Anatomy of a Cash Cow

An In-Depth Look at the Financial Characteristics of Infrastructure Companies

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building benchmarks
for infrastructure investors

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Executive Summary

This paper examines how infrastructure companies differ from the rest of the economy and in particular whether or not they tend to pay larger and more frequent dividends i.e. whether infrastructure really is a 'cash cow.' We find that infrastructure companies exhibit key systematic differences with a sample of 'matched' firms that are otherwise comparable in size, leverage, revenue growth or profits. Infrastructure companies are different because they tend to exhibit high asset tangibility, asset illiquidity and asset inflexibility, as well as lower operating leverage, as measured by a range of well-established metrics founds in the academic literature. Finally, we find that infrastructure companies do pay higher (but not more frequent) dividends than other firms and that these higher payout ratios correlate well with the characteristics we have identified. We argue that using these characteristics provides an important robustness check to identify infrastructure assets.

Preqin, a fund database, identifies infrastructure as a growing area of alternative investments. Preqin's database shows that funds under management for infrastructure firms have increased from USD$1,646 million for year 2000 vintage funds to USD$111,247 million for year 2019 vintage funds.

Increasing investor interest in infrastructure as an asset class is justified by what Blanc-Brude (2013) calls the 'infrastructure investment narrative': infrastructure is expected to possesses special characteristics such that "asset owners are expected to benefit from the low elasticity of demand creating pricing power and an inflation hedge, as well as low return covariance with other investments, allowing attractive risk-adjusted returns."

As such, infrastructure businesses are often portrayed as 'cash cows' i.e. the combination of semi-monopolistic conditions, limited opportunities for growth, high leverage and steady revenues should result in significant dividend payouts.

These dividend payouts then are likely to go a long way in explaining why, on a total return basis, infrastructure companies are somewhat less correlated with other asset classes and also provide attractive return.

In this paper, we explore the claim that infrastructure investments are indeed different from other types of firms by asking two related questions:

1. First, do infrastructure firms exhibit unique characteristics compared to equivalent firms in other sectors?
2. Second, do these characteristics correspond to a different dividend payout behaviour?

Characteristics of Infrastructure

Today, the academic literature evaluating the veracity of the 'infrastructure investment narrative' is scant, as is any testing as to whether identified infrastructure assets possess the characteristics hypothesised.

Papers such as Ammar and Eling (2015) assume that infrastructure does indeed possess these special qualities, and then goes on to examine asset pricing models in an attempt to explain infrastructure returns.

However, to the authors' knowledge, no research exists examining whether the characteristics of

infrastructure can be measured and whether these characteristics differ from those of other firms in the economy.

We hypothesise that infrastructure has specific characteristics, for example:

- There is some form of government regulation or input into the operations of the firm;
- The firm possesses natural monopoly characteristics, through either increasing returns to scale or traffic network effects; and
- The firm also enjoys large capital investment that is durable and immobile.

These characteristics can be measured using financial variables. As a result, we can firstly assess whether infrastructure assets exhibit these characteristics.

Secondly, we can then gauge whether these characteristics are different to those of other firms in an economy.

Finally, we can discover whether these characteristics contribute to the observed dividend pay-out behaviour of infrastructure firms.

In this paper, we formulate four hypotheses for characteristics of infrastructure, in comparison with non-infrastructure firms.

1. Infrastructure exhibits higher asset tangibility given its reliance on large capital investments.
2. Infrastructure exhibits higher asset illiquidity as infrastructure's large, capital intensive assets are hard to liquidate in times of firm distress.
3. Infrastructure exhibits higher asset inflexibility due to the firm's inability to reallocate their assets to other activities.
4. Infrastructure exhibits lower operating leverage as infrastructure firms have a significant asset base, and the level of operating costs in comparison to the size of these assets would be smaller than other 'capital light' businesses.

A High Quality, Handmade Dataset

For this study, we look at the UK as it has the largest and longest history of infrastructure investment. The Companies Act 2006 requires companies to submit yearly company accounts to Companies House, the UK's registrar of companies. The data we use comes from the FAME database provided by Bureau van Dijk, which provides 20 years of financial data. We extract accounting items from those companies that are the global ultimate owner, report group financials and are incorporated in the UK.

To ensure that there is no overlap between infrastructure and other firms, we employ the firms identified as infrastructure by EDHEC*infra* to filter out infrastructure companies that appear in the FAME dataset. This list of firms is identified from government and regulator databases as well as infrastructure news services and is cross checked to ensure the firms are conducting an infrastructure activity as defined by EDHEC*infra*'s TICCS® classifications (see docs.edhecinfra.com).

Regarding the relationship between infrastructure and dividend payouts, only including dividends as shareholder payout will not capture the total component of shareholder distributions for infrastructure as it has excluded the principal and interest components of shareholder loans (Blanc-Brude et al. (2016)). However, FAME does not consistently provide such details on the breakdown of shareholder loans. Hence, we include an additional unlisted infrastructure sample using EDHEC*infra* data, which incorporates shareholder loans in computing the dividend related measures.

Robust Controls for Endogeneity

The decision to set up an infrastructure firm is an endogenous decision which can result in firms exhibiting certain ratios and sizes. This endogeneity limits the ability to draw conclusions from the analysis unless it is explicitly controlled for.

As a result, we employ propensity score matching to attempt to control for endogenous differences between infrastructure and non-infrastructure firms and then conduct tests on differences again. By matching firms that are most alike in size, leverage, revenue growth and profitability, we are then able to determine if infrastructure firms are the only firms that possess the unique attributes hypothesised.

Significant and Systematic Differences

We then test our hypotheses and analyse whether infrastructure exhibits different characteristics from non-infrastructure assets. We first assess whether there are differences in the mean and median of the variables of interests.

Table 1 provides a summary of the findings and implications. We are able to conclude that infrastructure does exhibit different characteristics compared with other firms. For example, using FAME data, we observe that infrastructure indeed exhibits lower operating leverage compared with non-infrastructure firms. For inflexibility, we find that unlisted infrastructure has a statistically significant higher mean than unlisted non-infrastructure firms, which is in line with our hypothesis.

These characteristics are as a result of the nature of infrastructure businesses, specifically the requirement to invest in large, highly specialised assets that cannot be re-purposed easily.

The *Uniqueness* of Infrastructure

We then turn to examining whether these characteristics are able to explain a firm's dividend payout behaviour using various regression models. Three dividend related measures including the dividend payout ratio are used. We also examine whether the unique characteristics of infrastructure firms go some way to explaining the level of dividends for unlisted infrastructure firms. We find that:

1. Both listed and unlisted infrastructure firms do pay out a larger proportion of their revenues compared with other comparable firms; and unlisted infrastructure firms pay out more dividends relative to asset size, in comparison with unlisted non-infrastructure firms.
2. The higher the operating leverage of an infrastructure firm, the higher its dividend payout as a proportion of total assets. An explanation for this observation is the documented negative relationship between operating leverage and leverage. With lower leverage, a firm is able to pay out more free cash to shareholders.
3. Asset illiquidity has a positive relationship with dividend payout for non-infrastructure firms but a negative relationship with dividend payout for infrastructure firms. This means that an infrastructure firm with more illiquid assets pays out higher dividends as a proportion of its revenue and assets. This may be due to brownfield infrastructure companies being in a better position to pay out dividends than greenfield infrastructure companies, which have more liquid assets like cash.

One major issue with infrastructure investment is the lack of a commonly agreed definition. The characteristics identified and examined in this paper can go some way to understanding what makes infrastructure different as an investment.

Furthermore, it is possible to employ these characteristics to provide a check on whether firms classified as infrastructure, actually are infrastructure.

Table 1: Summary of the hypotheses tested in the paper

Hypothesis	Finding	Implications
Infrastructure exhibits higher asset illiquidity	Evidence that infrastructure has lower asset liquidity compared to non-infrastructure	Infrastructure has large capital investments which are relationship specific and hard to liquidate in times of firm distress
Infrastructure exhibits higher asset inflexibility	Strong evidence for unlisted infrastructure having higher inflexibility compared to non-infrastructure	Infrastructure has large and durable assets with sizable sunk costs and cannot adjust production to adapt as well as other firms in response to market shocks
Infrastructure exhibits higher asset tangibility	Strong evidence for unlisted infrastructure firms having a higher intensity of Property, Plant and Equipment compared to non-infrastructure	Infrastructure assets have high physical tangibility though they may not necessarily be mobile
Infrastructure exhibits lower operating leverage	Strong evidence for unlisted infrastructure's operating leverage being lower than that for non-infrastructure	Infrastructure is different from other firms by having an asset base so significant such that the level of operating costs in comparison to the asset size is small
Infrastructure has special characteristics which can explain dividend payout behaviour	Strong evidence for infrastructure paying out more dividends as a proportion of their revenues compared to non-infrastructure; strong relationships found between payout behaviour and characteristics such as operating leverage and asset illiquidity	Infrastructure does pay higher dividends than other firms and these higher payout ratios correlate with the identified characteristics

1. Introduction

This study identifies the characteristics of infrastructure firms and examines their impact on dividend payments. This issue is important given the increasing amount of funds invested in infrastructure. Preqin, a fund database identifies infrastructure as a small but growing area of alternative investments. Preqin's database shows that funds under management for infrastructure firms have increased from USD$1,646 million for year 2000 vintage funds to USD$111,247 million for 2019 vintage funds. The increase in interest in infrastructure as an investment is being driven by the narrative that this asset class offers specific benefits. This 'infrastructure investment narrative' according to Blanc-Brude (2013) is that

> "..tangible infrastructure assets, immobile and demanding high sunk-capital costs and long repayment periods, are expected to create monopolies thanks to barriers to entry and increasing returns to scale. Thus, assets owners are expected to benefit from the low elasticity of demand creating pricing power and an inflation hedge, as well as low return covariance with other investments, allowing attractive risk-adjusted returns." (Blanc-Brude, 2013, page 36).

The literature evaluating this 'infrastructure investment narrative' and testing whether identified infrastructure assets possess the characteristics hypothesised is scant. Research such as Ammar and Eling (2015) takes the view that the narrative holds, and then examines asset pricing models in an attempt to explain infrastructure returns. However, to the authors' knowledge, no research exists examining whether the characteristics of infrastructure can be measured and whether these characteristics are different from other firms in the economy.

This study makes two major contributions to understanding infrastructure as an investment. First, we identify ways to measure the hypothesised characteristics of infrastructure assets and compare them with a matched sample of control firms. We find that infrastructure firms do exhibit specific characteristics, such as greater asset tangibility, asset illiquidity and asset inflexibility. All of these findings fit with the view that infrastructure firms are special. Furthermore, we find that infrastructure firms exhibit a lower operating leverage when compared with non-infrastructure firms.

The second major contribution of this study is that it examines whether the characteristics of unlisted infrastructure firms can explain their dividend payout behaviour. We find that being an infrastructure firm does result in larger dividend payouts in comparison with non-infrastructure firms. When analysing the impact of each characteristic, we find that certain characteristics have statistically significant relationships with dividends. Operating leverage is positively related to the dividend over asset ratio, but negatively related with the dividend payout ratio. Asset illiquidity also displays a different relationship with dividend payout ratio for infrastructure firms, when compared with the relationship that non-infrastructure firms have.

The remainder of the study is organised as follows. Section 2 provides a brief survey of the literature. Section 3 outlines the data investigated in the study. Section 4 presents the methodology and findings of the study, and concluding remarks are in Section 5.

2. Literature Review

2.1 Characteristics of infrastructure

Thierie and De Moor (2016) provide a summary of the hypothesised characteristics of infrastructure as an investment. They highlight four main characteristics that infrastructure exhibits. These are:

- The insensitivity of infrastructure returns to general economic conditions;
- The requirement for large, up-front capital investment;
- The monopoly nature this tends to bestow on the asset; and
- The long life of the infrastructure assets.

Examining infrastructure as an investment has focused three major areas. These are the risk-adjusted returns of the assets, the diversification benefits of infrastructure in a portfolio and, finally, the ability for infrastructure to provide a hedge against inflation risks.

Infrastructure investment typically takes the form of an investment in an unlisted fund or company. Obtaining a return series of a long enough history to be informative is difficult. As a result, most research on the returns of infrastructure uses listed infrastructure where the data is typically more readily available (see (Ammar and Eling, 2015),(Bianchi et al., 2014), (Bird et al., 2014) and (Wurstbauer et al., 2016)).

The listed infrastructure studies employed either specifically identified infrastructure assets (Ammar and Eling (2015) and Wurstbauer et al. (2016)) or conducted index level analysis (Bianchi et al. (2014) and Bird et al. (2014)). These studies have all found that, on the whole, infrastructure exhibits a lower beta than the market, implying that infrastructure returns exhibit lower systematic risk. This lower beta is evidence, according to Thierie and De Moor (2016) of insensitivity to economic cycles.

When it comes to explaining the returns of listed infrastructure, Bianchi et al. (2014), Wurstbauer et al. (2016) and Ammar and Eling (2015) all demonstrate that the majority of the variation in returns is explained by the Fama and French (1993) three-factor model. Bianchi et al. (2014) does augment the Fama and French (1993) model with a Momentum and Utility industry factor. Ammar and Eling (2015) also develops a nine-factor model. Still, both nonetheless demonstrate that the factors Fama and French (1993) can capture at least 40.7% and up to 80.3% of the return variation (see page 264 (Ammar and Eling, 2015)).

For unlisted infrastructure, Newell et al. (2011), find that infrastructure exhibits higher returns than stocks with lower risk and lower correlations with other main asset classes. Employing a different unlisted infrastructure index, Bird et al. (2014) find that unlisted infrastructure generates lower returns than listed infrastructure. Bird et al. (2014) also find that unlisted infrastructure exhibits a lower systematic risk.

The lower systematic risk and low correlation with other assets make infrastructure an interesting asset for investors seeking diversification. Dechant and Finkenzeller (2013) develop a dynamic asset allocation model to determine whether infrastructure provides diversification benefits (reduces risk or increases returns).

The authors conclude that infrastructure improves the mean variance frontier, creating diversification benefits. This is in contrast with the findings of Blanc-Brude et al. (2017) which employs several portfolios of global listed infras-

tructure firms and find that the mean-variance frontier is not improved by infrastructure.

The final major area of research for infrastructure investments is on the ability of infrastructure to provide a hedge against inflation risks. Thierie and De Moor (2016) highlight this as a major factor driving investor interest in infrastructure investment. Wurstbauer and Schäfers (2015) examine this question employing both a listed and an unlisted infrastructure index.

They find that unlisted, directly invested infrastructure only provides a partial hedge against expected inflation risk in the short-term. Interestingly, the authors find that infrastructure provides no protection for unexpected inflation. This is important as it is the risk that most investors would be seeking protection against.

2.2 Defining infrastructure

The matter of how infrastructure is defined is important. Bird et al. (2014), Bianchi et al. (2014) and Newell et al. (2011) used indices to examine infrastructure returns. However, this effectively out-sources the identification of infrastructure assets to the index provider. Ammar and Eling (2015); Dechant and Finkenzeller (2013) and Wurstbauer et al. (2016) create curated lists of infrastructure assets based on industries, specifically Telecommunications, Transport and Utilities. However, these industries are more based on 'you know it if you see it' classification of infrastructure.

Another definition of infrastructure is provided by Gómez-Ibáñez (2003), according to whom infrastructure is composed of assets that provide a good or service through a network in a geographic space, with large capital investments that are durable and immobile. These characteristics Gómez-Ibáñez (2003) states are related to industries which require assets that are at or beneath the ground, typically roads, railroads, water, electric power and telecommunications.

As a result of these characteristics, these industries benefit from increasing returns to scale or traffic density (Gómez-Ibáñez, 2003)[pg 4.] and therefore exhibit the characteristics of a natural monopoly. They typically require the involvement of governments as either regulators, investment facilitators or the "public good" nature of these investments Gómez-Ibáñez (2003).

As a result, we hypothesise that infrastructure has characteristics such as:

- Some form of government regulation or input into the operations of the firm;
- The firm possesses natural monopoly characteristics, through either increasing returns to scale or traffic network effects; and,
- Large capital investment that is durable and immobile.

These characteristics are able to be measured using financial variables. As a result, we first assess whether infrastructure assets exhibit these characteristics and then test if these characteristics differentiate them from other firms in an economy.

Finally, we explore whether these characteristics are related to the observed dividend pay-out behaviours of infrastructure firms.

2.2.1 Identifying Infrastructure Characteristics

This section discusses the choice of proxies for infrastructure characteristics and how they are estimated from financial data. These characteristics, as described by Gómez-Ibáñez (2003) are large, durable capital investments that are immobile.

Large durable capital investment that is immobile

Measures of durable capital investment focus on firms' accumulation of fixed assets. It is hypothesised that infrastructure firms have large fixed

capital investment, as measured by the size of the Property, Plant and Equipment (PP&E) to total assets in their balance sheet.

Immobility in infrastructure assets refers to the inability to move the assets once invested, or redeploy them if a firm goes bankrupt. It stands to reason that infrastructure assets are likely to have high physical tangibility, but also to be illiquid and inflexible, that is unable to be reallocated to another task. [1]

Asset Tangibility

In this paper, we employ two measures for asset tangibility. The first is the measure from Berger et al. (1996). This estimates the liquidation values for the assets of a firm. A firm with a higher asset tangibility measure is likely to possess more liquid assets and a lower PP&E intensity in its total assets. The asset tangibility measure is given as:

$$Tangibility1 = \left[\frac{CashHoldings + 0.715 \times Receivables + 0.547 \times Inventory + 0.535 \times Capital}{TotalAssets}\right] \quad (2.1)$$

Where:

- Cash Holdings are Cash and Short-Term Investments;
- Receivables is Receivables-Total;
- Inventory is Inventories- Total;
- Capital is Property Plant and Equipment – Total (Net); and,
- Total Assets is Assets – Total.

The second measure employed in this paper was introduced in Campello and Giambona (2013). This is described below:

$$Tangibility2 = \frac{PropertyPlantandEquipment}{TotalAssets} \quad (2.2)$$

1 - Tangibility is the measure of how much value a firm's assets produce if the firm is wound up in bankruptcy. Firms with levels of assets that are easily converted to cash (cash and marketable investments) are considered to possess more 'tangible' assets than firms with assets that are harder to monetise.

Asset Illiquidity

Asset illiquidity is related to asset tangibility. Firms with large capital investments are hard to liquidate in times of distress for the firm.

As infrastructure possesses large, capital intensive, assets that are relationship specific, it is possible to conclude that these firms exhibit high asset illiquidity. To measure asset illiquidity, we adopt three measures from Gopalan et al. (2012) and Ortiz-Molina and Phillips (2014) which are detailed below:

$$WAL1_{i,t} = \frac{Cash\&Equivalents_{i,t}}{TotalAssets_{i,t}} \times 1 + \frac{OtherAssets_{i,t}}{TotalAssets_{i,t}} \times 0 \quad (2.3)$$

*WAL*1 or Weighted Average Liquidity 1 measures the proportion of highly liquid cash and cash equivalents to lagged total assets. This measure assumes all non-cash like assets are effectively illiquid.

$$WAL2_{i,t} = \frac{Cash\&Equivalents_{i,t}}{TotalAssets_{i,t}} \times 1 + \frac{NonCashCurrentAssets_{i,t}}{TotalAssets_{i,t}} \times 0.5 + \frac{OtherAssets_{i,t}}{TotalAssets_{i,t}} \times 0 \quad (2.4)$$

In the second Weighted Average Liquidity measure, Gopalan et al. (2012) assume non-cash current assets can be liquidated at 50% of their face value, whilst all other assets, except for cash, possess zero asset value.

$$WAL3_{i,t} = \frac{Cash\&Equivalents_{i,t}}{TotalAssets_{i,t}} \times 1 + \frac{NonCashCurrentAssets_{i,t}}{TotalAssets_{i,t}} \times 0.75 + \frac{TangibleFixedAssets(i,t)}{TotalAssets_{i,t}} \times 0.5 + \frac{OtherAssets_{i,t}}{TotalAssets_{i,t}} \times 0 \quad (2.5)$$

In the third Weighted Average Liquidity measure, Gopalan et al. (2012)) assumes that cash and equivalents and non-cash current assets have the same liquidation value as in WAL2. However, WAL3 assumes that tangible fixed assets when liquidated exhibit a 50% recovery rate and all other assets possess no liquidation value.

Tangible fixed assets measures the difference between the book value of assets and the sum of current assets and goodwill.

Infrastructure firms require large capital expenditure before the firm comes into existence as a functional entity. These expenditures are highly specific and the ability to redeploy these assets in the winding up of an infrastructure business is limited.

As a result, we hypothesise that infrastructure firms will exhibit a lower asset liquidity than other firms within the sample.

Asset Flexibility

Asset flexibility measures the ability of a firm to either expand or contract production in response to market shocks. Infrastructure firms, as a result of their assets being large, durable and with large sunk costs, would be unable to adapt as well as other firms that have greater operational flexibility.

Therefore, we hypothesise that infrastructure firms would have an inability to reallocate their assets to other tasks. To measure asset flexibility, we employ Gu et al. (2018)'s measure of asset inflexibility which is given as:

$$INFLEX_(i,t) = \frac{max_{i,0,t}\frac{OPC}{Sales} - min_{i,0,t}\frac{OPC}{Sales}}{std_{i,0,t}\Delta log\frac{Sales}{Assets}} \quad (2.6)$$

Where:

- OPC is the sum of selling and administrative expenses and cost of goods sold;
- Sales is the total revenue for the period; and,
- Assets is the book value of total assets.

The measure employed by Gu et al. (2018) aims to identify the range bounds for which a firm cannot change its production process when hit by a productivity shock. Firms with a higher measure are likely to exhibit inflexibility, due to contracts and capital investments that limits their ability to respond to shocks in the short term.

As a result, for the Gu et al. (2018) measure we hypothesise that infrastructure firms exhibit a higher inflexibility measure, on average.

Operating Leverage

The large capital expenditures required by infrastructure firms in order to operate means that their operating costs are low, compared with their asset base. This lower level of relative costs implies that infrastructure firms would have a lower operational leverage than other firms.

Operational leverage is the theory that a firm's production costs have the same impact on profitability as financial leverage (see (Novy-Marx, 2011)). A firm with a large proportion of fixed costs in its cost structure would be impacted more severely in an economic shock than firms with a smaller proportion.

For infrastructure firms, they have a significant asset base, and the level of operating costs in comparison with the size of these assets would be smaller than other 'capital light' businesses. Therefore, we assume that infrastructure firms will exhibit lower levels of operating leverage than other firms.

In this paper, we employ two measures for operating leverage. The first measure follows the work of Chen et al. (2019) which includes only selling and general administrative expenses as a measure of the fixed costs for the business. These costs are adjusted for the size of the business by dividing by the book value of assets as described in the following equation:

$$OL1_t = \frac{XSGA_t}{Assets_t} \quad (2.7)$$

Where:

- $XSGA_t$ is the selling and administrative expenses at time t; and,
- $Assets_t$ is the book value of total assets at time t.

The second measure of operating leverage employs a measure similar to Novy-Marx (2011). Employing the FAME data variables, we obtain total costs for the period. However, we have had to remove the depreciation expense as this is included by FAME in the variable. As a result, the following variable is employed as the second measure of operating leverage:

$$OL2_t = \frac{XSGA_t + COGS_t - Depreciation_t}{Assets_t} \quad (2.8)$$

Where:

- $XSGA_t$ is the selling and administrative expenses at time t;
- $Assets_t$ is the book value of total assets at time t;
- $COGS_t$ is the cost of goods sold at time t; and,
- $Depreciation_t$ is the depreciation and amounts written off fixed assets at time t.

As with the first measure of operating leverage, the second measure of operating leverage adjusts for the size of the business by scaling the measure by total assets.

The next section will provide a summary of the different hypotheses we expect for the different infrastructure characteristics discussed in this section.

Hypothesis summary

The summary of the different hypotheses we intend to test is provided in Table 2.

Table 2: Summary of infrastructure characteristics hypotheses

	Infrastructure	Non-Infrastructure
Asset Tangibility	Greater	Lower
Asset Illiquidity	Greater	Lower
Asset inflexibility	Greater	Lower
Operating Leverage	Lower	Greater

We expect that infrastructure will exhibit a higher asset tangibility given its reliance on large capital investments. As these capital investments are specific to the business of the infrastructure firm and not easily repurposed, this which would result in a higher asset illiquidity and asset inflexibility.

Finally, as a result of the large asset base for infrastructure firms compared to their operations, we expect that they will exhibit a lower operating leverage that non-infrastructure firms.

The next section summarises the data used in the analysis and provide initial univariate test results.

3. Data

For this study, we look at the UK as it has the largest and longest history of infrastructure investment. The data we use comes from the FAME database provided by Bureau van Dijk. This database was chosen as it provides financial statement information for both public and private UK companies.

The UK's Companies Act 2006 requires companies to submit yearly company accounts to Companies House, the national registrar of companies. The FAME database takes its financial statement information from the original accounts filed at Companies House. FAME provides 20 years of financial data, which enables analysis of a long time period that includes major economic shocks.

In our analysis, we employ the list of infrastructure firms identified by EDHEC*infra* as the infrastructure sample. This list is identified using government and regulator databases as well as infrastructure news services, and is cross checked to ensure the firms are conducting an infrastructure activity as defined by EDHEC*infra*'s TICCS® classifications.

Each firm is identified by its Company's House identifier number which allows for the collection of their filings. This results in 1,089 unique firms and 21,780 firm years of infrastructure firm observations. Taking into account the date of delisting for listed companies, there are 21,737 unlisted infrastructure firm observations and 23 listed infrastructure firm observations.

For the non-infrastructure firms, we extract accounting items from the entities that are the global ultimate owner, report group financials and are incorporated in the UK i.e. in England, Scotland, Wales and Northern Ireland; this follows the approach of Michaely and Roberts (2012).

To ensure that there is no overlap between infrastructure and non-infrastructure firms, we employ the firms identified as infrastructure by EDHEC*infra* to filter out infrastructure companies that appear in the FAME dataset. This results in 10,982 firms and 219,640 firm years of observations. Taking into account the date of delisting for listed companies, there are 211,857 unlisted non-infrastructure firm observations and 7,031 listed non-infrastructure firm observations.

The summary statistics for the pre-matched infrastructure and non-infrastructure firms are displayed in Panel A of Table 3 and are separated into listed and unlisted observations. The results show that both unlisted and listed infrastructure firms exhibit, on average, lower revenue growth, higher profitability and are larger in size. However, unlisted infrastructure reports higher mean leverage than non-infrastructure while the listed sample reports the opposite pattern.

Additionally, for the hypothesised characteristics, listed and unlisted infrastructure firms exhibit lower operating leverages and asset illiquidity compared with non-infrastructure firms. For the unlisted sample, infrastructure firms exhibit a higher mean but lower median in asset inflexibility than unlisted non-infrastructure firms. However, listed infrastructure firms show a lower inflexibility mean and median than listed non-infrastructure firms.

For dividends, the dividend payout ratio for unlisted infrastructure firms is higher compared to non-infrastructure firms but this measure is higher in listed non-infrastructure firms compared to listed infrastructure firms. An

unlisted infrastructure firm is also less likely to pay a dividend compared to an unlisted non-infrastructure firm although a listed infrastructure firm is more likely to pay a dividend compared with a listed non-infrastructure firm.

The data sample differs from that employed in Blanc-Brude et al. (2016) in that, as the FAME data does not include shareholder loan payments (both principal and interest), we only examine the dividend payments.

This effectively reduces the payout observed of dividends and does not reflect the full payout available to shareholders in infrastructure firms. As Blanc-Brude et al. (2016) show, the majority of the payout for equity investors in private infrastructure is in the form of shareholder loan principal and interest. However, FAME does not consistently provide such details on the breakdown of shareholder loans.

Hence, we employ EDHEC*infra*'s data which covers financial information, up to a more consistent and detailed level, of unlisted infrastructure companies in the UK as an additional source of financial data for further analysis which includes shareholder loans.

The difference resulted from incorporating shareholder loans in dividend payout computations and probability of dividends being paid by firms can be observed in the pre-matched dividend summary statistics using FAME data of unlisted infrastructure firms (Panel A of Table 3) as compared to the pre-matched dividend summary statistics using EDHEC*infra*'s data of unlisted infrastructure firms (Table 4).

3.1 Matched Samples

The decision to set up an infrastructure firm is an endogenous decision which can result in firms exhibiting certain ratios and sizes.

This endogeneity limits the ability to draw conclusions from the analysis unless it is explicitly controlled for. As a result, we employ propensity score matching to attempt to control for endogenous differences between infrastructure and non-infrastructure firms and then conduct tests on their differences again.

Methodology

The use of propensity scores to create a matched sample has a long history (e.g. in medical research) and can equally be applied to research in finance.

It helps address issues of self-selection bias (Conniffe et al., 2000) as well as largely increasing the robustness of regression results by limiting model specification errors (see Ho et al., 2011). For a discussion of matching firms for analysis, see Michaely and Roberts (2012), James J. Heckman (1997).

The matching of one or several non-infrastructure firm-year observations to each infrastructure firm-year observation is achieved by computing propensity scores, as proposed by Rosenbaum and Rubin (1983) and Rosenbaum and Rubin (1985).

The matching of firm-year observations is done in the same way as Michaely and Roberts (2012), employing firm characteristics that can be expected to explain underlying business models. These are firm size, profitability, leverage, investment opportunities and industry.

The match between infrastructure and non-infrastructure firm-year observations is determined by first estimating the following probit regression:

$$\begin{aligned} InfraDummy_{(i,t)} = {} & \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} \\ & + \beta_3 \Delta Revenue_{(i,t)} \\ & + \beta_4 Profitability_{(i,t)} + \varepsilon_{(i,t)} \end{aligned} \tag{3.1}$$

Table 3: Summary Statistics - FAME data

This Table presents the summary statistics for the infrastructure and non-infrastructure samples using FAME data. Panel A presents the results before any propensity score matching is conducted, whilst Panel B presents the results after propensity score matching is completed. $Size_{i,t}$ is log total assets; $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets, and is winsorized at the 1st and 99th percentile; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; and, $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t. The Operating Leverage definitions are: OL1 and OL2, respectfully. Asset Tangibility 1 and 2 are defined consistent with Equations 2.1 and 2.2, respectfully. Asset Illiquidity measures are the WAL1, WAL2 and WAL3, respectfully. Asset Inflexibility is as described in Equation 2.6 winsorized at the 1st and 99th percentile, respectfully. The dividend related measures are the dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue.

Panel A: Pre-Match Summary Statistics

	Unlisted								Listed							
	Infrastructure				Non-infrastructure				Infrastructure				Non-infrastructure			
Variable	Obs	Mean	Median	SD	Obs	Mean	Median	SD	Obs	Mean	Median	SD	Obs	Mean	Median	SD
Profitability	13220	-0.03	0.02	4.93	117320	-0.12	0.03	4.48	23	0.11	0.11	0.04	4949	-0.4	-0.01	3.96
Inflexibility	10642	2.7	0.78	7.9	79207	2.31	0.83	6.42	14	1.64	1.47	1.23	3499	11.96	1.89	32.39
Leverage	14002	0.76	0.86	0.34	130672	0.31	0.22	0.32	23	0.26	0.27	0.12	5043	0.31	0.19	0.45
Size	14582	10.62	10.65	2.05	130672	9.07	9.11	1.92	23	12.32	12.49	0.84	5043	9.55	9.4	2.31
Operating Leverage 1	14582	0.15	0.01	4.35	130672	0.67	0.34	17.66	23	0.07	0.04	0.06	5043	0.76	0.34	2.98
Operating Leverage 2	14379	0.49	0.07	23.75	126954	1.36	0.88	18.38	23	0.21	0.21	0.05	5043	1.19	0.72	3.23
Revenue/Assets	14582	0.57	0.15	25.28	99679	1.61	1.22	20.23	23	0.34	0.34	0.06	4231	1.03	0.77	1.5
Revenue Growth	11476	0.04	0.03	0.75	87113	0.08	0.05	0.56	20	0.05	0.05	0.07	3755	0.09	0.07	0.8
Tangibility 1	14582	0.3	0.24	0.22	130672	0.38	0.39	0.49	23	0.42	0.45	0.12	5043	0.3	0.27	0.27
Tangibility 2	14582	0.34	0	0.4	130672	0.29	0.18	0.3	23	0.65	0.64	0.23	5043	0.15	0.04	0.22
Illiquidity 1	13514	2.42	0.06	104.85	120126	3.18	0.1	298.37	20	0.05	0.01	0.09	4632	1.52	0.09	52.36
Illiquidity 2	13514	8.45	0.39	282.83	120126	10.77	0.38	1232.2	20	0.13	0.1	0.1	4632	3.1	0.3	128.76
Illiquidity 3	13514	14.53	0.72	468.29	120126	22.75	0.67	2753.83	20	0.52	0.55	0.15	4632	6.9	0.52	290.84
Dividends/Assets	1052	0.08	0.03	0.4	30219	0.11	0.02	2.89	18	0.03	0.03	0.01	1357	0.03	0.02	0.06
Dividends/Operating Profit	1049	-13.55	0.46	321.8	29915	-0.16	0.23	30.17	18	0.22	0.24	0.06	1347	0.42	0.24	4.82
Dividend Payout Ratio	1041	0.25	0.15	0.42	28633	0.09	0.01	1.98	18	0.07	0.08	0.03	1273	0.15	0.02	0.83
Pr(Dividend)	14582	0.07	0	0.25	130672	0.22	0	0.41	23	0.78	1.00	0.42	5043	0.25	0	0.43

Panel B: Post Match Summary Statistics

	Unlisted								Listed							
	Infrastructure				Non-infrastructure				Infrastructure				Non-infrastructure			
Variable	Obs	Mean	Median	SD	Obs	Mean	Median	SD	Obs	Mean	Median	SD	Obs	Mean	Median	SD
Profitability	11358	0.04	0.03	0.21	11358	0.03	0.03	0.37	20	0.1	0.11	0.03	20	0.08	0.06	0.07
Inflexibility	10173	2.69	0.78	7.9	9739	2.24	0.77	6.09	14	1.64	1.47	1.23	15	9.36	1.85	15.99
Leverage	11358	0.74	0.84	0.33	11358	0.74	0.74	0.37	20	0.27	0.3	0.12	20	0.24	0.21	0.2
Size	11358	10.96	10.81	1.69	11358	10.91	10.87	1.87	20	12.43	12.73	0.82	20	12.49	12.55	0.82
Operating Leverage 1	11358	0.08	0.02	0.24	11358	0.42	0.22	0.74	20	0.07	0.04	0.06	20	0.22	0.11	0.29
Operating Leverage 2	11306	0.24	0.08	0.75	11330	1.21	0.81	1.68	20	0.21	0.21	0.05	20	0.83	0.67	0.9
Revenue/Assets	11358	0.3	0.15	0.74	11358	1.27	0.88	1.7	20	0.33	0.32	0.06	20	0.93	0.79	0.9
Revenue Growth	11358	0.04	0.03	0.75	11358	0.07	0.06	0.62	20	0.05	0.05	0.07	20	0.15	0.13	0.26
Tangibility 1	11358	0.29	0.21	0.21	11358	0.31	0.31	0.19	20	0.41	0.44	0.11	20	0.26	0.14	0.21
Tangibility 2	11358	0.34	0	0.4	11358	0.27	0.13	0.3	20	0.63	0.63	0.23	20	0.12	0.04	0.2
Illiquidity 1	11299	0.12	0.06	1.95	11211	1.57	0.05	146.23	20	0.05	0.01	0.09	19	0.17	0.07	0.23
Illiquidity 2	11299	0.39	0.38	2.32	11211	5.43	0.33	462.52	20	0.13	0.1	0.1	19	0.36	0.27	0.31
Illiquidity 3	11299	0.76	0.7	5.29	11211	7.58	0.63	622.4	20	0.52	0.55	0.15	19	0.52	0.48	0.37
Dividend/Assets	1008	0.07	0.03	0.28	2514	0.03	0.01	0.1	15	0.03	0.03	0.01	13	0.03	0.02	0.02
Dividends/Operating Profit	1008	-8.43	0.47	311.24	2514	0.23	0.2	12.88	15	0.23	0.25	0.06	13	0.33	0.29	0.25
Dividend Payout Ratio	1008	0.25	0.15	0.42	2514	0.08	0.01	0.55	15	0.08	0.09	0.02	13	0.14	0.03	0.26
Pr(Dividend)	11358	0.09	0	0.28	11358	0.22	0	0.42	20	0.75	1.00	0.44	20	0.65	1.00	0.49

*Table 4: Summary Statistics - Unlisted EDHEC*infra *and FAME data*

This Table presents the summary statistics for the unlisted samples using EDHECinfra data for the infrastructure sample and FAME data for the non-infrastructure sample. The left side of the table presents the results before any propensity score matching is conducted for the EDHECinfra sample, whilst the right side of the table presents the results after propensity score matching is completed. $Size_{i,t}$ is log total assets; $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets, and is winsorized at the 1st and 99th percentile; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; and, $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t. The Operating Leverage definitions are: OL1 and OL2, respectfully. Asset Tangibility 1 and 2 are defined consistent with Equations 2.1 and 2.2, respectfully. Asset Illiquidity measures are the WAL1, WAL2 and WAL3, respectfully. Asset Inflexibility is as described in Equation 2.6 winsorized at the 1st and 99th percentile, respectfully. The dividend related measures are the dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. For the infrastructure sample here, shareholder loans are included in dividend ratio calculations.

	Pre-Match				Post-Match							
	Infrastructure				Infrastructure				Non-infrastructure			
Variable	Obs	Mean	Median	SD	Obs	Mean	Median	SD	Obs	Mean	Median	SD
Profitability	431	0.06	0.07	0.45	165	0.13	0.12	0.25	165	0.16	0.02	1.23
Inflexibility	215	2.13	1.48	1.89	122	2.33	1.39	2.17	153	2.88	1.01	5.15
Leverage	431	0.7	0.72	0.55	165	0.6	0.6	0.33	165	0.61	0.7	0.34
Size	431	17.26	19.15	5.32	165	18.38	18.77	1.41	165	16.49	16.46	1.26
Operating Leverage 1	431	0.05	0.01	0.13	165	0.05	0.03	0.1	165	0.19	0.03	0.33
Operating Leverage 2	430	0.38	0.12	0.74	165	0.62	0.26	0.82	159	0.63	0.07	2.02
Revenue/Assets	431	0.42	0.21	0.63	165	0.72	0.44	0.77	165	0.77	0.14	2.22
Revenue Growth	305	0.09	0.04	0.62	165	0.09	0.04	0.72	165	-0.03	0.06	0.91
Tangibility 2	431	0.48	0.53	0.36	165	0.56	0.68	0.32	165	0.26	0.13	0.31
Illiquidity 1	385	1637.99	0.03	22524	165	0.1	0.03	0.54	164	0.65	0.04	7.44
Illiquidity 2	385	5362.86	0.13	58749.68	165	0.24	0.14	0.67	164	3.37	0.24	39.2
Illiquidity 3	385	29002.05	0.52	391505.8	165	0.86	0.52	4.25	164	5.07	0.55	57.59
Dividends/Assets	262	0.3	0.13	0.39	121	0.25	0.11	0.27	59	0.04	0.01	0.22
Dividends/Operating Profit	246	-23.14	0.57	215.14	121	-9.78	0.56	74.37	59	3.14	0.13	22.04
Dividend Payout Ratio	233	2.15	0.41	7.71	121	1.34	0.36	3.81	59	0.48	0.03	3.05
Pr(Dividend)	328	0.35	0	0.48	165	0.73	1.00	0.44	165	0.36	0	0.48

Where:

- $InfraDummy_{(i,t)}$ is a dummy variable indicating whether the firm is an infrastructure firm or not;
- $Size_{(i,t)}$ is log total assets;
- $Leverage_{(i,t)}$ is defined as the sum of trade creditors, short term loans and long term debt, divided by total assets;
- $\Delta Revenue_{(i,t)}$ is the percentage change in revenue from time $t-1$ to t; and,
- $Profitability_{(i,t)}$ is operating profit at time t divided by total assets at time t.

The fitted values from the regression provide us with probabilities of the firms belonging to either group (the fitted values for the regressions are called the "propensity scores").

These propensity scores are then used to match firms, minimising the absolute difference in the propensity scores (a nearest neighbour matching process). To maximise matching firms with similar attributes, we only include those within the zone of mutual support.

By matching firms that are most alike in size, leverage, revenue growth and profitability, we are then able to determine if infrastructure firms are the only ones to possess the unique attributes hypothesised. Matching is conducted separately for listed and unlisted samples.

The results for the probit regression both pre and post matching are displayed in Table 5 for unlisted and listed samples. For the unlisted sample, prior to matching, all variables that were used as explanatory variables are statistically significant and the Pseudo R2 for the probit regression is 0.4502. For the listed sample, the Pseudo R2 prior to matching is 0.2680.

Post matching, the statistical difference of these variables explaining the difference between the infrastructure and non-infrastructure observations has fallen for both listed and unlisted samples. Furthermore, the Pseudo R2 for both regressions after matching have fallen to 0.0006 for the unlisted sample and to 0.0933 for the listed sample. As a result, we can conclude that the matching process has created homogeneous groups across the variables of interest.

The results for the unlisted and listed infrastructure and non-infrastructure samples after the matching has been conducted using FAME data are displayed in Panel B of Table 3. After matching, there is now a smaller difference between the infrastructure and non-infrastructure samples across the variables used to match the two samples (revenue growth, leverage, profitability and size).

As hypothesised, for any measure employed, infrastructure exhibits a lower mean and median operating leverage. For both asset tangibility measures, listed infrastructure exhibits a higher mean and median compared with listed non-infrastructure. When comparing unlisted firms, infrastructure has a lower median for both tangibility measures but a lower mean for Tangibility 1 and a higher mean for Tangibility 2, in contrast with non-infrastructure. For all measures of asset illiquidity across unlisted and listed samples, infrastructure firms exhibit a lower mean compared with non-infrastructure firms.

This is in line with our hypothesis that infrastructure firms exhibit lower asset liquidity than other firms in the sample. For asset inflexibility, the unlisted infrastructure sample exhibits a higher mean and median compared with the unlisted non-infrastructure sample, supporting our hypothesis that infrastructure exhibits a higher inflexibility measure. However, listed infrastructure firms exhibit a lower mean and median inflexibility measure compared with listed non-infrastructure firms.

When dividends are paid out, unlisted infrastructure firms exhibit a higher mean and median for the dividend over assets and dividend payout

Table 5: Probit regression results pre and post matching

This table presents the results of a probit regression that is conducted both before propensity score matching and after propensity score matching. The regression conducted is $InfraDummy_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 Leverage_{i,t} + \beta_3 \Delta Revenue_{i,t} + \beta_4 Profitability_{i,t} + \epsilon_{i,t}$ where, $InfraDummy_{i,t}$ is the dummy variable indicating whether the firm is an infrastructure firm or not; $Size_{i,t}$ is log total assets; $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; and, $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t. Standard errors are in parentheses.

	Unlisted		Listed	
Variable	Before Matching	After Matching	Before Matching	After Matching
Intercept	-4.42	-0.15	-4.61	3.28
	(0.04)	(0.06)	(0.46)	(5.14)
Size	0.23	0.01	0.2	-0.33
	(0.00)	(0.00)	(0.04)	(0.45)
Revenue Growth	-0.1	-0.04	-0.11	-1.92
	(0.01)	(0.01)	(0.13)	(1.43)
Leverage	1.62	0.03	-0.56	2.25
	(0.02)	(0.02)	(0.41)	(2.29)
Profitability	0.16	0.04	0.79	4.37
	(0.02)	(0.03)	(0.27)	(4.44)
Pseudo R^2	0.4502	0.0006	0.2680	0.0933

ratios compared with unlisted non-infrastructure firms; infrastructure firms have a negative mean dividend over operating profits ratio. In terms of mean, listed infrastructure firms have a similar dividend over assets ratio to listed non-infrastructure firms, lower dividend over operating profits ratio but higher dividend payout ratio.

Much like the summary statistics prior to matching, an unlisted infrastructure firm appears to be less likely to pay a dividend than an unlisted non-infrastructure firm although a listed infrastructure firm is more likely to pay a dividend than a listed non-infrastructure firm. However, as explained earlier, our FAME sample only includes dividend payments and this effectively reduces the payout observed and does not reflect the full payout available to shareholders in infrastructure firms.

Hence, we repeat this propensity score matching process using EDHEC*infra*'s unlisted infrastructure data with FAME's unlisted non-infrastructure data. The results pre- and post-matching are shown in Table 4. Similar to the sample using pure FAME infrastructure and non-infrastructure data, the post-match sample here also shows a smaller difference between unlisted EDHEC*infra* infrastructure and unlisted FAME non-infrastructure samples across the four matching variables. When comparing the variables for the hypothesised characteristics, we find again that infrastructure exhibits lower mean operating leverage and illiquidity measures, and a higher Tangibility 2 measure, as compared to unlisted non-infrastructure firms.

Tangibility 1 is not computed for comparison between EDHEC*infra* and FAME samples due to the differences in accounting variables collected. For asset inflexibility, infrastructure exhibits a lower mean but higher median than non-infrastructure firms do. When dividends are paid out, in comparison to non-infrastructure, infrastructure pays out a higher dividend as a proportion of revenue as well as of assets. Infrastructure firms are also more likely to pay a dividend than non-infrastructure firms are.

We now turn to testing if the post-match differences between infrastructure and non-infrastructure observed in Tables 3 and 4 are statistically significant, and whether these differences in characteristics can explain some of the observed dividend payout behaviour of infrastructure firms.

4. Results

We analyse whether infrastructure exhibits different characteristics from non-infrastructure assets by first examining if there are differences in the means and medians of the variables of interest. Next, we examine if these characteristics are related to the dividend payout behaviour of infrastructure firms.

4.1 Tests of mean and median

The first test uses the matched listed and unlisted samples and tests the differences observed between infrastructure and non-infrastructure firms in terms of the means and medians of their variables of interest. The results for this analysis are presented in Table 6.

For the unlisted sample of FAME financial data, we observe that there is a statistically significant difference for both measures of operating leverage between infrastructure and non-infrastructure firms in their mean and median measures. The negative sign implies that the operating leverage for infrastructure firms is lower than that for non-infrastructure firms, supporting our hypothesis. Infrastructure firms have a significant asset base and the level of operating costs compared with the size of these assets would be smaller than that of 'capital light' businesses.

For unlisted firms, we also observe that infrastructure has a lower, statistically significant measure of Tangibility 1 and a higher, statistically significant measure of Tangibility 2 in terms of mean, and a lower, statistically significant median than non-infrastructure firms for both tangibility measures. Similarly, for listed firms, we find that infrastructure has a significantly higher mean and median for Tangibility 2 than non-infrastructure.

Interestingly, for all three asset illiquidity measures, we find no statistically significant difference in means but significant differences in medians between unlisted infrastructure and non-infrastructure firms. For listed firms, in line with our hypothesis, we observe that infrastructure has lower, statistically significant measures of Illiquidity 1 and 2.

For inflexibility, unlisted infrastructure has a statistically significant higher mean than unlisted non-infrastructure firms do, which is in line with our hypothesis.

For the dividend related ratios, unlisted infrastructure has a higher, statistically significant measure of dividend over assets and dividend payout ratios, in terms of both mean and median. Unlisted infrastructure is also less likely to pay out a dividend than unlisted non-infrastructure, when only dividend payments are taken into account for payouts.

When the tests of mean and medians are repeated using matched EDHEC*infra*'s unlisted infrastruture data with FAME's unlisted non-infrastructure data, we find that infrastructure pays out higher dividend related ratios for all three measures in terms of median. Infrastructure also has a lower, statistically significant dividend over operating profits ratio. When shareholder loans are taken into account for payouts, there is no statistically significant difference in the probability of a dividend being paid by an infrastructure and a non-infrastructure firm.

From the results presented in Table 6, we can conclude that infrastructure does exhibit different characteristics to other firms. These characteristics are as a result of the nature of infrastructure businesses, specifically the

Table 6: Post Matching - Differences in Mean and Median of Infrastructure and Non-Infrastructure Samples

This table presents the results of a difference in mean and the Brown-Mood test for difference in medians for the variable of interest between the matched infrastructure and non-infrastructure samples. Size$_(i, t)$ is log total assets; Leverage$_(i, t)$ is defined as the sum of trade creditors, short term loans and long term debt over assets; ΔRevenue$_(i, t)$ is the percentage change in revenue from time t-1 to t; and, Profitability$_(i, t)$ is operating profit at time t divided by total assets at time t. The operating leverage definitions are OL1 and OL2 asset tangibility 1 and 2 are defined consistent with Equations 2.1 and 2.2, respectfully. Asset Illiquidity measures are the WAL1, WAL2 and WAL3, respectfully. Asset Inflexibility is as described in Equation 2.6. The dividend related measures are the dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	FAME				EDHECinfra and FAME	
	Unlisted		Listed		Unlisted	
Difference in	Mean	Median	Mean	Median	Mean	Median
Profitability	0.01	0***	0.02	0.05	-0.03	0.1***
Inflexibility	0.45***	0.01	-7.72	-0.38	-0.55	0.38
Leverage	0	0.1***	0.03	0.09	-0.01	-0.1
Size	0.05*	-0.06*	-0.06	0.18	1.89	2.31***
Operating Leverage 1	-0.34***	-0.2***	-0.15	-0.07**	-0.14	0
Operating Leverage 2	-0.98***	-0.72***	-0.62*	-0.46**	-0.01	0.19***
Revenue/Assets	-0.87***	-0.73	-0.6*	-0.47*	-0.05	0.3***
Revenue Growth	-0.03***	-0.03***	-0.1	-0.08	0.12	-0.02
Tangibility 1	-0.02***	-0.1***	0.15*	0.03*		
Tangibility 2	0.07***	-0.13***	0.51***	0.59***	0.3	0.55***
Illiquidity 1	-1.45	0.01***	-0.12*	-0.06***	-0.55	-0.01
Illiquidity 2	-5.04	0.05**	-0.23*	-0.17*	-3.13	-0.1***
Illiquidity 3	-6.82	0.07***	0	0.07	-4.21	-0.03
Dividends/Assets	0.04***	0.02***	0	0.01	0.21	0.1***
Dividends/Operating Profit	-8.66	0.27***	-0.1	-0.04	-12.92***	0.43***
Dividend Payout Ratio	0.17***	0.14***	-0.6	0.06**	0.86	0.33***
Pr(Dividend)	-0.13***	0	0.1	0	0.38	1

requirement to invest in large, highly specialised assets that cannot be easily repurposed. We now turn to explore whether, because of these characteristics, infrastructure firms pay out higher dividends.

4.2 Infrastructure firm dividend pay-out behaviour

Having examined whether infrastructure firms exhibit different characteristics from other firms, we now turn to examining if these characteristics are able to explain dividend payout behaviour. We first examine whether the variables used to match the firms explain dividend behaviour. This follows the analysis in Michaely and Roberts (2012). The following three fixed-effects panel regressions, where the dependent variable is either the dividend payout ratio, dividend-over-assets ratio or dividend-over-operating-profit ratio, and the independent variables are the four matching variables and a dummy variable, are conducted for the unlisted and listed samples. If the coefficient $InfraDummy_{(i,t)}$ in Eq.4.1 is statistically significant, it is possible to conclude that infrastructure pays a different dividend as proportion of revenue than the control groups.

$$DividendPayoutRatio_{(i,t)} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 InfraDummy_{(i,t)} + \varepsilon_{(i,t)} \quad (4.1)$$

$$\frac{Dividends_{(i,t)}}{Assets_{(i,t)}} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 InfraDummy_{(i,t)} + \varepsilon_{(i,t)} \quad (4.2)$$

$$\frac{Dividends_{(i,t)}}{OperatingProfit_{(i,t)}} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 InfraDummy_{(i,t)} + \varepsilon_{(i,t)} \quad (4.3)$$

Where:

- $DividendPayoutRatio_{(i,t)}$ is dividend at time t divided by revenue at time t;
- $Size_{(i,t)}$ is log total assets at time t;
- $Leverage_{(i,t)}$ is defined as the sum of trade creditors, short term loans and long term debt, divided by total assets at time t;
- $\Delta Revenue_{(i,t)}$ is the percentage change in revenue from time $t-1$ to t;
- $Profitability_{(i,t)}$ is operating profit at time t divided by total assets at time t; and,
- $InfraDummy_{(i,t)}$ is a dummy variable which takes the value of 1 when the firm is an infrastructure firm, and 0 otherwise.

We perform separate regressions using post-matched listed and unlisted infrastructure data from FAME, and unlisted infrastructure data from EDHEC*infra*, which has been matched with unlisted non-infrastructure data from FAME. The regression results are displayed in Table 7 and they show similar results to the results presented in Table 6.

The $InfraDummy_{(i,t)}$ coefficient, when the dividend-payout ratio ratio is used as the dependent variable, is positive and statistically significant at the 1% significance level for both unlisted and listed matched FAME samples. This implies that an unlisted, dividend-paying infrastructure firm will pay out 18% more dividends as a proportion of revenue, compared to a similar unlisted, dividend-paying non-infrastructure firm. The$InfraDummy_{(i,t)}$ coefficient is also positive and significant at the 1% significance level when looking at the regression involving the dividend-over-assets ratio for unlisted firms. This implies that both listed and unlisted infrastructure firms do pay out a larger proportion of their revenues than non-infrastructure firms do; and unlisted infrastructure firms pay out more dividends relative to the firm's asset size than unlisted non-infrastructure firms. The $InfraDummy_{(i,t)}$ coefficients are not statistically significant when comparing EDHEC*infra* unlisted infrastructure data and FAME unlisted non-infrastructure data.

4.3 Infrastructure firm characteristics and dividend pay-out behaviour

Having examined whether infrastructure firms pay a different dividend to other firms, we now examine whether the unique characteristics of infrastructure firms go some way to explaining the level of dividends for unlisted infrastructure firms. We conduct three regressions to examine if the characteristics are related with the observed dividend ratios. The following three regressions are performed for the unlisted infrastructure and non-infrastructure samples, and are repeated for each hypothesised characteristic.

$$DividendPayoutRatio_{(i,t)} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 VariableofInterest_{(i,t)} + \varepsilon_{(i,t)} \quad (4.4)$$

$$\frac{Dividends_{(i,t)}}{Assets_{(i,t)}} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 VariableofInterest_{(i,t)} + \varepsilon_{(i,t)} \quad (4.5)$$

Table 7: Panel Regression on Dividend Ratios

This table presents the results from a panel time fixed effects regression of dividend ratios using the matching variables over the unlisted and listed samples. The regression conducted is $DividendRatio_{i,t} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_2 \Delta Revenue_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Size_{i,t} + \beta_5 InfraDummy_{i,t} + \epsilon_{i,t}$ where, $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t; $Size_{i,t}$ is log total assets; and $InfraDummy_{i,t}$ is a dummy variable indicating whether the firm is an infrastructure firm or not. Three dividend related ratios are used – dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. Standard errors are reported in parentheses.

Panel A. FAME data

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Variable	Unlisted	Listed	Unlisted	Listed	Unlisted	Listed
Leverage	-0.07	-0.02	-0.06	-0.03	23.06	-0.46
	(0.03)	(0.02)	(0.01)	(0.03)	(11.14)	(0.29)
Revenue Growth	-0.01	0.04	-0.03	0.01	0.68	0.06
	(0.02)	(0.02)	(0.01)	(0.02)	(7.63)	(0.24)
Profitability	0.01	0.36	0.16	-0.02	6.41	-2.35
	(0.03)	(0.07)	(0.01)	(0.08)	(11.56)	(0.84)
Size	0.01	0.01	-0.01	0	-1.19	0.05
	(0.00)	(0.01)	(0.00)	(0.01)	(1.64)	(0.08)
Infra Dummy	0.18	0.06	0.05	0.01	-10.3	0.07
	(0.02)	(0.00)	(0.01)	(0.00)	(7.30)	(0.05)
Obs	3522	28	3522	28	3522	28

Panel B. EDHECinfra and FAME data (Unlisted)

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	0.16	0.42	-46.65
	(1.02)	(0.06)	(23.11)
Revenue Growth	-1.91	-0.07	-0.42
	(0.55)	(0.03)	(12.30)
Profitability	-2.33	0.14	28.37
	(1.84)	(0.10)	(41.50)
Size	0.18	0.06	-5.27
	(0.24)	(0.01)	(5.44)
Infra Dummy	-0.16	0.06	6.41
	(0.94)	(0.05)	(21.13)
Obs	180	180	180

$$\frac{Dividends_{(i,t)}}{OperatingProfit_{(i,t)}} = \beta_0 + \beta_1 Size_{(i,t)} + \beta_2 Leverage_{(i,t)} + \beta_3 \Delta Revenue_{(i,t)} + \beta_4 Profitability_{(i,t)} + \beta_5 VariableofInterest_{(i,t)} + \epsilon_{(i,t)} \quad (4.6)$$

Where:

- $DividendPayoutRatio_{(i,t)}$ is dividend at time t divided by revenue at time t;
- $Size_{(i,t)}$ is log total assets at time t;
- $Leverage_{(i,t)}$ is defined as the sum of trade creditors, short term loans and long term debt, divided by total assets at time t;
- $\Delta Revenue_{(i,t)}$ is the percentage change in revenue from time $t-1$ to t;
- $Profitability_{(i,t)}$ is operating profit at time t divided by total assets at time t; and,
- $VariableofInterest_{(i,t)}$ is either asset inflexibility, one of the two operating leverage, one of the three asset illiquidity or one of the two asset tangibility measures.

The results of the regressions for equations Eq.4.4, Eq.4.5 and Eq.4.6 are presented in Tables 9 to 12. A summary of the regression results can be found in Table 8.

Using the matched FAME data for unlisted firms, we observe that both measures of operating leverage exhibit a positive and statistically significant relationship with the $\frac{Dividends_{i,t}}{Assets_{i,t}}$ ratio, for the infrastructure sample. This implies that the higher the operating leverage of an infrastructure firm, the higher its dividend payout as a proportion of total assets. An explanation for this observation is the negative relationship between operating leverage and leverage, as documented by Chen et al. (2019) and also seen in the correlation

Table 8: Summary of Panel Regression on Dividend Ratios

	Dividend Payout Ratio			Dividends/Assets			Dividends/Operating Profit		
	FAME Infra	FAME Non	EDHECinfra	FAME Infra	FAME Non	EDHECinfra	FAME Infra	FAME Non	EDHECinfra
Operating Leverage 1				Positive***	Positive***				
Operating Leverage 2	Negative***	Negative*		Positive***	Positive***	Positive***			
Tangibility 1				Positive*			Positive*		
Tangibility 2		Negative*	Negative*	Negative*	Negative*		Positive*		
Illiquidity 1	Negative***	Positive***		Negative***				Positive***	
Illiquidity 2		Positive***						Positive***	
Illiquidity 3		Positive***	Negative*	Negative*				Positive***	
Inflexibility									

tables presented in the Appendix. With lower leverage, a firm is able to pay out more free cash to shareholders. We observe similar phenomena with non-infrastructure firms for the $\frac{Dividends_{i,t}}{Assets_{i,t}}$ ratio.

The second measure of operating leverage exhibits a negative and statistically significant relationship with the dividend-payout ratio for the infrastructure sample. This result is consistent with the findings of Kulchania (2016), which found that firms with higher fixed costs, or higher operating leverage, pay a lower proportion of their earnings out as dividends. In addition to selling and administrative expenses, Operating Leverage 2 takes into account the cost of goods sold in calculating total operating costs. Selling and administrative expenses are sticky costs. However, the inclusion of costs of goods sold, which is a variable cost, results in operating leverage becoming dependent on the level of revenue. This is consistent with the findings of Chen et al. (2019) that production costs are affected in a linear, almost "one-for-one" fashion with the level of sales of a firm. Similarly, from the correlation matrix of the FAME unlisted infrastructure sample (see Appendix), revenue growth is strongly correlated with Operating Leverage 2, but not Operating Leverage 1.

For Asset Illiquidity 1, we observe a positive and statistically significant relationship with the dividend-payout ratio and $\frac{Dividends_{i,t}}{OperatingProfits_{i,t}}$ ratio for non-infrastructure firms. An opposite relationship is observed for the infrastructure sample, where the dividend-payout and $\frac{Dividends_{i,t}}{Assets_{i,t}}$ ratios have a negative relationship with Asset Illiquidity 1. This means that an infrastructure firm with more illiquid assets pays out higher dividends as a proportion of its revenue and assets. This may be due to brownfield infrastructure companies being in a better position to pay out dividends than greenfield infrastructure companies, which have more liquid assets such as cash. The infrastructure characteristics of tangibility exhibit insignificant relationships and asset inflexibility exhibits no relationship with dividends. Also, the regression results using matched EDHEC*infra* show little or no significance relationships between the characteristics and dividend measures and this is likely due to the difference in granularity of data provided by FAME and EDHEC*infra*.

Table 9: Panel Regression on Dividend Ratios

This table presents the results from a panel time fixed effects regression of dividend ratios using the matching variables and a variable of interest over FAME unlisted infrastructure and non-infrastructure firms. The regression conducted is $DividendRatio_{i,t} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_2 \Delta Revenue_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Size_{i,t} + \beta_5 VariableofInterest_{i,t} + \epsilon_{i,t}$ where $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t; $Size_{i,t}$ is log total assets; and $VariableofInterest_{i,t}$ is either Operating Leverage 1, Operating Leverage 2, Tangibility 1, Tangibility 2, Illiquidity 1, Illiquidity 2, Illiquidity 3 and Inflexbility. Three dividend related ratios are used – dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. Standard errors are reported in parentheses.

Panel A. Unlisted Sample – Operating Leverage 1

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.19	0.01	-0.03	0	61.47	-0.08
	(0.05)	(0.04)	(0.02)	(0.01)	(36.48)	(1.10)
Revenue Growth	-0.03	-0.12	-0.06	-0.01	7.42	0.24
	(0.04)	(0.02)	(0.01)	(0.00)	(28.95)	(0.69)
Profitability	0.03	0.02	0.65	0.11	75.29	0.3
	(0.12)	(0.03)	(0.04)	(0.01)	(92.75)	(0.94)
Size	-0.02	0.03	-0.01	0	-4.7	0.32
	(0.01)	(0.01)	(0.00)	(0.00)	(5.35)	(0.16)
Operating Leverage 1	0.01	-0.02	1.06	0.01	6.93	-0.29
	(0.08)	(0.02)	(0.03)	(0.00)	(60.55)	(0.60)
Obs	1008	2514	1008	2514	1008	2514

Panel B. Unlisted Sample – Operating Leverage 2

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.2	0.03	-0.08	0	61.27	0.11
	(0.05)	(0.02)	(0.03)	(0.01)	(36.46)	(1.06)
Revenue Growth	-0.03	-0.13	-0.1	-0.02	7.16	0.26
	(0.04)	(0.01)	(0.02)	(0.00)	(28.87)	(0.17)
Profitability	0.07	0.01	0.98	0.11	77.12	0.68
	(0.12)	(0.01)	(0.07)	(0.01)	(90.72)	(0.25)
Size	-0.03	0.01	-0.01	0	-4.63	0.92
	(0.01)	(0.00)	(0.00)	(0.00)	(5.57)	(0.17)
Operating Leverage 2	-0.1	-0.02	0.15	0	1.73	-0.11
	(0.03)	(0.00)	(0.02)	(0.00)	(24.43)	(0.20)
Obs	1007	2504	1007	2504	1007	2504

Panel C. Unlisted Sample – Tangibility 1

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.21	0.01	-0.08	0	84.46	0.19
	(0.05)	(0.04)	(0.03)	(0.01)	(37.86)	(1.11)
Revenue Growth	-0.03	-0.12	-0.1	-0.01	7.74	0.24
	(0.04)	(0.02)	(0.02)	(0)	(28.78)	(0.69)
Profitability	0.1	0.02	0.98	0.11	15.68	0.28
	(0.12)	(0.03)	(0.07)	(0.01	(94.77)	(0.94)
Size	-0.02	0.03	-0.02	-0.01	-8.69	0.35
	(0.01)	(0.01)	(0)	(0)	(5.65)	(0.16)
Tangibility 1	-0.14	-0.01	0.11	0.02	135.74	1.59
	(0.08)	(0.06)	(0.05	(0.01)	(64.79)	(1.74)
Obs	1008	2514	1008	2514	1008	2514

Panel D. Unlisted Sample – Tangibility 2

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.19	0.01	-0.12	0	90.6	-0.01
	(0.05)	(0.04)	(0.03)	(0.01)	(37.84)	(1.09)
Revenue Growth	-0.03	-0.12	-0.1	-0.01	7.04	0.22
	(0.04)	(0.02)	(0.02)	(0)	(28.74)	(0.69)
Profitability	0.04	0.02	1.07	0.11	20.21	0.29
	(0.12)	(0.03)	(0.07)	(0.01)	(92.54)	(0.94)
Size	-0.02	0.03	-0.01	-0.01	-14.51	0.34
	(0.01)	(0.01)	(0)	(0)	(6.49)	(0.16)
Tangibility 2	-0.01	-0.07	-0.06	-0.01	93.85	0
	(0.05)	(0.03)	(0.03)	(0.01)	(35.78)	(1)
Obs	1008	2514	1008	2514	1008	2514

Table 10: Panel Regression on Dividend Ratios

This table presents the results from a panel time fixed effects regression of dividend ratios using the matching variables and a variable of interest over FAME unlisted infrastructure and non-infrastructure firms. The regression conducted is $DividendRatio_{i,t} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_2 \Delta Revenue_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Size_{i,t} + \beta_5 VariableofInterest_{i,t} + \epsilon_{i,t}$ where $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t; $Size_{i,t}$ is log total assets; and $VariableofInterest_{i,t}$ is either Operating Leverage 1, Operating Leverage 2, Tangibility 1, Tangibility 2, Illiquidity 1, Illiquidity 2, Illiquidity 3 and Inflexbility. Three dividend related ratios are used – dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. Standard errors are reported in parentheses.

Panel E. Unlisted Sample – Illiquidity 1

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.19	0.06	-0.1	0	61.1	0.33
	(0.05)	(0.02)	(0.03)	(0.01)	(36.37)	(1.07)
Revenue Growth	-0.02	-0.15	-0.1	-0.01	7.3	0.01
	(0.04)	(0.01)	(0.02)	(0)	(29.06)	(0.68)
Profitability	0.11	0.01	1.06	0.11	78.8	0.19
	(0.12)	(0.01)	(0.07)	(0.01)	(91.38)	(0.92)
Size	-0.04	0.01	-0.02	-0.01	-4.94	0.21
	(0.01)	(0)	(0)	(0)	(5.95)	(0.16)
Illiquidity 1	-0.76	0.24	-0.3	0	-10.1	1.8
	(0.17)	(0)	(0.1)	(0)	(130.76)	(0.17)
Obs	1004	2497	1004	2497	1004	2497

Panel F. Unlisted Sample – Illiquidity 2

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.18	0.03	-0.09	0	60.83	0.09
	(0.05)	(0.02)	(0.03)	(0.01)	(36.82)	(1.06)
Revenue Growth	-0.03	-0.15	-0.1	-0.01	7.02	0.05
	(0.04)	(0.01)	(0.02)	(0)	(29.09)	(0.68)
Profitability	0.02	0.02	1.02	0.11	78.41	0.26
	(0.12)	(0.01)	(0.07)	(0.01)	(91.15)	(0.92)
Size	-0.03	0.01	-0.02	-0.01	-4.56	0.21
	(0.01)	(0)	(0)	(0)	(6.3)	(0.16)
Illiquidity 2	-0.11	0.05	-0.07	0	3.34	0.35
	(0.08)	(0)	(0.05)	(0)	(60.96)	(0.03)
Obs	1004	2497	1004	2497	100	2497

Panel G. Unlisted Sample – Illiquidity 3

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.19	0.03	-0.1	0	60.6	0.08
	(0.05)	(0.02)	(0.03)	(0.01)	(36.3)	(1.06)
Revenue Growth	-0.03	-0.15	-0.09	-0.01	1.08	0.04
	(0.04)	(0.01)	(0.02)	(0)	(29.15)	(0.68)
Profitability	0.03	0.02	1.03	0.11	80.31	0.26
	(0.12)	(0.01)	(0.07)	(0.01)	(90.26)	(0.92)
Size	-0.02	0.01	-0.02	-0.01	-3.49	0.2
	(0.01)	(0)	(0)	(0)	(5.39)	(0.16)
Illiquidity 3	-0.07	0.03	-0.09	0	80.94	0.24
	(0.06)	(0)	(0.03)	(0)	(46.35)	(0.02)
Obs	1004	2497	1004	2497	1004	2497

Panel H. Unlisted Sample – Inflexibility

	Dividend Payout Ratio		Dividends/Assets		Dividends/Operating Profit	
Parameter	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure	Infrastructure	Non-Infrastructure
Leverage	-0.16	0.01	-0.1	-0.01	68.27	-0.12
	(0.05)	(0.04)	(0.03)	(0.01)	(38.74)	(1.21)
Revenue Growth	-0.09	-0.13	-0.16	-0.02	4.12	0.27
	(0.05)	(0.03)	(0.03)	(0.01)	(37.29)	(0.85)
Profitability	0.07	0.02	1.05	0.11	83.27	0.29
	(0.12)	(0.03)	(0.07)	(0.01)	(94.21)	(1)
Size	-0.02	0.03	-0.02	-0.01	-5.1	0.38
	(0.01)	(0.01)	(0)	(0)	(5.72)	(0.18)
Inflexibility	0	0	0	0	0.91	0.02
	(0)	(0)	(0)	(0)	(1.7)	(0.06)
Obs	938	2268	938	2268	938	2268

Table 11: Panel Regression on Dividend Ratios

This table presents the results from a panel time fixed effects regression of dividend ratios using the matching variables and a variable of interest over EDHECinfra unlisted infrastructure firms. The regression conducted is $DividendRatio_{i,t} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_1 \Delta Revenue_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Size_{i,t} + \beta_5 VariableofInterest_{i,t} + \epsilon_{i,t}$ where $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t; $Size_{i,t}$ is log total assets; and $VariableofInterest_{i,t}$ is either Operating Leverage 1, Operating Leverage 2, Tangibility 1, Tangibility 2, Illiquidity 1, Illiquidity 2, Illiquidity 3 and Inflexbility. Three dividend related ratios are used – dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. Standard errors are reported in parentheses.

Panel A. Operating Leverage 1

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	0.39	0.52	-78.9
	(1.8)	(0.08)	(40.26)
Revenue Growth	-2.06	-0.09	3.09
	(0.76)	(0.04)	(16.99)
Profitability	-2.54	0.2	21.52
	(2.65)	(0.12)	(59.28)
Size	0.26	0.08	-9.37
	(0.37)	(0.02)	(8.36)
Operating Leverage 1	1.57	-0.1	-95.22
	(9.73)	(0.46)	(217.81)
Obs	121	121	121

Panel B. Operating Leverage 2

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	-0.08	0.61	-82.29
	(1.73)	(0.07)	(38.77)
Revenue Growth	-1.91	-0.12	5.86
	(0.77)	(0.03)	(17.19)
Profitability	-3.03	0.3	11.86
	(2.68)	(0.11)	(59.96)
Size	0.23	0.09	-8.99
	(0.36)	(0.02)	(8.14)
Operating Leverage 2	-0.77	0.17	-19.49
	(0.89)	(0.04)	(19.86)
Obs	121	121	121

Panel C. Tangibility 2

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	0.77	0.52	-69.01
	(1.65)	(0.08)	(38.02)
Revenue Growth	-2.23	-0.08	1.01
	(0.74)	(0.04)	(17.02)
Profitability	-1.13	0.16	34.83
	(2.65)	(0.13)	(61.05)
Size	-0.02	0.09	-10.72
	(0.38)	(0.02)	(8.67)
Tangibility 2	-3.35	0.09	-26.32
	(1.59)	(0.08)	(36.7)
Obs	121	121	121

Panel D. Illiquidity 1

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	0.34	0.52	-66.98
	(1.7)	(0.08)	(37.89)
Revenue Growth	-2.06	-0.09	0.8
	(0.76)	(0.04)	(16.89)
Profitability	-2.44	0.18	40.62
	(2.74)	(0.13)	(60.89)
Size	0.24	0.09	-10.27
	(0.37)	(0.02)	(8.27)
Illiquidity 1	1.31	-0.19	167.57
	(7.11)	(0.33)	(158.1)
Obs	121	121	121

Table 12: Panel Regression on Dividend Ratios

This table presents the results from a panel time fixed effects regression of dividend ratios using the matching variables and a variable of interest over EDHECinfra unlisted infrastructure firms. The regression conducted is $DividendRatio_{i,t} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_1 \Delta Revenue_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Size_{i,t} + \beta_5 VariableofInterest_{i,t} + \epsilon_{i,t}$ where $Leverage_{i,t}$ is defined as the sum of trade creditors, short term loans and long term debt over assets; $\Delta Revenue_{i,t}$ is the percentage change in revenue from time t-1 to t; $Profitability_{i,t}$ is operating profit at time t divided by total assets at time t; $Size_{i,t}$ is log total assets; and $VariableofInterest_{i,t}$ is either Operating Leverage 1, Operating Leverage 2, Tangibility 1, Tangibility 2, Illiquidity 1, Illiquidity 2, Illiquidity 3 and Inflexbility. Three dividend related ratios are used – dividend over assets ratio, dividends over operating profit ratio and dividend payout ratio, which is dividends over revenue. Standard errors are reported in parentheses.

Panel E. Illiquidity 2

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	-0.15	0.54	-66.77
	(1.75)	(0.08)	(39.35)
Revenue Growth	-1.97	-0.09	1.48
	(0.76)	(0.04)	(17.02)
Profitability	-2.92	0.21	28.33
	(2.66)	(0.13)	(59.75)
Size	0.28	0.08	-9.01
	(0.36)	(0.02)	(8.2)
Illiquidity 2	-2.87	0.1	38.98
	(3.24)	(0.15)	(72.79)
Obs	121	121	121

Panel F. Illiquidity 3

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	-0.83	0.55	-67.99
	(1.68)	(0.08)	(39.26)
Revenue Growth	-1.83	-0.09	1.54
	(0.73)	(0.04)	(17.06)
Profitability	-2.46	0.2	23.05
	(2.54)	(0.12)	(59.11)
Size	0	0.09	-7.54
	(0.36)	(0.02)	(8.51)
Illiquidity 3	-6.6	0.13	28.15
	(2.72)	(0.13)	(63.41)
Obs	121	121	121

Panel G. Inflexibility

	Dividend Payout Ratio	Dividends/Assets	Dividends/Operating Profit
Leverage	2.3	0.31	-23.4
	(2.65)	(0.1)	(20.65)
Revenue Growth	-2.1	-0.09	2.72
	(1.21)	(0.05)	(9.4)
Profitability	-3.65	0.11	27.87
	(3.99)	(0.15)	(31.11)
Size	0.48	0.04	-2.18
	(0.51)	(0.02)	(3.99)
Inflexibility	0.24	0.01	-3.09
	(0.31)	(0.01)	(2.39)
Obs	87	87	87

5. Conclusion

This paper has examined two important questions regarding infrastructure finance. First, it identified characteristics of infrastructure, developed measurable proxies and tested whether infrastructure possesses the characteristics hypothesised in "the infrastructure narrative". We have shown that the characteristics of asset tangibility, illiquidity, inflexibility and operating leverage are different for infrastructure firms. They exhibit higher asset tangibility, asset illquidity and inflexibility and lower operating leverage than non-infrastructure firms.

Next, this paper examined whether infrastructure firms pay dividends differently from non-infrastructure firms. Specifically, for unlisted firms, we found that a dividend-paying infrastructure firm does pay out higher dividends as a proportion of their revenues and assets than a dividend-paying non-infrastructure firm. The paper then examined whether the dividend payout behaviour of unlisted firms can be explained by the infrastructure characteristics identified. It found that operating leverage was positively related with the dividend-over-assets ratio but negatively related with the dividend payout ratio. The first measure of asset illiquidity employed in this paper had a positive relationship with the dividend payout ratio for non-infrastructure firms but a negative relationship for infrastructure firms.

As Blanc-Brude et al. (2016) showed, including only dividends as shareholder payout will not incorporate all shareholder distributions for infrastructure as it excludes the principal and interest components of shareholder loans. However, FAME does not consistently provide such details. Hence, we incorporated shareholder loans in computing the dividend related measures for an additional unlisted infrastructure sample using EDHEC*infra* data instead. We recognise that there is little or no significance observed in the results utilising matched EDHEC*infra* data due to the difference in granularity of data provided by FAME and EDHEC*infra*. The characteristics identified and examined in this paper can go some way to understanding what makes infrastructure different as an investment. Furthermore, it is possible to employ these characteristics to provide a check on whether firms classified as infrastructure actually *are* infrastructure. One major issue with infrastructure investment is the lack of a commonly agreed definition. This research can go some way to ensure that assets, which index providers and other researchers have identified as infrastructure, possess actual characteristics of infrastructure.

This study found that asset illiquidity exhibits a different relationship with a firm's dividend payout behaviour, depending on whether it is an infrastructure or a non-infrastructure firm. Future analysis can collect and analyse information regarding these relationships to further investigate the impact of asset liquidity on different firm types. For infrastructure firms, this may be due to the different characteristics of greenfield and brownfield investments or as an accounting artifact for infrastructure firms. Further investigation of how accounting standards affects these variables is warranted. This will also ensure that the infrastructure characteristics identified by the ratios employed in this paper are robust to accounting treatment.

Finally, this study focused mostly on unlisted financial variables and dividends. However, there is scope to employ these ratios to examine listed infrastructure and to understand whether these

ratios do give infrastructure the risk and return characteristics that are hypothesised.

6. Appendix

Table 13: Unlisted Infrastructure (FAME)

Unlisted Infrastructure (FAME)

	Revenue Growth	Profitability	Size	Leverage	OL1	OL2	WAL1	WAL2	WAL3	Tangibility1	Tangibility2	Revenue/Assets	Inflex	Dividend Payout Ratio	Dividends/Assets
Profitability	0.05***														
Size	0.03**	0.05***													
Leverage	0.01	-0.18***	-0.06***												
Inflex	0.05***	-0.03**	0.02	-0.04***											
OL1	0.01	-0.09***	-0.12***	-0.10***	0.02*										
OL2	0.03**	-0.13***	-0.20***	-0.09***	-0.02*	0.36***									
WAL1	0.05***	0	-0.01	0	-0.01	0.01	0.01								
WAL2	0.05***	-0.01	-0.02*	0.02*	-0.02	0	0.01	0.98***							
WAL3	0.11***	0	0.02*	0.01	0	0	0	0.50***	0.59***						
Tangibility1	0.11***	0.11***	0.06***	-0.23***	0.08***	0.16***	0.06***	0.04***	-0.03**	0.02					
Tangibility2	0.13***	0.12***	0.26***	-0.19***	0.12***	0.05***	-0.07***	-0.02*	-0.09***	0	0.82***				
Revenue/Assets	0.04***	-0.02	-0.19***	-0.14***	-0.03**	0.36***	0.98***	0.01	0.01	0	0.13***	-0.01			
Dividend Payout Ratio	-0.02	0.05	-0.10**	-0.15***	0.06	0.04	-0.06	-0.07*	-0.03	-0.06*	-0.03	-0.02	-0.03		
Dividends/Assets	-0.11***	0.48***	-0.19***	-0.18***	0.01	0.77***	0.34***	0.08*	-0.02	-0.07*	0.18***	-0.02	0.49***	0.20***	
Dividends/Operating Profit	0	0.02	-0.03	0.06	0.01	0.01	0.01	0.01	0.02	0.06*	0.04	0.04	0.01	-0.07*	0

OL1 and OL2 refer to Operating Leverage 1 and 2; WAL1, WAL2 and WAL3 refer to Asset Illiquidity 1, 2 and 3; Tangibility1 and Tangibility2 refer to Asset Tangibility 1 and 2; Inflex refers to Asset Inflexibility

Table 14: Unlisted Infrastructure (EDHECinfra)

Unlisted Infrastructure (EDHECinfra)

	Revenue Growth	Profitability	Size	Leverage	OL1	OL2	WAL1	WAL2	WAL3	Tangibility2	Revenue/Assets	Inflex	Dividend Payout Ratio	Dividends/Assets
Profitability	0.12													
Size	0.01	0.1												
Leverage	0.21**	-0.24**	-0.37***											
OL1	0	-0.22**	-0.06	-0.26***										
OL2	0.01	-0.33***	-0.39***	0	0.29***									
WAL1	0.27***	0	0.02	-0.17*	0.15*	-0.04								
WAL2	0.27***	-0.03	-0.05	-0.14	0.13	0.1	0.98***							
WAL3	0.28***	0.01	-0.01	-0.13	0.15	-0.02	0.99***	0.98***						
Tangibility2	0.07	0.26***	-0.01	0.08	0.03	-0.35***	0.02	-0.09	0.07					
Revenue/Assets	0.05	-0.09	-0.40***	-0.05	0.23**	0.96***	-0.05	0.08	-0.03	-0.29***				
Inflex	0.08	-0.08	0	-0.1	0.42***	0.26**	0.20*	0.07	0.09	0.1	0.24**			
Dividend Payout Ratio	-0.20*	-0.18*	0.08	0.08	-0.08	-0.21*	-0.04	-0.14	-0.18	-0.07	-0.27**	-0.07		
Dividends/Assets	-0.08	-0.05	0.22*	0.38***	-0.30***	0.1	-0.24**	-0.13	-0.02	0.18	0.08	-0.15	0.30***	
Dividends/Operating Profit	-0.01	0.11	-0.01	-0.22*	0.05	-0.03	0.07	0.1	0.07	-0.09	0.01	-0.15	-0.16	-0.36***

OL1 and OL2 refer to Operating Leverage 1 and 2; WAL1, WAL2 and WAL3 refer to Asset Illiquidity 1, 2 and 3; Tangibility1 and Tangibility2 refer to Asset Tangibility 1 and 2; Inflex refers to Asset Inflexibility

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EDHEC*infra* Publications (2016-2020)

EDHECinfra Methdologies & Standards

- The Infrastructure Company Classification Standard (TICCS) - Updated March 2020
- Credit Risk Methodology - April 2020
- Infrastrcuture Index Methdology Standard - Updated March 2020
- Global Infrastructure Investment Data Standard - Updated March 2020
- Unlisted Infrastructure Valuation Methodology - A Moderm Approach to Measuring Fair Value in Illiquid Infrastructure Investments - Updated March 2020

Selected EDHEC Publications

- Amenc, N., F. Blanc-Brude, A. Gupta, J-Y. Lim. "2019 Global Infrastructure Investor Survey - Benchmarking Trends and Best Practices" (April 2019)
- Whittaker, T., S. Garcia. "ESG Reporting and Financial Performance: The case of infrastructure." (March 2019)
- Blanc-Brude, F, J-L. Yim. "The Pricing of Private Infrastructure Debt - A dynamic Approach" (February 2019)
- Blanc-Brude, F., C. Tran. "Which Factors Explain Unlisted Infrastructure Asset Prices?" (January 2019)
- S. Garcia, F. Blanc-Brude, T. Whittaker. "Tome La Siguiente Salida (Take the Next Exit) - A Case Study of Road Investments Gone Wrong, Spain, 1998-2018" (March 2018)
- Amenc, N., F. Blanc-Brude "Selecting Reference Indices for the Infrastructure Asset Class" (February 2018)
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- Blanc-Brude, F., T. Whittaker, and M. Hasan. "Cash Flow Dynamics of Private Infrastructure Debt" (March 2016).

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