy, and networking, among other resources. Hence, ownership structure becomes crucial in this respect. In terms of corporate governance, the larger shareholders may add strategic value through providing industry expertise, market connections, political clout, or investment stability. The strategic corporate shareholders may be able to offer operational competence, technology, and business relationships that make the firm more competitive and efficient. Institutional shareholders may bring added value through governance surveillance, political legitimacy, and access to the capital markets. State shareholders can help the firm politically and financially.

Resource dependence theory is especially applicable to the energy industry in Europe as companies operate in an environment that is capital intensive and politically controlled such that availability of external resources plays a crucial role in firm success. Renewable energy companies, for instance, rely heavily on government incentives, infrastructure, technological

collaboration, and project financing. Ownership structures have an impact on performance in such an environment not just via monitoring and control mechanisms, but by virtue of the external resources they command.

This perspective complements traditional agency theory by emphasizing that shareholders are not merely monitors of managerial behavior but can also act as strategic resource providers. Consequently, different types of ownership may affect firm performance differently depending on the resources, networks, and institutional support associated with each shareholder category.

2.2 Capital structure and firm performance evidence

Firms' performance represents a firm's ability to efficiently utilize its resources to generate profitability, shareholder value, and sustainable growth. In another sense, it captures how well a company converts its resources into value for its stakeholders. In practice, however, performance is multidimensional, and no single measure fully captures it (Richard et al., 2009). In corporate finance literature, firm performance is commonly evaluated using both accounting-based and market-based measures. Each has its strengths and blind spots, which is why most serious empirical work in this space uses both rather than choosing one over the other.

In this study, firm performance is measured through two proxies: Return on Assets (ROA), and Tobin's Q. Together, they capture current operational efficiency, and forward-looking market valuation. They are particularly relevant when examining how ownership structure and capital structure affect European listed energy firms over a decade of rapid transformation.

The relationship between capital structure and firm performance has been extensively examined in the corporate finance literature, yet findings remain mixed and context dependent. The seminal theoretical contributions of (Modigliani & Miller, 1958; Jensen & Meckling, 1976; Jensen & Meckling, 1976) established competing predictions about how leverage should affect firm value, and subsequent empirical work has tested these predictions across diverse samples, periods, and institutional contexts with considerably varied results.

Early empirical work largely documented a negative relationship between leverage and firm performance. (Zeitun & Tian, 2007) examine a sample of Jordanian listed firms over the period 1989 to 2003 using random effects panel estimation and find that is negatively associated with firm performance across both accounting and market-based proxies including ROA and Tobin's Q. Their results suggest that higher debt burdens are associated with weaker operational efficiency and lower firm value, consistent with the financial distress hypothesis embedded in

trade-off theory. Notably, they find that short term debt to total assets positively associated with Tobin's Q while exhibiting negative association with accounting based performance; an early indication that the relationship between leverage and performance differs systematically depending on whether accounting or market based measures are used, a divergence that recurs throughout the empirical literature and is directly relevant to the findings of this study.

Similarly, (Le & Phan, 2017) analyze a large panel of Vietnamese listed firms and find that both book value and market value leverage measures exert significant negative effects on ROA, ROE, and Tobin's Q across pooled OLS, fixed effects, random effects, and system GMM estimations. Their results are robust across multiple model specifications and suggest that the performance penalty of leverage is not confined to any single performance measure, with the negative effect being particularly pronounced for market value leverage. Taken together, these studies provide consistent evidence that excessive leverage is associated with weaker firm performance, supporting the financial distress cost argument of trade-off theory.

In the energy sector specifically, (Georgakopoulos et al., 2022) examine ten leading global energy companies listed on the NYSE over the period 2009 to 2019 using pooled OLS and fixed and time effects panel estimation. Measuring firm performance as EBIT scaled by total assets, they consistently find a significant negative relationship between leverage and profitability across all three model specifications employed. Their findings further suggest that liquidity positively influences performance while board size is positively associated with profitability, and that ownership concentration among the three largest shareholders is largely insignificant in explaining performance variation. (Georgakopoulos et al., 2022)conclude that pecking order and agency cost theories best explain the financing behavior of energy firms in their sample, with trade-off theory finding no empirical support a conclusion that has direct implications for the theoretical framework underpinning this study.

However, not all empirical evidence points toward a uniformly negative leverage effect. (Margaritis & Psillaki, 2010) take a different methodological approach, measuring firm performance as productive efficiency derived from data envelopment analysis rather than traditional accounting ratios. Using quantile regression on a sample of French manufacturing firms, they find a positive relationship between leverage and firm efficiency, consistent with the (Jensen & Meckling, 1976) agency cost hypothesis that debt disciplines managerial behavior by reducing free cash flow available for discretionary spending at the manager's

discretion. Their results suggest that at moderate leverage levels, debt can serve as a governance mechanism associated with stronger operational performance, a finding that provides partial theoretical support for the beneficial role of moderate leverage embedded in both trade-off theory and agency theory. This positive finding stands in contrast to the broadly negative results of (Zeitun & Tian, 2007) and (Le & Phan, 2017), highlighting the sensitivity of results to sample composition, sector context, and performance measurement choices.

The divergence between these findings points toward the possibility that the leverage-performance relationship is not linear but rather depends on the level of leverage itself. Moderate debt may discipline management and reduce agency costs as argued by (Jensen & Meckling, 1976), while excessive leverage triggers financial distress costs that outweigh the disciplining benefits producing the inverted U-shaped relationship predicted by trade-off theory. (Georgakopoulos et al., 2022), provide supporting evidence for this non-linear argument in the European Energy sector, finding that financial leverage at low levels is associated with stronger firm performance but this association weakens and reverses beyond a turning point of approximately 47.4%, a finding consistent with the existence of an optimal leverage threshold.

Regarding the moderating role of earnings volatility on the leverage-performance relationship, direct empirical evidence remains particularly limited. However, adjacent literature provides important theoretical and empirical foundations for this interaction. (Titman & Wessels, 1988) demonstrate that earnings volatility is a significant determinant of capital structure decisions, with firms exhibiting higher income variability maintaining lower leverage ratios to reduce their exposure to financial distress implying that earnings stability conditions the capacity of firms to sustain debt without performance deterioration.(Moradi & Paulet, 2019) corroborate this finding in the European context, identifying earnings volatility as a significant positive determinant of leverage among European firms across six countries over the period 1999 to 2015, suggesting that more volatile firms paradoxically carry higher leverage, potentially amplifying their exposure to financial distress costs.

(Tan et al., 2021) extend this line of enquiry by examining how business shocks interact with corporate leverage, finding that firms facing higher earnings uncertainty exhibit systematically different financing behavior compared to firms with stable profitability. Their results suggest that earnings volatility does not merely determine the level of leverage chosen by firms but

also conditions the financial consequences of carrying debt during periods of operational uncertainty. This is consistent with the argument underlying H2 of the present study, that firms with more volatile earnings may face amplified financial distress costs at any given leverage level relative to firms with more stable earnings streams. The absence of a significant moderating effect found in this study may therefore reflect sector-specific characteristics of the EU energy sector, where commodity price volatility is systemic and already incorporated into creditor expectations and firm-level financing decisions rather than generating incremental financial distress at the firm level.

(Frank & Goyal, 2009) further identify earnings volatility as one of the reliable determinants of leverage across large samples of firms, with higher volatility associated with lower optimal debt levels. These findings collectively imply that earnings volatility does not merely determine the level of leverage but also conditions its performance consequences firms with volatile earnings face amplified financial distress costs when leverage is high, since unpredictable income streams increase the probability of debt covenant violations and liquidity shortfalls during earnings downturns.

Despite this theoretical coherence, direct empirical tests of the moderating interaction between earnings volatility and leverage on firm performance remain scarce in the literature, particularly in the European energy sector context. This gap motivates the second hypothesis of this study.

A further empirical regularity worth noting is the consistent divergence between accounting based and market-based performance measures in capital structure research. As documented across multiple studies including (Zeitun & Tian, 2007) and (Le & Phan, 2017), the relationship between leverage and Tobin's Q is frequently weaker and less statistically consistent than the leverage ROA relationship. This divergence likely reflects the fact that market valuations incorporate a broader set of investor expectations including macroeconomic conditions, sector specific regulatory risks, growth prospects, and sentiment that introduces substantial noise which obscures the capital structure signal in market-based measures. In capital intensive regulated industries such as energy, where commodity price cycles and energy transition dynamics heavily influence market valuations independently of firm level financing decisions, this divergence is particularly pronounced. This empirical pattern is directly relevant to the findings of this study, as discussed further in the results and discussion chapters.

2.3 Ownership Structure and Firm Performance

The relationship between ownership structure and firm performance has generated a substantial body of empirical literature across multiple dimensions. Two dimensions are particularly relevant to the hypotheses of this study: the influence of state ownership on leverage decisions, and the effect of ownership concentration among the largest shareholders on firm performance. Empirical evidence on both dimensions is characterized by significant heterogeneity driven by institutional context, measurement choices, and methodological differences.

On the question of state ownership and capital structure, (Bortolotti & Faccio, 2007) provide foundational cross-country evidence from OECD privatized firms that governments systematically retain control after privatization through mechanisms including pyramidal ownership structures, dual class shares, and golden shares that confer special voting or veto rights. Their analysis reveals that as of 2000, a substantial majority of privatized firms still had effective government control through ownership or golden shares, with average ultimate voting rights of state-controlled firms exceeding 50 percent. Critically, they find that government control retention is particularly concentrated in strategic sectors including energy and utilities the exact sector examined by this study and that political incentives rather than legal systems best explain why governments retain control after privatization. This systematic retention of state influence in energy firms has direct implications for capital structure decisions, since state backed firms benefit from implicit government guarantees that reduce perceived default risk and enable access to debt financing on more favorable terms than purely private firms.

(Borisova et al., 2012) provide direct empirical evidence for the governance and financing consequences of state ownership using a sample of European listed firms. Their results demonstrate that government ownership is associated with weaker corporate governance practices and systematically altered financing behavior, suggesting that the normal relationship between leverage, risk, and performance predicted by capital structure theory is distorted in the presence of state ownership. The implicit government guarantee enjoyed by state influenced firms reduces the disciplining role of debt and weakens the monitoring incentives of other shareholders, creating conditions under which higher leverage does not impose the same financial discipline it would in purely private firms. This institutional distortion is particularly visible among European energy firms where many incumbent utility operators retain significant state shareholdings following partial privatization waves across the continent during the 1990s and 2000s. The findings of (Borisova et al., 2012) directly motivate the third hypothesis of this

study, which proposes that the different ownership types have significantly different effects on firm performance.

(Jaworski & Czerwonka, 2021) complement this evidence by examining capital structure determinants specifically within the European energy sector using fixed effects panel estimation across a sample of European energy firms. Their results confirm that profitability and liquidity negatively influence leverage consistent with pecking order theory while asset tangibility and firm size positively influence leverage levels, consistent with collateral capacity arguments embedded in trade-off theory. Importantly, they identify earnings volatility as a significant positive determinant of leverage in the energy sector context and find that country level governance indicators significantly shape capital structure decisions suggesting that the institutional environment in which European energy firms operate cannot be separated from their financing behavior. While their study focuses on leverage determinants rather than performance outcomes, it provides essential contextual evidence for understanding what drives capital structure decisions in the precise sector and regional context examined by this study and directly informs the variable selection and control variable specification of the empirical models employed here.

On the question of ownership concentration and firm performance, the foundational theoretical tension between the alignment effect and the entrenchment effect of large shareholders as articulated by (Shleifer & Vishny, 1997) has generated substantial but conflicting empirical evidence. (Demsetz & Villalonga, 2001) provide a particularly important methodological contribution to this debate by addressing the endogeneity of ownership structure. Using a simultaneous equations approach with two stage least squares estimation on a sample of US firms, they find that once the endogeneity of ownership is accounted for, neither managerial ownership nor blockholder ownership significantly associated with firm performance measured by Tobin's Q. Their results suggest that ownership structures are endogenous outcomes of market and firm level forces rather than exogenous determinants of performance a finding with important methodological implications for studies that treat ownership as strictly exogenous, including the present study. (Demsetz & Villalonga, 2001) further document that intangible investments including research and development and advertising significantly influence Tobin's Q, reflecting accounting distortions in the book value denominator of the market-based measure a limitation directly relevant to the use of Tobin's Q in this study.

(Han & Suk, 1998) examine the relationship between insider and institutional ownership and firm performance measured by five-year geometric stock returns using weighted least squares estimation. They find that insider ownership positively associated with returns at moderate levels, consistent with the alignment effect, but that excessive insider ownership is associated with lower returns consistent with the entrenchment hypothesis that controlling shareholders with very high stakes pursue private benefits at the expense of minority investors. Institutional ownership is found to consistently and positively associated with performance, suggesting that professional institutional monitors add governance value through active oversight of management. These findings are consistent with the theoretical framework of (Shleifer & Vishny, 1997) and suggest that the performance consequences of ownership concentration are non-monotonic; beneficial at moderate levels where alignment dominates but harmful at very high levels where entrenchment effects prevail.

(Kirchmaier & Grant, 2005) examine ownership categories and firm performance across major European markets using long horizon return analysis and OLS regressions with fixed effects. Their findings reveal significant heterogeneity across markets with widely held firms outperforming in some markets while concentrated ownership structures outperform others suggesting that the ownership concentration performance relationship is highly context dependent and shaped by country level legal and institutional frameworks. Notably they find that corporate and state owners are generally associated with lower performance relative to dispersed ownership structures, providing preliminary evidence that state ownership may impose governance costs that weaken firm performance even as it facilitates leverage access. This finding of governance costs associated with state ownership creates an important tension with H3 of this study while state ownership may increase leverage through implicit guarantees, it may simultaneously weaken the performance effects of that leverage through reduced governance quality.

(La Porta et al., 1999) provide foundational cross-country evidence that widely held firms are rare globally, with family and state control being the dominant ownership forms particularly in countries with weak legal shareholder protection. Their documentation of widespread use of pyramid structures and dual class shares mechanisms that create a wedge between voting rights and cash flow rights which establishes the empirical basis for the entrenchment concern that motivates H4 of this study. Where controlling shareholders exercise voting power disproportionate to their economic stake, their incentive to maximize firm value is weakened relative to their incentive to extract private benefits, with direct negative implications for ROA

and other accounting-based performance measures. This separation between voting and cash flow rights is directly captured in the ownership data collected for this study through the recording of both voting rights percentages and cash flow rights of the five largest controlling shareholders for each firm across the sample period 2014 to 2024.

Taken together, the empirical evidence reviewed in this section reveals several important gaps that this study addresses. First, despite growing evidence of non-linear leverage effects, studies specifically examining European listed energy firms over the post 2014 period incorporating both renewable and fossil fuel operators remain scarce. Second, the moderating role of earnings volatility on leverage performance dynamics has received limited direct empirical attention, particularly in regulated capital-intensive sectors where sector wide volatility patterns may differ from broader market samples. Third, while state ownership effects on governance and leverage have been documented in broad European contexts by (Borisova et al., 2012) and (Bortolotti & Faccio, 2009), evidence specific to listed energy firms combining both voting rights and cash flow data across the full post 2014 period remains limited. Finally, the performance implications of ownership concentration in the European energy sector distinguished across five owner type categories including state, institutional, strategic corporate, individual and family, and undisclosed owners have not been systematically examined in prior literature. This study addresses these gaps through a panel analysis of 104 European listed energy firms over the period 2014 to 2024.

2.4 Ownership Concentration and Firm Performance

Concentration of ownership represents the degree to which the shares of a corporation are owned by relatively few large owners, not distributed among numerous owners. In the area of corporate governance, ownership concentration is viewed as a key governance device that impacts how managers are monitored, decisions made, and ultimately, firm performance. The link between ownership concentration and performance is conceptually unclear because ownership concentration can create advantages and disadvantages for corporate governance.

According to agency theory, ownership concentration can enhance the performance of firms by resolving agency problems between managers and owners. Dispersed ownership usually makes it difficult for owners to have the motivation and capacity to efficiently supervise managers since the gains from supervising are realized by all owners collectively, whereas supervision costs are paid alone by each owner. On the other hand, large owners have higher motivations to supervise and regulate management activities, discourage opportunistic

behavior, and make the operations of the company more efficient since they are highly invested in the company (Jensen & Meckling, 1976; Shleifer & Vishny, 1997).

Additionally, the monitoring hypothesis implies that concentrated owners will be able to exercise direct control on the strategy formulation process, the financing strategies of the firm, and the efficiency of investment processes. As regards capital-intensive industries like energy, the presence of concentrated owners is likely to ensure rapid decision-making and improved strategic cooperation. On the other hand, concentrated owners will allow firms to benefit from access to financial, industry-specific, or even political expertise.

However, ownership concentration may also create governance risks. The entrenchment hypothesis argues that dominant shareholders may use their control power to pursue private benefits at the expense of minority shareholders (Claessens et al., 2002). In highly concentrated ownership structures, controlling shareholders may influence dividend policies, related-party transactions, or strategic decisions in ways that benefit themselves rather than maximizing overall firm value. This problem is particularly relevant in environments where investor protection is weaker or where controlling shareholders possess significant voting power relative to cash-flow rights.

Large shareholders partly resolve this monitoring problem. (Shleifer & Vishny, 1997) argue that concentrated ownership gives large shareholders both the incentive and the power to monitor managers effectively, reducing agency costs and improving firm performance, consistent with what the literature terms the alignment effect. When a controlling shareholder holds a significant stake, their financial interests are closely tied to firm value, creating a direct incentive to constrain managerial discretion and encourage value-maximizing operational and investment decisions. Empirical evidence from (Kirchmaier & Grant, 2005) and (Han & Suk, 1998) supports this argument alignment in European market contexts finding positive associations between concentrated ownership and firm performance at moderate concentration levels.

However, the same concentration of power that enables effective monitoring also creates a second layer of agency conflict, the risk that controlling shareholders expropriate value from minority shareholders. This entrenchment effect arises when blockholders use their control to extract private benefits through related-party transactions, tunneling of assets, or self-serving investment decisions that prioritize their own interests over those of outside investors (Shleifer

& Vishny, 1997).The net effect of ownership concentration on firm performance therefore depends on which of these two forces dominates, an empirical question whose answer varies across institutional contexts, ownership levels, and firm characteristics.

(Demsetz & Villalonga, 2001) provide an important methodological caution for ownership concentration research, demonstrating that once the endogenous nature of ownership structure is properly addressed through simultaneous equations estimation, ownership concentration does not significantly affect firm performance measured by Tobin's Q. Their finding suggests that ownership structures are equilibrium outcomes of firm and market characteristics rather than exogenous governance choices implying that observed performance differences between concentrated and dispersed ownership firms may reflect underlying firm characteristics rather than the governance effects of concentration per se. This endogeneity concern is addressed in this study through the DWH test, which does not provide evidence of endogeneity for ownership concentration in this specification. The empirical specification of this study addresses this concern through firm-level random effects, which account for time-invariant firm characteristics correlated with both ownership concentration and performance.

Within the energy sector, ownership concentration may play an especially important role because energy firms operate in highly regulated, capital-intensive, and politically sensitive environments. Concentrated shareholders may provide strategic stability and long-term investment commitment during periods of energy transition and market uncertainty. At the same time, concentrated ownership may also reinforce strategic rigidity or political influence, particularly in firms with strong state involvement or legacy ownership structures. Consequently, the net effect of ownership concentration on firm performance remains an empirical question that may vary across conventional and renewable energy firms.

2.5 Energy Sector Context

The energy sector in Europe presents a unique environment that is well-suited to investigate the interrelations between capital structure, ownership structure, and firm performance. The energy business is inherently capital intensive and faces considerable risks associated with extensive investment in infrastructure, long life cycles of projects, stringent regulation, and vulnerability to macroeconomic and geopolitical uncertainties. This makes energy businesses different from other businesses found in many sectors.

One of the major features of the energy industry is that the industry is heavily reliant on investments in infrastructure. Traditional energy companies such as those dealing with oil, gas,

and electricity require a lot of investment in their production and distribution infrastructures. This is also the case with renewable energy firms, where large investments are required in wind farms, solar energy parks, batteries, and energy grid management. This being an area of heavy reliance on investments, capital structure assumes a lot of importance for these firms.

Moreover, the structure of the European energy industry has been significantly transformed over the period 2014-2024 because of the ongoing energy transition. Various climate policies, as well as initiatives aimed at the decarbonization of economies and the European Green Deal, have put more and more pressure on organizations to minimize carbon emissions and invest in renewable energy resources. At the same time, firms operating in the sphere of energy have encountered numerous external factors, such as price volatility in oil and gas, inflation, as well as geopolitical instability because of the conflict between Russia and Ukraine.

The difference between conventional and renewable energy companies is especially pertinent here. The conventional energy company is typically characterized by its higher financial asset base, steadier income streams, and well-developed financing connections. The renewable energy company, on the other hand, tends to be relatively young, more growth-oriented, and more dependent on financing and government policy. This can have an impact not only on the capital structure but on the ownership structure as well. The renewable energy company may benefit more strongly from government ownership, strategic investment, or favorable financing policies even more than the conventional one will.

Furthermore, ownership structure in the European energy industry is also impacted by the privatization process and the role of government in it. Many of the large European energy firms emerged from the privatization of state-owned monopolies and as a consequence of such action; the states continue to maintain an influence through their equity positions or through regulations (Bortolotti & Faccio, 2009). Thus, state ownership is more prominent in the energy industry compared to many other sectors. Governments can have motives other than maximizing profits, such as securing energy needs, protecting jobs, maintaining price stability, and investing in renewable energy sources.

In addition, investment expectation in the energy sector is becoming increasingly influenced by issues of environmental, social, and governance (ESG). More attention from institutional investors and financial markets is being paid to sustainability, carbon, and transition. Therefore, market performance measures like Tobin’s Q could include not only performance but also future expectations of regulatory risks, decarbonization, and transition ability. It might provide

an explanation for why accounting and market measures of performance have generated different findings when applied to the energy sector literature.

Overall, the unique combination of capital intensity, regulatory influence, state involvement, energy-transition pressures, and financing dependence makes the European energy sector particularly suitable for examining how capital structure and ownership structures are associated with firm performance.

2.6 Hypothesis Development

Based on the theoretical system and empirical works mentioned in previous sections, this chapter develops four hypotheses which contribute to the literature reviewed on capital structure, ownership structure, and firm performance in the European energy sector.

Tradeoff theory states that a moderate level of debt is associated with higher value through tax shield benefits and lower agency costs of free cash flows, beyond a certain threshold, additional debt is associated with financial distress costs that outweigh the tax shield benefits. This suggests an inverted U shape relationship between performance and level of leverage, rather than the linear relationship predicted by the pecking order theory. The agency theory (Jensen & Meckling, 1976) also supports the notion that using a relatively conservative debt level would have a constraining effect on managers and encourage the alignment of their interests.

This non-linearity is broadly confirmed by the existing empirical evidence, (Margaritis & Psillaki, 2010) establish positive efficiency gains for moderate leverage ratios consistent with the agency cost hypothesis, whereas (Zeitun & Tian, 2007) and (Le & Phan, 2017), record significantly negative effects only above certain leverage levels consistent with the presence of agency costs. (Ibhagui & Olokoyo, 2018) demonstrate using threshold regression analysis that the negative effect of leverage on ROA is significant only below an estimate firm size threshold. It provides direct evidence that the leverage-performance relationship is non-linear and contingent. Although several studies including (Le & Phan, 2017) find only a negative linear relationship, the weight of more recent evidence incorporating non-linear specifications points toward an inverted U-shaped relationship as the more accurate characterization.

Based on this evidence the following hypothesis is proposed:

H1: The impact of leverage on financial performance is non-linear.

If the leverage-performance relationship is non-linear as proposed in H1, it follows that firm specific characteristics may shift the point at which leverage transitions from value creating to

value destroying. Trade-off theory predicts that firms with more volatile earnings should maintain lower leverage because earnings instability amplifies financial distress risk at any given debt level. When volatile firms carry leverage beyond their optimal level the performance consequences should therefore be more severe than for firms with stable earnings.

(Titman & Wessels, 1988) confirm empirically that earnings volatility is a significant determinant of capital structure, with more volatile firms optimally carrying less debt. (Frank & Goyal, 2009) also support this finding, identifying earnings volatility as one of the reliable determinants of leverage across large firm samples. In the European context specifically, (Moradi & Paulet, 2019) find that earnings volatility positively influences leverage among European firms suggesting that volatile firms may carry more debt than their risk profile warrants, amplifying their financial distress exposure. Direct empirical tests of this moderating interaction remain scarce, particularly in the European energy sector. Nevertheless, the theoretical logic and adjacent empirical evidence consistently point in the same direction.

Based on this reasoning the following hypothesis is proposed:

H2: Firms with more volatile earnings experience a stronger decline in performance at higher levels of leverage.

The third hypothesis examines whether different ownership types influence firm performance differently within the European energy sector. Different shareholders possess distinct incentives, monitoring capabilities, and strategic objectives that may be associated with different managerial decisions and firm outcomes. State ownership remains particularly important in the European energy industry, where governments continue to retain influence in several strategic energy firms even after privatization reforms (Bortolotti & Faccio, 2009). In renewable energy firms, state ownership may provide advantages such as policy support and easier access to financing during the energy transition process.

Institutional, family, and strategic corporate shareholders may also exhibit different association with performance. However, prior empirical evidence on ownership effects remains mixed and highly context dependent, particularly within regulated and capital-intensive industries such as energy.

Based on these arguments, the following hypothesis is proposed:

H3: Different ownership types have significantly different effects on firm performance.

While H3 examines the joint association between all ownership types and firm performance, a more specific directional prediction can be derived for state ownership in the context of the EU energy sector. State-owned energy firms may be associated with political objectives that conflict with value maximization, including employment preservation, energy security priorities, and price regulation that constrain managerial flexibility. (Bortolotti & Faccio, 2009) document that state-controlled firms in strategic sectors including energy are associated with lower performance relative to privately owned counterparts following privatization, which they attribute to the persistence of political interference in managerial decision-making. In the context of market-based performance specifically, state ownership may be associated with lower Tobin's Q if investors perceive governance inefficiencies and non-commercial objectives as valuation risks. However, in the European energy sector large state-owned firms such as Equinor, Eni, and EDF may be associated with implicit government guarantees and stable long-term investment frameworks that partially offset these valuation risks. The net direction of the association between state ownership and market valuation therefore remains an empirical question warranting direct investigation.

Based on this reasoning the following sub-hypothesis is proposed:

H3a: State-owned European energy firms exhibit lower market-based performance measured by Tobin's Q relative to non-state-owned firms.

The final hypothesis examines how ownership concentration among the largest shareholders relates to firm performance. (Shleifer & Vishny, 1997) identify two competing forces. The alignment effect suggests that large shareholders have strong incentives to monitor management effectively, reducing agency costs and improving performance outcomes. The entrenchment effect predicts that very high concentration enables controlling shareholders to extract private benefits at the expense of minority investors, reducing firm value. Together these two mechanisms predict a non-linear relationship between ownership concentration and firm performance, positive at moderate concentration levels where monitoring benefits dominate and negative at very high concentration levels where entrenchment effects prevail.

(Han & Suk, 1998) find empirical support for the alignment effect at moderate concentration levels, with insider ownership positively influencing firm returns. (Kirchmaier & Grant, 2005) document that ownership concentration performance dynamics vary across European markets but find that concentrated ownership by strategic and institutional investors is generally associated with better oversight and governance. (La Porta et al., 1999) establish that ownership

in European firms is frequently concentrated among a small number of state, institutional, or strategic corporate shareholders, which are the exact ownership categories captured in this study. While (Demsetz & Villalonga, 2001) caution that ownership structure is endogenous and its associations with performance may be sensitive to estimation method, the preponderance of evidence from European market contexts suggests that moderate ownership concentration positively associated with firm performance through the alignment effect, particularly in the energy sector where large shareholders facilitate long-term strategic investment decisions.

Based on this reasoning the following hypothesis is proposed:

H4: Ownership concentration exhibits a non-linear association with firm performance.

Chapter 3: Data

3.1. Data and sample selection

This study examines the relationship between capital structure, ownership structure, and financial performance among publicly listed European energy firms. The sample consists of 104 energy firms operating across various European countries for the period of 2014 to 2024 and includes firms engaged in both traditional fossil fuel activities and renewable energy operations. The financial data collected from FactSet includes key accounting and market-based variables such as total assets, total debt, revenues and financial ratios. Whereas ownership data including voting rights and cash flow rights of the largest shareholders, were collected separately from annual reports and corporate governance reports.

The sample in this study is chosen using the FactSet database through the RBICS Revenue industry classification system for conventional energy. Firms classified under the energy sector were selected, including companies operating within upstream energy, integrated oil and gas exploration and production, and downstream and midstream energy activities. The RBICS Revenue classification was utilized because it categorizes firms based on their primary revenue-generating business activities, thereby improving sectoral consistency within the sample.

The renewable energy firms were additionally identified using the Crunchbase category under the company details. This approach allowed the study to include firms involved in wind, solar hydroelectric, biomass, and other non-fossil fuel energy generation which reflects the diversity of clean energy business models. Firms whose operations spanned both conventional and renewable energy activities without a clear primary revenue dominance in either category were

classified as mixed energy firms. This combined classification approach yielded a final sample of conventional industry, consisting of 71 firms, while 19 firms represent renewable energy and remaining 14 represent mixed energy firms.

To ensure the reliability and homogeneity of the sample, we applied a pre-extraction filter in FactSet to retain only firms with a market capitalization[4] exceeding USD 50 million. This approach is supported by the size effect of literature. (Fama & French, 1993) demonstrate that small-capitalization firms exhibit distinct risk-return characteristics and behavior patterns compared to larger firms. Including nanocap firms (commonly defined as those below $50 million in market value) could therefore introduce unwanted heterogeneity, lower liquidity, and greater data inconsistencies into the analysis (Asness et al., 2018). By applying this threshold, we reduce the influence of potentially unreliable data and improve the comparability of financial and market-based performance measures across the sample.

In particular, the threshold for market capitalization at $50 million is likely to eliminate several smaller companies involved in renewables or in energy transition, since their market capitalization is likely to be lower than those of mature oil companies. However, such a filtering system is inevitably associated with certain costs.

It is acknowledged that this cut-off point may create a size bias in the sample, whereby only larger and more mature energy companies can be included. Specifically, this issue may affect renewable energy companies since they are smaller and less mature compared to regular energy companies and may be filtered out through this criterion. In this case, the subsample of renewable energy companies that comprise 19 firms may not be representative of the entire population of European renewable energy companies, especially smaller solar and wind power companies below the market value criterion. It is acknowledged as a sample selection limitation and suggests that the findings from this study regarding the renewable energy subsector will only apply to larger renewable energy companies listed on stock exchanges in Europe.

Several corrections have been made from the initial sample of firms based on classifications to ensure data quality and comparability.

Table 3.1 presents how the final number of firms and firms-year observations are obtained.

[4] Market capitalization refers to the firm's market value at the initial sample screening stage.

Table 3.1 Sample selection Process

Step	No. of firms	Firm-Year Observations
Initial firms identified from FactSet RBICS Energy classification	133	1463
Firms matched with Crunchbase renewable classification	60	660
Total	193	2123
Less: Firms with IPO listed after 2012	10	110
Less: Firms with incomplete ownership information	10	110
Less: Deducted observations from missing annual reports		5
Less: Firms classified primarily as utilities or non-energy sectors	69	759
Final sample	104	1139

Firms primarily classified as utilities or non-energy businesses were excluded from the sample to maintain sectoral consistency. Utility firms typically operate under distinct regulatory frameworks, financing structures, and risk characteristics compared to energy exploration, production, and integrated energy companies. The electricity companies usually follow the rules of rate-of-return regulations, which encourage them to over capitalize and affect their capital structure in ways that do not confirm to those followed by the energy producers. The inclusion of such firms would bring in regulatory induced financing patterns which are not representative of the wider energy sector and may confound the relationship between leverage and performance. As (Demsetz H & Lehn K, 1985) argue, the regulatory environment is a significant factor affecting corporate ownership and control, further supporting the need to isolate regulated utilities in a study of market-driven capital structure decisions.

Firms with insufficient financial information, missing ownership data, or incomplete observations during the study period were excluded from the final sample. Some of the companies have been removed due to the lack of fit for our sample, e.g., area of production.
Firms lacking sufficient ownership structure data were excluded because ownership variables constitute key explanatory variables within the study's empirical models. Maintaining consistent ownership information across firms was therefore necessary to ensure reliable estimation results. This approach follows the methodology established by foundational studies in corporate ownership, which emphasize the critical need for complete ownership data to construct reliable variables and the necessity of excluding observations with missing information.

Ownership categories were manually reviewed and classified based on shareholder identity and publicly available annual reports or governance reports. It was constructed following classifications commonly used in corporate governance and ownership structure literature(La Porta et al., 1999) (Faccio & Lang, 2002) Major shareholders were categorized into strategic/corporate owners, government/state owners, individual or family owners, institutional investors, and undisclosed or banking entities.

Table 3.2 Ownership Classification Scheme

Ownership Category	Examples of Shareholders Included	Code
Strategic Entity/ Corporate	Corporate shareholders, industrial companies, energy firms, holding companies, strategic investors	1
State/Government	National governments, ministries, sovereign wealth funds, state investment agencies, municipal authorities	2
Individual/Family	Founders, family members, individual shareholders, family trusts	3
Institutional Investors	Pension funds, mutual funds, asset managers, insurance companies, investment funds, hedge funds	4
Undisclosed/other	Custodians, nominee accounts, depository banks, unidentified beneficial owners	5

After applying these exclusions, the final sample comprises an unbalanced panel of 104 firms and 1,139 firm-year observations over the period 2014–2024. The panel is unbalanced, which is common in corporate finance research and is appropriately handled by the panel estimators used in this study.

Table 3.3 provides the distribution of the final sample by country and energy sub-sector, detailing the number of firms and firm-year observations across conventional, mixed and renewable energy categories.

Table:3.3 Sample distribution by country and sub-sector

	Conventional Energy		Mixed Energy		Renewable Energy		Total	
Country	Firms	Obs	Firms	Obs	Firms	Obs	Firms	Obs
Austria	1	11	1	11	1	11	3	33
Belgium	2	22	1	11	0	0	3	33
Croatia	0	0	0	0	1	11	1	11
Cyprus	2	22	0	0	0	0	2	22
Denmark	1	11	0	0	1	11	2	22
Finland	0	0	0	0	1	11	1	11
France	3	33	2	22	1	11	6	66
Germany	2	22	0	0	4	44	6	66
Greece	5	55	0	0	0	0	5	55
Hungary	0	0	1	11	1	10	2	21
Ireland	2	22	0	0	0	0	2	22
Italy	0	0	2	22	1	11	3	33
Lithuania	1	11	0	0	0	0	1	11
Luxembourg	2	22	0	0	0	0	2	22
Netherlands	2	22	0	0	0	0	2	22
Norway	21	227	1	11	1	11	23	249
Poland	4	44	1	11	0	0	5	55
Portugal	0	0	1	11	0	0	1	11
Romania	4	44	0	0	0	0	4	44
Slovenia	0	0	1	11	0	0	1	11
Spain	2	22	1	11	4	44	7	77
Sweden	3	33	0	0	2	22	5	55
United Kingdom	14	154	2	22	1	11	17	187
Total	**71**	**777**	**14**	**154**	**19**	**208**	**104**	**1139**

Note: Sample covers 104 listed European energy firms across 23 countries over the period 2014 to 2024.

Table 3.3 demonstrates the distribution of firms and firm-year observations across countries and energy subsectors. The final sample consists of 104 European listed energy firms generating a total of 1,139 firm-year observations over the 2014–2024 period. The sample is dominated by conventional energy firms, which account for 71 firms and 777 observations, followed by renewable energy firms with 19 firms and 208 observations, and mixed energy firms with 14 firms and 154 observations. This distribution reflects the continued dominance of conventional energy companies within European capital markets despite the accelerating transition toward renewable energy sources during the sample period.

The geographic distribution reveals substantial cross-country heterogeneity within the European energy sector. Norway represents the largest country component of the sample with

23 firms and 249 observations, followed by the United Kingdom with 17 firms and 187 observations, and Spain with 7 firms and 77 observations. The strong representation of Norway and the United Kingdom is economically intuitive given the historical importance of oil and gas production, offshore energy activities, and developed capital markets within these countries. Norway in particular hosts a large number of listed energy and offshore-related firms due to its significant petroleum sector and strong energy infrastructure base.

Renewable energy firms are more concentrated in countries such as Germany and Spain, which is consistent with the early adoption of renewable energy policies and substantial government support mechanisms implemented under European decarbonization initiatives. Germany contributes four renewable energy firms while Spain contributes four renewable firms as well, reflecting the relatively advanced development of renewable energy industries in these economies. In contrast, several countries including Greece, Romania, Cyprus, and Ireland are represented primarily by conventional energy firms, indicating differing stages of energy transition and market development across Europe.

The uneven distribution across countries and subsectors further supports the inclusion of firm and time effects within the empirical models, as institutional environments, regulatory frameworks, and national energy policies vary considerably across European economies. At the same time, the relatively smaller renewable energy subsample highlights an important limitation of the study, suggesting that renewable-specific findings should be interpreted with greater caution due to lower statistical power compared to the conventional energy sample.

To address the influence of extreme values on regression estimates, all continuous variables were winsorized at the 1st and 99th percentiles. This procedure replaces values below the 1st percentile with the 1st percentile value and values above the 99th percentile value, reducing the influence of outliers while retaining the full sample size. Winsorization[5] at these thresholds is standard practice in empirical corporate finance research and ensures that regression results are not driven by a small number of extreme observations that may reflect data errors or genuinely anomalous firm years.

[5] Winsorization replaces values below the 1st percentile with the 1st percentile value and values above the 99th percentile with the 99th percentile value, retaining the full sample size while reducing the influence of extreme observations.

3.2 Variable Specification

This section defines the variables employed in empirical analysis. It is categorized into dependent variables, independent variables and control variables.

3.2.1 Dependent Variables

The primary dependent variable for testing hypotheses is Return on Assets (ROA), calculated as net income divided by total assets. ROA measures how efficiently a firm generates profits from its asset base independently of its financing structure, making it particularly appropriate for capital structure research where leverage itself is the key independent variable. For capital-intensive energy firms, where the quality of asset deployment is a central determinant of competitive position, ROA is a particularly informative measure. It is also easily comparable across firms and countries when financial statements follow a common reporting standard, as is the case for European listed firms reporting under IFRS.

The secondary dependent variable is Tobin's Q, calculated as market capitalization plus total debt divided by total assets. Tobin's Q captures market-based expectations about firm value and future performance, complementing the backward-looking nature of ROA with a forward-looking market perspective. TQ above one means the market values the firm above the replacement cost of its assets, suggesting that the firm possesses intangible value, growth options, or governance qualities that accounting statements do not capture. TQ below one implies the opposite.

In ownership and governance research, TQ has a particularly important role. If controlling shareholders are associated with private benefit extraction at the expense of minority investors, markets may discount the firm's equity accordingly. This study employs Tobin's Q precisely because it captures these anticipated governance effects in a way that accounting measures cannot.

3.2.2 Independent Variables

Leverage is measured as total debt divided by total assets, where total debt is the sum of short-term debt and long-term debt. To test the non-linear relationship proposed in H1, a squared leverage term ($Leverage^2$) is included alongside the linear leverage term in the regression models. A significant negative coefficient on the squared term alongside a positive coefficient on the linear term would confirm the inverted U-shaped relationship predicted by H1.

Earnings volatility is calculated as the rolling three-year standard deviation of ROA for each firm. This measure captures firm level variability in operational profitability and is consistent with the approach used in capital structure determinants literature including (Titman & Wessels, 1988) and (Moradi & Paulet, 2019). To test H2, an interaction term between earnings volatility and leverage is included in the regression model. A significant negative coefficient on this interaction term would indicate that earnings volatility amplifies the negative performance consequences of high leverage as hypothesized.

Ownership variables were constructed using ownership data obtained from annual reports, measured as the percentage of voting rights held by different shareholder categories. Ownership types were classified into strategic ownership, state ownership, family ownership, institutional ownership and undisclosed based on the identity of the shareholder. Shareholders were manually classified using predefined category codes. Strategic or corporate ownership was assigned category code 1 and includes industrial corporations, energy companies, infrastructure firms, and other strategic corporate investors with potential long-term business interests in the firm. State ownership was assigned to category code 2 and included national, regional, or municipal governments as well as state-controlled entities. Individual and family ownership was assigned category code 3 and captures holdings by founding families, individual family members, or family-controlled investment vehicles. Institutional ownership was assigned category code 4 and includes pension funds, mutual funds, hedge funds, insurance companies, and asset management firms. Shareholders classified as custodians, banks, nominees, or entities with undisclosed or unknown ownership identities were assigned category code 5 and excluded from the main ownership-type analysis because they do not represent identifiable ultimate controlling owners.

Ownership concentration is measured as the voting percentage held by the single largest controlling shareholder, manually collected from company annual reports for each firm-year observation over the period 2014 to 2024. This measure follows the approach of (Faccio & Lang, 2002) who identify the largest shareholder voting stake as the most direct and theoretically relevant proxy for ownership concentration in European listed firms. Alternative measures such as the Herfindahl-Hirschman Index (HHI), which aggregates squared ownership shares across all shareholders, were considered but not adopted for two reasons. First, the monitoring hypothesis underlying H4 specifically concerns the incentive and ability of the

dominant controlling shareholder to oversee management making the largest shareholder voting stake the more appropriate measure. Second, complete shareholder data for all investors is unavailable for all firm-year observations, making HHI construction unreliable.

3.2.3 Control Variables

The regression models incorporate a set of firm-level control variables that are anticipated to affect both leverage choices and firm performance, in accordance with standard procedure in the capital structure and firm performance literature. Firm size is measured as the natural logarithm of total assets, with larger firms generally linked with greater debt capacity and potentially higher performance. It controls scale effects, market access, and financing capacity, as larger firms generally benefit from greater diversification, lower bankruptcy risk, and easier access to external financing.

Asset Tangibility is measured as net property plant and equipment divided by total assets, with tangible assets serving as collateral that facilitates debt access. Tangibility controls collateral capacity because firms with higher proportions of tangible assets may obtain debt financing more easily due to the availability of pledge able assets.

Cash Holdings are measured as cash and cash equivalents divided by total assets. The variable controls for firms are liquidity and financial flexibility, as firms with larger cash reserves maybe better able to finance operations and investment opportunities without relying on external financing.

The capital expenditure ratio controls investment intensity and long-term asset expansion, particularly relevant in the energy sector where infrastructure investment requirements are substantial. It captures the need for external financing to fund capital investments and may be positively associated with leverage if debt is used to finance asset growth.

All models are estimated using two-way Random Effects, accounting for both firm-level random effects and time-level unobserved heterogeneity simultaneously. The firm-level random effects capture unobserved time-invariant firm characteristics, while the time-level random effects account for common macroeconomic shocks and regulatory changes affecting all firms in a given year.

3.3. Descriptive Statistics

Table 3.3.1 presents the descriptive statistics for all variables used in the empirical analysis across the sample between 927 and 1,139 firm-year observations. The descriptive statistics

provide an overview of the financial performance, capital structure, financial characteristics, and ownership structures within the sample.

Table 3.3.1: Summary Statistics of Variables

Variable	N	Mean	S.D.	Median	Min	Max
ROA	1135	0.0053	0.1194	0.0176	-0.5202	0.3545
Tobin's Q	1137	0.8873	0.5180	0.7631	0.1459	3.4037
Leverage	1139	0.3146	0.2317	0.2875	0.0000	1.0099
Leverage^2	1139	0.1526	0.1890	0.0827	0.0000	1.0199
Firm size	1139	7.2971	2.3083	7.3294	0.7566	12.9363
Tangibility	1139	0.4515	0.2727	0.4694	0.0000	0.9601
Cash Holdings	1139	0.1327	0.1294	0.0992	0.0025	0.7635
Capex Ratio	1139	0.0705	0.0712	0.0500	0.0000	0.3685
Earnings Volatility	927	0.0756	0.1080	0.0374	0.0010	0.6302
Ownership_con	1086	33.4138	23.0065	29.0400	2.0800	92.0000
ownership_conc_sq	1086	1645.2898	1938.2240	843.3252	4.3264	8464.0000
Strategic owner	1086	0.3370	0.4729	0.0000	0.0000	1.0000
State owner	1086	0.1961	0.3973	0.0000	0.0000	1.0000
Family owner	1086	0.2505	0.4335	0.0000	0.0000	1.0000
Institutional owner	1086	0.1556	0.3627	0.0000	0.0000	1.0000

Note: All continuous variables are winsorized at the 1st and 99th percentiles except firm size, tangibility, and ownership concentration which recorded zero outliers. Ownership concentration squared is presented in its raw form for descriptive purposes. Prior to regression estimation, both ownership concentration and its squared term are mean centered to reduce multicollinearity between the linear and quadratic terms and to improve numerical stability of the estimates.

The accounting-based performance measures indicate relatively modest profitability levels across the sampled firms. The mean ROA reports a mean value of 0.0053 and ranges from -0.520 to 0.355 after winsorization, reflecting modest average profitability with considerable variation across firms. The relatively low profitability may reflect the capital-intensive nature of the energy sector, which is characterized by substantial infrastructure investments, volatile commodity prices, and exposure to macroeconomic and regulatory uncertainty.

The market-based performance measure, Tobin's Q, reports a mean value of 0.8873 and a median value of 0.7631 with a maximum of 3.404 reflecting a small number of high-performing firms. Since the average Tobin's Q remains below 1, the results may indicate that, on average, the market valuation of firms was slightly below the replacement cost of assets during the sample period. This may partly reflect investor uncertainty surrounding the long-

term transition of the European energy sector toward decarbonization and renewable energy investments.

The average leverage ratio is 0.315 with a standard deviation of 0.232, indicating moderate reliance on debt financing among European energy firms. The relatively wide range, extending from 0% to approximately 101%, suggests substantial heterogeneity in financing structures across firms. Some firms operate with minimal debt, while others rely heavily on external financing. This variation supports the relevance of examining the non-linear relationship between leverage and firm performance proposed in the study. The inclusion of the squared leverage term further allows the analysis to capture potential non-linear effects associated with excessive debt financing.

Firm size exhibits a mean value of 7.297, indicating that the sample includes both medium-sized and large listed energy firms. Tangibility displays a relatively high mean of 45.13%, reflecting the asset-intensive characteristics of the energy industry, where firms commonly maintain substantial physical infrastructure, production facilities, pipelines, and equipment.

The average cash holdings is 0.1327 while the mean capital expenditure ratio is 0.0705, indicating that energy firms reinvest approximately 7% of total assets annually. It is consistent with the high investment requirements typically associated with energy firms. Energy companies often engage in continuous infrastructure expansion, technological modernization, and long-term investment projects, particularly in relation to renewable energy development and energy transition strategies.

Earnings volatility reports a relatively low mean value of 0.0756 although the maximum value of 0.6302 suggests that certain firms experienced substantial fluctuations in profitability during the sample period. The inclusion of earnings volatility is particularly relevant given the cyclical and uncertain nature of energy markets.

The ownership structure variables reveal substantial heterogeneity across firms. State ownership reports an average value of 0.1961, while strategic ownership averages 0.3370. Family ownership and institutional ownership exhibit average levels of 0.2505 and 0.1556 respectively. Notably, the median values for all ownership categories equal zero, indicating that many firms do not possess a dominant ownership presence from a specific ownership group.

However, the maximum ownership values remain relatively high, suggesting that certain firms are strongly influenced by concentrated ownership structures.

Ownership concentration exhibits a mean value of 33.41%, with values ranging from 2% to 92%. This suggests that ownership among European energy firms is often concentrated among major shareholders rather than widely dispersed. The relatively high level of ownership concentration is consistent with the broader European corporate governance environment, where concentrated ownership structures are more common compared to Anglo-American markets.

Overall, the descriptive statistics indicate substantial variation in firm performance, financing structures, and ownership characteristics across European energy firms. The variation observed across key variables supports the suitability of panel data analysis and provides an appropriate foundation for examining the relationship between leverage, ownership structure, and firm performance within the European energy sector.

3.4 Correlation Matrix

Table 3.4.1 Correlation Matrix

	ROA	TQ	LEV	LEV²	SIZE	TANG	CASH	CAPEX	EVOL	OC	OC²	STR	STATE	FAM	INST
ROA	1														
TQ	-0.02	1													
LEV	-0.1	0.15	1												
LEV²	-0.2	0.21	0.93	1											
SIZE	0.21	-0.16	0.01	-0.12	1										
TANG	0.07	-0.07	0.45	0.38	0.21	1									
Cash	-0.01	0.22	-0.26	-0.18	-0.27	-0.35	1								
Capex Ratio	-0.05	0.12	-0.04	-0.05	-0.07	0.16	-0.05	1							
Earn Vol	-0.2	0.15	0.06	0.19	-0.4	-0.11	0.19	0.05	1						
OC	0.17	-0.02	0.11	0.09	-0.03	0.31	-0.01	-0.05	-0.15	1					
OC²	0.15	-0.03	0.1	0.08	-0.02	0.3	0.01	-0.04	-0.13	0.96	1				
STR	-0.06	0.06	0.19	0.22	-0.12	0.09	-0.02	-0.16	-0.03	0.17	0.11	1			
STATE	0.14	-0.04	-0.22	-0.21	0.27	0.09	-0.05	0.04	-0.13	0.21	0.18	-0.35	1		
FAM	0.04	-0.08	0.12	0.06	-0.12	0.11	-0.02	0.06	-0.04	0.08	0.08	-0.41	-0.29	1	
INST	-0.09	-0.04	-0.15	-0.14	0.07	-0.26	0.08	0.05	0.18	-0.45	-0.34	-0.31	-0.21	-0.25	1

Note: ROA = Return on Assets; TQ = Tobin's Q; LEV = Leverage; LEV² = Leverage Squared; SIZE = Firm Size; TANG = Tangibility; CASH = Cash Holdings; CAPEX = Capex Ratio; EVOL = Earnings Volatility; OC = Ownership Concentration; OC² = Ownership Concentration Squared; STR = Strategic Ownership; STATE = State Ownership; FAM = Family Ownership; INST = Institutional Ownership. Correlations computed using pairwise complete observations. Only lower triangle shown. Values above 0.80 indicate potential multicollinearity concerns.

Table 3.4.1 presents the Pearson correlation matrix for the variables included in the capital structure models and ownership structure models. The correlation analysis provides an initial overview of the relationships among the variables and serves as a preliminary assessment of potential multicollinearity issues.

Overall, the correlation coefficients indicate no severe multicollinearity concerns, as most pairwise correlations remain well below the commonly accepted threshold of 0.70. A notable observation in the matrix is the very high correlation between leverage and its square (0.935), as well as between ownership concentration and its square (0.963). These correlations exceed conventional thresholds for multicollinearity. To mitigate multicollinearity, mean-centering has been applied to leverage and ownership concentration before squaring, which substantially reduces the correlation between the linear and quadratic terms. This adjustment is standard practice and is discussed further in the methodology section.

Among the control variables, no pairwise correlation exceeds 0.5, indicating that multicollinearity is not a concern for the controls. The strongest correlation among controls is between tangibility and cash holdings (-0.355), followed by firm size and earnings volatility (-0.396). These are moderate and well below the threshold of 0.8, so they are unlikely to introduce significant multicollinearity into the regression estimates.

Regarding ownership types, the dummies for strategic, state, family, and institutional owners show negative correlations with each other (ranging from -0.21 to -0.41). This is expected because the presence of one dominant owner type often precludes others. These moderate negative correlations are not problematic for the regressions, as the ownership dummies are entered simultaneously to capture the distinct effects of each type.

Finally, earnings volatility shows a moderate negative correlation with firm size (-0.396) and a weak negative correlation with ownership concentration (-0.155), suggesting that larger, more concentrated firms tend to have more stable earnings. This supports the inclusion of both size and concentration as controls when testing the moderating role of earnings volatility (H2).
Overall, the correlation matrix does not reveal any problematic multicollinearity that would bias the regression results, provided mean-centering is applied to the quadratic terms.

Chapter 4: Methodology

This chapter outlines the empirical approach employed to examine the relationship between capital structure, ownership structure, and financial performance for a sample of European energy sector firms.

4.1 Panel Data

Panel data, also known as longitudinal data, is a dataset containing observations of multiple subjects such as individuals, firms, countries, or regions, tracked repeatedly over a set period. It is a combination of both cross-sectional and time-series dimensions. In this study, the dataset consists of 104 firms observed over an eleven-year period, resulting in a longitudinal dataset containing repeated firm-year observations. More specifically, the dataset represents an unbalanced panel, as the number of observations differs across firms and variables due to missing financial information, listing changes, incomplete ownership disclosures, and differences in reporting availability. Despite these variations, unbalanced panel data still provides substantial advantages for empirical analysis and allows the retention of valuable firm-year observations that would otherwise be lost in a balanced sample requirement. The panel data approach is particularly appropriate for this study for several reasons.

A panel framework allows the analysis to capture cross-sectional heterogeneity while simultaneously observing how firms evolve over time. It helps to control unobservable firm-specific characteristics that cannot be directly measured but may influence firm performance and financing decisions. It also provides a large number of observations compared to purely cross-sectional analysis, thereby increasing the degrees of freedom and improving statistical efficiency. The use of panel data also reduces collinearity among variables and improves the ability to identify dynamic relationships between leverage, ownership structure, and firm performance over time.

The use of panel data is especially helpful for the purpose of this thesis because capital structure and ownership are not static variables. The firm's financing policy is likely to change over time according to macroeconomic trends, fluctuations in commodity prices, the pressure to move away from carbon-based energy sources, and new regulations. In addition, company performance in the energy sector is affected by many outside influences such as fluctuating oil prices and changing environmental regulations.

4.2 Regression Estimation Methods

To estimate the empirical models, the study employs several panel data estimation techniques, including pooled Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) models. The use of multiple estimation approaches allows the study to compare model suitability and ensure the robustness of the empirical findings.

4.2.1 Pooled OLS regression

Pooled ordinary least squares (OLS) is the simplest estimator for panel data. It treats all observations across both cross-sectional units (e.g., firms, countries, individuals) and time periods as a single, pooled sample. In other words, the panel structure is ignored, every observation is assumed to be independent, regardless of whether it comes from the same unit over time.

The poled OLS model can be written as:

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \varepsilon_{it} \qquad 2$$

Where, Y_{it} is the dependent variable for unit i in time t, X is the independent variables, β_0 is a common intercept (identical for all units and time periods), $\beta_1 \ldots \beta_k$ are the coefficients to be estimated. ε_{it} is the error term, assumed to be independently and identically distributed with zero mean and constant variance.

The key assumption is that the error term is uncorrelated with all regressors. This implies that no unobserved, time-invariant characteristics of the cross-sectional units influence both the dependent and independent variables. Furthermore, observations are assumed to be independent across both units and time so the fact that two observations come from the same firm two years apart is irrelevant.

While pooled OLS is relatively easy to compute, it is usually regarded as inadequate when dealing with panel data since it fails to take into account the existence of heterogeneity and time dummies. This can be illustrated by taking into consideration the energy industry in Europe. Firms in this sector have unique differences in ownership, size, business strategy, and regulations.

4.2.2 Fixed Effects Model

The fixed effects model is a panel data estimator that addresses unobserved heterogeneity, time-invariant characteristics of cross-sectional units that may correlate with the independent variables. Unlike pooled OLS, which ignores the panel structure, the FE model allows each unit to have its own intercept. This intercept captures all unit-specific, time-constant factors, whether observed or not.

The fixed effects model can be written as:

$$Y_{it} = \alpha_i + \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \varepsilon_{it} \quad 3$$

Where, α_i is the firm-specific intercept (fixed effect) that does not vary over time.

The main advantage of FE method is its ability to account for all firm-specific variables that are constant over time, regardless of whether these variables are measurable. These might include factors like management quality, ownership history, governance culture, operational expertise, or consistent business strategies. The FE model essentially examines how changes within a firm over time affect firm performance or leverage decisions. Rather than comparing different firms against one another, the model compares each firm against itself across different years. Apart from the inclusion of firm-level fixed effects, the model further considers year fixed effects that account for any macroeconomic or industry-wide shocks impacting all firms in the sample period. Some examples include oil price shocks, interest rate movements, geopolitical occurrences, post-COVID economic recovery, and policy reforms related to energy transition in Europe.

4.2.3 Random Effects Models (RE)

The RE model also accounts for firm-specific heterogeneity. However, unlike the FE model, it assumes that the unobservable firm-specific effects are uncorrelated with the explanatory variables included in the regression model.

The RE model can be written as:

$$Y_{it} = \alpha_i + \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + u_i + \varepsilon_{it} \quad 4$$

Where, u_i is the unit specific random error (time-variant) that captures unobserved heterogeneity.

The RE model is relatively more efficient than the FE model when all of its assumptions are valid since it considers both firm-level variations. On the other hand, the FE model focuses

mainly on the variations within firms over time. However, one major drawback of the RE model is its strong assumption of no correlation between the firm-specific effects and the regressors. This assumption is hard to make in corporate finance and ownership studies. For instance, the factors that are unique to the firm can affect capital structure and financial performance.

Due to these concerns, the suitability of the FE and RE models is evaluated using the Hausman specification test. The final model selection is based on both statistical evidence and theoretical considerations relevant to the European energy sector.

4.3 Diagnostic Tests

In order to make sure that the regression analysis is reliable and valid, certain diagnostic tests are conducted to validate the estimation approach and ensure the reliability of the regression results. Each diagnostic procedure is described in the following subsections.

4.3.1 Multicollinearity

Multicollinearity occurs when two or more independent variables in a regression model are highly correlated with each other. When this happens, it becomes difficult to isolate the individual effect of each variable, making coefficient estimates unstable and unreliable.

The Variance Inflation Factor (VIF) measures how much the variance of a regression coefficient is inflated due to its correlation with other independent variables. A VIF value of 1 indicates no correlation with other variables. Values between 1 and 5 are generally considered acceptable. Values above 10 indicate problematic multicollinearity that may compromise the reliability of the estimates. The VIF table is shown below.

Table: 4.3.1 VIF Before and After Mean Centering

Variable	VIF Before	VIF After
Leverage	9.769	1.609
Leverage Squared	9.418	1.444
Ownership Concentration	13.975	1.526
Ownership Concentration squared	13.929	1.418
Firm Size	1.287	1.287
Tangibility	1.459	1.459
Cash Holdings	1.229	1.229
Capex Ratio	1.065	1.065
State owner	1.512	1.512
Family owner	1.303	1.303
Institutional owner	1.404	1.404

Note: VIF values for ownership type dummies are unchanged as no mean centering is applied to H3 variables. Conventional threshold for multicollinearity concern is VIF above 10 for severe concern and above 5 for moderate concern.

Prior to regression estimation, variance inflation factors are computed to assess multicollinearity across all model specifications. Before mean centering, leverage and its squared term exhibit VIF values of 9.769 and 9.418 respectively, and ownership concentration and its squared term exhibit VIF values of 13.975 and 13.929 respectively, all exceeding the conventional threshold of 10. These elevated values reflect the mathematical dependence between linear and quadratic terms rather than genuine multicollinearity among theoretically distinct variables. Following mean centering, all VIF values fall below 2 across all model specifications, confirming that multicollinearity is not a concern in the regression models. Control variables including firm size, tangibility, cash holdings, and capital expenditure ratio consistently record VIF values below 2 both before and after centering. Ownership type dummy variables in the H3 specification record VIF values below 2 without requiring any transformation.

4.3.2 Breusch-Pagan LM Test

The Breusch–Pagan Lagrange Multiplier (LM) test was conducted to determine whether panel effects were present in the data and whether a panel-data estimator was preferable to pooled ordinary least squares. The null hypothesis states that the variance of the unobserved individual effects is equal to zero, implying that pooled OLS is sufficient. The alternative hypothesis states that significant panel effects exist.

$$H_0 = No\ panel\ effects\ exist (POLS\ is\ sufficient)$$
$$H_1 = Panel\ effect\ exist\ (RE\ preffered\ over\ POLS)$$

Table 4.3.2 Breusch-Pagan LM Test Results - All Hypotheses

	ROA			Tobin's Q		
Hypothesis	Chi-Square	p-value	Decision	Chi-Square	p-value	Decision
H1	78.566	< 0.001	Panel effects exist	1116.343	< 0.001	Panel effects exist
H2	30.274	< 0.001	Panel effects exist	796.514	< 0.001	Panel effects exist
H3	46.162	< 0.001	Panel effects exist	818	< 0.001	Panel effects exist
H4	35.394	< 0.001	Panel effects exist	1031.631	< 0.001	Panel effects exist

Note: Breusch-Pagan LM test conducted on Pooled OLS model. H0: No significant individual effects. A significant p-value (p<0.05) rejects Pooled OLS in favor of panel estimation.

The test results are presented in Table 4.3.2 and confirm the presence of significant panel effects across all four hypotheses and both performance measures. The test statistics are highly significant across all model specifications ($p < 0.001$), leading to rejection of the null

hypothesis that no individual panel effects exist. These findings indicate the presence of unobserved firm-specific heterogeneity within the sample of European energy firms. Consequently, pooled OLS is not an appropriate estimation method, and panel-data estimators are required. Based on these results, the analysis proceeds with the Hausman test to determine the most appropriate panel-data specification between fixed effects and random effects.

4.3.3 Hausman Specification Test

To determine the most appropriate panel data estimation technique, the study employs the Hausman specification test. The Hausman test is used to compare the Fixed Effects (FE) and Random Effects (RE) models and evaluate whether unobservable firm-specific characteristics are correlated with the explanatory variables included in the regression models. The null hypothesis states that the Random Effects estimator is consistent and efficient, while the alternative hypothesis indicates that Fixed Effects is preferred due to correlation between the individual effects and the regressors.

$$H_0 : Random\ Effects\ is\ consistent.$$
$$H_1 : Fixed\ Effects\ is\ preferred.$$

In the context of this study, the Hausman test is particularly important because firms within the European energy sector differ substantially in terms of ownership structure, operational characteristics, governance practices, and regulatory exposure. These firm-specific factors may influence both leverage decisions and financial performance, making the choice between Fixed Effects and Random Effects consequential for the reliability of the estimates.

Table 4.3 presents the Hausman test results across all four hypotheses and both performance measures. The test yields insignificant results across all specifications, with p-values ranging from 0.078 to 1.000. The null hypothesis cannot be rejected, suggesting that Random Effects is appropriate relative to Fixed Effects in this specification . It should be noted that the Hausman test evaluates only whether the random effects assumption is violated relative to fixed effects and does not rule out other sources of endogeneity. Consequently, two-way Random Effects panel regression is adopted as the primary estimation strategy for all hypothesis models, with findings interpreted as conditional associations rather than causal effects.

Table:4.3.3 Hausman Specification Tests

	ROA				Tobin's Q			
Hypothesis	Chi-Square	df	p-value	Decision	Chi-Square	df	p-value	Decision
H1	0.623	6	0.996	RE	9.085	6	0.169	RE
H2	0.634	8	1	RE	5.008	8	0.757	RE
H3	2.116	8	0.977	RE	6.344	8	0.609	RE
H4	2.292	7	0.942	RE	12.781	7	0.078	RE

Notes: Failure to reject H0 suggests Random Effects is appropriate relative to Fixed Effects in this specification. A significant p-value ($p<0.05$) indicates Fixed Effects is preferred.

The Hausman test result not rejecting the null hypothesis does not imply the absence of firm-specific heterogeneity, nor does it rule out all forms of endogeneity. It indicates only that systematic correlation between firm-specific effects and regressors is not detected in this specification, making Random Effects the preferred estimator relative to Fixed Effects under this test. Residual endogeneity concerns, particularly for leverage in the ROA specifications, are addressed separately through the Durbin-Wu-Hausman test discussed in 4.4 Endogeneity Section.

4.3.4 Heteroscedasticity

Heteroscedasticity arises when the variance of the distribution of the error term conditional on the independent variables is not constant across entities and time. In panel data studies of firms this is common. Larger firms often have more variable performance outcomes than smaller firms. For example, if heteroscedasticity is present and ignored, the standard errors of the regression coefficients will be incorrect, making hypothesis tests unreliable even if the coefficient estimates themselves remain unbiased.

The Breusch-Pagan test is conducted to assess whether the variance of the residuals depends on the values of the independent variables presented in the table below. The null hypothesis is that variance is constant homoscedasticity. The alternative hypothesis states that heteroscedasticity is present. A p-value below 0.05 leads to rejection of the null hypothesis and indicates the presence of heteroscedasticity in the model residuals.

$$H_0 = Homoscedasticity\ present$$
$$H_1 = Heteroscedasticity\ present$$

Table:4.3.4 Breusch-Pagan Heteroscedasticity Test Results

	ROA				Tobin's Q			
Hypothesis	BP	df	p-value	Decision	BP	df	p-value	Decision
H1	157.593	6	< 0.001	Present	112.094	6	< 0.001	Present
H2	395.961	8	< 0.001	Present	91.167	8	< 0.001	Present
H3	125.702	8	< 0.001	Present	74.482	8	< 0.001	Present
H4	131.63	7	< 0.001	Present	104.09	7	< 0.001	Present

Note: Breusch-Pagan heteroscedasticity test conducted on the final selected model. H0: Homoskedasticity. A significant p-value ($p<0.05$) confirms heteroscedasticity in the residuals.

The Breusch-Pagan test rejects the null hypothesis of homoskedasticity across all four hypotheses and both performance measures, with all p-values below the 0.001 threshold. BP statistics range from 125.702 to 395.961 for ROA and from 74.482 to 112.094 for Tobin's Q, confirming the presence of heteroskedasticity throughout the sample. These findings are consistent with the expectation that European energy firms exhibit considerable variation in firm size, capital structure, and profitability, which is associated with non-constant residual variance across observations. The presence of heteroskedasticity across all specifications motivates the use of robust standard errors to ensure reliable inference in the regression models.

4.3.5 Autocorrelation

Serial correlation, also called autocorrelation, occurs when the error terms of a regression model are correlated across time for the same firm. In panel data spanning multiple years this is a common concern since a firm's performance in one year is often related to its performance in the previous year. If serial correlation is present and ignored, standard errors will be underestimated, leading to inflated t-statistics and false conclusions about statistical significance.

In our study, firms are observed for a period of eleven years, and it can be safely assumed that some of our variables are correlated through time for each firm. For example, a firm with high leverage in a particular year will most likely have high leverage in the next year since capital structure changes take place very slowly because of adjustment costs. This applies equally to profitability, size, and earnings variability, which also have persistence. Such variables, either used as regressors or left out (such as managerial attitude towards risk and organizational culture), will most probably correlate in time for each entity. In case there is autocorrelation in

the error terms, standard errors will be biased downwards and t-statistics biased upwards, resulting in spurious significance.

$$H_0 = There\ is\ no\ first\ order\ serial\ correlation\ in\ the\ idosyncratic\ errors.$$
$$H_1 = There\ is\ first\ order\ serial\ correlation\ in\ the\ idosyncratic\ errors.$$

The Breusch–Godfrey panel serial correlation test *(pbgtest)* is preferred over the Wooldridge autocorrelation test *(pwartest)* in this study because the final model selection procedure identifies the Random Effects (RE) estimator as the appropriate panel specification based on the Hausman test results. The Wooldridge test implemented through (*pwartest*) in R is specifically designed for fixed-effects ("within") panel models and is therefore not compatible with random-effects estimators. Consequently, applying the Wooldridge test to the selected RE models would be econometrically inappropriate and technically unsupported within the *plm* framework.

Table 4.3.5 Breusch-Godfrey Autocorrelation Test Results

	ROA				Tobin's Q			
Hypothesis	Chi-Square	df	p-value	Decision	Chi-Square	df	p-value	Decision
H1	98.926	6	< 0.001	Present	521.93	7	< 0.001	Present
H2	51.043	4	< 0.001	Present	435.093	4	< 0.001	Present
H3	78.785	3	< 0.001	Present	422.624	3	< 0.001	Present
H4	71.241	4	< 0.001	Present	469.315	4	< 0.001	Present

Note: Breusch-Godfrey serial correlation test conducted on the final selected Random Effects model. H0: No serial correlation in idiosyncratic errors. A significant p-value ($p < 0.05$) confirms serial correlation.

The Breusch-Godfrey test rejects the null hypothesis of no serial correlation across all four hypotheses and both performance measures, with all p-values below the 0.001 threshold. This finding is consistent with the nature of panel data in corporate finance, where firm-level variables such as leverage, ownership structure, and performance tend to exhibit strong persistence over time. Energy sector firms in particular are characterized by long-term investment cycles and stable capital structures, which are consistent with serially correlated residuals across consecutive years. To address this, standard errors are clustered at the firm level throughout all regression models, providing robustness to both heteroskedasticity and serial correlation within firms over time.

4.3.6 Cross-sectional dependence

In panel data studies, when firms operate in the same industry and macroeconomic environment, shocks affecting one firm may simultaneously affect others. This phenomenon represents a violation of the classical assumption of independence between cross-sectional units and is known as cross-sectional dependence. In the European energy industry, a common set of shocks can affect firms across the sample simultaneously, including oil and gas price fluctuations, European Union climate policy changes, interest rate movements, geopolitical disruptions, and broad macroeconomic shocks.

Given the nature of the sample, cross-sectional dependence is expected a priori. European energy firms are highly interconnected through shared regulatory frameworks, integrated energy markets, and joint exposure to external economic and political shocks. Events such as the COVID-19 pandemic, the European energy crisis following the Russia-Ukraine conflict, and commodity price fluctuations affected multiple firms simultaneously rather than in isolation, creating conditions highly conducive to correlated error terms across firms.

The Pesaran Cross-Sectional Dependence test is conducted to formally assess the presence of cross-sectional dependence in the regression residuals. The Pesaran CD test is particularly suitable for panel datasets because it can be applied to both balanced and unbalanced panels and remains reliable in the presence of large cross-sectional dimensions. The null hypothesis states that no cross-sectional dependence exists in the residuals. A p-value below 0.05 rejects the null hypothesis and confirms the presence of cross-sectional dependence.

$$H_0 = No\ cross\ sectional\ dependence\ across\ firms$$
$$H_1 = Cross\ sectional\ dependence\ across\ firms.$$

The test results are presented in Table 4.3.6.

Table 4.3.6 Pesaran CD Cross-Sectional Dependence Test Results

	ROA			Tobin's Q		
Hypothesis	z-statistic	p-value	Decision	z-statistic	p-value	Decision
H1	20.104	< 0.001	Present	6.707	< 0.001	Present
H2	14.604	< 0.001	Present	2.586	< 0.010	Present
H3	16.99	< 0.001	Present	7.789	< 0.001	Present
H4	17.442	< 0.001	Present	9.894	< 0.001	Present

Notes: Pesaran CD test conducted on the final selected Random Effects model. H0: No cross-sectional dependence. A significant p-value (p < 0.05) confirms cross-sectional dependence across firms.

The Pesaran CD test rejects the null hypothesis across all four hypotheses and both performance measures, with z-statistics ranging from 2.586 to 20.104 and all p-values at or below 0.010. This confirms that firm-level residuals are correlated across firms at the same point in time, consistent with the expectation that common macroeconomic and sector-specific shocks simultaneously affect European energy firms throughout the sample period. The simultaneous presence of heteroskedasticity, serial correlation, and cross-sectional dependence across all specifications motivates the use of Driscoll-Kraay standard errors as a robustness check, as this estimator jointly corrects for all three violations.

4.3.7 Robust Standard Errors

The diagnostic tests confirm the simultaneous presence of heteroskedasticity, serial correlation, and cross-sectional dependence across all model specifications. These violations, if left uncorrected, may render the standard errors unreliable, potentially leading to inflated t-statistics and incorrect conclusions about the relationships among variables. To address these issues, robust standard errors are employed throughout the empirical analysis. Firm-clustered standard errors are applied as the primary specification, clustering at the firm level to account for within-firm serial correlation and heteroskedasticity over time. This approach satisfies the minimum standard recommended for panel studies of this nature and is directly responsive to the violations identified by the Breusch-Pagan heteroskedasticity test and the Breusch-Godfrey serial correlation test.

While firm-clustered standard errors address within-firm serial correlation and heteroskedasticity, they do not correct for cross-sectional dependence identified by the Pesaran CD test. Driscoll-Kraay standard errors are therefore additionally reported as a robustness check, providing simultaneous correction for heteroskedasticity, serial correlation, and cross-sectional dependence through a non-parametric covariance estimator (Driscoll & Kraay, 1998). The maximum lag parameter is set to one, following the rule of thumb proposed by (Hoechle, 2007), which recommends setting the maximum lag equal to the floor of T raised to the power of one quarter. With T equal to 11 years in the sample, this yields a maximum lag of one. It should be noted that the asymptotic reliability of Driscoll-Kraay standard errors improves with a larger time dimension, and given the relatively short panel of 11 years, the Driscoll-Kraay results are interpreted with appropriate caution and reported as supplementary evidence rather than the primary basis for inference.

4.4 Endogeneity

A key methodological concern in examining the relationships between capital structure, ownership structure, and firm performance is the potential presence of endogeneity. Capital structure and firm performance are jointly determined, and ownership structure may also be endogenous. Better-performing firms may choose different leverage ratios, and firms with certain ownership structures may differ systematically from other firms in ways that are not fully captured by the control variables. In the context of capital structure research, reverse causality may arise because firms with superior financial performance may simultaneously adjust their leverage ratios, causing the explanatory variable to be correlated with the error term in the performance equation (Roberts & Whited, 2013). Additionally, omitted variable bias from unobserved firm characteristics such as managerial ability and organizational culture may further contribute to endogeneity concerns.

To formally test for endogeneity, the Durbin-Wu-Hausman test is employed using one-period lagged values of the potentially endogenous variables as instruments. The test is implemented through a two-stage procedure. In the first stage the potentially endogenous variable is regressed on its lagged value and the control variables to obtain first-stage residuals. In the second stage these residuals are included as an additional regressor in the main performance equation. A statistically significant coefficient on the first-stage residuals confirms the presence of endogeneity. The test results are presented in Table 4.4.

$$H_0 = The\ explanatory\ variable\ is\ exogenous.$$
$$H_1 = The\ explanatory\ variable\ is\ endogeneous.$$

Table 4.4 Durbin-Wu-Hausman Endogeneity Test Results

	ROA				Tobin's Q			
Hypothesis	Coefficient	t-value	p-value	Decision	Coefficient	t-value	p-value	Decision
H1	-0.278	-6.348	< 0.001	Yes	0.1624	0.846	0.398	No
H2	-0.3032	-6.969	< 0.001	Yes	0.1286	0.665	0.506	No
H3	-0.2789	-6.168	< 0.001	Yes	0.17	0.939	0.348	No
H4	-0.0007	-1.057	0.291	No	-0.0028	-1.013	0.311	No

Note: Durbin-Wu-Hausman test implemented via two-stage least squares. Stage 1 regresses the potentially endogenous variable on its one-period lag and controls. Stage 2 includes the Stage 1 residuals in the main regression. A significant residual coefficient ($p < 0.05$) confirms endogeneity. Evidence of endogeneity is found for leverage in ROA specifications across H1, H2, and H3. The test does not provide evidence of endogeneity in Tobin's Q specifications or H4. Failure to detect endogeneity does not confirm its absence.

The Durbin-Wu-Hausman test provides evidence of endogeneity of leverage in the ROA specifications across H1, H2, and H3, with highly significant residual coefficients indicating the presence of reverse causality between leverage and accounting-based performance. The test does not provide evidence of endogeneity in the Tobin's Q specifications across any hypothesis, nor in the ownership concentration models of H4, where the residual coefficients are small and statistically insignificant. It should be noted, however, that failure to detect endogeneity does not confirm its absence, particularly given that ownership structure and capital structure are generally difficult to treat as fully exogenous in corporate finance research.

To address the confirmed endogeneity in the ROA specifications, System GMM estimation using the Blundell-Bond estimator was attempted as a robustness check. System GMM is commonly employed in corporate finance research because it uses internal instruments derived from lagged variables to mitigate reverse causality and omitted-variable bias. However, the validity of the instrument set could not be satisfactorily established, indicating that the resulting estimates would not provide reliable inference. This failure is consistent with the well-documented limitation of System GMM in panels where the number of cross-sectional units is relatively small relative to the number of instruments (Roodman, 2009). With only 104 firms and 11 time periods the sample does not provide sufficient cross-sectional variation for valid GMM instrument construction. Given the failure of instrument validity, the GMM results are not reported.

Consequently, endogeneity is not formally corrected in this study. The findings should therefore be interpreted as conditional associations between the variables of interest and firm performance rather than as evidence of causal relationships. The primary estimation strategy employs Random Effects with firm-clustered standard errors, supplemented by Driscoll-Kraay robustness checks. This approach for unobserved time-invariant heterogeneity and provides inference that is robust to heteroscedasticity, serial correlation, and cross-sectional dependence. Although these methods do not fully resolve reverse causality, they improve the reliability of statistical inference and represent a reasonable empirical strategy given the limitations encountered in implementing a valid instrumental-variable or dynamic panel data approach.

Chapter 5: Empirical Results and Discussion

The following section presents empirical results and discussion of the associations between capital structure, ownership structure, and firm performance among European listed energy firms. The findings are organized around the four research hypotheses developed in Chapter 2 and are interpreted considering Trade-off Theory, Agency Theory, and the existing empirical literature. Section 5.1 presents the results for H1, examining the non-linear association between leverage and firm performance, including sub-sector analysis for conventional and renewable energy firms. Section 5.2 presents the results for H2, examining whether earnings volatility moderates the leverage-performance relationship. Section 5.3 presents the results for H3, examining whether different ownership types are associated with different firm performance outcomes, including the sub-hypothesis H3a on state ownership. Section 5.4 presents the results for H4, examining the non-linear association between ownership concentration and firm performance. Section 5.5 presents robustness checks including crisis period sensitivity analysis using a post-2021 energy crisis dummy. Throughout each section the main model results based on firm-clustered standard errors are presented alongside Driscoll-Kraay robustness checks and sub-sector analyses. Each hypothesis is evaluated as supported or not supported based on the statistical significance and direction of the key coefficients.

5.1 Empirical Results of H1

Table:5.1 H1 Regression Results-Main Model (Firm-Clustered SE)

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Leverage	-0.0144 (0.0302)	0.3563* (0.1810)	-0.0312 (0.0350)	0.3495* (0.1757)	0.0181 (0.0603)	0.2206 (0.6399)
Leverage²	-0.4663*** (0.0962)	1.5562** (0.5744)	-0.4405*** (0.1076)	1.3635* (0.5666)	-0.2986 (0.2155)	3.5937. (2.0636)
Firm Size	0.0078** (0.0025)	-0.0309* (0.0130)	0.0140*** (0.0042)	-0.0811*** (0.0230)	0.0051 (0.0035)	0.0797. (0.0417)
Tangibility	0.0418* (0.0207)	-0.1298 (0.1239)	0.0435. (0.0244)	-0.0413 (0.1295)	-0.0006 (0.0446)	-0.0666 (0.3832)
Cash Holdings	0.0827 (0.0568)	0.5350 (0.3844)	0.0690 (0.0626)	0.2851 (0.3951)	0.1711. (0.0956)	1.9455* (0.8949)
Capex Ratio	-0.1307 (0.0798)	0.9374* (0.3715)	-0.1585 (0.0984)	0.7509* (0.3815)	0.0110 (0.0716)	1.0749 (0.7811)
Observations	1135	1137	775	775	206	208
Number of Firms	104	104	71	71	19	19
Random Effects	Yes	Yes	Yes	Yes	Yes	Yes
Standard Errors	Firm-level	Firm-level	Firm-level	Firm-level	Firm-level	Firm-level
Within R^2	0.1111	0.1281	0.1196	0.1463	0.0316	0.1689

*Note: Standard errors in parentheses. Firm-clustered by firm and year. Random Effects model with firm and year random effects. Renewable Energy interpreted with caution given small sample of 19 firms. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Table 5.1 presents the main regression results examining the relationship between leverage and firm performance for the full sample as well as the conventional and renewable energy sub-samples. Firm performance is measured using both accounting-based indicators (ROA) and a market-based indicator (Tobin's Q). The Hausman specification test does not reject the null hypothesis for the H1 specifications, suggesting that Random Effects is appropriate relative to Fixed Effects in this context. This result does not rule out all endogeneity concerns, which are addressed separately in 4.4 Endogeneity section. Firm-clustered standard errors are employed throughout to account for within-firm correlation across time periods.

Full Sample Results

For the full sample, leverage itself is not statistically significant for ROA, while leverage squared is negative and highly significant ($\beta = -0.4663$, $p < 0.001$). The negative coefficient on the squared leverage term indicates a non-linear association between leverage and accounting-based performance. More specifically, the findings suggest that the association between

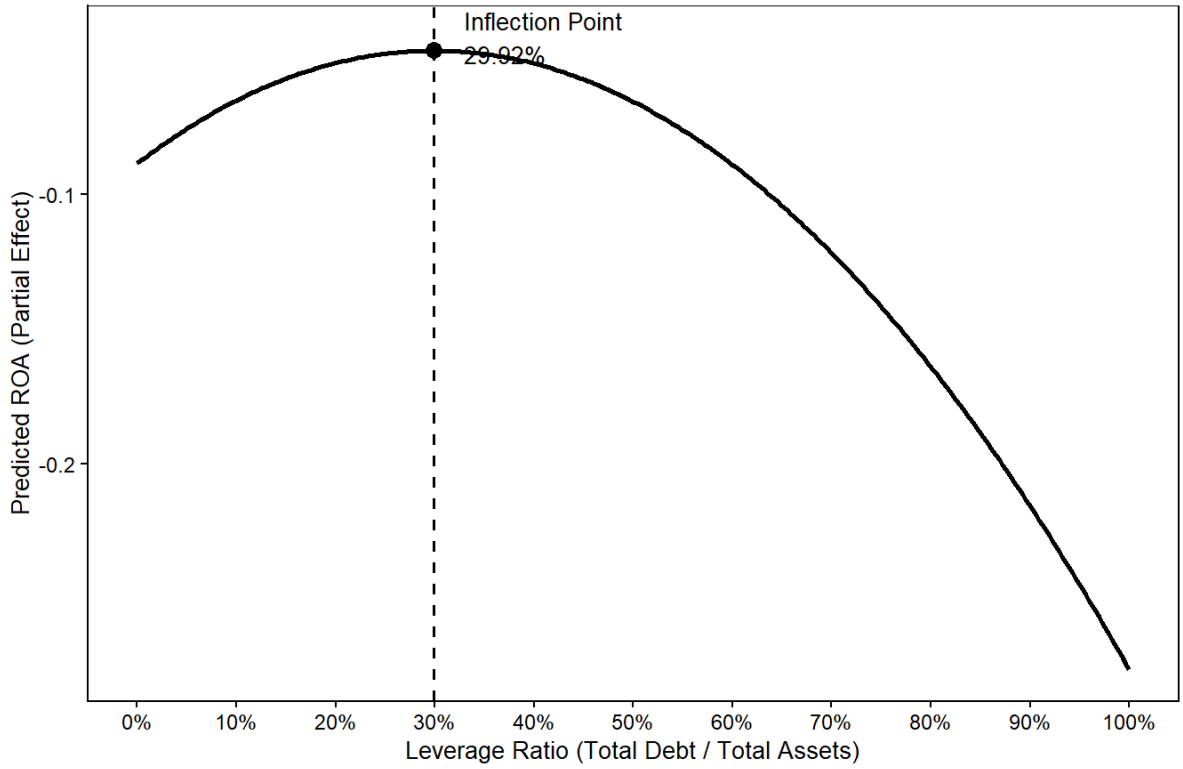
leverage and ROA becomes increasing as leverage rises. This result is broadly consistent with trade-off theory, which proposes that debt financing may initially provide tax advantages and financing benefits, but excessive leverage increases financial distress costs and agency problems that negatively affect operational performance (Kraus & Litzenberger, 1973).

The negative and significant coefficient on the squared leverage term indicates a concave association between leverage and ROA, suggesting that the relationship between debt financing and operational performance is non-linear. The estimated turning point of approximately 29.92% should be interpreted cautiously, as the linear leverage term is not statistically significant, meaning the numerator of the turning point formula is imprecisely estimated. This figure represents a sample-specific descriptive estimate of the leverage level at which the concave association with ROA reaches its peak, rather than a precisely identified or universally applicable optimal leverage ratio.

$$Turning\ point\ (centered) = \frac{-\beta 1}{2 * \beta 2}$$

Where,
β_1 is the coefficient on leverage.
β_2 is the coefficient on leverage squared.

Figure 5.1: Non-linear Relationship between Leverage and ROA



Note: Dashed line indicates the inflection point at 29.92% leverage ratio.

The inverted U-shaped pattern illustrated in Figure 5.1 visually supports the regression findings. At relatively lower leverage levels, debt financing at moderate levels is associated with stronger operational efficiency by providing additional funding capacity and tax advantages. However, as leverage increases further, the negative effects associated with financial distress risk, refinancing pressure, and debt servicing obligations appear to outweigh the benefits of debt financing. Notwithstanding the caveat regarding the insignificance of the linear leverage term, the estimated turning point falls within the observed leverage range of the sample, where the mean leverage is 31.46% and the median is 28.75%, suggesting that the non-linear pattern is not driven by extrapolation beyond the data.

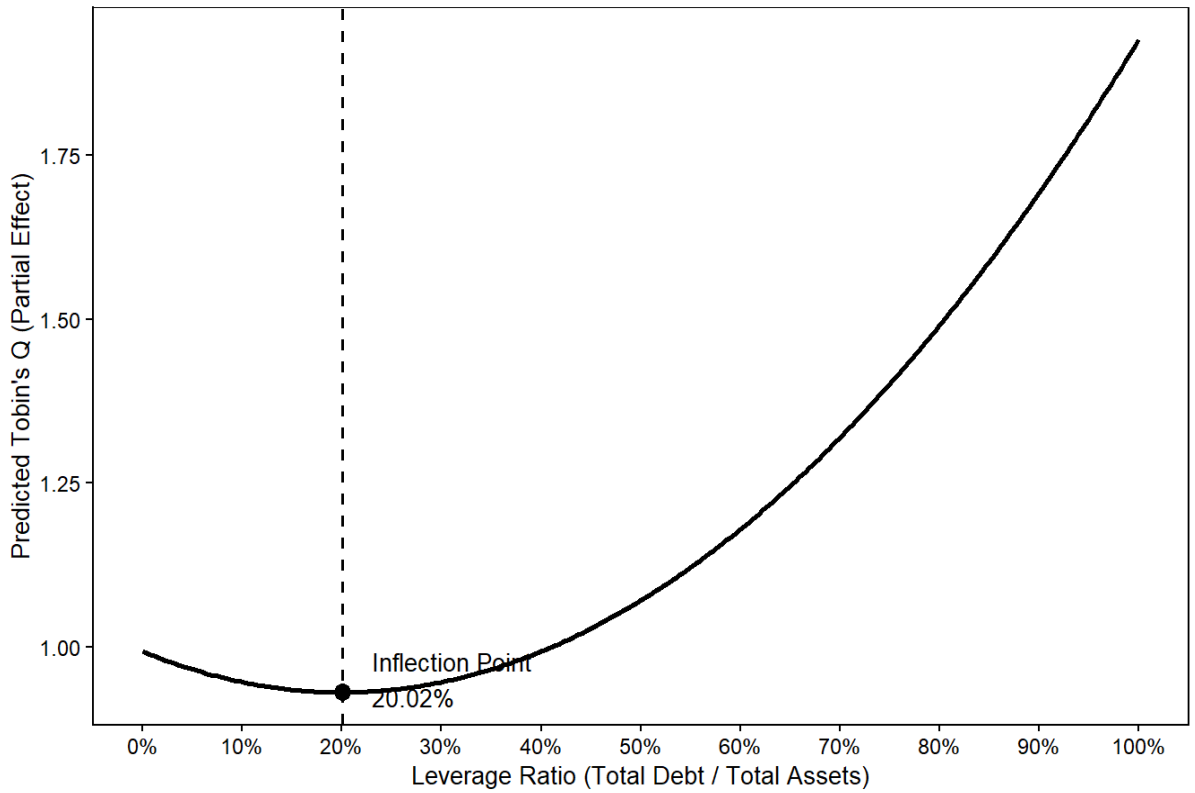
These findings are broadly consistent with the Trade-Off Theory proposed by (Modigliani & Miller, 1963)and later extended by (Kraus & Litzenberger, 1973), which predicts that the association between leverage and firm performance is non-linear: at moderate debt levels, the tax shield benefit of interest deductibility is associated with stronger operational efficiency, while beyond an estimated threshold, the costs associated with financial distress, refinancing pressure, and debt servicing obligations are linked to progressively weaker accounting performance. The observed concave pattern in the ROA model aligns with this theoretical

prediction and is consistent with prior empirical evidence from capital-intensive sectors documenting similar non-linear leverage-performance associations (Margaritis & Psillaki, 2010).

The market-based model using Tobin's Q produces a different pattern from the ROA results. Both the linear leverage term ($\beta = 0.3563$, $p < 0.05$) and the squared leverage term ($\beta = 1.5562$, $p < 0.05$) are positive and statistically significant, indicating a U-shaped association between leverage and market valuation. This stands in contrast to the inverted-U shaped concave pattern observed for ROA. The two results do not tell the same story, and this divergence is not contradictory but rather informative about the different dimensions of performance each measure captures.

Figure 5.1.2:

Non-linear Relationship between Leverage and Tobin's Q



Note: Dashed line indicates the inflection point at 20.02% leverage ratio.

The U-shaped relationship shown in figure 5.1.2 indicates that market valuation initially responds modestly to leverage but increases at higher leverage levels within the sample. One explanation is that investors may interpret higher leverage as a signal of growth expectations,

financing capacity, or investment confidence, particularly in capital-intensive sectors such as energy. At the same time, Tobin's Q may be especially sensitive to factors beyond current operating profitability, including commodity-price expectations, regulatory uncertainty, energy-transition policies, and investor sentiment regarding future growth opportunities. Consequently, it is not surprising that the market-based results differ from the accounting-based findings.

ROA measures current accounting-based operating efficiency, reflecting how productively a firm deploys its asset base in a given period. It responds to the immediate operational consequences of leverage, including debt servicing costs, financial distress pressure, and constraints on investment flexibility. The concave ROA pattern is therefore consistent with trade-off theory predictions that excessive debt is associated with weaker operational performance once financial distress costs dominate.

Tobin's Q, by contrast, reflects forward-looking market expectations rather than current profitability. In the European energy sector specifically, market valuations are shaped by a broader set of factors that extend well beyond current leverage levels, including commodity price expectations, energy transition dynamics, regulatory uncertainty, investor sentiment toward fossil fuel and renewable assets, and anticipated future investment opportunities. Higher leverage in this context may be interpreted by investors as a signal of financing capacity, infrastructure commitment, or confidence in future cash flows, particularly among large conventional energy firms whose debt is often linked to long-term asset development programs. This can produce a positive market response to leverage at higher levels even as the same leverage level is associated with weaker accounting performance.

This systematic divergence between ROA and Tobin's Q results is consistent with patterns documented in the broader capital structure literature. (Zeitun & Tian, 2007) and(Le & Phan, 2017) both note that the leverage-performance relationship is more consistent and statistically robust for accounting-based measures than for market-based measures, attributing this to the additional noise introduced by market expectations in Tobin's Q. In capital-intensive regulated sectors such as energy, where macroeconomic and policy factors independently drive market valuations, this divergence is particularly pronounced. The use of both ROA and Tobin's Q throughout this study is therefore not redundant but essential, as the two measures capture distinct and complementary dimensions of how leverage is associated with firm performance.

Among the control variables, firm size is positively associated with ROA and negatively associated with Tobin's Q. This finding suggests that larger energy firms may benefit from economies of scale and stronger operational efficiency while simultaneously facing lower market growth expectations relative to smaller firms. Tangibility is positively associated with ROA, indicating that firms with higher tangible asset bases may benefit from stronger collateral capacity and operational stability. Capital expenditure ratio is positively associated with Tobin's Q, implying that financial markets reward investment activity and long-term infrastructure development within the energy sector.

Conventional Energy Firms

To further examine whether the leverage-performance relationship differs across energy firm types, additional sub-sector analyses were conducted separately for conventional and renewable energy firms. This distinction is particularly important within the European energy sector, where conventional fossil-fuel firms and renewable energy firms operate under substantially different financing structures, regulatory environments, growth opportunities, and risk exposures.

The conventional energy subsample largely mirrors the full sample findings. Leverage squared remains negative and highly significant for ROA ($\beta = -0.4405$, $p < 0.001$), suggesting that excessive leverage is associated with weaker accounting performance among conventional energy firms. This finding is economically intuitive because conventional energy companies typically operate with high fixed costs, substantial debt dependence, and significant exposure to commodity-price fluctuations. Excessive leverage may therefore amplify financial vulnerability during periods of market volatility.

For Tobin's Q, leverage remains positively associated with market valuation ($\beta = 0.3495$, $p < 0.10$), while leverage squared is positive and marginally significant. These results may indicate that investors still perceive debt financing as supporting investment capacity and infrastructure expansion within conventional energy markets. However, the weaker significance in Tobin's Q specification suggests that investors may simultaneously incorporate transition-related risks associated with fossil-fuel assets and long-term decarbonization pressures. Firm size continues to display a positive association with ROA and a negative association with Tobin's Q. This may reflect the mature nature of conventional energy firms, where operational scale contributes

positively to profitability while lower expected future growth reduces market valuation multiples.

Renewable Energy Firms

In contrast to the conventional energy subsample, the renewable energy models do not provide statistically significant evidence supporting the non-linear leverage hypothesis. Neither leverage nor leverage squared exhibits statistically significant relationships with ROA, or Tobin's Q among renewable energy firms. These findings suggest that capital structure may play a less dominant role in explaining performance variation among renewable energy firms relative to conventional energy companies.

One possible explanation is that renewable energy companies are typically younger, smaller, and more growth-oriented than conventional energy firms. Instead of classic leverage dynamics, their financial performance may be more closely related with government subsidies, technological advancements, policy backing, and prospects for future growth. Furthermore, the comparatively smaller sample size for renewable energy may lower statistical power and result in lower significance levels.

Notably, cash holdings are positively associated with Tobin's Q among renewable energy firms. This suggests that investors place greater value on financial flexibility and liquidity within renewable energy businesses, likely because renewable-energy projects often require substantial upfront investment and involve longer investment horizons with uncertain future cash flows.

Overall, the results provide partial support for H1. A non-linear relationship between leverage and ROA is observed for both the full sample and the conventional energy sub-sector, broadly consistent with the predictions of Trade-off Theory. The divergence between accounting-based and market-based performance measures highlights the importance of employing multiple indicators when examining capital structure decisions within the energy sector. In contrast, renewable energy firms show no statistically significant leverage-performance relationship, which may reflect the distinct financing structures, growth dynamics, and policy dependence of this sub-sector. It should also be noted that the renewable energy sub-sample comprises only 19 firms and 208 observations, limiting statistical power and potentially contributing to the absence of significant findings. Results for this sub-sector should therefore be interpreted with caution. Importantly, all findings should be interpreted as conditional associations rather than

causal effects, as capital structure and firm performance may be jointly determined and residual endogeneity may remain despite the use of panel estimators and robust standard errors.

5.2 Empirical Results for H2

Table:5.2 H2 Regression Results

	Full Sample		Conventional Energy		Renewable Energy	
Variable	**R**OA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Leverage	-0.0543. (0.0317)	0.2746 (0.2123)	-0.0849* (0.0362)	0.1332 (0.2375)	-0.0305 (0.0506)	0.0974 (0.5749)
Leverage²	-0.5588*** (0.1066)	1.3892* (0.5825)	-0.5306*** (0.1141)	1.3058* (0.5729)	-0.2024 (0.2584)	3.0894 (2.0357)
Earnings Volatility	0.0205 (0.0838)	0.0111 (0.3307)	0.0382 (0.0876)	-0.0238 (0.3853)	0.1469 (0.2162)	1.9989 (1.9069)
Leverage × Earnings Volatility	0.3093 (0.2089)	0.9681 (0.8587)	0.3515 (0.2209)	1.3905 (0.8569)	2.0658. (1.1398)	2.8320 (9.9087)
Firm Size	0.0128*** (0.0030)	-0.0339* (0.0136)	0.0202*** (0.0044)	-0.1158*** (0.0262)	0.0104. (0.0058)	0.0246 (0.0427)
Tangibility	0.0638** (0.0232)	-0.0996 (0.1325)	0.0599* (0.0261)	0.0575 (0.1521)	-0.0185 (0.0540)	0.3030 (0.3579)
Cash Holdings	0.1394* (0.0612)	0.5832 (0.3892)	0.1110. (0.0657)	0.2770 (0.4368)	0.2833** (0.1051)	1.3272. (0.7029)
Capex Ratio	0.0254 (0.0761)	1.5140** (0.5073)	0.0138 (0.0901)	1.3275** (0.5052)	0.0467 (0.0908)	1.2552 (1.1619)
Observations	927	927	633	633	168	168
Number of Firms	104	104	71	71	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	Firm-level	Firm-level	Firm-level	Firm-level	Firm-level	Firm-level
Within R^2	0.1149	0.1508	0.1325	0.1635	0.0423	0.2007

*Note: Standard errors in parentheses clustered at the firm level. Random Effects model estimated using Amemiya variance component method with two-way effects. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Table 5.2 presents the regression results for Hypothesis 2, which examines whether earnings volatility moderates the relationship between leverage and firm performance across the full sample and the energy sub-sectors. Following the arguments of Frank and Goyal and Titman and Wessels, the study proposes that firms with more volatile earnings may experience a negative effect of leverage on performance due to higher financial risk and unstable cash flows.

Full Sample

Across the full sample, leverage is negatively associated with ROA, although the coefficient is statistically insignificant. However, the negative and significant coefficient on the squared

leverage term indicates a concave relation between leverage and ROA, suggesting that higher leverage levels are associated with progressively weaker accounting performance. This finding suggests that moderate leverage levels are associated with stronger operational performance, but beyond a certain level this association becomes increasingly negative, consistent with rising financial distress costs at higher leverage. This result is consistent with trade-off theory, which predicts that firms balance the tax advantages of debt against bankruptcy and agency costs (Kraus & Litzenberger, 1973).

For Tobin's Q, leverage is positively associated with market valuation, although the coefficient is statistically insignificant in the full sample ($\beta = 0.2746$). At the same time, the positive and marginally significant coefficient on leverage squared ($\beta = 1.3892$, $p < 0.10$) indicates a U-shaped relationship between leverage and market valuation. This suggests that financial markets may initially penalize leverage but reward firms with higher leverage levels once debt financing signals growth opportunities, investment capacity, or confidence in future cash flows. In the European energy sector, market valuations are strongly influenced by investor expectations regarding commodity prices, energy transition policies, and future investment opportunities, which may explain why Tobin's Q behaves differently from accounting-based performance measures.

Regarding the moderating effect of earnings volatility, neither earnings volatility nor the interaction term between leverage and earnings volatility is statistically significant in the full sample for either ROA or Tobin's Q. This indicates that earnings volatility does not substantially alter the leverage-performance relationship across the broader European energy sector.

Conventional Energy

The conventional energy subsample produces results broadly similar to those of the full sample. Leverage remains negatively associated with ROA and becomes marginally significant, while the squared leverage term remains negative and highly significant. This again supports the existence of an inverted U-shaped relationship between leverage and accounting performance among conventional energy firms. For Tobin's Q, the squared leverage term remains positive and marginally significant, suggesting a similar U-shaped relationship between leverage and market valuation in the conventional energy sector.

The interaction term between leverage and earnings volatility is positive in the conventional energy models but statistically insignificant. Therefore, there is limited evidence that earnings volatility materially changes the relationship between leverage and performance within conventional energy firms. One possible explanation is that conventional energy companies operate in industries naturally characterized by volatile earnings due to fluctuations in oil, gas, and electricity prices. Investors and creditors may therefore already price such volatility into financing decisions and market valuations.

Renewable Energy

The renewable energy subsample reveals a substantially different pattern. Neither leverage nor leverage squared is statistically significant for either ROA or Tobin's Q. Similarly, earnings volatility and the interaction term remain statistically insignificant, although the interaction coefficient for ROA is positive and marginally significant ($\beta = 2.0658$, $p < 0.10$). However, the large standard errors and relatively small renewable subsample suggest that these estimates should be interpreted cautiously.

The absence of significant leverage effects in renewable energy firms may reflect the distinct financial characteristics of the sector. Renewable energy companies are often younger, growth-oriented firms that rely heavily on external financing, policy support, and long-term project investment. Their performance and market valuation may therefore depend more strongly on future growth expectations and regulatory frameworks than on short-term capital structure decisions. Additionally, the relatively small number of renewable firms in the sample may reduce statistical power. This finding is not robust across standard error specifications and should be interpreted with caution given the small sample of 19 firms.

The results for H2 do not support the hypothesis that earnings volatility significantly moderates the relationship between leverage and firm performance. The interaction term between leverage and earnings volatility is statistically insignificant across all specifications, both performance measures, and both energy sub-sectors. This indicates that earnings volatility does not meaningfully alter the leverage-performance relationship within the European energy sector during the sample period. The nonlinear concave relationship between leverage and ROA documented in H1 remains present in the H2 models but is not systematically intensified or weakened by higher levels of earnings volatility. H2 is not supported. Earnings volatility does not exhibit a significant moderate role in the leverage-performance relationship among European listed energy firms over the 2014 to 2024 period.

5.3 Regression results for H3

Table 5.3 demonstrates the Random Effects regression results with firm-clustered standard errors testing H3, whether different ownership types have significantly different effects on the firm performance in the European energy market. The five largest controlling shareholders' voting rights percentages for each of the four ownership categories are analyzed. Three performance measures are used as dependent variables i.e, ROA and Tobin's Q across the full sample, conventional energy subsample, and renewable energy subsample.

Table: 5.3 Regression Results-Ownership Type and Firm Performance

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
State Ownership	0.0026 (0.0126)	0.0323 (0.0947)	0.0155 (0.0177)	0.0132 (0.0982)	0.0286 (0.0359)	-0.1444 (0.5382)
Family Ownership	0.0044 (0.0142)	-0.1167. (0.0668)	0.0091 (0.0176)	-0.1569* (0.0632)	-0.0014 (0.0247)	-0.0296 (0.2667)
Institutional Ownership	-0.0211 (0.0162)	-0.0385 (0.0771)	-0.0103 (0.0224)	-0.0510 (0.0912)	-0.0378 (0.0422)	-0.9181. (0.5106)
Leverage	-0.0893** (0.0309)	0.5836*** (0.1472)	-0.1048** (0.0342)	0.5792*** (0.1413)	-0.0075 (0.0760)	0.0085 (0.8890)
Firm Size	0.0127*** (0.0027)	-0.0395** (0.0120)	0.0197*** (0.0042)	-0.0626*** (0.0189)	0.0027 (0.0061)	0.1437 (0.0974)
Tangibility	0.0326 (0.0238)	-0.0574 (0.1150)	0.0400 (0.0276)	0.0029 (0.1091)	-0.0419 (0.0713)	0.4283 (0.6558)
Cash Holdings	0.0403 (0.0600)	0.6336 (0.3890)	0.0444 (0.0635)	0.3804 (0.3978)	0.0314 (0.2244)	4.5075** (1.4501)
Capex Ratio	-0.1026 (0.0939)	0.6484 (0.4110)	-0.1352 (0.1165)	0.5683 (0.3591)	0.0516 (0.1427)	1.3469 (1.0301)
Observations	1019	1020	718	719	162	162
Number of Firms	102	102	69	69	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	Firm-Level	Firm-Level	Firm-Level	Firm-Level	Firm-Level	Firm-Level
Within R^2	0.0698	0.1075	0.0848	0.1427	0.0332	0.0856

*Note: Standard errors in parentheses clustered at the firm level. Random Effects model with two-way effects. Strategic ownership is the reference category. Renewable Energy results interpreted with caution given small sample of 19 firms and 162 observations. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Across the full sample, none of the three ownership type variables show a statistically significant performance differential relative to the strategic ownership reference category for ROA. For Tobin's Q in full sample, family ownership shows a negative and marginally significant differential ($\beta = -0.1167$, $p < 0.10$) which suggests that firms where family shareholders are dominant are associated with lower market valuations relative to strategically owned firms, though this effect falls just below conventional significance thresholds.

The conventional energy subsample reveals a clearer pattern for market-based performance. Family ownership is negative and statistically significant for Tobin's Q ($\beta = -0.1569$, $p < 0.05$) among conventional energy firms indicating that conventional energy firms dominated by family shareholders trade at significantly lower market valuations compared to otherwise similar firms dominated by strategic corporate shareholders. This is consistent with the entrenchment hypothesis where markets discount equity in family-controlled conventional energy firms relative to strategically owned peers, anticipating that family control may prioritize private benefits or risk-averse strategic choices over commercial value maximization (Claessens et al., 2002; La Porta et al., 1999). State and institutional ownership do not show significant performance differentials relative to strategic ownership in the conventional subsample for either ROA or Tobin's Q which indicates that state-influenced and institutionally owned conventional energy firms perform comparably to their strategically owned counterparts once firm-level heterogeneity is controlled for.

Among renewable energy firms, institutional ownership shows a negative and marginally significant differential for Tobin's Q ($\beta = -0.9181$, $p < 0.10$) relative to the strategic ownership reference, indicating that renewable energy firms dominated by institutional investors are associated with lower market valuations compared to strategically owned renewable firms. This finding may reflect that institutional investors in the renewable energy context lack the sector-specific expertise and long-term strategic commitment of strategic corporate shareholders which generates a market discount relative to the strategically owned benchmark. The magnitude of this coefficient is notably large, though its interpretation should be treated with caution given the small renewable energy subsample of 19 firms and 162 observations which limits statistical reliability.

Across all specifications leverage maintains its negative association with ROA and positive association with Tobin's Q consistent with the H1 findings. Firm size is positive and highly significant for ROA in the full sample and conventional subsample while negative and significant for Tobin's Q, replicating the pattern identified throughout this study. Cash holdings is positive and highly significant for Tobin's Q among renewable firms consistent with the recurring finding that markets strongly reward financial liquidity in the renewable energy context.

H3 receives limited partial support. The hypothesis that different ownership types have significantly different effects on firm performance relative to the strategic ownership benchmark is confirmed in specific subsector and performance measure combinations. Family ownership is associated with significantly lower Tobin's Q than strategic ownership among conventional energy firms which is consistent with the entrenchment hypothesis that markets discount family-controlled firms relative to strategically owned peers. Institutional ownership is associated with marginally lower Tobin's Q than strategic ownership among renewable energy firms though this finding requires cautious interpretation given the small subsample. State ownership does not generate significantly different performance from strategic ownership in any specification indicating that state-influenced European energy firms perform comparably to strategically owned peers once other firm characteristics are controlled for.

The absence of significant ownership type differentials for ROA across all specifications is consistent with (Demsetz & Villalonga, 2001) who demonstrate that ownership effects on accounting performance disappear once firm fixed effects absorb time-invariant variation. The emergence of ownership effects for Tobin's Q but not ROA suggests that markets anticipate future governance consequences of ownership type, particularly the entrenchment risk of family control relative to strategic corporate shareholders before these consequences manifest in current period accounting returns.

5.3.1 H3a: State Ownership and Market-Based Performance

A directional sub-hypothesis examines whether state-owned European energy firms are associated with lower Tobin's Q relative to non-state-owned firms. Table 5.3.1 presents the regression results for H3a comparing state-owned firms against all non-state ownership types excluding undisclosed observations.

Table 5.3.1 H3a State Ownership and Tobin's Q

	Full Sample		Conventional Energy		Renewable Energy	
Variable	Firm-Clustered	Driscoll-Kraay	Firm-Clustered	Driscoll-Kraay	Firm-Clustered	Driscoll-Kraay
State Ownership	0.0779 (0.0889)	0.0779*** (0.0230)	0.0898 (0.0880)	0.0898** (0.0331)	0.1044 (0.3731)	0.1044 (0.1675)
Leverage	0.5727*** (0.1481)	0.5727*** (0.0872)	0.5753*** (0.1431)	0.5753*** (0.1146)	0.3608 (0.6529)	0.3608 (0.5034)
Firm Size	-0.0381** (0.0118)	-0.0381** (0.0141)	-0.0641** (0.0200)	-0.0641** (0.0228)	0.0565 (0.0556)	0.0565* (0.0237)
Tangibility	-0.0677 (0.1173)	-0.0677 (0.0853)	-0.0077 (0.1132)	-0.0077 (0.0816)	0.0535 (0.4914)	0.0535 (0.3358)
Cash Holdings	0.6375 (0.3902)	0.6375** (0.1933)	0.3384 (0.3983)	0.3384 (0.2622)	3.6149*** (1.0513)	3.6149*** (0.6689)
Capex Ratio	0.6745. (0.4030)	0.6745. (0.3980)	0.5088 (0.3490)	0.5088 (0.3930)	1.1539 (1.2892)	1.1539 (0.8938)
Observations	1020	1020	719	719	162	162
Number of Firms	102	102	69	69	19	19
Estimator	RE	RE	RE	RE	RE	RE
Within R^2	0.0998	0.0998	0.1104	0.1104	0.1112	0.1112

*Note: Dependent variable is Tobin's Q throughout. State ownership dummy equals 1 if the largest controlling shareholder is a state entity and 0 otherwise. Reference category includes all non-state ownership types excluding undisclosed observations. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance codes: ***p<0.001, **p<0.01, *p<0.05, .p<0.10.*

The coefficient on state ownership is positive across all model specifications, indicating that state-owned firms tend to exhibit higher Tobin's Q values relative to non-state-owned firms. However, the statistical significance of this relationship differs across the two standard error estimators. Under firm-clustered standard errors, the coefficient is not statistically significant, suggesting that state ownership is not systematically associated with market valuation. In contrast, the coefficient becomes statistically significant when Driscoll-Kraay standard errors are employed, indicating that the result is sensitive to the method used to estimate statistical inference.

Given the lack of consistency across specifications, the evidence does not provide strong support for a robust relationship between state ownership and Tobin's Q. Nevertheless, the positive sign of the coefficient may reflect characteristics commonly associated with large state-owned energy firms, including perceived government backing, stable access to financing, and long-term investment horizons. These factors may be viewed favorably by investors and could contribute to higher market valuations relative to other ownership structures.

Overall, H3a is not supported. The results do not provide consistent evidence that state ownership is associated with lower market-based performance among European energy firms. While some specifications suggest a positive association, this relationship is not sufficiently robust across alternative standard error estimators to support a definitive conclusion.

5.4 Regression results for H4

Table 5.4 presents the regression results for Hypothesis 4, which examines whether ownership concentration exhibits a non-linear relationship with firm performance within the European energy sector. Ownership concentration is measured as the percentage of shares held by major shareholders, while firm performance is captured using ROA and Tobin's Q. The results provide partial support for H4, suggesting that the relationship between ownership concentration and firm performance may be non-linear under certain specifications. However, similar to the H3 findings, the relationship appears to vary across subsectors and performance measures rather than remaining uniform across the industry.

Table:5.4 H4 Regression Results- RE

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Ownership Concentration	0.0010*** (0.0003)	0.0014 (0.0016)	0.0010*** (0.0003)	0.0016 (0.0019)	0.0007 (0.0008)	0.0036 (0.0056)
Ownership Concentration²	-0.0000* (0.0000)	-0.0001. (0.0001)	-0.0000 (0.0000)	-0.0001 (0.0001)	-0.0000 (0.0000)	-0.0002 (0.0002)
Leverage	-0.1016*** (0.0250)	0.5611*** (0.1523)	-0.1133*** (0.0300)	0.5340*** (0.1360)	-0.0184 (0.0605)	0.6643 (0.6483)
Firm Size	0.0131*** (0.0026)	-0.0537*** (0.0142)	0.0194*** (0.0042)	-0.0978*** (0.0239)	0.0090 (0.0081)	0.0376 (0.0667)
Tangibility	0.0378. (0.0216)	-0.0656 (0.1281)	0.0320 (0.0238)	-0.0011 (0.1377)	-0.0063 (0.0679)	0.1328 (0.5270)
Cash Holdings	0.0494 (0.0529)	0.6575 (0.4073)	0.0382 (0.0563)	0.4111 (0.3743)	0.1966. (0.1119)	2.5550* (1.2786)
Capex Ratio	-0.0908 (0.0939)	0.6537 (0.4287)	-0.1014 (0.1126)	0.6199 (0.4329)	0.0060 (0.1231)	0.8854 (1.0253)
Observations	1085	1086	761	762	171	171
Number of Firms	104	104	71	71	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	Firm-Level	Firm-Level	Firm-Level	Firm-Level	Firm-Level	Firm-Level
Within R^2	0.1005	0.0894	0.1162	0.0958	0.0298	0.1456

*Note: Standard errors in parentheses clustered at the firm level. Random Effects model with two-way effects. Ownership concentration and its squared term are mean centered prior to estimation. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Full Sample

For the full sample, ownership concentration is positively and significantly associated with ROA ($\beta = 0.0010$, $p < 0.01$), while the squared term is weakly negative and marginally significant ($\beta = -0.0000$, $p < 0.10$). These findings suggest that higher ownership concentration is associated with stronger accounting-based performance, although the positive association appears to diminish as ownership concentration increases. The results therefore provide limited evidence of a non-linear relationship between ownership concentration and operational performance.

The negative coefficient on the squared concentration term further suggests that the governance benefits linked with concentrated ownership may weaken at very high concentration levels. While concentrated ownership can improve monitoring and reduce agency conflicts between managers and shareholders, excessively concentrated ownership may create risks of entrenchment, minority shareholder expropriation, or reduced managerial flexibility. Consequently, the findings are broadly consistent with prior literature suggesting that the relationship between ownership concentration and firm performance may be non-linear rather than strictly positive across all ownership levels (Morck et al., 1988).

Conventional Energy

Conventional energy firms exhibit a similar pattern to the full-sample results, although the evidence for non-linearity is weaker. Ownership concentration is positively and significantly associated with ROA ($\beta = 0.0010$, $p < 0.01$), suggesting that firms with more concentrated ownership structures tend to achieve stronger accounting-based performance. This finding is consistent with the view that concentrated ownership can improve monitoring effectiveness and reduce agency conflicts between managers and shareholders.

However, the squared ownership concentration term is not statistically significant, providing little evidence that the relationship becomes non-linear within the conventional energy sub-sample. Similarly, neither ownership concentration nor its squared term is significantly associated with Tobin's Q. These findings suggest that while concentrated ownership may contribute to improved operational performance among conventional energy firms, its influence on market valuation appears limited. Market participants may place greater emphasis on external factors such as commodity-price expectations, regulatory developments, and energy-transition risks than on ownership structure alone.

Renewable Energy

Renewable energy results differ notably from those of conventional energy firms. Ownership concentration is not significantly associated with either ROA or Tobin's Q within the renewable energy sub-sample. One possible explanation is that renewable energy companies are generally younger and more growth-oriented, with performance depending more strongly on technological innovation, policy support, and future expansion opportunities. In such firms, ownership concentration alone may play a less important role in explaining performance variation. Additionally, the relatively small renewable energy sub-sample may limit statistical power, reducing the likelihood of detecting significant relationships even when they exist. Consequently, the renewable energy results should be interpreted with caution.

Leverage remains an important control variable across the models. Consistent with the H1 findings, leverage is negatively associated with ROA and positively associated with Tobin's Q in both the full sample and conventional energy firms. Firm size is positively associated with ROA but negatively associated with Tobin's Q, particularly among conventional energy firms. This may reflect stronger operational efficiency among larger firms combined with lower market growth expectations arising from transition-related risks faced by large incumbent energy companies. Cash holdings is positively associated with Tobin's Q among renewable energy firms, suggesting that investors place value on financial flexibility and liquidity within renewable energy businesses.

Overall, the results provide partial support for H4. Limited evidence of a non-linear relationship between ownership concentration and firm performance is observed in the full-sample ROA model, where the squared ownership concentration term is negative and marginally significant. However, this non-linear relationship is not consistently observed across market-based performance measures or energy sub-sectors. These findings suggest that the governance benefits associated with concentrated ownership may be reflected primarily in accounting-based performance, while market valuations appear to be influenced more strongly by external industry and macroeconomic factors. Consequently, the findings should be interpreted as conditional associations rather than causal effects. Although panel estimators and firm-clustered standard errors improve the reliability of statistical inference, the study does not establish definitive causal relationships between ownership concentration and firm performance.

5.5 Robustness Check

To assess the reliability of the main findings, a series of robustness checks are conducted across all four hypotheses. The primary robustness check applies Driscoll-Kraay standard errors to all Random Effects models, providing simultaneous correction for heteroskedasticity, serial correlation, and cross-sectional dependence. This specification is reported alongside the main firm-clustered standard error results throughout each hypothesis section and serves as the primary robustness check given the confirmed presence of cross-sectional dependence across all specifications. Additionally, a crisis period sensitivity analysis is conducted by augmenting all models with a post-2021 energy crisis dummy variable to assess whether the main findings are robust to the extraordinary macroeconomic shocks that characterized the latter part of the sample period.

5.5.1 H1 Robustness

To assess the sensitivity of the main H1 findings to the choice of standard error correction, the baseline Random Effects model is re-estimated using Driscoll-Kraay standard errors, which are robust to heteroskedasticity, serial correlation, and cross-sectional dependence simultaneously. This serves as an alternative to the firm-clustered standard errors employed in the primary specification. Table 5.5.1 presents the results.

Table: 5.5.1 H1 Robustness (RE Quadratic +Driscoll-Kraay SE)

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Leverage	-0.0144 (0.0123)	0.3563*** (0.0854)	-0.0312* (0.0145)	0.3495*** (0.0909)	0.0181 (0.0163)	0.2206 (0.3130)
Leverage²	-0.4663*** (0.0787)	1.5562*** (0.2606)	-0.4405*** (0.0928)	1.3635*** (0.2344)	-0.2986 (0.1838)	3.5937** (1.2132)
Firm Size	0.0078** (0.0026)	-0.0309* (0.0147)	0.0140*** (0.0039)	-0.0811** (0.0289)	0.0051 (0.0038)	0.0797** (0.0267)
Tangibility	0.0418** (0.0160)	-0.1298* (0.0645)	0.0435* (0.0189)	-0.0413 (0.0984)	-0.0006 (0.0300)	-0.0666 (0.3203)
Cash Holdings	0.0827. (0.0502)	0.5350* (0.2215)	0.0690 (0.0539)	0.2851 (0.2219)	0.1711 (0.1251)	1.9455* (0.8179)
Capex Ratio	-0.1307 (0.1134)	0.9374* (0.4061)	-0.1585 (0.1248)	0.7509* (0.3322)	0.0110 (0.0529)	1.0749* (0.4491)
Observations	1135	1137	775	775	206	208
Number of Firms	104	104	71	71	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	DK	DK	DK	DK	DK	DK
Within R^2	0.1111	0.1281	0.1196	0.1463	0.0316	0.1689

*Note: Driscoll-Kraay standard errors in parentheses with max lag = 1. Robust to heteroscedasticity, serial correlation, and cross-sectional dependence. Given the short time dimension of 11 years, results interpreted with caution. Renewable Energy interpreted with caution given small sample of 19 firms. Significance level: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

The point estimates for all coefficients are identical across the main model and robustness check confirming that the difference between the two specifications lies exclusively in the standard error correction method rather than in the underlying model estimates. This is expected given that both specifications use the same random effects estimator applied to the same sample.

Overall, the robustness check provides results that are broadly consistent with the main findings. For ROA, the negative and highly significant squared leverage term remains unchanged in both the full sample ($\beta = -0.4663$, $p < 0.001$) and the conventional energy subsample ($\beta = -0.4405$, $p < 0.001$). This indicates that the observed non-linear relationship between leverage and accounting-based performance is robust to alternative standard error corrections that account simultaneously for heteroskedasticity, serial correlation, and cross-sectional dependence.

For Tobin's Q, the direction and magnitude of the leverage coefficients remain unchanged, while statistical significance generally increases under Driscoll-Kraay standard errors. In the full sample and conventional energy subsample, both the linear and squared leverage terms remain positive and statistically significant, providing additional support for the non-linear relationship observed in the main specification. Within the renewable energy subsample, the squared leverage term becomes statistically significant under Driscoll-Kraay standard errors. However, this result should be interpreted with caution given the small sample size of only 19 firms and the limited time dimension of the panel.

Overall, the robustness analysis confirms that the main H1 conclusions are not sensitive to the choice of standard error correction. The non-linear relationship between leverage and firm performance remains qualitatively unchanged across specifications, and the key inferences drawn from the primary analysis continue to hold when using a more comprehensive correction for heteroskedasticity, serial correlation, and cross-sectional dependence. These results collectively strengthen confidence in the reliability of the main H1 findings reported in 5.1 Empirical Results of H1

5.5.2 H2 robustness

To assess the robustness of the H2 findings, the analysis was re-estimated using Driscoll–Kraay standard errors, which are robust to heteroscedasticity, serial correlation, and cross-sectional dependence. The results are reported in Table 5.5.2.

Table: 5.5.2 H2 Robustness (RE Quadratic +Driscoll-Kraay SE)

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Leverage	-0.0543*** (0.0111)	0.2746* (0.1356)	-0.0849*** (0.0156)	0.1332 (0.1548)	-0.0305 (0.0567)	0.0974 (0.3468)
Leverage²	-0.5588*** (0.0816)	1.3892*** (0.3284)	-0.5306*** (0.0801)	1.3058*** (0.3743)	-0.2024 (0.1907)	3.0894** (1.1843)
Earnings Volatility	0.0205 (0.1344)	0.0111 (0.1265)	0.0382 (0.1457)	-0.0238 (0.1701)	0.1469 (0.2189)	1.9989 (1.6869)
Leverage × Earnings Volatility	0.3093 (0.1896)	0.9681 (0.9269)	0.3515. (0.1956)	1.3905 (1.0027)	2.0658 (1.9315)	2.8320 (12.6861)
Firm Size	0.0128** (0.0044)	-0.0339. (0.0174)	0.0202*** (0.0055)	-0.1158* (0.0507)	0.0104. (0.0059)	0.0246 (0.0264)
Tangibility	0.0638*** (0.0148)	-0.0996 (0.0856)	0.0599*** (0.0140)	0.0575 (0.1458)	-0.0185 (0.0437)	0.3030 (0.3070)
Cash Holdings	0.1394* (0.0582)	0.5832* (0.2633)	0.1110. (0.0575)	0.2770 (0.2795)	0.2833*** (0.0797)	1.3272 (0.9735)
Capex Ratio	0.0254 (0.0382)	1.5140*** (0.3389)	0.0138 (0.0381)	1.3275*** (0.2566)	0.0467 (0.0509)	1.2552* (0.5313)
Observations	927	927	633	633	168	168
Number of Firms	104	104	71	71	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	DK	DK	DK	DK	DK	DK
Within R²	0.1149	0.1508	0.1325	0.1635	0.0423	0.2007

*Note: Driscoll-Kraay standard errors in parentheses with max lag = 1. Robust to heteroscedasticity, serial correlation, and cross-sectional dependence. Given the short time dimension of 11 years, results interpreted with caution. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance level: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Overall, the findings remain largely consistent with the main specification using firm-clustered standard errors. Across both the full sample and the conventional energy subsample, the negative and statistically significant squared leverage term in the ROA models is preserved under Driscoll-Kraay standard errors, providing continued support for a non-linear relationship between leverage and accounting-based performance. Similarly, the positive and significant squared leverage term in the Tobin's Q models remains unchanged, indicating that the U-shaped relationship between leverage and market valuation is robust to alternative standard error corrections. These results suggest that the principal H2 findings are not sensitive to the choice of standard error estimator.

The moderating role of earnings volatility also remains generally weak. Earnings volatility itself is insignificant across all specifications, and the interaction term between leverage and earnings volatility remains statistically insignificant for both ROA and Tobin's Q in the full sample. This is consistent with the main results and provides further evidence that earnings volatility does not substantially alter the leverage–performance relationship in the European energy sector.

For the conventional energy subsample, the interaction term becomes marginally significant for ROA ($\beta = 0.3515$, $p < 0.10$). While this may indicate a limited moderating effect of earnings volatility, the magnitude and significance of the coefficient are relatively weak and do not materially change the overall interpretation of the results. Consequently, the evidence for moderation remains limited.

The renewable energy subsample continues to display weaker and less stable results, likely reflecting the smaller sample size of only 19 firms. Neither leverage nor earnings volatility is significantly associated with ROA. For Tobin's Q, however, the positive coefficient on leverage squared remains statistically significant ($\beta = 3.0894$, $p < 0.05$), indicating that the U-shaped market valuation relationship observed in the main analysis is robust to alternative standard error specifications. Nevertheless, these results should be interpreted cautiously given the limited number of firms and observations.

The control variables also exhibit similar patterns to the main models. Firm size remains positively associated with ROA and negatively associated with Tobin's Q in most specifications, while cash holdings and capital expenditure intensity continue to show positive associations with market valuation. The consistency of these coefficients further supports the stability of the main findings.

Taken together, the robustness analysis confirms that the principal conclusions of H2 are not driven by the choice of standard error estimator. The evidence continues to indicate a nonlinear concave association between leverage and firm performance, while providing limited support for the hypothesis that earnings volatility moderates this relationship. The interaction term between leverage and earnings volatility remains insignificant across all specifications confirming that H2 is not supported under either standard error approach.

5.5.3 H3 Robustness

To examine the robustness of the H3 findings, the ownership type models were re-estimated using Driscoll–Kraay standard errors. This approach accounts for heteroscedasticity, serial correlation, and cross-sectional dependence, providing a more conservative assessment of statistical significance. The results are reported in table 5.5.3.

Table: 5.5.3 H3 Robustness (RE Quadratic +Driscoll-Kraay SE)

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
State Ownership	0.0026 (0.0187)	0.0323 (0.0415)	0.0155 (0.0234)	0.0132 (0.0371)	0.0286 (0.0225)	-0.1444 (0.3147)
Family Ownership	0.0044 (0.0092)	-0.1167*** (0.0346)	0.0091 (0.0113)	-0.1569*** (0.0316)	-0.0014 (0.0136)	-0.0296 (0.2985)
Institutional Ownership	-0.0211 (0.0133)	-0.0385 (0.0715)	-0.0103 (0.0165)	-0.0510 (0.0589)	-0.0378 (0.0259)	-0.9181. (0.5425)
Leverage	-0.0893*** (0.0235)	0.5836*** (0.0948)	-0.1048*** (0.0240)	0.5792*** (0.1213)	-0.0075 (0.0604)	0.0085 (0.5047)
Firm Size	0.0127*** (0.0022)	-0.0395* (0.0155)	0.0197*** (0.0033)	-0.0626** (0.0227)	0.0027 (0.0068)	0.1437** (0.0539)
Tangibility	0.0326. (0.0181)	-0.0574 (0.0816)	0.0400. (0.0237)	0.0029 (0.0818)	-0.0419 (0.0400)	0.4283 (0.2686)
Cash Holdings	0.0403 (0.0525)	0.6336** (0.1964)	0.0444 (0.0598)	0.3804 (0.2615)	0.0314 (0.1896)	4.5075*** (0.7467)
Capex Ratio	-0.1026 (0.1263)	0.6484. (0.3844)	-0.1352 (0.1285)	0.5683 (0.3774)	0.0516 (0.0998)	1.3469** (0.5079)
Observations	1019	1020	718	719	162	162
Number of Firms	102	102	69	69	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	DK	DK	DK	DK	DK	DK
Within R^2	0.0698	0.1075	0.0848	0.1427	0.0332	0.0856

*Note: Driscoll-Kraay standard errors in parentheses with max lag = 1. Robust to heteroscedasticity, serial correlation, and cross-sectional dependence. Given the short time dimension of 11 years, results interpreted with caution. Strategic ownership is the reference category. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

Most ownership-type variables remain statistically insignificant across both performance measures and industry subsamples, suggesting that ownership type generally exhibits limited explanatory power for firm performance within the European energy sector. The only notable exception is family ownership, which exhibits a negative and significant association with Tobin's Q in both the full sample and conventional energy subsample. The persistence of this result under Driscoll-Kraay standard errors strengthens the evidence that family-controlled firms may be associated with lower market valuations relative to the strategic ownership reference category.

The remaining ownership categories continue to display limited and inconsistent relationships with firm performance. State ownership and institutional ownership are not significantly associated with either ROA or Tobin's Q across most specifications, while the few marginally significant coefficients are not consistently observed across performance measures or industry subsamples. These findings suggest that ownership type alone does not appear to be a major determinant of firm performance in the European energy sector.

Overall the robustness analysis confirms that the main H3 findings are not sensitive to the choice of standard error specification. Ownership type remains generally not strongly associated with firm performance across most specifications. The negative association between family ownership and Tobin's Q relative to strategic ownership is the most robust finding, strengthening under Driscoll-Kraay for both the full sample and conventional energy subsample.

5.5.4 H4 robustness

To evaluate the robustness of the H4 findings, the ownership concentration models are re-estimated using Driscoll-Kraay standard errors, providing simultaneous correction for heteroskedasticity, serial correlation, and cross-sectional dependence. The results are reported in Table 5.5.4.

Table: 5.5.4 H4 robustness (RE Quadratic +Driscoll-Kraay SE)

	Full Sample		Conventional Energy		Renewable Energy	
Variable	ROA	Tobin's Q	ROA	Tobin's Q	ROA	Tobin's Q
Ownership Concentration	0.0010*** (0.0002)	0.0014** (0.0004)	0.0010*** (0.0003)	0.0016** (0.0006)	0.0007* (0.0003)	0.0036 (0.0023)
Ownership Concentration²	-0.0000 (0.0000)	-0.0001*** (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	-0.0000*** (0.0000)	-0.0002*** (0.0000)
Leverage	-0.1016*** (0.0202)	0.5611*** (0.0772)	-0.1133*** (0.0252)	0.5340*** (0.1124)	-0.0184 (0.0303)	0.6643 (0.4395)
Firm Size	0.0131*** (0.0024)	-0.0537** (0.0195)	0.0194*** (0.0033)	-0.0978** (0.0319)	0.0090 (0.0052)	0.0376. (0.0199)
Tangibility	0.0378. (0.0200)	-0.0656 (0.0828)	0.0320 (0.0272)	-0.0011 (0.0993)	-0.0063 (0.0320)	0.1328 (0.2765)
Cash Holdings	0.0494 (0.0482)	0.6575** (0.2004)	0.0382 (0.0528)	0.4111* (0.1989)	0.1966 (0.1558)	2.5550* (1.0522)
Capex Ratio	-0.0908 (0.1183)	0.6537 (0.4100)	-0.1014 (0.1224)	0.6199 (0.3429)	0.0060 (0.0775)	0.8854 (0.6779)
Observations	1085	1086	761	762	171	171
Number of Firms	104	104	71	71	19	19
Estimator	RE	RE	RE	RE	RE	RE
Standard Errors	DK	DK	DK	DK	DK	DK
Within R^2	0.1005	0.0894	0.1162	0.0958	0.0298	0.1456

*Note: Driscoll-Kraay standard errors in parentheses with max lag = 1. Robust to heteroscedasticity, serial correlation, and cross-sectional dependence. Given the short time dimension of 11 years, results interpreted with caution. Ownership concentration and its squared term are mean centered prior to estimation. Renewable Energy results interpreted with caution given small sample of 19 firms. Significance: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

For the full sample, the robustness results broadly confirm the main findings. Ownership concentration remains positively and significantly associated with both ROA and Tobin's Q, while the squared ownership concentration term remains negative. The negative squared term is statistically significant in the Tobin's Q model but not in the ROA model. These results suggest that ownership concentration is associated with improved firm performance up to a certain level, after which the benefits gradually diminish.

The conventional energy subsample produces results that are highly consistent with the full-sample findings. Ownership concentration remains positively and significantly associated with both ROA and Tobin's Q, while the squared concentration term remains negative and statistically significant in the Tobin's Q model. These findings suggest that concentrated ownership may enhance monitoring and governance efficiency among conventional energy firms, although the marginal benefits appear to weaken at higher ownership levels.

For renewable energy firms, ownership concentration is positively associated with ROA and achieves statistical significance, although the estimated effect remains relatively small. The

squared concentration term is negative and significant for both ROA and Tobin's Q, suggesting evidence of a non-linear relationship. However, given the small renewable energy subsample of only 19 firms, these findings should be interpreted with caution.

Overall, the robustness analysis confirms the main conclusions of H4. Ownership concentration exhibits a non-linear association with firm performance across multiple standard error specifications, with the results remaining broadly consistent under both firm-clustered and Driscoll-Kraay standard errors. In several cases, the statistical significance of the ownership concentration variables increases under the Driscoll-Kraay specification, providing additional confidence in the stability of the findings. As with all results in this study, these findings should be interpreted as conditional associations rather than causal relationships.

5.6 Robustness Checks Around Major Crisis Years

To assess the sensitivity of the main findings to extraordinary macroeconomic shocks during the sample period, a crisis period robustness check is conducted by augmenting all regression models with a post-2021 energy crisis dummy variable. The dummy equals one for the years 2022 to 2024, capturing the period of the Russia-Ukraine conflict and the associated commodity price surge that was associated with significant disruptions in European energy markets, and zero otherwise. This approach allows the sensitivity of the main findings to be assessed while accounting for the potential structural break introduced by the energy crisis period. The inclusion of an explicit crisis dummy is motivated by the concern that the post-2021 period may have systematically altered the leverage-performance and ownership-performance relationships documented in the main analysis, potentially biasing the main estimates if this structural shift is left uncontrolled. All models retain the Random Effects specification with firm-clustered standard errors consistent with the primary analysis. The robustness check covers all four hypotheses and both performance measures across the full sample. The results are presented in Table 5.6.

Table 5.6 Crisis Period Robustness

Variable	ROA	Tobin's Q	ROA	Tobin's Q
	H1: Leverage		H2: Earnings Volatility	
Leverage	-0.0109 (0.0303)	0.3566* (0.1813)	-0.0478 (0.0311)	0.2802 (0.2083)
Leverage2	-0.4715*** (0.0956)	1.5439** (0.5734)	-0.4688*** (0.0961)	1.3444* (0.5696)
Earnings Volatility			-0.0521 (0.0787)	0.0114 (0.3262)
Leverage x Earnings Volatility			0.3163 (0.2058)	0.9807 (0.8685)
Firm Size	0.0064* (0.0025)	-0.0317* (0.0131)	0.0065** (0.0025)	-0.0229. (0.0133)
Tangibility	0.0505* (0.0205)	-0.1296 (0.1243)	0.0533** (0.0202)	-0.1401 (0.1320)
Cash Holdings	0.0787 (0.0574)	0.5371 (0.3852)	0.0947. (0.0566)	0.6274 (0.3876)
Capex Ratio	-0.1291 (0.0798)	0.9612** (0.3710)	0.0323 (0.0708)	1.5437** (0.5076)
Energy Crisis Dummy	0.0416*** (0.0076)	0.0002 (0.0326)	0.0358*** (0.0081)	-0.0373 (0.0338)
	H3: Ownership Type		H4: Ownership Concentration	
State Ownership	0.0101 (0.0121)	0.0239 (0.0947)		
Family Ownership	0.0062 (0.0136)	-0.1161. (0.0667)		
Institutional Ownership	-0.0169 (0.0155)	-0.0465 (0.0777)		
Ownership Concentration			0.0010*** (0.0003)	0.0014 (0.0016)
Ownership Concentration2			-0.0000* (0.0000)	-0.0001. (0.0001)
Leverage	-0.0797* (0.0316)	0.5675*** (0.1467)	-0.0959*** (0.0255)	0.5543*** (0.1520)
Firm Size	0.0109*** (0.0026)	-0.0361** (0.0120)	0.0118*** (0.0026)	-0.0506*** (0.0141)
Tangibility	0.0418. (0.0231)	-0.0702 (0.1153)	0.0445* (0.0210)	-0.0786 (0.1285)
Cash Holdings	0.0363 (0.0593)	0.6566. (0.3918)	0.0438 (0.0530)	0.6615 (0.4089)
Capex Ratio	-0.1070 (0.0925)	0.7125. (0.4092)	-0.0862 (0.0926)	0.6518 (0.4272)
Energy Crisis Dummy	0.0444*** (0.0076)	-0.0240 (0.0317)	0.0403*** (0.0073)	-0.0237 (0.0331)
Observations	1135	1137	1135	1137
Number of Firms	104	104	104	104
Estimator	RE	RE	RE	RE
Standard Errors	Firm level	Firm level	Firm level	Firm level
Energy Crisis Control	Yes	Yes	Yes	Yes

*Note: Standard errors in parentheses clustered at the firm level. Energy crisis dummy equals 1 for years 2022 to 2024 and zero otherwise, capturing the post-2021 commodity price surge and Russia-Ukraine energy crisis. All core findings remain robust to crisis period control. Significance level: ***p<0.001, **p<0.01, *p<0.05, .p<0.1.*

The crisis period robustness check augments all four hypothesis models with a post-2021 energy crisis dummy to assess whether the main findings are sensitive to the extraordinary macroeconomic shocks that characterized the latter part of the sample period.

For H1, the negative and significant squared leverage term in the ROA model and the positive squared leverage term in the Tobin's Q model remain statistically significant and economically similar in magnitude to the baseline results. This confirms that the non-linear relationship between leverage and firm performance persists after controlling for the energy crisis period. Likewise, the control variables display patterns that are broadly consistent with the main analysis.

For H2, the results continue to provide evidence of a non-linear association between leverage and firm performance, while the interaction term between leverage and earnings volatility remains statistically insignificant. This indicates that the conclusion that earnings volatility does not materially moderate the leverage-performance relationship remains robust to the inclusion of the crisis-period control.

For H3, ownership-type variables remain largely insignificant across both performance measures. Family ownership continues to exhibit a negative association with Tobin's Q, while state ownership and institutional ownership remain statistically insignificant. These findings are consistent with the main conclusion that ownership type generally has limited explanatory power for firm performance within the European energy sector.

For H4, ownership concentration continues to display a positive association with ROA, while the squared concentration term remains negative, providing continued evidence of a non-linear ownership concentration-performance relationship. The magnitude and significance of the ownership concentration coefficients remain highly similar to those reported in the baseline specification.

The energy crisis dummy itself is positive and highly significant across all ROA specifications, suggesting that firms experienced higher accounting-based profitability during the post-2021 period after controlling for firm characteristics. In contrast, the crisis dummy is not statistically significant in any Tobin's Q specifications, indicating that the crisis period did not systematically affect market-based valuations once the other explanatory variables were taken into account.

Overall, the robustness analysis provides strong evidence that the principal findings of the study are not sensitive to the inclusion of a post-2021 energy crisis control. The stability of the coefficients across all four hypotheses increases confidence that the documented relationships reflect broader structural patterns within the European energy sector rather than temporary effects associated with the recent energy crisis. Table 5.5.6 below provides a consolidated overview of hypothesis testing results across all models and robustness checks.

Table 5.5.6 Summary of Hypothesis Testing and Robustness

Hypothesis	Prediction	Main Evidence	Robustness	Verdict
H1	Non-linear leverage-performance relationship	Concave association confirmed for ROA. U-shaped association observed for Tobin's Q	Confirmed and strengthened under DK	Partially Supported
H2	Earnings volatility moderates leverage-performance relationship	Interaction term insignificant across all specifications and both performance measures.	Consistently insignificant under DK	Not supported
H3	Ownership types are associated with different performance outcomes.	Family ownership is negatively associated with Tobin's Q. No significant ROA effects.	Strengthened under DK for family ownership	Partially supported-Family ownership only-Tobin’s Q
H3a	State ownership is associated with lower market-based performance	Positive and significant under DK. Insignificant under firm-clustered SE. Contradicts predicted direction.	Not robust across specifications	Not supported
H4	Ownership concentration associated with performance	Positive association with ROA; nonlinear pattern observed	Confirmed and strengthened under DK	Supported

Chapter 6: Conclusion

6.1 Summary of Findings

This thesis examined the relationship between capital structure, ownership structure and firm performance among 104 publicly listed European energy firms across 23 countries over the period 2014 to 2024. This thesis employed two-way Random Effects panel regression with firm-clustered standard errors as the primary estimation method and Driscoll-Kraay standard errors as a robustness check. The study investigated four hypotheses addressing leverage, earnings volatility, ownership type and ownership concentration as correlates of firm performance measured by ROA and Tobin's Q.

The first hypothesis concerned the shape of the leverage-performance association, and the evidence is partly consistent with a non-linear pattern. The results provide partial support for this hypothesis. The squared leverage term is negative and highly significant for ROA across the full sample and conventional energy sub-sector, indicating a concave association between leverage and accounting-based operating performance. For Tobin's Q, both the linear and squared leverage terms are positive and significant, indicating a U-shaped association between leverage and market valuation. These two results reflect different dimensions of firm performance rather than contradictory findings. ROA captures current operational efficiency and responds to the immediate costs of debt servicing and financial distress, while Tobin's Q reflects forward-looking market expectations shaped by energy transition dynamics, commodity price outlooks, and investor sentiment, factors that may produce a different association with leverage in the European energy sector context.

The estimated turning point for ROA falls at approximately 29.92% of total assets. This estimate should be interpreted cautiously, as the linear leverage term is not statistically significant, limiting the precision of the turning point calculation. It is presented as a descriptive sample-specific reference rather than a precisely identified threshold. Sub-sector analysis confirms the concave leverage-ROA relationship for conventional energy firms while renewable energy firms show no significant leverage effects, likely reflecting the distinct financing structures and growth dynamics of this sub-sector. These findings are robust to the use of Driscoll-Kraay standard errors and the inclusion of a post-2021 energy crisis control.

Attention then turned to earnings volatility, and here the hypothesis is not supported. The interaction term between leverage and earnings volatility is statistically insignificant across the full sample and both sub-sectors, under either standard error specification. Within this sample, the negative association between leverage and ROA does not appear to be moderated by how volatile a firm's earnings are.

On ownership type, the evidence is more limited and only partly supportive. For ROA, no ownership type shows a significant association in any specification or sub-sector. The exception appears in market valuation: family ownership is negatively and significantly associated with Tobin's Q relative to strategic ownership, in both the full sample and the conventional energy sub-sector. This pattern fits the entrenchment hypothesis, under which markets discount family-controlled firms relative to strategically owned peers. State and institutional ownership, by contrast, show no significant performance differentials against strategic ownership anywhere in the sample. The sub-hypothesis H3a fares no better. There is no robust evidence linking state ownership to lower Tobin's Q, and the positive coefficient under Driscoll-Kraay runs opposite to the predicted direction, so H3a is not supported.

Finally, the fourth hypothesis examined whether ownership concentration exhibits a non-linear association with firm performance. The results support this hypothesis. Ownership concentration exhibits a positive and significant association with ROA in both the full sample and the conventional energy sub-sector, consistent with the monitoring hypothesis that large controlling shareholders are associated with reduced agency costs and stronger operational efficiency. The squared concentration term is negative and significant, particularly under Driscoll-Kraay standard errors confirming the inverted-U shaped association between concentration and performance. No significant association is found for Tobin's Q under firm-clustered standard errors though results strengthen under Driscoll-Kraay. The Durbin-Wu-Hausman test does not detect endogeneity for ownership concentration, suggesting that Random Effects estimates for H4 are appropriate in this specification, though full exogeneity of ownership concentration cannot be established with certainty.

6.2 Theoretical Contributions

This study makes several contributions to capital structure and corporate governance literature. The first is empirical evidence of a non-linear leverage-performance relationship in the European energy sector, with a concave association observed for ROA and a U-shaped

association for Tobin's Q. The divergence between these two measures contributes to the understanding that accounting-based and market-based performance respond differently to capital structure decisions in energy markets undergoing structural transformation, extending trade-off theory predictions into a context where investor expectations and regulatory dynamics independently shape market valuations.

A second contribution concerns earnings volatility. The finding that volatility does not significantly moderate the leverage-performance relationship suggests that systemic volatility in energy markets may already be incorporated into financing decisions and market expectations.

The study also adds to the ownership-performance literature by documenting that family ownership is negatively associated with Tobin's Q relative to strategic ownership in conventional energy firms, consistent with the entrenchment hypothesis. It extends work on ownership concentration as well, providing evidence of a non-linear inverted-U shaped association between concentration and ROA, in line with the monitoring and entrenchment arguments of (Shleifer & Vishny, 1997).

Finally, the study contributes methodologically by applying a comprehensive diagnostic framework and employing both firm-clustered and Driscoll-Kraay standard errors to ensure robust inference across all specifications.

6.3 Practical Implications

The findings carry practical implications for managers, investors, and policymakers involved in the financing and governance of European listed energy firms. For corporate managers, the estimated turning point of approximately 29.92% may serve as a broad indicative reference point, though it should be interpreted with caution given that the linear leverage term is not statistically significant. The finding nonetheless suggests that firms operating at substantially higher leverage levels within this sample tend to exhibit weaker operational performance, consistent with the financial distress costs predicted by trade-off theory. For investors the negative association between family ownership and Tobin's Q in conventional energy firms suggests that additional scrutiny may be warranted when assessing family-controlled firms, while the positive association between moderate ownership concentration and ROA may inform investment screening criteria. For policymakers the monitoring hypothesis finding suggests that moderate ownership concentration may be associated with stronger operational efficiency in energy firms, a consideration relevant to privatization policy and the design of ownership structures for state-backed renewable energy projects.

6.4 Limitations

Several limitations of this study should be acknowledged.

6.4.1 Sample and Data Limitations

The sample construction involves several constraints that limit the scope and generalizability of the findings. Firms with market capitalization below 50 million USD and those listed after 2012 are excluded, introducing size and listing biases that may limit representativeness for smaller and more recently listed energy companies. The mixed energy subsample of 14 firms is excluded from sub-sector analyses due to the heterogeneous nature of mixed operations. The most significant sample limitation is the small renewable energy subsample of 19 firms, where the considerable imbalance relative to the 71 conventional energy firms means that the absence of significant results may reflect insufficient statistical power rather than genuine structural differences. Future research with larger renewable energy samples would be needed to confirm or refute the patterns identified in this sub-sector.

6.4.2 Variable and Measurement Limitations

The study examines only voting rights as the measure of ownership structure and cannot analyze the wedge between voting rights and cash flow rights as a governance mechanism, as only 12 firms in the sample employ dual class share structures. The near time-invariant nature of ownership variables limits within-firm variation available for panel identification, potentially attenuating estimated ownership coefficients. Earnings volatility measured as a rolling three-year standard deviation of ROA reduces the effective sample by excluding early observations for each firm.

6.4.3 Methodological Limitations

The most significant methodological limitation concerns endogeneity. Evidence of endogeneity is found for leverage in the ROA specifications across H1, H2, and H3 but System GMM estimation could not be validated due to instrument invalidity arising from the small sample of 104 firms. Consequently, the leverage-performance associations should be interpreted as conditional associations rather than causal effects. The asymptotic reliability of Driscoll-Kraay standard errors improves with a larger time dimension and the results based on this estimator should therefore be interpreted with appropriate caution. The relatively short time dimension of 11 years also limits the asymptotic reliability of Driscoll-Kraay standard errors.

6.4.4 General Limitation

The findings are specific to publicly listed European energy firms over 2014 to 2024, a period characterized by extraordinary macroeconomic disruptions including the COVID-19 pandemic, the post-2021 commodity price surge, and the Russia-Ukraine energy crisis. While crisis period robustness checks confirm the stability of the main findings the associations documented may not generalize to other time periods, geographic contexts, or institutional environments beyond the European energy sector.

6.5 Directions for Future Research

The most immediate extension would involve broadening the renewable energy subsample, either by extending the time period beyond 2024 or expanding the geographical scope to include non-European markets such as North America and Asia-Pacific where renewable energy sectors are more developed and larger samples are available. A larger renewable energy sample would provide greater statistical power to reliably examine ownership-performance and leverage-performance associations in this rapidly growing sub-sector.

The endogeneity of leverage remains an unresolved methodological challenge in this study. Future research could address this by developing valid external instruments for leverage in European energy sector panels, such as country-level tax rate changes or regulatory shocks that exogenously shift financing incentives without directly affecting firm performance. Alternatively, a difference-in-differences design exploiting regulatory events such as the EU Green Deal or national energy policy reforms could provide more credible causal identification of the leverage-performance relationship.

The wedge between voting rights and cash flow rights as a governance mechanism represents a further avenue for future research. The limited prevalence of dual class shares structures in the current sample prevented meaningful analysis of this dimension. Future research could examine the dynamic evolution of ownership structures in European energy firms over the energy transition period, investigating whether the shift toward renewable energy is associated with systematic changes in ownership type, concentration, and governance quality over time. The growing role of institutional investors and ESG-focused funds in European energy markets suggests that ownership dynamics may be shifting in ways that have yet to be captured in the existing literature.

References

Asness, C., Frazzini, A., Israel, R., Moskowitz, T. J., & Pedersen, L. H. (2018). Size matters, if you control your junk. *Journal of Financial Economics*, *129*(3), 479–509. https://doi.org/10.1016/j.jfineco.2018.05.006

Baker, M., & Wurgler, J. (2002). Market Timing and Capital Structure. *The Journal of Finance*, *57*(1), 1–32. https://doi.org/10.1111/1540-6261.00414

Borisova, G., Brockman, P., Salas, J. M., & Zagorchev, A. (2012). Government ownership and corporate governance: Evidence from the EU. *Journal of Banking & Finance*, *36*(11), 2917–2934. https://doi.org/10.1016/j.jbankfin.2012.01.008

Bortolotti, B., & Faccio, M. (2007). *Government Control of Privatized Firms*. https://docs.lib.purdue.edu/ciberwp

Bortolotti, B., & Faccio, M. (2009). Government control of privatized firms. *Review of Financial Studies*, *22*(8), 2907–2939. https://doi.org/10.1093/rfs/hhn077

Bradley, M., Jarrell, G. A., & Kim, E. H. (1984). On the Existence of an Optimal Capital Structure: Theory and Evidence. *The Journal of Finance*, *39*(3), 857. https://doi.org/10.2307/2327950

Brealey, R. A., Myers, S. C., & Allen, F. (2020). *Principles of Corporate Finance*.

Claessens, S., Djankov, S., Fan, J. P. H., & Lang, L. H. P. (2002). Disentangling the Incentive and Entrenchment Effects of Large Shareholdings. *The Journal of Finance*, *57*(6), 2741–2771. https://doi.org/10.1111/1540-6261.00511

Demsetz H, & Lehn K. (1985). The structure of corporate ownership: Causes and consequences. . *Journal of Political Economy*, *93*(6), 1155–1177.

Demsetz, H., & Villalonga, B. (2001). Ownership structure and corporate performance. In *Journal of Corporate Finance* (Vol. 7). www.elsevier.comrlocatereconbase

DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, *48*(2), 147. https://doi.org/10.2307/2095101

Donaldson, G. (1961). *Corporate debt capacity: A study of corporate debt policy and the determination of corporate debt capacity*. Division of Research, Graduate School of Business Administration, Harvard University.

Driscoll, J. C., & Kraay, A. C. (1998). Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *Review of Economics and Statistics*, *80*(4), 549–560. https://doi.org/10.1162/003465398557825

European Commission. (2019). *The European Green Deal*. https://www.consilium.europa.eu/media/47573/st_15051_2019_init_en.pdf

European Council. (2014). *Conclusions on 2030 climate and energy policy framework (EUCO 169/14)*. https://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/

European Parliament and Council of the European Union. (2021). Regulation (EU) 2021/1119. *Official Journal of the European Union*, *L243*, 1–17. https://eur-lex.europa.eu/eli/reg/2021/1119/oj

Faccio, M., & Lang, L. H. P. (2002). The ultimate ownership of Western European corporations. *Journal of Financial Economics*, *65*(3), 365–395. https://doi.org/10.1016/S0304-405X(02)00146-0

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Fischer, E. O., Heinkel, R., & Zechner, J. (1989). Dynamic Capital Structure Choice: Theory and Tests. *The Journal of Finance*, *44*(1), 19. https://doi.org/10.2307/2328273

Frank, M. Z., & Goyal, V. K. (2009). Capital structure decisions: Which factors are reliably important? *Financial Management*, *38*(1), 1–37. https://doi.org/10.1111/j.1755-053X.2009.01026.x

Georgakopoulos, G., Toudas, K., Poutos, E. I., Kounadeas, T., & Tsavalias, S. (2022). Capital Structure, Corporate Governance, Equity Ownership and Their Impact on Firms' Profitability and Effectiveness in the Energy Sector. *Energies*, *15*(10). https://doi.org/10.3390/en15103625

Han, K. C., & Suk, D. Y. (1998). The effect of ownership structure on firm performance: Additional evidence. *Review of Financial Economics*, *7*(2), 143–155. https://doi.org/10.1016/S1058-3300(99)80150-5

Hoechle, D. (2007). Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. *The Stata Journal: Promoting Communications on Statistics and Stata*, *7*(3), 281–312. https://doi.org/10.1177/1536867X0700700301

Ibhagui, O. W., & Olokoyo, F. O. (2018). Leverage and firm performance: New evidence on the role of firm size. *North American Journal of Economics and Finance*, *45*, 57–82. https://doi.org/10.1016/j.najef.2018.02.002

International Energy Agency. (2020). *World Energy Outlook 2020*. https://www.iea.org/reports/world-energy-outlook-2020

International Energy Agency. (2022). *World Energy Outlook 2022*. https://www.iea.org/reports/world-energy-outlook-2022

Jaworski, J., & Czerwonka, L. (2021). Determinants of Enterprises' Capital Structure in Energy Industry: Evidence from European Union. *Energies*, *14*(7), 1871. https://doi.org/10.3390/en14071871

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, *72*(2), 323–329.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Kirchmaier, T., & Grant, J. (2005). Corporate ownership structure and performance in Europe. *European Management Review*, *2*(3), 231–245. https://doi.org/10.1057/palgrave.emr.1500043

Kraus, A., & Litzenberger, R. H. (1973). A State-Preference Model of Optimal Financial Leverage. In *Source: The Journal of Finance* (Vol. 28, Number 4).

La Porta, R., Lopez-De-Silanes, F., & Shleifer, A. (1999). Corporate Ownership Around the World. *The Journal of Finance*, *54*(2), 471–517. https://doi.org/10.1111/0022-1082.00115

Le, T. P. V., & Phan, T. B. N. (2017). Capital structure and firm performance: Empirical evidence from a small transition country. *Research in International Business and Finance*, *42*, 710–726. https://doi.org/10.1016/j.ribaf.2017.07.012

Margaritis, D., & Psillaki, M. (2010). Capital structure, equity ownership and firm performance. *Journal of Banking and Finance*, *34*(3), 621–632. https://doi.org/10.1016/j.jbankfin.2009.08.023

Modigliani, F., & Miller, M. H. (1958). *The Cost of Capital, Corporation Finance and the Theory of Investment* (Vol. 48, Number 3).

Modigliani, F., & Miller, M. H. (1963). *Corporate Income Taxes and the Cost of Capital: A Correction* (Vol. 53, Number 3).

Moradi, A., & Paulet, E. (2019). The firm-specific determinants of capital structure – An empirical analysis of firms before and during the Euro Crisis. *Research in International Business and Finance*, *47*, 150–161. https://doi.org/10.1016/j.ribaf.2018.07.007

Morck, R., Shleifer, A., & Vishny, R. W. (1988). Management ownership and market valuation. *Journal of Financial Economics*, *20*, 293–315. https://doi.org/10.1016/0304-405X(88)90048-7

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, *13*(2), 187–221. https://doi.org/10.1016/0304-405X(84)90023-0

Paris Agreement, United Nations Framework Convention on Climate Change (2015). https://unfccc.int/process-and-meetings/the-paris-agreement

Pfeffer, Jeffrey., & Salancik, G. R. . (1978). *The external control of organizations : a resource dependence perspective*. Harper & Row.

Richard, P. J., Devinney, T. M., Yip, G. S., & Johnson, G. (2009). Measuring organizational performance: Towards methodological best practice. In *Journal of Management* (Vol. 35, Number 3, pp. 718–804). https://doi.org/10.1177/0149206308330560

Roberts, M. R., & Whited, T. M. (2013). *Endogeneity in Empirical Corporate Finance1* (pp. 493–572). https://doi.org/10.1016/B978-0-44-453594-8.00007-0

Roodman, D. (2009). A Note on the Theme of Too Many Instruments *. *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158. https://doi.org/10.1111/j.1468-0084.2008.00542.x

Shleifer, A., & Vishny, R. W. (1997). A Survey of Corporate Governance. *The Journal of Finance*, *52*(2), 737–783. https://doi.org/10.1111/j.1540-6261.1997.tb04820.x

Shleifer, A., & Vishny, R. W. (1997). A Survey of Corporate Governance. *The Journal of Finance*, *52*(2), 737–783. https://doi.org/10.1111/j.1540-6261.1997.tb04820.x

Tan, K. J. K., Zhou, Q., Pan, Z., & Faff, R. (2021). Business shocks and corporate leverage. *Journal of Banking and Finance*, *131*. https://doi.org/10.1016/j.jbankfin.2021.106208

Titman, S., & Wessels, R. (1988). The Determinants of Capital Structure Choice. *The Journal of Finance*, *43*(1), 1–19. https://doi.org/10.1111/j.1540-6261.1988.tb02585.x

Zeitun, R., & Tian, G. (2007). Capital structure and corporate performance: evidence from Jordan. *Australasian Accounting, Business and Finance Journal*, *1*(4), 40–61. https://doi.org/10.14453/aabfj.v1i4.3

Appendix

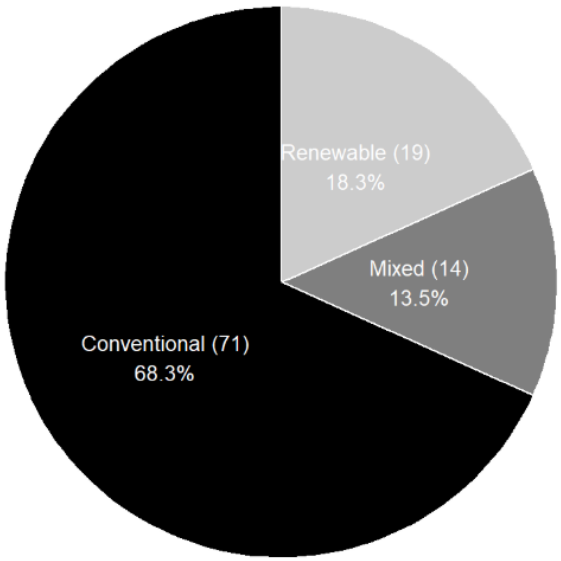
Appendix 1

Table 7.1 Sample Distribution by year

Year	Number of Firms	Observations
2014	103	103
2015	102	102
2016	103	103
2017	103	103
2018	104	104
2019	104	104
2020	104	104
2021	104	104
2022	104	104
2023	104	104
2024	104	104

Appendix 2

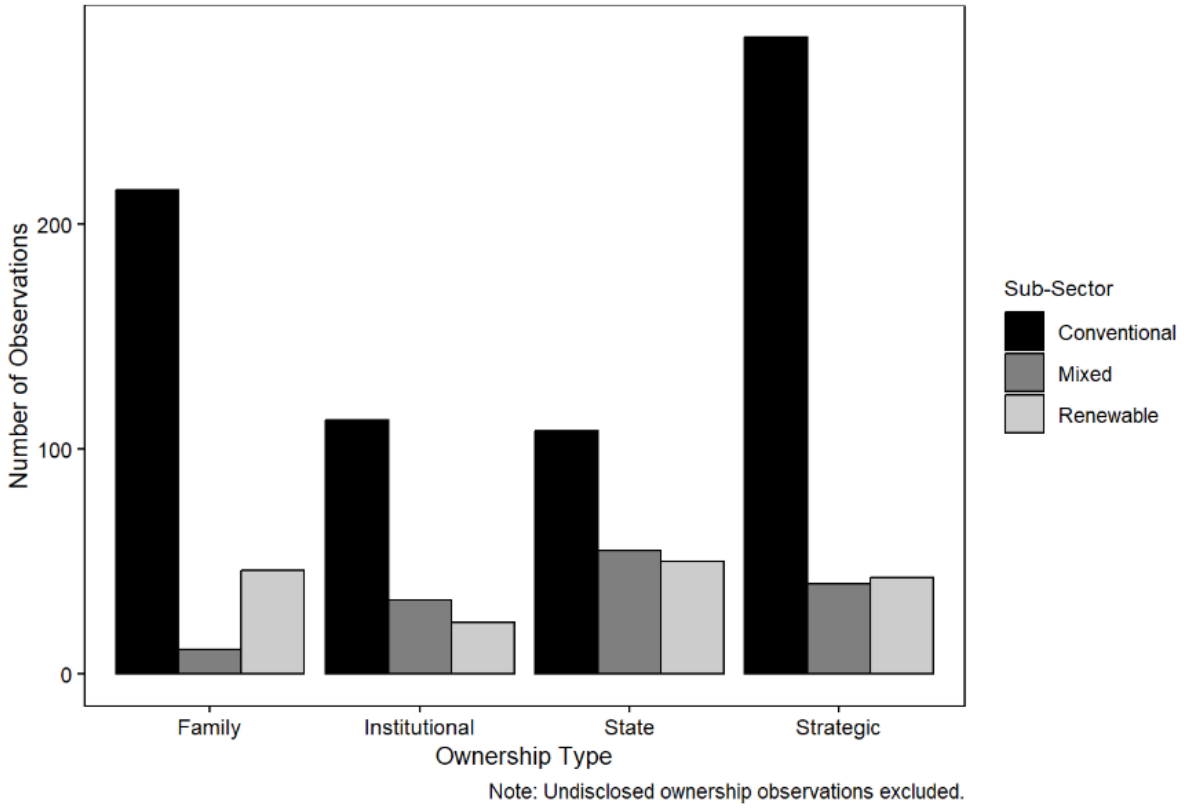
Figure 7.2: Samples Distribution by Energy Sub-Sector



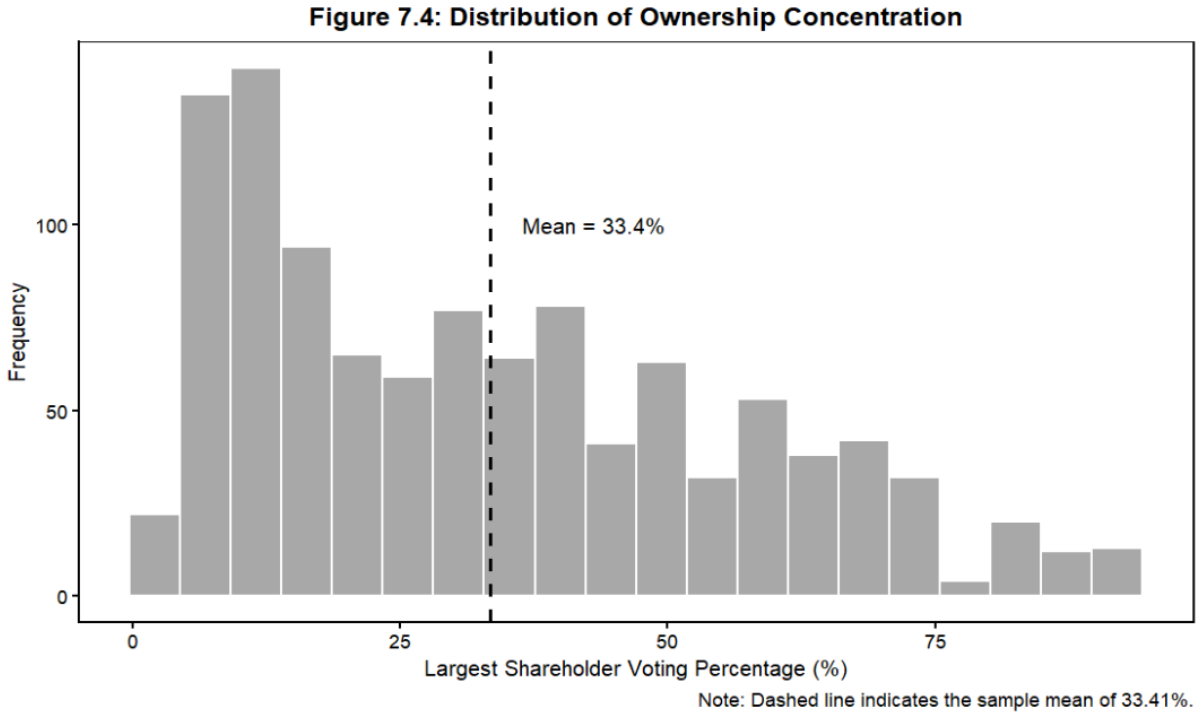
Notes: Based on 104 unique firms

Appendix 3

Figure 7.3 Ownership Type Distribution by Sub-Sector



Appendix 4



The figure presents the distribution of the largest controlling shareholder's voting percentage across all firm-year observations. The distribution is right skewed with a sample mean of 33.41% and median of 29.04%, indicating that most European energy firms are characterized by significant but non-majority block holders. A notable proportion of observations exceed 50% voting rights, reflecting the presence of dominant controlling shareholders in a minority of firms. The dashed vertical line indicates the sample mean.

Appendix 5

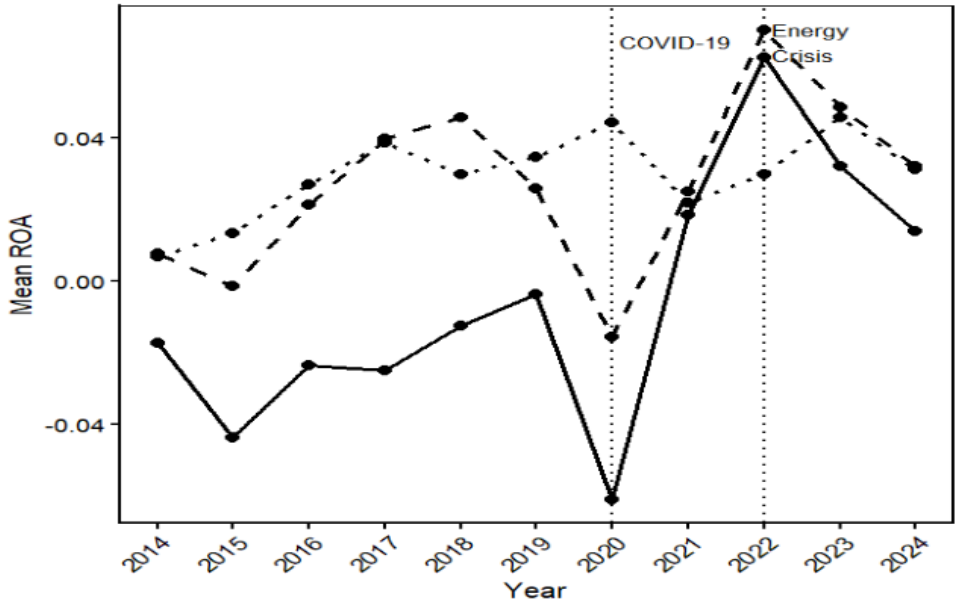
Variables Description

Variables	Definition	Expected Sign	Source
Dependent			
Return on Assets	Net Income/ Average Total Assets		FactSet
Tobin's Q	(Market Capitalization + Total Debt)/ Total Assets		Own Calculation
Independent Variables			
Leverage	Total Debt/Total Assets	+/-	Own Calculation
Leverage^2	Squared leverage term	-	Own Calculation
Earnings Volatility	Rolling 3-year SD of ROA	-	Own Calculation
Leverage x Earnings Volatility	Interaction between leverage and earnings volatility	-	Own Calculation
Ownership Concentration	Voting percentage of largest shareholder	+/-	Annual Report
Ownership Concentration^2	Squared Ownership Concentration	-	
State ownership	Dummy = 1 if the largest controlling shareholder is state entity	+/-	Annual Report
Institutional ownership	Dummy = 1 if the largest controlling shareholder is institutional investor	+/-	Annual Report
Family Ownership	Dummy = 1 if the largest controlling shareholder is family or individual	+/-	Annual Report
Strategic Ownership	Dummy = 1 if largest controlling shareholder is strategic corporate	Reference	Annual Report
State vs Private	Dummy = 1 if largest controlling shareholder is a state entity and 0 otherwise	-	Annual Report
Control Variables			
Firm Size	Natural logarithm of total assets	+/-	FactSet
Tangibility	Net PPE/ Total Assets	+/-	FactSet
Cash Holdings	Cash and Equivalents/Total Assets	+/-	FactSet/Own Calculation
Capex Ratio	Capital Expenditure/Total Assets	+/-	FactSet

Notes: The expected sign indicates the theoretically predicted direction of association between each independent variable and firm performance based on Trade-off Theory and Agency Theory. A positive sign (+) indicates an expected positive association with firm performance. A negative sign (-) indicates an expected negative association. An ambiguous sign (+/-) indicates that theory or prior literature provides competing predictions regarding the direction of association. A reference category has no coefficient and therefore no expected sign. Dependent variables do not carry expected signs as they are the outcome measures.

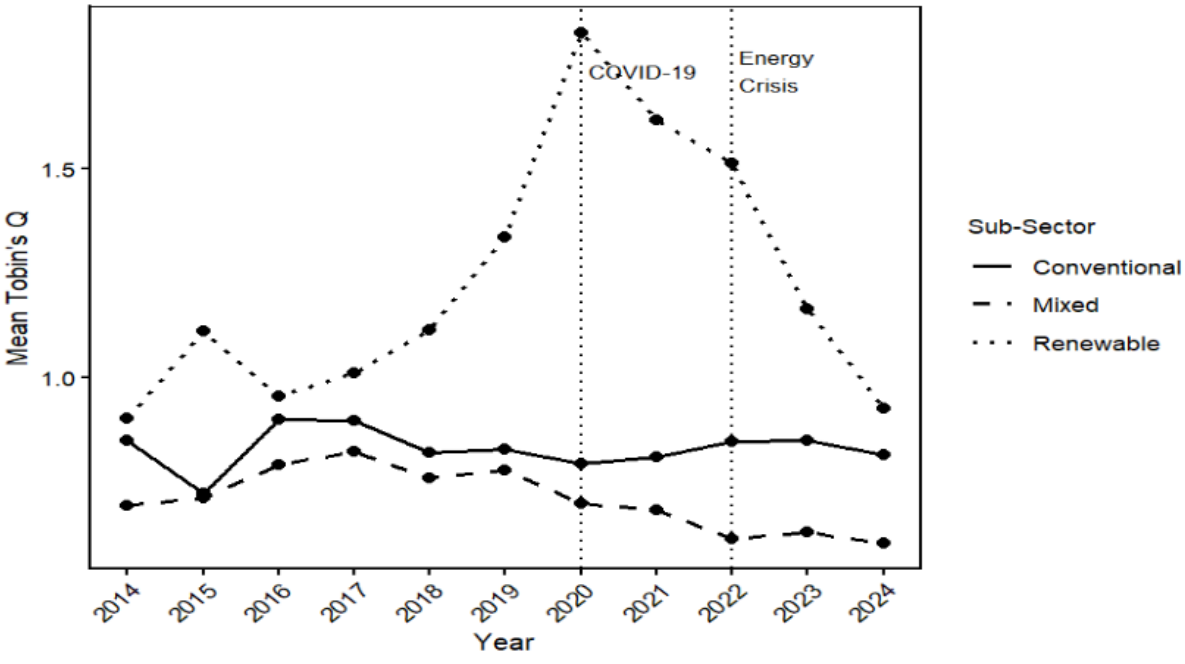
Appendix 6

Figure 6.1: Mean ROA by Energy Sub-Sector (2014-2024)



Note: Dotted vertical lines indicate COVID-19 (2020) and energy crisis (2022).

Figure 6.2: Mean Tobin's Q by Energy Sub-Sector (2014-2024)



Note: Dotted vertical lines indicate COVID-19 (2020) and energy crisis (2022).

Appendix 7

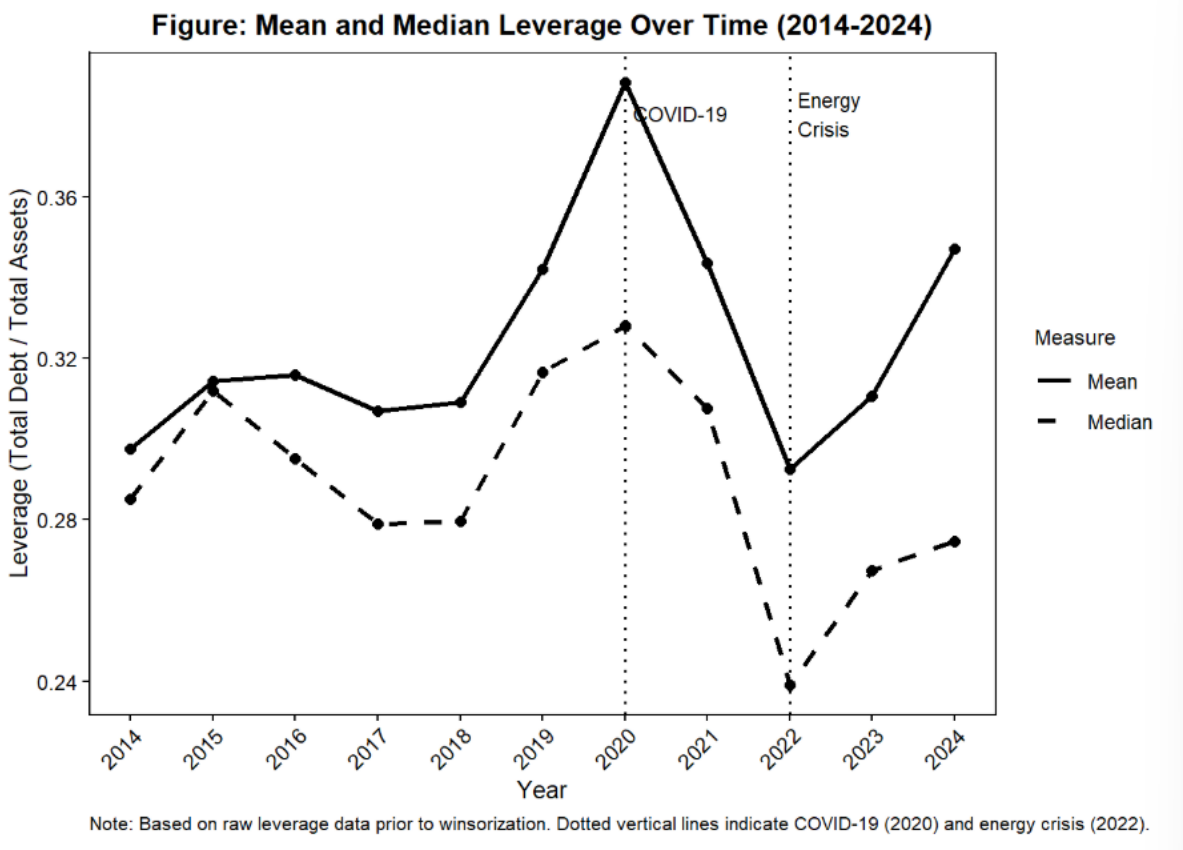


Figure Appendix 7illustrates the evolution of mean and median leverage ratios across European energy firms over the sample period. Leverage remained relatively stable between 2014 and 2019 before rising sharply in 2020 during the COVID-19 pandemic, reflecting declining revenues against sustained debt obligations. The post-2021 energy crisis period is associated with a marked decline in median leverage, likely to reflect improved profitability and asset values driven by elevated commodity prices. Both measures gradually recover toward pre-pandemic levels by 2024. The persistent gap between mean and median throughout the period confirms the presence of high-leverage outliers and justifies the winsorization applied prior to regression estimation.

Appendix 8

Pooled OLS Across Hypotheses

H1 Pooled OLS Results

Variable	ROA	Tobin's Q
Leverage	-0.0195	0.4599***
	(0.0183)	(0.0776)
Leverage2	-0.4043***	1.1162***
	(0.0543)	(0.2301)
Firm Size	0.006***	-0.0019
	(0.0016)	(0.007)
Tangibility	0.0477**	-0.2233***
	(0.0148)	(0.0628)
Cash Holdings	0.0526.	0.9264***
	(0.0287)	(0.1217)
Capex Ratio	-0.1145*	1.2332***
	(0.0486)	(0.2059)
Observations	1135	1137
R2	0.1122	0.1517
Adjusted R2	0.1074	0.1472
Estimator	Pooled OLS	Pooled OLS

*Note: Pooled OLS estimation without firm or time effects. Standard errors are not clustered. Results presented for comparison purposes only. Panel diagnostic tests confirm that Pooled OLS is inappropriate for this dataset. Significance codes: ***p<0.001, **p<0.01, *p<0.05, .p<0.10.*

H2 Pooled OLS Results

Variable	ROA	Tobin's Q
Leverage	-0.0565*	0.4414***
	(0.0229)	(0.0985)
Leverage2	-0.4038***	0.9592***
	(0.0644)	(0.2766)
Earnings Volatility	-0.1053**	-0.0476
	(0.0393)	(0.1689)
Leverage x Earnings Volatility	0.3727***	0.7632.
	(0.1067)	(0.4585)
Firm Size	0.0058**	-6e-04
	(0.0019)	(0.0081)
Tangibility	0.0414*	-0.2396***
	(0.0163)	(0.0701)
Cash Holdings	0.0776*	1.0509***
	(0.0318)	(0.1367)
Capex Ratio	0.0592	1.8009***
	(0.0582)	(0.2501)
Observations	927	927
R2	0.127	0.1832
Adjusted R2	0.1194	0.1761
Estimator	Pooled OLS	Pooled OLS

*Note: Pooled OLS estimation without firm or time effects. Standard errors are not clustered. Results presented for comparison purposes only. Panel diagnostic tests confirm that Pooled OLS is inappropriate for this dataset. Significance level: ***p<0.001, **p<0.01, *p<0.05, .p<0.10.*

H3 Pooled OLS Results

Variable	ROA	Tobin's Q
State Ownership	0.0177.	0.017
	(0.0106)	(0.042)
Family Ownership	0.0184*	-0.1218***
	(0.009)	(0.0359)
Institutional Ownership	-0.0259*	-0.0733.
	(0.0111)	(0.0444)
Leverage	-0.0685***	0.5839***
	(0.0185)	(0.0737)
Firm Size	0.0101***	-0.0078
	(0.0017)	(0.0069)
Tangibility	0.0307.	-0.116.
	(0.0163)	(0.0649)
Cash Holdings	0.0318	1.0173***
	(0.0311)	(0.1242)
Capex Ratio	-0.0772	1.0148***
	(0.0532)	(0.2121)
Observations	1019	1020
R2	0.0768	0.1315
Adjusted R2	0.0694	0.1247
Estimator	Pooled OLS	Pooled OLS

*Note: Pooled OLS estimation without firm or time effects. Standard errors are not clustered. Strategic ownership is the reference category. Results presented for comparison purposes only. Panel diagnostic tests confirm that Pooled OLS is inappropriate for this dataset. Significance codes: ***p<0.001, **p<0.01, *p<0.05, .p<0.10.*

H4 Pooled OLS Results

Variable	ROA	Tobin's Q
Ownership Concentration	0.0011***	0.001
	(2e-04)	(8e-04)
Ownership Concentration2	0*	-1e-04**
	(0)	(0)
Leverage	-0.0832***	0.5196***
	(0.0172)	(0.0727)
Firm Size	0.0115***	-0.0107
	(0.0016)	(0.0068)
Tangibility	0.0285.	-0.1667*
	(0.0162)	(0.0684)
Cash Holdings	0.0315	1.0068***
	(0.0301)	(0.1274)
Capex Ratio	-0.0521	1.0548***
	(0.0505)	(0.2137)
Observations	1085	1086
R2	0.1027	0.1197
Adjusted R2	0.0968	0.114
Estimator	Pooled OLS	Pooled OLS

Note: *Pooled OLS estimation without firm or time effects. Standard errors are not clustered. Ownership concentration and its squared term are mean centered prior to estimation. Results presented for comparison purposes only. Panel diagnostic tests confirm that Pooled OLS is inappropriate for this dataset. Significance codes: ***p<0.001, **p<0.01, *p<0.05, .p<0.10.*

Appendix 9

Regression Lines

H1:

$$ROA_{it} = \alpha + \beta_1 Leverage_{it} + \beta_2 Leverage_{it}{}^2 + \beta_3 FirmSize_{it} + \beta_4 Tangibility_{it} + \beta_5 Cashholdings_{it} + \beta_6 CapexRatio_{it} + \varepsilon_{it}$$

$$TQ_{it} = \alpha + \beta_1 Leverage_{it} + \beta_2 Leverage_{it}{}^2 + \beta_3 FirmSize_{it} + \beta_4 Tangibility_{it} + \beta_5 Cashholdings_{it} + \beta_6 CapexRatio_{it} + \varepsilon_{it}$$

H2:

$$ROA_{it} = \alpha + \beta_1 Leverage_{it} + \beta_2 Leverage_{it}{}^2 + \beta_3 EarningVolatilitye_{it} + \beta_3 (Leverage_{it} \cdot EarningVolatilitye_{it} + \beta_4 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

$$TQ_{it} = \alpha + \beta_1 Leverage_{it} + \beta_2 Leverage_{it}{}^2 + \beta_3 EarningVolatilitye_{it} + \beta_3 (Leverage_{it} \cdot EarningVolatilitye_{it} + \beta_4 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

H3:

$$ROA_{it} = \alpha + \beta_1 StateOwn_{it} + \beta_2 FamilyOwn_{it} + \beta_3 InstOwn_{it} + \beta_4 Leverage_{it} + \beta_3 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

$$TQ_{it} = \alpha + \beta_1 StateOwn_{it} + \beta_2 FamilyOwn_{it} + \beta_3 InstOwn_{it} + \beta_4 Leverage_{it} + \beta_3 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

H3a

$$TQ_{it} = \alpha + \beta_1 State\ vs\ Private_{it} + \beta_4 Leverage_{it} + \beta_3 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

H4:

$$ROA_{it} = \alpha + \beta_1 OwnCon_{it} + \beta_2 OwnCon_{it}^2 + \beta_3 Leverage_{it} + \beta_4 FirmSize_{it} + \beta_5 Tangibility_{it} + \beta_6 Cashholdings_{it} + \beta_7 CapexRatio_{it} + \varepsilon_{it}$$

Where,
i: Numbers of Firms
t: Numbers of Years
ε: error terms