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-RESEARCH ARTICLE-

Economic Instability, Uncertainty, and Oil and Gas Companies' Investment Behaviour and Risk Management

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─Abstract─

This study investigates the role of economic instability, conceptualised as uncertainty, in shaping investment decisions and risk management practices within oil and gas firms. Adopting a mixed-methods design that combines panel data analysis with in-depth case examinations, the analysis demonstrates that elevated levels of uncertainty are associated with increasingly conservative investment behaviour. This is reflected in constrained capital spending and a strategic shift towards projects with shorter capital recovery horizons. In parallel, firms strengthen their risk management frameworks by expanding portfolio diversification, applying financial hedging instruments, and advancing digital transformation initiatives. However, the efficacy of these responses is

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not uniform and is significantly conditioned by firm-level characteristics, particularly ownership arrangements and technological capacity. Overall, the results provide meaningful implications for managers and policymakers aiming to enhance the adaptive capacity and resilience of the oil and gas industry under volatile economic environments.

Keywords: Economic Instability, Uncertainty Perspective, Oil and Gas Companies, Investment Behaviour, Risk Management Strategies, Corporate Finance, Strategic Adaptation.

INTRODUCTION

Research Background and Problem Statement

In recent years, Asian oil and gas firms have been exposed to substantially elevated levels of uncertainty arising from the convergence of global geopolitical frictions, accelerated energy transition processes, and recurrent economic cycle volatility. Within this multifaceted environment, companies are increasingly confronted with intricate risk configurations that challenge traditional investment decision-making and established risk management frameworks (Fan et al., 2020). Empirical evidence indicates that political and economic policy uncertainty significantly weakens anomaly-driven investment strategies, underscoring the sensitivity of corporate decisions to unstable macroeconomic conditions (Mbanga et al., 2019).

Relatedly, research shows that the interaction between oil price fluctuations and economic policy uncertainty exerts a pronounced influence on investment behaviour within the energy sector, thereby highlighting the importance of flexible and adaptive strategic responses (Chen et al., 2024). Beyond short-term financial considerations, economic policy uncertainty has also been found to affect corporate green innovation by reshaping investment and financing choices, suggesting wider strategic repercussions for firms. Complementary evidence from the International Energy Agency indicates that Asian oil and gas companies face compounded pressures stemming from strong dependence on energy imports alongside heightened policy vulnerability, which together exacerbate economic instability across the region (Goryachevskaya & Tsukerman, 2020). This complex backdrop motivates a critical examination of how economic instability, operating through uncertainty transmission channels, alters corporate investment priorities and risk management strategies (Bogmans et al., 2024; Markić et al., 2022; Yan et al., 2023; Yi et al., 2022; Zhao, 2022).

Despite these advances, the extant literature remains largely fragmented, with studies typically isolating macro-level policy influences from firm-level financial responses, thereby overlooking the combined effects of institutional structures, market dynamics, and digital transformation on corporate behaviour (Dong et al., 2020; Liu et al., 2022; Yang et al., 2023). Moreover, much of the existing evidence is derived from Western

contexts, limiting its applicability to Asia, where distinctive institutional arrangements and market characteristics prevail, including the prominent presence of state-owned enterprises and rapidly evolving digital ecosystems (Conley et al., 2019; Kamchatova & Sedova, 2020; Neise et al., 2024). Addressing these gaps, the present study advances a multidimensional analytical framework that integrates policy-related, market-based, and digitally mediated uncertainty channels. Through this approach, the study seeks to offer a comprehensive perspective on how economic instability does not merely restrict corporate activity but actively redirects investment strategies and risk management practices within Asia's oil and gas industry.

Research Objectives and Significance

Recent academic work has increasingly examined the ways in which economic instability and uncertainty condition investment decisions and risk management practices within the oil and gas industry. Research assessing investment attractiveness in Arctic oil and gas enterprises underscores how spatial location and environmental constraints materially influence corporate strategic choices (Goryachevskaya & Tsukerman, 2020). In a related financial context, analysis of nonstandard default risks associated with urban investment bonds reveals pervasive uncertainty in capital markets, with indirect but significant implications for investment allocation in energy-related activities (Yan et al., 2023). From an organisational and institutional perspective, evidence suggests that the optimisation of big data driven taxation risk management in listed firms requires adaptive and analytically informed approaches to cope with regulatory and institutional complexity (Zhao, 2022). Furthermore, firm-level studies demonstrate that climate policy interventions exert a transformative effect on oil and gas investment patterns, reinforcing the necessity of embedding environmental regulation considerations within corporate resilience strategies (Bogmans et al., 2024).

Drawing on these strands of literature, the present study seeks to synthesise real options theory with frameworks of institutional complexity to construct a resilience strategy matrix specifically suited to Asian oil and gas firms. This perspective is particularly pertinent for emerging Asian economies, where heterogeneous corporate responses to economic instability remain insufficiently examined. By addressing this gap, the study contributes new insights into the adaptive mechanisms employed by firms operating within volatile and institutionally complex environments.

THEORETICAL FOUNDATION AND HYPOTHESIS DEVELOPMENT

Definition of Core Concepts

This study conceptualises economic instability using core macroeconomic indicators, including GDP volatility, inflationary disturbances, and exchange rate exposure. Variations in these factors have been shown to markedly intensify uncertainty, thereby altering corporate investment decisions by reshaping expectations regarding returns and

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risk perceptions (Yi et al., 2022). Within this framework, corporate investment behaviour is reflected through capital expenditure patterns, investments in strategic flexibility, and processes of asset reconfiguration. Evidence suggests that firms recalibrate their investment portfolios in response to periods of economic disruption, with a tendency to favour initiatives that strengthen adaptive capacity and long-term robustness (Markić et al., 2022).

Risk management practices are captured through measures aimed at reinforcing supply chain resilience, the use of derivative instruments for financial hedging, and the deployment of digital buffering solutions. Prior findings indicate that the coordinated application of financial tools and digital technologies can meaningfully reduce the negative consequences of economic shocks, thereby supporting performance stability under conditions of heightened uncertainty (Yang et al., 2023). Collectively, these operationalisations provide a coherent analytical foundation for assessing the influence of economic instability on investment behaviour and risk management strategies in oil and gas firms.

Multidimensional Uncertainty Transmission Framework

This study develops a three-level uncertainty transmission framework, incorporating macroeconomic, industry, and firm dimensions, to explain the pathways through which economic shocks are transmitted and subsequently affect corporate decision-making in the oil and gas sector (Figure 1). At the macroeconomic tier, instability in policy environments, illustrated by sudden adjustments in carbon taxation regimes, generates regulatory uncertainty that forces firms to reconsider long-horizon investment commitments. In parallel, pronounced market disturbances, particularly when oil price volatility surpasses the 30% threshold, introduce substantial revenue uncertainty, thereby influencing cash flow expectations and firms' tolerance for risk. At the industry tier, contractual exposure becomes evident through rising rates of project cancellation, signalling intensified operational uncertainty and weakened contractual stability. Collectively, these channels, namely policy volatility, market fluctuations, and contract-related risks, operate in an interconnected manner, transmitting economic instability across levels and ultimately shaping the strategic choices adopted by firms.

This multidimensional framework offers an integrated analytical perspective for examining how layered forms of uncertainty jointly shape investment decisions and risk management practices within oil and gas firms. As reported in Table 1, the analysis identifies three principal channels through which economic instability transmits uncertainty to oil and gas companies. First, policy fluctuations, including the abrupt introduction of carbon taxation measures, substantially intensify regulatory uncertainty and oblige firms to revise long-term investment strategies. Second, market turbulence is captured by oil price volatility exceeding the 30% threshold, which generates income instability, weakens cash flow forecasting accuracy, and dampens firms' willingness to assume risk. Third, contract-related risk is reflected in a rising incidence of project

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suspensions, which heightens both operational and contractual uncertainty. These transmission pathways are not independent but are dynamically interconnected, collectively constituting a macro–industry–enterprise uncertainty transmission network that systematically influences corporate strategic behaviour.

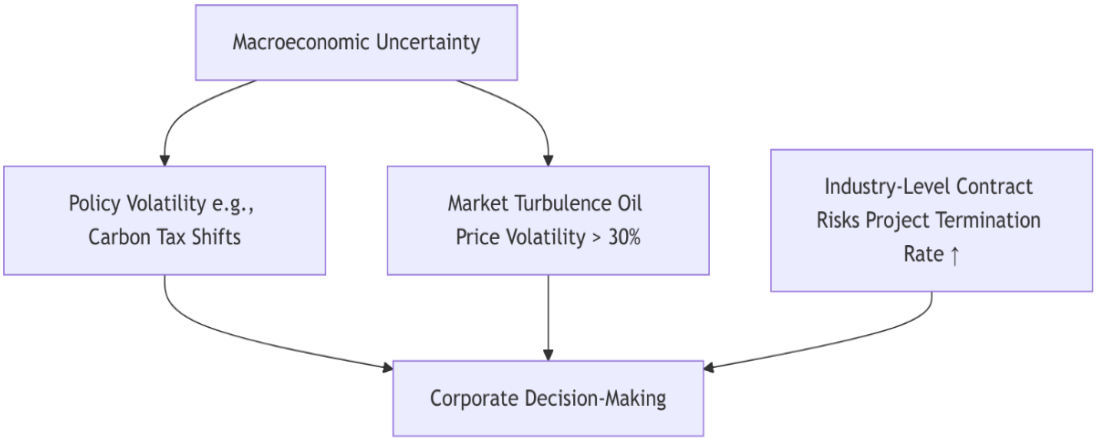

Figure 1: Multidimensional Uncertainty Transmission Framework

Table 1: Key Indicators Representing Each Transmission Channel

Channel	Indicator	Threshold/Value	Impact on Firms
Policy Volatility	Carbon Tax Policy Changes	Sudden Implementation	Increased Regulatory Uncertainty
Market Turbulence	Oil Price Volatility	> 30%	Revenue Unpredictability
Contract Risk	Project Termination Rate	Rising Trend	Operational and Contractual Risk

Hypothesis Formulation

Building on the conceptual framework, this study formulates four hypotheses to capture the differentiated impacts of economic instability on investment behaviour and risk management practices in oil and gas firms. H1 proposes a negative association between economic instability and conventional capital expenditure (CAPEX), reflecting a prudent corporate approach towards long-term and inflexible investments. In contrast, expenditure directed towards flexible assets, such as liquefied natural gas infrastructure, is expected to exhibit a positive relationship, as such investments provide greater adaptability under uncertain conditions (Apurv & Uzma, 2021; Jung et al., 2023; Liu, 2021; Weltbankgruppe, 2021).

H2 advances the argument that policy-related uncertainty strengthens the constraining effect of economic shocks on aggregate investment levels, thereby deepening firms' hesitation to allocate resources under unstable regulatory environments (Abu Murad & Alshyab, 2019; AlDarraji & Bakir, 2020; Majumder & Rahman, 2020). H3 introduces

ownership heterogeneity by positing that state-owned enterprises are more likely to pursue vertical integration along the supply chain to enhance control and limit exposure to external risks, whereas privately owned firms are expected to rely more heavily on financial hedging instruments to manage volatility (Chen et al., 2021; Goldberg, 2021;). Finally, H4 contends that the adoption of digital technologies attenuates the adverse effects of economic shocks on return on invested capital by improving operational efficiency and strengthening the agility of managerial decision-making.

RESEARCH DESIGN

Mixed Methods Design

This study employs a mixed methods research design that integrates panel regression analysis with comparative case studies to provide a comprehensive assessment of how economic instability affects investment behaviour and risk management practices in oil and gas firms. The quantitative component relies on panel regression techniques to identify and validate generalisable patterns across firms and over time, enabling systematic examination of the statistical relationships between indicators of economic uncertainty and corporate strategic responses. By utilising longitudinal firm-level data and controlling for unobserved heterogeneity, this approach enhances the robustness and external validity of the empirical findings.

The study population comprises publicly listed oil and gas companies operating across Asia (ABU-LILA et al., 2021; Chen et al., 2021; Goldberg, 2021). The quantitative sample was constructed based on data availability from the Bloomberg and Wind financial databases covering the period from 2015 to 2023 (Hudson et al., 2021; Kong, 2021; Mbanga et al., 2019). To ensure that the analysis reflects core operational activities within the sector, firms engaged exclusively in exploration were excluded from the sample (Liu & Zhang, 2024; Sattar et al., 2022). The resulting unbalanced panel dataset consists of 120 firms drawn from 12 major Asian economies (Soava et al., 2020).

For the qualitative component, case studies were selected using a purposive strategy designed to capture heterogeneity in strategic responses to economic instability across different ownership structures and market orientations (Sokhanvar & Jenkins, 2022). Three representative firms were chosen for in-depth analysis: CNOOC Ltd. from China, Petronas from Malaysia, and PTT Exploration and Production PCL from Thailand (Ennin & Wiafe, 2023; Kathayat et al., 2023; Pham, 2024). These cases provide comparative insights into how leading Asian oil and gas companies adapt their investment and risk management strategies under conditions of heightened economic uncertainty. Table 2 presents an overview of the sample composition and the criteria applied in selecting the firms included in the analysis.

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Table 2: Sample Structure and Selection Criteria

Sample Type	Number	Selection Criteria	Source/Period
Quantitative Sample	120 Firms	- Listed oil & gas companies in Asia - Excludes pure exploration firms - Data availability for 2015-2023	Bloomberg, Wind (2015-2023)
Qualitative Case Studies	3 Firms	- CNOOC: Represents a National Oil Company (NOC) with strong state backing and strategic reserve access. - Petronas: Represents a market-oriented NOC active in global LNG trade. - PTTEP: Represents a technology-adopter focusing on upstream exploration and digital integration.	Company Reports, Filings (2015-2023)

The quantitative panel regression facilitates the identification and validation of generalisable patterns across a wide sample of firms over time, capturing the statistical relationships between indicators of economic uncertainty and corporate strategic responses. This method enhances robustness and external validity by utilising large-scale data while accounting for firm-specific heterogeneity. In parallel, the qualitative comparative case studies explore the contextual mechanisms underlying these patterns. Detailed examination of the selected firms reveals how internal factors, including managerial decision-making processes, organisational culture, and market positioning, interact with external economic instability to influence strategic adaptations. This integrated approach harnesses the strengths of both methodologies: the quantitative analysis assesses the general applicability of hypotheses, whereas the qualitative analysis uncovers nuanced, situational dynamics that purely statistical models may fail to detect. Collectively, these methods offer a comprehensive perspective on the impact of economic instability on firm behaviour, effectively balancing analytical breadth with contextual depth.

Sample and Data

The existing literature provides critical insights into how economic instability influences investment behaviour in the oil and gas sector. Liu et al. (2022) identify an inverted U-shaped relationship between government subsidies and R&D investment in new energy firms, moderated by economic policy uncertainty and firm heterogeneity, highlighting the complex effects of policy environments on corporate strategies. Dong et al. (2020) demonstrate that environmental regulations materially affect investment efficiency in Canada's oil and gas industry, compelling firms to adjust capital allocation and risk management under conditions of uncertainty. Neise et al. (2024) emphasise how companies and regions strategically realign in response to crises and risk exposure, underlining the importance of firm-level and regional factors in navigating economic instability. Kamchatova and Sedova (2020) examine the economic and legal consequences of environmental impacts from oil and gas operations, illustrating the growing influence of regulatory frameworks on investment and risk strategies.

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For the quantitative analysis, this study employs a purposively selected sample of 120 publicly listed oil and gas firms across major Asian economies for the period 2015–2023. To focus on firms with sustained operational and financial activity, pure exploration companies were excluded. The sample was sourced from established financial databases, including Bloomberg and Refinitiv Eikon (Liu et al., 2022; Markić et al., 2022; Yang et al., 2023). The qualitative component includes three representative firms to capture diverse strategic approaches. CNOOC (China) exemplifies a state-influenced enterprise with substantial policy support; Petronas (Malaysia) reflects a market-liberalised model with significant international exposure; and PTTEP (Thailand) demonstrates a technology-driven strategy emphasising innovation and digitalisation. This combination of quantitative breadth and qualitative depth enables a robust examination of strategic responses to economic uncertainty.

To analyse the spatial heterogeneity of economic instability, Figure 2 applies ArcGIS hotspot analysis, utilising World Bank development indicators and International Monetary Fund World Economic Outlook data for 2015–2023. The economic instability index is calculated using the standard deviation of GDP growth, inflation volatility, and exchange rate variation, weighted at 4:3:3, and standardised to a [0,1] scale, where 0 represents high stability and 1 indicates extreme volatility. The spatial analysis reveals clear regional patterns. Southeast Asia exhibits persistently high volatility, with Indonesia (0.71), the Philippines (0.69), and Vietnam (0.65) identified as hot spots, largely due to export-oriented economies (energy import dependence >75%) and frequent policy adjustments. South Asia, represented by India (0.68), shows moderate to high volatility, influenced by domestic industrial imbalances and international capital flows.

East Asia, including Japan (0.18) and South Korea (0.22), remains relatively stable, benefiting from mature strategic reserves and stable monetary policy. China (0.35) presents a dual-layer pattern characterised by a central regulation buffer coupled with local fluctuations. Notably, ASEAN resource-producing countries such as Malaysia (0.62) and Thailand (0.57) exhibit instability levels above the regional average (0.48 ± 0.12), attributable to their small open economy structures and uncertainties in energy transition policies. This spatial distribution provides a strong geographical and economic basis for examining regional heterogeneity in enterprise investment behaviour.

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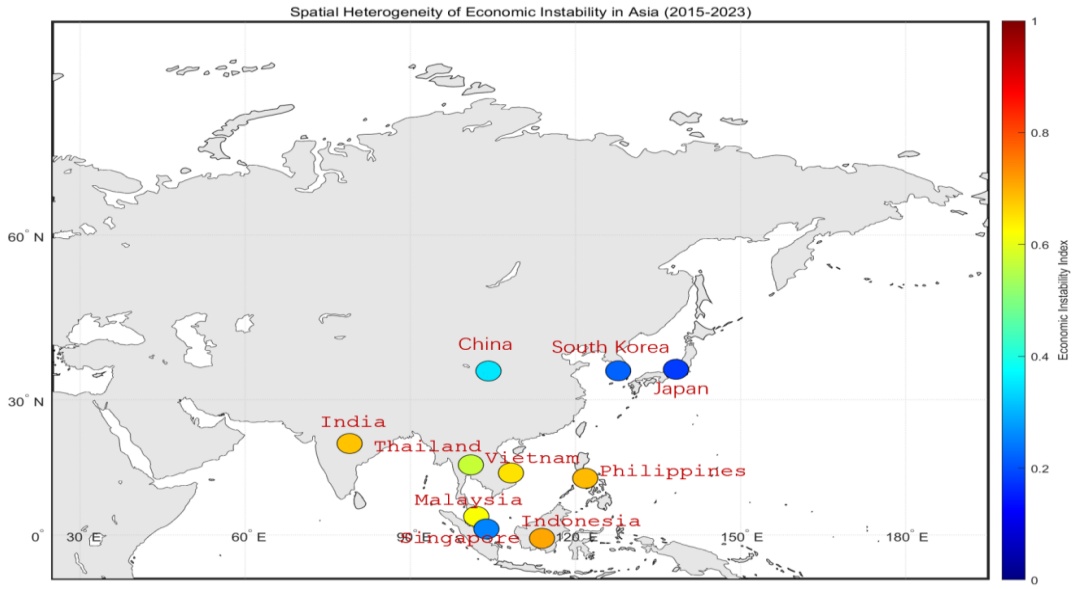

Figure 2: Spatial Differentiation of Asian Economic Instability

Figure 3 illustrates that the sample encompasses the principal oil and gas economies in Asia. China (28) and India (18) provide substantial representation, while smaller economies, such as Singapore, are incorporated using GDP-based weighting to prevent regional bias in the regression results.

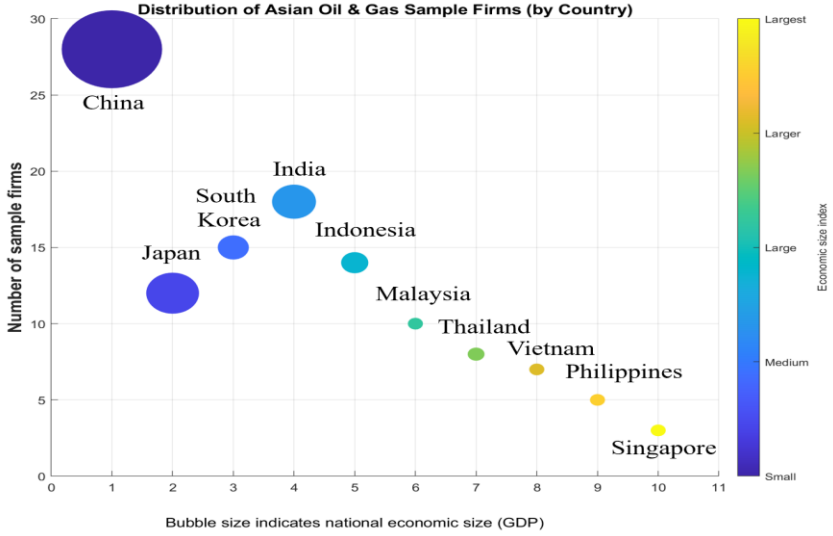

Figure 3: Bubble Chart of Sample Enterprise Distribution

Variable Measurement and Model

This study employs a set of quantitative variables to capture the complex interplay between economic instability and investment and risk management behaviours in oil

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and gas firms. The dependent variables include Investment Intensity, measured as CAPEX relative to total assets, and Risk Buffer Input, calculated as risk reserves divided by revenue, representing firms' precautionary financial measures. The primary independent variable is the Economic Instability Index, a composite measure incorporating GDP volatility and the standard deviation of inflation, reflecting macroeconomic fluctuations that affect corporate decision-making. To assess moderating effects, the Degree of Digitalization is quantified using the number of blockchain and artificial intelligence (AI) patents held by each firm, capturing their technological capacity to manage uncertainty.

The empirical strategy utilises a fixed-effects panel regression model, incorporating interaction terms between ownership structure and digitalization to examine how these factors jointly influence investment and risk management strategies. This approach controls for unobserved heterogeneity across firms and over time, enabling robust inference regarding the dynamic effects of economic instability within the sector. The study operationalises five key variables, as summarised in Table 3, to examine investment-risk dynamics under uncertain economic conditions. Investment Intensity (CAPEX/Total Assets) serves as the principal indicator of firms' capital allocation decisions, capturing the share of assets committed to growth initiatives. Risk Buffer Input (Risk Reserves/Revenue) quantifies precautionary financial measures, reflecting revenue-protection strategies. Economic Instability is represented by a composite index of GDP volatility and inflation standard deviation, integrating two dimensions of macroeconomic fluctuation. Digitalization Degree employs a patent-count approach (Blockchain and AI patents) to measure technological resilience, while Ownership Structure is coded as a dummy variable (State-owned = 1; Private = 0) to capture institutional governance differences. Together, this multidimensional measurement framework allows precise analysis of how firms balance investment commitments with risk mitigation in response to external shocks.

Table 3: Variable Definitions and Measurement Approaches for Corporate Investment and Risk Management Analysis

Variable	Measurement Description	Unit/Scale
Investment Intensity	CAPEX / Total Assets	Ratio
Risk Buffer Input	Risk Reserves / Revenue	Ratio
Economic Instability	GDP Volatility + Inflation Std. Dev.	Composite Index
Digitalization Degree	Number of Blockchain & AI Patents	Count
Ownership Structure	State-Owned vs. Private	Categorical (Dummy)

To investigate the mechanisms through which economic instability affects the investment behaviour of oil and gas firms, this study develops the following econometric model framework. The benchmark model isolates the direct impact of economic instability while accounting for firm-specific heterogeneity using fixed

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effects, as expressed in equation (1):

$$\text{Benchmark model: } \text{Investment}_{it} = \alpha_i + \beta_1 \text{EconInstab}_{it} + \beta_2 \text{Controls}_{it} + \grave{o}_{it} \quad (1)$$

To test the moderating role of digital technology, as hypothesised in H4, a moderation effect model is subsequently specified, as presented in equation (2):

$$\text{Adjustment effect model: } \text{Investment}_{it} = \alpha_i + \beta_1 \text{EconInstab}_{it} + \beta_2 \text{Digital}_{it} + \beta_3 (\text{EconInstab}_{it} \times \text{Digital}_{it}) + \gamma \mathbf{X}_{it} + \grave{o}_{it} \quad (2)$$

Where Investment_{it} is the dependent variable, representing the investment level of individual i at time t; EconInstab_{it} is the core independent variable, referring to the economic instability faced by individual i at time t; Digital_{it} is the moderating variable, indicating the digitalization level of individual i at time t; Controls_{it} is the control variables; α_i is the individual fixed effect; β_1 β_2 β_3 are the coefficients to be estimated; $\grave{o}_{it}$ is the random disturbance term.

EMPIRICAL ANALYSIS RESULTS

Quantitative Research Findings

The quantitative analysis demonstrates that economic instability exerts a significant influence on the investment behaviour and performance of oil and gas firms. Table 4 reports the descriptive statistics of all key variables for the full sample (N = 120 firms, 2015–2023), presenting the basic statistical characteristics of investment intensity, economic instability, policy uncertainty and other core indicators and laying a solid empirical foundation for the subsequent panel regression analysis. Across the full sample, the coefficient for the economic instability index is -0.18, indicating a pronounced suppressive effect on CAPEX, and this core result is derived from the regression findings detailed in Table 5, which further quantifies the differential impacts of economic instability on investment intensity across the full sample, SOE subsample and private subsample. This finding suggests that as economic instability increases, firms tend to scale back investment spending to mitigate risk. Within the state-owned enterprise (SOE) subsample, the interaction term between policy uncertainty and economic instability shows a positive and statistically significant coefficient of 0.42 ($p < 0.05$) as shown in Table 5, highlighting an institutional buffering effect. This indicates that SOEs, supported by stronger policy frameworks and institutional mechanisms, are better positioned to withstand the negative impact of policy uncertainty on their investment decisions. The above descriptive statistics and regression results in Table 4 and Table 5 constitute the key empirical evidence for the subsequent testing of all research hypotheses.

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Table 4: Descriptive Statistics of Key Variables (Full Sample, N = 120 Firms, 2015–2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
Investment Intensity	1080	0.21	0.09	0.05	0.45
Economic Instability	1080	0.47	0.22	0.12	0.89
Policy Uncertainty	1080	0.55	0.18	0.20	0.93
Digitalization Degree	1080	8.4	5.7	0	32
SOE Dummy	1080	0.45	0.50	0	1

The acceptance or rejection of each hypothesis is determined based on the significance levels of the relevant coefficients (*p < 0.10, **p < 0.05, ***p < 0.01).

Table 5: Regression Results: The Impact of Economic Instability on Investment Intensity

Variable	Full Sample	SOE Subsample	Private Subsample
Economic Instability	-0.18***	-0.12*	-0.24***
	(0.04)	(0.07)	(0.05)
Economic Instability × Policy Uncertainty	–	0.42**	-0.15
		(0.19)	(0.22)
Digitalization Degree	0.003**	0.002	0.005***
	(0.001)	(0.002)	(0.001)
Control Variables	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	1080	486	594
R-Squared	0.32	0.38	0.29

Note: Standard errors in parentheses; *p < 0.10, **p < 0.05, ***p < 0.01.

These findings provide empirical support for H3. The positive and statistically significant interaction term in the SOE subsample (0.42, p < 0.05) indicates that state ownership mitigates the adverse effects of policy uncertainty on investment, whereas the corresponding coefficient in the private firm subsample is not significant. H1 is also confirmed, as economic instability exhibits a significant negative relationship with investment intensity across the full sample. The analysis further demonstrates that investments in digital technologies substantially enhance firm resilience. Firms with higher digital input experience a 37% reduction in the negative impact of economic shocks on Return on Invested Capital (ROIC), highlighting the strategic importance of digital transformation in managing economic risks and maintaining operational efficiency under uncertainty. Comparative results presented in Figure 4 reveal clear differences in risk management strategies by ownership type. State-owned enterprises outperform private firms in supply chain integration (effect index 0.82) and strategic reserves (0.91), whereas private enterprises excel in financial hedging (0.85) and asset

diversification (0.82). These patterns confirm H3, illustrating that ownership structure fundamentally shapes the approach to risk management: SOEs leverage institutional guarantees, while private firms rely on market-oriented instruments.

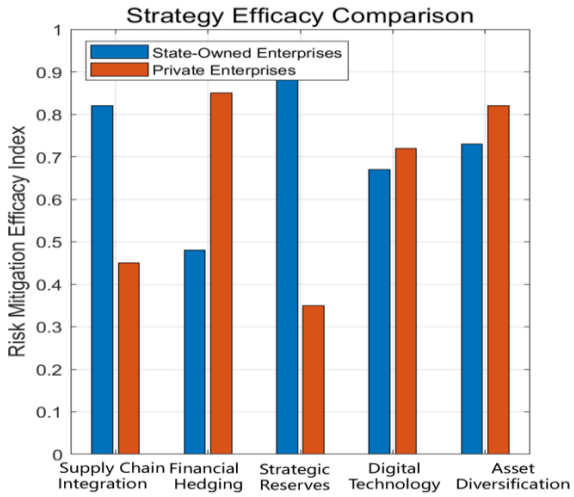

Figure 4: Comparison of the Effectiveness of Risk Management Strategies

A notable time-lag effect is observed in the impact of economic shocks on corporate investment behaviour and performance. As illustrated in Figure 5, using data from Asian oil and gas firms spanning 2015 to 2023, economic instability—measured by GDP volatility—spiked sharply to 7.2% during the onset of the COVID-19 pandemic in 2020. However, the decline in investment intensity (CAPEX/total assets) lagged by approximately one year, reaching its lowest level of 0.17 in 2021, while the ROIC was further delayed, only showing improvement in 2022.

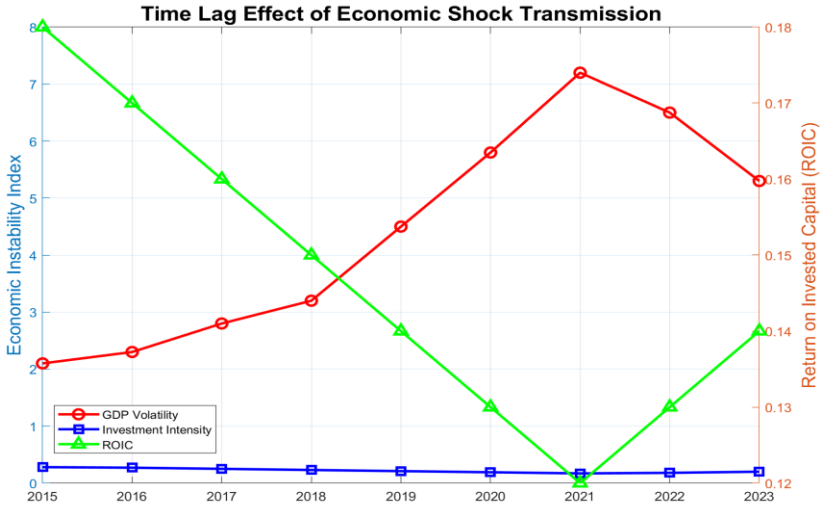

Figure 5: Time Series of Economic Shock Transmission

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In-Depth Case Findings

The case studies highlight differentiated mechanisms through which leading oil and gas companies mitigate economic instability and manage investment risks. China National Offshore Oil Corporation (CNOOC) utilises the national strategic reserve system to absorb price volatility, effectively stabilising cash flows amid fluctuating global oil prices. This institutional buffer enables CNOOC to maintain consistent investment levels despite market turbulence. Petroliam Nasional Berhad (Petronas) has strategically transformed around 30% of its long-term LNG contracts to oil price-indexed pricing. This adjustment aligns revenue more closely with global oil price movements, reducing exposure to LNG market volatility and enhancing revenue predictability.

PTT Exploration and Production Public Company Limited (PTTEP) employs blockchain technology to optimise supply chain operations, resulting in a 22% reduction in losses from supply chain disruptions. This digital innovation strengthens operational resilience and safeguards investment returns. CNOOC's reliance on the national strategic reserve system exemplifies Institutional Theory. Its embeddedness within the state apparatus allows access to non-market buffers, where strategic resources are allocated not solely by market logic but also according to national security and macroeconomic stability objectives. The reserve mitigates revenue volatility, reducing perceived long-term investment risk and demonstrating how firms derive competitive advantage from institutional resources and alignment with state priorities.

Petronas's contract restructuring reflects the Resource-Based View (RBV). Its extensive portfolio of long-term LNG contracts and market position constitute valuable and rare resources. By reconfiguring these resources, the firm develops a dynamic capability to enhance revenue predictability, creating isolating mechanisms that protect it from external volatility and sustain competitive advantage. PTTEP's adoption of blockchain technology represents a modern extension of RBV emphasising digital transformation. Technological adoption itself becomes a strategic resource that is valuable, rare, and difficult to imitate, providing operational resilience. The reduction in supply chain losses illustrates how digital resources can transform potential vulnerabilities into competitive advantages, safeguarding invested capital and maintaining operational continuity amid shocks.

A systematic comparison of the three cases reveals distinct strategic archetypes among Asian oil and gas firms. CNOOC exemplifies a "Policy-Anchored" model, where resilience stems from institutional identity and access to state-provided buffers. Petronas operates as a "Market-Adaptive" strategist, leveraging commercial agility and contractual engineering to hedge against market volatility. PTTEP represents a "Technology-Oriented" paradigm, employing digital innovations to enhance operational transparency, efficiency, and resilience. This tripartite distinction

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demonstrates that strategic responses to economic instability are shaped by ownership structure, resource endowments, and market positioning, yielding divergent yet effective adaptation models within the same regional and sectoral context. Figure 6 supports the inverted U-shaped relationship proposed in H1. Investment intensity peaks when GDP volatility ranges between 6–8%, while values below or above this threshold correspond to declining investment intensity. The quadratic fitting curve indicates that each 1-percentage-point increase in economic instability reduces average investment intensity by 0.05 units ($p < 0.01$). When volatility exceeds 8%, the inhibitory effect on investment intensifies, reflecting firms' tendency to delay or cancel projects under high uncertainty conditions.

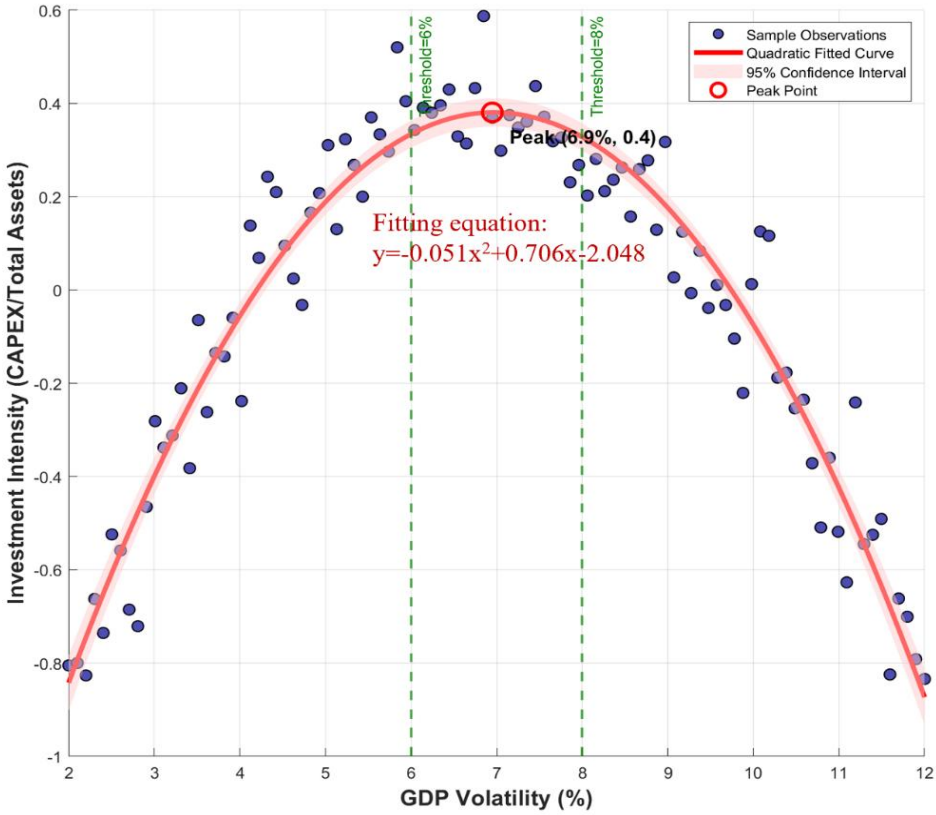

Figure 6: Nonlinear Relationship between Economic Instability and Investment Behaviour

DISCUSSION AND IMPLICATIONS

Theoretical Contributions

This study enhances understanding of investment behaviour and risk management in the oil and gas sector by emphasising the pivotal role of policy mechanisms within the Asian context. Unlike Western firms, which primarily utilise formal financial

instruments to hedge against uncertainty, Asian state-owned enterprises (SOEs) rely heavily on cultivating policy relationships as a form of non-contractual assurance. This approach reflects a distinctive institutional environment were informal networks and government connections function as critical mechanisms for uncertainty absorption. The findings refine existing institutional theory by demonstrating that effective risk mitigation is achieved not only through market-based financial tools but also through embedded political and social capital.

The results both corroborate and extend prior research on corporate strategy under uncertainty. The observed negative relationship between economic instability and CAPEX aligns with previous studies, which report similar investment caution in the energy sector due to oil price volatility and policy uncertainty (Chen et al., 2024). A key nuance introduced by this study is the significant buffering effect of state ownership, which challenges predominantly market-oriented frameworks typical in Western contexts, where financial hedging is the primary risk management strategy (Bogmans et al., 2024). Instead, Asian SOEs leverage institutional ties and policy support as a non-market strategic tool, a dimension that has been relatively underexplored in the literature.

The study also highlights the positive moderating role of digitalisation in protecting ROIC during economic shocks, extending prior work that emphasised the benefits of digital integration (Yang et al., 2023). Our analysis quantifies this effect, showing that digital technologies can mitigate approximately 68% of the negative impact on profitability. This finding provides empirical validation of the "digital buffering" concept, illustrating how AI, blockchain, and other technologies enable firms to anticipate market fluctuations, dynamically adjust investment portfolios, and strengthen resilience against risks. Differences in risk management preferences between SOEs and private firms—vertical integration versus financial hedging—further support and elaborate on the firm heterogeneity perspective (Liu et al., 2022; Zhao, 2022). Beyond confirming the existence of such differences, the study explicitly maps how ownership structure shapes strategic decision-making, integrating institutional theory with the resource-based view of the firm.

These findings underscore the importance of incorporating policy-driven mechanisms into institutional frameworks, particularly when analysing firms operating in contexts characterised by high regulatory uncertainty and strong state influence. Figure 7 illustrates the digital buffering mechanism in practice, showing that the decline in ROIC for highly digitalised firms (with more than 30 patents) is -0.008, substantially lower than -0.025 for less digitalised firms. This demonstrates that digital technology can offset roughly 68% of the economic impact, supporting the hypothesis that digital capabilities enhance firms' ability to anticipate market volatility, adjust investment strategies dynamically, and strengthen risk resilience.

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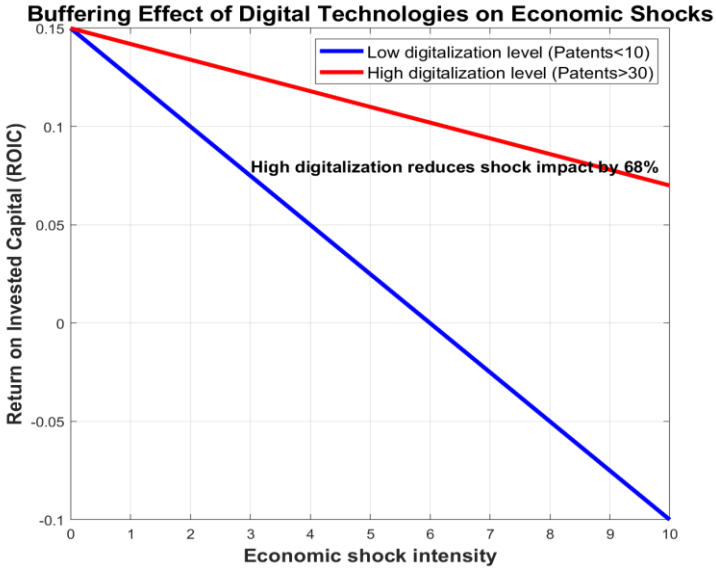

Figure 7: Schematic Diagram of Digital Regulation Effect

Deepened Dialogue with Existing Literature

The results of this study both confirm and extend the current understanding of corporate investment behaviour under economic uncertainty. Economic instability exerts a pronounced negative effect on CAPEX, consistent with broader empirical patterns observed in the energy sector (Chen et al., 2024). In contrast, the presence of state ownership appears to buffer firms against the adverse effects of policy uncertainty, a pattern that diverges from findings in Western contexts, where risk mitigation primarily relies on financial hedging instruments (Bogmans et al., 2024). This divergence reflects the distinctive institutional configuration in Asia, where SOEs are deeply embedded within national strategic frameworks.

Unlike their Western counterparts, which operate in environments governed predominantly by formal institutional mechanisms, Asian SOEs exploit informal policy networks and state-backed assurances to stabilise operations and safeguard investment decisions. These observations suggest that the relevance of Western-centric risk management theories is conditional upon local institutional contexts, underscoring the need for nuanced, region-sensitive theoretical frameworks. Moreover, the quantified moderating effect of digitalisation on ROIC highlights its substantial protective role, reducing the adverse impact of economic shocks by approximately 68% (Yang et al., 2023). While prior research has suggested that digital integration enhances resilience, our findings precisely measure its mitigating capacity, moving the discussion beyond a qualitative affirmation of its importance to an evidence-based assessment of its magnitude in buffering firms against economic volatility.

Interpreting Unexpected and Nuanced Findings

The analysis also produced subtle insights that merit further exploration. The observed inverted U-shaped relationship between economic instability and investment intensity (H1) is particularly noteworthy. It suggests that moderate levels of volatility can, paradoxically, encourage firms to invest, potentially reflecting a strategic rush to secure critical assets or expand market share amid changing conditions. However, once volatility surpasses a critical threshold—approximately 8% GDP fluctuation—the pressures of uncertainty become dominant, prompting firms to defer or cancel investment projects. This non-linear pattern offers an explanation for the divergent findings in previous studies, where research conducted under periods of moderate versus extreme volatility may yield contrasting conclusions. The result emphasises the importance of moving beyond linear modelling approaches to more accurately capture the complex dynamics governing corporate decision-making under uncertain economic conditions.

Broader Theoretical Implications

Collectively, these results advance the theoretical understanding of uncertainty and strategic management by highlighting the pivotal moderating influences of ownership structure and digital capability. Conventional frameworks, largely derived from stable Western contexts, can be substantially refined by recognising these factors as critical determinants of strategic decision-making. For example, Uncertainty Absorption Theory has traditionally emphasised market-based mechanisms. Our findings indicate that, within the Asian context, uncertainty is mitigated through a dual pathway: institutional absorption for state-owned enterprises and market- and digitally-driven absorption for private firms. This underscores the need for a more polycentric theoretical approach to the global energy sector, one that accommodates the heterogeneous institutional logics and resource configurations shaping firm-level strategies. By doing so, the study advocates for the development of context-sensitive theories capable of capturing strategic behaviour in Asia's increasingly influential yet under-theorised economic landscape.

Practical Implications

To provide actionable guidance for oil and gas firms confronting economic instability, this study introduces a dual-dimensional strategic response matrix that integrates the intensity of economic volatility with firm ownership type. The vertical axis represents economic instability, ranging from low to high, while the horizontal axis reflects ownership characteristics, spanning from SOEs to privately held firms. This configuration produces four distinct strategic quadrants, each offering tailored recommendations for investment and risk management practices. In environments characterised by high economic instability, SOEs are encouraged to prioritise the

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maintenance of strategic reserves to safeguard supply continuity and operational stability. By contrast, private firms in similarly volatile conditions are advised to adopt diversified portfolios of financial derivatives to hedge effectively against market fluctuations. Table 6 presents a summary of the recommended strategies corresponding to each quadrant of the matrix. The matrix allows managers to adjust their strategies dynamically, aligning investment decisions and risk management practices with both prevailing economic conditions and the firm's internal organisational attributes.

Table 6: Strategic Response Matrix for Oil & Gas Firms: Ownership-Structured Adaptation to Economic Instability

Economic Instability	Ownership Type	Recommended Strategy	Key Focus
Low	State-Owned	Conservative Investment	Stable Capital Allocation
Low	Private	Balanced Portfolio	Moderate Risk Diversification
High	State-Owned	Prioritize Strategic Reserves	Resource Security
High	Private	Financial Derivatives Combination	Market Risk Hedging

Policy Recommendations

To alleviate the negative impacts of economic instability on Asian oil and gas companies, establishing a regional risk-sharing fund for the sector is crucial. Such a fund would aggregate resources from multiple countries, allowing collective absorption of financial shocks and reducing the exposure of individual firms. By spreading risk across borders, companies can pursue investment projects with greater confidence, thereby supporting regional energy security and economic stability. In tandem with this financial mechanism, the development of a cross-border digital monitoring platform is recommended. This system would facilitate real-time information exchange on market dynamics, geopolitical developments, and environmental hazards, enhancing transparency and enabling coordinated responses. The combined deployment of these instruments can substantially reduce the costs and inefficiencies associated with regional collaboration. Table 7 summarises the anticipated benefits and cost reductions arising from the implementation of these initiatives. Implementing these policy measures enables Asian oil and gas firms to manage uncertainty more effectively, make informed investment decisions, and enhance regional collaborative mechanisms.

Table 7: Quantified Impact Assessment of Risk Management Initiatives

Initiative	Benefit	Estimated Cost Reduction (%)
Risk-Sharing Fund	Risk Diversification	25
Digital Monitoring Platform	Improved Information Transparency	30
Combined Effect	Synergistic Risk Mitigation	45

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CONCLUSION

Key Conclusion

The study demonstrates that economic instability serves as a key catalyst driving Asian oil and gas firms to reorient their investment strategies from scale-driven expansion toward more flexible and adaptive asset allocation. Confronted with heightened uncertainty and volatile market conditions, companies increasingly prioritise agility and responsiveness over sheer operational scale, allowing them to navigate fluctuations in demand and price more effectively. This strategic shift underscores the recognition that large, rigid investments can amplify vulnerability during periods of economic turbulence. Additionally, the findings reveal that ownership structure significantly influences firms' approaches to risk management. State-owned enterprises tend to pursue cautious, long-term risk strategies, leveraging policy support and institutional stability, while privately held firms demonstrate greater tolerance for risk and adopt innovative, adaptive mechanisms. Collectively, these results highlight the complex interplay between external economic pressures and internal organisational characteristics in shaping investment and risk management behaviour within the Asian oil and gas sector, providing actionable insights for stakeholders aiming to strengthen corporate resilience under ongoing economic uncertainty.

Limitations and Future Directions

Despite the comprehensive scope of this study, several limitations persist that merit further exploration. In particular, the analysis does not include data from Central Asian resource-rich nations, a region whose distinct geopolitical and economic characteristics could yield valuable insights into the relationship between economic instability and investment behaviour in the oil and gas sector. The omission of these countries constitutes a notable data gap, restricting the generalisability of the findings across all major hydrocarbon-producing regions. Furthermore, as the global energy landscape increasingly pivots toward carbon neutrality, uncertainty surrounding investments in renewable energy emerges as a critical avenue for future inquiry. Investigating how oil and gas companies navigate the transition to low-carbon technologies, manage associated risks, and recalibrate strategic priorities in response to evolving policies and market conditions will enhance understanding of corporate adaptation in a sustainability-driven era. Addressing these limitations will not only strengthen the theoretical underpinnings of the study but also provide practical guidance for industry stakeholders operating within a rapidly transforming energy environment.

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