Structural Contingency of ESG Value: Comparing Green Transformation and Market Response in China's Petrochemical Giants

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Abstract. With the worldwide energy transition and China's dual carbon approach, ESG plays a critical role in determining long-term competitiveness and market value of traditional firms. In comparison with PetroChina and Sinopec, this paper has observed that ESG-driven change can help build strategic legitimacy, facilitate organisational progress, and enhance the basis of firm value reassessment for China's high-carbon industry. However, the contribution of ESG in creating value is not necessarily constant, but still structurally independent. Factors such as high transition costs, uncertain short-term returns, divergent business models, and low market recognition severely reduce its impact. Comparing other firms, this paper demonstrates that PetroChina and Sinopec adopt different transformations due to upstream and downstream positions, financial backgrounds, and priorities. This paper proposes 3 suggestions in order to increase the efficiency and measurability of green investment, design transformation plans tailored for industrial structure, and improve ESG disclosure and investor communication quality. This paper introduces this work by hypothesising the structural aspect of ESG valuation and providing practical advice for setting context-sensitive transition strategies in carbon-intensive industries.

Keywords: ESG, Green Transformation, Structural Contingency, Chinese National Oil Companies, Firm Valuation

1 Introduction

1.1 Research Background

The ascendancy of Environmental, Social, and Governance (ESG) principles from peripheral reporting metrics to central strategic imperatives is reshaping global capital markets. This shift imposes particularly acute pressures and opportunities on high-carbon industries, such as oil and gas, where the tension between legacy business models and the imperative for green transformation is most pronounced. Recent review studies show that ESG disclosure research has grown rapidly and is closely related to firm performance, market returns, environmental performance, disclosure

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regulations, and governance policies [1]. Concurrently, evidence from Chinese listed companies confirms that ESG performance is linked to market value, reflecting investors' growing reliance on these factors alongside traditional financial metrics [2]. In that sense, ESG has transcended its role as a symbolic disclosure tool, evolving into a strategic communication model that signals a firm's adaptability and long-term viability.

This effect is especially evident in high-carbon industries such as oil and gas. Unlike firms in other industries, oil and gas giants face a fundamental valuation dilemma: they must finance a costly green transition while maintaining the profitability of carbon-intensive legacy assets. Investors, in turn, are forced to reassess corporate value not just on historical financials, but increasingly on the credibility and trajectory of their decarbonisation strategies. In this context, ESG performance becomes a critical signal, potentially redefining corporate reputation, cost of capital, and long-term investor confidence.

In China, this issue is particularly relevant because the energy sector is related to national energy security, industrial policy, and the dual-carbon strategy. PetroChina and Sinopec are two of the most representative listed state-owned firms in China's petroleum and petrochemical industries. Their transformations take commercial and policy interests into account. A focused comparison of PetroChina and Sinopec is therefore analytically powerful. As sectoral peers under identical macro and policy pressures, their divergent starting points (upstream vs downstream) create a natural experiment to isolate how industrial structure moderates the ESG-value relationship. Examining their parallel yet distinct journeys elucidates the contingent mechanisms through which ESG-driven transformation translates—or fails to translate—into capital market reassessment.

1.2 Literature Review

Existing work points to several links. Firstly, ESG disclosure of Chinese firms is positive and stable at the long-term level [3]. Research in Chinese energy also contributes to a positive but heterogeneous ESG-valuation relationship under the "dual-carbon" policy, with the effect dominated by firm ownership and pollution [3,4]. The heterogeneity underscores that the transport from ESG performance to market recognition is not automatic and passes through sector, policy and firm-specific channels.

Second, transition finance and green technology innovation are key enablers of sustainability in China, especially for carbon-hungry firms such as oil and gas firms that need immense capital to further decarbonise and diversify [5].

Third, research with oil and gases indicates that sustainability and firm value are harder and conditional relationships between investors, as investors evaluate ESG to profitability tradeoffs, legacy assets and transition credibility, with value reassessed based on the firm's business model and financial health [6]. A persistent issue is the lack of standardisation and low comparability of ESG measures and reporting [7]. Systematic reviews suggest that this uncertainty complicates cross-firm and cross-

sector studies and inevitably adversely impacts academic research and market performances [7].

1.3 Research Gap

Despite these insights, some important gaps still exist between industry context, corporate policy, and valuation. First, there are a few comparatives, detailed cases that go beyond statistical correlations to explain how ESG-driven transformation occurs in particular operational and strategic realities of major high-carbon firms under intense policy pressure.

In particular, there is no comparative analysis of how industrial structure determines the specific transformation pathways, ESG integration and thus capital market responses of PetroChina and Sinopec. Prior studies concluded that ESG disclosure can spur green innovation and improve sustainability performance, but the degree of effect of ESG changes on the firm value is highly influenced by industrial context, policy environment, and investor outlook. Therefore, a case-based comparison is necessary to go beyond general theory and explain how the ESG actually impacts transition costs, profits and investor expectations in China's oil and gas industry.

Consequently, this paper aims to address the following key research question: How do existing industrial structures and strategic pathways affect the process and capital market results of ESBG-driven green transformation in China's state-owned oil companies? Through a structured comparison of PetroChina and Sinopec, this paper aims to bridge the gap between abstract ESG value theories and grounded realities of transition in an underlying but challenging industry.

1.4 Research Framework

To answer this question, first, survey related work on ESG, green innovation, transition finance, and firm value [1-7]. Second, present the basic profile, structure, and green transition practices of PetroChina and Sinopec on official company documents [8]. Third, review positive and negative impacts of ESG transformation, such as legitimacy, value re-examination and transition costs. Finally, this paper compares the two firms and suggests why the same pressure may help in different strategies and valuations. These recommendations for transformation performance and long-term value gain can be suggested.

2 A Comparative Profile: Business Structure and ESG Strategy of PetroChina and Sinopec

2.1 Contrasting Business Structures and Strategic Anchors

PetroChina and Sinopec stand as the two dominant, listed state-owned pillars of China's energy and petrochemical sector. PetroChina's 2024 annual report shows that its business remains strongly connected to upstream exploration and production,

natural gas, and related value-chain activities, while Sinopec's 2024 annual disclosures emphasise its position as a major integrated refining and petrochemical enterprise with strong downstream and marketing capabilities [8,9]. This difference in industrial structure is important because it shapes each firm's profitability patterns, cash flow base, asset structure, and strategic space for green transformation.

2.2 Convergence and Divergence in ESG Disclosure Frameworks

New ESG and sustainability reports also show that both companies are increasingly adding ESG issues to their management, but have different shifts in attitude. PetroChina's 2024 ESG report highlights material ESG issues, such as climate change, environment, governance and social responsibility and includes ESG management as part of their sustainable development [10]. Sinopec's 2024 sustainability report also reports quantified ESG disclosures, particularly focusing on environmental and social metrics, governance, and transition projects, such as clean energy infrastructure [11]. These reports suggest that both firms have increasingly treated ESG as a management and reporting system and not a symbolic story. This convergence in formal ESG management implies that the two firms are more aligned in focus and implementation, both in their business structures and in the practical implementation, as discussed next.

2.3 Divergent Transition Logics: Implications for Green Transformation

At the same time, the two firms are different in practice. PetroChina's upstream orientation and strong resource availability give it more resilience and strong internal support for capital-intensive transition projects [8,9]. Sinopec is more tightly linked to refining, chemicals, and end-market distribution, which has stronger network advantages and more direct connections to downstream margin pressure and demand variation [10,11]. It is, however, not just in the greener and more diversified energy direction, but from different starting points. Therefore, PetroChina and Sinopec are not just two companies in the same industry. They represent two transformation logics in China's traditional high-carbon energy industry. To this end, PetroChina and Sinopec constitute two different kinds of transition in the policy environment. This inter-relationship tells us that their industrial structure is not only a small aspect, but that the key factor is their transformation logic, financial capability, and ultimately the capital marketing assessment of their ESG-based value proposition. What follows will discuss the implications of this basic divergence.

3 Unpacking the ESG-Value Nexus: A Comparative Examination of Impacts and Challenges

3.1 Value-Creating Pathways of ESG Transformation

Empirical Legitimacy for A Low-Carbon Transition Content. One of the advantages of ESG-driven changes is that traditional oil firms are more confident in a climate-driven environment [1]. It has been shown that ESG disclosure is more relevant to regulatory, governance, and market review [1,9]. For carbon-intensive firms, credible sustainability management makes them long-term players rather than short-term ones. For PetroChina and Sinopec, green transformation is not only an operational change but also an attempt to gain more confidence. PetroChina's detailed climate governance frameworks and Sinopec's stakeholder-based sustainability reporting, which are intended to align with national "dual-carbon" goals and international sustainability standards, therefore enhancing their social and political freedom to operate [9,11]. The ESG reporting and climate-related disclosure by both firms also align with the national transition goals, which is crucial for state-owned firms such as PetroChina as well as Sinopec, whose long-term sustainability depends not only on profitability, but moreover on maintaining policy consistency, social acceptance, and institutional trust, all of which are further enhanced by strong ESG legitimacy.

Expanding the Basis for Corporate Value Reassessment. Another advantage is that ESG-driven change may raise the scale at which investors evaluate firm value. Studies on Chinese listed companies show that the ESG scores still remain positive for the market even when the effect changes in time [2]. It also emerges that in China's energy sector, ESG is better than market value when a dual-carbon policy is in place, and green innovation and transition finance guide how this value impact can occur [3-5]. Together, they have shown that firms can be assessed not only by the traditional financial indicators but also by the attractiveness of firms in a low-carbon economy. At PetroChina or Sinopec, ESGs could broaden the valuation structure for investors by incorporating forward-looking transition capacity in the evaluation. PetroChina announced environmental governance and sustainable development as part of the management system and planning [8,9]. Sinopec disclosed the sustainability governance and transition-related changes of its corporate development model [10,11], and if green projects do not offer strong returns, they can influence investors by signalling transition sourcing.

Promoting Organizational Upgrading and Green Capability Building. A third positive impact is that ESG can foster organisational rewiring. Studies on Chinese firms show that ESG disclosure and assessment can promote green innovation and long-term capability renewal, although the payoff of the rewilling does not vary as much across industries [3]. Transition finance studies also reveal that sustainable

investment and green technology can make long-lived corporate sustainability more sustainable [5]. This suggests that firms can use ESG to build new capabilities instead of submitting external disclosure requests. For PetroChina and Sinopec, energy transition requires more than emission reductions. It needs technology, resource allocation, governance, project evaluation, stakeholder communication, etc. For this purpose, ESG may help PetroChina to optimise carbon management and energy diversification and Sinopec to further enhance integrated energy-service capability and transition-driven management [9,11]. For PetroChina, this rewiring means carbon measures in upstream asset assessment and building competencies in the new energy sector. Sinopec aims to digitise the supply chain more efficiently to build business models around integrated energy stations. In this way, ESGs can initiate different structure-specific capability upgrades. As a result, ESGA may lead to improved organisational rewires.

3.2 The Structural and Market Constraints

High Transition Costs and Uncertain Short-Financial Returns. Despite these positive effects, the first major problem is the high cost of transition and the uncertainty of short-term returns. The literature shows that transition finance and green technology are important for sustainability, but it also makes clear that decarbonisation-oriented change requires significant capital commitment and long-term resource allocation [5]. In the oil and gas sector, this creates a structural tension: firms must invest in transformation while their legacy businesses still provide the main source of earnings and cash flow [6]. This problem is especially relevant to Petro-China and Sinopec, as both operate in capital-intensive segments of the energy industry. Although official reports present their ESG and transition agendas positively, green investment in practice often has a long payback period and uncertain profitability [8-11]. As a result, ESG-driven transition may be strategically necessary but financially burdensome, particularly when investors continue to focus heavily on short-term profit and cash generation. Consequently, the "value" in ESG-driven value reassessment is deferred, creating a temporal mismatch between high upfront costs (which depress short-term valuation metrics) and the long-term, often intangible benefits of transition.

Uneven Transformation Capacity Caused by Structural Business Differences. A second, fundamental constraint is the highly uneven capacity for transformation, which is structurally determined. PetroChina and Sinopec do not face ESG pressure from the same structural position. PetroChina's disclosures point to a business base more strongly linked to upstream and natural-gas-related activities, while Sinopec's profile remains more concentrated in refining, chemicals, and downstream market networks [8,10]. These structural differences matter because they shape capital allocation ability, exposure to margin volatility, and the speed at which firms can scale new transition projects. This means that ESG pressure does not produce uniform outcomes. PetroChina can more easily frame green transformation as an expansion

supported by a stronger resource and profitability base, while Sinopec may need to transform under tighter downstream operating pressure [8,10]. Sector-specific research also suggests that sustainability-value relationships in the oil and gas industry are conditioned by industry characteristics rather than being automatically positive [6]. Therefore, the effectiveness of ESG-driven transformation depends not only on ambition or disclosure quality but also on industrial structure and financial capacity.

Limited Immediate Capital Market Reward for ESG Efforts. The third major problem is that capital markets may not immediately reward ESG efforts, especially in high-carbon sectors. Research on Chinese listed companies suggests that ESG can have a lasting influence on market value, but this influence is often gradual rather than immediate [12]. Evidence from China's energy sector also shows that the valuation effect of ESG is shaped by policy and firm characteristics rather than appearing uniformly across all firms [4]. Moreover, sector-level research indicates that ESG risks affect market valuations through different risk channels, while oil and gas studies further suggest that sustainability does not automatically translate into a straightforward valuation premium [6,13]. This problem is particularly visible in sectors where transition outcomes are uncertain. Investors may question whether green investment will generate scalable returns, whether transition commitments are credible, and whether firms can balance decarbonisation with profitability. Even if PetroChina and Sinopec improve ESG governance and disclosure, the market may still discount those efforts if their transition economics remain unclear [8-11]. Recent oil-and-gas evidence also shows that stronger ESG profiles can reduce systemic risk, but that the relationship is nonlinear rather than automatically value-enhancing across contexts [12]. Therefore, ESG may support long-term reassessment without guaranteeing short-term market reward. This delayed, and conditional market reward underscores that investor confidence is earned not by ESG scores alone, but by the credible convergence of ESG strategy with a viable business model for transition. This convergence is inherently more challenging for firms like Sinopec, whose core downstream business faces immediate transition headwinds.

3.3 Synthesising the Comparison: Paths Diverge

To clarify the differences between PetroChina and Sinopec, Table 1 summarises their business structures, green transition pathways, ESG strengths, and market implications.

Table 1. Comparison of green transition and market response between PetroChina and Sinopec

Dimension	PetroChina	Sinopec
Business structure	Stronger upstream oil and gas exploration and production	Stronger downstream refining, chemicals, and fuel sales
Financial support	Relatively stronger profitability	Greater pressure from

for transition	and more stable earnings	weaker downstream profitability
Main green transition pathway	CCUS, wind, solar, hydrogen, and broader new energy investment	Hydrogen energy, charging infrastructure, biofuels, and low-carbon refining
ESG-related strength	Stronger carbon management and transition investment capacity	Stronger visibility in social responsibility and governance practices
Capital market implication	More stable support for ESG-driven value revaluation	Greater short-term uncertainty in the market response to transition efforts

According to Table 1, the difference between PetroChina and Sinopec should not be a one-sided argument. Firstly, the two firms do not agree on the transformation. PetroChina's internal company disclosures are more upstream and natural-gas oriented, and Sinopec's integrated refining and downstream orientation heavily focuses on processing and market-end operations [8,10]. These differences affect the speed, the flexibility, and the credibility of long-term green growth. Secondly, the two companies do not differ on transformation; PetroChina's ESG reporting is more focused on climate change, environmental governance, and material ESG management within a sustainable development framework [9]. Sinopec's sustainability report emphasises ESG governance and environmental performance, but its transition is more closely connected to integrated energy services, cleaner-energy infrastructure, and stakeholder-facing sustainability [11]. This indicates that the two companies are not doing more or less ESG. They have simply pursued different transitions according to their industrial endowments. Thirdly, the likely market attitude of the two businesses may differ. As sector work demonstrates that ESG in oil and gas correlates to legitimacy, risk and value in a conditional way [6,12,13], investors may evaluate PetroChina when ESG is supported by stronger operating resilience. In contrast, Sinopec's transition may be judged more cautiously if downstream pressure weakens confidence in short-term performance. Therefore, ESG-driven value reassessment in this sector is not determined solely by disclosure. It depends on how the ESG strategy, industrial structure, profitability, and transition credibility fit together.

4 Strategic Recommendations for ESG-Driven Transformation

4.1 Enhancing Financial Rigour and Accountability in Green Investment

To address the problem of high transition costs and uncertain short-term financial returns, both PetroChina and Sinopec should improve economic efficiency and the measurability of green investment. As discussed above, green transformation in the oil and gas industry requires substantial capital input, while many projects have long payback periods and uncertain short-term profitability [5,6]. Therefore, moving

beyond broad strategic commitments, a clear investment logic that tightly couples ESG objectives with financial discipline and operational feasibility is essential.

First, both firms should establish more refined screening and evaluation mechanisms for green projects. Instead of treating all transition projects as equally necessary, they should distinguish between projects with high strategic symbolism and projects with stronger commercial scalability. Priority should be given to investments that can create synergies with existing business advantages, generate relatively stable cash flow, or improve energy efficiency in measurable ways. For example, projects that reduce production emissions, improve energy use, or strengthen transition-related infrastructure within the existing industrial chain may create more immediate and traceable value than highly experimental projects.

Second, this study needs a rigorous staged investment and post-investment assessment. Green investments should be understood as an early strategic declaration, not a long-term portfolio of projects with different risk-returns. Firms should also monitor project performance dynamically and determine whether investment outcomes match expected environmental and financial objectives. This would lead to less wasteful capital and the credibility of ESG investment decisions [5].

Third, firms should also quantify transition outcomes in their ESG disclosures. If green investments are not explicit, investors may not have an answer to whether or not they are actually seeing their value. More specific reporting of carbon-reduction efficiency, project progress, cost-recovery logic, and long-term profitability trends could help the market understand transition economics; in that way, firms can avoid getting confused with financial uncertainty [7,9,11].

4.2 Formulating Structure-Specific Transition Pathways

To address the problem of uneven transformation capacity driven by structural business differences, PetroChina and Sinopec should adopt more differentiated transition strategies rather than follow a homogeneous ESG model. The earlier analysis shows that the two firms do not face the same transformation from the same industrial starting point. PetroChina has a stronger upstream and resource-based foundation, while Sinopec has a more downstream-oriented structure with stronger market-end and refining characteristics [8,10]. Therefore, effective green transformation requires strategic alignment with each firm's existing industrial logic.

PetroChina should leverage its stronger profitability and resource base to drive capital-intensive, scalable transitions into low-carbon energy sectors. Because the company has relatively stronger financial resilience and a broader upstream foundation, it is better positioned to invest in renewable energy integration, carbon management, and cleaner energy substitution within a relatively stable strategic framework [8,9]. Its transition strategy should therefore emphasise long-cycle projects with stronger asset support, such as cleaner production systems, low-carbon upstream upgrading, and expansion into renewable and gas-related energy segments that fit its existing capabilities.

For Sinopec, the most efficient strategy will not be to copy PetroChina's transition path, but to build on its downstream network and service capabilities. As Sinopec

already enjoys higher end-market access, better links, and infrastructure benefits, its transition path should emphasise transitions such as integrated energy services, hydrogen applications, cleaner transportation energy, and low-carbon service networks [10,11]. As such, Sinopec should not assume a global transition path that is based on market connectivity and infrastructure cooperation only, but on upstream-style growth.

At a broader level, this means the two firms should not be evaluated based on the same uniform ESG strategy. Different industrial structures will lead naturally to different transition speeds, risk profiles, and performance indicators [6]. A differentiated strategy is not an indication of inconsistency but a condition for realistic and effective transformation. Only if ESG action is well aligned with the industrial structure, then the green transition becomes operationally suitable and tractable.

4.3 Bridging the ESG Communication Gap to Secure Market Valuation

In order to address this problem of limited immediate capital market reward for ESG, PetroChina and Sinopec should be more transparent about ESG information and communication with investors. It has been shown that ESG can impact firm value and market perception, but the influence is slow and context-dependent rather than immediate [2,4]. Thus, in high-carbon and energy industries, investors are more cautious about transition credibility, profitability tradeoffs, and sector-specific risk to make sure that firms do more than undertake green programmers, that they communicate such an energy-based, measurable, and value-related approach [6,12,13]. As a result, communication between firms should include more decision-useful information such as transition time, project status, carbon management outcomes, management mechanisms, and strategic relationship between ESG programs and long-term strategy [9,11]. Clear disclosure of ESGs can reduce information asymmetry and inform investors about how ESG performance impacts enterprise resilience and future value. Two-way dialogue should be closer to investors about what an energy-related green transformation could be. In most cases, investors do not accept ESG itself and do not understand whether green practices could provide a sustainable return or strengthen competitiveness. Both firms should then explain not only what they are doing, but why specific transition projects are important for future growth, risk control and strategic positioning (e.g., for oil and gas markets, which are still paying close attention to cash flow, profitability, and asset quality [6,12,13].

Finally, both firms should gradually build a more integrated picture of ESG performance, transition capability, and future value creation. ESG communication should not be exclusive to sustainability reports, nor should it be incorporated in annual reports, investor relations materials, and long-term strategies. Once the market has better intuited how the ESG actions can be translated into future economic value, it is likely that a meaningful value reassessment will be more likely. In particular, a high-carrier and energy-oriented industry is in the oil and Gas industry, where investors are still paying attention to cash flow, profitability and asset risk. This is especially for the oil or energy sectors. Both companies should gradually develop a more coherent story around ESG performances, transition ability and corporate value creation. ESG communication should not be included in sustainability reports.

5 Conclusion

This study examined how pre-existing industrial structures shape the process and capital market outcomes of ESG-driven green transformation in China's state-owned oil giants, PetroChina and Sinopec. This analysis shows that ESG has turned from a reporting issue into a strategic problem, is able to enhance strategic meaning, drive organisational improvement, and increase the basis for firm value reassessment in decarbonisation, as it is more valid for reassessing firm value in a large industrial environment in a decarbonisation environment in the presence of sustainability. On the other hand, ESG transformation is not always positive or negative. PetroChina and Sinopec suffer from the same external effects, but their transition results differ from their industrial status, financial backgrounds and strategic interests. PetroChina has a larger upstream base and stronger financial stability, while Sinopec has tighter operating constraints and a transition logic according to infrastructure and market end energy. It appears that ESG-based value re-training depends not only on how firms move to green transformation, but also whether their transition strategy is credible, economical, and consistent with their industrial interests. The analysis also shows three main problems: high transition costs with uncertain short-term returns, uneven transformation capacity due to structural differences between businesses, and low immediate capital market rewards for ESG efforts. This study suggests three complementary strategies: how ESG can effectively optimise green investment efficiency, distinguish transition strategies by industrial structure, and improve ESG disclosure quality and investor communication, which can narrow the gap between strategic transformation and market recognition, and enable long-term performance of ESG-related value creation. Overall, PetroChina's case suggests that ESGs can be useful in value reassurance for traditional energy firms in some cases. This can be viewed as part of a larger transformation process where management, industrial structure and transition credibility interact with one another. Thus, this study provides a clear picture of two large Chinese oil companies and how ESG might shift the development logic of state-owned firms in carbon-intensive industries.

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