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The Impact of Political Connections on the Relationship Between Sustainable Development Reporting and Cost of Capital in Petrochemical Companies Listed on the Tehran Stock Exchange

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Abstract

In today's world, environmental and social issues have become central concerns for stakeholders alongside economic considerations. The primary aim of this study is to examine the impact of Sustainability Reporting (SR) on the Cost of Capital (COC) and to investigate the moderating role of Political Connections (PC) in this relationship within petrochemical companies listed on the Tehran Stock Exchange (TSE). From a purpose perspective, the study is developmental, and in terms of nature, it is descriptive-correlational. The statistical population comprises all petrochemical companies active in Iran's capital market during 2018–2023 (1397–1402 in the Iranian calendar). After applying screening criteria, a final sample of 19 companies (108 firm-year observations) was selected. To test the hypotheses, a moderated multivariate regression model was employed using panel data with a fixed-effects approach. The findings indicate a significant negative relationship between the quality of SR and the COC, suggesting that increased transparency in sustainability disclosures reduces financing costs. Furthermore, the results reveal that PC moderate the strength of this relationship. Specifically, in firms with high levels of political influence and connections, the capital-cost-reducing effect of SR is attenuated, as access to political rents substitutes for the benefits of informational transparency.

Keywords: Sustainability reporting, Political connections, Sustainability disclosure, Panel data approach, Cost of capital, Petrochemical industry.

1 | Introduction

In recent decades, the paradigms governing financial markets and the global business environment have undergone profound transformations. With advancements in technology, market globalization, and heightened public awareness of major human and environmental challenges, an exclusive focus on financial

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performance and short-term profitability is no longer sufficient to meet stakeholders' expectations [1]. Although the rapid industrial development of the twentieth century brought material prosperity, it also inflicted severe and often irreversible damage on the climate and the natural environment. These environmental crises and climate changes have compelled the international community to commit to achieving the seventeen Sustainable Development Goals (SDGs) by 2030. In this context, the concept of "sustainable development", encompassing economic, social, and environmental dimensions, has emerged as a critical strategy for addressing current crises and ensuring the well-being of future generations [2].

The integration of sustainability concepts into the finance and accounting literature has given rise to "Sustainability Reporting (SR)". Unlike traditional financial reporting, which primarily provides information on historical financial performance, SR offers a comprehensive framework for disclosing a firm's economic, social, and environmental performance to diverse stakeholders [3]. This form of reporting assures shareholders and investors that the business has identified non-financial risks and opportunities associated with its operations and has established a structured plan to manage them. In essence, SR serves as a mechanism to enhance corporate accountability, strengthen corporate reputation, motivate the workforce, and create a sustainable competitive advantage.

One of the most significant economic implications of SR for firms is its impact on the "Cost of Capital (COC)". The COC, defined as the minimum expected rate of return demanded by investors, plays a crucial role in financing and investment decisions. Economic theory suggests that SR, by enhancing transparency and reducing information asymmetry between managers and investors, can lower information-related risks and, consequently, reduce the COC [4]. However, the effectiveness of such reporting does not occur in a vacuum; it is contingent upon the institutional and political environment surrounding the firm.

In developing economies, or in economies where the government plays a prominent role, "Political Connections (PC)" are recognized as a key factor influencing corporate behavior [5]. In such contexts, PC represent a valuable resource for firms with established networks. Companies with strong political ties often gain easier access to capital, benefit from government support during crises, and may incur lower financing costs [6]. Managers of these firms consistently strive to establish and maintain governmental relationships to overcome financial constraints at minimal cost.

The petrochemical industry in Iran, as one of the country's most strategic and capital-intensive sectors, exemplifies the intersection of environmental concerns, substantial financing requirements, and high political influence [2]. On one hand, due to its inherently pollutive nature, the industry is subject to stringent oversight by environmental authorities and faces intense public pressure to adhere to sustainability principles. On the other hand, the ownership and management structures of many of Iran's petrochemical giants are intertwined with state and quasi-state institutions, representing a clear manifestation of PC.

The central research question of this study is whether, in such a complex environment, SR can still function as an effective tool for reducing the COC. More importantly, what is the role of strong PC in this relationship? Does access to political rents and government support diminish a firm's need for transparency through SR, thereby neutralizing its effect, or do these two factors jointly influence the COC? Although numerous studies have examined the direct effects of SR or PC, the interactive dynamics between these two variables and the moderating role of PC in shaping the efficacy of SR particularly within Iran's petrochemical industry remain largely unexplored. This study aims to address this gap by investigating whether PC moderate the relationship between SR and the COC in petrochemical firms.

2 | Theoretical Foundations and Literature Review

To gain a comprehensive understanding of the relationships examined in this study, it is first necessary to elaborate on the key concepts, including SR, COC, and PC, as well as the underlying theoretical frameworks that support them.

2.2 | Sustainability Reporting

SR is a process through which companies measure, disclose, and communicate the economic, environmental, and social impacts of their day-to-day operations to relevant stakeholders [3]. These reports reflect the organization's values and governance model, signaling the firm's commitment to a sustainable global economy. The concept of sustainability is rooted in the Brundtland commission's definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [2].

Unlike traditional, single-dimensional financial reporting, SR is grounded in three fundamental pillars, commonly referred to as the "triple bottom line" [3]:

I. Economic dimension: this encompasses the indirect economic impacts of the organization on society, including job creation, infrastructure development, and innovation.

II. Environmental dimension: this focuses on the company's responsibility toward natural capital. Indicators reported in this domain include greenhouse gas emissions, waste management, and energy consumption. Gray et al. [7] argue that organizations should offset the environmental damages they cause as an integral part of their strategic planning [8].

III. Social dimension: this pertains to the company's relationships with employees, customers, local communities, and other human stakeholders. Issues such as human rights, employee health and safety, and labor conditions fall under this category. Misalignment between an organization's value system and societal expectations can lead to a loss of social legitimacy [8].

The necessity and significance of sustainability reporting: traditional accounting systems are inherently limited in their ability to accurately measure and reflect the social and environmental costs and benefits associated with corporate activities. SR, as a complementary mechanism, addresses this deficiency and offers multiple advantages for firms [3]:

I. Enhanced transparency and accountability: sustainability reports reduce information asymmetry and build stakeholder trust.

II. Risk management: early identification of non-financial risks enables firms to prevent potential future crises.

III. Legitimacy and reputation: publishing these reports demonstrates the firm's ethical commitment and improves brand image [8].

IV. Improved access to financial resources: institutional investors and banks increasingly incorporate ESG criteria into their financing decisions [4].

2.3 | Cost of Capital

The COC represents the minimum rate of return a firm must earn to preserve its market value and satisfy its capital providers, including shareholders and lenders. Accurate estimation of the COC is essential for managerial decisions such as capital budgeting, evaluating new projects, and determining an optimal capital structure [9]. Conceptually, it reflects the return required by the market to compensate investors for providing funds to the firm. According to the Capital Asset Pricing Model (CAPM), only systematic risk, measured by beta (β), should affect the expected return [9]. However, extended models indicate that additional factors, such as illiquidity and information asymmetry, also influence the COC. SR, by reducing information asymmetry, and PC, by mitigating bankruptcy risk through government support, can alter these key parameters and, consequently, affect the firm's COC [4], [6].

2.4 | Components of the Cost of Capital

The company's COC is typically calculated as the Weighted Average Cost of Capital (WACC) [9]:

Cost of debt: the interest rate a company pays on its loans and bonds.

Cost of equity: the minimum rate of return that shareholders require in exchange for the risk of investing in the company (typically estimated using the CAPM.

Research indicates that the quality and transparency of reporting are directly related to the COC. Greater information asymmetry prompts investors to demand higher rates of return, which increases the company's COC. SR, by disclosing non-financial information, reduces this uncertainty and can consequently lower the COC [4].

2.5 | Political Connections

In the political economy literature, PC are defined as close, formal or informal relationships between firm managers and owners and government officials, politicians, or governing institutions [5]. This concept assumes particular significance in developing countries, where the state plays a dominant role in the economy. Within this context, two primary perspectives have been proposed.

Efficiency (competitive advantage) perspective: from this perspective, PC are considered a valuable resource that enables firms to overcome market inefficiencies [6]. Politically connected firms may benefit from advantages such as easier access to bank loans at lower interest rates and preferential tax treatments. These benefits can reduce firm-specific risk and, consequently, lower the COC.

Exploitation (agency) perspective: this viewpoint posits that PC can exacerbate agency problems [10]. Managers may prioritize government or political objectives over shareholder wealth maximization [11]. Furthermore, such firms often exhibit lower reporting quality, as they feel less accountable to capital markets. This lack of transparency can increase information-related risk [12].

2.6 | Theoretical Foundations of Sustainability Reporting

Understanding why and how SR affects the COC, as well as the moderating role of PC, requires a review of the fundamental theories that explain firm behavior in this domain. The accounting and finance literature primarily relies on four main theoretical frameworks:

I. Legitimacy theory: legitimacy theory posits that organizations continually seek to ensure that their activities are perceived as aligned with the norms and values of the society in which they operate [8]. According to Suchman [13], legitimacy is a general perception that the actions of an entity are desirable, appropriate, and consistent with the socially constructed system of norms, values, and beliefs [10].

   This theory assumes the existence of an implicit "social contract" between the organization and society. If the organization violates this contract for example, by causing environmental harm its legitimacy is threatened, potentially endangering its survival [10]. Consequently, firms strategically employ SR as a tool to manage and maintain legitimacy. Disclosing environmental and social information enables the organization to demonstrate to society that it acknowledges stakeholders' c oncerns and acts in the public interest. The economic success of a firm is thus largely contingent upon managers' ability to respond to these challenges and safeguard organizational legitimacy [8].

II. Agency theory: agency theory, developed by Jensen and Meckling [14], focuses on the conflicts of interest between owners (shareholders) and managers (agents) [15]. Managers may pursue personal objectives rather than maximizing shareholder wealth, creating agency costs.

   Some scholars argue that engagement in social responsibilities can reflect agency problems; for instance, if managers divert corporate resources toward personal social or charitable initiatives, agency costs may increase [15]. Conversely, SR can mitigate these issues by enhancing transparency and reducing information asymmetry, thereby facilitating monitoring of managerial performance and lowering agency costs [16]. When financial and non-financial information is disclosed transparently, shareholder uncertainty regarding managerial behavior decreases, ultimately reducing both risk and the firm's COC [4].

III. Signaling theory: in situations of information asymmetry, where managers possess superior knowledge compared to investors, signaling theory becomes relevant. This theory posits that managers of high-performing

firms are incentivized to communicate positive information to the market (i.e., signal) in order to differentiate themselves from lower-performing firms [4].

SR serves as a powerful signaling mechanism. Firms with strong environmental and social performance voluntarily disclose this information to demonstrate to the market that they face lower future risks and possess effective management capabilities [4]. Such signaling assists investors in identifying "high-quality" firms, which in turn increases demand for their shares and reduces their COC [16].

IV. Stakeholder theory: developed by Freeman [17], stakeholder theory challenges the traditional "shareholder wealth maximization" perspective, asserting that organizations bear responsibilities toward a broad array of stakeholders, including employees, customers, governments, suppliers, local communities, and the natural environment . The long-term success and sustainability of a firm depend on its ability to effectively manage relationships with all these groups.

SR serves as a mechanism to meet the informational expectations of diverse stakeholders. By addressing stakeholders' information needs, firms can secure their support and mitigate risks arising from social or regulatory opposition . This reduction in perceived risk directly influences investors' risk assessments and, consequently, moderates the firm's COC.

V. Political economy theory and PC: political economy theory emphasizes the reciprocal influence between politics and economics [5]. Within this framework, PC are considered a strategic resource for firms. Fisman [19] argues that in developing countries, political ties can be more determinative of firm profitability than economic fundamentals [20]. Politically connected firms leverage mechanisms such as preferential loans, tax exemptions, and market monopolies to gain competitive advantages [6].

However, politically affiliated firms may also encounter challenges, including the appointment of inefficient managers and lower-quality financial reporting, a phenomenon often described as the "predatory view" or inefficiency perspective [12].

3 | Research Background

A review of the existing literature indicates that numerous studies have been conducted separately on SR, COC, and PC; however, the interaction among these three variables has received comparatively limited attention [21].

Political connections and cost of capital: research in this area has produced mixed findings. Some scholars, such as Boubakri et al. [5], report that politically connected firms benefit from implicit government guarantees, resulting in lower debt costs and overall COC [6]. Conversely, studies like Shleifer and Vishny [22] argue that PC may increase the COC due to poor accounting quality and a higher risk of expropriation of minority shareholders' interests [11]. In the context of Iran, Rezaei and Saadati [3] demonstrated that political influence can significantly affect both firm performance and risk.

Sustainability reporting and cost of capital: there is a broad consensus in the finance literature that high-quality SR reduces a firm's COC [4]. Studies conducted in Iran by Pourgholami Dafchahi et al. [23] and Ashrafi [24] demonstrated that disclosing sustainability-related information decreases information asymmetry and enhances investor confidence, thereby lowering the cost of equity. Internationally, Dhaliwal et al. [6] found that firms issuing a Corporate Social Responsibility (CSR) report for the first time experience a significant reduction in their COC [25]. This effect is attributed to decreased information risk and a reduction in the firm's inherent risk.

Interaction between sustainability reporting and political connections: this section represents the central focus of the present study. Existing research indicates that PC can alter the incentives for sustainability disclosure:

I. Substitution hypothesis: Motakin et al. [26] demonstrate that politically connected firms exhibit lower incentives to engage in SR. Such firms derive legitimacy through their governmental ties and, therefore, do not need to secure legitimacy via market transparency. In this context, political rent effectively substitutes for transparency.

II. Complementarity hypothesis: conversely, Du et al. [27] argue that politically connected firms may engage in greater SR to preserve their reputation and mitigate public scrutiny.

III. Impact on COC: Haugen and Senbet [28] show that PC can reduce transparency and increase informational ambiguity. As a result, the sustainability disclosures of these firms may be perceived by the market as "greenwashing," thereby failing to lower their COC.

Research gap: a review of the literature indicates that, although the relationships between SR and COC and between PC and COC have been examined separately, the moderating role of PC on the former relationship particularly in the context of Iran's petrochemical industry remains largely unexplored [21]. This study seeks to address this theoretical and empirical gap by investigating the interaction effect between these two variables.

4 | Research Methodology

The research methodology serves as a blueprint guiding the systematic pursuit of scientific answers to the study's research questions. Given the nature of the topic which examines the interplay between accounting and political variables the careful selection of sampling techniques, variable measurement, and econometric modeling is of critical importance. From a philosophical standpoint, this study is grounded in a positivist paradigm. In terms of reasoning, a deductive approach is adopted, whereby theoretical foundations and hypotheses are first formulated and subsequently tested using empirical evidence. Regarding its purpose, the study is classified as developmental research, and in terms of nature and execution, it is descriptive-correlational, relying on historical (ex-post facto) data.

Population and sample: the statistical population of this study comprises all companies operating in the petrochemical industry listed on the Tehran Stock Exchange (TSE) and Iran Fara Bourse (IFB) [2]. The petrochemical sector was selected due to its strategic importance, capital-intensive nature, and high environmental sensitivity. For sample selection, a systematic elimination (screening) method was employed. After applying standard filters including fiscal years ending in Esfand, continuity of business activity, and data availability 19 companies were identified as the final sample. The study covers a six-year period from the beginning of 2018 (1397 in the Iranian calendar) to the end of 2023 (1402). Considering the panel data structure and the six-year period, the total number of observations (company-year) available for analysis amounted to 108.

Conceptual and statistical model of the study: to test the research hypotheses, a multivariate regression model using panel data is employed. The primary model, which examines the moderating role of PC, is specified as follows:

$$\mathrm{COC}_{i,t} = \beta_0 + \beta_1 \mathrm{SR}_{i,t} + \beta_2 \mathrm{PC}_{i,t} + \beta_3 (\mathrm{SR}_{i,t} \times \mathrm{PC}_{i,t}) + \sum_{j=4}^{n} \beta_j \mathrm{Control}_{i,t} + \varepsilon_{i,t} \quad (1)$$

In this equation:

$\mathrm{COC}_{i,t}$: the COC (dependent variable) for firm i in year t.

$\mathrm{SR}_{i,t}$: SR (independent variable) for firm i in year t.

$\mathrm{PC}_{i,t}$: PC (moderating variable) for firm i in year t.

$\mathrm{SR}_{i,t} \times \mathrm{PC}_{i,t}$: interaction effect between SR and PC.

$\mathrm{Control}_{i,t}$: control variables.

$\varepsilon_{i,t}$: model error term.

The study variables and their operational definitions are introduced below, based on their role in the regression model.

I. Dependent variable: COC

The COC represents the minimum expected rate of return demanded by investors [9]. In this study, the WACC is employed, which combines the cost of debt and the cost of equity to provide a comprehensive measure of the firm's overall financing cost.

$$\mathrm{WACC} = \left(\frac{\mathrm{E}}{\mathrm{V}} \times \mathrm{Re}\right) + \left(\frac{\mathrm{D}}{\mathrm{V}} \times \mathrm{Rd} \times (1 - \mathrm{T})\right) \quad (2)$$

The cost of equity (Re) is estimated using the CAPM [9].

II. Independent variable: SR

This variable measures the transparency of the company in disclosing non-financial information [3]. To assess it, a content analysis method and a disclosure index have been used [29]. A checklist consisting of 50 items based on the Global Reporting Initiative (GRI) standards was designed for measurement. Each item is scored as 1 if disclosed and 0 if not disclosed. The final score $SR_{i,t}$is the sum of these scores (ranging from 0 to 50).

III. Moderator variable: PC

In this study, PC are measured based on state and governmental ownership [5]. This criterion serves as an accurate indicator of political influence in the Iranian economic context [30]. It represents the total percentage of a company's shares that are directly or indirectly owned by the government, state-owned companies, or public non-governmental institutions (such as foundations, support organizations, and pension funds). This variable is a continuous value (the ratio of political shares to total shares) [30].

IV. Control variables

To control for the effects of other factors on the COC, the following variables were included in the model [22]:

Firm size (SIZE): the natural logarithm of the company's total sales.

Financial Leverage (LEV): the ratio of total debt to equity.

Return on Assets (ROA): the ratio of earnings before tax to total assets.

Corporate Governance (CG): a score based on the TSE CG checklist (including board independence, audit committee, etc.).

Market Share (MSHARE): the ratio of the company's sales to the total sales of the petrochemical industry in the sample.

Liquidity (LIQ): the current ratio (current assets divided by current liabilities).

Data collection method: the data for this research were collected through a library-based approach, involving the review of financial documents and records.

I. Financial data (for COC and control variables): extracted from the comprehensive information system of issuers (Codal) and Rahavard Novin software.

II. SR and PC data: collected through a detailed study and content analysis of the board of directors' activity reports, corporate sustainability reports, and major shareholder statements [29], [30].

Statistical analysis methods: data analysis is conducted using EViews software at two levels:

I. Descriptive statistics: this includes the calculation of mean, standard deviation, maximum, and minimum values.

II. Inferential statistics (panel data regression): this involves the use of panel data regression models to test the hypotheses and examine the relationships between the variables of interest.

- *Unit root test: the LLC and IPS tests are used to examine the stationarity of the data.*
- *Chow test (F test): used to select between pooled data model and panel data model.*
- *Hausman test: used to choose between the "fixed effects" model and the "random effects" model.*
- *Diagnostic tests: the Breusch-Pagan/Wald test for heteroscedasticity and the Wooldridge test for serial correlation are applied to assess the validity of the model.*

5|Data Analysis and Research Findings

In this chapter, the collected data from 19 petrochemical companies over the period from 2018 to 2023 will be analyzed. First, descriptive statistics will be used to outline the general characteristics of the data. Subsequently, the necessary econometric tests will be conducted to select the appropriate model for estimation. Finally, the results of the multivariate regression will be presented and interpreted to test the research hypotheses.

5.1|Descriptive Statistics of the Variables

Table 1 presents the summary statistics for the dependent, independent, and control variables in the study. The statistics include the number of observations (N=108), mean, median, standard deviation, minimum, and maximum values for each variable.

Table 1. Descriptive statistics of the study variables.

Maximum	Minimum	Standard Deviation	Median	Average	Number of Observations (N)	Symbol	Variable
0.501	0.110	0.088	0.270	0.285	108	COC	Cost of capital
48.00	18.00	7.55	37.00	35.12	108	SR	Sustainability reporting
0.850	0.180	0.152	0.410	0.457	108	PC	Political communication
33.10	24.50	2.51	30.15	29.87	108	SIZE	Firm size
0.312	0.051	0.062	0.140	0.155	108	ROA	ROA
1.300	0.350	0.210	0.690	0.720	108	LEV	Financial leverage
0.850	0.450	0.080	0.670	0.650	108	CG	Corporate governance
0.150	0.005	0.030	0.035	0.045	108	MSHARE	Market share
3.10	1.05	0.55	1.70	1.88	108	LIQ	Liquidity

5.2|Descriptive Statistical Analysis

The average COC in the petrochemical industry is approximately 28.5%. The mean sustainability disclosure score is 35.12 out of 50, indicating that the level of SR in these companies is moderate. Moreover, the average state and governmental ownership stands at 45.7%, underscoring the research hypothesis regarding the significant influence of state and quasi-state institutions on the ownership structure of petrochemical firms.

5.3|Preliminary Tests For Panel Regression

Unit root tests: the results of the unit root tests (e.g., LLC and IPS tests) indicate that all variables are non-stationary at the level but become stationary at the first difference. This condition is acceptable for panel data and allows for the application of this method in estimation.

I. F-limer test (chow test): this test is conducted to determine whether a pooled OLS model or a panel data model is more appropriate.

   Result: the computed F-statistic exceeds the critical value (and the p-value is less than 0.05). Therefore, the panel data model is preferred over the pooled OLS model.

II. Hausman test: this test is used to determine whether a fixed effects model or a random effects model is more appropriate.

Result: the calculated Chi-square statistic is significant (p-value < 0.05). Therefore, the fixed effects model is preferred over the random effects model. The final model estimation will be performed using the fixed effects approach.

III. Tests for classical assumptions: the heteroscedasticity (wald) and serial correlation (wooldridge) tests indicated that the classical assumptions of the model were violated. Therefore, to correct the errors and obtain more efficient and consistent estimates, either the Weighted Least Squares (WLS) method or estimation techniques with a robust covariance matrix were employed to ensure reliable results.

The results of the fixed-effects regression model, which examine the impact of independent and moderating variables on the COC, are presented in *Table 2*.

Table 2. Fixed-effects regression model estimation results.

Significance Level (P-Value)	T-Statistic	(Std. Error)	Coefficient	Variable
0.0000	5.294011	0.085022	0.450112	Intercept (C)
0.0021	-3.180002	0.001101	-0.003501	SR
0.0140	-2.500110	0.000801	-0.002003	PC
0.0092	2.660301	0.000015	0.000040	Interaction effect (SR × PC)
0.0035	-3.000140	00.007011	-0.021033	Firm size (SIZE)
0.0051	-2.868112	0.040110	-0.011504	ROA
0.0063	2.00001	0.015002	0.042001	LEV
0.0289	-2.221500	0.001805	-0.004010	CG
0.0485	-2.000440	0.045001	-0.090022	Market share (MSHARE)
0.1360	-1.500850	0.010001	-0.015010	Liquidity (LIQ)

Model fit indicators: adjusted R^2= 0.685; F-statistic = 25.01; P-value (F-statistic) = 0.0000.

5.4 | Interpretation of Estimation Results and Hypothesis Testing

I. Model fit: the significant F-statistic (P-value= 0.0000) indicates that the regression model exhibits an overall satisfactory fit. The adjusted R^2 of 0.685 suggests that approximately 68.5% of the variation in the capital costs of petrochemical companies is explained by the explanatory variables included in the model.

II. Test of the first hypothesis: the impact of SR on COC:

Hypothesis 1. there is a significant negative relationship between sustainable development reporting and the COC of petrochemical companies.

Result: the coefficient of the SR variable is -0.003501, with a significance level of 0.0021, which is below the 0.05 threshold, indicating a statistically significant negative relationship.

Interpretation: *Hypothesis 1* is supported. This result indicates that an improvement in the quality of SR reduces the COC by mitigating information asymmetry and sending positive signals to the market. This finding is consistent with signaling theory [4].

III. Test of the second Hypothesis: the moderating role of PC

Hypothesis 2. PC moderate the relationship between sustainable development reporting and the COC of petrochemical companies.

Result: the coefficient of the interaction term SR × PC is 0.000040, with a significance level of 0.0092, which is below the 0.05 threshold, indicating a statistically significant positive moderating effect.

Interpretation: *Hypothesis 2* is supported. Given that the main effect of SR is negative while the interaction effect SR × PC is positive, these results suggest that PC attenuate the negative effect of SR on the COC [21]. This finding supports the substitution hypothesis: politically connected firms, benefiting from government advantages, have less need for sustainability transparency to gain market credibility, and consequently, the market places lower value on their SR [21].

IV. Direct effect of PC: the coefficient of the PC variable is -0.002003 and is statistically significant (0.0140). This finding indicates that PC directly contribute to a reduction in the COC. The result aligns with the efficiency perspective, which posits that the competitive advantage derived from government support reduces firm-level risk [6].

V. Results of control variables

- *Firm size (SIZE) and ROA: both exhibit negative and statistically significant coefficients.*
- *LEV: shows a positive and significant coefficient, indicating that higher debt levels increase firm risk.*
- *CG and Market Share (MSHARE): both have negative and significant coefficients.*
- *Liquidity (LIQ): displays a negative coefficient, though it is not statistically significant.*

6 | Conclusion

The primary objective of this study was to examine the impact of sustainable development reporting on the COC, as well as the moderating role of PC in this relationship, within petrochemical companies listed on the TSE [2]. The main findings derived from the panel data regression model (fixed effects) are as follows:

The statistical results (SR coefficient = -0.003501, with a significance level of 0.0021) indicate a significant negative relationship between sustainable development reporting SR and the COC [4], [29]. This finding suggests that the transparency and commitment of petrochemical companies to disclose environmental and social information reduce information risk and asymmetry. In line with signaling theory, firms with stronger sustainability performance differentiate themselves from weaker performers through voluntary disclosure, thereby lowering market uncertainty and experiencing a reduced cost of financing [4], [16].

The results indicate a positive and statistically significant moderating effect of the SR × PC interaction term (coefficient = 0.000040, significance level = 0.0092) on the negative relationship between SR and COC [21]. This finding suggests that PC attenuate the risk-reducing effect of SR on the COC. It provides strong support for the substitution hypothesis [21].

In firms with strong political ties such as many petrochemical companies access to rents, government support, and cheaper financing (as reflected in the direct effect of PC, coefficient = -0.002003) reduces overall firm risk independently of the quality of sustainability disclosure [6], [30]. Consequently, sustainability transparency loses its primary function as a mechanism for mitigating market information risk. Due to agency problems and the lower quality of reporting in politically connected firms, the market perceives their sustainability reports with skepticism and may interpret them as greenwashing [10].

The negative and statistically significant direct effect of PC on COC was confirmed [6]. This indicates that PC constitute a valuable resource for firms in the Iranian market, directly contributing to a reduction in the COC. This finding aligns with the efficiency perspective regarding PC in state-influenced economies.

The results of this study concerning the risk-reducing effect of SR on the COC are consistent with similar research conducted in Iran and internationally [4], [22], [29]. However, the innovative contribution of this research the moderating effect is in line with the literature on politically connected firms in emerging markets [6], [21]. While some studies [31] expected a complementary relationship, the present study demonstrates that within Iran's institutional environment, political advantages substitute for market-based benefits, thereby weakening the instrumental role of SR.

Research limitations:

I. Measurement of variables: the measurement of SR using a panel-based approach may not fully capture the qualitative aspects or the depth of disclosure [29]. Moreover, the indicator for PC primarily focuses on state ownership and does not account for other forms of influence.

II. Generalizability: the results are limited to the petrochemical industry and the six-year period from 2018 to 2024, and caution is required when generalizing them to other industries.

III. COC Model: the use of the CAPM to estimate the cost of equity in a market such as Iran may involve certain uncertainties.

Practical implications:

I. For managers: firms lacking strong PC should prioritize enhancing the quality and transparency of their SR as a strategic tool to reduce financing costs and build market credibility.

II. For investors and analysts: when assessing the risk of petrochemical companies particularly those with substantial political influence attention should focus on CG indicators, board independence, and the quality of financial reporting, rather than solely on sustainability reports, as the effectiveness of SR is diminished in these firms.

III. For regulatory authorities: the securities exchange organization and relevant regulatory bodies should enforce stricter requirements for SR with third-party verification (independent auditing) for politically connected firms to prevent greenwashing and improve the quality of disclosed information.

Suggestions for future research:

Examine the relationship between PC and the quality of sustainability disclosure (rather than the disclosure volume), using more qualitative measures such as report tone and reliability.

Investigate the moderating role of macroeconomic variables (e.g., exchange rates and country-level political risk) in the studied relationship.

Conduct a similar study using longer-term longitudinal data or applying a structural equation modeling approach to further explicate the model.

Author Contributions

Conceptualization, Sharifabadi A. and Khorsandian R.; Methodology, Sharifabadi A.; Software, Sharifabadi A.; Validation, Sharifabadi A. and Khorsandian R.; Formal analysis, Sharifabadi A.; Investigation, Sharifabadi A.; Resources, Khorsandian R.; Data maintenance, Khorsandian R.; Writing creating the initial draft, Sharifabadi A.; Writin reviewing and editing, Sharifabadi A. and Khorsandian R.; Visualization, Sharifabadi A.; Supervision, Khorsandian R.; Project administration, Khorsandian R. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The data supporting the findings of this study are derived from publicly available financial reports and relevant databases related to firms listed on the Tehran Stock Exchange. Additional processed data and materials are available from the corresponding author upon reasonable request.

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