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ESG ratings in the mining industry: Factors and implications

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ABSTRACT

While previous research explores the relationship between ESG ratings, firm size, and financial outcomes, there is a lack of comprehensive analysis comparing multiple ESG ratings within the mining industry. This gap is crucial given the increasing focus on ESG in mining operations and its potential impact on company performance. Based on proprietary financial and ESG ratings data from 200 mining companies, this study investigates the relationship between two different ESG ratings and firm characteristics. We compare ESG-rated firms with unrated firms in terms of firm size, and financial performance indicators, and explore country-level patterns in ESG ratings. Findings reveal that ESG-rated mining companies are generally larger than unrated firms but neither more profitable nor face lower debt costs. The results also show that, among rated firms, larger mining firms have more favorable ESG ratings than smaller ones. However, we fail to find a correlation between ESG ratings and financial performance. Finally, the evidence suggests that mining companies rated high for unmanaged ESG risk are likely to have lower ESG scores. This research contributes to understanding whether and how ESG ratings could impact investment decisions and risk management strategies in the mining sector.

1. Introduction

The mining industry has long been associated with environmental challenges, strained community relations, and inherent investment risks. As a result, investors, communities, and policymakers are increasingly interested in quantitatively monitoring the sustainability performance of mining firms. This has led the industry to be more proactive in its sustainability efforts by transparently addressing risks and concerns related to environmental, social, and governance (ESG) performance.[1] Despite growing ESG initiatives in the mining sector, there remains uncertainty about which types of mining companies are best positioned to lead in adopting ESG commitments and setting industry benchmarks. Additionally, due to data limitations, it remains unclear to what extent these ESG initiatives enhance performance at a significant scale and whether successful ESG performance has a measurable impact on the financial performance of the sector, including profitability, access to capital, and favorable borrowing terms. As more ESG metrics become available, careful consideration will be necessary to assess their meaningfulness in guiding investment decisions.

Besides company-initiated ESG reports and disclosures, third-party agencies compile a variety of ESG-related information from multiple sources and provide company-specific ESG ratings to provide investors with a single metric. These ESG ratings can be used by investors to assess and compare ESG performance across companies and time. Bloomberg, Refinitiv, and Sustainalytics are among several ESG-rating agencies. A growing number of studies apply these third-party ratings to understand the correlation between ESG ratings and financial performance as well as examine factors that could affect these ratings, but the mining sector remains largely understudied (Tsang et al., 2024). For example, a substantial number of studies examine determinants of ESG scores in banking and financial industries (Crespi and Migliavacca, 2020). Although some studies use ESG scores as an indicator of ESG performance (Pinheiro et al., 2023; Abdul Razak et al., 2023), ESG-related activities or initiatives such as corporate disclosures (Baldini et al., 2018) (e.g., favorably rated firms are assumed to have good measurable impacts such as lower greenhouse gas emissions, etc.), the focus of this

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study is understanding factors affecting third-party ESG scores and the potential impact of these ratings on the financial health of mining companies. This is because investors often find ESG scores/ratings a more efficient way to consistently evaluate companies without having to analyze a wide range of raw data (e.g., greenhouse gas emissions, energy consumption, water usage, land use, workplace injury, policies on child labor, board composition, etc.).

Two of the most widely discussed factors highly correlated with favorable ESG ratings are *firm-level characteristics* such as firm size, resources, and capabilities (Bissoondoyal-Bheenick et al., 2023; Crespi and Migliavacca, 2020; Drempetic et al., 2020) as well as *institutional factors* shaped by the countries where companies originate or operate (Pinheiro et al., 2023; Costantiello and Leogrande, 2023; Dougherty, 2017). In terms of firm-level characteristics, Crespi and Migliavacca (2020) find that firm size and profitability largely affect ESG ratings due to greater financial resources and greater visibility. In terms of institutional factors, there is a common theme in scholarship, finding a positive relationship between institutional quality and ESG performance where good ESG performance could lead to more favorable ratings. Abdul Razak et al. (2023) and Costantiello and Leogrande (2023) find that both institutional "social equity" and "political stability" are positively correlated with ESG performance. Based on a global sample of firms in the energy sector, Pinheiro et al. (2023) use Refinitiv's ESG scores (ranging from 0 to 100) as a proxy for environmental performance and find that a country's institutional quality (e.g., rule of law, economic freedom, etc.) affects ESG scores.

There are limited studies analyzing *ESG ratings* in the mining industry (Jin, 2023; Fu et al., 2024). Thus, it is not clearly understood which types of mining companies end up being rated versus not and whether the same factors that matter for other industries (e.g., firm size and country of origin) hold the same significance for mining firms. In addition, it is not clearly understood how well financial markets in general, and creditors in particular, respond to the ESG ratings of mining companies. Studies by Chen et al. (2022a,b), and Jang et al. (2020) suggest that poor ESG scores can lead to higher costs of debt, as firms that neglect ESG investments are perceived to have higher credit risk. This increased risk arises from potential future cash flow disruptions due to non-compliance with ESG regulations "imposed on the economy", as well as a reduction in "reputation capital." Enhanced ESG disclosure helps build reputation capital, which can mitigate informational asymmetry and, consequently, lower borrowing costs. However, both studies acknowledge that the mechanisms linking ESG scores to debt costs are not fully understood and remain particularly unclear for the mining sector.

Studies based on data from other industries suggest the importance of favorable ESG scores in facilitating financial performance (Velte, 2017; Sinha Ray and Goel, 2023) and earning market value which could reduce financial risks. While studies such as Apergis et al. (2022) and Eliwa et al. (2021) argue that, for non-mining sectors, poor ESG scores could lead to higher cost of debt due to sustainability factors being factored in capital allocation decisions (e.g., environmental liability expected to increase the probability of default, market response to ESG ratings, etc.), these mechanisms are not properly understood for mining firms. For example, poorly rated mining firms could be excluded from the capital market (e.g., not able to find creditors), they could end up with a higher cost of debt, or ESG ratings may not matter at all as long as mining operations are profitable and financially healthy (Chen et al., 2022b).

Our study specifically focuses on the mining sector due to its potential risks regarding ESG (Fikru et al., 2024). ESG risks including environmental and human rights risks within the mining industry are discussed in Frederiksen (2018). Mining practices can contribute to land deterioration as well as water and air pollution. There are also risks regarding law and regulation compliance as well as labor issues. Maybee et al. (2023) emphasize the pressure investors, customers, and regulators are putting on mining companies to monitor and manage ESG risk.

In a similar line of the literature, Huang and Ge (2024) focus on ESG disclosure in the mining industry while Dougherty (2017) presents a qualitative discussion of reputational risks within the mining industry. We contribute to the emerging literature that directly focuses on the '*ESG ratings in the mining sector*' by addressing the following research questions: (1) What type of mining companies end up being rated for ESG by third-party rating agencies? (2) Among ESG-rated mining companies, how strongly do ESG ratings correlate with firm size, country of origin, firm profitability, and the cost of debt? (3) How well do ESG ratings from different third-party rating agencies correlate to provide consistent information? Our answers to these questions contribute to a greater understanding of ESG ratings in the mining sector where results have implications for informed investment choices and sustainable practices in the mining industry. To that end, we contribute to the literature on ESG ratings in mining in at least three important ways.

First, understanding which mining companies are likely to be rated by third parties for their ESG performance is crucial for various reasons, and very few studies are addressing this question for the mining industry. ESG ratings significantly influence investor decisions, with higher-rated companies attracting more investment and lower-rated firms facing challenges to secure investment funds. While the lack of an ESG rating does not imply poor ESG performance, investors interested in sustainability may perceive a lack of rating as a *lack of visibility*. For instance, Bissoondoyal-Bheenick et al. (2023) find that firms with visibility (e.g., media coverage) can help reduce ESG-related information asymmetry among several stakeholders. Moreover, the availability of an ESG rating may help increase investor confidence, providing data for performing risk assessments while the absence may require investors to conduct their investigation which requires more time and effort. Unrated firms could be viewed as uncertain in their ESG commitments and miss out on investment opportunities while ESG-rated firms offer benchmarks for informed decision-making.

Second, despite a growing number of recent studies correlating ESG scores to firm size and financial indicators for other industries, the mining industry remains largely unexplored with only a handful of studies comparing ESG scores to firm profitability and cost of debt (Doughery, 2017; Pinto-Gutiérrez, 2023; Drempetic et al., 2020). Understanding the relationship between ESG ratings, firm profitability, and cost of debt contributes to informed investment decision-making, risk management, and long-term sustainability. Policymakers could also tailor regulations and incentives based on these correlations to encourage sustainable practices within the mining industry. Third, examining the alignment, discrepancy, or complementarity of ESG ratings across the different third-party agencies is important because some investors may rely on more than one rating, and if the information communicated diverges it can lead to confusion, reduce investor confidence, and increase information asymmetry problems. Some recent studies compare ESG ratings from multiple sources (Dimson et al., 2020; Berg et al., 2022; Lopez et al., 2020), but none in the context of mining.

To address the three research questions, we collect financial data on the population of mining companies found in the Pitchbook database (a software, data, and technology provider with proprietary and comprehensive data on global capital markets) based on which we look for ESG ratings from two ESG rating companies: *Sustainalytics* ESG Risk Rating and *Refinitiv*'s ESG Score (recently renamed LSEG) (Refinitiv Website, 2024). We contribute to the literature by using *two* ESG ratings by *two different* third-party evaluators. Using multiple ESG ratings provides a more comprehensive outlook for performance than relying on a single score.

In Section 2, we present a summary of existing studies on ESG ratings. Section 3 presents data and methods used to address our research questions. Section 4 presents and discusses our main findings, while Section 5 concludes by addressing limitations and questions for future research.

2. The conceptual evolution of ESG ratings

ESG can trace its conceptual lineage back to the 1990s when scholars began to apply approaches to sustainable development to a more specific concept of sustainability in mining and other natural resource sectors. The literature on sustainability in mining sought to illustrate how industry might take the lead in finding ways to reduce the impact of mining on the environment ranging from developing new techniques (e.g., more resilient tailing ponds; less invasive extraction methods) to technologies (e.g., on-site solar power usage; on-site use of electric vehicles) (Azapagic, 2004; Glavič et al., 2007; McLellan et al., 2009; Franks et al., 2013; Lodhia and Hess, 2014). Although they welcomed such techniques and technologies that were more environmentally friendly, critics of sustainability in mining contended that such initiatives and practices amounted to little more than 'greenwashing' (Hamann and Kapelus, 2004; Fonseca et al., 2014; Contreras-Pacheco and Claasen, 2017; de Freitas Netto et al., 2020; Katz-Lavigne, 2022; Ruiz-Blanco et al., 2022). ESG sought to move the discussion forward – beyond the environmental (the 'E' in ESG) – of the sustainability and greenwashing camps by incorporating more societal and governance considerations, which led to the rise of corporate social responsibility (CSR) and social license to operate (SLO) terminologies (Hodge, 2014; Butler, 2020; Enns et al., 2020, 2022) and initiatives (Alorse et al., 2015; Alorse and Andrews, 2022; Campbell, 2020; Grant and Wilhelm, 2022). Though the concept of ESG has gained much traction in scholarly circles in recent years, it would be naïve to assume that it has displaced the work of sustainability researchers or assuaged observers concerned with greenwashing. Indeed, the literature on sustainability and greenwashing in mining has adapted to contemporary governance issues, such as evaluating governance strategies in critical minerals (Moran et al., 2014; Atkins, 2023; Eke et al., 2024). Ultimately, analyses that are inspired by either sustainability in mining or greenwashing help ESG scholars remain cognizant of the agency of industry and vigilant of the need to scrutinize the motivations of the industry – themes that permeate the three strands of the literature on ESG factors in mining.

Despite the growing number of studies examining ESG scores in several manufacturing sectors highlighting the relationship between ESG ratings and financial performance, from which many conclude that ESG performance has a positive relationship with financial performance (Sun et al. 2023; Popescu et al., 2023; Chen et al., 2022a; Buallay 2019; Albertini, 2013; Jennifer Ho and Taylor, 2007), there are relatively fewer studies that examine ESG ratings for the mining and extractive industry, and none that use and compare multiple ESG ratings. Most of the existing studies that look at ESG in mining focus on (1) describing the importance of ESG (e.g., performance, disclosure, ratings) for the industry (Leonida, 2022a,b; Garcia-Zavala et al., 2023); (2) exploring the impact of firm size and country of origin on ESG related performance (Dougherty, 2017); and (3) examining the impact of ESG ratings or disclosures on financial risks and market valuation of mining companies.

In the first strand of the literature (description of ESG factors in mining), studies focus on ESG disclosures in the mining sector and assess the extent to which disclosed information matches actual performance (Herbohn et al., 2014; Lodhia and Hess, 2014). For example, Talbot and Barbat (2020) examine the extent to which mining disclosures in water quality sustainability reports match with actual water quality impacts. Earlier studies such as Deegan et al. (2000) and Coetzee et al. (2011) argue that mining firms disclose sustainability-related topics when there is a need to manage risk and loss of reputation while other studies focus on the role of pressure from local communities and government in

promoting transparency (Arthur et al., 2017).

More recently, Leonida (2022a) argues that while sustainability and environmental impacts have historically been inherent risk factors for the mining sector, the focus on ESG as a company strategy has just evolved in the past two decades. Mining companies have started to make ESG a central focus of their investment strategies, company structures, and culture to garner trust and secure a social license to operate.[2] This is because companies understand that ESG factors could affect the company's overall performance. For example, mining companies are integrating ESG risk management across their operations starting from the exploration phase to mine closures while at the same time enhancing transparency to fulfill their ESG commitments (Leonida, 2022b). Garcia-Zavala et al. (2023) find that mining companies in Chile face high levels of ESG risks while the study by Knizhnikov et al. (2021) depicts the growing importance of improving ESG management in the Russian mining industry where being listed in an international stock exchange market does not guarantee ESG transparency.

In the second strand of literature, although studies are showing a positive correlation between firm size and ESG ratings in other non-mining sectors, there are limited parallel studies in the mining industry – among which the study by Dougherty (2017) helps move the literature forward. Previous studies in general show that bigger firms with better financial resources are in a better position to invest in ESG disclosure and performance resulting in more favorable ratings. This is because according to the resource-based view of the firm, available resources and hard-to-replicate capabilities can enable investments in ESG (e.g., measurable performance and transparency) which could lead to favorable ESG ratings. For instance, Drempetic et al. (2020) find a positive correlation between firm size (number of employees, total assets, and revenue) and ESG scores, while Bissoondoyal-Bheenick et al. (2023) find that larger firms invest in ESG activities to reflect stakeholder's demand better and due to economies of scale. Further, Drempetic et al. (2020) find that larger firms use more resource-intensive "structured management and reporting tools" that increase data availability in the ESG database, further bolstering sustainability performance regardless of the content of data. Their findings also note that the resources "fit better to the measurement system of the ESG rating agencies" (Drempetic et al., 2020). Such findings confirm the work of Giannarakis (2014), who found that bigger firms are better equipped to absorb the costs of environmental regulation measures.

In the mining industry, Dougherty (2017) based on a qualitative assessment of companies operating in Guatemala, shows that ESG risks could vary by firm size where junior mining firms tend to be more risk-tolerant than senior firms, suggesting that firm size matters for managing ESG related risk. Dougherty (2017) also finds that smaller firms are better able to perform well in volatile environments (e.g., weaker institutional framework) as compared to larger firms. We contribute to this line of literature by providing a quantitative assessment of ESG ratings for mining companies by using data from two different third-party raters and examining the correlation between firm size, financial performance, and ESG ratings among a sample of mining firms headquartered in different countries.

With respect to institutional factors in shaping company commitments to ESG, neo-institutional theory has established that the institutional framework within which a firm operates could affect its ESG practices (Meyer and Roman, 1977; DiMaggio and Powell, 1983; DiMaggio, 1988). Pinheiro et al. (2023) demonstrate that institutional quality is a complement to firms' ESG performance because country norms and rules are dominant guidelines for firm behavior. For example,

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[2] These sentiments have been echoed by mining company executives and consultants at industry gatherings such as the Prospectors and Developers Association of Canada (PDAC), which draws some 30,000 participants from across the globe each year. As observed by one of the authors in June 2022, March 2023, and March 2024 during the PDAC annual meetings in Toronto, Canada.

firms operating in countries or serving markets with long-standing and established ESG standards will likely adopt the established standards to meet stakeholder expectations (Dacin et al., 2002). Related to this, institutional frameworks that support firms to develop and implement sustainability practices (e.g., such as disclosures) could allow firms to achieve objectives while fulfilling their social contract (e.g., operating as expected by society) (Suchman, 1995; Burlea and Popa, 2013). The study by Huang and Ge (2024), based on a sample of mining companies, shows that country of origin matters where companies from developed countries have higher ESG disclosure quality, and these disclosures are strongly correlated with market values. The study by Dougherty (2017) also shows that the extent to which mining companies improve ESG performance (e.g., engaging host communities and monitoring environmental impacts) depends on the origin country of the mining companies. Our study contributes to this line of literature by exploring the pattern (if any) in ESG ratings by headquarters of ESG-rated companies.

There are fewer studies in the third strand of the literature examining the impact of ESG ratings on the financial performance of the mining industry. Galbreath (2013) and Fu et al. (2024) examine the impact of ESG ratings on the financial risk of mining companies in general, and in China, respectively. Another example is Huang and Ge (2024) who examine the correlation between ESG disclosure quality and market value and find that mining companies in developed countries have a higher correlation between their ESG disclosures and market values but not so in developing countries. Häßler (2011) offers insights into the role of institutional factors in shaping ESG outcomes and ratings for mining companies. Jin (2023) examines the correlation between ESG scores and stock returns for US mining companies and shows that excess stock returns for firms with favorable ESG ratings are higher potentially due to market risk premium and firm size factors. Garcia et al. (2017) focus on the ESG performance of "sensitive industries", which includes mining – yet it is not a sole focus, while Shipton and Dauvergne (2022) study mining corporations – yet focus on corporate social responsibility (CSR) which includes ESG as one of several considerations. Pinto-Gutiérrez (2023) shows that climate-related risks (drought) are relevant for the cost of debt of mining companies, and banks consider such risks when making lending decisions to borrowers that have low capability to mitigate these risks. This is one of the few papers on the cost of debt implication of ESG ratings for the mining industry.

Our study contributes to the third strand of the literature by discussing the potential role of ESG ratings on a company's cost of debt. Apergis et al. (2022) argue for the correlation between ESG scores obtained from Refinitiv and the cost of debt for borrowing firms using a sample of S&P 500 firms from 2010-2019 (e.g., sustainability could be an important factor in determining capital allocation). Their study shows that firms with poor ESG scores are viewed to be riskier and more exposed to environmental liability which might increase their probability of default and hence increase their cost of debt. Likewise, based on the legitimacy and institutional theories, Eliwa et al. (2021) argue for the role of ESG performance and disclosure in affecting the cost of debt suggesting that the market can reward favorable ESG performance/score. We add to these studies by focusing on the mining sector, studying determinants, and potential impact on the financial health of a company. Despite our understanding of the role of transparency for mining companies to gain legitimacy and the need to correctly disclose ESG-related information to investors and stakeholders, it is not clearly understood to what extent country context versus firm capabilities and resources could explain the variation in ESG ratings, and whether favorable ESG ratings contribute to a mining firm's cost of debt. The ability to acquire capital cost-effectively is important for the mining sector for at least two reasons. First, mining operations are typically performed in stages whereby earlier stages are financed by raising funds or borrowing money – which is paid back at the resource exploitation stages. In this case, firms need to demonstrate reputation and ability to repay borrowed capital. If ESG risks occur before exploitation/production stages, the borrowed capital may not be returned and so firms

that are suspected to face high ESG risk may face a higher cost of capital acquisition (e.g., interest rate).

Lastly, although there is a growing number of studies that document potential divergence in ESG ratings from different agencies, the extent to which ratings are in alignment in the mining sector (and the implications) are not fully understood. Dimson et al. (2020) argue that ESG ratings could sometimes be divergent where one company gets a higher score from one agency – but lower from another. This is primarily due to the weightings given to each pillar of the ESG metrics, which could vary across rating agencies. Dimson et al. (2020) also find that there is a low rate of correlation among the different ESG ratings based on agency rules and scoring mechanisms. Berg et al. (2022) compare six different ESG raters (including Sustainalytics and Refinitiv) and attribute the rating divergence to different methods used by different agencies. In particular, the differences are primarily due to measurement (56%) followed by scope (38%) and weight (6%). Lopez et al. (2020) also document disagreements across different ESG ratings based on two factors: different emphasis on the three pillars and the use of different data. The authors recommend that when raters disclose their prioritization of the three pillars, it will allow investors to choose a rating source that closely aligns with their preference and that raters should come up with a way to harmonize what data is collected and used in ratings. Dorfleitner et al. (2015) compare three ESG raters and report on the lack of convergency of ESG measurement concepts, where ratings from different sources do not have the same distribution.

In short, contradictory ratings may indicate hidden risks or discrepancies that require further investigation. Different rating agencies assess ESG performance from varying angles so when ratings are complementary using multiple ratings, it ensures a more comprehensive view of the firm (e.g., one score may not capture everything). While the scores must reflect different perspectives, they should provide complementary information and not contradictory ones. Inconsistent ratings may distract from strategic ESG priorities and open the door for greenwashing; it could also mean that companies will spend resources trying to address divergent ESG rating requirements and standards. Inconsistently interpreted scores can also introduce uncertainty in the market.

3. Data and methods

3.1. Characteristics of mining companies in the sample

We use our institutional subscription to Pitchbook Inc. to identify the population of public and privately owned mining companies across the globe for the year 2022. A total of 200 mining firms have full data on their key financial variables, representing the sample used for analysis. For each of the 200 sample mining companies, we searched for their ESG ratings provided by third-party rating agencies. We use ESG ratings obtained from two different sources: an institutional subscription to Sustainalytics ESG Risk Ratings and publicly available ESG Scores provided by Refinitiv. While the former focuses on unmanaged ESG risks and provides a measure of ESG Risk Ratings, the latter focuses on ESG performance and disclosures and presents an ESG Score. These two rating companies use a combination of different algorithms, formulas, and data sources to inform their ratings, where the rating models are proprietary.

Out of the 200 firms in the sample, 79% are headquartered in Canada ($N = 109$), the US ($N = 30$), and China ($N = 19$), while the rest are headquartered in a variety of other countries with at most five observations per country. See Table 1 for a descriptive statistic of variables obtained from the Pitchbook database. See the Appendix for a distribution of the 200 firms by headquarters country.

Following previous studies, we use three different variables to control for company size: total assets measured in million dollars (TA); total revenue measured in million dollars (TR); and the number of workers measured in thousands of employees for the year 2022 (Akgun et al. 2021; Gregory, 2024; Bissoondoyal-Bheenick et al., 2023). For example,

Table 1
Descriptive statistics for 200 mining companies in the Pitchbook database.

Variables	Observations	Mean	Std. dev.	Min.	Max.
Total assets- TA (million dollars)	200	2.76	9.29	0.00	86.89
Total revenue-TR (million dollars)	200	1.61	5.12	0.00	43.84
Workers (thousands)	200	3.04	10.75	0.00	125.00
Cost of debt-COD	174	11.45	57.99	0.00	765.11
Return over asset-ROA	200	-155.19	1164.07	-15901.95	399.36

using a global sample of non-mining firms, Drempetic et al. (2020) use the number of employees, total assets, and revenue to find a positive correlation between firm size and ESG scores.

For mining firms, it is crucial to consider multiple measures of firm size. First, mining companies engage in various activities, from exploration and development to production and extraction. During the initial exploration stages, they may not generate sales or revenue. However, they still have assets (such as mineral deposits, machinery, and land) and hire workers. Thus, using multiple metrics provides a more comprehensive view of their size and impact. For instance, a mining company with substantial assets – but low sales – may appear smaller than it is when compared to a sales-driven firm.

Second, the mining industry is inherently risky due to environmental and resource use impacts, commodity price fluctuations, and regulatory challenges. Firms may have substantial assets but could face severe financial instability. Considering employment levels alongside assets could help account for the volatility and risk associated with mining. A company with significant assets – but a minimal workforce – may still be vulnerable. Third, mining requires substantial capital investment in equipment, infrastructure, and land. These assets contribute to the firm's overall size. However, focusing solely on assets ignores the labor-intensive nature of mining in certain contexts. Employment levels could reflect the company's operational capacity and its impact on local communities. In addition, considering employment metrics acknowledges the social dimension of mining (e.g., a large asset base does not necessarily translate to positive community outcomes, but employment may reflect local economic opportunities). Therefore, controlling for firm size using various metrics is essential in understanding their performance (Visser, 2020; Dougherty, 2017). The average mining company in the sample of 200 firms has 3,037 workers, close to $1.61 million in sales, and close to $2.76 million in company assets. See the Appendix for an additional description of the sample.

We use return on assets (ROA) to measure profitability and this is calculated as the ratio of net income to total assets. ROA measures how effectively a mining company utilizes assets (e.g., invested capital) to generate profits. A higher (lower) ROA indicates a company that can earn more (less) with a given asset investment while a firm with a negative ROA indicates a company operating at a loss. The average ROA across the sample of 200 mining firms is -155, illustrating negative profitability for the average firm. Close to 67% ($N = 133$) of the mining companies have a negative ROA.

We use pre-tax cost of debt (COD) which is calculated as the effective interest rate a company pays on its debts (interest over debt). COD represents the cost of borrowing each additional dollar of debt, reflects the financial risk faced by a company, and is influenced by factors such as the borrower's creditworthiness, the prevailing market interest rate, and the terms of the debt agreement. Since mining operations require significant capital investment in machinery, land, exploration, and infrastructure, they may rely on borrowed funds which could alter their capital structure ultimately affecting their profitability (e.g., high-interest payment reduces net income) (Pinto-Gutiérrez, 2023). When debt financing is high, it reflects a company facing a high interest rate

reflecting default risk (DePamphilis, 2019). For instance, Pinto-Gutiérrez (2023) shows that COD is higher for mining companies that face a higher climate change risk because banks consider and evaluate the impact of climate change on the firm's ability to mitigate risk and then repay debt. Overall, firms that face higher than the average market interest rate (within a given industry and country) could face higher credit risk and higher than average cost of debt. The average cost of debt for the sample is 11.45.

3.2. Third-party ESG ratings for mining companies

To address our research questions, we adopt two approaches. First, we identify ESG-rated firms based on whether an ESG Risk Rating (from Sustainalytics) or ESG Score (Refinitiv) is available and refer to these firms as ESG-rated firms. We then compare ESG-rated firms with firms where no ESG rating is available with respect to ROA, COD, and the three firm size metrics. This approach determines the characteristics of firms that are more likely to be typically rated by third-party agencies for their ESG performance. Understanding which mining firms are likely to be rated by third parties for ESG performance is essential for investors, market access, risk management, and long-term sustainability.

To address the second and third research questions, we focus on ESG-rated mining companies as a sub-sample and then we perform several correlation analyses to understand the strength of the relationship among different ESG ratings, and the strength of the relationship between ESG ratings, the three firm size metrics, ROA, and COD. In the rest of this sub-section, we discuss each of the ESG ratings (ESG Risk Ratings from Sustainalytics and ESG Score from Refinitiv) and provide a summary of the considerations in forming those ratings.

Sustainalytics' ESG Risk Ratings: Sustainalytics *ESG Risk Ratings* are designed to help investors identify and understand financially material ESG risks at the security and portfolio level. Sustainalytics is accessed through subscription and provides ESG data to institutional investors and companies where the full scoring methodologies and algorithms are proprietary (Source: https://www.sustainalytics.com/about-us). The ESG Risk Rating captures an issuer's exposure to material, industry-specific ESG risks (e.g., environmental and social) and an issuer's management of those risks (e.g., commitments, programs, and actions). For example, the rating captures unmanageable risk due to mining operations (e.g., mining companies cannot fully eliminate land use) and manageable risk not addressed by the firm, if any, based on the degree to which the identified ESG factor affects the company's valuation (e.g., risk-return profile, investment decision, etc.). The unit-free ESG Risk Rating ranges from zero representing companies that face negligible ESG risk to a value over 40 representing companies that face severe unmanaged ESG risk (Sustainalytics Website, 2024). Table 2 presents the ESG Risk Rating category and the industry-specific interpretation (Morrow et al., 2018; Morrow et al., 2019; Sustainalytics, 2020). Investors are the main consumers of these risk ratings which are designed to help investors understand the financial material risk of the overall company (Garz and Volk, 2018).

There are only a handful of studies that use Sustainalytics proprietary ESG Risk Ratings and the earliest of these is Surroca et al. (2010) which use Sustainalytics products to examine the relationship between corporate social responsibility and financial performance, followed by Wolf (2014) who uses Sustainalytics corporate sustainability performance indicator to examine its impact on sustainable supply chains. Most recently, Filbeck et al. (2019) examined the stock market performance of firms rated positively by Sustainalytics. None of these studies focus on mining.

Refinitiv ESG Score: We manually collect Refinitiv's ESG scores from public sources. Refinitiv is a financial market data and infrastructure provider and their ESG scores are measured by assessing the three pillars of sustainability namely, environmental (emissions, resource use, innovation), social (human rights, product responsibility, workforce, community), and governance (management, shareholders,

Table 2

Comparing different third-party ESG rating agencies.

Agency's product (rating)	Sustainalytics (ESG Risk Rating)	Refinitiv (ESG Score)
Focus	*Risk centric approach* (exposure to material industry risk and how affectively a company manages ESG risk) *Holistic industry perceptive* (ability to manage risks inherent in industry)	*Performance centric approach* (relative performance assessing how well a company performs compared to peers) *Quality of transparency* is directly assessed (ESG reporting/ disclosure)
Scoring Range	Unit-free score ranging from zero (negligible ESG risk) to over 40 (severe risk). • 0-10: negligible risk • 10-20: low risk • 20-30: medium risk • 30-40: high risk • 40+: severe risk	On a numerical scale from 0 to 100, representing relative performance and transparency. • A (+75): excellent performance, high transparency (ESG leaders) • B (50-75): good performance, above average transparency • C (25-50): satisfactory performance, moderate transparency, • D (0-25): poor performance, insufficient transparency (ESG laggards)
Audience	Helps investors understand financially material risks	Informs investors, emphasizing relative performance
Industry Context	Considers both industry-level material ESG issues and company-specific adjustments	Focuses on relative performance within the industry

CSR strategy) issues. Refinitiv's ESG Score quantitatively measures "a company's relative ESG performance, commitment and effectiveness across ten main themes (emissions, environmental product innovation, human rights, shareholders, etc.) based on publicly reported data" (Refinitiv Website, 2024).

Refinitiv uses a Z-scoring methodology to standardize data and ensure comparability across companies. This approach adjusts for outliers and allows companies to be benchmarked against their peers (e.g., a company's performance including transparency relative to similar others in the industry). The ESG Score ranges from 0 to 100 where a higher score reflects excellent relative ESG performance and transparent disclosures (see Table 2). Like other ESG rating providers, Refinitiv's specific algorithms, data models, and weighting methodologies are proprietary. This ensures that their ESG scoring system remains a competitive product in the market. Refinitiv regularly updates its ESG scores to reflect new data and changes in company performance or disclosure practices, ensuring that the ratings remain relevant and timely. Detailed information on Refinitiv's scoring methodology is available through the company's website (Refinitiv, 2022).

While Sustainalytics focuses on the ability to manage a higher extent of ESG risk exposures that are inherent to the entire industry, Refinitiv focuses on relative performance (relative to others in the industry) as well as the quality of transparency regarding ESG performance. This suggests that while both rating agencies focus on assessing a company based on ESG factors as well as the objective of informing investors, their approaches differ which may have a bearing on the comparability of the scores. For instance, Sustainalytics' proprietary algorithm captures risks inherent to the industry and how effectively or not an individual company is managing them (beyond what other peers are doing in the industry) while Refinitiv's proprietary z-scoring method provides relative assessment. See Table 2 for a summary of key aspects considered for each rating agency.

4. Results and discussions

4.1. ESG-rated firms are larger than unrated firms

In this subsection, we address the first research question: *What type of mining companies end up being rated for ESG by third-party rating agencies such as Sustainalytics and Refinitiv?* We address this question by comparing ESG-rated firms with unrated firms with respect to their firm size (assets, revenue, and number of workers), ROA, and COD.

While a lack of ESG rating does not necessarily indicate poor ESG performance, investors interested in sustainability may perceive it as a visibility issue, impacting confidence and requiring more effort in conducting their investigations. Furthermore, given the lack of a third-party rating, investors may need to investigate themselves to learn more and understand ESG risk profiles which could require more time and effort (e.g., investors may use their judgments for risk assessment, or decide not to invest in unrated firms). Unrated firms may also be perceived as indecisive in their ESG commitments, not yet having proactively developed sustainability plans, efforts, and reports that third-party agencies typically look for. ESG-rated companies could also serve as a benchmark based on which investors could compare others and make informed decisions. Unrated firms may miss out on investment opportunities from ESG-focused funds. Finally, a lack of rating could prompt a reputational risk if accidents occur because there is no data to back up sustainability commitments. Thus, the examination of how ESG-rated mining firms differ from peers not rated for their ESG could inform investment choices and risk management.

Out of the 200 firms in the Pitchbook database, we find a total of 49 mining companies that are rated by both the agencies representing one-fourth of the sample, and 21 that are rated by one but not both, 63 rated by Sustainalytics, and 56 rated by Refinitiv. A total of 130 companies do not have any ESG ratings data. Table 3 presents descriptive statistics for the 63 firms with ESG Risk Ratings and the 56 firms with ESG Scores. The table suggests that ESG-rated firms by either third party are larger, more profitable, and with a lower cost of debt compared to the average mining company in the Pitchbook dataset. Figs. 1-3 show that the sub-sample of ESG-rated mining companies (either by both or just one rating agency) are relatively larger as measured by revenue, assets, and workers, as well as have lower cost of debt and higher ROA, respectively.

These findings are consistent with studies that suggest that bigger firms are more likely to come under ESG scrutiny than smaller firms (Akgun et al., 2021; Gregory, 2024). Fig. 2 illustrates that among the given sample of firms, unrated firms have on average the lowest total revenue and total assets ($66,760 and $111,405 on average for TR and TA respectively), as well as the lowest average number of workers (196 workers). Larger firms, due to their scale and visibility, may have sufficient resources to invest in ESG commitments and provide corporate

Table 3

Descriptive statistics for ESG-rated mining companies.

Sample 1: Firms with ESG Risk Rating data ($N = 63$)	Mean	Std. Dev.	Min	Max
Sustainalytics ESG Risk Rating	40.14	11.86	17.31	65.29
Total assets-TA (million dollars)	8.48	15.1	0.039	86.9
Total revenue-TR (million dollars)	4.96	8.19	0.00	43.8
Workers	9,194	17697	39	125000
COD	4.94	3.89	0.00	22.70
ROA	-0.29	22.27	-132.19	25.45

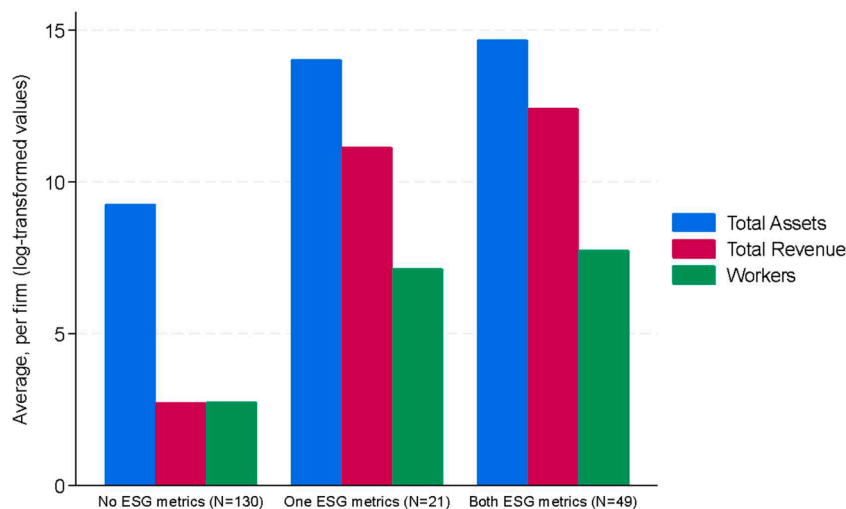| Sample 2: Firms with ESG Score data ($N = 56$)	Mean	Std. Dev.	Min	Max
Refinitiv ESG Score	49.41	23.46	6	88
Total assets-TA (million dollars)	6.60	11.7	0.0478	51.1
Total revenue-TR (million dollars)	3.03	4.95	0.00	22.8
Workers	6,515	9953	21	37610
COD	5.71	4.94	0	24.60
ROA	0.52	13.42	-55.60	25.45

Fig. 1. Comparing firm size of ESG-rated versus non-rated mining companies.
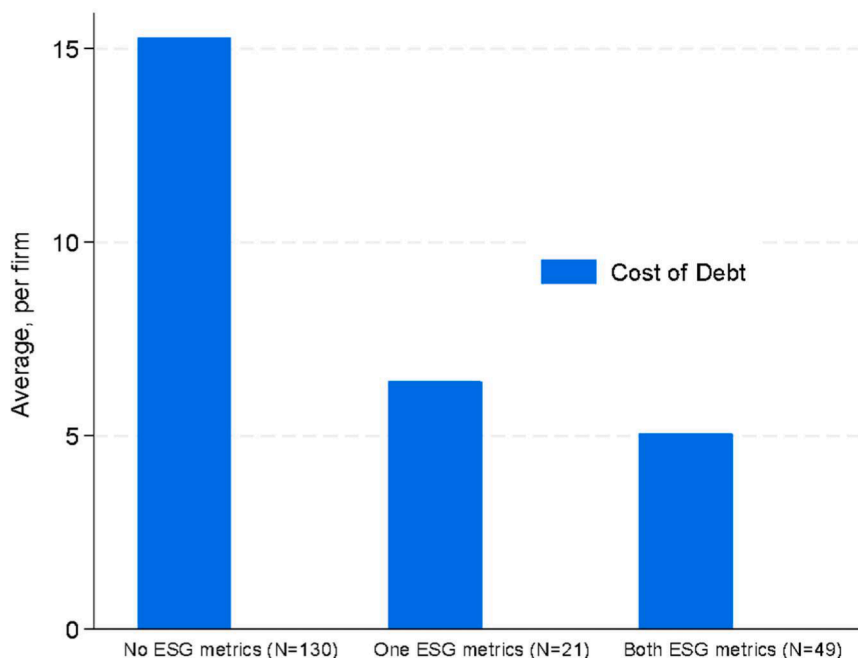

Fig. 2. Comparing cost of debt of ESG-rated versus non-rated mining companies.

reports (e.g., public reports on their websites) which might be easily picked up by rating companies in their assessment. Second, raters may prioritize providing ESG ratings to larger companies with visible financial outlooks as these are the ones that attract capital from investors, so prioritizing them would provide ESG-related data for potential investors. Larger mining companies are more likely to be closely monitored by institutional investors, analytics, and lenders, and providing ESG ratings may provide information for investment decisions. In some cases, there may be regulatory pressure for larger mining companies to publicly disclose certain sustainability data which can form the basis for which raters can provide scores (e.g., compared to smaller firms that may not feel the pressure to communicate sustainability-related commitments and hence raters may find it difficult to collect data to inform their assessment).

Profitability and cost of debt are also more favorable for ESG-rated firms than firms that are not rated. This could potentially be due to the firm size effects explained in the preceding paragraph where bigger firms have more resources and capabilities. It could also be that firms with ESG ratings have better financial performance for a combination of reasons. Fig. 3 shows that unrated firms have on average the highest loss (-238 as the ROA), firms with an ESG rating have a significantly lower loss (-7.9 as the ROA), while firms with both ESG ratings have positive profitability (1.8). ESG ratings could reflect ESG practices that are correlated with cost savings, resource efficiency, and improved operational performance. For example, Eng et al. (2021) find that firms with better environmental performance experience higher profits and firm valuation. Mining companies without ESG ratings, while not necessarily having poor ESG performance, may miss out on opportunities to communicate their sustainability commitments. They may also be excluded from capital markets that prioritize ESG and without an ESG score investors may not be willing or able to evaluate non-rated firms. When unrated firms face idiosyncratic risks, they will not have an option to demonstrate ESG improvements which may eventually affect their financial performance.
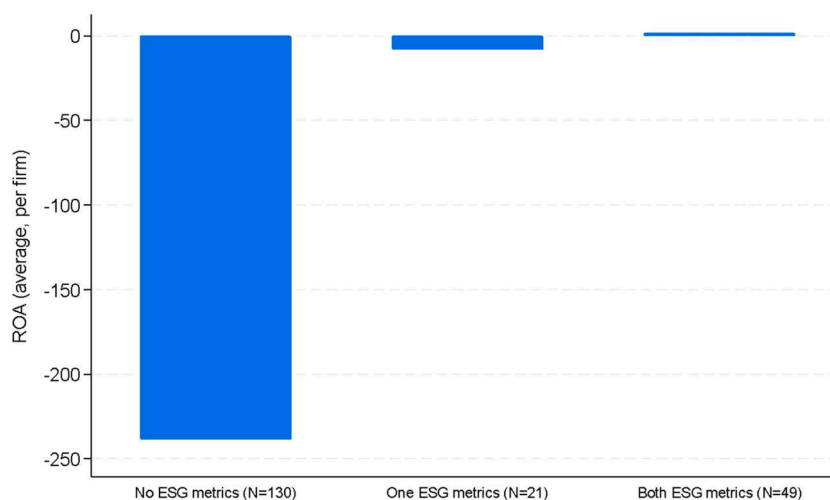
Fig. 3. Comparing ROA for ESG-rated versus unrated firms.

ESG-rated firms may have lower cost of debt if banks and lenders explicitly factor in ESG scores in their lending decisions. For example, Fig. 2 shows that the COD for unrated firms is 15.3 on average while the COD for firms with at least one ESG rating is 6.4, and firms that are rated by both agencies have an average COD of 5. Lenders may view ESG scores as additional information in their lending decisions and lack of rating may signal uncertainty or information asymmetry leading to a higher COD. Unrated firms may lack the benefit of a recognized ESG rating and as a result, lenders may view unrated firms as riskier due to the lack of information. To compensate for perceived risk, lenders could charge a higher interest rate to unrated firms.

We perform a two-sample t-test to determine whether the patterns presented in Figs. 1-3 are statistically significant. The null hypothesis for the test states that the differences in the means of the financial indicators between the two groups of mining firms (ESG rated versus unrated) are the same. Thus, rejecting the null hypothesis implies that the means of the two groups are not equal. Results presented in Table 3 suggest that differences in firm size (measured by TA, TR, and number of workers) are different where ESG-rated mining companies are on average bigger with respect to their number of employees, total assets, and total revenue, compared to the rest of the Pitchbook sample with no ESG ratings.

The positive correlation between firm size and ESG ratings could be due to several factors. For example, Dashwood (2005, 2007) highlights the possibility that larger multinational mining companies are likely the ones that shape corporate social responsibility standards (e.g., promoting standards for responsible mining practices, setting industry norms, etc.). This could imply that the rating process could be influenced by what companies are already doing rather than by an objective assessment of their practices. In addition, larger companies may be rated because they have the resources to adopt and promote the standards developed by rating agencies.

Companies that are rated by Sustainalytics have on average 2.3 times lower COD compared to others, as well as lower losses as measured by the ROA. However, these differences are not statistically significant. Table 4 also indicates that Refinitiv-rated firms do not necessarily have statistically lower COD and positive profitability compared to others. Overall, these comparisons seem to suggest that bigger companies are more likely to be rated, but there is limited statistical evidence that rated firms perform better in the form of higher ROA and lower COD. These findings suggest that being rated for ESG by itself does not appear to offer financial advantages in terms of profitability or cost of debt. For the specific sample considered, investors and lenders may not be consistently or primarily looking for the availability of third-party ESG ratings (e.g., other factors may have a stronger role). The result could also suggest that ESG ratings may be more correlated with long-term

Table 4

Comparing ESG-rated firms with others using a two-sample t-test. Cells present average values. [a] represents statistically significant mean difference at the 5 % significance level.

	Sustainalytics rated firms ($N = 63$)/Others ($N = 137$)	Refinitiv rated firms ($N = 56$)/Others ($N = 144$)
Total assets-TA	\$8,486,891/\$126,098 [a]	\$6,604,371/\$1,264,617 [a]
Total revenue-TR	\$4,962,212/\$65,854 [a]	\$3,028,468/\$1,055,884[a]
Workers	9,194/205 [a]	6,515/1686 [a]
COD	4.94/14.96 (not sig.)	5.71/14.03 (not sig.)
ROA	-0.29/-226 (not sig.)	0.52/-215 (not sig.)

financial measures and not immediately reflected in short-term financial metrics such as ROA and COD.

4.2. ESG ratings by headquarters country

In this subsection, we show that there is an observable pattern in the ESG ratings, based on both Sustainalytics and Refinitiv, based on the country of the rated company's headquarters. About 35% of the 63 Sustainalytics-rated firms are headquartered in Canada ($N = 22$), 21% in China ($N = 13$), and 13% in the United States ($N = 8$), and the rest of the countries are represented by either one or two companies. Most Refinitiv-rated firms are headquartered in Canada (45%), China (13%), and the US (14%). Fig. 4 presents a comparison of mining companies in China, Canada, and the US with countries with fewer representation in our sample. The figure highlights the variability in ESG ratings across regions where Chinese firms have the highest ESG Risk Rating while Canadian firms have the lowest ESG Scores on average.

When looking at the Sustainalytics-based rating for all firms, we find that except for Norway, with one mining company in the sample, all countries have on average >20 ESG Risk Rating putting them in the medium, higher, and serve risk categories. The risk ratings range from 17 to 65 and the average ESG Risk Rating is 40.1 (with a standard deviation of 12). This implies that the average mining company in the sample faces a severe risk category which suggests that the average Sustainalytics-rated firm has a significant amount of unmanaged ESG risk. This could be due to a variety of reasons. First, mining companies are often exposed to commodity price fluctuations making it more financially challenging to invest in sustainable practices such as responsible sourcing, environmental conservation, community engagement, and efforts to reduce environmental impact. High ESG risk can
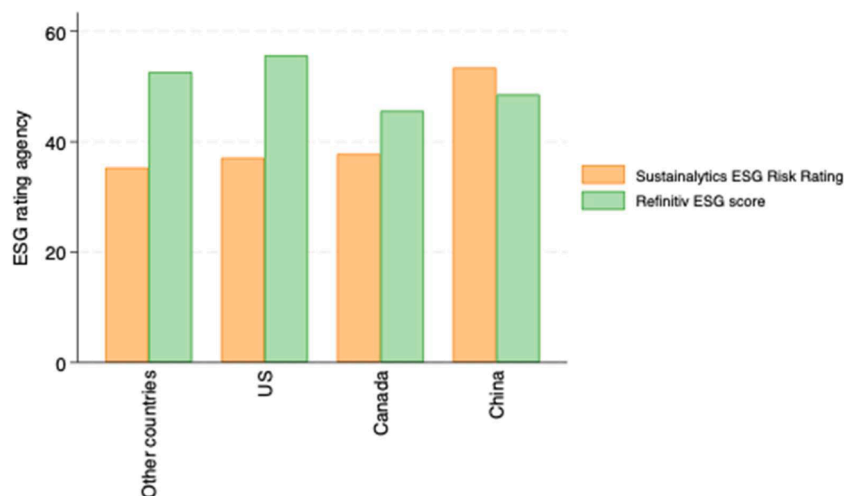
Fig. 4. ESG ratings for top mining nations.

also be caused by occupational health and safety issues involved in high-risk working environments. Third, mining operations are resource-intensive requiring large amounts of water, energy, and raw materials that can strain local resources and contribute to reduced environmental quality.

Norsk Hydro, a Norway-based bauxite mining and alumina refining company (and present in four countries), has the lowest ESG Risk Rating of 17 and a low ESG risk, which are possibly due to the company's focus on sustainable operations (e.g., storing bauxite tailings from mines in Brazil, no net biodiversity targets, ISO 14001 certification, etc.), the use of renewable energy for mining operations, as well as its aluminum recycling facilities. However, the company has had a history of environmental impact in its Brazilian sites (e.g., toxic waste spills in Brazil in 2017/2018). The forerunner companies with the second and third lowest ESG Risk Rating are gold mining companies, US-based Newmont (ESG Risk Rating of 21, medium risk), and Canada-based Eldorado Gold Corp (ESG Risk Rating of 22, medium risk). In 2022, Newmont produced about 5% of the global volume of gold and stands among the largest gold miners in the world. The company has historically been committed to ESG practices (e.g., publishing sustainability reports, etc.) and been recognized as one of the most sustainability-focused and ESG-leading gold miners in the industry. Eldorado Gold has operations in multiple other countries such as Turkey, Greece, and Romania where it has long-term partnerships with local communities, thereby likely resulting in one of the lowest ESG risk ratings. Despite facing high ESG exposure, these three companies have relatively stronger management of these ESG issues. Newmont and Eldorado Gold also have among the highest Refinitiv-based ESG scores.

Among the companies with the highest ESG Risk Ratings (greater than 60) are the bottom three companies all based in China (Tongling Nonferrous Metals Group Company, Shenghe Resources Holding Company, and Yunnan Tin). Yunnan Tin, a China-based exploration, mining, smelting, and processing company, ranks with the highest ESG Risk Rating of 65 (severe risk). While most of the other Chinese mining companies have on average one of the highest ESG Risk Ratings, their ESG scores are not necessarily among the bottom low. This highlights the heterogeneous information captured by different rating agencies. For instance, while some of the Chinese firms in the sample may have not devised strategies and commitments to address industry-wide ESG risks, they may have either a better ESG performance (e.g., lower waste generation relative to others) or more quantity of ESG disclosures. For example, Shenghe Resources has one of the highest ESG Risk Ratings (65) in the severe risk category. However, its ESG scores are in the B range (51) where it is rated better than others in terms of environmental performance compared to social or governance issues.

The result highlights the importance of institutional factors in potentially affecting the ESG effort of firms where countries with stronger institutional frameworks (e.g., stronger regulatory framework regarding ESG issues, stronger industry association, and competition from other similar firms) could be in a better position to encourage a favorable ESG performance, hence improving ESG ratings. Institutional pressure can significantly impact the ESG performance of mining companies. Institutional pressure can come from various sources, including investors, regulatory bodies (coercive pressure), non-governmental organizations (NGOs), industry associations (normative pressure), and industry peers (mimetic pressure). Companies that respond proactively to these pressures by integrating ESG considerations into their strategies and operations are more likely to thrive in an environment where responsible and sustainable business practices are increasingly valued.

4.3. Among ESG-rated firms larger firms have favorable ratings than smaller ones

In this subsection, we address the second research question: *Among ESG-rated mining companies, how strongly do ratings correlate with firm size, firm profitability, and the cost of debt?* Table 5 presents results from Spearman correlation analysis where * represents rank correlations that are statistically significant at a 5% level or less. Table 5 suggests that all three firm size metrics are positively and highly correlated for both samples of ESG-rated firms (e.g., statistically significant rank correlations >0.90). As expected, revenue, total assets, and number of workers are all positively correlated with ROA suggesting that for the sub-sample considered in the analysis, firm size is positively related to firm profitability. COD is generally negatively correlated with firm size.

The table shows that among Sustainalytics-rated firms, those with higher ESG Risk Ratings have lower total assets and number of workers. This suggests that firms with a higher (lower) extent of unmanaged ESG risk tend to be smaller (larger) in terms of their asset value and number of workers. Among Refinitiv-rated firms, those with higher ESG scores have higher revenue, assets, and workers suggesting that bigger firms (as measured by all three metrics) have favorable scores. These correlations imply that among ESG-rated firms those that rank higher in their unmanaged risks also rank lower in their asset value and employment size while those that rank higher in ESG relative performance and disclosure quality also rank higher in all measures of size. This seems to suggest that ESG ratings, among rated firms, could significantly vary based on firm size, resources, and capabilities. However, we fail to find any significant correlation between ESG ratings and profitability and cost of debt across the given sample.

The implication is that while firm size could enable or facilitate a

Table 5
Spearman rank correlation results.

Sample 1: Sustainalytics rated mining companies ($N = 61$)						
	ESG Risk Ratings	Total Revenue	Total Assets	Workers	ROA	COD
ESG Risk Ratings	1					
Total Revenue	-0.2185	1				
Total Assets	-0.3442*	0.9395*	1			
Workers	-0.2602*	0.9192*	0.8957*	1		
ROA	-0.002	0.5607*	0.4963*	0.5033*	1	
COD	-0.2459	-0.2955*	-0.3003*	-0.2827*	-0.1958	1
Sample 2: Refinitiv rated mining companies ($N = 54$)						
	ESG Score	Total Revenue	Total Assets	Workers	ROA	COD
ESG Score	1					
Total Revenue	0.7091*	1				
Total Assets	0.7666*	0.9397*	1			
Workers	0.6375*	0.9322*	0.8899*	1		
ROA	0.1734	0.4967*	0.3905*	0.4712*	1	
COD	-0.174	-0.263	-0.2805*	-0.2791*	-0.0491	1

favorable ESG rating due to the availability of resources and capability, ESG ratings are not necessarily correlated with financial performance, nor are they correlated with the cost of financing debt. Hence, investors may not be able to infer any meaningful information about the financial performance or financial risk by looking at ESG ratings alone.

Our findings are consistent with studies that find a positive correlation between firm size and ESG ratings but diverge from some studies that find a correlation between ESG ratings and financial performance. For example, Drempetic et al. (2020) use the number of employees, total assets, and revenue to examine the impact of firm size on ESG scores and find a significant correlation between firm size and ESG scores. The study by Bissoondoyal-Bheenick et al. (2023) shows that larger firms tend to invest in ESG activities to better reflect stakeholder demand and due to economies of scale.

Our findings regarding ESG ratings versus financial performance (ROA and COD) are in contrast to what the literature finds regarding the correlation between ESG ratings and the financial performance among mining and non-mining companies. In a recent study, Fu et al. (2024) evaluated Chinese mining companies and found that higher ESG ratings backed by good ESG performance could alleviate financial constraints, enhance risk control, and mitigate agency problems with shareholders, thereby reducing financial risks. Similarly, a report by PWC (2021) shows that mining companies with higher ESG ratings had 10% higher shareholder returns during the pandemic. Using a sample of publicly listed Latin American firms, Lavin and Montecinos-Pearce (2022) find that ESG disclosures could affect the cost of financing through its impact on costs. Fabisik et al. (2023) use firms from the US to examine the impact of changing ESG ratings on the cost of debt. The study finds that ESG-downgraded firms have (about 10%) more COD after they are downgraded compared to non-downgraded firms in the same industry, and these impacts are higher for firms more exposed to climate risk (e.g., high carbon emissions). The discrepancies in findings could be attributed to differences in sample characteristics and measurement differences. For example, Fu et al. (2024) consider mining companies in China while our sample is based on mining companies in several countries. The studies by Lavin and Montecinos-Pearce (2022) and Fabisik et al. (2023) consider publicly traded companies in several industries, while ours is specific to the mining industry. The report by PWC (2021) focuses on shareholder returns, while we focus on profitability and COD. Further research is needed to fully understand the dynamics between ESG ratings and financial performance and how this relationship evolved for the mining industry.

To further investigate the potential relationship between ESG ratings and COD and understand why our results diverge from existing studies we conduct additional robustness checks involving sub-groups of firms that are profitable (positive ROA) and unprofitable (negative ROA). The

results presented in the Appendix suggest that the relationship between ESG ratings and COD is not statistically significant across firm type.

4.4. ESG scores and ESG risk ratings are correlated

Given differences in focus, measurements, and priorities represented in the ESG Risk Ratings versus the ESG Score (see Table 3), it is important to examine to what extent the information relayed by the two ESG ratings is consistent and exhibits complementarity, versus divergent. This addresses the last research question: *How well do ratings from different third-party rating agencies correlate to provide consistent information?*

If the two ratings have a negative correlation, it implies that firms with high ESG risk have lower ESG scores suggesting that having a lower relative ranking in ESG performance and disclosure quality is associated with higher unmanaged ESG risks. If the two ratings have a positive correlation it implies that firms may perform better relative to others in the industry with respect to ESG performance and transparency even when they carry a higher extent of unmanaged risks. A Spearman's Rho test was conducted where the null hypothesis states that ESG Risk Rating and ESG score are independent. The test yields a rank correlation of -0.59 and a p-value<0.001 ($N = 49$). Hence, we reject the null hypothesis of independence between the two rating mechanisms. Fig. 5 illustrates this negative correlation between the two rating mechanisms. This provides confidence that the two third-party rating agencies (Sustainalytics and Refinitiv) provide generally consistent information to investors regarding the ESG ratings of mining companies, although this correlation is not perfect. Firms with higher unmanaged ESG risks are the ones that are likely to have lower ESG scores (poorer relative performance).

5. Conclusion

The research on *ESG* ratings in the mining and extractive industry is relatively sparse compared to other manufacturing sectors. There is a research gap in comprehensively analyzing and comparing multiple ESG ratings within the mining sector and understanding potential correlations with financial performance. This gap is critical because in recent decades, ESG factors have become central to mining companies' strategies and operations, influencing their investment decisions, organizational structures, and overall performance. Understanding the correlation between firm characteristics, financial metrics, and ESG ratings is essential for evaluating the effectiveness of ESG practices and their impact on the financial health of mining firms. Additionally, the divergence in ESG scoring mechanisms poses challenges and uncertainties for investors, regulators, and companies, highlighting the
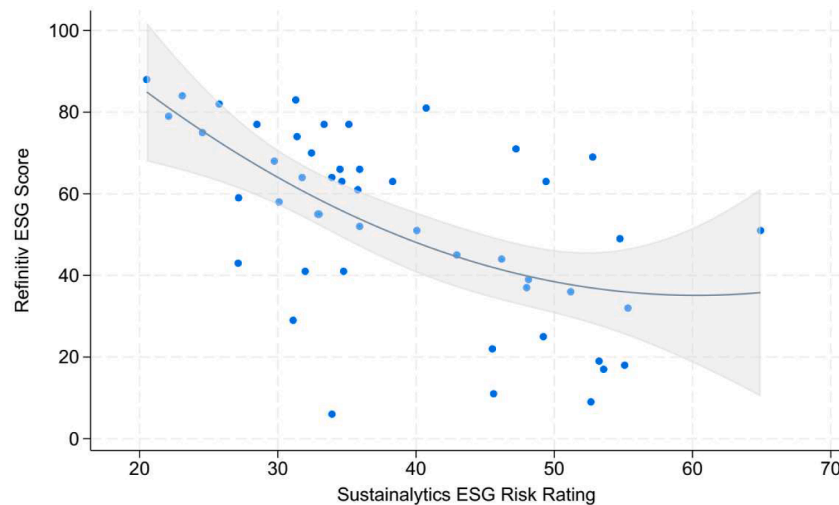
Fig. 5. Comparing ESG Score with ESG Risk Ratings ($N = 49$).

need for more comprehensive and harmonized approaches to ESG measurement and reporting in the mining industry.

The key findings of this study are summarized as follows: (1) Compared to unrated firms, ESG-rated firms have on average higher asset valuation, larger revenues, and more workers but not necessarily higher profitability and lower cost of debt; (2) The pattern in ESG ratings by headquarter country is different by rating agency; (3) There is no correlation between ESG ratings and financial indicators (return on asset, cost of debt); (4) Bigger mining companies with higher assets, sales, and many workers have favorable ESG ratings than smaller ones; and (5) Mining companies rated as having high unmanaged ESG risk are generally rated low in ESG relative performance and transparency of disclosures.

The findings suggest that while ESG ratings are expected to play a significant role in the mining industry, particularly in shaping investor perceptions and influencing investment decisions, they may not be strongly correlated to financial indicators such as profitability and the cost of capital. While our analysis highlights that (1) ESG-rated mining companies are generally larger in terms of assets, revenue, and work-force compared to their unrated counterparts, (2) and favorably rated mining firms (e.g., higher scores) are larger in size than firms with lower rating scores, neither the availability of ESG ratings nor having a favorable ratings signal better financial performance in the form of profitability (ROA) and lower cost of debt (COD).

Larger companies might have more resources to invest in ESG initiatives, leading to better ratings. However, this does not automatically translate into improved profitability or a lower cost of debt. This finding suggests that, at present, ESG ratings may not significantly influence financial outcomes in the mining sector. This disconnect could imply several things: First, the benefits of strong ESG ratings might not yet be fully realized or measurable in terms of immediate financial metrics (e.g., favorable ratings could have long-term benefits that are not reflected in short-term indicators). Second, the market, investors, or lenders might not be adequately pricing in information from ESG ratings, or they might prioritize other factors over ESG ratings. Lastly, it is possible that while ESG-rated companies are larger and potentially more capable of implementing ESG practices, these practices have not yet led to tangible financial improvements. This could indicate a time lag between ESG investments or commitments and ESG ratings, or the gap between ESG ratings becoming available and their financial impact.

In the course of arriving at our findings, we discovered other areas and questions for future research. For instance, due to the small sample size, additional studies are needed to address the limitations of this study in four areas of inquiry. First, the ESG rating process could be shaped by the private sector or industry associations that may be more favorable to bigger companies – which means ESG scores may not be fully exogenous. Second, our analysis is based on a limited number of mining companies so future studies can expand the sample size using alternative data sources to check the external validity of the main results. With a larger sample size, it is possible to run regressions and other more complex data analyses to ascertain whether the proposed relationships are robust after controlling for other relevant factors. Third, the ESG performance of mining companies likely depends on a combination of institutional factors which are not all captured in this study. For example, when a company has operations in multiple countries, foreign countries, or simply the headquarters location, the parent company may incorporate a diverse set of factors in its decision-making and governance outcomes. Finally, future studies are encouraged to compare ESG ratings from third-party rating agencies – other than the two ratings presented in this paper – and offer analyses.

Despite its limitations, the study also reveals some patterns in ESG ratings based on the country of the rated company's headquarters, with countries having stronger institutional frameworks (e.g., Norway) potentially encouraging more favorable ESG performance among mining companies. Overall, our analyses underscore the need to thoroughly examine conditions and scenarios under which ESG ratings can be used to meaningfully guide investment decisions in the mining sector.

CRediT authorship contribution statement

Mahelet G. Fikru: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jennifer Brodmann:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Li Li Eng:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **J. Andrew Grant:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Methodology, Investigation, Data curation, Conceptualization.

Declarations

All authors have read this paper and have no conflict of interest to declare.

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Supplementary materials

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