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ESG Reporting and Financial Performance: the Case of Infrastructure

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EDHEC*infra*
building benchmarks
for infrastructure investors

Table of Contents

The authors would like to thank GRESB for contributing its data on ESG reporting and Rick Walters for useful comments and suggestions. Financial support from the Long-Term Infrastructure Investor Association is acknowledged. This study presents the author's views and conclusions which are not necessarily those of EDHEC Business School or LTIIA.

Foreword

Institutional investors are demanding information about the ESG management and investment processes undertaken by infrastructure fund managers and asset operators.

GRESB Infrastructure exists to respond to this demand through a standardized, globally applicable reporting and benchmarking framework.

In 2018 75 funds participated in the Infrastructure Fund Assessment and 280 assets participated in the Asset Assessment representing over USD100 billion in value.

It is a great pleasure to have collaborated with the EDHEC Infrastructure Institute and the Long-Term Infrastructure Investor Association on this independent research paper.

Research like this helps us to refine our understanding of why ESG matters, ask the right questions in our Assessments and identify data gaps what will help to shape tomorrows approach to ESG.

GRESB Infrastructure is entering its 4th year but it's already clear that the ESG momentum needs to move beyond transparency towards measuring actual ESG performance and impacts over the long term.

This is not an easy task for this diverse and somewhat nascent industry, but with considerations such as climate change impacts, growing resource scarcity, changing societal expectations on license to operate, demographic shifts, technological disruption and legislative changes becoming more acute and material to long-term investment outcomes, the need for better ESG data and insights has never been clearer.

We look forward to collaborating on future research as the practice of ESG integration continues to mature and we work with the industry to foster more and better data availability.

Rick Walters
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Executive Summary

Executive Summary

This paper represents the first attempt at studying the relationship between the Economic, Social and Governance (ESG) and financial characteristics of infrastructure companies, which is now a central question for investors in the infrastructure asset class.

ESG is very relevant to the infrastructure sector. Infrastructure is critical to the health, wealth and well-being of economies, communities and society, and infrastructure spending increases economic output and overall factor productivity.

Furthermore, some types of infrastructure, such as renewable energy projects, are expected to directly contribute to a more sustainable future and can be considered *Sustainable Infrastructures*.

In the 2016 edition of the EDHEC/Global Infrastructure Hub survey of major infrastructure investors, 17% of asset owners identified achieving ESG objectives to be a 'first order question', possibly at the expense of financial performance. In 2019, this figure has reached 35% of respondents amongst 150 of the largest asset owners in the world.

Meanwhile, the argument is often made by asset managers that better ESG investing goes hand-in-hand with higher returns or even that an 'ESG factor' drives the performance of companies, over and above traditional risk factors.

Does ESG Reporting Make a Difference?

In this paper, as a first attempt to address this topic, we investigate the role of **ESG reporting** in relation to the financial performance of infrastructure companies. Indeed, data on ESG reporting is available and there is ground in the academic literature for arguing that the tendency to report ESG practices are related to actual sustainable outcomes.

This paper is made possible by cross-referencing two unique databases covering the behaviour of infrastructure firms: the ESG scores computed by GRESB Infrastructure since 2016, which measure the level of reporting and management of ESG, and the financial metrics corresponding to the EDHEC*infra* universe.

We examine three simple questions:

1. What firms choose to report ESG data?
2. What explains differences in ESG reporting scores?
3. Do higher ESG reporting scores tend to correspond to higher or lower returns?

Using a series of statistical tests and regression analyses, we report the following findings:

- **The likelihood of ESG reporting is related to corporate structure and size**. Using the EDHEC*infra* universe as a reference, we find that companies that report ESG data tend to be larger and less leveraged than the firms in a representative universe of investable infrastructure companies. They are also more likely to be

Executive Summary

'corporates' rather than 'project' companies (i.e. project finance SPVs). Interestingly, contrary to our expectation, firms that tend to report ESG data are not the most profitable firms.

- **The ESG reporting scores are driven by similar factors**. We find that the level of ESG scores is positively correlated with firms' size and age, while firms that are more leveraged tend to have lower scores. Indeed, larger, less leveraged and more mature firms have more resources available and likely more free cash flow to implement social responsibility initiatives, thus boosting their ESG scores. In this study, there is no support for the hypothesis found in the academic literature that more profitable firms also have higher ESG performance ratings.

- Finally, we find that *ESG scores do not correlate positively or negatively with financial performance* for unlisted infrastructure firms. Importantly, we do not find any negative relation between ESG reporting scores and financial performance (return on assets), suggesting that implementing ESG policies and practices does not harm financial performance either.

ESG Is Not a Risk Factor

This findings make sense in the context of existing academic research on reporting and the characteristics of firms.

They also make sense from an asset pricing perspective: once traditional risk factors that tend to explain performance are taken into account (e.g. size, leverage, corporate structure, etc.), any difference in the level of ESG reporting by firms is explained away.

This is congruent with the finding in listed equity research that ESG screens tend to 'load' on multiple risk factors (like 'value' or 'low volatility'), which are well-known drivers of excess returns in equity markets. Hence, ESG screens create implicit risk factor tilts in investment portfolios. Once these effects are taken into account, any ESG effect that might be correlated with higher or lower returns disappears.

In a context where institutional investors are increasingly demonstrating that ESG filters represent principle-based investment philosophies, the notion that ESG should be somehow implicitly linked to performance is in fact not helpful.

There are many reasons that infrastructure investors, managers and operators may choose to report on, and improve, their ESG performance. These include protecting reputation and social licence, the pre-emptive insurance effect for adverse ESG events (tail risks), responding to investor preferences and mandates, changes in environmental legislation, increasingly stringent governance requirements and reflecting the values of stakeholders including pension holders, employees and the community

Instead, investors can aim to design investment strategies and policies that are optimal, given their investment prefer-

Executive Summary

ences and objectives, including any ESG filter that they may wish to implement upfront.

Tomorrow: Better Reporting, Better Data

This study highlights that much further work is needed to understand the link between ESG and financial performance, especially long-term effects.

Our results are limited by the length of the time series available and would benefit from an update when longer time series become available. This is particularly relevant when it comes to ESG, because one of the key expected mechanisms by which ESH might impact financial performance is by lowering the volality of a company's cashflows as the impact of negative effects can be avoided or mitigated. These 'tail risks' may only be detected in datasets covering long time periods. It should be noted that if this was the case, higher ESG scores would of course mean lower returns, since such firms would be exposed to lower total risk.

More granularity in future datasets will also allow differentiating the effect of the E, the S and the G in ESG, which may have different and contrary relationships with firms characteristics and performance.

Future research can also explore relationships between ESG scores and other measures financial performance such as probability of default, Sharpe ratio, Maximum Drawdown and Value-at-Risk.

These results also have implications for ESG reporting and benchmarking - the tendency of mainly larger corporates to report more often and to provide better ESG data can be addressed through the development of more streamlined, standardized ESG reporting that is independently validated. This will improve the granularity of the data available and better discriminate between the characteristics of infrastructure corporates and projects.

This first research paper represents a stepping stone for future empirical research on impact investing in infrastructure. In particular a sharper focus on ESG issues that are material to each firm, and the development of new metrics that focus on the actual environmental, social and economic impact of infrastructure companies will allow for a much deeper understanding of the relationship between ESG and the performance of infrastructure investments. These are all areas of active development that will enhance any future research.

The authors and EDHEC*infra* wish to thank GRESB Infrastructure for making this study possible by sharing the GRESB 2016-2018 datasets of ESG reports by infrastructure investors.

1. Introduction

1. Introduction

This paper represents the first attempt at studying the relationship between the Economic, Social and Governance (ESG) and the financial characteristics of infrastructure companies.

The relationship between the **impact** of certain companies' activities on their social and natural environment on the one hand, and their ability to deliver a certain level of financial performance on the other, is now a central question in the debate around responsible investment, especially when investors represent large constituencies of pension plan members, whether they belong to collective or individual schemes.

In the 2016 edition of the EDHEC/G20 survey of major infrastructure investors, 17% of asset owners identified achieving ESG objectives to be a 'first order question', possibly at the expense of financial performance (Blanc-Brude et al., 2016). In 2019, this figure has reached 35% of respondents amongst 150 of the largest asset owners in the world (Gupta et al., 2019).

Meanwhile, the argument is often made by asset managers that better ESG investing goes hand-in-hand with higher returns or even that an 'ESG factor' exists and that it drives the performance of companies, over and above traditional risk factors (see Amundi, 2019, for a recent example).

ESG is very relevant to the infrastructure sector. Infrastructure is critical to the health and wealth of economies and infrastructure spending increases economic output and overall factor productivity. Furthermore, some types of infrastructure, such as renewable energy projects, are expected to contribute to a more sustainable future and can be considered *Sustainable Infrastructure*. Wiener (2014) defines sustainable infrastructure as integrating ESG directly into a project's planning, building and operating phases, with the aim of mitigating risk, reducing emissions, promoting social cohesion and economic development, while ensuring resilience in the face of climate change or other shocks.

Why more sustainable infrastructure should exhibit systematically higher returns might seem puzzling from the point of view of asset pricing theory. The question of ESG's impact on infrastructure returns relates to the risk exposures created by the corresponding firm characteristics. If different levels of ESG impact make infrastructure companies more or less risky investments, their value should reflect this.

Thus, if more sustainable energy infrastructure is less likely to face costly future carbon emission regulation, it can be considered less risky than otherwise equivalent assets: hence it should have lower expected returns.

Conversely, if renewable energy investments are understood to create a large exposure to energy sector regulatory risk, then such investments should indeed be expected to exhibit higher returns. For instance, a government could abruptly withdraw subsidies to the solar sector, pushing an entire generation of renewable energy projects to the brink of bankruptcy.

1. Introduction

One question is whether the ESG characteristics of infrastructure companies, and the risk exposure they create, can be expected to have a clear-cut, systematic impact on returns. In fact, the effect of the *E* in ESG is not necessarily the same than that of the *S* or the *G*. These effects, which are mostly a matter of current and future regulation, may have different sizes and signs. They may also change size and sign over time. What the net effect of better ESG incorporation on infrastructure returns should be is not self-evident.

A second question is whether, the relationship between the actual impact of certain infrastructure businesses on the economy, environment and society at large may ever enter the realm of the regulation of these sectors and impact their bottom line. For instance, say that most ports in Europe are part of well-documented drug trafficking routes ensuring the distribution of cocaine across Europe (see for example Europol, 2013, p.46), contributing to an equally well-documented negative social impact. It seems unlikely that the same port companies should, as a result, be expected to face new and costly regulation to address what is essentially a law enforcement issue. Not all social or environmental impacts of infrastructure companies, of which there are many, are the object of regulation or re-regulation that may have a systematic effect on the financial performance of infrastructure firms. Externalities are, by definition, not priced.

Furthermore, it should be noted that while ESG may not be a clear-cut source of *beta*, in the case of infrastructure, it may still coincide with *alpha* generation. While the market prices assets using all the information available at the time, a degree of information asymmetry and idiosyncratic pricing remains unavoidable in private markets. Buyers of *more* resilient assets may thus be able to better mitigate certain ESG risk while buying at the *relatively lower* market price. Better-than-average ESG risk management could thus be equated with a Value strategy.

Unfortunately, such claims about the links between impact and returns in infrastructure are hard to substantiate. They are not verifiable, let alone falsifiable, in the current state of available data, because data on the **actual impact** of individual infrastructure companies on their immediate or distant social and environmental milieu simply does not exist today.

In this paper, as a first attempt to address this topic, we investigate the role of **ESG reporting** in relation to the financial performance of infrastructure companies. Indeed, data on ESG reporting is available and there is ground in the academic literature for arguing that the tendency to report ESG practices and the quality of this reporting are related to actual sustainable outcomes.

This paper is made possible by cross-referencing two unique databases covering the behaviour of infrastructure firms: the ESG scores computed by GRESB Infrastructure since 2016, and the financial metrics corresponding to the EDHEC*infra* universe. [1]

1 - The EDHEC*infra* universe is built to be representative of the investable infrastructure market in the 25 most active markets worldwide. See EDHEC*infra* Index Computation Methodology for more details.

1. Introduction

In what follows, infrastructure is defined as firms qualifying under The Infrastructure Company Classification Standard or TICCS, created by EDHEC*infra*, and to which GRESB is a contributing partner.

We examine three questions:

1. What firms choose to report ESG data? We test the existence of a bias in the type of infrastructure companies that choose to report ESG data to GRESB relative to the much larger EDHEC*infra* universe.
2. What explains differences in ESG scores? We examine the factors that systematically explain higher ESG scores.
3. Do higher ESG scores tend to correspond to higher or lower returns? We examine the impact of ESG scores on financial performance, controlling for other well-documented factors.

In previous research, both Artiach et al. (2010) and Beck et al. (2018) found that a firm's engagement in ESG reporting activities is related to size and profitability. Hence, we expect firms that are larger and more profitable firms to be more likely to report ESG data.

Waddock and Graves (1997), Herbohn et al. (2014) and Beck et al. (2018) have all found that larger, more profitable firms are also more likely to have higher ESG scores. This is consistent with the conjecture that it takes resources to develop, maintain and report on the ESG policies and procedures of a firm. Therefore, we expect firms that are larger, have lower leverage and are more profitable to have the necessary resources to invest in ESG policies and procedures and, as a result, to achieve higher ESG scores.

We find, consistent with prior evidence in other asset classes, that, all else being equal, larger, less leveraged firms are more likely to report their ESG practices to GRESB and these firms obtain higher ESG scores than smaller, more leveraged firms. We also find no return bias in the reporting sample relative to the overall population, once we control for size, leverage and other characteristics. Hence, controlling for other effects, we find no linkage between ESG scores and the financial performance of infrastructure companies.

These results make sense. We find that the ESG reporting behaviour of infrastructure companies is consistent with theory and empirical results for other sectors. We also find that once the traditional risk factors that explain financial performance are taken into account, ESG reporting has been 'explained away' from that point of view.

These results are also consistent with the view reported by an increasing share of asset owners that ESG is a distinct, principle-based filter applied on their investment universe, which does not compromise their risk and return preferences or choices. Finally, it is a significant finding that better ESG performance does not seem to be particularly costly for investors and nor is it a factor of lower returns.

Still, the role of size in driving the ability of infrastructure (and other) firms to report

1. Introduction

their ESG practices suggests that streamlining and standardisation of such reporting to allow smaller firms, including project vehicles, to report better could be welcome improvements.

This rest of this paper is structured as follows: Section 2 reviews the relevant literature with respect to the three research questions above; Section 3 describes the the data employed in the analysis; Section 4 presents the methodology used to answer each question; Section 5 presents our results; and Section 6 concludes.

2. ESG Reporting and Performance in the Literature

2. ESG Reporting and Performance in the Literature

This section examines the existing academic literature on the matter of ESG reporting, its drivers and its relationship with financial performance.

With Socially Responsible Investment (SRI), investors chose to express their Corporate Social Responsibility (CSR) and focus not only on financial performance but also on non-financial considerations such as their ethical, social and religious preferences, which are given significant weight in investment decisions (Benson et al., 2006).

The matter of SRI/CSR's role in firms' management and investors' decisions has continuously evolved over the past several decades. In recent years, these questions have increasingly come under more sharp focus with the rise of Economic, Social and Governance (ESG) considerations in the investment process.

The acronym ESG was first introduced in 2005 and was adopted as part of the UN Principles for Responsible Investment (UNPRI) in 2006 for equity and, since 2007, has been extended to fixed income and other asset classes (Inderst and Stewart, 2018).

For the purposes of this paper, we use the terms SRI, CSR and ESG interchangeably. As most of the existing literature refers to CSR we will continue to use this term in this chapter. However, in subsequent chapters we will explicitly employ the term ESG.

2.1 Firm Characteristics and ESG Disclosure

Stakeholder theory is one of the main theoretical frameworks relevant to the decision to disclose ESG information for a firm. In a founding text on the subject, Ullmann (1985) argues that the key to understanding the decision of a firm to disclose said information is an examination of the relationships between the firm, its management and its stakeholders. Three aspects in particular are considered relevant:

- Stakeholder power: if the power of a firm's stakeholders is large, it is likely that it will perform well on CSR criteria and disclose more about this performance. Conversely, if the firm's stakeholder power is low, then the firm is likely to engage in minimal social responsibility activities and disclose the mandatory minimum about such activities.

- Management's strategic posture: firms whose management adopt an active strategic posture (in response to the social demands made on the firm) are more likely to make ESG a focus of the firm than if their strategic posture is passive.

- Current and past economic performance: firms with low profitability or high debt levels are likely to make responses to ESG demands a lower order consideration than if the firm is profitable.

Following Ullmann (1985), firms can be expected to implement and disclose their ESG activities and the quality of these activities

2. ESG Reporting and Performance in the Literature

will be of a higher standard if their stakeholders are more powerful, management has a strategic focus on engaging said stakeholders, and if the firm is economically profitable.

These hypotheses have been explored in a number of studies.

Gamerschlag et al. (2011) find that the decision to disclose sustainability performance is strongly and positively related to a firm's size and profitability. That is, the larger and more profitable a firm is, the more likely it is to disclose information about its social and environmental impact.

Both Gamerschlag et al. (2011) and Chan et al. (2014) find that firms with stronger corporate governance are more likely to disclose their social responsibility performance. Stronger corporate governance indicates that management is more likely to be engaged with their stakeholders and, as a result, more likely to implement CSR measures. Finally, Wanderley et al. (2008) and García-Sánchez et al. (2016) both find that the decision to disclose ESG information is related to country and industry factors.

There is further evidence that the decision to disclose CSR/ESG practices is related to actual outcomes. Herbohn et al. (2014) and Beck et al. (2018) both find that a firm's disclosure of its sustainability practices is strongly linked to its social responsibility performance. Hence, firms that choose to disclose and to report more can also be expected to perform better in terms of social responsibility.

In line with Ullmann (1985)'s arguments, it is reasonable to expect that larger, more profitable firms are more likely to disclose and adhere more to socially responsible practices.

2.2 ESG and Financial Performance

Today, the main ESG approaches implemented in the investment process are the following (Inderst and Stewart, 2018):

- Negative screening: exclusion of securities belonging to controversial industries.
- Positive screening: selection of companies with better ESG performance than their peers.
- Active ownership - voting - engagement - stewardship: investors attempt to influence the company's actions in order to address ESG issues either through direct dialogue or by exercising their voting rights.
- ESG integration: based on the systematic inclusion of ESG risks and opportunities in investment analysis, portfolio construction and risk management.
- Thematic investment: choosing ESG investment themes, e.g. Green investments.

Taking these practices into account, a number of empirical studies have found a negative relationship between ESG and financial returns (see Renneboog et al. (2008) and Geczy et al. (2005)). Lower returns, however, can be offset by lower risk, as shown by Nofsinger and Varma (2014), where portfolios with a positive ESG screen have a higher risk-adjusted return than conventional funds in times of crisis.

2. ESG Reporting and Performance in the Literature

Other research has found no difference in the returns of SRI-driven and conventional investments (see Bauer et al. (2005), Bello (2005)) i.e. if the market does not price social responsibility characteristics, then ESG factors have no effect on expected returns or on companies' cost of capital (Hamilton et al., 1993).

Other studies find a positive effect of ESG filters on returns (Verheyden et al. (2016), Auer (2016)), particularly when ESG screening is applied by selecting the highest ESG scores. For instance, Kempf and Osthoff (2007) find higher returns using a strategy that buys the most highly ranked SRI firms and sells the firms with the lowest SRI rank. Barnett and Salomon (2006) found that the intensity and type of social screening influences the risk-adjusted performance, hence the relationship between financial performance and ESG performance is neither strictly negative nor strictly positive but rather curvilinear: the strongest financial returns are found in firms with low and high levels of ESG and lower financial performance corresponds to moderate levels of ESG performance.

Friede et al. (2015) aggregate the evidence of multiple empirical studies on this topic and conclude that around 90% of the studies provide a non negative association and the large majority report positive findings that are stable over time. It can be tempting to conclude that better ESG practices result in better risk-adjusted returns and better financial performance.

However, it is important to ask why this might be the case. In effect, when factor-based asset pricing is considered, that there is no sustainability factor that can explain returns better than Fama and French (1993)'s existing three factor model (see for example Xiao et al. (2013)).

As a result, there is no 'ESG factor' in equities. Instead, ESG screens appear to load on multiple other factors (like 'value' or 'low volatility') which are well-known drivers of excess returns in equity markets. [2]

Most of the academic and industry research exploring the relationship between CSR and financial performance uses equity market data, but far less research is available about the effect of ESG on fixed income or other asset classes such as real estate (Inderst and Stewart, 2018).

Several empirical studies examine ESG and listed REITs in the USA (Eichholtz et al., 2012) and in Europe, North America and Asia (Fuerst, 2015). They report that the relationship between ESG ratings and stock returns is not statistically significant, but do find a positive relation between ESG and three measures of operating performance: return on assets, return on equity and the ratio of funds from operations to total revenue (Eichholtz et al., 2012), (Cajias et al., 2014). Eichholtz et al. (2010) conducted a study on private office buildings and found that buildings with a "green rating" command rental rates that are 3% higher per square foot than otherwise identical buildings and selling prices of green buildings are roughly 16% higher.

2 - Amenc and Le Sourd (2010) shows that SRI investments load on traditional asset pricing factors whilst Christiansen and Esakia (2018) show that firms with high pollution are associated with large, value factors.

2. ESG Reporting and Performance in the Literature

We conclude from the literature that ESG reporting is likely to be impacted by firm characteristics such as size and profitability. However, whether ESG scores can be expected to systematically discriminate between higher and lower financial performance in infrastructure investment remains an open question.

The literature suggests that despite controlling standard and well-documented risk factors, the ESG characteristics of firms do not explain returns. However, they also correspond to an implicit filter of these risk factors and therefore can be found to 'load' on remunerated risk factors that do increase portfolio returns.

Whether this effect itself is systematic is not self-evident since ESG reporting can mean different things in different sectors. In the case of infrastructure, larger, less leveraged firms are also less likely to be project financed, for example, and more likely to be in regulated sectors like network utilities or airports.

Next, we examine the data used in the study.

3. Data and Univariate Tests

3. Data and Univariate Tests

3.1 ESG Reporting

To date, the wholesale adoption of ESG reporting has not been mandated. A number of factors can be attributed to this. However, the factor that has the most impact is the lack of a common definition of ESG measures and how to rank their relative importance.

Current methods for ESG measurement are two-fold. For listed firms, large ESG ratings firms such as MSCI, Refinitiv or Sustainalytics rank firms according to their public market disclosures and other public information sources. [3] Whilst the large firms have a large set of rating criteria, said criteria may not be applied consistently. As a result, the same firm can get widely divergent ESG ratings from different firms. [4]

For unlisted firms, where there is significantly less disclosure, the approaches employed by large indexing companies fail when it comes to rating ESG performance. Instead, firms can choose to report to external organisations that specialise in ESG ratings for unlisted firms, such as GRESB. These provide a similar service to that of the large ESG ratings firms. However, reporting of the infrastructure industry is immature and there is not standardization of ESG performance metrics. Hence reporting has been focused on the firm's management approach and transparency of performance reporting rather than the performance itself. These indicators may provide a good measure of ESG performance and outcomes but are not direct measures.

Inherent therefore, in the application of Environmental, Social and Governance reporting is the assumption that the act of reporting and measuring ESG performance leads to better ESG performance.

3.2 GRESB ESG Assessment and EDHEC*infra* Investable Universe

The data employed in this study is a combination of ESG data provided by GRESB and infrastructure data from the EDHEC*infra* database. GRESB assesses and benchmarks the ESG performance of real assets, providing standardized and validated data to the capital markets. They assess the ESG characteristics of real estate, debt and infrastructure assets world-wide. As one of the few assessors of the ESG performance of infrastructure assets, GRESB examines the performance of 272 assets (as at 2018). So far, GRESB has covered three full years of completed ESG data on infrastructure companies under its Infrastructure Asset Assessment process – this represents, to the authors' knowledge, the largest ESG dataset on infrastructure worldwide.

The GRESB Infrastructure Asset Assessment provides the basis for systematic reporting, objective scoring and peer benchmarking of ESG management and performance of infrastructure assets. The participants in this process report ESG performance data on an annual basis, which is then subjected to validation, scoring and benchmarking by GRESB. The assessment is structured into seven ESG Aspects. The weighted combination of scores for each aspect generates the overall GRESB Score (see Table 1). Within each indicator,

3 - MSCI and Refinitiv both state that their ESG ratings are determined by public disclosures (see (MSCI, 2018) and (Refinitiv, 2018)). As these disclosures are not reported in a standardised format (like company accounts with accounting standards) or audited by the company's auditors, they may be incomplete or otherwise incomparable.

4 - Mackintosh (2018) highlights this issue by comparing the ESG scores for several large firms in the U.S. Differing weighting of the E, S and G components as well as different inclusions for the ranking of their Environmental, Social or Governance performance drives the differences in the rankings. As a result, the ESG scores are inconsistent, and this has real-world impacts for investors who rely on a single firm for their ESG screening.

3. Data and Univariate Tests

the following scoring allocations are displayed (GRESB Asset Scoring Document, 2018):

- **Total Points**: the sum of the scores for each indicator adds up to a maximum of 100 points; the overall GRESB Score is expressed as a percentage – from 0 to 100.
- **IM/MP Dimensions**: to provide additional understanding of performance, the score is divided into two dimensions: Management & Policy (MP) and Implementation & Measurement (IM).
- **ESG Score**: each indicator is allocated to one of the three sustainability dimensions (E - Environmental, S - Social, G - Governance).

Under each of the aspect scoring concepts, a series of questions are put to the asset managers. Their response, with accompanying evidence, determines the score across the E, S and G metrics. The ESG score is awarded on the basis of ESG reporting on the following:

- For *Management*, GRESB assesses how the entity addresses ESG management through: assessing whether material issues have been identified and what they are; identifying responsibilities for management of ESG issues; and assessing the approach to ESG training.
- *Policy and Disclosure* aspect scoring assesses the entity's ESG policies and approach to disclosure.
- *Risks and Opportunities* assesses the entity's understanding and mitigation of the key sustainability risks and opportunities.
- *Monitoring and EMS* examines the firm's monitoring practice of its ESG performance.
- *Stakeholder Engagement* assesses the entity's stakeholders engagement program, including actions taken to engage with those stakeholders and to characterize the nature of the engagement.
- *Performance Indicators* assesses the entity's ESG performance in relation to data captured and reporting for a set of common infrastructure performance metrics covering environmental and health and safety issues.
- *Certifications and Awards* assess the entity's achievement and/or maintenance of ESG related certifications.

As infrastructure assets are idiosyncratic, the assessment incorporates materiality-based scoring whereby issues that are not material for the entity are not assessed or scored, while issues that are highly material are scored more highly. This tailors the assessment to the particular entity sector and situation.

In order to understand the characteristics of firms that choose to report their ESG performance to GRESB, the EDHEC*infra* infrastructure universe has been used as benchmark.

EDHEC*infra* has identified the investment universe of unlisted infrastructure companies based on two main criteria:

- **National-market inclusion**: only relevant markets are considered based on their level of activity in terms of number of transactions, relative size and minimum data availability. To qualify as 'principal' markets (in the IFRS-13 sense) included markets have to correspond to at least 0.5% of global the deal flow and have a secondary-to-

3. Data and Univariate Tests

Table 1: This table presents the Aspect Scoring Concepts employed by GRESB to calculate the ESG scores for infrastructure assets.

Aspect	Weight (% overall score)
Management	12.3%
Policy and Disclosure	12%
Risks and Opportunities	22.3%
Monitoring and EMS	10.2%
Stakeholder Engagement	10.4%
Performance Indicators	30.2%
Certifications and Awards	2.5%

Source: GRESB Scoring Methodology 2018.

primary transaction ratio of 20% by value or number.

- **Individual-company inclusion**: only companies that meet a minimum criteria in terms of investability, age and minimum data availability are included in the investment universe.

The EDHEC*infra* Universe contains 4,785 individually identified infrastructure companies as of 2018. This represents, to the authors' knowledge, the world's largest collection of identified investable infrastructure companies.

Firms in the GRESB dataset and EDHEC*infra* Universe are classified according to The Infrastructure Company Classification Standard (TICCS). TICCS is a classification system developed by EDHEC*infra* to better describe infrastructure assets. TICCS consists of four major classification perspectives to define infrastructure as an asset class. [5]

3.3 Data and Descriptive Statistics

The GRESB sample contains 272 firms as of 2018 for which ESG ratings are available. [6] These firms are matched to the companies present in the EDHEC*infra* universe and this yields a sample of 165 companies reporting to GRESB in at least one of the three years for which data is available, as is sufficient financial information (size, leverage, profits, etc.). These firms also qualify as infrastructure under TICCS.

3.3.1 Reporting Firms vs. Investable Universe

First, we compare firms in the GRESB sample with firms in the EDHEC*infra* Universe (the benchmark population) in order to understand which kind of companies disclose ESG data, in which countries and sectors, and to explore the characteristics of ESG-reporting companies.

As of 2018, the GRESB sample includes 22 different countries, mainly OECD countries. Some 39.4% of the firms are UK companies, 11.7% are Spanish and 14% are Australian (see Table 2).

In 2018, the EDHEC*infra* Universe covers 23 countries, mostly OECD countries and

5 - The TICCS pillars include:
- **Business Risk Classification**: This considers the business model of the assets, whether it is merchant, regulated or contracted.
- **Industrial Classification**: This classifies assets according to the technology and purpose.
- **Geo-Economic Classification**: This is a measure of common economic exposure of the asset. It allows for four categories of geo-economic exposure, Global, Regional, National and Sub-National.

3. Data and Univariate Tests

some emerging economies. 49.4% of the firms are UK companies, 15.1% are Spanish companies and 10% are Brazilian firms. The high proportions of Spanish and UK firms are reflected in the GRESB sample, however, some countries with a strong presence in the EDHEC*infra* Universe are under-represented in the GRESB sample (e.g. Brazil 10% verus 0.5%), while countries such as Australia are over-represented in the GRESB sample (14% versus 1.3%).

Table 3 shows the sector breakdown in the two populations. Education Services is the sector with the highest representation in the GRESB sample followed by Airports. Education Services have also a high representation in EDHEC*infra* Universe, however, the sectors with more weight in the investable infrastructure universe are Solar Power Generation (19.6%) and Wind Power Generation (14%). Solar generation companies appear to be in a smaller reporting segment for GRESB when compared to the investable infrastructure population.

Table 4 shows the proportions of business model[7] in the GRESB sample and the EDHEC*infra* Universe. In terms of business risk classification, the GRESB sample contains a lower percentage of contracted companies and higher percentages of merchant and regulated firms.

This reflects the fact that the GRESB sample consists of large corporations that are normally regulated or merchant business, while the EDHEC*infra* Universe contains a higher proportion of contracted SPV projects.

Clearly, large firms in certain sectors with regulated and merchant business models have more weight in GRESB dataset.

3.3.2 Explanatory Variables

The explanatory variables considered in this study to determine the characteristics of companies that report ESG data and to explain ESG scores are:

- **Leverage**: expressed as a ratio, is measured as total debt (long- and short-term debt) dividend by total assets.
- **Return on Assets**: expressed as a ratio, is measured as net income divided by total assets.
- **Operational Expenditure Intensity**: expressed as a ratio, is measured as operational expenditure divided by revenues.
- **Total Assets**: is the natural log of total assets expressed in USD converted at the prevailing year-end exchange rate. Natural log is taken to remove the impact of outliers.
- **Age**: the number of years of existence of the firm since its incorporation date.
- **Net Profit Margin**: expressed as a ratio, is measured as net income divided by revenues.

Descriptive statistics of the explanatory variables for the GRESB sample and the EDHEC*infra* Universe are presented in Table 5.

The statistics are calculated based on 3 years of financial data (2016- 2018). Opex Intensity (OpexInt), Return on Assets (ROA) and Net Profit Margin (NPM) have been winsorized to within three standard deviations from the

7 - **Business models:** Merchant firms are exposed to market risk (price and demand risk); Contracted firms sell a major proportion of their output at a pre-agreed price and quantity; Regulated firms have revenues and profits that are regulated by an economic regulator that sets limits on rates of return, revenues, capital expenditure, efficiency of a network design, etc.

3. Data and Univariate Tests

*Table 2: This table presents the summary of the different countries of firms that report to GRESB and the global investable infrastructure population. GRESB sample refers to firms that report to GRESB and EDHEC*infra *Universe refers to firms identified as investable by EDHEC*infra*. This table only reports firms that have financial information obtained in the 2016, 2017 and 2018.*

Country	GRESB sample	EDHEC*infra* Universe
Australia	14.0%	1.3%
Austria	1.1%	0.0%
Belgium	0.5%	0.0%
Brazil	0.5%	10.0%
Canada	0.5%	0.2%
Chile	1.1%	1.0%
Denmark	2.3%	0.0%
Finland	1.1%	0.5%
France	9.4%	8.3%
Germany	0.3%	0.6%
India	1.4%	0.0%
Ireland	2.9%	1.2%
Italy	2.9%	5.4%
Malaysia	0.0%	1.3%
Netherlands	2.6%	0.2%
New Zealand	1.7%	0.2%
Norway	2.0%	0.06%
Philippines	0.0%	0.5%
Poland	0.3%	1.0%
Portugal	1.7%	2.6%
Singapore	0.0%	0.0%
Spain	11.7%	15.1%
Sweden	1.7%	0.1%
United Kingdom	39.4%	49.4%
United States	0.5%	1.0%

mean to approximate a normal distribution, thus transforming extreme values in the data to reduce the impact of outliers in the two populations.

Firms characteristics of the GRESB sample and the EDHEC*infra* Universe can be compared using a test for differences in mean values. As most distributions in the two populations are skewed, a non-parametric test has been used to test if the differences in mean values in the two groups are statistically significant. A Wilcox test is conducted to overcome the non-normality concern and univariate tests results are shown in Table 6.

Results show that differences in mean values between the two populations are statistically significant for all the variables except for Age and Opex Intensity. We find that firms in the GRESB sample are less leveraged and larger. Interestingly, we find that GRESB firms exhibit a lower mean value of ROA and a lower mean value of Net Profit Margin.

The univariate test presented in this section shows the first insights of observations of differences in explanatory variables between GRESB firms and firms in the EDHEC*infra* Universe. The Multivariate test described in Chapter 5 explores further these differences.

3. Data and Univariate Tests

*Table 3: This table provides a TICCS sector breakdown for both the firms that report to GRESB and the global investable infrastructure population. GRESB sample refers to firms that report to GRESB and EDHECinfra Universe refers to firms identified as investable by EDHEC*infra*. This table only reports firms that have financial information obtained in the years 2016, 2017 and 2018*

Sector	GRESB sample	EDHEC*infra* Universe
Airport Companies	9.7%	2.2%
Car Park Companies	0.0%	0.2%
Convention, Entertainment, and Recreational Facilities	3.4%	0.6%
Data Transmission	3.7%	0.6%
Defence Services	0.0%	1.9%
District Cooling/Heating Companies	1.1%	0.0%
Education Services	16.0%	12.3%
Electricity Distribution Companies	4.5%	0.9%
Electricity Transmission Companies	2.9%	2.7%
Energy Resource Processing Companies	0.0%	0.4%
Energy Resource Storage Companies	1.4%	0.0%
Environmental Management	0.9%	0.0%
Gas Distribution Companies	3.7%	0.4%
Government Services	4.0%	8.7%
Health and Social Care Services	8.6%	11.0%
Hydroelectric Power Generation	2.6%	2.1%
Independent Power Producers	1.1%	4.4%
Other Renewable Power Generation	2.0%	0.0%
Pipeline Companies	0.5%	3.8%
Port Companies	5.1%	2.3%
Rail Companies	1.4%	1.0%
Road Companies	6.9%	5.2%
Solar Power Generation	4.0%	19.6%
Solid Waste Treatment	0.6%	3.0%
Urban Commuter Companies	2.9%	0.7%
Wastewater Treatment	0.0%	1.5%
Water and Sewerage Companies	3.4%	0.0%
Water Supply and Treatment	0.5%	0.6%
Wind Power Generation	9.0%	14.0%

*Table 4: Companies business model in populations. GRESB sample refers to firms that report to GRESB and EDHECinfra Universe refers to firms identified as investable by EDHEC*infra*. This table only reports firms that have financial information obtained in 2016, 2017 and 2018.*

Business model	GRESB sample	EDHEC*infra* Universe
Contracted	59%	81%
Merchant	23%	10%
Regulated	18%	9%

3.3.3 What variables explain ESG scores?

We now turn to understanding the characteristics of the ESG scores. In this analysis and all subsequent analyses, the ESG score used is the average of the ESG score reported in 2017 and 2018. The distribution of ESG scores calculated by GRESB is shown in Table 7 and presented in Figure 1. The mean ESG score was 44.97 points (out of 100) and a median of 48.68 points.

Table 8 presents a correlation matrix of ESG scores and the explanatory variables for GRESB reporting firms. It shows that:

3. Data and Univariate Tests

*Table 5: This table presents the descriptive statistics of the Infrastructure Universe and the firms that report to GRESB. Panel A presents the descriptive statistics for the Infra Universe identified as investable by EDHEC*infra*. Panel B presents the descriptive statistics for the firms that report to GRESB. This table only reports firms that have financial information obtained in 2016, 2017 and 2018. LEV is leveraged; ROA is Return on Assets; OpexInt is Opex Intensity; TA is the natural log of total assets; Age of the firm is the number of years of existence since incorporation date; NPM is net profit margin. OpexInt, ROA and NPM variables have been winsorized to within three standard deviations from the mean to approximate a normal distribution, thus transforming extreme values in the data to reduce the impact of outliers.*

	LEV	ROA	OpexInt	TA	Age	NPM
Panel A: EDHEC*infra* Universe firms						
Mean	0.63	0.02	0.75	17.91	13.34	0.08
Median	0.68	0.01	0.77	17.81	12.00	0.09
St Dev	0.46	0.06	0.26	1.64	9.51	0.29
Min	-1.18	-0.13	0.20	9.83	1.00	-1.00
Max	10.54	0.19	1.48	24.35	121.00	0.65
Panel B: GRESB firms						
Mean	0.55	0.01	0.72	19.56	14.94	0.05
Median	0.59	0.01	0.72	19.28	11.00	0.07
St Dev	0.38	0.04	0.24	1.93	13.79	0.27
Min	0.00	-0.09	0.18	14.04	1.00	-0.80
Max	2.05	0.12	1.19	23.93	106.00	0.53

Table 6: This table presents the results for the Wilcox difference in mean test the investable infrastructure universe and the firms that report to GRESB. This table only reports firms that have financial information available for a period of 3 years (2016 - 2018). LEV is leveraged; ROA is Return on Assets; OpexInt is Opex Intensity; TA is the natural log of total assets; Age of the firm is the number of years of existence since incorporation date; NPM is net profit margin.

Variable	Mean diff	W	p-value
LEV	**0.08**	490580	**0.00011**
ROA	**0.01**	498830	**0.00066**
OpexInt	0.02	526810	0.06172
TA	**-1.65**	840950	**< 0.0000**
Age	-1.6	560720	0.9933
NPM	**0.03**	520460	**0.02664**

Note: Significance at $p \leq 0.05$ is highlighted in bold.

Table 7: This table presents the summary statistics of the ESG scores calculated by GRESB. Only firms that report to GRESB are provided with an ESG score. The ESG score is the average of the scores provided in 2017 and 2018.

Min.	1st Qu.	Median	Mean	St Dev	3rd Qu.	Max.
2.63	17.67	48.68	44.97	25.00	66.76	92.29

- Leverage is negatively associated to ESG score, meaning that firms with higher debt levels have a lower ESG score, although this correlation is weak as shown in Figure 2.
- Opex Intensity has a very weak negative association of -0.09, which indicates there is no relation between the operational expenditure intensity and the ESG score (see Figure 2).
- Company size and age are positively associated with ESG score. Particularly, total assets exhibit the strongest correlation with ESG scores (see Figure 3).

3.3.4 Is a higher ESG score related to higher financial performance?

Consistent with prior research on other assets classes about the relationship between ESG and financial performance, we consider whether higher ESG scores correspond to higher financial performance.

3. Data and Univariate Tests

Figure 1: Histogram of ESG scores

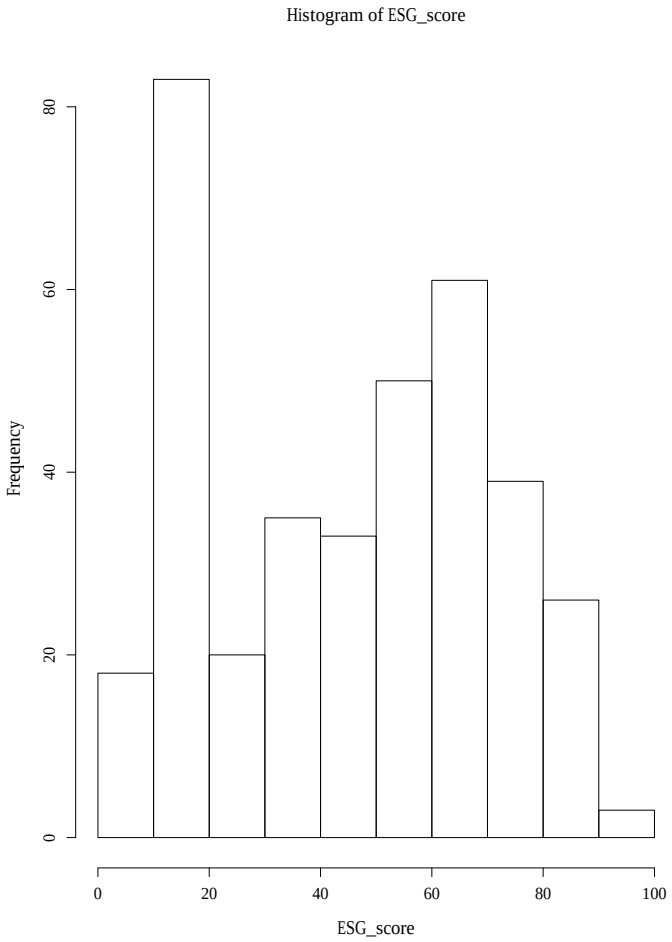


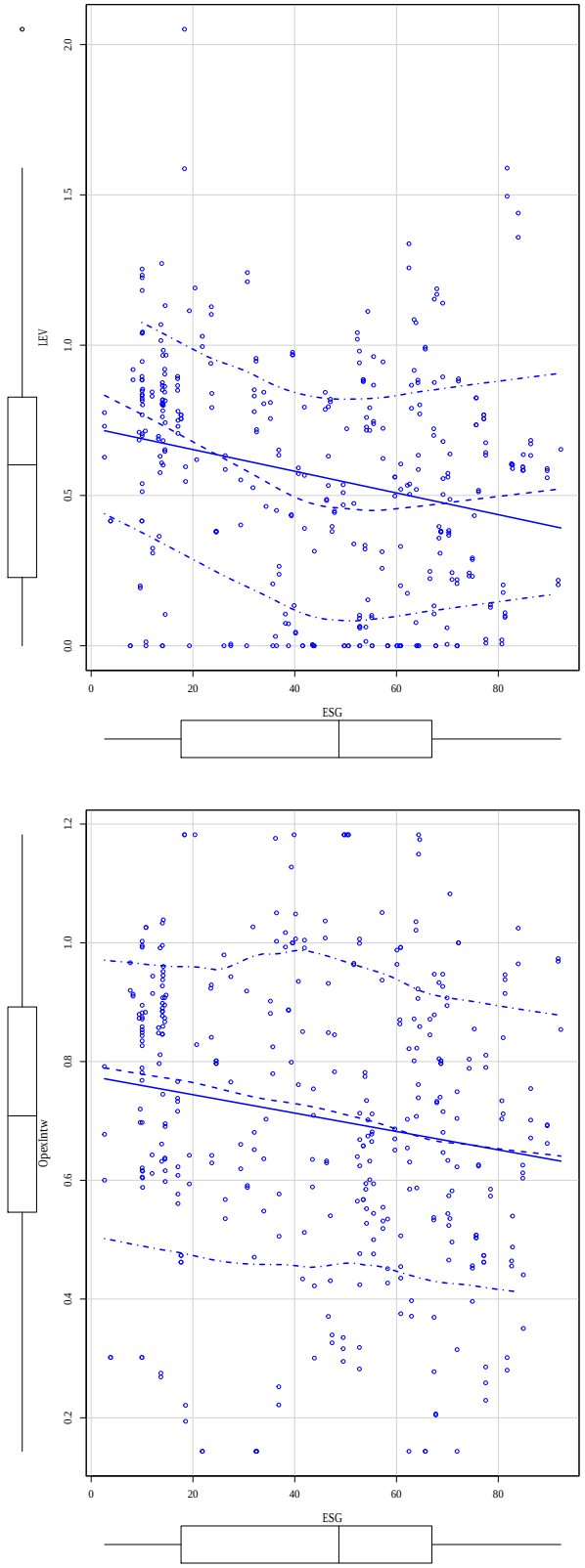
Table 8: This table presents the correlation matrix of ESG scores and other explanatory variables. All firms included in this table are the GRESB reporting firms. This table only reports firms that have financial information obtained from 2016 to 2018. LEV is leveraged; ROA is Return on Assets; OpexInt is Opex Intensity; TA is the natural log of total assets; Age of the firm is the number of years of existence since incorporation date; NPM is net profit margin. ESG is the average of the scores provided in 2017 and 2018.

	LEV	ROA	OpexInt	TA	Age	NPM	ESG
LEV	1.00						
ROA	-0.08	1.00					
OpexInt	-0.12	-0.61	1.00				
TA	-0.06	0.25	-0.30	1.00			
Age	-0.12	0.15	-0.08	0.30	1.00		
NPM	-0.12	0.26	-0.03	0.10	0.04	1.00	
ESG	**-0.24**	0.06	-0.09	**0.45**	**0.25**	-0.03	1.00

Numbers in bold show significant correlations

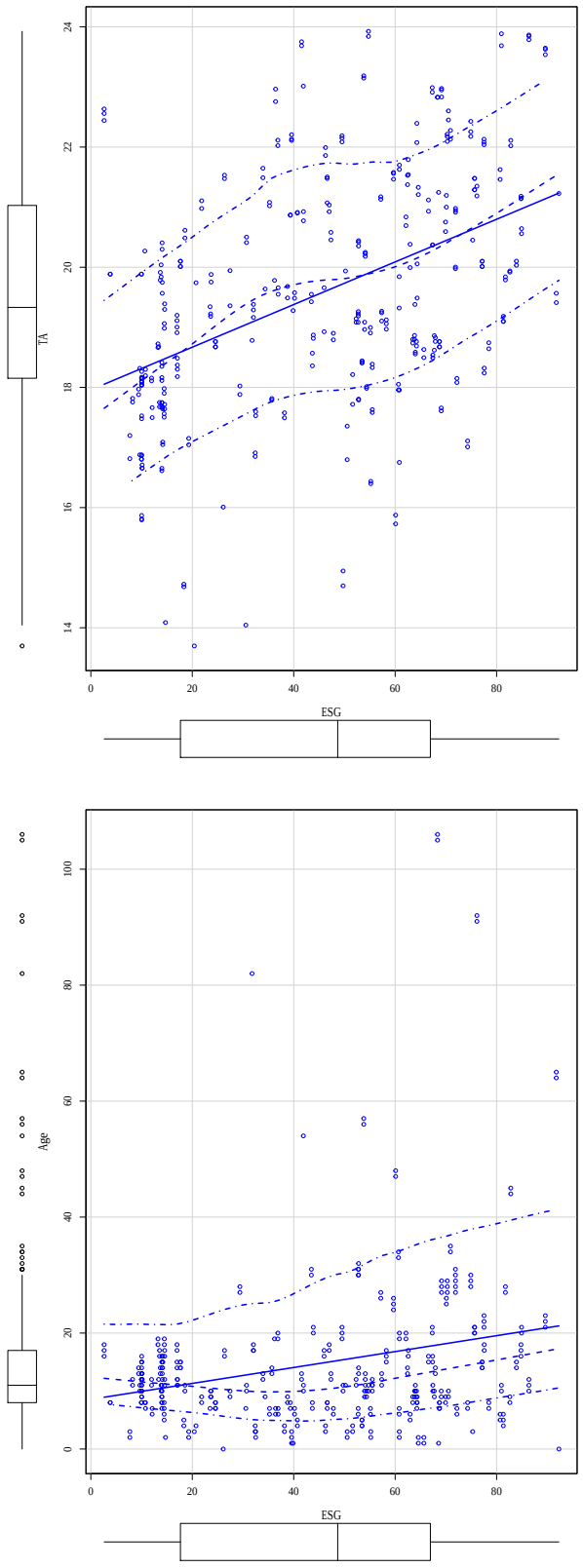
3. Data and Univariate Tests

Figure 2: Leverage and Opex Intensity - ESG scores. Opex Intensity has been winsorized to within three standard deviations from the mean to approximate a normal distribution, thus transforming extreme values in the data to reduce the impact of outliers



3. Data and Univariate Tests

Figure 3: Total Assets and Age - ESG scores

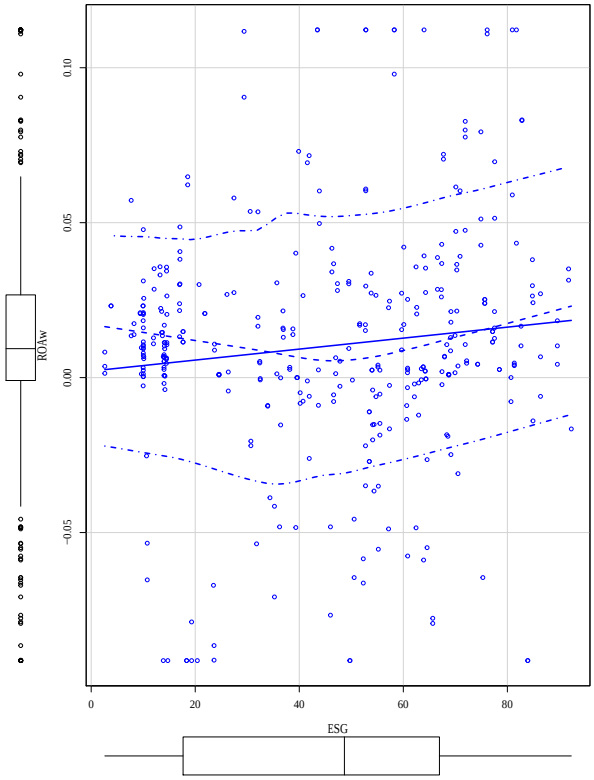


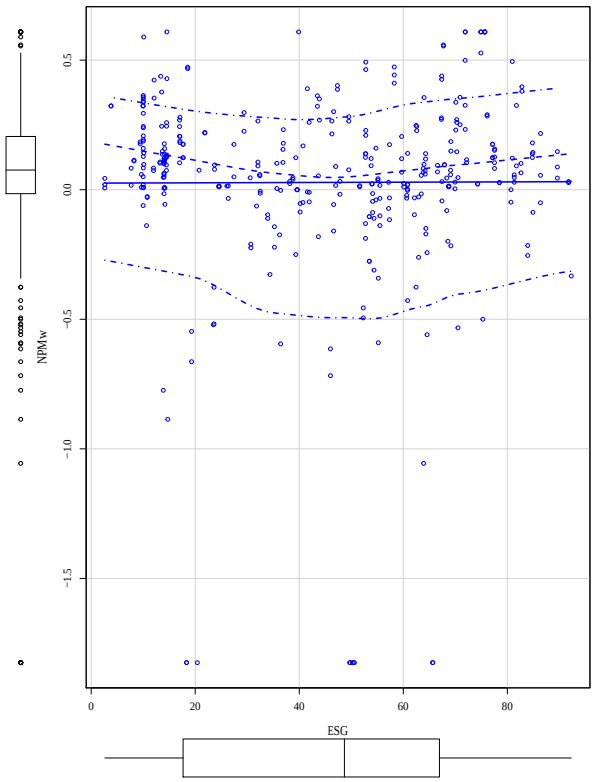
3. Data and Univariate Tests

In this study we have considered Return on Assets as the main accounting variable to measure financial performance. The correlation shown in Table 7 and Figure 4 exhibit no correlation of ROA with ESG score, likewise no association is seen between Net Profit Margin and ESG score. These first insights suggest there may be no relation between the financial performance of the companies in the GRESB sample and their ESG score. In Section 5 this association is analysed further through multivariate analysis.

3. Data and Univariate Tests

Figure 4: Return on Assets and Net Profit Margin - ESG scores. ROA and NPM variables have been winsorized to within three standard deviations from the mean to approximate a normal distribution, thus transforming extreme values in the data to reduce the impact of outliers.





4. Methodology

4. Methodology

In order to answer the research questions introduced in Section 1 three different regressions are performed. The first is a probit regression (where the dependent variable is either 0 or 1) designed to see what characteristics are associated with firms choosing to report to GRESB. Any statistically significant variables are associated with the an increase, or decrease (depending on the sign) in probability of firms reporting.

The second regression conducted in this paper examines what characteristics are associated with the level of the ESG rating. As a result of this chosen methodology, we are able to conclude that the ESG rating is impacted positively (negatively) if the sign of the coefficient is positive (negative). As this is an Ordinary Least Squares (OLS) regression, it assumes that there are linear effects between the size of the coefficient and the ESG rating. As a result, it is possible to infer that a 1-level change in any of the independent variables will have an impact on the ESG score commensurate with the size and sign of the coefficient.

The final regression examines the impact of ESG performance on firm financial performance. As explained in subsection 4.0.3, a pooled OLS regression is performed with the ESG score used as an independent variable. The sign, size and significance of this variable will allow us to draw inferences on the impact on financial performance of ESG performance.

The following subsections will provide more detail of the set up of the different methodologies employed and detail the variables employed in the analysis.

4.0.1 Characteristics of Reporting Firms

The following multi-variate pooled probit regression is conducted to determine if there are any common characteristics that explain the choice of firms to report their ESG activities to GRESB:

$$Indicator_{i,t} = \beta_0 + \beta_1 Log(TotalAssetsUSD)_{i,t} + \tag{4.1}$$

$$\beta_2 ROA_{i,t} + \beta_3 OpexIntens_{i,t} + \beta_4 Leverage_{i,t} +$$

$$\beta_5 \text{Corp} + \sum_{j=1}^{8} \phi_j TICCSGroupCode +$$

$$\sum_{k=1}^{3} \delta_k Year + \varepsilon_{i,t}$$

where:

- $Indicator_{i,t}$ is an indicator variable at time t for firm i equalling 1 if the firm reports to GRESB and 0 otherwise;
- $Log(TotalAssetsUSD)_{i,t}$ is the log of the total assets recording in USD at time t for firm i;
- $ROA_{i,t}$ it the Return on Assets (net income after tax divided by total asset) at time t for firm i;
- $OpexIntens_{i,t}$ is the operating cost intensity (operating costs divided by total assets) at time t for firm i; and,
- $Leverage_{i,t}$ is the log of 1 + leverage where leverage id defined as $\frac{\text{short-term loans}+\text{long-term loans}}{\text{total assets}}$ at time t for firm i; and,
- Corp is a dummy variable representing 1 if the company is considered a corporation and 0 otherwise.

4. Methodology

The choice of variables is a result of prior research as well as infrastructure investment specific factors. $Log(TotalAssetsUSD)_{i,t}$, $ROA_{i,t}$ and $Leverage_{i,t}$ are all included as Artiach et al. (2010),Herbohn et al. (2014) and Beck et al. (2018) find these are related to firms choosing to undertake or report on their sustainability or corporate social responsibility activities. As infrastructure assets are large and have relatively fixed costs for their output, $OpexIntens_{i,t}$ was selected as an input to represent the cost efficiency of the infrastructure company. As infrastructure assets can be either long-lived corporations or project companies set up as a Special Purpose Vehicle (SPV) with a finite life the dummy variable, Corp was included to represent the difference between these two different classes of companies. As it is a pooled regression, the TICCS Group Code and Year variables are dummy variables to control for industry and time effects.

4.0.2 Determinants of the ESG Scores

To examine the second research question, what variables explain the ESG score of firms that report to GRESB, the following regressions are conducted:

$$ESGScore_{i,t} = \beta_0 + \beta_1 Log(TotalAssetsUSD)_{i,t} + \beta_2 ROA_{i,t} + \beta_3 OpexIntens_{i,t} + \beta_4 Leverage_{i,t} + \beta_5 \text{Corp} + \sum_{j=1}^{8} \phi_j TICCSGroupCode + \sum_{k=1}^{3} \delta_k Year + \varepsilon_{i,t} \quad (4.2)$$

where:

- $ESGScore_{i,t}$ is the average of the 2018 and 2017 ESG performance rating provided by GRESB;
- $Log(TotalAssetsUSD)_{i,t}$ is the log of the total assets recording in USD at time t for firm i;
- $ROA_{i,t}$ it the Return on Assets (net income after tax divided by total asset) at time t for firm i;
- $OpexIntens_{i,t}$ is the operating cost intensity (operating costs divided by total assets) at time t for firm i; and,
- $Leverage_{i,t}$ is defined as $\frac{\text{short-term loans}+\text{long-term loans}}{\text{total assets}}$ at time t for firm i; and,
- Corp is a dummy variable representing 1 if the company is considered a corporation and 0 otherwise.

As before, the choice of variables for the regression explaining the ESG score is inspired by prior research. Artiach et al. (2010) and Beck et al. (2018) demonstrated a link between corporate social responsibility engagement with size, leverage and profitability. As a result, we include these three variables proxied by $Log(TotalAssetsUSD)$, ROA and $Leverage$. As with the regression described in Eq. 4.1, we include $OpexInten$ as a measure of infrastructure firm expenses, Corp as a dummy variable indicating 1 if the firm reporting is a corporation and 0 if it is an SPV and, finally, the TICCS Group Code and Year variables are dummy variables to control for industry and time effects.

Consistent with Artiach et al. (2010), Herbohn et al. (2014) and we expect that coefficients for size (as proxied by *log*(Total Assets USD)

4. Methodology

and ROA will be positive and statistically significant. Whilst the regression coefficient for Leverage will be negative and significant. We expect firms that are in highly profitable industries, such as Network Utilities, to possess the resources to obtain higher ESG scores while firms in industries where profitability is capped, such as in Government Services, to obtain a lower ESG score.

4.0.3 ESG Performance and Financial Performance

Finally, to examine how ESG performance relates to financial performance, the following regression is conducted with Return on Assets as the variable for analysis. Return on Assets was employed following the specification of Waddock and Graves (1997) and Barnett and Salomon (2012) when analysing the financial performance of corporate social responsibility proxies.

$$ROA_{i,t} = \beta_0 + \beta_1 Log(TotalAssetsUSD)_{i,t} + \beta_2 LaggedROA_{i,t} + \beta_3 OpexIntens_{i,t} + \beta_4 Leverage_{i,t} + \beta_5 ESG_{i,t} + \sum_{j=1}^{8} \phi_j TICCSGroupCode + \sum_{k=1}^{3} \delta_k Year + \varepsilon_{i,t} \quad (4.3)$$

where:

- $ROA_{i,t}$ it the Return on Assets (net income after tax divided by total asset) at time t for firm i;
- $Log(TotalAssetsUSD)_{i,t}$ is the log of the total assets recording in USD at time t for firm i;
- $LaggedROA_{i,t}$ is the ROA for firm i at time $t-1$;
- $OpexIntens_{i,t}$ is the operating cost intensity (operating costs divided by total assets) at time t for firm i;
- $Leverage_{i,t}$ is the log of 1 + leverage where leverage id defined as $\frac{\text{short-term loans+long-term loans}}{\text{total assets}}$ at time t for firm i;
- Corp is a dummy variable representing 1 if the company is considered a corporation and 0 otherwise, and,
- $ESGScore_{i,t}$ is the average of the 2018 and 2017 ESG performance rating provided by GRESB.

If higher ESG ratings result in better financial performance, then the ESG coefficient in Eq. 4.3 should be positive and statistically significant. The other control variables are included to isolate other effects on the ROA performance. Following Barnett and Salomon (2012), we have included *Log*(*TotalAssetsUSD*), *LaggedROA* and *Leverage*. Meanwhile, for the infrastructure context, we have included *OpexIntens* and the Corp dummy variable. As with the regressions performed in Eq. 4.1 and Eq. 4.2, fixed industry and year effects are included to control for industry and time variations.

Having described the research approach, the next section describes the results of this analysis.

5. ESG and Infrastructure

5. ESG and Infrastructure

This Section presents the results of multivariate tests of the link between ESG reporting and financial performance. The results examining the characteristics of the ESG reporting firms are presented first. These are followed by the determinants of ESG performance ratings and the examination of ESG performance on firm financial performance, respectively.

5.1 Characteristics of Reporting Firms

To examine the characteristics of firms that report to GRESB, the regression detailed in Eq. 4.1 is conducted on all firms in the EDHEC*infra* population and the GRESB dataset.[8] Firms common to both datasets are removed from the EDHEC*infra* population and only included in the GRESB dataset. The results are presented in Table 9. For the purposes of the regression, the indicator variable is equal to 1 if the firm reports to GRESB and 0 otherwise.

The results in Table 9 show that compared to the complete EDHEC*infra* universe, firms that report to GRESB are larger and have less leverage than the population of infrastructure firms. Interestingly, firms that report to GRESB are more likely to be corporations and have a negative sign for the ROA coefficient, indicating that they are less profitable than other firms within the EDHEC*infra* population.

The results for the size of the firm, in Table 9 are consistent with Artiach et al. (2010), Herbohn et al. (2014) and Beck et al. (2018). These studies found that larger firms are more likely to disclose their corporate sustainability performance. This is consistent with the hypothesis that larger firms are more likely to possess the resources to put in place the policies and procedures for implementing and monitoring corporate sustainability or social responsibility initiatives.

The results in Table 9 show a negative relationship between leverage and the choice of reporting sustainability or social responsibility reporting. This finding is likely due to the fact that EDHEC*infra* population has a significant number of SPVs created as project finance vehicles for a set lifespan.[9] These projects are heavily leveraged and as the results for the Corporate dummy show, these firms are less likely to engage in social responsibility reporting. As a result, the negative relationship between leverage and reporting to GRESB is understandable. As mentioned previously, the positive and statistically significant coefficient for the corporate dummy is consistent with the hypothesis that corporations have the resources to devote to setting up the policies and procedures required of ESG reporting and as a result, are more likely to report on their performance.

5.2 What Explains ESG Performance Rating?

Next, we turn to the analysis of the determinants of the level of the ESG performance rating produced by GRESB. A pooled Ordinary Least Squares (OLS) regression was conducted using the form described in Eq. 4.2, the results of which are presented in Table 10. The ESG scores are calculated using data from the

8 - In unreported analysis, firms in the GRESB dataset were matched to firms in the EDHEC*infra* universe and the differences between the two groups were compared. When firms were matched using propensity scores, no difference between the two populations could be observed.

9 - Employing SPVs for infrastructure investment is a common method in OECD countries.

5. ESG and Infrastructure

Table 9: This table presents the probit regression results of variables explaining the choice to report on ESG performance to GRESB. The dependent variable is a dummy variable taking the value of 1 if the firm reports to GRESB and 0 otherwise. log(TotalAssetsUSD) is the log of the USD value of total assets,ROA is the return on assets, Leverage is the ((short term + long term debt) / Total Assets), Opex Intensity is the operating cost intensity (operating costs/ revenue) and Corp is a dummy variable equalling 1 if the firm is a Corporate and 0 otherwise. ESG_{ROA} are regressions where ROA has been winsorised.

	Dependent variable:					
	ESG	ESG_{ROA}	ESG with industry	ESG_{ROA} with industry	ESG with industry €tyear effects	ESG_{ROA} with industry €tyear effects
	(1)	(2)	(3)	(4)	(5)	(6)
log(Total Assets USD)	0.202***	0.199***	0.221***	0.216***	0.234***	0.229***
	(0.019)	(0.019)	(0.023)	(0.023)	(0.023)	(0.023)
ROA	−0.119	−2.277***	−0.139	−2.822***	−0.149*	−2.623***
	(0.086)	(0.684)	(0.086)	(0.772)	(0.087)	(0.779)
Leverage	−0.114	−0.184**	−0.276***	−0.357***	−0.242**	−0.318***
	(0.087)	(0.090)	(0.097)	(0.099)	(0.099)	(0.100)
Opex Intensity	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Corp	0.261***	0.271***	0.469***	0.480***	0.510***	0.519***
	(0.082)	(0.083)	(0.104)	(0.104)	(0.105)	(0.105)
Environmental Services			1.051***	1.066***	1.175***	1.194***
			(0.328)	(0.334)	(0.335)	(0.342)
Social Infrastructure			1.668***	1.692***	1.811***	1.835***
			(0.273)	(0.278)	(0.281)	(0.287)
Energy and Water Resources			0.573*	0.570*	0.629**	0.632*
			(0.313)	(0.318)	(0.319)	(0.325)
Data Infrastructure			1.913***	1.938***	1.958***	1.985***
			(0.340)	(0.345)	(0.348)	(0.353)
Transport			1.266***	1.298***	1.366***	1.400***
			(0.262)	(0.267)	(0.269)	(0.274)
Renewable Power Generation			1.043***	1.055***	1.141***	1.154***
			(0.270)	(0.276)	(0.278)	(0.283)
Network Utilities			1.150***	1.197***	1.311***	1.358***
			(0.272)	(0.277)	(0.279)	(0.285)
year2017					−0.389***	−0.379***
					(0.072)	(0.072)
year2018					−0.805***	−0.792***
					(0.143)	(0.143)
Constant	−5.051***	−4.917***	−6.636***	−6.468***	−6.735***	−6.578***
	(0.359)	(0.360)	(0.533)	(0.540)	(0.548)	(0.555)
Observations	3,660	3,660	3,660	3,660	3,660	3,660
Log Likelihood	−920.167	−910.939	−920.167	−910.939	−893.335	−885.542
Akaike Inf. Crit.	1,866.334	1,847.878	1,866.334	1,847.878	1,816.671	1,801.085

Note: *p<0.1;**$p < 0.05$; ***$p < 0.01$

prior year. Owing to changes in methodologies employed to calculate the ESG scores, we use the average of the ESG performance rating from 2017 and 2018 as a way to remove any large swings in ESG rating. This results in the number of firm-year observations being 369.

The results in Table 10 show the ESG performance rating is positively related to size and negatively related to firm leverage. The finding that size is positively related to sustainability/ESG performance is consistent with Artiach et al. (2010) and Beck et al. (2018), both of which found size to be positively related to corporate sustainability performance. Whilst the leverage finding is negative and statistically significant, is consistent with Beck et al. (2018), it contrasts with the finding of Artiach et al. (2010), who found that leverage was not related to sustainability performance. For all regressions, ROA is not

5. ESG and Infrastructure

Table 10: This table presents the regression results of variables explaining the ESG performance rating. ESG is the average ESG performance rating for the years 2017 and 2018 provided by GRESB excluding firms that failed to report on their ESG performance and subsequently received a score of 0. Log(Total Assets USD) is the log of the USD value of total assets, Leverage is the ((short term + long term debt) / Total Assets), ROA is the return on assets, Opex Intensity is the operating cost intensity (operating costs/ revenue) and Corp is a dummy variable equalling 1 if the firm is a Corporate and 0 otherwise. All regressions with ESG_{ROA} are regressions where ROA has been winsorised.

	Dependent variable:					
	ESG	ESG_{ROA}	ESG with industry effects	ESG_{ROA} with industry effects	ESG with industry & year effects	ESG_{ROA} with industry & year effects
	(1)	(2)	(3)	(4)	(5)	(6)
log(Total Assets USD)	4.604***	4.518***	4.021***	3.989***	3.913***	3.881***
	(0.769)	(0.767)	(0.805)	(0.802)	(0.811)	(0.808)
Leverage	−13.248***	−13.244***	−10.511***	−10.162***	−10.456***	−10.120***
	(3.179)	(3.297)	(3.166)	(3.284)	(3.168)	(3.289)
ROA	−20.804	−29.324	−5.961	0.887	−5.947	0.590
	(13.958)	(32.491)	(13.701)	(31.549)	(13.710)	(31.590)
Opex Intensity	−3.253	−1.371	−0.030	0.894	0.019	0.929
	(3.459)	(3.079)	(3.462)	(3.034)	(3.463)	(3.035)
Corp	6.203**	6.654**	0.982	0.996	0.777	0.794
	(3.100)	(3.099)	(3.184)	(3.194)	(3.189)	(3.199)
Environmental Services			18.047	17.938	17.544	17.436
			(12.910)	(12.921)	(12.924)	(12.934)
Social Infrastructure			−8.144	−8.319	−8.804	−8.972
			(10.665)	(10.699)	(10.679)	(10.713)
Energy and Water Resources			2.096	1.714	0.992	0.617
			(12.641)	(12.646)	(12.672)	(12.676)
Data Infrastructure			−2.279	−2.244	−2.662	−2.624
			(11.711)	(11.724)	(11.718)	(11.730)
Transport			6.406	6.450	5.687	5.735
			(10.300)	(10.320)	(10.317)	(10.336)
Renewable Power Generation			8.172	8.277	7.423	7.529
			(10.700)	(10.706)	(10.718)	(10.723)
Network Utilities			10.293	10.360	9.415	9.483
			(10.434)	(10.444)	(10.458)	(10.468)
year2017					−0.565	−0.540
					(2.188)	(2.190)
year2018					6.344	6.369
					(5.121)	(5.124)
Constant	−37.749**	−37.448**	−30.714	−30.981	−27.944	−28.203
	(15.216)	(15.294)	(20.185)	(20.194)	(20.294)	(20.304)
Observations	355	355	355	355	355	355
R^2	0.277	0.274	0.353	0.352	0.356	0.356
Adjusted R^2	0.267	0.264	0.330	0.330	0.330	0.329
Note:						*p<0.1; **p<0.05; ***p<0.01

significant in explaining the level of the ESG performance rating. This is interesting as Beck et al. (2018) found their profitability measure, ROE, was related to the corporate social responsibility score. That ROA is not related in this dataset implies that profitability does not affect the ESG performance rating of firms. Finally, the corporate dummy indicates that corporates obtain a higher ESG performance rating than SPVs. This was to be expected, as with the reporting choice, corporates are likely to have access to more resources to devise and implement ESG policies and procedures. As a result, they are better placed to achieve a higher ESG performance rating.

These results indicate that the ESG performance rating is dependent on the resources available to a firm. Firms that are larger and have less leverage (so likely more free cash flow) are available to devote resources to

5. ESG and Infrastructure

obtaining and improving their ESG performance rating.

5.3 Does ESG Reporting Improve Financial Performance?

Finally, we turn to the analysis of whether the firms that have higher ESG ratings have superior financial performance. To do this, a pooled regression described in Eq. 4.3 is conducted on the GRESB firm dataset. As with the analysis presented in the previous section, the ESG performance rating is the average of the ESG performance rating from 2017 and 2018. The results of the regression are presented in Table 11.

The results in Table 11 show that the prior period's ROA is positively related and statistically significant in explaining the current period's ROA; furthermore, size is also positive and statistically significant. Both of these findings are consistent with Barnett and Salomon (2012). Opex intensity is negatively related to the current period's ROA. This makes sense as higher costs will result in lower ROA. Leverage is statistically significant in all regressions. For all regression specifications, the ESG variable is not statistically significant and its sign changes. We can therefore conclude that ESG performance provides no positive or negative impact on the current period's ROA.

The finding that ESG performance has no impact on financial performance is an interesting one. It indicates that in infrastructure, ESG policies and procedures do not improve the financial performance. There are many different reasons for this result. Firstly, as this is the first study on ESG reporting and infrastructure, the time series is limited. A longer time series might show a different result. Secondly, we observe that large corporate infrastructure operators possess the higher ESG performance ratings. There may be diminishing returns to scale to infrastructure projects, so the higher the ESG performance rating is may not be related to ROA. Finally, the ESG scoring employed measures the management approach and transparency of performance reporting of firms . While there is evidence in extractive industries that firms that develop such policies have better sustainability performance (see (Herbohn et al., 2014)), no evidence exists for infrastructure to date. As a result, the ESG measure may not be measuring actual sustainability performance. This could explain the lack of the hypothesised link between ESG performance and financial performance. [10]

Robustness Checks

Several robustness checks were conducted on the analysis. Firstly, to control for possible multicollinearity between the independent variables in the regression two tests were conducted. Firstly the Variance Inflation Factors (VIF) were calculated and examined. Secondly, it was hypothesised that firms size and ESG score were collinear, as a result, an interaction term was included (demeaned log USD total assets $*$ demeaned ESG score) was included and regressions re-ran. In the first instance the largest VIF score for all regressions was 2.31. As a result, we can conclude that the specifications for the models was not impacted by multicollinearity. In the

10 - As a robustness check firms that GRESB indicated that had incomplete or had completed their ESG return in a hurried manner were removed. The rationale was that these firms did not correctly consider their answers to the ESG questions and so any score would not be reflective of their ESG performance. When these firms were removed the coefficients did change slightly but the conclusions of the analysis were the same. As a result we choose not to present these results.

5. ESG and Infrastructure

Table 11: This table presents the regression results of variables explaining the Return on Assets (ROA). log(Total Assets USD) is the log of the USD value of total assets, Leverage is the ((short term + long term debt) / Total Assets), ROA is the return on assets, Opex Intensity is the operating cost intensity (operating costs/ revenue) and Corp is a dummy variable equalling 1 if the firm is a Corporate and 0 otherwise and ESG is the average ESG performance rating for the years 2017 and 2018 provided by GRESB excluding firms that failed to report on their ESG performance and subsequently received a score of 0.

	Dependent variable:		
	ROA	ROA with industry effects	ROA with industry and year effects
	(1)	(2)	(3)
log(Total Assets USD)	0.009***	0.008***	0.009***
	(0.003)	(0.003)	(0.003)
lagged ROA	0.901***	0.905***	0.910***
	(0.066)	(0.068)	(0.068)
Leverage	−0.011	−0.012	−0.012
	(0.011)	(0.011)	(0.011)
Opex Intensity	−0.059***	−0.066***	−0.065***
	(0.011)	(0.011)	(0.011)
Corp	−0.023**	−0.018*	−0.017*
	(0.010)	(0.010)	(0.010)
ESG	−0.0001	−0.00003	−0.00002
	(0.0002)	(0.0002)	(0.0002)
Environmental Services		−0.057	−0.055
		(0.042)	(0.042)
Social Infrastructure		−0.069**	−0.068*
		(0.035)	(0.035)
Energy and Water Resources		−0.037	−0.035
		(0.041)	(0.041)
Data Infrastructure		−0.085**	−0.085**
		(0.038)	(0.038)
Transport		−0.086**	−0.086**
		(0.034)	(0.034)
Renewable Power Generation		−0.086**	−0.085**
		(0.035)	(0.035)
Network Utilities		−0.091***	−0.089***
		(0.034)	(0.034)
year2017			−0.009
			(0.007)
year2018			−0.017
			(0.017)
Constant	−0.108**	−0.022	−0.025
	(0.050)	(0.067)	(0.067)
Observations	346	346	346
R^2	0.610	0.626	0.629
Adjusted R^2	0.603	0.612	0.612
Note:			*p<0.1; **p<0.05; ***p<0.01

second instance the interaction term was not statistically significant. As a result, we can conclude that whilst size (as measured by USD total assets) and the ESG score are correlated, it is not in a way that will impact on the regression.

5.3.1 Summary of Findings

This section presents the results of the multi-variate tests detailed in Section 4. We show that:

- Firms that are larger, that are corporations and have lower leverage are more likely to report on their ESG performance than other firms.
- ESG performance rankings are positively affected by size and whether the firm is a corporation, while they are negatively impacted by the amount of leverage. This finding is consistent with the theory put forward by Ullmann (1985).

5. ESG and Infrastructure

- Finally, we find that there is no positive or negative relationship between ESG and the financial performance of infrastructure assets.

Next, we discuss the implications of this research and discuss the limitations and areas for improvement.

6. Conclusion

6. Conclusion

An extensive amount of research has examined the relationship between financial performance (and returns) and ESG performance in different asset classes. This paper presents the first insights about financial performance and ESG performance in unlisted infrastructure companies and the association between ESG reporting and other characteristics of infrastructure firms. Using the EDHEC*infra* Universe and GRESB ESG rating database on infrastructure companies, we analyse three aspects: first, we investigate the characteristics of infrastructure firms that choose to report ESG data; second, we explore the different variables that may explain ESG scores; and third, we examine the relationship between ESG performance and financial performance in infrastructure firms.

6.1 Characteristics of Firms that Report ESG Data

We find that the companies reporting ESG data are larger and less leveraged than the firms in the investable Infrastructure Universe. They are also more likely to be 'corporates' rather than project companies. This is not that surprising as the most heavily leveraged firms in the Infrastructure Universe are SPVs created as project finance vehicles. These companies are set up to carry out one infrastructure project for a set period of time, with few to no employees, strict enforcement of permitted activities, and they are financed significantly with debt. These characteristics would limit the ability of the SPV to either create or maintain ESG policies and procedures. Corporations involved in infrastructure provision tend to have lower levels of debt. Thus, larger and less leveraged companies are more likely to posses the necessary resources to implement sustainability and social responsible policies. Interestingly, and contrary to our expectations, firms that report ESG data are not the most profitable firms.

6.2 What Explains ESG Scores?

Secondly, we explore which of the firms' characteristics explain their relative ESG performance ratings. We find that ESG scores are positively correlated to firms' size and age, while firms that are more leveraged tend to have lower ESG scores. This result indicates that larger, less leveraged and more experienced firms have more resources available and likely more free cash flow to implement social responsibility initiatives, which in turn increases their higher ESG performance ratings.

6.3 ESG Scores and Financial Performance

Lastly, we investigate if there is a relationship between ESG performance and financial performance of infrastructure firms. Previous research on this topic reports mixed evidence of a positive relationship between financial performance (or returns) and SRI in other asset classes. In this study, we found that higher ESG ratings are not associated with higher levels of financial performance for unlisted infrastructure firms.

We have shown that larger corporations with more resources are the ones that exhibit higher ESG scores. Larger corporations can

6. Conclusion

realise economies of scale when implementing social responsibility incentives, while more profitable and smaller infrastructure projects do not have this advantage and hence ESG policies not as well-implemented at the project level. This could partly explain the lack of a relationship between financial performance and ESG performance in infrastructure firms.

The finding of no positive relationship between ESG and financial performance for infrastructure is important given the size and nature of infrastructure assets. Importantly, we also do not discover any negative relationship between ESG performance and financial performance, showing that implementing ESG policies does not harm the economic performance of the firm. As a result, this finding should not preclude investors from adopting an ESG approach with respect to their infrastructure investments.

6.4 Limitations to the Study and Future Research

This is first study that examines the impact of ESG scores on financial performance. As a result, there are limitations in this study that can be addressed in future research.

1. **Analysis time horizon**: Employing only three years of data of ESG performance is a short horizon. The relationship between ESG performance and financial performance is expected to be a long-term one. That is, decisions made today to improve ESG performance will only be observed in the firm's financial performance some years later. As a result, drawing long-term conclusions regarding the interaction between ESG performance and financial performance is difficult.

2. **ESG measurement methodology**: Improving methodologies of ESG measurement may result in impact as well as measurement and transparency being included in the ESG score. GRESB has made some steps in this direction with an introduction a materiality adjustment in 2018. Materiality examines how important different aspects of the E, S or G are to different companies. For instance any changes in greenhouse gas emission law will likely have a more material impact on coal fired power stations than a solar or wind farm. Improvements such as this are likely to improve our understanding of the relationship between ESG scores and financial performance.

3. **ESG component scores**: Finally, this study only considered an aggregate ESG score. This aggregate analysis of ESG performance ratings may eliminate effects of the components of the ESG performance ratings if individual aspects have opposite effects. Since different infrastructure sectors have different sustainability issues that are material for financial performance, understanding the effects of each ESG aspect on the firm is fundamental.

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About The Long-Term Infrastructure Investors Association

About The Long-Term Infrastructure Investors Association

Founded in 2014 by investors and for investors, Long Term Infrastructure Investors Association works with a wide range of stakeholders, including infrastructure investors, policy-makers and academia, on supporting long-term, responsible deployment of private capital to public infrastructure around the world.

Our principal activities include:

- public advocacy and engagement with policy-makers;
- investment in research and innovation for the benefit of infrastructure investors;
- education and training on long-term investing in infrastructure.

LTIIA is a not-for-profit international association and most of our members are institutional investors and fund managers with responsibilities over long-term and open-ended infrastructure investment mandates. LTIIA is a Network Supporter of UN-PRI.

LTI/A | Long-term Infrastructure Investors Association

About EDHEC Infrastructure Institute-Singapore

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EDHEC*infra* addresses the profound knowledge gap faced by infrastructure investors by collecting and standardising private investment and cash-flow data and running state-of-the-art asset pricing and risk models to create the performance benchmarks that are needed for asset allocation, prudential regulation, and the design of new infrastructure investment solutions.

Origins

In 2012, EDHEC-Risk Institute created a thematic research program on infrastructure investment and established two Research Chairs dedicated to long-term investment in infrastructure equity and debt, respectively, with the active support of the private sector.

Since then, infrastructure investment research at EDHEC has led to more than 20 academic publications and as many trade press articles, a book on infrastructure asset valuation, more than 30 industry and academic presentations, more than 200 mentions in the press, and the creation of an executive course on infrastructure investment and benchmarking.

A testament to the quality of its contributions to this debate, EDHEC*infra*'s research team has been regularly invited to contribute to high-level fora on the subject, including G20 meetings.

Likewise, active contributions were made to the regulatory debate, in particular directly supporting the adaptation of the Solvency-II framework to long-term investments in infrastructure.

This work has contributed to growing the limited stock of investment knowledge in the infrastructure space.

A Profound Knowledge Gap

Institutional investors have set their sights on private investment in infrastructure equity and debt as a potential avenue toward better diversification, improved liability-hedging, and reduced drawdown risk.

Capturing these benefits, however, requires answering some difficult questions:

1. **Risk-adjusted performance measures** are needed to inform strategic asset allocation decisions and monitor performance;
2. **Duration- and inflation-hedging properties** are required to understand the liability-friendliness of infrastructure assets;
3. **Extreme risk measures** are in demand from prudential regulators, among others.

Today none of these metrics is documented in a robust manner, if at all, for investors in privately held infrastructure equity or debt. This has left investors frustrated by an apparent lack of adequate investment solutions in infrastructure. At the same time, policy-makers have begun calling for a widespread effort to channel long-term savings into capital projects that could support long-term growth.

To fill this knowledge gap, EDHEC has launched a new research platform, EDHEC*infra*, to collect, standardise, and produce investment performance data for infrastructure equity and debt investors.

Mission Statement

Our objective is the creation of a global repository of financial knowledge and investment benchmarks about infrastructure equity and debt investment, with a focus on delivering useful applied research in finance for investors in infrastructure.

We aim to deliver the best available estimates of financial performance and risks of reference portfolios of privately held infrastructure investments and to provide

About EDHEC Infrastructure Institute-Singapore

investors with valuable insights about their strategic asset allocation choices in infrastructure, as well as to support the adequate calibration of the relevant prudential frameworks.

We are developing unparalleled access to the financial data of infrastructure projects and firms, especially private data that is either unavailable to market participants or cumbersome and difficult to collect and aggregate.

We also bring advanced asset pricing and risk-measurement technology designed to answer investors' information needs about long-term investment in privately held infrastructure, from asset allocation to prudential regulation and performance attribution and monitoring.

What We Do

The EDHEC*infra* team is focused on three key tasks:

1. **Data collection and analysis**: we collect, clean, and analyse the private infrastructure investment data of the project's data contributors as well as from other sources, and input it into EDHEC*infra*'s unique database of infrastructure equity and debt investments and cash flows. We also develop data collection and reporting standards that can be used to make data collection more efficient and more transparently reported. This database already covers 15 years of data and hundreds of investments and, as such, is already the largest dedicated database of infrastructure investment information available.

2. **Cash- flow and discount-rate models**: Using this extensive and growing database, we implement and continue to develop the technology developed at EDHEC-Risk Institute to model the cash flow and discount-rate dynamics of private infrastructure equity and debt investments and derive a series of risk and performance measures that can actually help answer the questions that matter for investors.

3. **Building reference portfolios of infrastructure investments**: Using the performance results from our asset pricing and risk models, we can report the portfolio-level performance of groups of infrastructure equity or debt investments using categorisations (e.g., greenfield vs. brownfield) that are most relevant for investment decisions.

Partners of EDHEC*infra*

Monetary Authority of Singapore

In October 2015, Deputy Prime Minister of Singapore Tharman Shanmugaratnam announced officially at the World Bank Infrastructure Summit that EDHEC would work in Singapore to create "usable benchmarks for infrastructure investors."

The Monetary Authority of Singapore is supporting the work of the EDHEC Singapore Infrastructure Investment Institute (EDHEC*infra*) with a five-year research development grant.

Sponsored Research Chairs

Since 2012, private-sector sponsors have been supporting research on infrastructure investment at EDHEC with several Research Chairs that are now under the EDHEC Infrastructure Investment Institute:

About EDHEC Infrastructure Institute-Singapore

1. The EDHEC/NATIXIS Research Chair on the Investment and Governance Characteristics of Infrastructure Debt Instruments, 2012-2015
2. The EDHEC/Meridiam/Campbell-Lutyens Research Chair on Infrastructure Equity Investment Management and Benchmarking, 2013-2016
3. The EDHEC/NATIXIS Research Chair on Infrastructure Debt Benchmarking, 2015-2018
4. The EDHEC / Long-Term Infrastructure Investor Association Research Chair on Infrastructure Equity Benchmarking, 2016-2019
5. The EDHEC/Global Infrastructure Hub Survey of Infrastructure Investors' Perceptions and Expectations, 2016

Partner Organisations

As well as our Research Chair Sponsors, numerous organisations have already recognised the value of this project and have joined or are committed to joining the data collection effort. They include:

- The Global Infrastructure Hub;
- The European Investment Bank;
- The World Bank Group;
- The European Bank for Reconstruction and Development;
- The members of the Long-Term Infrastructure Investor Association;
- Over 20 other North American, European, and Australasian investors and infrastructure managers.

EDHEC*infra* is also :

- A member of the Advisory Council of the World Bank's Global Infrastructure Facility
- An honorary member of the Long-term Infrastructure Investor Association

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- Blanc-Brude, F., A. Chreng, M. Hasan, Q. Wang, and T. Whittaker. "Private Infrastructure Equity Indices: Benchmarking European Private Infrastructure Equity 2000-2016" (June 2017).
- Blanc-Brude, F., A. Chreng, M. Hasan, Q. Wang, and T. Whittaker. "Private Infrastructure Debt Indices: Benchmarking European Private Infrastructure Debt 2000-2016" (June 2017).
- Blanc-Brude, F., G. Chen, and T. Whittaker. "Towards Better Infrastructure Investment Products: A Survey of Investors' Perceptions and Expectations from Investing in Infrastructure" (July 2016).
- Blanc-Brude, F., T. Whittaker, and S. Wilde. "Searching for a Listed Infrastructure Asset Class: Mean-Variance Spanning Tests of 22 Listed Infrastructure Proxies" (June 2016).
- Blanc-Brude, F., T. Whittaker, and M. Hasan. "Cash Flow Dynamics of Private Infrastructure Debt" (March 2016).
- Blanc-Brude, F., T. Whittaker, and M. Hasan. "Revenues and Dividend Payouts in Privately-Held Infrastructure Investments" (March 2016).
- Blanc-Brude, F., and M. Hasan. "The Valuation of Privately-Held Infrastructure Equity Investments" (January 2015).

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- Blanc-Brude, F., S. Wilde, and T. Witthaker. "Looking for an Infrastructure Asset Class: Definition and Mean-Variance Spanning of Listed Infrastructure Equity Proxies." *Financial Market & Portfolio Management*, 31, 2017, pp. 137-179.
- Blanc-Brude, F., and M. Hasan. "A Structural Model of Credit Risk for Illiquid Debt." *Journal of Fixed Income*, 26(1), 2016, pp. 6-19
- Blanc-Brude, F., M. Hasan, and T. Witthaker. "Benchmarking Infrastructure Project Finance–Objectives, Roadmap and Recent Progress." *Journal of Alternative Investments*, 19(2), 2016, pp. 7-18
- Bianchi, R., M. Drew, E. Roca, and T. Whittaker. "Risk Factors in Australian Bond Returns," *Accounting & Finance*, 2015.

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- Blanc-Brude, F. "Long-Term Investment in Infrastructure and the Demand for Benchmarks." *JASSA: The Finsia Journal of Applied Finance*, 3, pp. 57–65, 2014.

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