

The Effect of Corporate Sustainability Performance on Information Asymmetry: The Moderating Role of Ownership Concentration in Companies Listed on the Tehran Stock Exchange



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Abstract: The present study examines the effect of environmental, social, and governance (ESG) performance on information asymmetry and analyzes the moderating role of ownership concentration in this relationship. The statistical sample consists of 111 companies listed on the Tehran Stock Exchange over the 2015–2024 period, yielding a total of 1,110 firm-year observations. Information asymmetry was measured using the bid–ask spread, while ESG performance was measured using a composite sustainability score. The data were analyzed using fixed-effects panel-data regression models with standard errors corrected for heteroskedasticity and autocorrelation. The findings showed that ESG performance has a negative and highly significant effect on information asymmetry (coefficient = -0.032 , $t = -5.802$, $p < .001$), such that a one-unit increase in the ESG score reduces the information gap by an average of 0.032 units. This result is interpreted within the frameworks of disclosure theory, agency theory, and signaling theory and is consistent with the domestic and international literature. In contrast, the moderating effect of ownership concentration was not statistically significant (interaction coefficient = -0.001 , $t = -1.418$, $p = .157$); therefore, ownership concentration neither strengthens nor weakens the relationship between ESG performance and information asymmetry. In other words, the transparency-enhancing property of corporate sustainability operates independently of ownership structure in the Iranian market. By enriching the sustainable finance literature in emerging markets, this study provides practical guidance for managers, investors, and regulatory institutions and emphasizes the need to establish sustainability-reporting requirements and incorporate ESG indicators into investment decision-making.

Keywords: environmental, social, and governance performance; information asymmetry; ownership concentration; disclosure theory.

1. Introduction

In contemporary capital markets, the quality and accessibility of corporate information play a central role in determining the efficiency of resource allocation, the cost of capital, investor confidence, and the effectiveness of corporate governance mechanisms. A persistent challenge in this context is information asymmetry, which arises when different parties to a transaction possess unequal amounts or qualities of information about a firm's activities, prospects, risks, and underlying economic condition. Managers and controlling shareholders generally have greater access to firm-specific information than outside investors, particularly minority shareholders, thereby creating opportunities for adverse selection,

opportunistic behavior, and inefficient investment decisions. From a corporate governance perspective, information asymmetry is therefore not merely a market microstructure problem but also an important manifestation of agency conflicts between corporate insiders and external stakeholders. Governance mechanisms that improve monitoring, strengthen disclosure, and align managerial and shareholder interests may contribute to reducing these informational inequalities [1]. At the same time, the increasing complexity of modern corporations has expanded the scope of information demanded by investors beyond traditional accounting figures. Financial statements alone may not adequately communicate firms' exposure to environmental risks, human capital issues, stakeholder relationships, ethical conduct, governance quality, and long-term sustainability. Consequently, environmental, social, and governance (ESG) information has increasingly become an important component of the corporate information environment and a potentially significant mechanism for mitigating information asymmetry.

ESG performance represents a multidimensional assessment of the manner in which a corporation manages its environmental responsibilities, relationships with employees and other stakeholders, and governance structures. The growing prominence of ESG reflects a broader transformation in the conceptualization of corporate performance, in which value creation is increasingly evaluated not solely in terms of short-term financial outcomes but also in relation to organizational sustainability, stakeholder accountability, risk management, and long-term resilience. Research on corporate social responsibility (CSR) and ESG has accordingly become a major field within corporate finance and management, with evidence showing that sustainability-related practices can interact with firm value, financing decisions, risk, institutional ownership, disclosure practices, and governance mechanisms [2]. From a broader managerial perspective, social and environmental responsibility can contribute to corporate legitimacy, stakeholder relationships, reputation, and the firm's capacity to respond to institutional expectations. A holistic interpretation of corporate social responsibility further suggests that the effectiveness of responsible corporate behavior depends partly on information flows and the cognitive distance between corporations and their stakeholders, making information asymmetry an important antecedent and consequence of sustainability-oriented corporate behavior [3]. The economic consequences of environmental responsibility may also extend beyond immediate costs, as environmentally responsible strategies can generate longer-term benefits through reputation, operational efficiency, competitive positioning, and stakeholder trust [4]. These considerations have made the informational implications of ESG performance increasingly important to both researchers and practitioners.

The theoretical connection between ESG performance and information asymmetry can be explained through disclosure theory, agency theory, stakeholder theory, legitimacy theory, and signaling theory. From the disclosure perspective, companies with stronger environmental and social performance may have incentives to provide more extensive sustainability-related information in order to distinguish themselves from weaker-performing firms. Evidence concerning environmental disclosure indicates that corporate environmental performance and disclosure behavior are systematically related, supporting the argument that firms use environmental reporting to communicate their underlying environmental quality to external stakeholders [5]. Under signaling theory, credible ESG activities and related disclosures can act as signals regarding managerial quality, organizational integrity, long-term orientation, and the firm's exposure to nonfinancial risks. From an agency perspective, additional ESG information can constrain managerial discretion and reduce the informational advantage enjoyed by insiders. Similarly, stakeholder theory suggests that firms face information demands from a broad range of stakeholders, including shareholders, employees, creditors, customers, regulators, and communities. Institutional investors in particular have increasingly demonstrated interest in corporate responsibility, indicating that ESG-related information can influence portfolio decisions and institutional engagement with firms [6]. Consequently, when ESG

disclosures are substantive, credible, comparable, and decision-useful, they may improve the corporate information environment, facilitate more accurate firm valuation, and reduce the information gap between corporate insiders and market participants.

A growing body of empirical research supports the proposition that corporate sustainability and social responsibility can reduce information asymmetry. One of the earlier studies directly examining this relationship reported that stronger CSR performance is associated with lower information asymmetry, indicating that socially responsible behavior and related disclosure can improve the information environment faced by investors [7]. Subsequent evidence similarly indicates that CSR may function as an informational mechanism through which firms communicate otherwise difficult-to-observe characteristics to capital-market participants [8]. Research has also demonstrated a relationship between asymmetric information and corporate social responsibility, suggesting that CSR practices and disclosure are embedded within firms' broader information environments rather than representing isolated reputational activities [9]. More comprehensive evidence further shows that corporate social responsibility can significantly affect information asymmetry and that this relationship can be understood through improved transparency, stakeholder engagement, and reduced informational uncertainty [10]. These findings collectively provide an important empirical foundation for expecting superior ESG performance to reduce the informational disadvantages faced by outside investors.

Nevertheless, the strength of the relationship between sustainability performance and information asymmetry is unlikely to be identical across all firms and institutional environments. Sustainability disclosure operates within governance, ownership, regulatory, and stakeholder-protection structures that may either amplify or constrain its informational value. For example, the relationship between sustainability disclosure and information asymmetry has been shown to vary according to the stakeholder protection context, implying that institutional arrangements influence how sustainability information is interpreted and incorporated into capital-market decisions [11]. Similarly, evidence from the Korean market indicates that the association between CSR and information asymmetry can differ across organizational structures, including membership in large business groups, demonstrating that firm-specific governance conditions can influence the informational consequences of social responsibility [12]. Analyst coverage may also affect this relationship, as analysts themselves serve as information intermediaries capable of collecting, interpreting, and disseminating firm-specific information. Research examining this mechanism has shown that analyst coverage moderates the relationship between CSR performance and information asymmetry [13]. These findings indicate that the effects of ESG performance cannot be fully understood without considering the institutional and governance characteristics that shape information production and transmission.

Ownership structure is particularly important in this regard because it simultaneously affects monitoring, control, access to private information, managerial incentives, and the protection of minority shareholders. Ownership concentration refers to the extent to which a relatively small number of shareholders control substantial portions of a company's equity. Concentrated ownership can potentially produce two competing effects. On the one hand, large shareholders possess stronger incentives and greater resources to monitor managers, constrain opportunistic behavior, and improve corporate governance, potentially reducing agency problems and increasing organizational efficiency. On the other hand, controlling shareholders may enjoy privileged access to private information and may exercise control in ways that disadvantage minority shareholders, thereby increasing information asymmetry between informed insiders and less-informed external investors. The broader corporate governance literature emphasizes the importance of such governance arrangements for firms' informational

environments [1]. Evidence regarding institutional ownership further demonstrates that major shareholders can influence corporate social responsibility policies and outcomes, reinforcing the importance of ownership characteristics in understanding corporate sustainability behavior [14]. Corporate governance quality may likewise influence the relationship between information asymmetry and firms' ability to exploit investment opportunities efficiently [15]. Ownership concentration can therefore theoretically either complement ESG transparency or substitute for it, making its moderating role an important empirical question.

Recent studies have increasingly investigated this moderating mechanism. Rehman et al. directly examined the role of ownership concentration in the relationship between CSR performance and information asymmetry, highlighting that ownership structure can condition the informational consequences of corporate responsibility [16]. More recently, Pinto and Gaio specifically investigated ESG performance and information asymmetry while considering ownership concentration as a moderating variable, further emphasizing the relevance of integrating sustainability performance with ownership structure in explaining information environments [17]. Ownership concentration has also been investigated in relation to the association between ESG performance and firm value, suggesting that concentrated control can alter the economic consequences of sustainability performance beyond the information-asymmetry channel [18]. These findings are particularly relevant because they suggest that the informational benefits of ESG cannot necessarily be assumed to operate independently of corporate control structures. When dominant owners already possess direct access to managerial information, public ESG disclosure may have a different marginal informational value than it does in firms characterized by dispersed ownership. Conversely, controlling shareholders may encourage credible ESG reporting as part of a monitoring and reputation-building strategy, thereby strengthening its transparency-enhancing effects.

The relationship is also likely to be sensitive to industry and market characteristics. Firms operating in environmentally or socially sensitive sectors are often subject to greater scrutiny from regulators, investors, local communities, and other stakeholders. Research on emerging markets indicates that firms in sensitive industries may demonstrate stronger ESG performance, plausibly because they face greater legitimacy pressures and stakeholder expectations [19]. Such pressures may increase both the amount of sustainability information disclosed and the informational relevance of ESG performance. At the same time, the effects of ESG-related practices may extend to other financial and strategic outcomes. Iranian evidence, for example, has investigated the moderating role of competitive power in the relationship between social and environmental performance and financial performance, illustrating the growing importance of organizational and market contingencies in sustainability research [20]. International and domestic evidence therefore increasingly supports an approach in which ESG is treated not as an isolated reporting variable but as part of a broader system encompassing corporate governance, competitive position, ownership structure, financial decisions, and market information.

The Iranian capital market provides a particularly relevant setting for investigating these relationships. The Tehran Stock Exchange is characterized by substantial differences among listed firms in ownership structures, the presence of large strategic and institutional shareholders, industry composition, corporate governance practices, and disclosure quality. These characteristics can make information asymmetry especially consequential for minority investors and can influence the effectiveness of sustainability information as a transparency mechanism. Iranian research has increasingly begun to examine ESG-related issues within this institutional setting. Rostami et al. investigated the moderating role of ownership concentration in the relationship between CSR performance and information asymmetry among companies listed on the Tehran Stock Exchange, directly demonstrating the domestic relevance of combining responsibility performance, ownership structure, and information asymmetry in

a single analytical framework [21]. Najafi Moghadam and Doshman Ziyari examined ESG performance and investment inefficiency while considering the role of information asymmetry, suggesting that the informational consequences of ESG may extend to corporate investment quality [22]. More recent Iranian studies have broadened this line of inquiry by investigating the relationship between ESG performance and investor sentiment in the presence of information asymmetry [23], the role of ESG performance in the relationship between the information environment and the cost of debt [24], and the moderating influence of ESG performance on the association between investment efficiency and firm performance [25]. Together, these studies demonstrate the growing recognition of ESG as an economically meaningful component of corporate decision-making and capital-market information in Iran.

Other recent studies further illustrate the widening range of corporate consequences associated with ESG and CSR. Mohseni et al. examined the effect of ESG performance on asymmetric cost behavior among firms listed on the Tehran Stock Exchange, linking sustainability performance to managerial resource-adjustment decisions and internal cost structures [26]. Touski examined corporate social responsibility, information asymmetry, and stock price crash risk from a moderated perspective, illustrating how the informational implications of socially responsible behavior may ultimately affect extreme downside market risk [27]. These developments suggest that ESG performance may influence not only firms' external legitimacy but also the quality of managerial decisions, financing conditions, investor perceptions, and capital-market risk. At the same time, the diversity of these outcomes makes it important to clarify the fundamental informational mechanism through which ESG may generate economic consequences. Information asymmetry is especially important because it connects managerial disclosure decisions with investor behavior, trading conditions, valuation, financing, and governance. If ESG performance meaningfully reduces information asymmetry, then its benefits may propagate through numerous corporate-finance channels; however, if those benefits depend heavily on ownership structure, regulatory conditions, or market institutions, the interpretation of ESG performance must be correspondingly more conditional.

Despite the increasing volume of research, several issues remain unresolved. First, much of the established evidence on CSR, ESG, and information asymmetry has emerged from developed or comparatively information-rich markets, whereas the institutional characteristics of emerging capital markets can differ substantially. Second, earlier studies frequently relied on broad CSR measures, while contemporary ESG frameworks provide a more structured separation of environmental, social, and governance dimensions. Third, evidence on moderating mechanisms remains heterogeneous. Analyst coverage, stakeholder protection, business-group affiliation, and ownership concentration have all been identified as potentially important contingencies [11-13, 16], but the direction and magnitude of their effects can depend on market-specific governance conditions. Fourth, the dual theoretical nature of ownership concentration makes its moderating influence inherently ambiguous. Concentrated ownership can improve monitoring and reduce managerial agency problems, yet it can simultaneously create information advantages for controlling shareholders and increase conflicts between majority and minority owners. The empirical relevance of this ambiguity is particularly pronounced in markets where large shareholders play a substantial role in corporate control.

Accordingly, examining ESG performance together with ownership concentration can contribute to both sustainability management and corporate governance research. Evidence that ESG performance reduces information asymmetry would support the proposition that sustainability activities and disclosures provide capital-market participants with useful incremental information and improve transparency. Evidence of a

significant moderating effect of ownership concentration would indicate that the informational consequences of ESG depend upon the distribution of corporate control and access to private information. Conversely, an insignificant moderating effect would suggest that the transparency benefits of ESG are sufficiently broad to operate across different ownership structures. Such evidence has practical implications for corporate managers deciding whether and how to expand ESG reporting, for investors incorporating sustainability indicators into valuation and portfolio decisions, and for regulators considering the development of standardized sustainability disclosure requirements. It may also help clarify whether stronger ESG disclosure should be treated primarily as a voluntary corporate communication mechanism or as an element of the formal information infrastructure of the capital market. Therefore, the aim of this study is to examine the effect of environmental, social, and governance performance on information asymmetry and to determine whether ownership concentration moderates this relationship among companies listed on the Tehran Stock Exchange.

2. Methodology

This study is applied in terms of purpose and descriptive–correlational in nature, employing an ex post facto approach because actual corporate data are analyzed without any intervention by the researcher. The study seeks to investigate the relationship between environmental, social, and governance (ESG) performance and corporate information asymmetry while considering the moderating role of ownership concentration. In terms of data collection, the study is based on secondary data obtained from audited financial statements, management commentary reports, the Codal disclosure system, the Tehran Securities Exchange Technology Management Company system (TSETMC), and reputable ESG databases in Iran. By extracting actual and reliable data, the study tests the relationships among the principal and control variables using multivariate regression models and panel-data econometric analysis. In this study, the direct effect of environmental, social, and governance performance on information asymmetry among companies listed on the Tehran Stock Exchange is tested using the following model:

$$\text{INFASS}_{it} = \beta_0 + \beta_1 \text{ESG}_{it} + \beta_2 \text{SIZE}_{it} + \beta_3 \text{TANG}_{it} + \beta_4 \text{CAPEX}_{it} + \beta_5 \text{FCF}_{it} \\ + \beta_6 \text{VOL}_{it} + \beta_7 \text{PRICE}_{it} + \beta_8 \text{LEV}_{it} + \beta_9 \text{STDEV}_{it} + \beta_{10} \text{DSENT}_{it} + \varepsilon_{it}$$

where:

INFASS_{it} : Information asymmetry.

ESG_{it} : Overall environmental, social, and governance performance.

OWNC_{it} : Ownership concentration.

SIZE_{it} : Firm size.

TANG_{it} : Tangible asset ratio.

CAPEX_{it} : Capital expenditures.

FCF_{it} : Free cash flow.

VOL_{it} : Trading volume.

PRICE_{it} : Stock price.

LEV_{it} : Financial leverage.

STDEV_{it} : Stock price volatility.

DSENT_{it} : Dummy variable for sensitive industries.

To test the moderating role of ownership concentration in the effect of environmental, social, and governance performance on information asymmetry, the interaction term $\text{ESG} \times \text{OWNC}$ is also introduced into the model:

$$\text{INFASS}_{it} = \beta_0 + \beta_1 \text{ESG}_{it} + \beta_2 \text{OWNC}_{it} + \beta_3 (\text{OWNC}_{it} \times \text{ESG}_{it}) + \beta_4 \text{SIZE}_{it}$$

$$+\beta_5 \text{TANG}_{it} + \beta_6 \text{CAPEX}_{it} + \beta_7 \text{FCF}_{it} + \beta_8 \text{VOL}_{it} + \beta_9 \text{PRICE}_{it} \\ + \beta_{10} \text{LEV}_{it} + \beta_{11} \text{STDEV}_{it} + \beta_{12} \text{DSENT}_{it} + \varepsilon_{it}$$

where:

OWNC_{it} : Ownership concentration.

$\text{OWNC}_{it} \times \text{ESG}_{it}$: The interaction effect between ownership concentration and overall environmental, social, and governance performance. In this section, the study variables—including the dependent, independent, moderating, and control variables—are presented separately in terms of their operational definitions, measurement methods, symbols, and theoretical foundations.

3. Dependent Variable: Information Asymmetry (INFASS)

Information asymmetry is a condition in which one party to a transaction (such as managers or large shareholders) possesses more information than another party (such as retail investors). This variable is measured using the bid–ask spread, which is a direct measure of transaction costs arising from adverse selection (Glosten & Milgrom, 1985). Operational definition and measurement: For each firm-year, the difference between the ask and bid prices in each month is first calculated as a ratio of the closing price for that month. The simple average of these ratios over the 12 months of the year is then used as the annual measure of information asymmetry:

$$\text{INFASS}_{it} = \frac{1}{12} \sum_{m=1}^{12} \frac{\text{Ask}_{imt} - \text{Bid}_{imt}}{\text{Close}_{imt}}$$

where:

Ask_{imt} : Average ask price of the stock of company i in month m of year t .

Bid_{imt} : Average bid price of the stock of company i in month m of year t .

Close_{imt} : Closing stock price in the same month.

Data source: Tehran Securities Exchange Technology Management Company (TSETMC) and databases such as Rahavard Novin and Tadbir Pardaz.

Independent Variable: Environmental, Social, and Governance Performance (ESG)

The independent variable in this study is environmental, social, and governance (ESG) performance, which is derived from the sum of three dimensions: environmental disclosure (EESG), social disclosure (SESG), and governance disclosure (GESG). Each of these independent-variable components is defined separately below.

1. Environmental Disclosure (EESG)

Environmental disclosure refers to the voluntary, quantitative, comparable, and reliable disclosure of information by a company that demonstrates its accountability and transparency regarding the environmental impacts of its activities (Lu & Abeysekera, 2017). Such disclosure can serve as a mechanism for enhancing corporate legitimacy and reputation. Operational definition and measurement: The level of environmental disclosure for each company is assessed through content analysis of annual reports, sustainability reports, and financial statements using a researcher-developed checklist. The checklist is based on the relevant literature and international reporting standards, such as the Global Reporting Initiative (GRI), and encompasses the following nine principal dimensions:

Pollution and waste.

Energy, efficiency, and water.

Biodiversity.

Climate change.

Environmental risk assessment.

Supply-chain issues.

Environmental education.

Environmental management systems.

Environmental transparency.

A score is assigned to each disclosed indicator within these dimensions. The company's final environmental disclosure score (EESG) is obtained by summing the scores earned across all dimensions. A higher score indicates a higher level of corporate environmental commitment and transparency.

2. Social Disclosure (SESG)

Social disclosure refers to the voluntary and transparent dissemination of information reflecting a company's commitment and performance toward all of its human stakeholders, including employees, customers, the local community, and the supply chain (Zhang et al., 2019). Such disclosure reflects corporate social responsibility (CSR) and the company's attention to creating value for society. Operational definition and measurement: The level of social disclosure for each company is measured through content analysis of the aforementioned documents using a structured checklist covering the following 12 principal dimensions:

Workforce health, safety, and productivity.

Labor rights.

Stakeholders' social perceptions.

Product health and safety.

Non-discrimination and social inclusion.

Customer and supply-chain social issues.

Compliance with human rights principles.

Social development and philanthropy.

Social-responsibility investment.

Brand protection and anti-competitive conduct.

Social learning and education.

Social transparency.

As with the preceding variable, a score is assigned to each disclosed item. The company's final social disclosure score (SESG) is obtained by summing the scores across all 12 dimensions.

3. Governance Disclosure (GESG)

Governance disclosure refers to the transparent and structured dissemination of information that reveals to stakeholders the quality, integrity, and effectiveness of a company's leadership, control, and oversight framework (Boralho et al., 2022). Such disclosure forms the foundation of corporate transparency and accountability.

Operational definition and measurement: The level of corporate governance disclosure is assessed by reviewing board of directors' reports, articles of association, and other governance-related disclosures using a checklist comprising the following nine key dimensions:

Protection of shareholder rights.

Board committees.

Risk management.

Performance-based compensation.

Ethics and codes of conduct.

Governance transparency.

Regulatory compliance.

Board composition.

Investment risk management.

Scoring is conducted in the same manner, and the final governance disclosure score (GESG) is calculated as the sum of the scores for these dimensions.

4. Overall ESG Performance (ESG)

This composite variable represents the company's overall performance in environmental, social, and governance responsibility. Overall ESG performance is calculated as the simple sum of the scores for the three dimensions described above. Data sources for all ESG variables include annual reports, sustainability reports, audited financial statements, and information disclosed through the Codal system (Codal.ir).

Moderating Variable: Ownership Concentration (OWNC)

Ownership concentration indicates the extent to which a company's shares are held by strategic owners (large and strategic shareholders). Strategic owners, because of their direct access to internal information and their ability to influence management, may moderate the relationship between ESG performance and information asymmetry. Operational definition and measurement: Following the corporate governance literature and established Iranian studies (Pourheidari et al., 2011; Rahmani et al., 2016), ownership concentration is measured as the ratio of the aggregate shares held by the three largest ultimate shareholders to the total shares outstanding:

$$OWNC_{it} = \frac{\text{Aggregate shares held by the three largest ultimate shareholders}_{it}}{\text{Total shares of the company}_{it}}$$

For data collection, the ownership percentage of each major shareholder is extracted from the official "List of Major Shareholders and Insiders" report published through the Codal system (Codal.ir) at the end of each financial period. The three shareholders with the highest ownership percentages are then identified, and their shareholdings are summed and divided by the company's total shares. OWNC takes a value within the interval (0,1). A larger ratio indicates a higher concentration of ownership in the hands of a limited number of major shareholders. Data source: Major shareholders' reports available through the Codal system (Codal.ir).

Control Variables

To isolate the effects of other factors influencing information asymmetry, the following control variables—which have been emphasized in the empirical literature—are included in the model.

Firm Size (SIZE)

Firm size represents the scale of operations and the volume of resources controlled by the company and is measured through the book value of total assets. Larger firms, because of broader analyst coverage, stricter disclosure requirements, and higher political costs, have stronger incentives and greater capacity to reduce information asymmetry (Demsetz & Lehn, 1985; Freeman, 1987). Accordingly, this variable is included in the research models as a control factor affecting the relationship between ESG performance and information asymmetry. Operational definition and measurement: The natural logarithm of the company's total assets at the end of the fiscal year:

$$SIZE_{it} = \ln(TA_{it})$$

where TA_{it} denotes the total book value of assets of company i at the end of year t . Data source: Audited balance sheet available through the Codal system.

1. Tangible Asset Ratio (TANG)

This variable represents the company's asset structure in terms of the extent to which it possesses physical and observable assets. A higher ratio indicates a larger share of tangible fixed assets in the company's total resources

and may affect financing behavior and information asymmetry (Rajan & Zingales, 1995). Operational definition and measurement: Following foundational corporate finance research and domestic studies, the tangible asset ratio is calculated by dividing net tangible fixed assets (property, plant, and equipment after accumulated depreciation) by total assets:

$$TANG_{it} = \frac{PPE_net_{it}}{TA_{it}}$$

where:

PPE_net_{it} : Net tangible fixed assets of company i at the end of year t .

TA_{it} : Total assets of company i at the end of year t .

Data source: Audited balance sheet available through the Codal system.

2. Capital Expenditures (CAPEX)

The CAPEX variable represents the company's long-term investment in fixed assets and reflects its operating capacity and development strategies. Greater investment in tangible assets may affect information asymmetry because these assets can serve as collateral, possess a tangible assessable value, and reduce information risk (Biddle et al., 2009).

Operational definition and measurement: To measure capital expenditures, and following established domestic and international empirical research (Mashayekh et al., 2011; Fazzari et al., 1988; Richardson, 2006), data from the balance sheet and income statement are used. Accordingly, annual fixed investment is defined as the increase in net tangible fixed assets in the current year relative to the previous year plus current-year depreciation expense. To ensure comparability across firms, this amount is divided by total assets at the end of the period (García Lara et al., 2016):

$$CAPEX_{it} = \frac{(PPE_net_{it} - PPE_net_{i,t-1}) + DEP_{it}}{TA_{it}}$$

where:

PPE_net_{it} : Net tangible fixed assets of company i at the end of year t (after deducting accumulated depreciation).

DEP_{it} : Depreciation expense for the current period (from the income statement).

In this formula, the numerator represents gross capital expenditures.

Data source: Audited balance sheet and income statement available through the Codal system.

3. Free Cash Flow (FCF)

This variable represents the cash remaining after deducting the investment required in tangible fixed assets from operating cash flows. High excess liquidity may increase agency-cost risk and affect information transparency and information asymmetry (Jensen, 1986). Operational definition and measurement: The most operational form of this measure is the difference between operating cash flow (OCF) and CAPEX. This definition has been used as a measure of free cash flow in domestic empirical studies (e.g., Mashayekh et al., 2011) and international studies (Richardson, 2006). In the present study, free cash flow is therefore defined as the difference between operating cash flow and capital expenditures and is standardized by dividing it by total assets at the end of the period:

$$FCF_{it} = \frac{OCF_{it} - [(PPE_net_{it} - PPE_net_{i,t-1}) + DEP_{it}]}{TA_{it}}$$

where:

OCF_{it} : Operating cash flow (net cash generated from operating activities).

The expression in brackets is exactly the absolute amount of capital expenditures (CAPEX) before scaling by assets. The full expression represents excess cash remaining after required investments relative to total assets. Data source: Audited statement of cash flows, balance sheet, and income statement available through the Codal system.

4. Trading Volume (VOL)

This variable represents the level of trading activity in the company's shares. High trading volume is generally associated with greater liquidity and lower transaction costs and may therefore reduce information asymmetry (Demsetz, 1968; Stoll, 2000). Operational definition and measurement: To normalize the distribution and adjust for scale effects, the natural logarithm of average monthly trading volume is used:

$$VOL_{it} = \ln(\text{Average monthly trading volume}_{it})$$

Data source: Monthly trading statistics from TSETMC or software/databases such as Rahavard Novin and Tadbir Pardaz.

5. Stock Price (PRICE)

Stock price is an important determinant of the bid-ask spread and, consequently, of information asymmetry.

Operational definition and measurement: Higher-priced stocks may exhibit larger absolute spreads and may also generate scale effects in regression analyses. The natural logarithm of the average monthly stock price is used to control for these effects (Ellul & Pagano, 2006):

$$PRICE_{it} = \ln(\text{Average monthly stock price}_{it})$$

Data source: Monthly closing prices from TSETMC or Tehran Stock Exchange databases.

6. Financial Leverage (LEV)

This variable represents the company's level of debt and financial risk. Higher leverage may be associated with greater uncertainty and information asymmetry (Jensen & Meckling, 1976). Operational definition and measurement: Total liabilities include both current and long-term liabilities.

$$LEV_{it} = \frac{\text{Total liabilities of the company at year-end}_{it}}{\text{Total assets of the company at year-end}_{it}}$$

Data source: Audited balance sheet available through the Codal system.

7. Stock Price Volatility (STDEV)

This variable represents the level of risk and instability in the stock price. Greater volatility implies higher risk and is generally associated with a wider bid-ask spread and greater information asymmetry (Glosten & Milgrom, 1985).

Operational definition and measurement:

$$STDEV_{it} = \sqrt{\frac{\sum_{m=1}^{12} (R_{imt} - \bar{R}_{it})^2}{11}}$$

where:

R_{imt} : Monthly return in month m for the stock of company i in year t , calculated as:

$$R_{imt} = \frac{P_{imt} - P_{i(m-1)t}}{P_{i(m-1)t}}$$

P_{imt} : Closing price at the end of month m .

$\bar{R}_{it}$: Average monthly return of company i in year t .

Data source: Monthly closing prices from TSETMC.

8. Sensitive Industries (DSENT)

This dummy variable indicates whether a company operates in industries subject to greater scrutiny and disclosure expectations because of environmental, social, or governance (ESG) considerations. Companies operating in these industries are exposed to higher ESG risk because of their potential adverse effects on the environment, public health, or ethical issues and, consequently, face greater information demand from investors. This may influence transparency and information asymmetry. Operational definition and measurement: DSENT equals 1 for companies operating in the following sensitive industries: oil, gas, petrochemicals, and refining; mining; chemicals; cement, lime, and gypsum; paper and wood products; automobile manufacturing and parts; sugar; and lead and zinc. It equals 0 for companies in all other industries. Source: Tehran Stock Exchange industry classifications and companies' ISIC codes.

Table 1. Operational Definitions and Measurement of Research Variables

Variable Type	Symbol	Variable Name	Variable Definition	Calculation and Measurement
Dependent	INFASS	Information asymmetry	The difference between stock bid and ask prices, serving as a measure of information asymmetry in the capital market.	Annual average of the monthly bid-ask price difference divided by the stock closing price.
Independent	ESG	Environmental, social, and governance performance	A company's performance across environmental, social, and governance dimensions based on reported data.	Overall ESG score obtained by summing environmental, social, and governance performance scores.
Moderator	OWNC	Ownership concentration	The share of strategic ownership in the company, reflecting the degree of ownership concentration.	Ratio of shares held by strategic owners to the company's total shares.
Control	SIZE	Firm size	Represents the scale of operations and the volume of resources controlled by the company and is measured using the book value of total assets.	Natural logarithm of the company's total assets at the end of the fiscal year.
Control	TANG	Tangible asset ratio	Ratio of the company's tangible assets to total assets, reflecting asset structure.	Net tangible fixed assets (property, plant, and equipment after depreciation) divided by total assets.
Control	CAPEX	Fixed investment	The company's capital expenditures relative to total assets.	Capital expenditures divided by total assets.
Control	FCF	Free cash flow	Cash remaining after deducting required investment in tangible fixed assets from operating cash flows.	Operating cash flow minus capital expenditures, divided by total assets at the end of the period.
Control	VOL	Trading volume	Average monthly trading volume of the company's shares.	Natural logarithm of average monthly stock trading volume.
Control	PRICE	Stock price	Average monthly price of the company's shares.	Natural logarithm of average monthly stock price.
Control	LEV	Financial leverage	Ratio of total liabilities to total assets.	Current-year total liabilities divided by total assets.
Control	STDEV	Stock price volatility	Standard deviation of monthly stock returns.	Standard deviation of monthly stock returns.
Control	DSENT	Sensitive industries	Dummy variable indicating whether the company operates in a sensitive industry.	Equals 1 for sensitive industries, including oil, gas, petrochemicals, and refining; mining; chemicals; cement, lime, and gypsum; paper and wood products; automobile manufacturing and parts; sugar; and lead and zinc, and 0 otherwise.

4. Findings and Results

After conducting the diagnostic tests, confirming that the underlying assumptions were satisfied, and selecting the preferred specification (fixed effects), this section presents the final estimation of the regression models and analyzes the results of the hypothesis tests. The research hypotheses are accepted or rejected based on the signs of the estimated coefficients and the significance levels of the corresponding statistics. Coefficient significance is assessed using the *t* statistic at a 5% significance level (95% confidence level). If the calculated probability value (*p*-value) for a coefficient is less than .05, the null hypothesis is rejected and the relationship is considered statistically significant. It should be noted that, given the balanced panel structure of the data, the presence of heteroskedasticity and autocorrelation, and the fact that the number of cross-sectional units exceeds the number of time periods, Panel Least Squares with period fixed effects and Period SUR panel-corrected standard errors (PCSE) was identified as the more appropriate estimation method.

The first research model examines the direct effect of environmental, social, and governance performance on information asymmetry among companies listed on the Tehran Stock Exchange. Given the balanced panel structure of the data, the presence of heteroskedasticity and autocorrelation, and the fact that the number of cross-sectional units exceeds the number of time periods, Panel Least Squares with period fixed effects and Period SUR panel-corrected standard errors (PCSE) was identified as the more appropriate method for estimating the model. The results of estimating this fixed-effects model are presented in Table 4-10. The *F* statistic for the first model was estimated at 159.207, with a corresponding *p*-value of less than .001. This finding rejects, with greater than 99% confidence, the null hypothesis that the regression as a whole is not significant. Therefore, the model is highly significant overall, confirming a linear relationship between the independent and dependent variables.

The coefficient of determination for the first model was estimated at $R^2 = .735$. This indicates that approximately 73.5% of the variation in information asymmetry (INFASS) among the sampled companies is explained by the variables included in the model—namely, environmental, social, and governance performance together with the control variables—while the remaining variation is attributable to other variables outside the model. This level of the coefficient of determination indicates that the model has very strong explanatory power. The Durbin–Watson statistic was calculated at 1.763. Because this value falls within an acceptable range and is close to 2, the residuals from the estimated model do not exhibit a concerning first-order autocorrelation problem.

To examine the presence of multicollinearity among the independent and control variables, the variance inflation factor (VIF) was used, and VIF values were calculated for all variables in the model. The results showed that all VIF values were below 5; the highest values were observed for capital expenditures and free cash flow, at 4.177 and 4.027, respectively. Because these values are below the conventional threshold of 5, it can be concluded that there is no severe multicollinearity problem among the explanatory variables and, consequently, the estimated coefficients can be interpreted reliably.

Table 2. Estimation and Goodness-of-Fit Results for the First Research Model

Model 1 (Dependent Variable: Information Asymmetry)

Variable	Symbol	Coefficient	Standard Error	<i>t</i> Statistic	<i>p</i> -Value	VIF
Intercept (constant)	C	0.638	0.095	6.737	< .001	—
Environmental, social, and governance performance	ESG	−0.032	0.005	−5.802	< .001	1.169
Firm size	SIZE	−0.013	0.005	−2.501	.013	2.165
Tangible assets	TANG	−0.033	0.035	−0.946	.344	1.139
Capital expenditures	CAPEX_W	0.001	0.025	0.028	.977	4.177

Free cash flow	FCF_W	-0.028	0.023	-1.222	.222	4.027
Trading volume	VOL	0.009	0.005	1.756	.079	2.122
Stock price	PRICE	0.012	0.007	1.799	.072	1.364
Financial leverage	LEV	-0.014	0.031	-0.448	.654	1.067
Stock return standard deviation	STDEV	0.020	0.001	17.163	< .001	1.324
Sensitive industries	DSENT	-0.044	0.022	-2.016	.044	1.289
Durbin-Watson	1.763			<i>F</i> statistic	159.21	
R^2	0.735			<i>p</i> -value	< .001	

Main Hypothesis: There is a significant relationship between environmental, social, and governance (ESG) performance and information asymmetry. The path coefficient for environmental, social, and governance (ESG) performance was estimated at -0.032 , with a t statistic of -5.802 . Because the significance level for this variable ($p < .001$) is below the 5% error level, the relationship is statistically highly significant at the 95% confidence level (and even at the 99% confidence level). The negative sign of the coefficient indicates an inverse relationship between the two variables; that is, as companies improve their environmental, social, and governance performance and increase disclosure of these indicators, information asymmetry between managers and investors decreases significantly. Therefore, the first main hypothesis of the study is supported. From a theoretical perspective, this finding is consistent with disclosure theory and agency theory because corporate commitment to social and environmental responsibilities and improvements in governance structures strengthen transparent information flows, constrain opportunistic behavior, and reduce information gaps in the market.

The second research model examines the moderating role of ownership concentration in the relationship between environmental, social, and governance performance and information asymmetry among companies listed on the Tehran Stock Exchange. Given the balanced panel structure of the data, the presence of heteroskedasticity and autocorrelation, and the fact that the number of cross-sectional units exceeds the number of time periods, Panel Least Squares with period fixed effects and Period SUR panel-corrected standard errors (PCSE) was identified as the more appropriate method for estimating the model.

The F statistic for the second model was estimated at 145.06, with a significance level below .001. This finding rejects, with greater than 99% confidence, the null hypothesis that the regression as a whole is not significant. Therefore, the second model is highly significant overall, confirming a linear relationship between the set of independent, moderating, interaction, and control variables and the dependent variable, information asymmetry. The coefficient of determination for the second model was estimated at $R^2 = .737$. This indicates that approximately 73.7% of the variation in information asymmetry among the sampled companies is explained by the variables included in the second model, including environmental, social, and governance performance, ownership concentration, their interaction effect, and the control variables, while the remaining variation is attributable to other factors outside the model. This level of the coefficient of determination indicates very strong explanatory power.

The Durbin-Watson statistic for the second model was calculated at 1.774. Because this value falls within an acceptable range and is close to 2, it can be concluded that the residuals from the estimated model do not exhibit a concerning first-order autocorrelation problem. In addition, to assess multicollinearity among the independent, moderating, interaction, and control variables in the second model, the variance inflation factor was used and VIF values were calculated for all model variables. The results showed that all VIF values were below 5; the highest values were observed for capital expenditures and free cash flow, at 4.199 and 4.045, respectively. The VIF for the

interaction variable was also low, indicating that introducing this variable into the model did not create a multicollinearity problem. Because all values are below the conventional threshold of 5, it can be concluded that the second research model does not suffer from severe multicollinearity among the explanatory variables and that the estimated coefficients remain suitably interpretable.

Table 3. Goodness-of-Fit Results for the Second Research Model

Model 2 (Dependent Variable: Information Asymmetry)

Variable	Symbol	Coefficient	Standard Error	<i>t</i> Statistic	<i>p</i> -Value	VIF
Intercept (constant)	C	0.630	0.092	6.861	< .001	—
Environmental, social, and governance performance	ESG	-0.030	0.003	-8.818	< .001	1.282
Ownership concentration	OWNC	0.001	0.0002	2.153	.032	1.295
Interaction effect (moderator)	EO	-0.001	0.0005	-1.418	.157	1.145
Firm size	SIZE	-0.017	0.005	-3.515	.001	2.506
Tangible assets	TANG	-0.037	0.036	-1.040	.298	1.141
Capital expenditures	CAPEX_W	-0.001	0.026	-0.026	.979	4.199
Free cash flow	FCF_W	-0.031	0.023	-1.383	.167	4.045
Trading volume	VOL	0.012	0.004	2.789	.005	2.544
Stock price	PRICE	0.010	0.006	1.691	.091	1.373
Financial leverage	LEV	-0.022	0.026	-0.840	.401	1.092
Stock return standard deviation	STDEV	0.019	0.001	21.612	< .001	1.339
Sensitive industries	DSENT	-0.039	0.014	-2.875	.004	1.316
Durbin-Watson		1.774		<i>F</i> statistic	145.06	
R^2		0.737		<i>p</i> -value	< .001	

Sub-Hypothesis: Ownership concentration has a moderating role and weakens the negative effect of environmental, social, and governance (ESG) performance on information asymmetry. The coefficient of the interaction variable between environmental, social, and governance performance and ownership concentration (EO) was estimated at -0.0007, with a *t* statistic of -1.418. Because the significance level for this variable is .156, which is greater than the 5% error level, the effect of the interaction variable is not statistically significant. The non-significant EO coefficient indicates that, in the sample examined, ownership concentration does not alter the strength or direction of the relationship between ESG performance and information asymmetry. Therefore, the research sub-hypothesis that ownership concentration moderates and weakens the negative effect of ESG performance on information asymmetry is rejected. It can consequently be stated that the significant negative effect of ESG performance on reducing information asymmetry is generally observed independently of companies' ownership concentration levels, and the transparency mechanism generated by ESG disclosure in the market is sufficiently strong that different levels of ownership concentration do not produce a statistically significant change in this relationship.

The results of estimating the models using Panel Least Squares with PCSE-corrected standard errors showed that the models possess overall statistical significance and satisfactory goodness of fit. The findings indicate a negative and significant relationship between environmental, social, and governance performance and information asymmetry; therefore, the main hypothesis was supported. The interaction effect between ownership concentration and ESG performance was not statistically significant; consequently, the moderating role of ownership concentration in this relationship was not supported, and the sub-hypothesis was rejected.

5. Discussion and Conclusion

The present study examined the effect of environmental, social, and governance (ESG) performance on information asymmetry among companies listed on the Tehran Stock Exchange and assessed whether ownership concentration moderates this relationship. The findings of the first model showed that ESG performance has a negative and statistically significant effect on information asymmetry. Specifically, the estimated coefficient for ESG performance was -0.032 , with a t -statistic of -5.802 and a significance level below 0.001 , indicating that higher ESG performance is associated with a substantial reduction in information asymmetry. Accordingly, the main hypothesis of the study was supported. This finding suggests that firms demonstrating stronger environmental responsibility, greater attention to social stakeholders, and more effective governance practices provide a richer and more transparent information environment to capital-market participants. From an information perspective, ESG performance appears to decrease the informational advantage held by managers and other corporate insiders relative to outside investors. The result is consistent with the broader argument that nonfinancial sustainability information supplements conventional accounting disclosures and can convey information about organizational quality, risk exposure, long-term strategy, stakeholder relations, and managerial conduct that may not otherwise be observable through financial statements alone. This interpretation is consistent with prior research indicating that corporate social responsibility and ESG-related performance can improve the information environment and reduce information asymmetry [7-10]. The finding also supports the general corporate-finance literature in which ESG and CSR are treated as economically relevant dimensions of corporate behavior rather than merely symbolic or reputational activities [2].

The negative relationship between ESG performance and information asymmetry can first be interpreted through disclosure theory. Firms with stronger ESG performance are generally in a better position to communicate environmental, social, and governance achievements to stakeholders and therefore have greater incentives to disclose information capable of differentiating them from firms with weaker sustainability performance. Such disclosure can reduce uncertainty regarding firms' exposure to environmental liabilities, social controversies, governance weaknesses, regulatory risks, and stakeholder conflicts. Earlier evidence has shown that environmental performance is systematically associated with environmental disclosure, supporting the proposition that stronger-performing firms have incentives to communicate their environmental quality to external audiences [5]. Accordingly, ESG-related disclosure can function as an additional information channel that reduces investors' dependence on private or selectively distributed information. The present finding is also consistent with the argument that CSR disclosure contributes to a more transparent corporate information environment and reduces information gaps between insiders and external market participants [7]. Lu and Chueh likewise reported a meaningful connection between corporate social responsibility and information asymmetry, reinforcing the view that responsibility-oriented practices can improve the informational conditions under which investors evaluate firms [8]. Thus, in the context of the Tehran Stock Exchange, superior ESG performance appears to provide informational benefits that extend beyond the ethical or legitimacy-related dimensions of sustainability and directly affect market transparency.

The result is also explainable through agency theory. Information asymmetry constitutes one of the central conditions that enables managerial opportunism because managers typically possess more detailed knowledge about corporate operations, risks, prospects, and strategic decisions than outside shareholders. When firms provide more comprehensive ESG information and establish stronger governance mechanisms, the informational

advantage available to managers can be reduced, thereby limiting opportunities for opportunistic behavior and improving external monitoring. In this respect, ESG performance may operate as both an outcome and an instrument of stronger governance. Governance practices associated with accountability, board oversight, risk management, ethical codes, and shareholder rights can constrain managerial discretion, while environmental and social disclosures enable investors to evaluate dimensions of corporate activity that may otherwise remain outside traditional financial reporting. The result is therefore compatible with evidence emphasizing the close relationship between governance mechanisms and information asymmetry [1]. It is also consistent with the broader perspective proposed by Caputo, according to which information asymmetry plays an important role in shaping the relationship between corporations and stakeholders and in determining how corporate social responsibility is understood and evaluated [3]. By reducing cognitive and informational distance between the firm and its stakeholders, ESG-related reporting can facilitate more informed assessments of corporate conduct and reduce uncertainty.

From a signaling perspective, superior ESG performance may further communicate unobservable attributes of firm quality. Environmental initiatives, employee-oriented policies, responsible stakeholder relations, transparent governance, and effective risk-management systems often require sustained organizational commitment and resources. Firms that perform strongly in these areas may therefore use ESG information to signal managerial competence, long-term orientation, ethical conduct, and resilience. Such signals may be particularly valuable in emerging markets, where differences in disclosure quality and information access can be more pronounced. Strong ESG performance can consequently reduce adverse-selection risk by helping investors distinguish relatively transparent and responsibly managed firms from firms that provide fewer credible indicators of organizational quality. This interpretation is consistent with findings showing that CSR performance reduces information asymmetry and improves investors' access to relevant firm-specific information [9, 10]. Furthermore, institutional investors increasingly consider corporate responsibility in their investment and engagement decisions, indicating that sustainability information has become relevant to sophisticated market participants rather than remaining peripheral to valuation processes [6]. Evidence regarding institutional investors and CSR also suggests that major investors can influence and respond to firms' sustainability activities, further reinforcing the informational significance of ESG performance [14].

The present findings are particularly consistent with studies that have directly examined CSR or ESG performance in relation to information asymmetry. Cho et al. documented that stronger CSR performance is associated with lower information asymmetry, supporting the argument that socially responsible firms provide a superior information environment [7]. Cui et al. similarly found that CSR affects information asymmetry and demonstrated that corporate responsibility can carry meaningful informational consequences for market participants [10]. Lopatta et al. provided further evidence concerning the connection between asymmetric information and CSR, suggesting that the two constructs are closely linked within corporate information environments [9]. The findings are also compatible with research showing that sustainability disclosure can reduce information asymmetry, although the magnitude of this effect may depend on the institutional environment and level of stakeholder protection [11]. Likewise, evidence from the Korean market demonstrates an association between CSR and information asymmetry while also suggesting that organizational characteristics may influence this relationship [12]. Collectively, these studies support the present result and indicate that the transparency-enhancing role of sustainability performance is observable across different institutional settings.

The result also contributes to the emerging Iranian literature on ESG. Recent studies in Iran have increasingly demonstrated that ESG performance is related to dimensions of firms' information environments, financing outcomes, investment behavior, and managerial decision-making. Najafi Moghadam and Doshman Ziyari examined the effect of ESG performance on investment inefficiency while emphasizing the role of information asymmetry, supporting the proposition that information quality may represent an important mechanism linking ESG practices to investment decisions [22]. Razavi et al. investigated ESG performance and investor sentiment in the presence of information asymmetry, further demonstrating that sustainability information may shape investor perceptions and market behavior [23]. Similarly, Hamidreza examined ESG performance in relation to the information environment and the cost of debt among Tehran Stock Exchange firms, suggesting that ESG may also influence financing conditions through informational channels [24]. Mohseni et al. extended the ESG literature to asymmetric cost behavior, demonstrating that sustainability performance may also be associated with internal managerial decisions and cost adjustment processes [26]. In addition, Heydari et al. considered ESG performance as a moderating mechanism in the association between investment efficiency and firm performance [25]. These domestic studies collectively suggest that ESG performance is becoming an increasingly important component of financial and managerial decision-making in the Iranian market and support the present conclusion that ESG performance has meaningful informational consequences.

The second major finding concerned the moderating role of ownership concentration. Although the direct coefficient of ownership concentration in the second model was positive and statistically significant, the interaction term between ESG performance and ownership concentration was negative but statistically insignificant. The estimated interaction coefficient was approximately -0.0007 , with a t -statistic of -1.418 and a significance level of approximately 0.156 – 0.157 . Thus, the hypothesis that ownership concentration weakens the negative effect of ESG performance on information asymmetry was not supported. In substantive terms, the transparency-enhancing effect of ESG performance appears to operate relatively independently of differences in ownership concentration among the firms included in the sample. That is, although ownership concentration itself may have implications for information distribution, it does not significantly alter the extent to which stronger ESG performance reduces information asymmetry. This finding is important because ownership concentration theoretically possesses competing informational consequences. Large shareholders may improve monitoring and reduce managerial opportunism, but they may simultaneously obtain privileged access to private information and potentially increase informational disadvantages for minority investors. The insignificant interaction effect observed in this study suggests that these opposing mechanisms may offset one another or that the information provided through ESG performance is sufficiently broad and public to remain useful regardless of the degree of ownership concentration.

The finding regarding ownership concentration presents a more nuanced relationship with previous studies. Rehman et al. found that ownership concentration can moderate the relationship between CSR performance and information asymmetry, indicating that corporate ownership structure may condition the informational effects of responsibility-oriented corporate behavior [16]. Pinto and Gaio also examined ESG performance and information asymmetry specifically through the moderating role of ownership concentration, emphasizing the theoretical relevance of concentrated ownership in determining the informational consequences of ESG [17]. Likewise, Rostami et al. investigated this moderating mechanism among firms listed on the Tehran Stock Exchange, demonstrating that ownership structure is an empirically relevant factor to consider in the Iranian context [21]. The lack of a statistically significant moderating effect in the present study does not necessarily contradict the theoretical importance of ownership concentration; rather, it suggests that its conditional influence may depend on sample

composition, measurement methods, regulatory context, the identity of controlling shareholders, or the specific form of sustainability performance considered. This interpretation is also consistent with broader evidence showing that ownership concentration can alter other consequences of ESG, such as firm value, but that its influence may be context dependent [18]. Thus, ownership concentration may matter for some ESG-related outcomes without necessarily altering the association between ESG performance and information asymmetry in every institutional setting.

One explanation for the insignificant moderation effect is that public ESG disclosure may reduce information asymmetry through mechanisms available to all investors rather than primarily through governance channels controlled by dominant shareholders. Once environmental, social, and governance information is disclosed in annual reports, sustainability reports, audited statements, and regulatory reporting systems, minority shareholders can potentially benefit from this information regardless of whether ownership is concentrated or dispersed. In such circumstances, ESG disclosure functions as a public information mechanism whose transparency-enhancing effect is not strongly dependent on the monitoring incentives of blockholders. Another explanation is that the positive monitoring effect of concentrated ownership may be counterbalanced by private-information advantages enjoyed by controlling shareholders. Large shareholders can have greater incentives to monitor management, yet their close relationships with managers may provide them with information unavailable to smaller investors. Consequently, ownership concentration may simultaneously reduce managerial–shareholder agency problems while intensifying majority–minority shareholder information inequalities. The net moderating effect may therefore become statistically weak. This reasoning is compatible with the broader governance literature showing that information asymmetry and governance mechanisms are intertwined in complex ways [1, 15].

Additional contextual factors may also explain the findings. Analyst coverage has been found to moderate the relationship between CSR performance and information asymmetry, indicating that information intermediaries can influence the extent to which sustainability information reaches and benefits investors [13]. Similarly, stakeholder protection can condition the informational consequences of sustainability disclosure [11], while business-group affiliation can shape the relationship between CSR and information asymmetry [12]. These findings imply that ownership concentration represents only one of several institutional mechanisms through which ESG information may affect market transparency. In the Tehran Stock Exchange, regulatory disclosure requirements, the role of institutional shareholders, industry characteristics, market liquidity, and the accessibility of information through Codal and other reporting platforms may be sufficiently important to reduce the relative influence of ownership concentration on the ESG–information asymmetry relationship. The finding therefore highlights the need to avoid assuming that governance mechanisms operate independently of their institutional context.

The control-variable results provide additional insight into the determinants of information asymmetry. Firm size exhibited a significant negative association with information asymmetry in both models, suggesting that larger firms may have more transparent information environments. This result is plausible because larger firms are generally subject to greater investor attention, regulatory scrutiny, media coverage, and disclosure expectations. In the second model, trading volume was positively significant, while stock-return volatility exhibited a strong positive association with information asymmetry, indicating that greater market uncertainty and price instability are associated with wider informational disparities. Sensitive-industry status was negatively associated with information asymmetry, which may reflect the comparatively higher scrutiny and disclosure pressure imposed on firms operating in environmentally and socially sensitive industries. This interpretation is compatible with evidence indicating that firms in sensitive industries may display stronger ESG performance as a response to

greater stakeholder and regulatory pressure [19]. Furthermore, the economic relevance of environmental and social performance may depend on competitive conditions, as demonstrated by research examining competitive power as a moderator of the relationship between sustainability performance and financial outcomes [20]. These supplementary findings reinforce the broader conclusion that corporate information environments are shaped by an interaction among firm characteristics, sustainability performance, market conditions, and governance arrangements.

More broadly, the findings contribute to understanding why ESG practices may influence a range of corporate outcomes documented in prior research. Reducing information asymmetry can improve investors' ability to assess firm value, decrease uncertainty surrounding corporate prospects, facilitate external financing, and improve capital allocation. This informational mechanism may partly explain why environmental strategies can generate economic benefits over longer horizons [4] and why ESG and CSR have become increasingly integrated into corporate-finance research [2]. It may also help explain the association of CSR and ESG with downside market risks. Touski's analysis of CSR, stock price crash risk, and information asymmetry highlights the possibility that improved corporate transparency can reduce the accumulation of undisclosed negative information that might otherwise contribute to sudden price declines [27]. In this sense, the negative relationship documented in the present study is not merely a statistical association between two corporate indicators; it represents a potentially important mechanism through which sustainability-oriented management can improve the functioning of capital markets.

Taken together, the study provides evidence that ESG performance plays a meaningful transparency-enhancing role in the Tehran Stock Exchange. The robust negative association between ESG performance and information asymmetry suggests that firms with stronger environmental, social, and governance performance contribute to a richer and more balanced information environment for investors. At the same time, the absence of a significant interaction between ESG performance and ownership concentration indicates that this beneficial informational effect does not appear to depend substantially on the concentration of corporate ownership. This finding adds to a literature in which governance arrangements and information intermediaries have sometimes been shown to condition the effects of sustainability practices [13, 16, 17], while demonstrating that such conditional relationships are not necessarily universal. The findings therefore reinforce the importance of studying ESG within specific institutional environments and suggest that, in the Iranian capital market, enhanced ESG performance may operate as a relatively independent mechanism for improving transparency and reducing information asymmetry.

This study is subject to several limitations that should be considered when interpreting its findings. First, the sample was restricted to companies listed on the Tehran Stock Exchange during the selected period, and therefore the findings may not be generalizable to unlisted firms, smaller enterprises, financial institutions excluded by sampling criteria, or firms operating in other capital markets with different regulatory and ownership structures. Second, ESG performance was measured through content analysis and disclosure-based scoring, which, despite the use of a structured checklist, may not fully capture the substantive quality or actual effectiveness of firms' environmental, social, and governance activities. A firm may disclose extensive ESG information without necessarily achieving correspondingly strong real-world sustainability performance. Third, information asymmetry was measured primarily through the bid–ask spread, which is a widely used market-based proxy but does not capture every dimension of informational inequality. Fourth, ownership concentration was measured based on the aggregate holdings of the largest shareholders, without distinguishing among institutional, governmental, family, corporate, or other types of controlling owners whose incentives and access to information may differ considerably. Fifth, although several firm-level control variables were incorporated into the regression

models and corrected standard errors were employed to address econometric concerns, unobserved institutional, macroeconomic, managerial, and market-specific factors may still influence information asymmetry. Finally, the observational and ex post facto research design limits strong causal interpretation, and the estimated relationships should therefore be interpreted primarily as robust empirical associations.

Future studies can extend the present research in several directions. Researchers may examine the separate effects of environmental, social, and governance dimensions rather than relying only on an aggregate ESG score, because each component may affect information asymmetry through different mechanisms. Comparative studies across emerging and developed markets would be useful for determining whether the transparency effect of ESG depends on investor protection, disclosure regulation, ownership systems, or capital-market development. Future research may also distinguish different forms of ownership concentration, including institutional, governmental, family, managerial, and foreign ownership, to determine whether the identity of controlling shareholders is more important than concentration alone. Additional moderating or mediating variables such as board independence, analyst coverage, audit quality, institutional ownership, corporate reputation, financial constraints, media attention, digital disclosure quality, and investor sentiment may also be examined. Alternative measures of information asymmetry, including probability of informed trading, price impact measures, analyst forecast dispersion, abnormal trading behavior, and liquidity indicators, could improve the robustness of future findings. Researchers may further employ dynamic panel models, instrumental-variable approaches, propensity-score methods, natural experiments, or regulatory changes to strengthen causal inference. Finally, longitudinal research examining changes in ESG disclosure standards and sustainability reporting requirements would help determine whether greater standardization increases the information value of ESG reporting over time.

The findings have several implications for managers, investors, regulators, and other capital-market participants. Managers of listed companies should regard ESG performance and sustainability reporting as components of the firm's information strategy rather than merely as reputational or compliance activities. Greater attention should be given to providing measurable, comparable, consistent, and decision-useful environmental, social, and governance information so that investors can more accurately evaluate corporate risks and long-term prospects. Companies should integrate ESG indicators into annual reporting, internal control systems, strategic planning, risk management, and investor-relations practices. Regulators and the Tehran Stock Exchange may consider developing more standardized sustainability-reporting requirements and sector-specific ESG disclosure frameworks to enhance comparability among firms and reduce discretionary reporting. Investors and financial analysts should incorporate ESG indicators into valuation, risk assessment, portfolio construction, and due-diligence procedures because stronger ESG performance may signal a more transparent information environment. Particular attention should also be paid to protecting minority shareholders in firms with highly concentrated ownership, even though ownership concentration did not significantly moderate the ESG–information asymmetry relationship in this study. Finally, professional associations, accounting bodies, and corporate-governance institutions can support the development of ESG reporting through training, assurance standards, disclosure guidelines, and independent evaluation mechanisms that improve the credibility and usefulness of sustainability information.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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