

Heterogeneous ESG Disclosure and Risk Diversification in Cross-Industry Portfolios: A Review

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Abstract

Environmental, Social, and Governance (ESG) information is increasingly used to evaluate long-horizon risks and to construct cross-industry portfolios. Yet the usefulness of that information depends not only on whether firms disclose, but also on whether disclosures are comparable across industries, firms, and data providers. This review synthesizes research on disclosure regulation, ESG rating disagreement, asset pricing, and portfolio choice to examine how heterogeneous ESG disclosure may alter diversification. The literature supports two conclusions that must be held together. First, common disclosure requirements can improve firms' information environments, market liquidity, and investors' ability to compare exposures. Second, a fully uniform score can obscure industry-specific materiality because environmental, social, and governance risks do not affect every business model in the same way. When scope, measurement, and weighting choices differ without transparent reconciliation, rating disagreement becomes an additional layer of estimation uncertainty. Portfolio managers may then misclassify exposures, underestimate common risk drivers, and obtain less diversification than historical covariance estimates suggest. The review therefore favors a tiered regulatory design: a mandatory cross-industry core of comparable metrics, supplemented by industry-specific material disclosures and transparent methodological bridges. Direct causal evidence at the portfolio level remains limited, so future research should connect disclosure heterogeneity to covariance estimation error, out-of-sample portfolio risk, and stress-period performance.

Keywords

ESG disclosure, comparability, cross-industry portfolios, diversification, rating disagreement

1. Introduction

Sustainability information has moved from a specialist concern to a routine input in capital allocation. Investors use ESG disclosures to identify transition, physical, labor, governance, and reputational risks that may not be fully visible in conventional financial statements. Regulators have responded by expanding mandatory reporting. The International Sustainability Standards Board's IFRS S1 establishes a global baseline focused on sustainability-related risks and opportunities that could affect cash flows, access to finance, or the cost of capital, while the European Union's Corporate Sustainability Reporting Directive broadens mandatory sustainability reporting and standard setting [1, 2]. These initiatives share an informational ambition: decision-

useful disclosure should help investors distinguish firm-specific exposures from risks that are common across firms and industries.

That ambition is especially important for cross-industry portfolios. Modern portfolio theory explains that diversification reduces idiosyncratic risk when asset returns are imperfectly correlated [3]. In practice, however, the covariance matrix is estimated from historical returns and interpreted with forward-looking information. ESG disclosures can affect that interpretation by revealing latent common exposures, such as carbon regulation, supply-chain labor practices, or governance failures. If disclosures are incomplete or measured differently across industries, apparently unrelated securities may share risks that investors fail to identify. Diversification can then look stronger *ex ante* than it proves *ex post*.

The central difficulty is that comparability and materiality pull regulation in different directions. A common reporting baseline makes firms easier to compare, but the same indicator may be economically central in one industry and peripheral in another. Khan et al. show that strong performance on financially material sustainability issues is more closely associated with future performance than strength on immaterial issues [4]. Conversely, excessive industry discretion can make the definition, measurement, and weighting of ESG information inconsistent. Berg et al. document substantial disagreement among major ESG ratings and attribute most of it to measurement and scope rather than weighting alone [5]. The resulting uncertainty is not merely a labeling problem; it affects expected returns, risk estimates, and portfolio demand [6, 7].

This review asks how heterogeneous ESG disclosure influences risk diversification in cross-industry portfolios and what regulatory architecture best balances comparability with industry relevance. It argues that heterogeneous disclosure weakens diversification when it prevents investors from mapping economically similar risks onto comparable measures. However, differentiation is not inherently harmful. A tiered structure combining common core metrics, industry-specific supplements, and transparent reconciliation rules can improve both comparability and materiality. This conclusion is bounded by an important evidence gap: most studies examine disclosure, ratings, liquidity, returns, or ESG-constrained frontiers separately, while few directly estimate the causal effect of disclosure heterogeneity on out-of-sample portfolio diversification.

2. Conceptual Foundations

2.1 Information Asymmetry and Disclosure

Disclosure regulation is commonly justified as a response to information asymmetry. Managers know more than outside investors about operational exposures, controls, and strategic dependencies. Credible reporting can narrow that gap, improve price discovery, and reduce adverse-selection costs. International evidence is broadly consistent with this channel. Krueger et al. find that mandatory ESG disclosure improves stock liquidity, particularly when mandates are government-led, strongly enforced, and applied to firms with weak information environments [8]. Yet disclosure does not mechanically create useful information. Benefits depend on precision, verification, scope, and the ability to compare the reported item with a relevant benchmark.

2.2 Portfolio Diversification and Estimation Risk

Portfolio diversification depends on the joint distribution of returns, not on the number of industries represented. Markowitz's framework highlights expected return, variance, and covariance [3]. The capital asset pricing model further distinguishes systematic from diversifiable risk [9]. ESG information can enter this framework in at least three ways: it can reveal cash-flow risks, affect investor preferences, or change beliefs about the probability and covariance of adverse events. Pedersen et al. formalize this interaction through an ESG-efficient frontier [10]. Pástor et al. show that investor tastes and green-asset supply can affect equilibrium returns [11]. When ESG inputs are noisy or incomparable, the optimization problem inherits additional parameter uncertainty.

2.3 Materiality and Comparability

Materiality asks which sustainability issues could reasonably influence enterprise prospects; comparability asks whether economically similar exposures are represented consistently across reporting entities. The two concepts are complements rather than substitutes. Industry-specific metrics are needed because a bank, a

software company, and an oil producer face different operational pathways. A common core remains necessary because investors must aggregate exposures across the portfolio. Regulation therefore needs both a shared semantic layer and sector-level detail. Heterogeneity becomes harmful when different terms, boundaries, denominators, or assurance levels cannot be reconciled.

3. Literature Review

3.1 ESG Disclosure and the Information Environment

The first literature stream evaluates whether sustainability disclosure changes the quality of the market information environment. Earlier firm-level studies associate stronger sustainability systems and reporting with distinctive governance processes and long-term performance [12]. Reverte reports that higher-quality CSR disclosure is associated with a lower cost of equity among Spanish firms, consistent with reduced information risk [13]. More recent policy studies use disclosure mandates as quasi-experiments. Using a global data set of ESG mandates, Krueger et al. document improved stock liquidity and stronger effects where enforcement is credible [8]. Roy et al. similarly find increased liquidity following India's mandatory CSR expenditure regime [14]. These findings support the proposition that standardized and enforceable disclosure can reduce frictions relevant to valuation and trading.

The evidence is not uniformly positive, which is important for regulatory design. Mandatory reporting may produce boilerplate, compliance costs, strategic impression management, or changes in trading incentives. Chinese evidence illustrates this heterogeneity. Some studies find that mandatory CSR reporting improves liquidity by reducing information asymmetry [15]. Others find reduced stock-price informativeness or liquidity when disclosure lowers the private-information rents that motivate informed trading [16]. Chen et al. also show a trade-off: mandatory CSR disclosure reduced pollution in affected cities but was followed by lower profitability among reporting firms [17]. The appropriate conclusion is therefore conditional. Disclosure mandates can improve the common information set, but the benefit depends on content quality, enforcement, governance, and the behavior of market participants.

This conditionality clarifies why a rule focused only on disclosure volume is insufficient. Portfolio investors need standardized definitions, decision-useful metrics, time consistency, and links to financial effects. IFRS S1 reflects this logic by emphasizing material risks and opportunities, governance, strategy, risk management, and metrics and targets [1]. The framework also recognizes industry-specific information. In cross-industry analysis, the regulatory objective should be neither maximum uniformity nor maximum discretion, but a structure that permits common aggregation without suppressing economically relevant sector differences.

3.2 ESG Information in Asset Pricing and Portfolio Construction

A second literature stream examines whether ESG characteristics affect expected returns and optimal portfolios. Pedersen et al. show that ESG scores can contain information about fundamentals while also influencing investor preferences [10]. Their ESG-efficient frontier makes the trade-off explicit: the highest attainable Sharpe ratio varies with the portfolio's ESG level. This framework rejects the simplistic claim that higher ESG is always costless or always return-enhancing. Portfolio consequences depend on how informative the score is, how investors value sustainability, and how constraints alter the opportunity set.

Empirical asset-pricing evidence reinforces the need for industry-aware interpretation. Bolton and Kacperczyk find a carbon premium in U.S. equities: firms with higher emissions earn higher returns after controlling for standard predictors, consistent with compensation for carbon exposure [18]. Krueger et al. report that institutional investors view climate risk as financially relevant and generally prefer risk management and engagement to simple divestment [19]. Khan et al. distinguish material from immaterial sustainability issues and find that the material subset is more informative for performance [4]. Together, these studies imply that portfolio managers should not treat an aggregate ESG score as a homogeneous characteristic. The economic channel, exposure measure, and industry context matter.

Cross-industry diversification can nevertheless benefit from ESG disclosure when disclosures uncover common drivers that historical classifications miss. Industries that appear distinct may depend on the same energy system, labor market, supplier geography, data-governance regime, or regulatory transition.

Comparable ESG measures can reveal these connections and prevent the portfolio from concentrating in a latent factor. Conversely, non-comparable measures may create false distinctions. For example, if emissions are reported with different organizational boundaries or labor indicators use incompatible denominators, the investor cannot reliably compare exposures or aggregate them at portfolio level. The resulting problem is a form of model risk: the covariance matrix may be numerically precise but economically mis-specified.

3.3 Rating Disagreement as a Transmission Mechanism

The rating-disagreement literature provides the clearest bridge from disclosure heterogeneity to portfolio risk. Chatterji et al. show that social ratings of the same firms do not converge, raising questions about commensurability and the underlying theory of what is measured [20]. Berg et al. decompose disagreement across six major providers [5]. Pairwise correlations range from 0.38 to 0.71; measurement divergence accounts for 56% of total divergence, scope for 38%, and weighting for only 6% [5]. This result matters because aligning headline weights would solve little if providers measure different attributes or use different indicators for the same attribute.

Corporate disclosure can both reduce and increase rating disagreement. Christensen et al. find that firms with greater ESG disclosure can display greater rating disagreement because additional disclosure provides raters more attributes to interpret and because methodologies differ [21]. More information is therefore not identical to more consensus. Where reporting frameworks, units, and category definitions are inconsistent, disclosure expansion may create additional interpretive degrees of freedom. The relevant policy objective is usable comparability rather than disclosure quantity.

Disagreement has economic consequences. Gibson Brandon et al. find that higher ESG rating disagreement is associated with higher stock returns in an S&P 500 sample, consistent with a disagreement-related risk premium [7]. Avramov et al. model ESG rating uncertainty and show that it affects equilibrium demand, effective beta, alpha, the risk-return trade-off, and welfare [6]. Evidence from China also links disagreement to returns, volatility, and investor sentiment, although the estimated direction varies across settings [22, 23]. These differences caution against a universal sign, but they consistently identify disagreement as financially relevant uncertainty.

For cross-industry portfolios, rating disagreement can weaken diversification through four connected mechanisms. First, classification error assigns firms to the wrong ESG risk bucket. Second, covariance error arises when common ESG exposures are measured on incompatible scales. Third, optimization instability follows because small changes in expected-return or risk inputs can produce large changes in portfolio weights. Fourth, stress-period convergence may occur when previously hidden common exposures become salient at the same time. Disclosure heterogeneity therefore acts as a moderator: it determines whether ESG information sharpens or blurs the investor's view of portfolio dependence.

3.4 Comparison of Evidence and Key Findings

Across the three literature streams, the most consistent finding is that disclosure quality and comparability matter more than disclosure volume alone. Mandatory regimes often improve liquidity and the public information environment, but enforcement and institutional context determine the strength and even the direction of the effect. Likewise, ESG integration can improve risk identification, yet aggregate scores may conceal material differences across industries. Rating studies show that disagreement is systematic, not random noise that can safely be ignored.

The principal disagreement concerns standardization. One view favors industry differentiation because financially material sustainability issues vary by business model. This position is supported by evidence on materiality and by the industry-specific architecture embedded in ISSB practice. The opposing concern is that excessive differentiation destroys cross-firm comparability. Berg et al.'s decomposition supports this concern: scope and measurement choices account for most rating divergence [5]. Both views identify a real problem. Uniform indicators can be irrelevant; unconstrained differentiation can be incomparable.

A tiered disclosure model reconciles the two positions. The first tier should contain a mandatory cross-industry core: reporting boundaries, governance, materiality process, principal risks, time horizons, assurance status, and a small set of consistently defined metrics. The second tier should contain industry-specific

exposures and denominators. A third reconciliation layer should explain changes in methodology, map company-specific measures to standard categories, and disclose missing or estimated data. This architecture supports portfolio aggregation while preserving sector relevance.

The strongest defensible conclusion is therefore narrower than the original outline's claim that differentiated disclosure necessarily increases portfolio risk. Heterogeneity raises risk when it is opaque, weakly assured, or non-reconcilable. Transparent industry differentiation can instead improve risk assessment by representing material exposures more faithfully. The regulatory task is to distinguish useful heterogeneity from arbitrary heterogeneity. For investors, the practical implication is to treat rating dispersion and data provenance as risk inputs rather than to rely on a single composite score.

The synthesis suggests a transmission chain linking reporting design to diversification outcomes. Regulatory requirements shape the scope, units, assurance, and timing of firm disclosures. Data vendors then transform those disclosures using provider-specific taxonomies and weights. Investors use the resulting data to estimate expected returns, exposures, and covariance. Portfolio weights reflect those estimates. If heterogeneity is not mapped transparently, measurement error enters each stage and may appear ultimately as unexpected tracking error, concentration, or drawdown. This chain makes clear why disclosure is not merely a corporate-reporting issue; it is part of the portfolio model's data-generating process.

4. Discussion and Research Agenda

4.1 Research Limitation

The review has limitations. It combines evidence from ESG, CSR, climate, disclosure, liquidity, and asset-pricing studies whose outcomes and institutional settings differ. Much of the evidence is observational or based on policy changes affecting selected firms and countries. Rating disagreement is an imperfect proxy for disclosure heterogeneity because disagreement also reflects provider judgments and incentives. Finally, a literature review cannot establish that disclosure heterogeneity causally increases realized portfolio risk. Its contribution is to identify a plausible and evidence-supported mechanism, clarify boundary conditions, and define tests that could establish the portfolio effect more directly.

Furthermore, current research does not fully identify the final link in this chain. Rating disagreement is well documented, and portfolio models show how ESG uncertainty should matter, but direct portfolio-level tests remain scarce. A convincing design would construct a disclosure-heterogeneity index using differences in scope, units, reporting boundaries, assurance, and timeliness. Researchers could then test whether the index predicts covariance forecast errors, weight instability, realized volatility, and diversification shortfall after controlling for conventional firm and industry characteristics. Out-of-sample tests and stress periods would be especially informative because hidden common exposures are most likely to emerge when markets reprice risk.

4.2 Future Research Direction

Three additional questions deserve attention. First, researchers should separate useful industry specificity from arbitrary inconsistency. This requires evaluating whether sector supplements improve prediction after a common baseline is imposed. Second, provider disagreement should be decomposed at the metric level rather than treated only as the standard deviation of headline ratings. Third, disclosure regulation should be evaluated for distributional and behavioral effects, including compliance costs, strategic reporting, informed-trader exit, and the possibility that standardization encourages herding around the same data.

5. Conclusion

ESG disclosure can strengthen cross-industry diversification when it reveals material exposures in a form that investors can compare and aggregate. It can weaken diversification when differences in scope, measurement, boundaries, or assurance create rating disagreement and estimation error. The literature therefore does not support either extreme proposition that uniform disclosure is always superior or that industry differentiation is inherently beneficial. Materiality requires sector-specific information; portfolio construction requires a common baseline.

A tiered regulatory architecture offers the most credible balance: mandatory cross-industry definitions and core metrics, industry-specific supplements, and transparent reconciliation of methodologies and missing data. For portfolio managers, rating disagreement and data lineage should be incorporated into sensitivity analysis, robust optimization, and stress testing. For regulators, success should be measured by decision usefulness and comparability rather than report length. The remaining research priority is direct causal evidence connecting disclosure heterogeneity to covariance error, weight instability, and realized diversification shortfall. Until that evidence develops, claims should remain bounded: heterogeneous disclosure is a material source of model uncertainty, but its portfolio effect depends on whether differences are economically informative and transparently reconcilable.

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