A Publication of the EDHEC Infrastructure Institute-Singapore

# Revenue and dividend payouts in privately-held infrastructure investments

## Evidence from 15 years of UK data

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with the support of

Long-term Infrastructure Investors Association

meridiam
INVESTING FOR THE COMMUNITY

CAMPBELL LUTYENS
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EDHECinfra
Singapore Infrastructure Investment Institute

# Table of Contents




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# Foreword

The purpose of the present publication, "Revenue and dividend payouts in privately-held infrastructure investments", which is drawn from the Meridiam/Campbell-Lutyens research chair on infrastructure equity investment at EDHEC Infrastructure Institute-Singapore, is to empirically validate the hypothesis that infrastructure firms correspond to a different underlying business model and have a different dividend payout behaviour than non-infrastructure firms, whether they are private or publicly traded.

This study makes use of the EDHEC*infra* infrastructure database. To date, with data for hundreds of investments over 15-20 years, it is the most comprehensive database of infrastructure cash flows currently available for research.

This dataset is one of the early outputs of a substantial effort launched at EDHEC to collect private information and document the investment characteristics of infrastructure investments, and create a global database of infrastructure cash flows spanning several decades.

This paper offers a powerful validation of the insights developed in earlier publications of the EDHEC/Meridiam/Campbell Lutyens Research chair about the existence of an "infrastructure investment narrative" informed from a number of intuitions drawn from economic literature on natural monopolies and the theory of contracts.

This is the largest study of this kind ever undertaken and the authors' findings suggests that infrastructure firms exhibit a unique business model in terms of revenues and profits dynamics compared to a large control group of public and private firms. Infrastructure firms have significantly lower volatility of revenues and profits and pay a much higher proportion of their revenues much more frequently to their owners, independent of the business cycle.

Such findings have important ramifications for investment management and prudential regulation: they confirm that the project to build benchmarks of the risk-adjusted of private infrastructure investments is worthwhile and can can had tremendous value to the investment sector insofar as it can help improve price discovery and, in turn, asset allocation decision to long-term illiquid assets like infrastructure.

We are grateful to Meridiam and Campbell-Lutyens for their support of this study in the context of this research chair, and we are also very happy to announce that this work will continue with the support of the Long-Term Infrastructure Investors Association (LTIIA), which is endowing a new Research Chair on the benchmarking of privately-held infrastructure equity investments at the EDHEC Infrastructure Institute for the 2016-2019 period.

# Foreword

**Noël Amenc**

Associate Dean, EDHEC Business School

# About the Authors

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# Executive Summary

# Executive Summary

In this paper, we conduct the first large scale empirical analysis of the characteristics of cash flows in private infrastructure firms from the perspective of equity owners.

The paper addresses two main questions: do infrastructure firms correspond to a different business model than the rest of the firms active in the economy? and do infrastructure firms exhibit a different equity payout behaviour than other firms?

## Are infrastructure firms different?

Our motivation springs from what we have called the "infrastructure investment narrative" (Blanc-Brude, 2013), according to which investors in infrastructure can look forward to low return correlations with the business cycle (hence potentially better diversification), as well as lower sensitivity to economic shocks (implying better drawdown protection).

Empirical evidence for or against such hypotheses has so far been very limited. This study is a first iteration in a series of research papers using a new, global and growing database of infrastructure investment data, and aims to measure the relative financial performance of such investments through the creation of fully-fledged benchmarks or reference portfolios.

Here, we are interested in the volatility of revenues in infrastructure firms as well as their relative correlation with macro factors such as GDP growth, inflation or financial markets. We are also interested in the equity payout behaviour of infrastructure firms, relative to the business cycle as well as to other private and public firms.

## A Unique New Database

This study makes use of the EDHEC*infra* database: a collection of cashflow, investment and balance sheet data collected from infrastructure investors and creditors, as well as manually from individual firm's audited accounts. To date, the database covers more than 500 individual infrastructure assets over 10 different countries and a period of 15-20 years, making it the most comprehensive database of infrastructure cash flows available for research.

For this study, we focus on firms situated solely in the UK: firms identified as being either special purpose vehicle created in the context of the financing of a specific infrastructure project, or a firm conducting specific infrastructure-related activities (such as a port or an airport) or a regulated utility.

Thus, detailed accounts for each firm were obtained from infrastructure investors, lenders and/or from Companies House [1] and analysed individually in order to classify each firm into one of three groups: Contracted, Merchant and Regulated infrastructure, which we describe next.

*Contracted infrastructure firms* are not exposed to end user demand. In the United Kingdom, the Private Finance Initiative (PFI)

1 - The UK Company Register

# Executive Summary

is the prime example of such projects. Under the PFI scheme, infrastructure investors have delivered a broad range of infrastructure, including schools, hospitals and prisons. Such projects spring from a long-term contract for the provision of an infrastructure asset or service between the public sector and private entity (the firm), by which the public sector commits to paying a regular income to the firm as long as the relevant infrastructure services are delivered according to a pre-agreed specification.

*Merchant infrastructure firms* in comparison are exposed to some degree of market risk. Such infrastructure projects can have long-term contracts supporting their revenue in the form of a Power Purchase Agreement (PPA) or take-or-pay contract, but as such contracts may cover only part of the project's capacity or lifespan and the counter-party is typically not the Treasury. Other Merchant infrastructure firms are fully exposed to end user demand and market prices and include airports or toll roads.

Finally, *Regulated infrastructure firms* are typically natural monopolies involved in the provision of essential services, such as sewage treatment, water distribution or power transmission. In the United Kingdom, such companies are regulated by independent agencies such as Ofwat or Ofgem. [2]

The data span information from the early 1990s to 2015, as illustrated on figure 11.

We focus on UK data because they represent the largest, longest and most coherent set of infrastructure cash flow data available at this time, with the added advantage of corresponding to a single currency and regulatory environment, thus limiting the need to control for these dimensions in the analysis.

Starting from UK infrastructure firms, we can also build several control groups of non-infrastructure firms, with which to compare the data.

## Controlling for the different aspects of firm behaviour

Our sample of several hundred infrastructure firms is compared with a "matched sample" of non-infrastructure, UK firms, both private and listed.

Indeed, while public market data on infrastructure related firms has sometimes been used as a proxy of private infrastructure firms, recent research has shown that private firms exhibit significant differences in terms of size, capital structure and dividend policy: private firms tend to be smaller than listed firms, and to exhibit higher leverage, making their profits more sensitive to fluctuations in performance, to have different dividend payout policies than listed firms and to be less inclined to smooth their dividends in the presence of profit shocks.

Moreover, differences in ownership structure in private firms are also shown

2 - Blanc-Brude (see 2013, for a detailed discussion of these different infrastructure business models)

# Executive Summary

*Figure 1: Number and time frame of reporting firms in the EDHECinfra database. Each line represents a time series of cash flow data.*

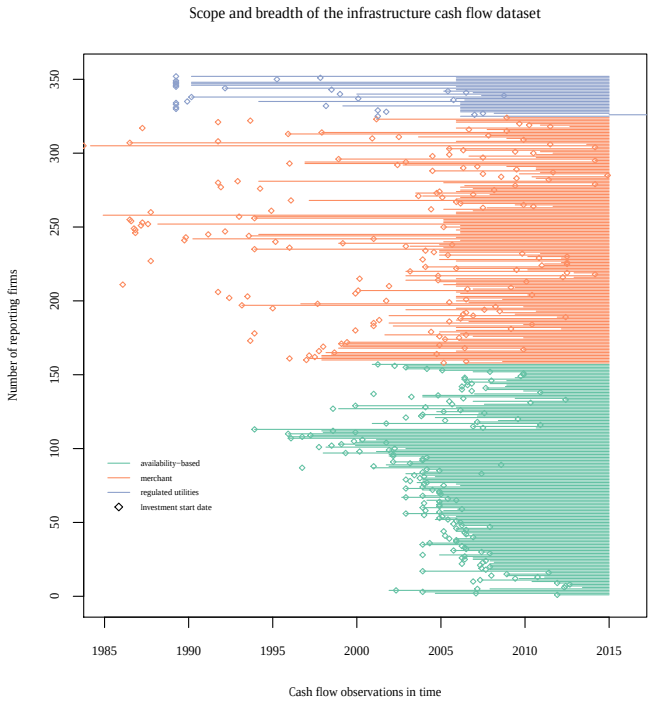
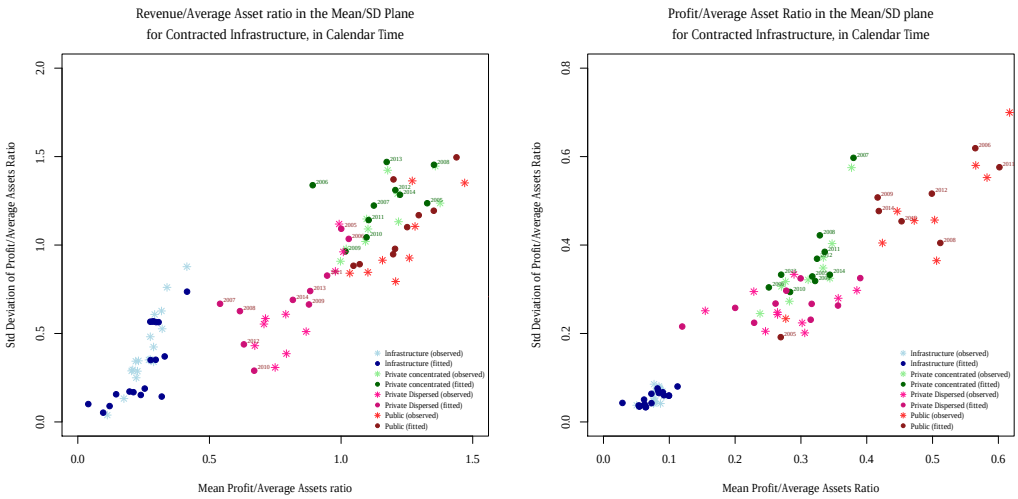



*Figure 2: Estimates of the mean and variance parameters of the unit revenues and profits in* ***calendar time*** *for* ***Contracted Infrastructure*** *and matched control firms*



# Executive Summary

*Figure 3: Estimates of the mean and variance parameters of the unit revenues and profits in **calendar time** for **Merchant Infrastructure** and matched control firms*

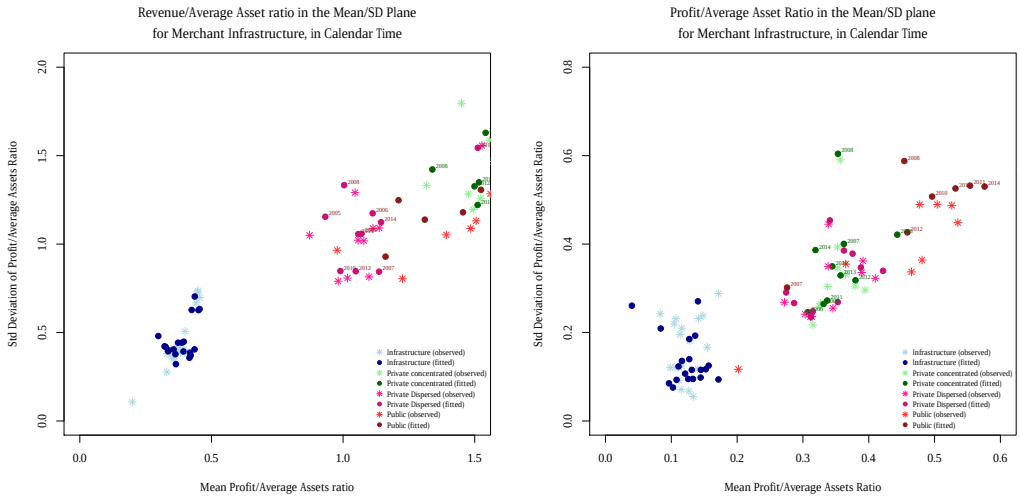
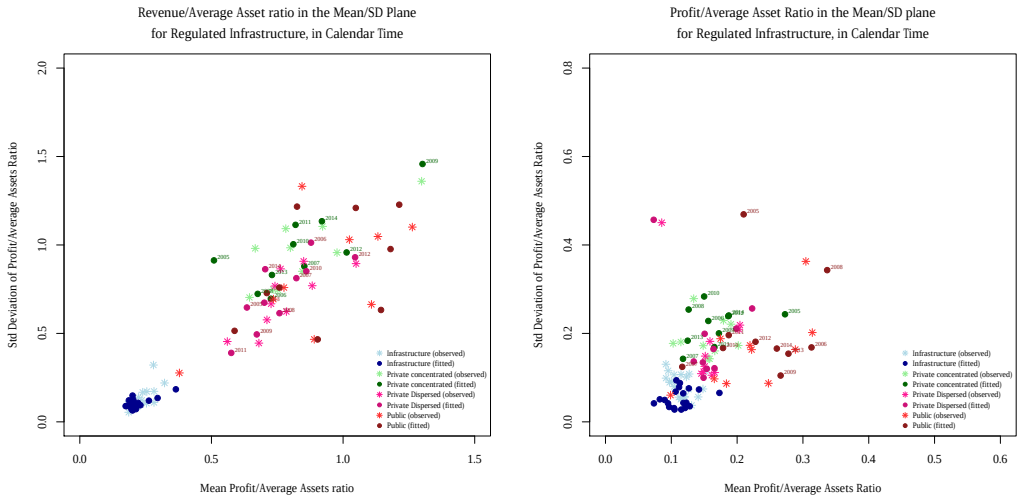



*Figure 4: Estimates of the mean and variance parameters of the unit revenues and profits in **calendar time** for **Regulated Infrastructure** and matched control firms*




to explain differences in dividend payout policy between different types of firms (see Brav, 2009; Michaely and Roberts, 2012, for a detailed study).

To isolate the effect of ownership structure and corporate governance on the behaviour of infrastructure firms, we build three control groups for each one of our infrastructure firm type: private firms with concentrated ownership, private firms with dispersed ownership and public (listed) firms.

Each of these three control groups is then "matched" to each infrastructure firm-year observation of a given type using a "nearest neighbour" methodology for total asset size, leverage and profitability and an exact

# Executive Summary

match for "investment year" i.e. the number of years since the creation of the firm.

Hence, we test the difference in revenue and profit volatility and in dividend payout ratio level and volatility between infrastructure and non-infrastructure firms using nine different tests: three types of infrastructure firms (contracted, merchant and utilities) each compared to three types of corporate governance (private concentrated, private dispersed, public), while controlling for individual firm characteristics (size, leverage, profitability) as best as available data allows.

Such tests go a long way in addressing the matter of the "uniqueness" of infrastructure investments. Indeed, if firm characteristics and corporate governance can be expected to explain in large part the business model and dividend payout behaviour of the firm, then for infrastructure to be unique and not easily replicable by combining other types of investments, it must correspond to a unique combination of firm characteristics and corporate governance.

Likewise, the revenues of infrastructure firms can only create a unique form of exposure to economic factors if their business model is not an easily replicable combination of the business models of other firms.

## Infrastructure *is* unique

We find that, as far as UK data show over the past 15 years, infrastructure firms are indeed truly unique: that is, after controlling for size, leverage and profitability, as well as the impact of the investment "lifecycle", infrastructure firms exhibit lower revenue volatility and higher payout ratios (dividends to revenue) than any other group of private or public firms.

1. Compared to their control groups, infrastructure firms have **lower revenues and profits per dollar invested**, highlighting the **capital-intensive and long-term nature** of their business;
2. They are also characterised by **significantly lower volatility of revenues and profits** compared to their matched control groups, both at the aggregate level (all periods) and at each point in investment and calendar time;
3. Infrastructure firms also exhibit a very **dynamic lifecycle** compared to control groups, with unit revenues and profits evolving by an order of magnitude over the investment cycle;
4. **Regression analyses** show that different proxies of the "business cycle" have a strong statistical effect on profits and revenues in non-infrastructure firms, but that this effect is absent in the different infrastructure firm test groups i.e. **infrastructure firm revenues and profits are less or not linked to the business cycle.** Instead, the effect of the "investment lifecycle" is what tends to explains the change in unit revenues and profits of infrastructure firms.
5. The **probability of positive equity payouts** in infrastructure firms is also significantly higher than in any of the control groups, reaching as high as 80%

# Executive Summary

*Figure 5: Probability of positive payouts and expected payout ratio in* ***Contracted Infrastructure****, investment time*

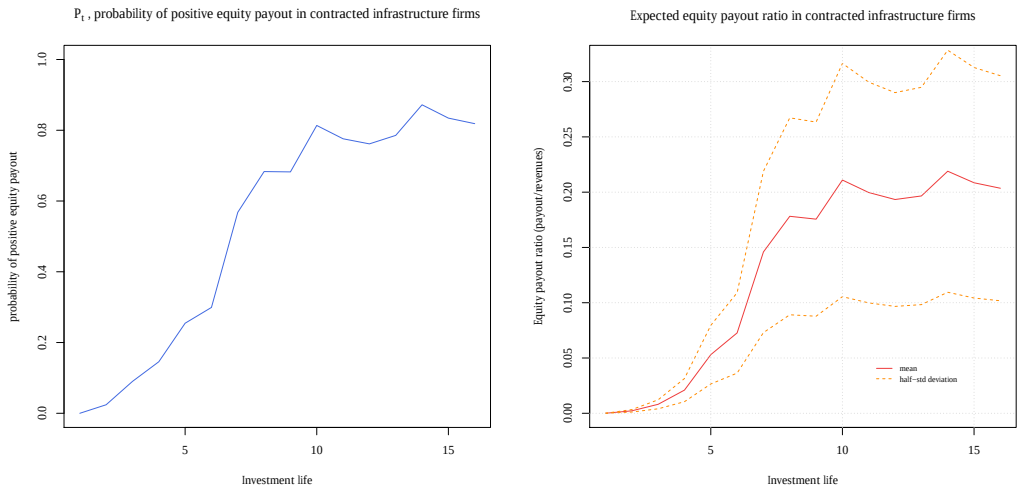
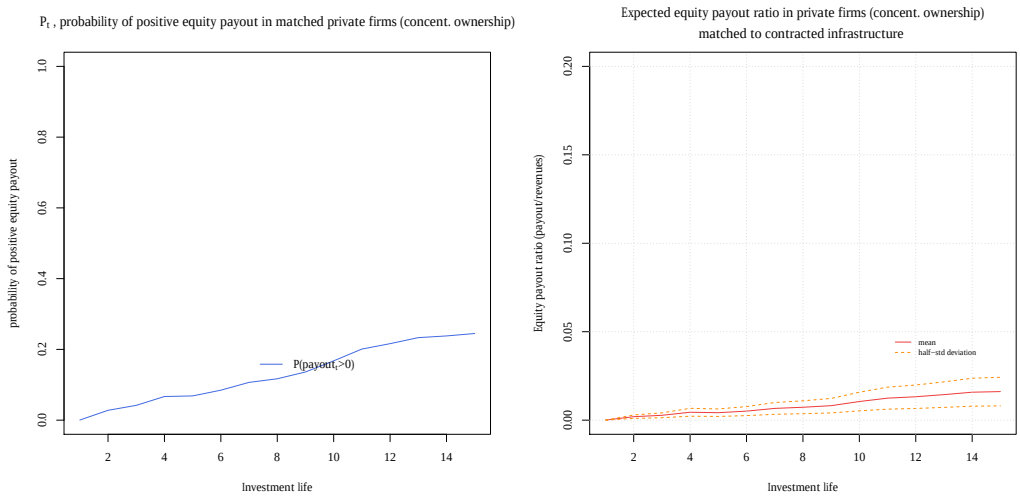



*Figure 6: Estimated probability of positive payouts and payout ratio density in* ***private firms with concentrated ownership****, matched to* ***Contracted Infrastructure***




after investment year 10 in Contracted infrastructure and the 60-70% range in Merchant and Regulated infrastructure. Control groups never reach a (conditional) probability of payout higher than 40%. These results are illustrated in figures 2 to 4.

6. Finally, equity **payout ratios in infrastructure firms are considerably higher** than in the relevant control groups, reaching expected values of between 10% and 15% of revenues when matched controls never payout more than 3-5% of revenues. Infrastructure firms payout more often and significantly higher proportions of their revenues than other firms once the lifecycle of the firm is taken into account, as shown in figures 5 to 10, which show the equity payout probability and payout ratio for each of our infrastructure test groups compared

# Executive Summary

*Figure 7: Probability of positive payouts and expected payout ratio in **Merchant Infrastructure**, investment time*

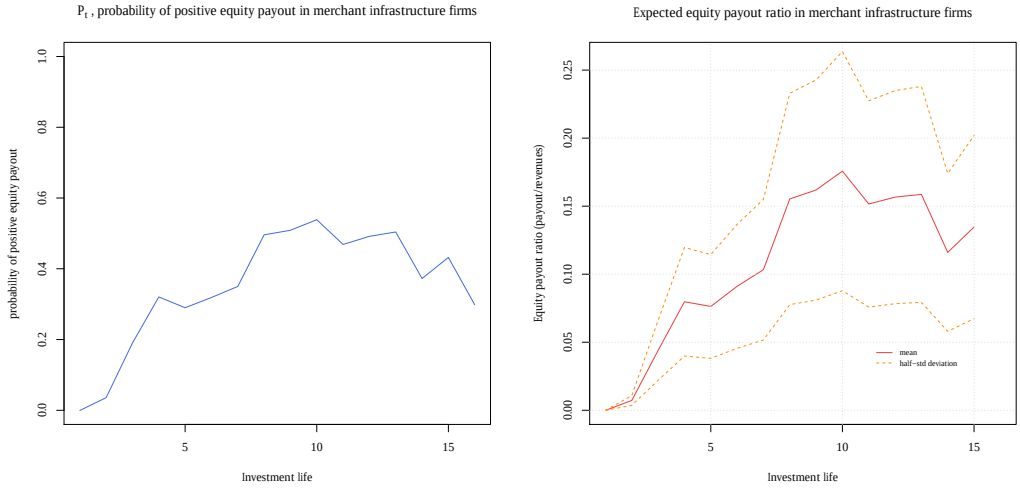
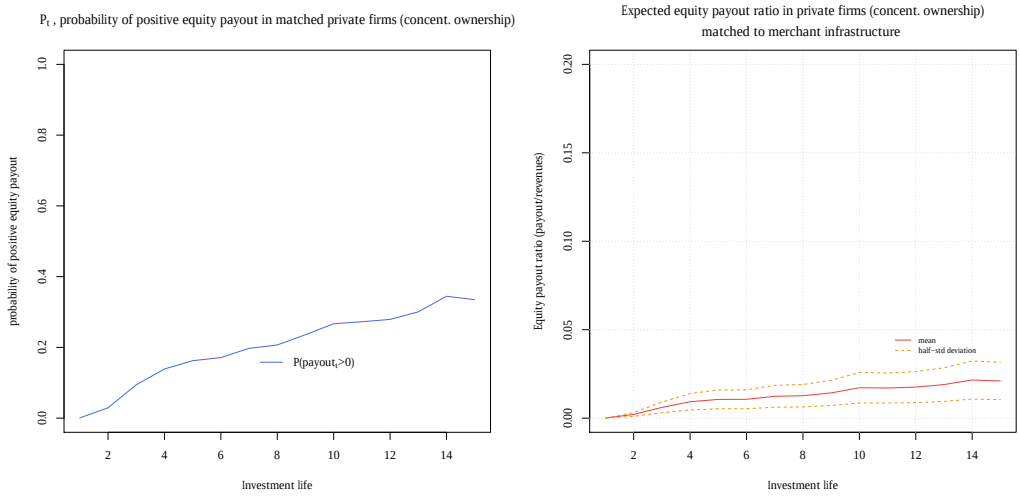



*Figure 8: Estimated probability of positive payouts and payout ratio density in **private firms with concentrated ownership**, matched to **Merchant Infrastructure***




to the matched "private concentrated" group. Similar results for other control groups are presented in chapter 4.

The combination of these findings suggests that infrastructure firms exhibit a unique business model in terms of revenues and profits dynamics compared to a large control group of public and private firms. **Infrastructure firms have significantly lower volatility of revenues and profits and pay a much higher proportion of their revenues much more frequently to their owners, independent of the business cycle.**

Another significant result is that each of the three types of infrastructure firms that we define (according to a typology we first described in Blanc-Brude (2013)) corresponds to a unique infrastructure business model as well i.e. albeit more

# Executive Summary

*Figure 9: Probability of positive payouts and payout ratio density in **Regulated Infrastructure**, investment time*

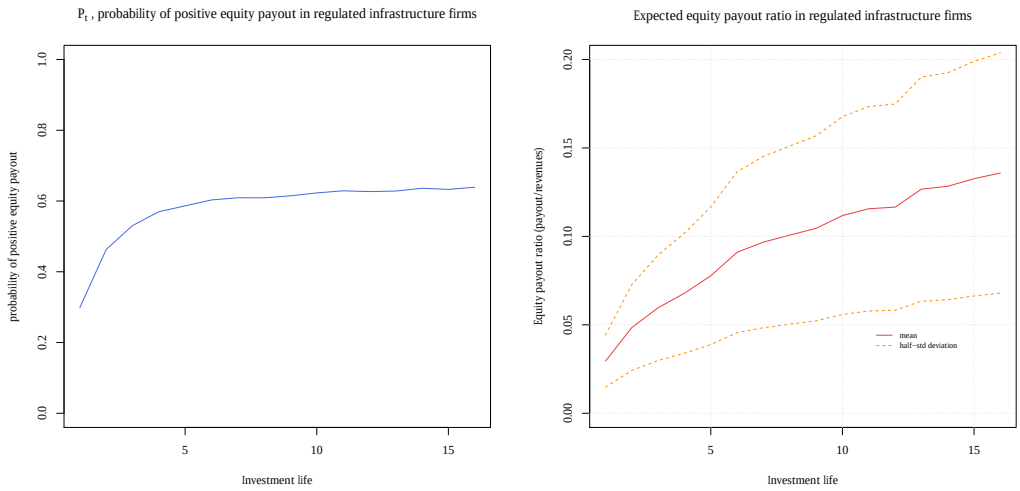
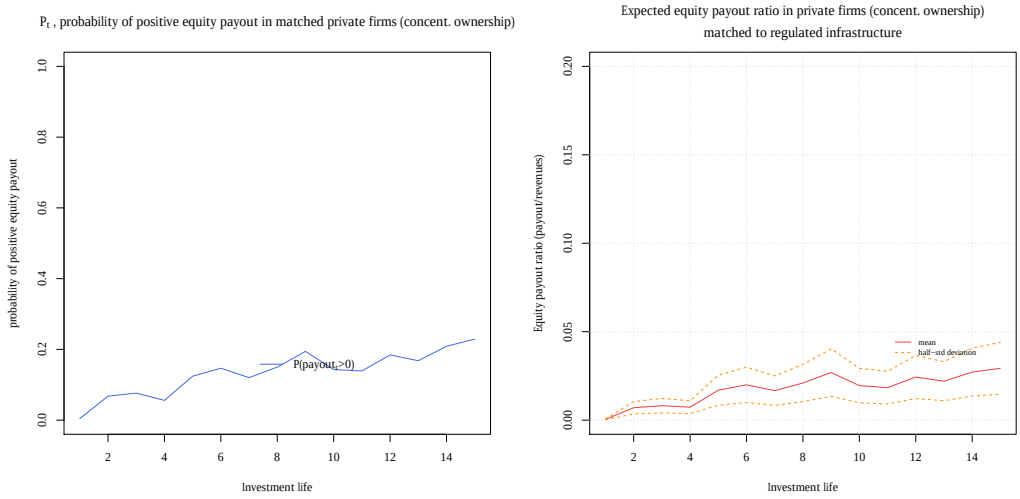



*Figure 10: Estimated probability of positive payouts and payout ratio density in **private firms with concentrated ownership**, matched to **Regulated Infrastructure***




alike amongst themselves then compared with the rest of the corporate universe, Contracted, Merchant and Regulated infrastructure firms have their own different cash flow dynamics.

## Implications and Next Steps

These results have implications for investment management and prudential regulation:

1. While these results are not about investment returns *per se*, a financial asset that pays more frequently a larger proportion of the free cash flow of the firm can be expected to have a different pricing dynamic compared to the instruments in the control group. Importantly, it can be expected to provide diversification benefits compared to other private and public equity investments because of the low covariance between

# Executive Summary

revenues and profits of infrastructure and non-infrastructure firms. In other words, from the unique business model of infrastructure firms may well spring **a unique combination of factor exposures** that are relevant to investors.

2. Likewise, the quasi-absence of impact of discrete financial or economic shocks, or of the business cycle captured by macro or market factors, suggests non only low correlations but also **a form drawdown protection in bad times** from holding infrastructure firms.
3. Hence, it is also likely that a large basket of infrastructure firm equity can claim to be treated differently from a regulatory perspective than the rest of available public and private investment opportunities. Of course, the metrics presented here are not directly compatible with the ones required to calibrate a prudential framework such as Solvency-II (which requires computing the 99.5% VaR) but they suggest strongly that **infrastructure firms, with their lower revenue volatility and lesser sensitivity to the business cycle are a good candidate for a specific treatment**.

Next steps, include using these findings to calibrate cash flow models to derive valuations of individual infrastructure assets (see for example Blanc-Brude and Hasan, 2015b) and to build reference portfolios that can be used as benchmarks by investors and regulators alike.

# 1. Introduction

# 1. Introduction

In this paper, we conduct the first large scale empirical analysis of the characteristics of cash flows in privately-held infrastructure firms, from the perspective of equity investors. The paper addresses two main questions: do infrastructure firms correspond to a different business model than the rest of the firms active in the economy? and do infrastructure firms exhibit a different equity payout behaviour than other firms?

Our motivation springs from what we have called known "infrastructure investment narrative" (Blanc-Brude, 2013), according to which investors in infrastructure can look forward to low return correlations with the business cycle (hence potentially better diversification), as well as lower sensibility to economic shocks (implying better drawdown protection).

Empirical evidence for or against such hypotheses has so far been very limited. This study is a first iteration in a series of research papers that aim to measure the relative financial performance of such investments through the creation of fully-fledged benchmarks or reference portfolios.

In this paper, we address the first dimension of this question with a study of the dynamics of *cash flows* to private equity holders in infrastructure investments. [3]

We use an abstract from the unique database of infrastructure investment cash flows created by EDHEC*infra* to study the revenues, profits and equity payouts of different types of private infrastructure businesses in the UK over a period of 10 to 15 years.

We are interested in the volatility of revenues in infrastructure firms as well as their relative correlation with macro factors such as GDP growth, inflation or financial markets. We are also interested in the equity payout behaviour of infrastructure firms, relative to the business cycle as well as to other private and public firms.

We focus on UK data because they are the largest, longest and most coherent set of infrastructure cash flow data available at this time, with the added advantage of corresponding to a single currency and regulatory environment, thus limiting the need to control for these dimensions in the analysis. Starting from UK infrastructure firms, we can also build robust control groups of non-infrastructure firms, with which to compare the data.

We focus on three types of infrastructure firms: "Contracted Infrastructure", corresponds to firms benefiting from long-term revenue contracts with public or private entities, "Merchant Infrastructure", corresponds to firms which are exposed to demand and price uncertainty, and "Regulated Infrastructure", corresponds to firms which typically are regulated natural monopolies. Since the early 1990s, the UK has seen numerous such private investments, from the privatisation of its utilities and transport infrastructure to the creation of the "Private Finance Initiative"

3 - See Blanc-Brude and Hasan (2015b) for a theoretical approach to discount rate estimation in private infrastructure assets.

# 1. Introduction

for numerous central and local government services, and various other private infrastructure procurement programs in the energy and telecommunication sectors. Hence, as we discuss in details in the rest of this paper, the opportunity to compare a wide range of private infrastructure investments.

Our sample of several hundred infrastructure firms is compared with a "matched sample" of non-infrastructure UK firms, both private and listed.

Indeed, while public market data has sometimes been used as a proxy of private infrastructure firms, recent research has shown that private firms exhibit significant differences in terms of size, capital structure and dividend policy: private firms tend to be smaller than listed firms, they exhibit higher leverage, making their profits more sensitive to fluctuations in performance, they have different dividend payout policies than listed firms and are less inclined to smooth their dividends in the presence of profit shocks. Moreover, differences in ownership structure in private firms are also shown to explain how much they differ from public firms (see Brav, 2009; Michaely and Roberts, 2012, for a detailed study).

To control for the effect of ownership structure and corporate governance on the behaviour of infrastructure firms, we build three control groups for each of our infrastructure firm types: private firms with concentrated ownership, private firms with dispersed ownership and public (listed) firms.

Each of these three control groups is "matched" to the each infrastructure firm of a given type using a "nearest neighbour" methodology for total asset size, leverage and profitability and an exact match for "investment year" i.e. the number of years since the creation of the firm.

We test the difference in revenue volatility and payout ratio of infrastructure investment using nine different tests: three types of infrastructure firms (contracted, merchant and utilities) against three types of corporate governance (private concentrated, private dispersed, public), while controlling for individual firm characteristics (size, leverage, profitability).

Such tests go a long way in addressing the matter of the "uniqueness" of infrastructure investments. Indeed, if firm characteristics and corporate governance can be expected to explain in large part the business model and dividend payout behaviour of the firm, then for infrastructure to be unique and not easily replicable by combining other types of investments, it must correspond to a unique combination of firm characteristics and corporate governance.

Likewise, the revenues of infrastructure firms can only create a unique form of exposure to the economy if the business model of infrastructure firms is not an easily replicable combination of the business models of other firms.

# 1. Introduction

We show that, as far as UK is concerned, over the past 15 years, infrastructure firms are indeed truly unique. We find that after controlling for size, leverage and profitability, as well as the impact of the investment "lifecycle", infrastructure firms exhibit lower revenue volatility and higher payout ratios (dividends to revenue) than any other group of private or public firms.

In other words, we find that infrastructure firms exhibit a truly unique business model compared to a large control group of public and private firms. We also report that the "contracted" type of infrastructure investments is so unique that it cannot successfully be matched to private non-infrastructure firms.

We also find that the equity payout behaviour of infrastructure firms is very different from that of other firms: infrastructure firms payout more often and significantly higher proportions of their revenues than other firms once the lifecycle of the firm is taken into account.

**We conclude that infrastructure firms have significantly lower volatility of revenues and profits and pay a much higher proportion of their revenues much more frequently to their owners, independent of the business cycle.**

Another significant result is that each of the three types of infrastructure firms that we define (according to a typology we first described in Blanc-Brude (2013)) corresponds to a unique business model as well i.e. albeit more alike amongst themselves then compared with the rest of the corporate universe, Contracted, Merchant and Regulated infrastructure firms have their own coherent cash flow dynamic.

The rest of this paper is structured thus: section 2 describes our dataset and control groups, including how data was collected and metrics calculated.

Section 3 analyses the characteristics of the revenue stream and profitability of infrastructure investments and the different control groups, their volatility and correlations with macro and market factors.

Next, section 4 models the dividend payout behaviour of infrastructure and non-infrastructure firms and explores differences in payout ratio dynamics.

Section 5 concludes and summarises our results.

# 2. Dataset and Control Group

# 2. Dataset and Control Group

In this section, we detail the process by which the infrastructure cash flow data used in this paper was collected and how the different control groups were built.

## 2.1 Infrastructure Dataset

The major issue limiting research in unlisted infrastructure assets has been data paucity. Previous studies have had to rely on data from third parties, without being able to check the accuracy of this data.

This study makes use of the EDHEC*infra* database: a collection of cashflow, investment and balance sheet data collected from infrastructure investors and creditors, as well as manually from individual firm's audited accounts. To date, the database covers more than 500 individual infrastructure assets over 10 different countries and a period of 15-20 years, making it the most comprehensive database of infrastructure cash flows available for research.

For this study, we focus on firms situated solely in the UK: firms identified as being either special purpose vehicle created in the context of the financing of a specific infrastructure project, or a firm conducting specific infrastructure-related activities (such as a port or an airport) or a regulated utility.

Thus, detailed accounts for each firm were obtained from infrastructure investors, lenders and/or from Companies House [4] and analysed individually in order to classify each firm into one of three groups: Contracted, Merchant and Regulated infrastructure, which we describe next.

*Contracted infrastructure firms* are not exposed to end user demand. In the United Kingdom, the Private Finance Initiative (PFI) is the prime example of such projects. Under the PFI scheme, infrastructure investors have delivered a broad range of infrastructure, including schools, hospitals and prisons. Such projects spring from a long-term contract for the provision of an infrastructure asset or service between the public sector and private entity (the firm), by which the public sector commits to paying a regular income to the firm as long as the relevant infrastructure services are delivered according to a pre-agreed specification.

*Merchant infrastructure firms* in comparison are exposed to some degree of market risk. Such infrastructure projects can have long-term contracts supporting their revenue in the form of a Power Purchase Agreement (PPA) or take-or-pay contract, but as such contracts may cover only part of the project's capacity or lifespan and the counter-party is typically not the Treasury. Other Merchant infrastructure firms are fully exposed to end user demand and market prices and include airports or toll roads.

Finally, *Regulated infrastructure firms* are typically natural monopolies involved in the provision of essential services, such as sewage treatment, water distribution or power transmission. In the United

4 - The UK Company Register

# 2. Dataset and Control Group

Kingdom, such companies are regulated by independent agencies such as Ofwat or Ofgem. [5]

5 - Blanc-Brude (see 2013, for a detailed discussion of these different infrastructure business models)

Table 1 describes our sample of 331 firms by sector and business model categories, 175 of which correspond to the Contracted category, 128 to Merchant infrastructure, and 28 to Regulated infrastructure. Cash flow and balance sheet items were collected and analysed manually from audited statements of accounts going back to the incorporation date of each firm, or as far as available accounts allows. The data span information from the early 1990s to 2015, as illustrated on figure 11.

We focus on UK data because they represent the largest, longest and most coherent set of infrastructure cash flow data available at this time, with the added advantage of corresponding to a single currency and regulatory environment, thus limiting the need to control for these dimensions in the analysis.

Starting from UK infrastructure firms, we can also build several control groups of non-infrastructure firms, with which to compare the data.

As the companies examined did not consistently provide cash flow statements, the cash flows from operations, investment and financing activities are estimated employing the 'indirect method'. This method employs changes in accrual accounts and operating profit to derive the cash flow from operations. Similar approaches were employed for the cash flows from investing and financing activities. Details on cash flow data collection and calculations are provided in the technical appendix (Section 6.1).

Whilst the application of the indirect method is straightforward, issues did arise when applying this estimation procedure. These included changes in accounting standards, annual reports with balance sheets not balancing, notes to financial accounts that did not reconcile to the face of the balance sheet and the inconsistent application of accounting standards across similar projects at the same time. When these and similar issues were encountered, judgement was applied to ensure that the resulting cash flow statements were consistent with an understanding of the underlying project's cash flows. To ensure consistency, the cash flows for all projects, even projects that provided a cash flow statement, were estimated in this way.

As a product of their development from the project finance industry, equity investors in private infrastructure projects often receive two cash flow streams. The first one, as with any other company, is dividends. The second one consists of the principal and interest payments of "shareholder loans" made to the infrastructure project company by the shareholders for tax reasons because shareholder loans generally benefit from corporate tax deductibility, if properly structured.

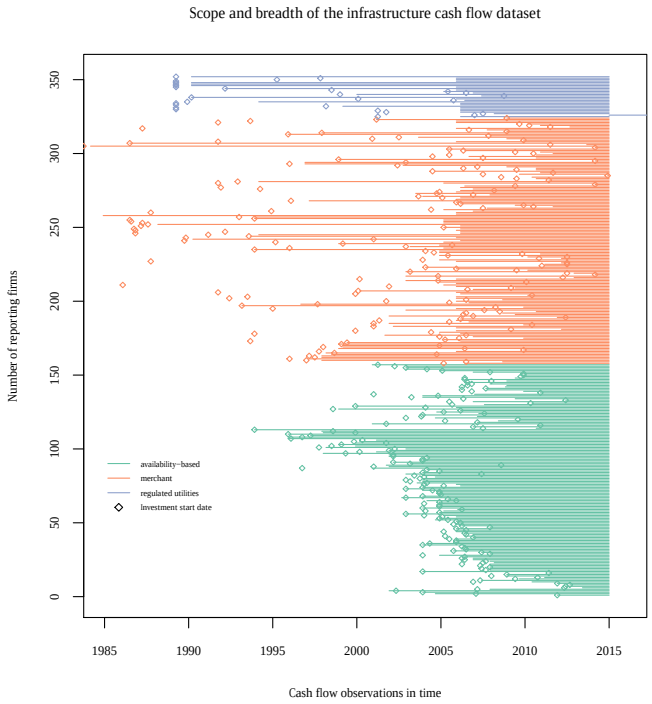
Shareholder loans are subordinated debt instruments that rank below the secured

# 2. Dataset and Control Group

*Table 1: Sample of UK infrastructure firms by sector and business model*

| | Contracted | Merchant | Regulated | Total |
|---|---|---|---|---|
| Energy | 1 | 70 | 17 | **88** |
| Environment | 16 | 1 | 10 | **27** |
| Social | 138 | 1 | – | **134** |
| Oil & Gas | – | 12 | 1 | **13** |
| Telecoms | 2 | 4 | – | **6** |
| Transport | 18 | 40 | – | **58** |
| **Total** | **175** | **128** | **28** | **331** |

*Figure 11: Number and time frame of reporting firms in the EDHECinfra database. Each line represents a time series of cash flow data.*




and mezzanine debt instruments provided by banks, bond holders or other debt investors. For investors, the equity capital raised by issuing shares is typically a nominal amount, with the bulk of the equity funds provided by shareholder loans.[6]

In our sample, shareholder loans generally pay a fixed rate of interest. Since shareholders receive both cash dividends and the principal and interest payments of shareholder loans, we compute the **equity payout** as the sum of the two.

Having estimated the cash flows of each firm in the sample, the variables of interest are:

- Equity payouts (dividends + shareholder loans principal and interest payments);
- Revenues;
- Gross profit.

## 2.2 Control Groups

To isolate the differences between public and private firms, we build two samples of

6 - In order to make distribution to equity holders, the infrastructure firm must ensure it is meeting its current senior and mezzanine debt covenants. As an example of the junior nature of the shareholder loans, in one company, Healthcare Support (Newcastle) Limited, shareholders repaid both a dividend and a principal and interest payment of shareholder loans. This was done at the request of the senior lenders as it was found to be paid in error.

# 2. Dataset and Control Group

comparable cash flow data of listed and unlisted UK firms.

To control for the impact of ownership structure and corporate governance on dividend payout behaviour, we further split the private firm control group between "concentrated" and "dispersed" ownership firms.

Our initial control sample focused on all United Kingdom companies that were either private limited or publicly listed. Following Michaely and Roberts (2012), we exclude assurance companies, guarantees, limited liability partnerships, public investment trusts, and "other" company types. To remove the possibility of obtaining abridged accounts, we select firms that satisfy at least two of the three following conditions: 1/ revenues are greater than £1.4 million, 2/ the number of employees are greater than 50, and 3/ the book value of total assets is greater than £1.4 million.[7] Furthermore, also consistent with Michaely and Roberts (2012), we only select group company accounts to reduce any bias as a result of inter-company transactions. As a final filter, to ensure our study is consistent with other studies of payout behaviour, we remove financial, agricultural and public sector firms.[8]

Applying these filters to UK Companies House data resulted in a 10-year sample of 11,616 unlisted and 1,117 listed firms with 85,837 and 8,896 firm-year observations, respectively, for which the same data is collected than for our infrastructure sample.[9] Private firms are split between "contracted" or "dispersed" if they have less or more than 25 shareholders (see Michaely and Roberts, 2012).

## 2.3 Matched Samples

### 2.3.1 Methodology

While the use of three control groups of non-infrastructure firms helps account for differences in the behaviour of firms as a consequence of their being public or private with concentred or dispersed ownership, further controls are required to account for firm-level characteristics that may also correspond to different risk profiles and dividend payout behaviours.

Hence, using each control group, we create three "matched samples" of non-infrastructure firms for each category of infrastructure firms identified above. 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 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).

7 - The United Kingdom's Companies Act 2006 requires the submission of audited company accounts every year for any limited liability company. Accounts provided to Companies House contain varying levels of detail. Section 444 of the Companies Act 2006 allows a small companies to lodge abridged versions of accounts, comprising just the balance sheet. Companies that are not classified as small, are required to lodge more substantive financial statements. For the purposes of this paper the small company accounts are excluded from analysis.

8 - The firms are identified by U.S. Standard Industrial Classification [SIC] codes. Financial firms possess a code between 6,000 and 6,999, agricultural firms possess a U.S. SIC codes less than 1,000 and public sector firms possess an U.S. SIC codes greater than 8,999.

9 - This data is extracted using the FAME database which compiles audited account data from the UK's Companies House.

# 2. Dataset and Control Group

Large control groups are also well-suited for such matched sampling (see Michaely and Roberts, 2012; James J. Heckman, 1997, for a discussion of matching firms).

The matching of firm-year observations is done using those firm characteristics that can be expected to explain or signal differences in underlying business models and dividend payout behaviour: size, leverage and profitability [10]

10 - Michaely and Roberts (2012) use firm size, profitability, leverage, investment opportunities and industry, but the latter two are, respectively, irrelevant or mostly redundant in the case of studying infrastructure vs. non-infrastructure firms.

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

$$InfraDummy_{i,t} = \beta_0 + \beta_1 Log(Assets)_{i,t} + \beta_2 Leverage_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Age_{i,t}$$

where,

- $InfraDummy_{i,t}$ is a dummy variable indicating whether the firm is an infrastructure firm or not;
- $Assets_{i,t}$ is total assets;
- $Leverage_{i,t}$ is defined as the sum of short-term and long-term debt divided by the sum of short-term and long-term debt and total equity;
- $Profitability_{i,t}$ is defined as the ratio of gross profits over total assets;
- $Age_{i,t}$ is the number of years since the firm was created, computed as the difference between incorporation date and observation date for the control group and the difference between financial close or investment date and the observation date for the infrastructure test data. [11]

11 - It is a common occurrence for the project company to be a "shelf" company that was created years before the project was tendered, hence for infrastructure investments we use the date of financial close as

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).

Hence, matching the control data (non-infrastructure firms) to the test data (infrastructure firms) consists of dropping those firms in the control groups that are "less like" the firms in the test groups (infrastructure) as far as the four variables in equation **??** are concerned, and this to keep only those control firms for which these factors are not likely to explain differences in outcome (e.g. payout ratios) between infrastructure and non-infrastructure firms.

The result is a matrix of matched unique firm identifiers represented by each firm's Company registration number at Companies House, thus ensuring that control groups are uniquely defined relative to the test data.

### 2.3.2 Matching Results

Tables 23 to 31 in the appendix (Section 7) report the coefficients for the *probit* regressions both pre- and post-match. If a test group of infrastructure firms is well-matched to a control group of non-infrastructure firms, the results of the regressions post-matching should be largely *insignificant* compared to the same results applied to the control group data before matching.

# 2. Dataset and Control Group

*Contracted infrastructure*

Most of the firms in the contracted infrastructure category of our UK sample are PFI projects. These special purpose companies created solely to deliver a public infrastructure project in exchange for a pre-agreed, RPI-linked revenue stream underwritten by the public sector prove difficult to match with other types of public or private firms in the UK.

Private concentrated firms offer a reasonable but incomplete match. In effect, it is difficult to find non-infrastructure firms that have such high leverage. Figure 12, shows the test and control data along three axes (size, leverage, profitability) before and after matching, illustrates (also see table 23 in appendix 7).

Beyond private concentrated firms, matching firm-year observations by propensity scores for private dispersed firms and public firms does not create a more homogenous group of firms as also shown on figure 12 and as tables 24 and 25 in section 7 confirm. All variables of the regression model continue to be significant (p-values close to zero) and the post-match pseudo R-square fairly high. In other words, even the "nearest neighbour" data does not match the characteristics of contracted infrastructure firms very well.

The results suggest that UK contracted infrastructure firms represent a unique form of corporate structure.

*Merchant Infrastructure*

Matching merchant infrastructure to a control group of private and public firms is more successful. As shown in tables 26, 27 and 28 in the appendix, pseudo R-square values drop to almost zero for the three control groups whilst the statistical significance and size of the coefficients in the post-match regressions disappears as well.

Pre- and post-match *probit* regression results show that after propensity score matching, we have three valid control groups of non-infrastructure firms for merchant infrastructure. Again, private concentrated ownership is the best match, with all significance of the control variables disappearing between the test and the control data. Even after matching however, merchant infrastructure retains some difference with private dispersed firms in terms of profitability and with public firms in terms of leverage and profitability.

*Regulated Infrastructure*

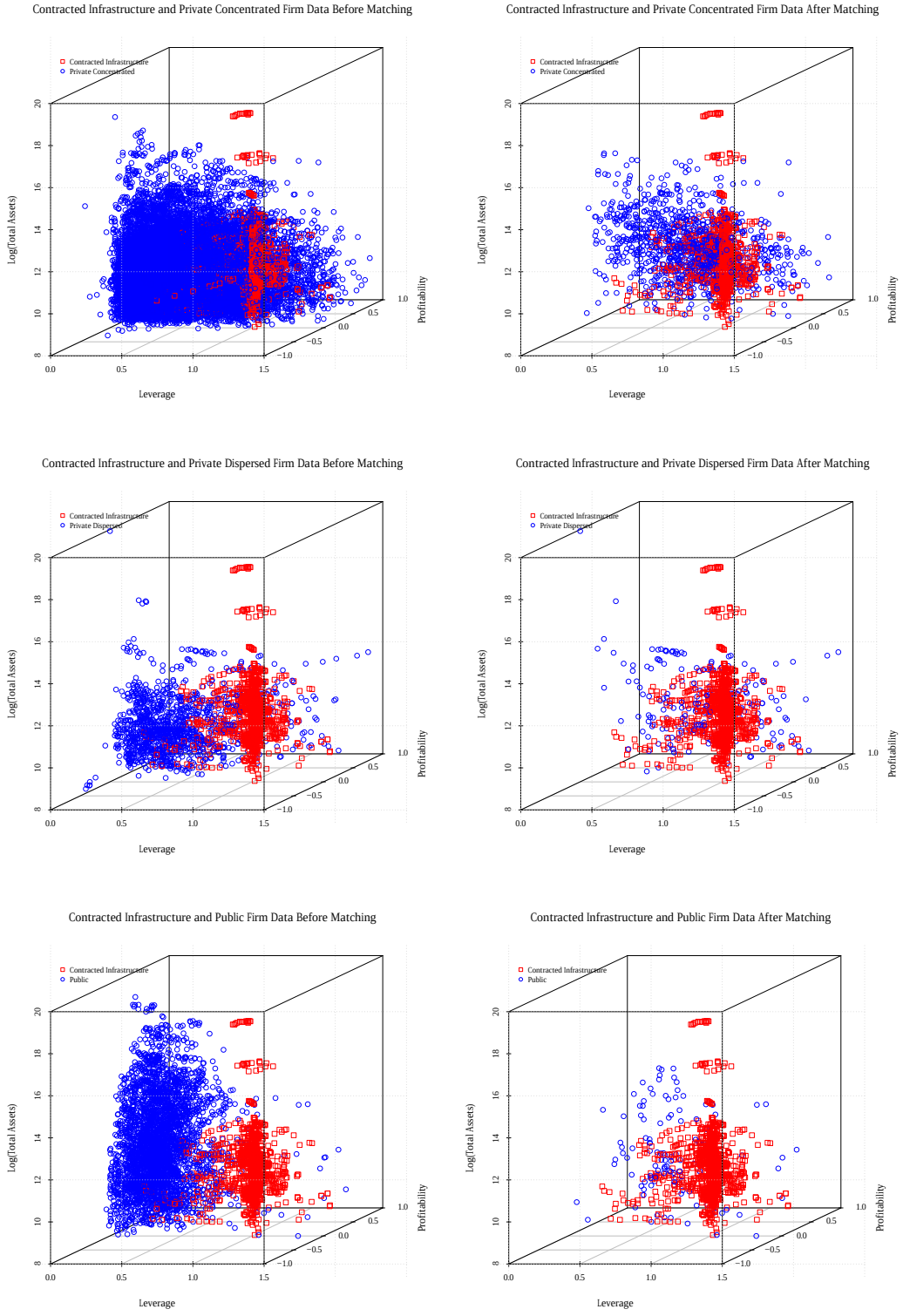
Likewise, when matching the test data for regulated infrastructure, post-match pseudo R-square values are reduced to near zero, and *probit* regression model coefficients are reduced, as well as their statistical significance.

Figure 14 shows the pre- and post-match control data for regulated infrastructure. Tables 29, 30 and 31 in the appendix show the *probit* regression results.

As above, regulated infrastructure firms are best matched with control group of private

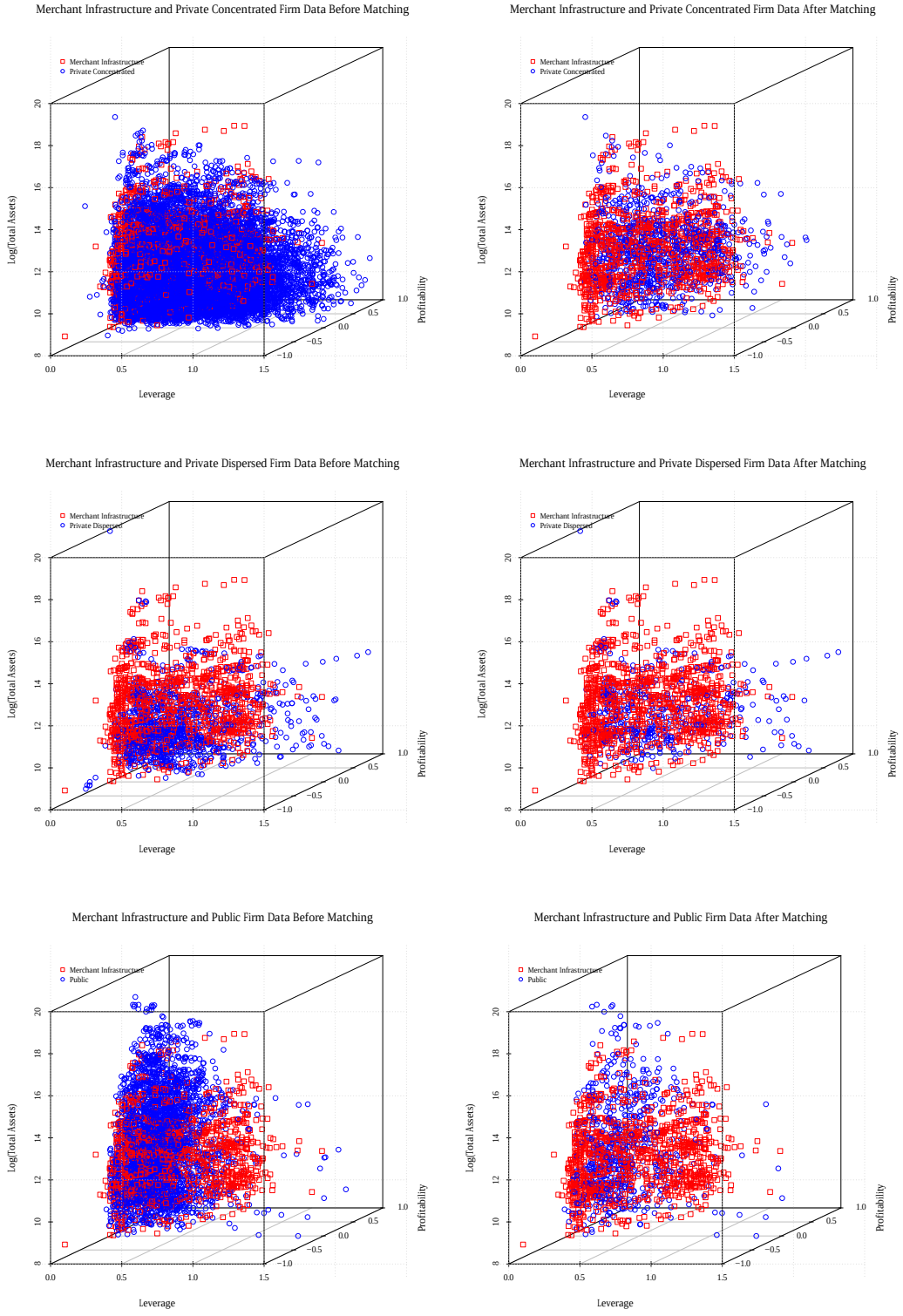
# 2. Dataset and Control Group

*Figure 12: Pre- and post-matching test and control groups for contracted infrastructure firms*



# 2. Dataset and Control Group

*Figure 13: Pre- and post-matching test and control groups for merchant infrastructure firms*



# 2. Dataset and Control Group

concentrated firms, but they retain statistically significant differences with their private dispersed and public firms control groups only in terms of leverage and size, respectively. Overall, the pseudo R-square of the *probit* regressions suggest that matching has greatly improved the robustness of the control groups insofar as differences in size, leverage or profitability cannot be expected to explain any differences of revenue risk profile or dividend payout behaviour that may exist between the test infrastructure data and the control data.

## 2.4 Conclusions

In conclusion, we have built a unique test dataset of UK infrastructure firms spanning at least 15 years, categorising the data between three "infrastructure business models": contracted, merchant and regulated. To our knowledge, this is the largest sample of such data available for research to date.

We have also applied a robust methodology to build multiple control groups to estimate the characteristics of the test infrastructure data. Our approach is two-tiered: first, we differentiate between three types of ownership structures (private concentrated, private dispersed and public) since ownership structure can be expected to influence the dividend payout behaviour that we aim to study.

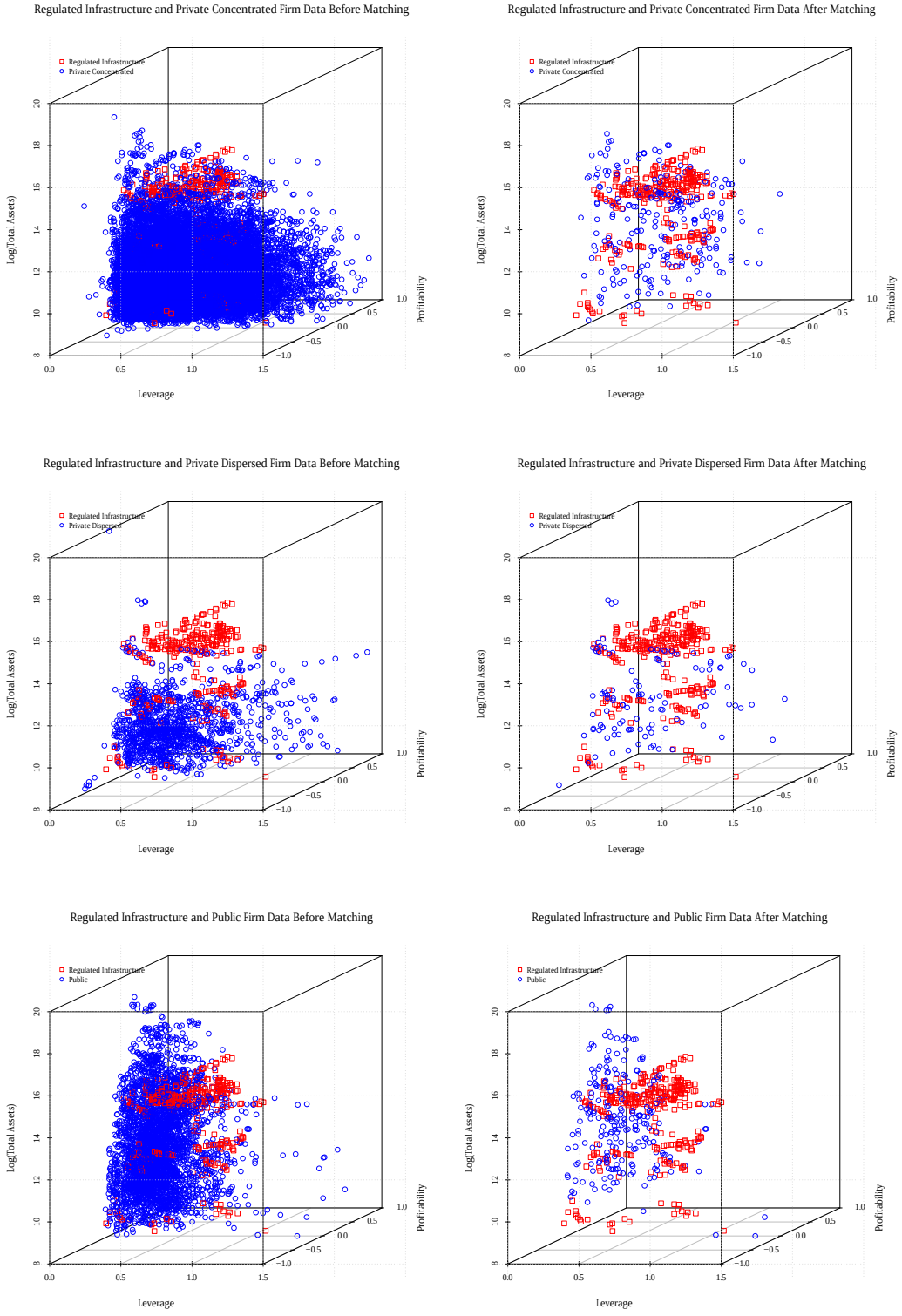
Next, using propensity scores, we build control groups that are *as alike as possible* to each of the test infrastructure firms in terms of size, leverage and profitability. We repeat this for each of the three infrastructure "business models" identified (Contracted, Merchant and Regulated).

We find, perhaps unsurprisingly, private infrastructure firms are best matched to a control group of private firms with concentrated ownership. In the case of Contracted infrastructure, which corresponds mostly to the so-called PFI projects, we cannot create a well-matched control using a control group of private concentrated firms and even less so using private firms with dispersed ownership or public firms. This finding has its own significance, insofar as it signals that UK Contracted infrastructure can be considered to correspond to a unique kind of firm in itself.

Next, having built the control groups required for each of our three categories of infrastructure test data, we analyse the differences between each group with respect to their revenues (scaled by asset size) in the next chapter, and with respect to their equity payout ratios in chapter 4.

# 2. Dataset and Control Group

*Figure 14: Pre- and post-matching test and control groups for regulated infrastructure firms*



# 3. A Distinctive Infrastructure Business Model

# 3. A Distinctive Infrastructure Business Model

In this chapter, we examine the evidence supporting the hypothesis that infrastructure firms correspond to a different business model than other firms. To do so, we analyse the revenue and profit characteristics of our three test samples of infrastructure firms, along with each control group of matched private and public firms described in the previous chapter.

Our dataset allows an examination of the data in time using two different perspectives: "investment years" and "calendar years", where investment years refer to the number of periods elapsed since the firm was created or the investment started. Hence, as well as controlling for ownership structure and firm characteristics, as discussed in chapter 2, we can observe and take into account the effect of its "investment lifecycle" on the average firm.

Infrastructure firms, notably, can have a very dynamic lifecycle, as they transform from a greenfield construction project into a mature activity. But, other firms are also likely to exhibit a degree of change in time from the date of their creation, especially in terms of their ability to generate revenues and profits, as well as their payout behaviour. Hence, in what follows, we examine and analyse our data using both investment and calendar time perspectives.

We first provide some descriptive statistics in section 3.1. Section 3.2 outlines the results of several regression models of revenues and profits as a function of time, macroeconomic and market factors.

## 3.1 Descriptive Statistics

### 3.1.1 Revenues and Profits Metrics

To compare the revenues and profits of infrastructure and non-infrastructure firms, we simply standardise the data by dividing revenues and gross profits by total assets.

Gross profits provide an indirect measure of the firm's revenue stream [12] and allows measuring the joint effects of revenues and expenses.

Indeed, in the early years of certain types of infrastructure firms (e.g. PFI projects), construction costs and revenues are recognised as they are incurred. Using the gross profit measure removes the gross up effect of these revenues and costs. The effect of the gross up is noise in the data, which is driven by the accounting treatment of certain expenses during the construction years, and does not reflect the underlying reality of the revenues and profits of infrastructure firms.

Total assets is the sum of the book value of equity and debt in each period, thus ensuring consistency when comparing metrics across different types of firms.

While dividing revenues and profits by total assets allows comparing firms with each other, both numerator and denominator can change over time and can make the ratio of contemporaneous values difficult

12 - Gross profits = Revenues − Operating Cost + Finance Interest Revenue

# 3. A Distinctive Infrastructure Business Model

to interpret if covariance is not taken into account. Table 2 describes the correlation between contemporaneous revenues, profits and total asset values for each one of our test and control datasets.

The reported correlations vary considerably between different types of infrastructure and the control groups. We note that contracted infrastructure exhibits the lowest correlations and that the correlation between asset values and revenues is close to zero and negative (asset value, that is, the outstanding contracted income to receive, decrease continuously during the project's life, while revenues are constant).

Merchant infrastructure exhibits a higher correlation between revenues and asset values but one that is still noticeably lower than that of the control groups shown in the three right-hand side columns.

Finally, Regulated infrastructure is found to have a much higher correlation of its revenue stream with total assets, which is to be expected in the UK context: the regulatory asset base (RAB) is the main point of reference for setting tariffs.

Table 2 thus suggests a marked difference of business model between each test infrastructure group and their control groups.

Given the sometimes high and varying level of correlation between revenues, profits and total assets in the data, we choose to standardise the data by dividing revenues and profits by "average total assets" i.e. the arithmetic average of total assets during the relevant reporting period. Hence, any variability observed in these **unit revenues** or **unit profits** can readily be interpreted as the volatility of the numerator.

Next, tables 3, 4 and 5 provide detailed descriptive statistics for revenues over average assets for each test and matched control group of firms. It is clear from the casual observation of these results that the three test samples of infrastructure firms have a very different unit revenue profile compared to their matched control groups.

Both mean and median revenues are significantly lower for infrastructure firms compared to private and public firms. Table 9 shows that the mean (median) revenue per dollar of average asset is 30 (14) cents in Contracted infrastructure, when firms with similar characteristics (size, leverage and profitability) report between 90 and 100 (62 and 69) cents per dollar of average total assets.

In the case of Merchant infrastructure, average revenues per dollar invested are about 3 times lower than in the control groups, while they are 2 to 5 times lower for regulated infrastructure.

This reflects the capital intensive (long-term) nature of infrastructure investments.

Importantly, the standard deviation of unit revenues is also significantly lower in the case of infrastructure firms.

# 3. A Distinctive Infrastructure Business Model

*Table 2: Correlation coefficients of revenues and profits with contemporaneous asset (book) values for different types of firms.*

| | Contracted | Merchant | Regulated | Private Conc. | Private Disp. | Public |
|---|---|---|---|---|---|---|
| Revenue | -4.371 | 36.813 | 87.745** | 52.516 | 58.183 | 60.592 |
| Profit | 20.069 | 29.187 | 71.514* | 45.590 | 49.456 | 54.746 |

* significant at the 10% level, ** significant at the 5% level

The volatility of contracted infrastructure revenues is almost half of that of its 3 control groups. In the case of merchant infrastructure, the revenue volatility is more than 2 to 3 times lower as that of the control groups, and in the case of regulated infrastructure, it is between 5 and 14 times lower.

Likewise, tables 6, 7 and 8 show the aggregate descriptive statistics for unit profits. A similar picture emerges: infrastructure firms have unit profits that are 3 times lower than the matched control firms in the case of Contracted infrastructure, and 2 to 3 times lower in the case of Merchant infrastructure. In the case of Regulated infrastructure, unit revenues are similar or higher than for the control groups.

The volatility of profits is also very different in infrastructure firms: around 5 times lower in contracted infrastructure, and two to three times lower in merchant and regulated infrastructure.

Similar observations can be made in figures 15 and 16, which show the densities of unit revenue and profit metrics for contracted infrastructure and matched firms with concentrated ownership as an illustration. Both types of firms clearly have very different revenue and profit profile (here in calendar time).

13 - The accounting treatment of PFI construction costs mentioned above is also visible in table 9: revenues first decrease during the first years corresponding to the construction period.

### 3.1.2 Revenue and Profit Dynamics

Next, we examine the same data as in each time period available in the sample, both *investment time* and *calendar time*.

*Contracted infrastructure*

Tables 9 and 10 show the number of firm-year observations, the 5% quantile, the median ($0.5^{th}$ quantile) and standard deviation of each metric in contracted infrastructure firms, compared to their relevant control groups in investment time. The effect of the infrastructure lifecycle is clearly visible: Contracted infrastructure firms see their revenues and profits increase over time. [13] Control groups do not exhibit such a dynamic lifecycle effect (we test the statistical significance of lifecycle effects in the next section).

As was the case with the aggregate statistics shown in table 3 to 8, revenue and profit volatility are significantly lower for infrastructure firms even though they tend to increase with investment time

Tables 11 and 12 show the same data in calendar time. Because our dataset contains contracted projects that start in later parts of the sample's history, scaled revenues show a decrease in calendar time (as more newer projects are added to the sample) and its volatility shows a corresponding increase. This highlights the importance

# 3. A Distinctive Infrastructure Business Model

*Table 3: Descriptive statistics of revenues scaled by average assets for the full sample of **contracted infrastructure** test data and the relevant control data, percentage.*

| | Contracted infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 170.000 | 848.000 | 110.000 | 104.000 |
| No of firm-year obs | 1,596.000 | 1,283.000 | 254.000 | 167.000 |
| 2.5th Quantile | 1.555 | 2.829 | 6.933 | 3.568 |
| 25th Quantile | 6.927 | 28.663 | 42.513 | 29.316 |
| 50th Quantile | 14.878 | 62.707 | 69.631 | 63.541 |
| 75th Quantile | 32.867 | 130.342 | 122.986 | 115.686 |
| 97.5th Quantile | 121.754 | 390.134 | 378.853 | 363.437 |
| Mean | 29.269 | 98.210 | 100.996 | 90.370 |
| Std Deviation | 52.772 | 107.219 | 107.630 | 100.702 |
| Skewness | 8.055 | 2.660 | 3.790 | 2.829 |
| Kurtosis | 95.307 | 15.709 | 26.336 | 14.038 |

*Table 4: Descriptive statistics of revenues scaled by average assets for the full sample of **merchant infrastructure** test data and the relevant control data, percentage.*

| | Merchant infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 125.000 | 829.000 | 215.000 | 400.000 |
| No of firm-year obs | 1,129.000 | 1,027.000 | 511.000 | 753.000 |
| 2.5th Quantile | 0.920 | 3.654 | 9.422 | 3.816 |
| 25th Quantile | 15.017 | 40.218 | 52.149 | 38.592 |
| 50th Quantile | 25.309 | 103.729 | 98.986 | 78.762 |
| 75th Quantile | 46.731 | 189.234 | 178.069 | 135.027 |
| 97.5th Quantile | 175.184 | 501.324 | 507.506 | 395.958 |
| Mean | 40.207 | 143.157 | 144.434 | 106.715 |
| Std Deviation | 54.036 | 154.624 | 177.829 | 105.998 |
| Skewness | 5.200 | 3.165 | 5.584 | 2.799 |
| Kurtosis | 41.953 | 20.367 | 53.508 | 14.406 |

*Table 5: Descriptive statistics of revenues scaled by average assets for the full sample of **regulated infrastructure** test data and the matched control data, percentage.*

| | Regulated infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 27.000 | 171.000 | 72.000 | 133.000 |
| No of firm-year obs | 325.000 | 246.000 | 115.000 | 240.000 |
| 2.5th Quantile | 6.212 | 2.640 | 3.506 | 1.451 |
| 25th Quantile | 15.533 | 11.585 | 27.756 | 13.379 |
| 50th Quantile | 20.207 | 42.206 | 60.062 | 38.847 |
| 75th Quantile | 26.849 | 122.797 | 103.093 | 75.138 |
| 97.5th Quantile | 51.112 | 318.722 | 788.844 | 203.375 |
| Mean | 22.810 | 80.123 | 107.253 | 56.711 |
| Std Deviation | 13.990 | 91.028 | 182.498 | 58.554 |
| Skewness | 5.010 | 1.555 | 3.910 | 1.954 |
| Kurtosis | 49.478 | 5.212 | 18.738 | 8.186 |

*Table 6: Descriptive statistics of profits scaled by average assets for the full sample of **contracted infrastructure** test data and the relevant control data, percentage.*

| | Contracted infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 170.000 | 848.000 | 110.000 | 104.000 |
| No of firm-year obs | 1,596.000 | 1,283.000 | 254.000 | 167.000 |
| 2.5th Quantile | −0.048 | −0.231 | 2.021 | −8.400 |
| 25th Quantile | 6.129 | 8.712 | 15.291 | 8.476 |
| 50th Quantile | 7.694 | 19.794 | 26.860 | 22.543 |
| 75th Quantile | 9.663 | 36.269 | 45.737 | 42.403 |
| 97.5th Quantile | 28.424 | 113.717 | 165.977 | 119.365 |
| Mean | 8.966 | 29.420 | 38.743 | 34.477 |
| Std Deviation | 6.824 | 34.360 | 39.496 | 33.112 |
| Skewness | 3.824 | 4.130 | 2.688 | 1.589 |
| Kurtosis | 24.444 | 29.924 | 12.049 | 5.188 |

# 3. A Distinctive Infrastructure Business Model

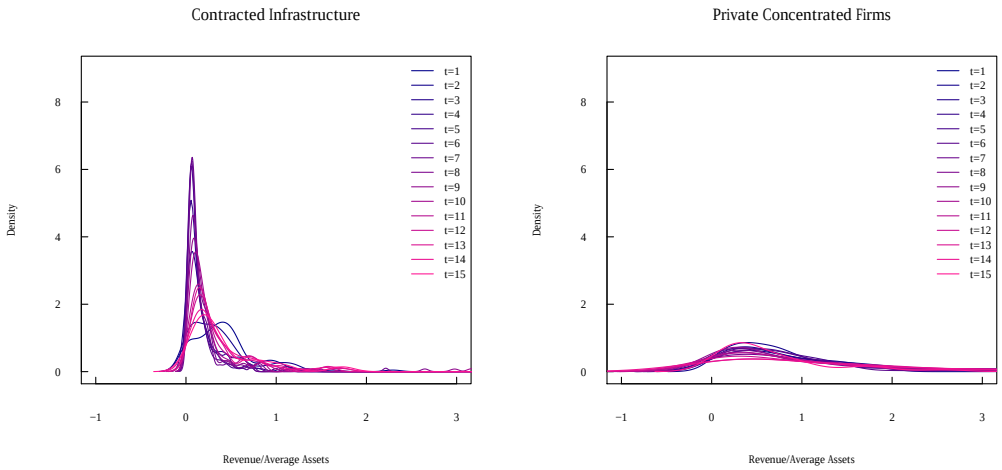
*Table 7: Descriptive statistics of profits scaled by average assets for the full sample of* ***merchant infrastructure*** *test data and the relevant control data, percentage.*

| | Merchant infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 125.000 | 829.000 | 215.000 | 400.000 |
| No of firm-year obs | 1,129.000 | 1,027.000 | 511.000 | 753.000 |
| 2.5th Quantile | −17.359 | 0.035 | 2.871 | −4.605 |
| 25th Quantile | 5.415 | 11.584 | 18.118 | 11.525 |
| 50th Quantile | 11.624 | 24.079 | 31.694 | 27.060 |
| 75th Quantile | 19.262 | 44.728 | 54.015 | 48.501 |
| 97.5th Quantile | 44.726 | 121.149 | 166.141 | 124.086 |
| Mean | 15.465 | 33.638 | 45.922 | 36.554 |
| Std Deviation | 14.309 | 36.248 | 62.258 | 32.161 |
| Skewness | 5.408 | 4.720 | 7.469 | 1.887 |
| Kurtosis | 57.663 | 50.020 | 86.179 | 8.100 |

*Table 8: Descriptive statistics of profits scaled by average assets for the full sample of* ***regulated infrastructure*** *test data and the matched control data, percentage.*

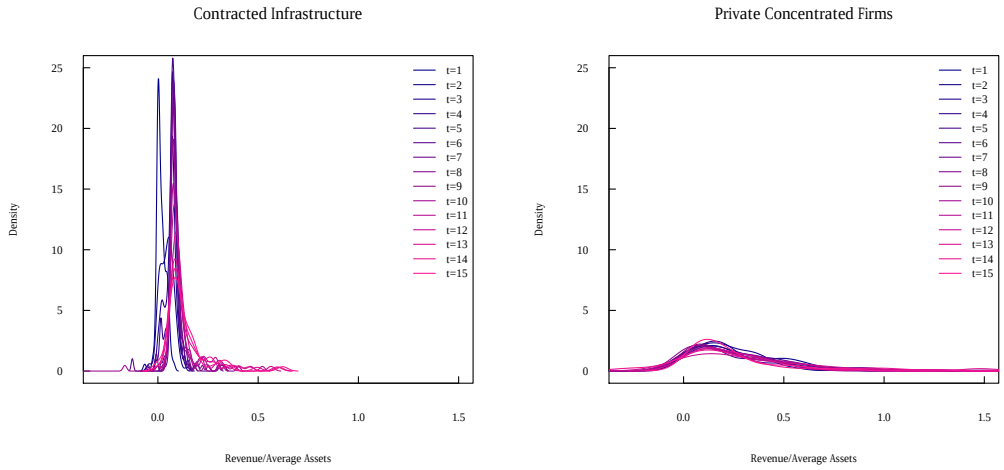
| | Regulated infra. | Private concent. | Private dispersed | Public firms |
|---|---|---|---|---|
| No of firms | 27.000 | 171.000 | 72.000 | 133.000 |
| No of firm-year obs | 325.000 | 246.000 | 115.000 | 240.000 |
| 2.5th Quantile | −7.155 | −10.466 | −6.729 | −9.723 |
| 25th Quantile | 9.128 | 4.309 | 6.105 | 3.250 |
| 50th Quantile | 12.013 | 8.666 | 13.072 | 9.743 |
| 75th Quantile | 15.593 | 19.159 | 22.126 | 17.507 |
| 97.5th Quantile | 25.869 | 47.737 | 49.795 | 37.145 |
| Mean | 13.046 | 14.222 | 17.291 | 13.930 |
| Std Deviation | 5.108 | 12.909 | 14.129 | 11.275 |
| Skewness | 1.167 | 1.452 | 1.701 | 1.439 |
| Kurtosis | 5.602 | 5.179 | 6.855 | 6.165 |

*Figure 15: Density plots of the unit revenues in investment time for* ***contracted infrastructure*** *and matched private firms with concentrated ownership*



# 3. A Distinctive Infrastructure Business Model

*Figure 16: Density plots of the unit profits in investment time for* ***contracted infrastructure*** *and matched private firms with concentrated ownership*




of controlling for the investment lifecycle (as well as the regulatory cycle) when examining infrastructure investment data in calendar time.

Contrary to other types of firms, infrastructure firms are more heterogeneously distributed in space and time and only certain types of infrastructure investments at a certain point in their lifecycle may be observable at each point in calendar time.

As before, contracted infrastructure exhibits a lower average and volatility of revenues and profits compared to other firms.

*Merchant infrastructure*

Turning to tables 13 and 14, the lifecycle effect of infrastructure investment, including its impact on volatility seems very clear. Scaled revenues and profits increase markedly during the life of the investment and volatility tends to decrease. As for contracted infrastructure, there is a difference of an order of magnitude between the average revenues and profits per dollar of infrastructure and non-infrastructure firms. Likewise for observed levels of volatility.

Tables 15 and 16, which show the same data in calendar time, reveal that revenues and profits are quite stable across the business cycle for both infrastructure, which is in line with the hypothesis that that infrastructure businesses are more immune to the business cycle than others.

Looking at our matched control groups, these firm are not equally resilient to well documented downturns in the economic cycle (the 2008 and 2011 downturns) which correspond to spikes in revenue volatility in the control groups, despite the fact that these firms have similar characteristics than the merchant infrastructure sample: leverage, size and profitability have been matched to the nearest neighbour and an exact match was obtained for investment years (matched firm data must be of the

# 3. A Distinctive Infrastructure Business Model

*Table 9: Descriptive statistics of* ***revenues scaled by average assets*** *for the full sample of* ***contracted infrastructure*** *test data and the matched control data*

| | Contracted | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 93 | 0.077 | 37.547 | 36.544 | 178 | 0.096 | 63.558 | 80.747 |
| 2 | 110 | 0.058 | 29.618 | 56.037 | 135 | 0.873 | 69.347 | 87.022 |
| 3 | 130 | 0.693 | 11.179 | 61.216 | 138 | 0.687 | 65.928 | 87.666 |
| 4 | 133 | 1.003 | 8.782 | 76.816 | 127 | 0.899 | 57.543 | 79.231 |
| 5 | 132 | 1.895 | 8.209 | 59.099 | 116 | 2.533 | 75.104 | 96.788 |
| 6 | 135 | 1.427 | 8.456 | 58.991 | 87 | 2.706 | 80.159 | 114.140 |
| 7 | 131 | 2.175 | 9.500 | 25.509 | 72 | 1.881 | 80.956 | 83.922 |
| 8 | 123 | 2.628 | 11.526 | 32.305 | 59 | 2.527 | 65.982 | 143.622 |
| 9 | 108 | 3.134 | 13.615 | 37.149 | 44 | 1.143 | 47.206 | 113.897 |
| 10 | 92 | 3.971 | 15.091 | 40.029 | 42 | 0.587 | 46.238 | 147.048 |
| 11 | 82 | 4.535 | 18.928 | 47.407 | 32 | 0.496 | 99.290 | 254.407 |
| 12 | 63 | 5.288 | 22.068 | 54.101 | 19 | 5.672 | 49.549 | 100.163 |
| 13 | 57 | 5.297 | 19.507 | 54.772 | 24 | 2.943 | 43.150 | 135.182 |
| 14 | 50 | 6.749 | 24.997 | 70.469 | 19 | 2.532 | 37.102 | 135.118 |
| 15 | 43 | 3.653 | 26.732 | 76.111 | 13 | 5.978 | 28.575 | 40.909 |
| 16 | 26 | 8.573 | 28.222 | 37.803 | 13 | 6.039 | 56.353 | 57.049 |
| 17 | 15 | 12.822 | 34.710 | 33.528 | 13 | 3.313 | 127.459 | 186.514 |
| 18 | 8 | 13.396 | 38.506 | 48.834 | 7 | 3.667 | 35.818 | 103.775 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 33 | 10.416 | 61.266 | 80.748 | 16 | 2.982 | 63.408 | 141.219 |
| 2 | 37 | 15.105 | 64.632 | 61.166 | 14 | 6.878 | 58.051 | 189.181 |
| 3 | 27 | 35.108 | 74.517 | 186.577 | 12 | 3.858 | 48.792 | 77.062 |
| 4 | 28 | 4.048 | 79.296 | 103.479 | 15 | 8.070 | 59.937 | 57.868 |
| 5 | 15 | 25.061 | 99.082 | 70.610 | 15 | 6.951 | 82.418 | 94.528 |
| 6 | 17 | 29.437 | 83.833 | 77.073 | 11 | 0.432 | 40.260 | 132.523 |
| 7 | 16 | 14.590 | 103.351 | 139.581 | 12 | 0.970 | 42.395 | 67.192 |
| 8 | 10 | 0.294 | 62.606 | 86.706 | 8 | 13.387 | 79.991 | 47.876 |
| 9 | 8 | 13.509 | 57.155 | 95.852 | 4 | 26.232 | 55.464 | 45.028 |
| 10 | 4 | 48.079 | 224.523 | 188.271 | 9 | 30.100 | 61.025 | 59.675 |
| 11 | 7 | 49.883 | 105.741 | 79.599 | 6 | 14.909 | 75.264 | 72.923 |
| 12 | 5 | 37.167 | 126.500 | 44.443 | 5 | 77.320 | 228.995 | 103.645 |
| 13 | 2 | 77.931 | 78.939 | 1.440 | 6 | 9.676 | 110.843 | 72.966 |
| 14 | 5 | 18.495 | 133.915 | 199.992 | 4 | 7.507 | 137.762 | 104.497 |
| 15 | 2 | 146.758 | 208.107 | 87.637 | 2 | 70.525 | 95.097 | 35.101 |
| 16 | 1 | 195.945 | 195.945 | – | 1 | 8.248 | 8.248 | – |
| 17 | 1 | 58.480 | 58.480 | – | 3 | 37.184 | 155.535 | 141.473 |
| 18 | 1 | 24.692 | 24.692 | – | 1 | 103.340 | 103.340 | – |

exact same vintage as the infrastructure firm data).

Looking at figure 17, which plots the unit revenues and profits of merchant infrastructure firms and matched non-infrastructure private firms (concentrated ownership): it appears that firms of that kind have been much more affected by the business cycle than merchant infrastructure firms, despite the fact these are much more exposed to commercial risks than contracted infrastructure firms.

Figure 18 shows a similar picture for regulated infrastructure.

*Regulated infrastructure*

Finally, tables 17 and 18 show the descriptive statistics for regulated infrastructure and the corresponding matched public and private firms. The lifecycle effect is again clearly visible as revenues increase

# 3. A Distinctive Infrastructure Business Model

*Figure 17: Revenue and profit-to-average asset ratio in calendar time for* ***merchant infrastructure*** *test data and matched private firms with concentrated ownership control data*

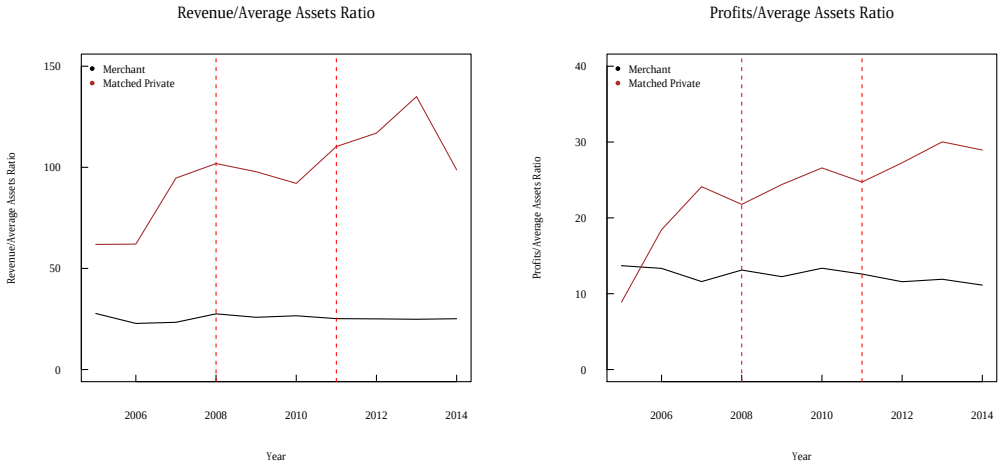
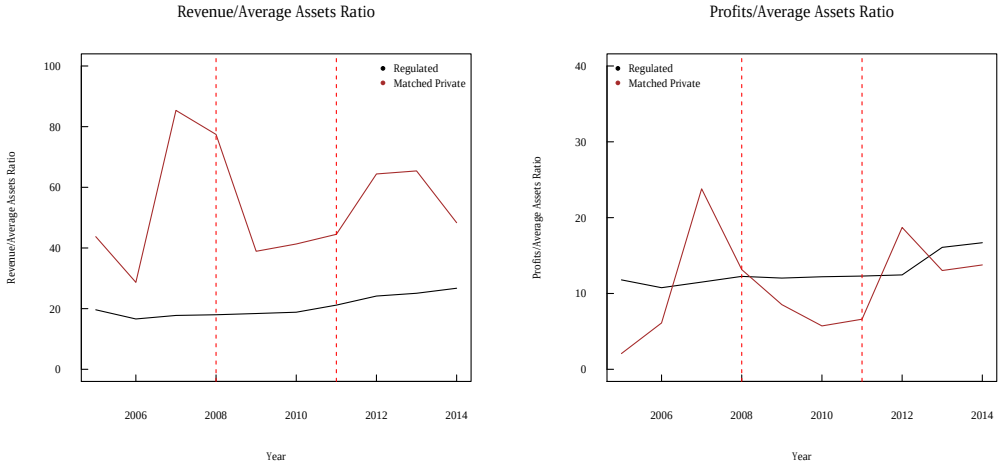



*Figure 18: Revenue and profit-to-average asset ratio in calendar time for* ***regulated infrastructure*** *test data and matched private firms with concentrated ownership control data*



# 3. A Distinctive Infrastructure Business Model

*Table 10: Descriptive statistics of **profits scaled by average assets** for the full sample of **contracted infrastructure** test data and the matched control data, in project year.*

| | Contracted | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 93 | −4.617 | 0.954 | 1.941 | 178 | −7.102 | 21.383 | 23.142 |
| 2 | 110 | −4.340 | 4.755 | 2.947 | 135 | −6.061 | 21.597 | 21.701 |
| 3 | 130 | −2.146 | 6.806 | 2.682 | 138 | −10.239 | 21.768 | 28.119 |
| 4 | 133 | −1.114 | 7.359 | 2.673 | 127 | −12.373 | 18.721 | 23.730 |
| 5 | 132 | 2.238 | 7.763 | 1.954 | 116 | −15.944 | 23.175 | 25.340 |
| 6 | 135 | −12.761 | 8.129 | 2.050 | 87 | −1.335 | 25.772 | 42.722 |
| 7 | 131 | −0.789 | 8.110 | 3.058 | 72 | −47.759 | 24.223 | 49.850 |
| 8 | 123 | 0.411 | 8.140 | 4.259 | 59 | 0.075 | 16.777 | 22.954 |
| 9 | 108 | 4.854 | 8.276 | 5.402 | 44 | 0.008 | 18.894 | 34.251 |
| 10 | 92 | −49.932 | 8.696 | 4.788 | 42 | −43.349 | 16.148 | 43.627 |
| 11 | 82 | 1.273 | 9.282 | 8.197 | 32 | −32.381 | 17.305 | 58.542 |
| 12 | 63 | 1.279 | 9.828 | 10.217 | 19 | 2.611 | 14.441 | 30.318 |
| 13 | 57 | 1.103 | 9.415 | 10.591 | 24 | −68.435 | 8.965 | 72.961 |
| 14 | 50 | 1.036 | 9.979 | 10.911 | 19 | 1.605 | 15.511 | 63.749 |
| 15 | 43 | 0.085 | 9.908 | 10.755 | 13 | 2.635 | 14.741 | 7.083 |
| 16 | 26 | 0.375 | 9.747 | 13.005 | 13 | −28.599 | 10.097 | 10.498 |
| 17 | 15 | 0.046 | 10.865 | 16.271 | 13 | −130.213 | 22.026 | 96.435 |
| 18 | 8 | 0.049 | 15.409 | 18.590 | 7 | −5.008 | 4.203 | 96.261 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 33 | −8.620 | 20.356 | 12.172 | 16 | 2.233 | 11.854 | 16.130 |
| 2 | 37 | 2.276 | 27.861 | 14.924 | 14 | 0.662 | 19.720 | 17.247 |
| 3 | 27 | −17.684 | 36.168 | 23.046 | 12 | −8.898 | 24.575 | 20.796 |
| 4 | 28 | 2.156 | 28.734 | 32.645 | 15 | −26.874 | 15.575 | 34.114 |
| 5 | 15 | 13.437 | 27.921 | 19.365 | 15 | −7.432 | 20.965 | 23.711 |
| 6 | 17 | 5.667 | 50.560 | 34.074 | 11 | −3.538 | 22.898 | 51.014 |
| 7 | 16 | −22.714 | 35.732 | 55.729 | 12 | −6.694 | 16.152 | 24.499 |
| 8 | 10 | 0.173 | 19.123 | 29.886 | 8 | 6.944 | 29.305 | 20.296 |
| 9 | 8 | 9.106 | 29.806 | 35.872 | 4 | 12.266 | 32.877 | 16.779 |
| 10 | 4 | 19.431 | 93.301 | 121.947 | 9 | 12.708 | 32.896 | 34.233 |
| 11 | 7 | 19.908 | 68.975 | 79.725 | 6 | 5.811 | 57.324 | 58.255 |
| 12 | 5 | 20.322 | 31.300 | 38.948 | 5 | 9.547 | 87.297 | 55.483 |
| 13 | 2 | 21.077 | 22.570 | 2.133 | 6 | −2.049 | 36.386 | 41.214 |
| 14 | 5 | 9.464 | 94.942 | 79.327 | 4 | 5.682 | 54.556 | 48.920 |
| 15 | 2 | 4.417 | 65.686 | 87.524 | 2 | 22.948 | 25.152 | 3.148 |
| 16 | 1 | 49.479 | 49.479 | – | 1 | −3.947 | −3.947 | – |
| 17 | 1 | 24.310 | 24.310 | – | 3 | 1.172 | 96.226 | 59.123 |
| 18 | 1 | 4.274 | 4.274 | – | 1 | 1.613 | 1.613 | – |

over the life of the average regulated infrastructure firm while volatility tends to decrease, in marked contrast with private firms, the scaled revenues and profits of which tend to decrease as the firms age while the volatility of revenue and profits remains substantially higher than for regulated infrastructure firms.

The lifecycle of regulated infrastructure firms is also visible in the lower quantiles of the profit metric, which remain negative until the 7th year but then increase into positive territory. This effect is also visible in table 20, in which the lowest quantile of regulated infrastructure firms turns highly negative after 2007, before continuously increasing towards positive values. Rather than the effect of the 2008 recession, this phenomenon can be readily interpreted as the result of the opening of the UK market for regulated utilities in 2007, which led to a number of new entrants and investments in greenfield assets (e.g. ESP Utilities, which

# 3. A Distinctive Infrastructure Business Model

*Table 11: Descriptive statistics of* ***revenues scaled by average assets*** *for the full sample of* ***contracted infrastructure*** *test data and the matched control data*

| | Contracted | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 72 | 0.195 | 17.835 | 24.023 | 24 | 2.597 | 69.634 | 95.229 |
| 2006 | 114 | 0.445 | 19.857 | 33.463 | 75 | 4.028 | 54.935 | 108.834 |
| 2007 | 146 | 0.665 | 19.235 | 33.620 | 79 | 2.590 | 59.571 | 95.184 |
| 2008 | 154 | 0.384 | 18.059 | 34.784 | 100 | 0.064 | 69.714 | 107.489 |
| 2009 | 166 | 0.121 | 16.087 | 40.959 | 130 | 0.517 | 55.860 | 94.450 |
| 2010 | 168 | 0.713 | 13.133 | 53.289 | 154 | 0.917 | 52.172 | 122.976 |
| 2011 | 168 | 2.197 | 13.231 | 62.309 | 169 | 2.002 | 58.948 | 105.875 |
| 2012 | 167 | 2.183 | 12.321 | 75.953 | 190 | 0.829 | 58.649 | 100.667 |
| 2013 | 166 | 1.979 | 11.577 | 66.443 | 214 | 1.535 | 78.079 | 115.182 |
| 2014 | 92 | 2.166 | 15.233 | 88.021 | 148 | 2.112 | 71.792 | 105.516 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 3 | 5.930 | 29.727 | 16.301 | 14 | 3.997 | 29.757 | 33.798 |
| 2006 | 7 | 29.648 | 43.064 | 17.799 | 17 | 3.877 | 77.980 | 147.233 |
| 2007 | 16 | 13.005 | 63.053 | 68.126 | 18 | 6.928 | 77.711 | 166.424 |
| 2008 | 16 | 8.496 | 45.505 | 56.791 | 24 | 3.637 | 67.108 | 77.771 |
| 2009 | 20 | 10.269 | 68.724 | 66.913 | 20 | 8.514 | 104.127 | 63.192 |
| 2010 | 28 | 6.691 | 76.858 | 102.614 | 15 | 6.951 | 52.378 | 99.540 |
| 2011 | 37 | 0.655 | 70.048 | 71.303 | 19 | 0.570 | 64.655 | 64.602 |
| 2012 | 41 | 9.591 | 72.793 | 76.935 | 16 | 1.133 | 52.576 | 71.218 |
| 2013 | 47 | 18.770 | 75.535 | 173.313 | 10 | 25.075 | 94.002 | 64.352 |
| 2014 | 39 | 27.383 | 82.992 | 110.246 | 14 | 2.112 | 54.156 | 132.223 |

*Table 12: Descriptive statistics of* ***profits scaled by average assets*** *for the full sample of* ***contracted infrastructure*** *test data and the matched control data, in calendar year.*

| | Contracted | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 72 | −1.514 | 4.928 | 3.614 | 24 | 0.049 | 4.316 | 92.505 |
| 2006 | 114 | −1.469 | 6.973 | 5.763 | 75 | −2.070 | 17.925 | 38.017 |
| 2007 | 146 | −2.587 | 7.637 | 6.660 | 79 | −3.173 | 17.654 | 28.874 |
| 2008 | 154 | −4.910 | 7.488 | 7.025 | 100 | −15.292 | 19.341 | 42.409 |
| 2009 | 166 | −12.761 | 7.526 | 7.050 | 130 | −17.791 | 18.594 | 32.698 |
| 2010 | 168 | −3.343 | 7.863 | 7.023 | 154 | −61.683 | 17.509 | 26.189 |
| 2011 | 168 | 0.441 | 7.978 | 6.820 | 169 | −19.667 | 19.761 | 37.192 |
| 2012 | 167 | 2.245 | 8.252 | 6.639 | 190 | −13.113 | 19.825 | 30.392 |
| 2013 | 166 | −49.932 | 8.077 | 6.561 | 214 | −13.157 | 23.473 | 28.169 |
| 2014 | 92 | 0.993 | 8.240 | 8.871 | 148 | −88.386 | 22.604 | 29.429 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 3 | 1.994 | 4.824 | 2.375 | 14 | 2.197 | 9.381 | 9.522 |
| 2006 | 7 | 5.906 | 15.366 | 11.779 | 17 | −2.124 | 19.186 | 29.182 |
| 2007 | 16 | 8.199 | 20.327 | 37.759 | 18 | −7.494 | 27.668 | 31.769 |
| 2008 | 16 | −19.244 | 18.981 | 12.347 | 24 | −25.671 | 32.818 | 35.078 |
| 2009 | 20 | 4.428 | 27.793 | 22.224 | 20 | −3.552 | 32.359 | 35.997 |
| 2010 | 28 | −21.904 | 26.545 | 45.662 | 15 | −6.475 | 15.575 | 40.304 |
| 2011 | 37 | 0.431 | 25.560 | 32.953 | 19 | 0.316 | 19.891 | 31.427 |
| 2012 | 41 | −8.132 | 31.300 | 25.954 | 16 | −8.887 | 19.977 | 26.145 |
| 2013 | 47 | 2.582 | 29.275 | 41.121 | 10 | −12.434 | 34.379 | 30.710 |
| 2014 | 39 | 9.478 | 30.508 | 59.354 | 14 | −6.692 | 27.120 | 44.355 |

# 3. A Distinctive Infrastructure Business Model

*Table 13: Descriptive statistics of* ***revenues scaled by average assets*** *for the full sample of* ***merchant infrastructure*** *test data and the matched control data*

| | Merchant | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 44 | 0.002 | 10.217 | 19.626 | 84 | 4.845 | 75.176 | 132.154 |
| 2 | 55 | 0.032 | 15.554 | 72.783 | 76 | 1.439 | 71.143 | 83.657 |
| 3 | 65 | 0.190 | 20.698 | 72.218 | 83 | 1.306 | 94.503 | 92.307 |
| 4 | 60 | 1.947 | 26.369 | 75.852 | 72 | 3.127 | 107.231 | 110.772 |
| 5 | 63 | 0.765 | 25.667 | 79.434 | 71 | 2.889 | 101.966 | 142.172 |
| 6 | 59 | 1.306 | 26.958 | 34.152 | 50 | 3.166 | 95.391 | 132.794 |
| 7 | 60 | 0.388 | 26.838 | 31.228 | 59 | 6.537 | 115.251 | 150.334 |
| 8 | 59 | 1.942 | 24.056 | 42.461 | 51 | 2.362 | 119.303 | 124.588 |
| 9 | 55 | 2.912 | 24.922 | 27.840 | 34 | 2.715 | 108.176 | 216.508 |
| 10 | 45 | 3.561 | 27.450 | 33.438 | 34 | 1.908 | 128.880 | 142.764 |
| 11 | 40 | 5.846 | 32.166 | 35.191 | 30 | 1.158 | 109.493 | 144.169 |
| 12 | 33 | 6.566 | 41.346 | 46.460 | 25 | 3.149 | 153.412 | 114.433 |
| 13 | 36 | 8.176 | 31.464 | 48.105 | 28 | 5.593 | 134.333 | 280.577 |
| 14 | 37 | 5.965 | 25.829 | 48.763 | 24 | 7.999 | 185.002 | 360.553 |
| 15 | 38 | 4.885 | 26.947 | 51.224 | 16 | 6.771 | 98.598 | 149.741 |
| 16 | 34 | 8.712 | 30.014 | 54.152 | 13 | 6.236 | 219.223 | 261.862 |
| 17 | 33 | 7.165 | 31.553 | 59.356 | 18 | 8.832 | 99.152 | 92.225 |
| 18 | 31 | 7.034 | 29.824 | 65.281 | 20 | 5.740 | 219.350 | 201.625 |
| 19 | 33 | 1.552 | 31.476 | 49.368 | 9 | 67.519 | 161.333 | 66.096 |
| 20 | 33 | 7.341 | 29.207 | 38.266 | 10 | 5.486 | 76.316 | 97.210 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 49 | 6.196 | 72.715 | 120.624 | 44 | 0.693 | 79.855 | 101.671 |
| 2 | 48 | 1.130 | 78.626 | 154.217 | 38 | 6.943 | 53.301 | 147.846 |
| 3 | 54 | 19.760 | 94.194 | 151.059 | 31 | 0.203 | 52.378 | 123.261 |
| 4 | 43 | 4.151 | 116.686 | 373.749 | 46 | 2.067 | 68.439 | 76.209 |
| 5 | 29 | 23.334 | 113.465 | 58.630 | 45 | 0.892 | 48.834 | 86.687 |
| 6 | 26 | 8.737 | 104.084 | 82.729 | 39 | 0.711 | 61.034 | 157.385 |
| 7 | 24 | 10.964 | 115.482 | 81.312 | 49 | 1.635 | 73.265 | 109.288 |
| 8 | 25 | 0.495 | 79.729 | 96.799 | 28 | 13.821 | 70.745 | 109.415 |
| 9 | 17 | 52.781 | 199.823 | 256.817 | 44 | 3.014 | 75.585 | 146.065 |
| 10 | 14 | 11.947 | 161.757 | 377.854 | 28 | 6.892 | 77.082 | 126.857 |
| 11 | 11 | 42.906 | 118.330 | 222.676 | 24 | 1.966 | 85.752 | 55.583 |
| 12 | 6 | 9.981 | 53.649 | 96.611 | 21 | 1.830 | 121.585 | 58.629 |
| 13 | 8 | 50.843 | 170.763 | 98.585 | 25 | 8.298 | 89.247 | 82.480 |
| 14 | 12 | 17.713 | 105.559 | 137.843 | 18 | 33.380 | 123.748 | 97.528 |
| 15 | 6 | 15.789 | 92.178 | 142.182 | 10 | 21.218 | 70.121 | 89.887 |
| 16 | 8 | 36.905 | 184.526 | 108.846 | 13 | 0.740 | 74.062 | 48.376 |
| 17 | 2 | 51.570 | 90.933 | 56.230 | 21 | 21.973 | 72.713 | 94.611 |
| 18 | 7 | 25.655 | 120.871 | 63.596 | 15 | 17.717 | 66.776 | 116.151 |
| 19 | 6 | 16.895 | 148.798 | 155.042 | 15 | 8.375 | 73.468 | 81.393 |
| 20 | 4 | 92.383 | 170.989 | 86.213 | 11 | 27.892 | 66.392 | 101.996 |

# 3. A Distinctive Infrastructure Business Model

*Table 14: Descriptive statistics of **profits scaled by average assets** for the full sample of **merchant infrastructure** test data and the matched control data, in project year.*

| | Merchant | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 44 | −9.743 | 5.983 | 12.697 | 84 | −1.436 | 22.235 | 27.631 |
| 2 | 55 | −99.363 | 9.910 | 11.379 | 76 | −0.107 | 21.324 | 24.884 |
| 3 | 65 | −99.359 | 11.028 | 14.769 | 83 | −1.333 | 22.402 | 24.794 |
| 4 | 60 | −111.751 | 12.390 | 10.706 | 72 | 0.192 | 31.450 | 33.800 |
| 5 | 63 | −135.835 | 12.765 | 26.433 | 71 | −8.392 | 21.235 | 42.881 |
| 6 | 59 | −88.442 | 13.505 | 9.481 | 50 | −14.649 | 28.426 | 23.002 |
| 7 | 60 | −3.500 | 14.578 | 10.913 | 59 | −21.355 | 27.807 | 80.831 |
| 8 | 59 | −36.454 | 13.811 | 30.381 | 51 | −1.355 | 28.086 | 29.183 |
| 9 | 55 | −1.971 | 13.572 | 7.277 | 34 | −7.104 | 20.797 | 50.226 |
| 10 | 45 | −67.547 | 14.693 | 7.208 | 34 | 1.203 | 23.755 | 27.420 |
| 11 | 40 | −9.632 | 13.258 | 7.894 | 30 | −2.667 | 23.749 | 29.245 |
| 12 | 33 | −13.764 | 11.439 | 10.100 | 25 | −2.667 | 24.869 | 40.817 |
| 13 | 36 | 1.252 | 12.983 | 9.348 | 28 | −1.096 | 30.663 | 45.907 |
| 14 | 37 | −2.919 | 13.235 | 12.369 | 24 | −1.686 | 25.228 | 43.860 |
| 15 | 38 | −2.202 | 12.885 | 10.148 | 16 | 5.211 | 23.039 | 44.537 |
| 16 | 34 | −26.974 | 12.277 | 9.660 | 13 | 0.528 | 36.797 | 31.982 |
| 17 | 33 | −6.759 | 13.682 | 10.855 | 18 | −1.393 | 27.491 | 24.680 |
| 18 | 31 | −22.079 | 12.531 | 11.560 | 20 | 2.265 | 36.877 | 31.506 |
| 19 | 33 | −21.558 | 11.931 | 12.011 | 9 | 8.748 | 59.643 | 34.157 |
| 20 | 33 | −33.178 | 8.579 | 11.128 | 10 | −5.983 | 28.863 | 51.998 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 49 | 1.541 | 22.820 | 28.698 | 44 | −77.376 | 17.646 | 27.738 |
| 2 | 48 | 0.345 | 28.595 | 39.126 | 38 | −0.982 | 17.107 | 29.207 |
| 3 | 54 | 5.174 | 34.499 | 26.502 | 31 | −7.870 | 15.274 | 41.311 |
| 4 | 43 | 2.239 | 36.254 | 49.807 | 46 | −38.056 | 19.705 | 33.735 |
| 5 | 29 | 2.637 | 38.809 | 41.936 | 45 | −14.013 | 19.951 | 20.335 |
| 6 | 26 | 4.903 | 34.724 | 34.510 | 39 | −8.960 | 22.898 | 24.123 |
| 7 | 24 | 0.955 | 35.267 | 35.011 | 49 | −139.694 | 23.445 | 25.300 |
| 8 | 25 | 0.321 | 28.273 | 51.883 | 28 | −139.493 | 19.882 | 36.908 |
| 9 | 17 | 12.998 | 67.806 | 154.884 | 44 | −23.088 | 33.047 | 48.837 |
| 10 | 14 | 9.654 | 64.097 | 220.486 | 28 | 0.070 | 29.110 | 27.245 |
| 11 | 11 | 27.032 | 68.975 | 64.723 | 24 | 0.659 | 34.539 | 32.434 |
| 12 | 6 | 6.446 | 25.512 | 51.151 | 21 | 0.881 | 35.252 | 32.067 |
| 13 | 8 | 21.237 | 37.271 | 53.039 | 25 | 5.830 | 40.860 | 33.437 |
| 14 | 12 | 9.224 | 37.004 | 38.214 | 18 | 5.128 | 47.509 | 30.015 |
| 15 | 6 | 10.531 | 37.149 | 43.794 | 10 | 6.830 | 28.753 | 30.783 |
| 16 | 8 | 9.064 | 48.244 | 105.819 | 13 | −3.698 | 40.360 | 29.264 |
| 17 | 2 | 20.922 | 24.493 | 5.101 | 21 | 1.049 | 35.804 | 25.102 |
| 18 | 7 | 2.327 | 30.921 | 15.624 | 15 | −14.489 | 35.878 | 39.106 |
| 19 | 6 | 5.367 | 50.078 | 26.575 | 15 | 1.767 | 26.586 | 27.155 |
| 20 | 4 | 12.863 | 67.062 | 52.848 | 11 | 7.266 | 25.761 | 22.140 |

# 3. A Distinctive Infrastructure Business Model

*Table 15: Descriptive statistics of* ***revenues scaled by average assets*** *for the full sample of* ***merchant infrastructure*** *test data and the matched control data, in calendar year.*

| | Merchant | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 36 | 0.134 | 27.716 | 52.790 | 20 | 6.045 | 102.526 | 107.851 |
| 2006 | 80 | 0.106 | 22.800 | 40.551 | 54 | 1.902 | 102.067 | 92.941 |
| 2007 | 90 | 1.828 | 23.353 | 39.756 | 83 | 4.067 | 88.295 | 102.067 |
| 2008 | 92 | 1.678 | 27.542 | 40.611 | 81 | 0.212 | 103.539 | 203.022 |
| 2009 | 96 | 0.111 | 25.828 | 44.076 | 111 | 0.586 | 108.476 | 104.756 |
| 2010 | 99 | 3.976 | 26.586 | 46.971 | 108 | 2.691 | 91.345 | 115.041 |
| 2011 | 104 | 1.530 | 25.170 | 70.923 | 136 | 2.587 | 102.547 | 142.133 |
| 2012 | 107 | 1.226 | 25.051 | 71.535 | 166 | 2.742 | 116.081 | 172.098 |
| 2013 | 110 | 0.238 | 24.859 | 70.567 | 155 | 6.298 | 125.017 | 165.838 |
| 2014 | 88 | −8.570 | 25.115 | 78.133 | 113 | 2.119 | 92.153 | 206.842 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 15 | 26.070 | 76.083 | 68.972 | 59 | 3.037 | 51.521 | 115.672 |
| 2006 | 20 | 12.158 | 65.444 | 68.424 | 67 | 1.235 | 73.265 | 98.031 |
| 2007 | 37 | 5.554 | 67.311 | 109.449 | 82 | 0.263 | 69.271 | 115.673 |
| 2008 | 41 | 4.670 | 80.608 | 97.599 | 71 | 2.085 | 69.130 | 80.348 |
| 2009 | 43 | 4.464 | 95.229 | 79.408 | 77 | 1.581 | 77.769 | 80.821 |
| 2010 | 52 | 7.021 | 118.441 | 87.136 | 63 | 4.166 | 93.810 | 83.404 |
| 2011 | 76 | 1.176 | 85.009 | 103.592 | 82 | 0.995 | 73.822 | 86.455 |
| 2012 | 73 | 5.869 | 112.411 | 156.944 | 83 | 0.406 | 90.613 | 86.227 |
| 2013 | 82 | 13.030 | 111.899 | 307.330 | 88 | 1.354 | 109.389 | 134.652 |
| 2014 | 72 | 11.885 | 109.011 | 221.198 | 81 | 10.394 | 93.707 | 137.770 |

*Table 16: Descriptive statistics of* ***profits scaled by average assets*** *for the full sample of* ***merchant infrastructure*** *test data and the matched control data, in calendar year.*

| | Merchant | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 36 | −121.383 | 13.697 | 29.039 | 20 | 0.018 | 3.531 | 124.071 |
| 2006 | 80 | −100.661 | 13.339 | 24.092 | 54 | 0.440 | 18.628 | 17.708 |
| 2007 | 90 | −68.738 | 11.599 | 10.399 | 83 | −0.926 | 18.445 | 21.640 |
| 2008 | 92 | −16.555 | 13.120 | 10.798 | 81 | −8.643 | 19.406 | 26.748 |
| 2009 | 96 | −88.831 | 12.247 | 12.045 | 111 | −9.355 | 22.619 | 25.197 |
| 2010 | 99 | −27.575 | 13.359 | 10.530 | 108 | −10.588 | 22.306 | 27.601 |
| 2011 | 104 | −34.799 | 12.589 | 10.565 | 136 | 0.487 | 25.948 | 30.089 |
| 2012 | 107 | −21.518 | 11.579 | 20.543 | 166 | −0.742 | 27.703 | 29.870 |
| 2013 | 110 | −28.117 | 11.905 | 12.292 | 155 | −28.628 | 28.800 | 42.141 |
| 2014 | 88 | −40.826 | 11.134 | 9.753 | 113 | −3.446 | 28.153 | 43.050 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 15 | 1.987 | 5.827 | 49.107 | 59 | −23.674 | 15.785 | 25.532 |
| 2006 | 20 | 3.267 | 26.904 | 20.478 | 67 | −59.070 | 23.800 | 24.553 |
| 2007 | 37 | 3.006 | 23.952 | 34.511 | 82 | −29.809 | 22.479 | 26.062 |
| 2008 | 41 | 0.570 | 28.216 | 30.978 | 71 | −32.398 | 24.578 | 29.762 |
| 2009 | 43 | 2.846 | 28.100 | 24.633 | 77 | −22.316 | 25.498 | 28.615 |
| 2010 | 52 | 3.970 | 40.959 | 41.377 | 63 | −8.505 | 32.300 | 29.667 |
| 2011 | 76 | 0.806 | 29.131 | 30.115 | 82 | −2.400 | 20.920 | 26.773 |
| 2012 | 73 | 1.834 | 32.249 | 42.988 | 83 | −5.616 | 32.715 | 31.735 |
| 2013 | 82 | 2.363 | 37.717 | 87.031 | 88 | −108.687 | 37.227 | 37.357 |
| 2014 | 72 | 1.956 | 34.579 | 110.463 | 81 | −103.640 | 36.656 | 45.809 |

# 3. A Distinctive Infrastructure Business Model

starts operations in 2008 and makes losses until 2013).

Thus, casual examination of the descriptive statistics for our test and control data suggests that infrastructure and non-infrastructure firms do have a different business model, and also that the different sub-categories of infrastructure firms as defined by Blanc-Brude (2014) are different from each other, albeit more alike than their control groups of private and public firms.

Four salient facts emerge at this stage:

1. Infrastructure firms have lower revenues and profits per dollar of investment, highlighting the **capital intensive and long-term nature of their business model**;
2. The revenues and profits of infrastructure firms are **significantly less volatile than a control group of public and private firms**, indicating the greater stability of their business model;
3. Infrastructure firms exhibit a **very dynamic lifecycle** which greatly impacts the trajectory of their revenues and profits. This effect appears to be much more significant than it is for other firms even after taking into account their startup date;
4. The revenues and profits of UK infrastructure firms appear to have **withstood the 2008 recession** better than those of their matched control group.

Next, we conduct a regression analysis of the data to test the statistical significance of the various effects discussed above on the revenues and profits of infrastructure firms.

## 3.2 Regression Analysis

To understand the explanatory power of exogenous (firm-independent) factors in affecting the revenue and profitability of each type of firm, we run panel regressions with "investment time" fixed effects, while controlling for firm specific variables.

As above, we use revenue/average assets ratio, and gross profits/average assets ratio as the dependent variables.

To control for exogenous economy-wide factors, we use both calendar year dummy variables,[14] macroeconomic, as well as market factors in separate regression models.

Because our matched sample was built using nearest neighbours, we cannot completely discard the effect of firm characteristics as explanatory variables of the revenue and profit ratios of each group. Hence, each regression controls for firm-specific variables. In revenue/average assets regressions, these firm-specific variables are: leverage, firm size (proxied by the log of assets), and profitability. In profits/average assets regressions: firm-specific variables consist of leverage, size, and revenue/assets ratio. We run these regression models separately for each test and control group and report the results of twelve regression

14 - Dummy variables take a value of one or zero, here, to each calendar year in the sample corresponds a dummy which take a value of one or zero in the relevant years.

# 3. A Distinctive Infrastructure Business Model

*Table 17: Descriptive statistics of* ***revenues scaled by average assets*** *for the full sample of* ***regulated infrastructure*** *test data and the matched control data*

| | Regulated | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 5 | 0.189 | 8.162 | 11.832 | 11 | 4.838 | 11.003 | 56.680 |
| 2 | 6 | 2.162 | 13.579 | 12.757 | 17 | 2.841 | 39.178 | 76.578 |
| 3 | 8 | 0.428 | 12.820 | 12.475 | 12 | 0.857 | 38.668 | 53.258 |
| 4 | 9 | 2.774 | 14.243 | 13.275 | 20 | 0.493 | 51.732 | 65.331 |
| 5 | 14 | 9.817 | 14.627 | 8.324 | 9 | 3.140 | 37.360 | 55.567 |
| 6 | 16 | 9.096 | 15.431 | 7.041 | 15 | 4.954 | 43.295 | 72.640 |
| 7 | 17 | 8.283 | 16.473 | 12.320 | 15 | 4.490 | 44.179 | 99.187 |
| 8 | 17 | 9.185 | 17.871 | 20.634 | 15 | 2.479 | 16.387 | 94.403 |
| 9 | 16 | 9.549 | 18.096 | 39.883 | 11 | 1.139 | 20.993 | 142.805 |
| 10 | 15 | 11.672 | 18.516 | 7.712 | 5 | 6.443 | 21.116 | 33.694 |
| 11 | 16 | 12.579 | 18.745 | 7.569 | 6 | 5.399 | 25.039 | 111.477 |
| 12 | 16 | 12.571 | 18.877 | 8.009 | 6 | 5.677 | 14.305 | 89.557 |
| 13 | 15 | 13.053 | 23.650 | 8.469 | 4 | 2.913 | 15.488 | 11.529 |
| 14 | 15 | 9.192 | 23.778 | 10.561 | 5 | 7.098 | 24.192 | 21.291 |
| 15 | 11 | 14.639 | 18.077 | 10.646 | 4 | 42.462 | 109.915 | 44.489 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 1 | 16 | 17.686 | 53.002 | 161.413 | 11 | 3.354 | 77.980 | 35.525 |
| 2 | 10 | 3.470 | 45.682 | 255.068 | 17 | 3.257 | 41.124 | 36.459 |
| 3 | 10 | 4.984 | 108.862 | 301.043 | 14 | 2.300 | 29.389 | 42.746 |
| 4 | 10 | 4.033 | 48.799 | 335.726 | 20 | 2.065 | 32.727 | 33.250 |
| 5 | 4 | 22.233 | 64.940 | 35.090 | 18 | 0.442 | 24.442 | 29.120 |
| 6 | 4 | 10.258 | 34.506 | 23.078 | 18 | 0.985 | 62.621 | 88.613 |
| 7 | 8 | 14.066 | 96.033 | 87.829 | 10 | 0.723 | 43.000 | 44.938 |
| 8 | 4 | 0.751 | 46.740 | 38.756 | 17 | 0.971 | 18.656 | 72.858 |
| 9 | 5 | 20.087 | 60.062 | 27.672 | 12 | 1.901 | 34.521 | 57.677 |
| 10 | 1 | 102.897 | 102.897 | – | 7 | 5.426 | 74.949 | 67.573 |
| 11 | 2 | 89.812 | 432.871 | 490.059 | 5 | 0.089 | 5.483 | 5.006 |
| 12 | 2 | 76.229 | 119.585 | 61.933 | 8 | 29.835 | 115.044 | 57.645 |
| 13 | 0 | – | – | – | 1 | 6.499 | 6.499 | – |
| 14 | 2 | 107.721 | 178.352 | 100.896 | 8 | 8.512 | 32.164 | 32.052 |
| 15 | 1 | 15.260 | 15.260 | – | 5 | 14.596 | 23.882 | 18.773 |

models for each of the two dependent variables: revenues and profits.

### 3.2.1 Revenues

To estimate the parameters of panel regression models, we construct regression models with both time fixed-effects and firm-specific (individual) fixed-effects. Time fixed-effects control for investment age by fitting a different intercept for each investment year, and individual fixed-effects control firm-specific (idiosyncratic) effects by fitting a different intercept for each firm.

We then test the significance of both time and individual fixed-effects, and retain the effects that are significant. For example, Contracted infrastructure firms exhibit significant time and individual effects, while dispersed non-infrastructure firms matched to contracted firms only exhibit significant individual effects. Thus, we estimate regression model with "two-ways" effects (with both time and individual) for the Contracted sample, and a regression model with only individual effects for dispersed non-infrastructure firms matched to contracted firms.

# 3. A Distinctive Infrastructure Business Model

*Table 18: Descriptive statistics of **profits scaled by average assets** for the full sample of **regulated infrastructure** test data and the matched control data, in project year.*

| | Regulated | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | 0.5$^{th}$Q | 50$^{th}$Q | STD | N | 0.5$^{th}$Q | 50$^{th}$Q | STD |
| 1 | 5 | −18.923 | 3.891 | 6.502 | 11 | 0.785 | 7.104 | 9.162 |
| 2 | 6 | −17.354 | 5.456 | 6.527 | 17 | −101.978 | 7.742 | 15.531 |
| 3 | 8 | −12.250 | 3.885 | 5.114 | 12 | −100.916 | 9.899 | 16.391 |
| 4 | 9 | −12.678 | 7.601 | 3.523 | 20 | 0.153 | 8.932 | 9.852 |
| 5 | 14 | −10.115 | 6.781 | 2.729 | 9 | −10.312 | 8.327 | 8.934 |
| 6 | 16 | −17.409 | 7.977 | 3.000 | 15 | −37.991 | 7.056 | 19.067 |
| 7 | 17 | −15.955 | 9.779 | 2.758 | 15 | −8.986 | 16.070 | 12.627 |
| 8 | 17 | 3.791 | 10.650 | 5.596 | 15 | 0.637 | 6.935 | 9.025 |
| 9 | 16 | 6.950 | 11.235 | 6.094 | 11 | −0.340 | 8.495 | 12.623 |
| 10 | 15 | 8.875 | 10.845 | 3.713 | 5 | 5.025 | 8.906 | 7.933 |
| 11 | 16 | 8.536 | 12.118 | 3.925 | 6 | 0.889 | 7.018 | 6.992 |
| 12 | 16 | 7.903 | 12.265 | 4.675 | 6 | 1.731 | 5.459 | 17.933 |
| 13 | 15 | 8.317 | 12.652 | 5.612 | 4 | 0.403 | 3.595 | 6.238 |
| 14 | 15 | 6.200 | 11.214 | 7.384 | 5 | 3.988 | 7.656 | 8.727 |
| 15 | 11 | 9.279 | 11.507 | 4.150 | 4 | −58.289 | 18.014 | 9.174 |
| | Private Dispersed | | | | Public | | | |
| | N | 0.5$^{th}$Q | 50$^{th}$Q | STD | N | 0.5$^{th}$Q | 50$^{th}$Q | STD |
| 1 | 16 | 5.529 | 15.640 | 11.587 | 11 | −32.282 | 15.133 | 11.540 |
| 2 | 10 | 2.546 | 7.910 | 9.322 | 17 | 1.327 | 16.308 | 10.375 |
| 3 | 10 | 3.053 | 17.723 | 14.059 | 14 | −8.893 | 6.639 | 7.592 |
| 4 | 10 | 2.956 | 10.322 | 10.603 | 20 | −12.884 | 7.715 | 8.799 |
| 5 | 4 | 2.347 | 5.893 | 8.274 | 18 | −7.830 | 7.157 | 6.795 |
| 6 | 4 | −3.361 | 4.253 | 3.261 | 18 | −9.391 | 17.066 | 16.837 |
| 7 | 8 | −24.503 | 19.716 | 16.246 | 10 | −174.440 | 4.857 | 11.423 |
| 8 | 4 | −88.688 | 9.839 | 6.241 | 17 | −10.653 | 8.968 | 8.208 |
| 9 | 5 | 7.193 | 25.138 | 12.793 | 12 | −1.294 | 11.528 | 11.853 |
| 10 | 1 | 35.688 | 35.688 | – | 7 | −1.213 | 8.953 | 17.600 |
| 11 | 2 | 69.028 | 74.231 | 7.432 | 5 | −7.841 | 3.541 | 0.934 |
| 12 | 2 | 20.218 | 28.038 | 11.170 | 8 | 8.277 | 15.152 | 8.664 |
| 13 | 0 | – | – | – | 1 | −6.542 | −6.542 | – |
| 14 | 2 | 5.504 | 7.657 | 3.076 | 8 | −7.334 | 15.022 | 23.000 |
| 15 | 1 | 10.416 | 10.416 | – | 5 | −6.208 | 9.713 | 12.024 |

*Table 19: Descriptive statistics of **revenues scaled by average assets** for the full sample of **regulated infrastructure** test data and the matched control data, in calendar year.*

| | Regulated | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | 0.5$^{th}$Q | 50$^{th}$Q | STD | N | 0.5$^{th}$Q | 50$^{th}$Q | STD |
| 2005 | 8 | 15.529 | 19.626 | 8.229 | 4 | 5.834 | 15.559 | 7.305 |
| 2006 | 16 | 6.097 | 16.596 | 9.487 | 19 | 2.511 | 18.415 | 53.968 |
| 2007 | 24 | 8.262 | 17.759 | 9.063 | 18 | 4.898 | 37.826 | 82.996 |
| 2008 | 25 | 1.304 | 17.988 | 10.218 | 28 | 1.421 | 53.466 | 104.468 |
| 2009 | 26 | 1.511 | 18.391 | 10.537 | 22 | 0.798 | 20.785 | 74.980 |
| 2010 | 27 | 1.957 | 18.821 | 10.592 | 29 | 2.771 | 45.243 | 81.598 |
| 2011 | 25 | 5.689 | 21.165 | 10.484 | 30 | 0.866 | 60.597 | 115.292 |
| 2012 | 27 | 11.261 | 24.154 | 10.536 | 35 | 3.122 | 40.770 | 89.980 |
| 2013 | 27 | 16.625 | 25.070 | 16.372 | 33 | 2.394 | 64.356 | 70.604 |
| 2014 | 24 | 19.149 | 26.726 | 32.371 | 28 | 3.145 | 49.462 | 112.786 |
| | Private Dispersed | | | | Public | | | |
| | N | 0.5$^{th}$Q | 50$^{th}$Q | STD | N | 0.5$^{th}$Q | 50$^{th}$Q | STD |
| 2005 | 4 | 26.224 | 60.077 | 38.310 | 19 | 5.694 | 29.419 | 46.292 |
| 2006 | 5 | 0.535 | 17.744 | 24.542 | 18 | 0.231 | 24.994 | 52.368 |
| 2007 | 9 | 26.421 | 55.202 | 58.733 | 25 | 6.455 | 55.302 | 70.215 |
| 2008 | 6 | 19.686 | 38.810 | 80.778 | 24 | 2.333 | 57.140 | 49.582 |
| 2009 | 7 | 1.524 | 42.517 | 86.670 | 25 | 5.376 | 36.678 | 67.885 |
| 2010 | 13 | 3.816 | 47.483 | 68.635 | 22 | 1.877 | 45.080 | 55.365 |
| 2011 | 16 | 4.495 | 46.850 | 163.741 | 23 | 0.057 | 42.763 | 67.263 |
| 2012 | 19 | 12.006 | 64.623 | 197.961 | 30 | 0.252 | 34.462 | 51.264 |
| 2013 | 16 | 10.057 | 88.923 | 244.234 | 29 | 1.548 | 41.112 | 41.706 |
| 2014 | 20 | 15.652 | 96.746 | 271.989 | 25 | 1.132 | 32.602 | 77.954 |

# 3. A Distinctive Infrastructure Business Model

*Table 20: Descriptive statistics of **profits scaled by average assets** for the full sample of **regulated infrastructure** test data and the matched control data, in calendar year.*

| | Regulated | | | | Private Concentrated | | | |
|---|---|---|---|---|---|---|---|---|
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 8 | 9.558 | 11.793 | 3.298 | 4 | 0.007 | 0.067 | 0.532 |
| 2006 | 16 | 3.927 | 10.763 | 4.331 | 19 | 0.782 | 5.903 | 8.567 |
| 2007 | 24 | 4.527 | 11.501 | 5.030 | 18 | 1.046 | 10.245 | 11.469 |
| 2008 | 25 | −5.630 | 12.255 | 4.439 | 28 | −36.228 | 7.400 | 12.073 |
| 2009 | 26 | −17.406 | 12.031 | 4.354 | 22 | 0.177 | 7.205 | 11.809 |
| 2010 | 27 | −16.936 | 12.207 | 4.445 | 29 | −8.190 | 8.576 | 15.309 |
| 2011 | 25 | −12.717 | 12.297 | 4.936 | 30 | −103.370 | 10.903 | 12.343 |
| 2012 | 27 | −10.180 | 12.450 | 4.794 | 35 | −89.455 | 9.680 | 11.638 |
| 2013 | 27 | −16.395 | 16.083 | 5.347 | 33 | −124.198 | 8.805 | 15.324 |
| 2014 | 24 | −13.399 | 16.693 | 5.931 | 28 | −29.297 | 15.248 | 14.175 |
| | Private Dispersed | | | | Public | | | |
| | N | $0.5^{th}$Q | $50^{th}$Q | STD | N | $0.5^{th}$Q | $50^{th}$Q | STD |
| 2005 | 4 | 2.044 | 8.493 | 3.948 | 19 | −30.786 | 9.224 | 11.339 |
| 2006 | 5 | −88.300 | 5.750 | 7.175 | 18 | −0.243 | 5.649 | 10.741 |
| 2007 | 9 | 7.046 | 16.446 | 5.204 | 25 | −7.560 | 11.924 | 9.344 |
| 2008 | 6 | 17.653 | 25.763 | 7.319 | 24 | −13.041 | 13.872 | 13.754 |
| 2009 | 7 | 0.418 | 5.482 | 4.518 | 25 | −7.291 | 8.968 | 9.176 |
| 2010 | 13 | −24.005 | 11.509 | 11.530 | 22 | −9.407 | 8.632 | 11.904 |
| 2011 | 16 | −29.763 | 7.230 | 15.037 | 23 | −7.310 | 13.186 | 8.941 |
| 2012 | 19 | −2.657 | 14.720 | 11.347 | 30 | −8.849 | 10.802 | 9.493 |
| 2013 | 16 | −1.861 | 12.957 | 14.611 | 29 | −158.626 | 9.773 | 7.112 |
| 2014 | 20 | 5.708 | 24.514 | 19.731 | 25 | −8.204 | 8.399 | 18.365 |

*Table 21: Summary of the effect of different business cycle proxies on the revenues of infrastructure test and control groups*

| | Test Group | Control Group |
|---|---|---|
| Model 1 (cal. years) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 2 (GDP) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 3 (RPI) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 4 (mkt factors) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |

*X*: not statistically significant; ✓ : statistically significant (above 5% level)

The business cycle is proxied by four different types of variables: calendar time dummy variables (model 1), an index of nominal GDP (model 2), an index of the UK retail price index (model 3) and three uncorrelated indices of well-known market factors: market, size and value as defined by Fama and French (1993) (model 4).

Regression results (reported in the appendix 8) are robust and stable across specifications. Two of the control variables (Size and Profitability) tend to be significant and have the expected signs, while Leverages does not (i.e. our matching already controls well for the effect of leverage).

The main result is that calendar year dummies, nor GDP, RPI or market factors have limited or no explanatory power with respect to the variance of revenues in infras-

# 3. A Distinctive Infrastructure Business Model

tructure assets, whereas these four proxies of the business cycle (which are all highly correlated with each other) have a high significant impact on the revenues of non-infrastructure firms for all three test groups.

In other words, whether the data has been matched to contracted, merchant or regulated infrastructure, non-infrastructure firm revenues are highly correlated with the business cycle, once their investment lifecycle (investment year fixed effects) and firm-specific effects have been taken into account.

Conversely, the variability of revenues in infrastructure firms, controlling for the characteristics of the firm discussed above, are mostly explained by the evolution of their lifecycle i.e the investment time "fixed effects" used in our panel regression models.

Indeed, the amplitude of the change in revenue or profits that occurs during investment time dwarfs the effect of the change in GDP or market factors. Since such macro or market factors are found to explain the volatility of revenues and profits in the control groups, it suggests that infrastructure can be a powerful diversifier of investments in both public and private firms after controlling for size, leverage and profitability.

In the case of Merchant infrastructure the impact of calendar years is more complex. The 2001 and 2002 year dummies, which correspond to very bad states of the world for both the world economy and numerous merchant (power) assets show a negative and statistically significant colleration with revenues. Unfortunately these calendar years are not available for the control data, which spans 2005-15. Interestingly, the 2008 and 2009 calendar year effects are significant and negative in the control groups but not in the merchant infrastructure sample. This denotes an evolution in the correlation of the energy sector with the rest of the economy, in particular the evolution of the risk profile of new merchant assets, including the appearance of a greater proportion of renewable energy assets benefitting from long-term revenue contracts.

This suggests that a more granular decomposition of merchant assets between more or less "contracted" firms can be a informative.[15]

Incidentally, the finding that average revenues are not correlated with the index RPI in contracted infrastructure, which, in the UK, includes numerous index-linked PFI projects, does not mean that PFI revenues are not linked to RPI. Rather, this analysis compares the "levels" of different indices and finds that the movements in the RPI are not correlated with that of the unit revenues of contracted infrastructure. As we argued, the scale of the change in revenues driven by the investment lifecycle is much larger than that which characterises the RPI. To capture the relationship between infrastructure firm revenues and the RPI, a co-integration analysis is necessary to

15 - The EDHEC*infra* database can make this distinction and captures the percentage contracted and the duration of such contracts.

# 3. A Distinctive Infrastructure Business Model

control for the absence of "stationnarity" in the data. However, this is a topic for another paper.

### 3.2.2 Profits

The results for profit regressions are reported in the appendix (section **??**). Since the dependent variable is now profits-over-average assets, we replace profitability with the contemporaneous ratio of revenues to total assets as an independent variable.

Again, calendar year effects have no impact on the level of profits in any of the test infrastructure groups. Likewise, macroeconomic and market factors, while they tend to explain part of the variance of profits in the control groups, mostly do not explain the variance of profits in merchant or regulated infrastructure.

The only exception as above concerns the profits of merchant projects in 2001 and 2002.

## 3.3 Fitted Values

To better illustrate these results, we use estimated coefficients to compute the "fitted values" predicted by the regression models. Figures 19, 20 and 21 show the mean and standard deviation in each calendar year of both observed and fitted values of the revenue and profits ratios, using model 1 (calendar year effects), for each test group of infrastructure firms and their control groups. Given the stability of the coefficient estimates in the different models, plots drawn using fitted values for model 2 (GDP effects), model 3 (RPI effects) and 4 (market factors) look very similar.

The figures confirm that the impact of the business cycle on mean (expected) values is significant for non-infrastructure firms but compared to the firms in the control groups, infrastructure firms are a lot less affected by these factors.

## 3.4 Conclusions

In conclusion, descriptive and analytical results in this chapter strongly support the argument that infrastructure firms, whether they are of the Contracted, Merchant or Regulated kind, have different revenue and profit dynamics than a series control groups for firms representing the three main forms of corporate ownership (private concentrated, private dispersed and public) and with as-similar-as-possible characteristics in terms of size, leverage and profitability.

Infrastructure firms have consistently lower revenues and profits per dollar invested than other firms, reflecting the uniquely capital intensive and long-term nature of their business, and they also have consistently lower volatility of revenues and profits.

Moreover, neither revenues nor profits in infrastructure firms seems to be driven by the business cycle, whether it is proxied using calendar year effects or macroeconomic and market factors, whereas all control groups are have a systematic exposure to these variables.

# 3. A Distinctive Infrastructure Business Model

*Table 22: Summary of the effect of different business cycle proxies on the **profits** of infrastructure test and control groups*

| | Test Group | Control Group |
|---|---|---|
| Model 1 (cal. years) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 2 (GDP) | Contracted: *X*<br>Merchant: *X*<br>Regulated: ✓ | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 3 (RPI) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |
| Model 4 (mkt factors) | Contracted: *X*<br>Merchant: *X*<br>Regulated: *X* | Priv. Conc.:✓<br>Priv. Disp.:✓<br>Public:✓ |

*X*: not statistically significant; ✓ : statistically significant (above 5% level)

*Figure 19: Observed and fitted data for unit revenues and profits in calendar time for **Contracted infrastructure** and control groups*

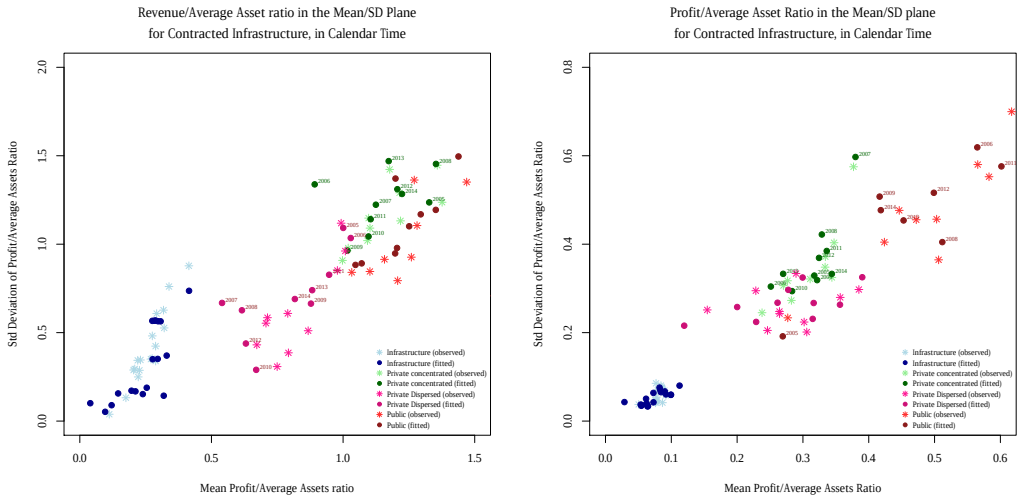
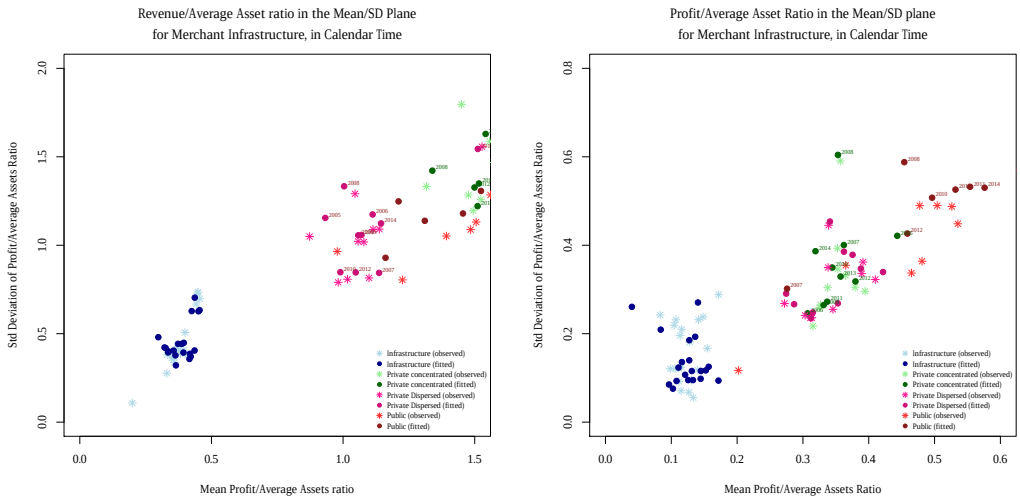
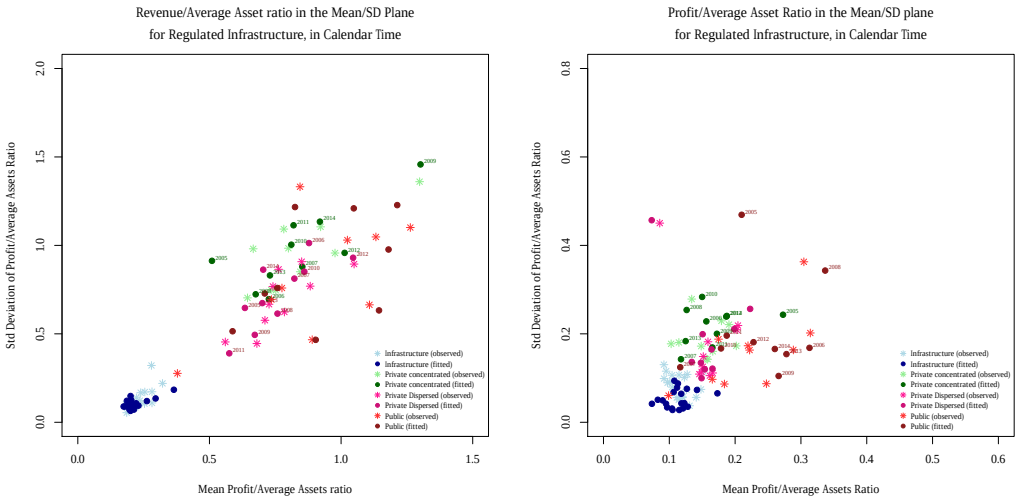



*Figure 20: Observed and fitted data for unit revenues and profits in calendar time for **Merchant infrastructure** and control groups*



# 3. A Distinctive Infrastructure Business Model

*Figure 21: Observed and fitted data for unit revenues and profits in calendar time for* ***Regulated infrastructure*** *and control groups*




Finally, infrastructure firms tend to be characterised by a very dynamic investment lifecycle. Even after taking into account the lifecycle of the firms in each control group, the effect of "investment time" in infrastructure firms is of a different order of magnitude and partly explains the de-correlation of these firm's revenues or profits from the business cycle proxies used here.

Given these results, we argue that infrastructure firms correspond to a different underlying business model than other firms, whether they are public or private. We also note that the three types of infrastructure firms used in this study correspond to distinctive sub-models with their own dynamics, themselves the result of the contractual and financial arrangements made to create these firms (see Blanc-Brude and Hasan, 2015a, for a full discussion of the nature of infrastructure investment)

In the next chapter, we study the dividend payout behaviour of infrastructure firms and whether or not it differs from their control groups.

# 4. Equity Payout Ratio Dynamics

# 4. Equity Payout Ratio Dynamics

In this chapter, we model and estimate empirically the dynamics of equity payout ratios for our test infrastructure data and its matched control groups.

Intuitively, we expect a certain degree of "path-dependency" in the dividend payout behaviour of infrastructure projects, suggesting that, rather than a stochastic, mean reverting process, dividend payout ratios are likely to be highly auto-regressive. This intuition is informed by the sequential nature of the resolution of uncertainty in infrastructure investments, most of which are standalone firms created for the sole purpose of delivering a single investment project. Hence, outcomes are likely to be rather binary: either projects are well conceived and executed and they go well, or they suffer from significant flaws which are very hard to reverse due to the relationship specific nature of infrastructure assets (e.g. perhaps the infrastructure was built in the wrong place). In other words, as opposed to a regular firm, it can be hard to "turn around" an infrastructure project.

It follows that reporting simple period averages for dividend payout ratios may not represent the underlying dynamics of individual investments well. Some individual investments may be making equity payouts with great regularity, while others may never do so and the average value may not be representative of any central tendency of the dividend payout ratio in private infrastructure investments.

Furthermore, capturing the average effect of investing in a large portfolio of private infrastructure firms may not be straightforward (see Blanc-Brude, 2014, for a discussion of the lot size problem in infrastructure investment), thus explicitly modelling path-dependency in private infrastructure investments can be helpful to better understand the nature of conditional expectations and how they may be revised as investments follow one path or another.

We model the expected value of payout ratios in private infrastructure investments as the **product of the conditional probability of receiving a payout at a given point in time, with the expected value of the payout ratio process** in states of the world when payouts actually occur.

In what follows, we review relevant findings about the payout behaviour of the firm in the academic literature in section 4.1. Next, we provide a model of the conditional dynamics of the dividend payout ratio (section 4.2). Section 4.3 presents our estimation results calibrated with the data presented in section 2. Section 4.4 concludes.

## 4.1 Hypotheses

Since Miller and Modigliani (1961) argued that dividend policy does not possess any value relevance for investors, a number of studies have examined why firms pay dividends and the nature of these payments. The first study of corporate dividend payments Lintner (1956) found

# 4. Equity Payout Ratio Dynamics

that listed firms rarely change their dividend policy or that they are 'sticky'. Furthermore, Lintner (1956) found that firms set a target payout ratio (dividends divided by earnings) and that earnings from the previous period, have a greater impact on dividends than current period earnings. This finding implies that dividends are 'smoothed' throughout a business cycle: any positive (or negative) income shock to the company is not passed on in the form of a higher (or lower) dividend immediately. Lintner (1956) postulated that this was due to managers and investors preferring a stable dividend. As a result, managers are hesitant to change their dividend policy, lest the change has to be reversed in future years.

Bhattacharya (1979) and Miller and Rock (1985) also argue that dividends play a role in minimising information asymmetry between owners and managers as firms use dividends to signal their quality. If a firm initiates or increases a dividend then the firm is signalling that management expects positive future opportunities. The opposite occurs when firms cut a dividend. Easterbrook (1984) also argues that investor demand for high dividends requires significant free cash flow, thus forcing the firm to seek external financing (i.e. debt). In turn, external financing creates a well-known discipline mechanism on the firm's management, also reducing agency costs.

This line of thought suggests that dividend payout ratios may be smoothed and exhibit low volatility, irrespective of the volatility of the firm's business model.

However, when Michaely and Roberts (2012) examine unlisted companies in the United Kingdom, they find that private firm dividend policies are different from that of listed companies. Key differences include, the level of dividend smoothing and the size of the dividend payout: unlisted firms tend to smooth their dividend payout less than publicly listed companies.

The decision to smooth dividend payouts is further linked to the dispersal of ownership: the authors find that private firms with concentrated ownership are less likely to smooth dividends than other unlisted companies, while public companies are the most likely to smooth dividends.

The authors find that public firms distribute 27% of their operating profits in dividends (a 2% dividends-to-assets ratio), while private firms with dispersed ownership distribute 17.8% of operating profits (0.9% of assets) and concentrated private firms pay the lowest relative dividend at 13.4% of operating profits and 0.7% of assets.

Such fundings are in line with the Bhattacharya (1979) and Easterbrook (1984) argument about the role of dividend payout policy in mitigating agency costs between shareholders and managers. Indeed, private firms with concentrated ownership are most likely owned by their managers, thus reducing agency costs, and removing the requirement to use dividend payout as either a signal (from the managers to the shareholders) or a

# 4. Equity Payout Ratio Dynamics

discipline mechanism (of the managers by the shareholders).

We know from previous results in chapter 2 and 3 that private infrastructure firms most resemble private firms with concentrated ownership. We can thus assume that the dividend payout ratio of infrastructure firms is likely to be less smooth than that of listed firms. There is however a suggestion in a recent paper by Bremberger et al. (2016) that utility regulation can re-introduce agency costs and and lead to dividend smoothing as well. Hence, regulated infrastructure may exhibit lower payout ratio volatility than other infrastructure firms.

16 - Accounting standards require availability payment projects to be recognised as finance leases. This results in the recognition of the finance component of the unitary charge as finance revenue while the service component of the unitary charge is recognised as turnover. By combining the two we are able to obtain the total revenue for availability-based infrastructure firms such as PFI SPVs.

## 4.2 Dynamic Model

### 4.2.1 Payout State Definition

As stated above, we follow the approach described in Blanc-Brude and Hasan (2015b) and explicitly model the probability of observing a positive equity payout (as defined earlier) at a given point in time (section 4.2.2), in combination with estimating the distribution of payout ratios when positive payouts are made.

Hence, if the payout ratio at time $t$ is $\zeta_t$, and $P_t$ is a payment "state" taking a value of 1 when an equity payout occurs and zero otherwise, then

$$E(\zeta_t) = E(\zeta_t | P_t = 1)$$

As previously stated, infrastructure project owners receive both cash dividends and the principal and interest payments of shareholder loans and, in this study, the payouts to shareholders are calculated as a combination of the two.

The payout ratios is calculated thus:

$$\text{payout ratio} = \frac{\text{dividends}_t + \text{shareholder loans}_t}{\text{revenue}_t} \quad (4.1)$$

where: $\text{dividends}_t$ are the realised dividends at time $t$; $\text{shareholder loans}_t$ is the shareholder loan principal and interest payments at time $t$; and, $revenue_t$ is the sum of turnover and finance revenue at time $t$. [16]

Traditionally the payout ratio is calculated as dividends divided by earnings but since any payout ratio calculation that ignores shareholder loans would not represent the full cash flow distribution to shareholders, our payout ratio calculations includes shareholder loan payments.

Revenue is used as the denominator for our measure of payout ratios, as shareholder loan interest payments are made before earnings are calculated. Using the traditional earnings measure of operating profit, would overstate the payout ratio of infrastructure investments. Using revenues as the denominator, creates a common metric that allows comparison across different types of firms both listed and unlisted.

### 4.2.2 Payment state transition probabilities

### 4.2.3 Setup

As suggested above, dividend payments can take two states $P_t$ in each period $t$: a strictly

# 4. Equity Payout Ratio Dynamics

positive payment, denoted by $P_t = 1$, or no payment denoted by $P_t = 0$. The probability of observing a strictly positive dividend $C_t$ is defined as $Pr(P_t = 1) = p_t$ while $Pr(P_t = 0) = q_t = 1 - p_t$.

Intuitively, the likelihood of observing positive equity payouts in infrastructure investments may not be time-invariant. Infrastructure investments in new projects in particular imply a transformation from a quasi-certain zero payout during the development stage to a non-zero probability of payout at later stages. Conversely, well-established utilities or fully operational projects may exhibit a more constant tendency to produce positive equity payouts, as is the case for other private or public companies.

Future payment states are assumed to be a function of the current state. For $i, j = 0, 1$, let $\pi_{ij} = Pr(P_{t+1} = j | P_t = i)$ be the state transition probabilities, with the one-step transition probability matrix given by:

$$\mathbb{P}_t = \begin{pmatrix} \pi_{11} & \pi_{10} \\ \pi_{01} & \pi_{00} \end{pmatrix} \qquad (4.2)$$

$\pi_{11}$ is the probability of observing a strictly positive dividend at time $t+1$ conditional on having observed a strictly positive dividend at time $t$, and $\pi_{01}$ is the probability of observing a strictly positive dividend at time $t + 1$ conditional on having observed zero dividend at time $t$. By definition, $\pi_{11} + \pi_{10} = 1$, hence

$$\mathbb{P}_t = \begin{pmatrix} \pi_{11} & 1 - \pi_{11} \\ 1 - \pi_{00} & \pi_{00} \end{pmatrix} \qquad (4.3)$$

The significant values of $\mathbb{P}_t$ are $\pi_{11}$ and $\pi_{00}$. The probability of observing a positive dividend at $t+1$ conditional on the realised state at $t$ is written:

$$p_{t+1} = p_t \pi_{11} + (1 - p_t)(1 - \pi_{00}) \qquad (4.4)$$

As discussed in Blanc-Brude and Hasan (2015b), $\mathbb{P}_t$ defines a **Markov Binomial distribution** and we need to estimate $\mathbb{P}_t$ for all values of $t$ as well as initial payment state conditions to know the conditional probabilities of receiving a strictly positive dividend at time $t + 1$.

In the context of a new firm, infrastructure or not, initial conditions at the investment start date $t = 0$ are set to $\pi_{11} = p_0 = 0$ and $\pi_{00} = q_0 = 1$, i.e. it is assumed that no dividend is paid at the start of business. This is intuitive for infrastructure because no dividends are paid during the construction period. For our control firms, it is also reasonable to assume that they begin their life in the zero dividend payout state. For existing firms such as utilities, the initial conditions can be set to an agnostic 50/50 or long-run empirical average positive/zero payout frequencies.

### 4.2.4 Bayesian estimates of $\pi_{ii}$

*Conjugate prior of $\pi_{ii}$*

Each row of $\mathbb{P}_t$ is equivalent to an independent Bernoulli draw of parameter $\pi_{ii}$. With $N_i$ observations of state $i$, the number $n_i$ of successful draws (observing a strictly positive ($i = 1$) or zero ($i = 0$) equity payout) follows a binomial distri-

# 4. Equity Payout Ratio Dynamics

bution $Binomial(\pi_{ii}, N)$, with the likelihood

$$\mathcal{L}(\pi_{ii}; n, N) = p(n|\pi_{ii}) = \binom{N}{n} \pi_{ii}^{n}(1-\pi_{ii})^{N-n} \quad (4.5)$$

as is well known, the prior density $Pr(\pi_{ii}) = Beta(\alpha, \beta)$ is conjugate with respect to the binomial likelihood so that:

$$Pr(\pi_{ii}|n, N) = Beta(\alpha + n_i, \beta + N_i - n_i) \quad (4.6)$$

In other words, by assuming that the true value of $\pi_{ii}$ is the mean of a Beta distribution of parameters ($\alpha$, $\beta$) (prior distribution), given that the likelihood function of the data follows a binomial distribution of parameter $\pi_{ii}$ and $N_i$, we can deduct the values of the parameters of the *posterior* distribution of the value of $\pi_{ii}$ *conditional* on having observed the data given by $N_i$.

Hence, with this very simple estimation procedure, as long as we can count the number of positive and zero payout states in each period, we can estimate the probability to observe a payout in the next period.

*Sequential learning*

In the first observation period, prior values of $\alpha$ and $\beta$ result from our choice of initial conditions and a prior guess for the first period. For new infrastructure projects, this is intuitively set at zero probability of positive equity payout and the certainty of no payout. For existing projects, utilities and the FAME control groups, this is set at 50/50.

Next, the first round of observations of realised payment states in the first period is used to update the prior according to the procedure described above. For $i = 0, 1$, the number of corresponding state observations is computed $((N_0, N_1))$ as well as the number of transitions from state $i$ to $i$ between two periods $(n_0, n_1)$ and the posterior values of $\alpha$ and $\beta$ computed as per equation 4.6. Posterior estimates of these meta-parameters are direct estimates of the mean and variance of parameter $\pi_{ii}$ (see Blanc-Brude and Hasan, 2015b, for a detailed discussion).

Subsequently, prior estimates of $\pi_{ii}$ in the next periods are derived from the posterior estimate at the current period, so that:

$$\pi^{-}_{ii,t+1} = \pi^{+}_{ii,t} \quad (4.7)$$

where the $+$ and $-$ signs indicate posterior and prior estimates of parameter $\pi_{ii}$.

In each period, the prior estimate of $\pi_{ii}$ gives a direct value of the mean estimate of its Beta distribution. The prior value of the variance of $\pi_{ii}$, which expresses the extent to which our knowledge of the value of $\pi_{ii}$ is uncertain, is set in each period to be the inverse log of the cumulative number of observations made for each state. That is,

$$\sigma\pi^{-}_{ii,t} = \frac{1}{log(\sum_{k=1}^{t} N_{i,k})} \quad (4.8)$$

Since our sample tends to have more observations in the earlier years of each infrastructure investment, this measure captures the impact of learning from the available data.

### 4.2.5 Distributions of payout ratios

Having estimated the likelihood of observing positive payouts, we turn to

# 4. Equity Payout Ratio Dynamics

estimating the distribution of payout ratios in the positive payout state. $\zeta_t$, the equity payout ratio defined as the ratio of the equity payout to the firm's revenues at time $t$ is assumed to follow a (negative) exponential distribution.

Hence $\zeta \sim \widetilde{X} = \lambda \exp^{-\lambda x}$, with expected value $E(X) = \lambda^{-1}$ and variance $Var(X) = \lambda^{-2}$, and $n$ observations at time $t$ of $X_{n,t} = \{X_{1,t}, X_{2,t}, \ldots, X_{n,t}\}$. Bayes' rule implies that,

$$Pr(\lambda|X_{n,t}) \propto Pr(\lambda) \times \mathcal{L}(\lambda|X_{n,t}) \quad (4.9)$$

The likelihood function of $X_{n,t}$ is written

$$\mathcal{L}(\lambda|X_{n,t}) = \lambda^n \exp^{-\lambda \sum_i X_{i,t}} \quad (4.10)$$

A prior distribution for $\lambda$ is the Gamma distribution with parameters $a$ and $b$, which is conjugate with respect to the exponential likelihood, so that

$$Pr(\lambda) \propto c\lambda^{a-1} exp^{-\lambda b} \quad (4.11)$$

with $c$ a constant term independent of $\lambda$. It follows that the posterior distribution of $\lambda$ given the data $X_{n,t}$ is written,

$$p(\lambda|X_{n,t}) \propto c\lambda^{a+n-1} \exp^{-\lambda(b+\sum_i X_{i,t})} \quad (4.12)$$

$$\sim \Gamma(a+n, b+\sum_i X_{i,t}) \quad (4.13)$$

Since the expected value and variance of the prior distribution are known ($E(\lambda) = a/b$ and $Var(\lambda) = a/b^2$), as well as the sample size $n$ and the sum of its parts $\sum_i X_{i,t}$, calculating the new value of $\lambda = \lambda'$ given $X_{n,t}$ is given by the parameters $a'$ and $b'$ of the posterior distribution,

$$a' = a + n$$

$$b' = b + \sum_i X_{i,t}$$

.

## 4.3 Estimation Results

We implement the procedure described above to estimate the transition probabilities between payments states as well as the parameters of the payout ratio distribution when firms are in the payment state for Contracted, Merchant and Regulated Infrastructure, as well as the relevant control groups.

For each type of infrastructure firm and its control groups, we report the number of positive and zero payouts and the number of transitions between payouts states in the appendix (Chapter **??**). We also report the resulting conditional (at time 0) probability of being in the positive state ($\pi_{11}$) at time $t$ given a positive payout at $t-1$ and the equivalent for $\pi_{00}$.

Finally, we report the predicted value of the mean payout ratio and its volatility and the calibrated density plot of the payout ratio in the positive payout state.

For instance, for Contracted Infrastructure, figure 40 on page 92 shows that the probability of moving to and staying in the positive payout state increases rapidly and that of staying in the zero payout state once a firm is there first decreases but then

# 4. Equity Payout Ratio Dynamics

*Figure 22: Probability of positive payouts and expected payout ratio in* ***Contracted Infrastructure****, investment time*

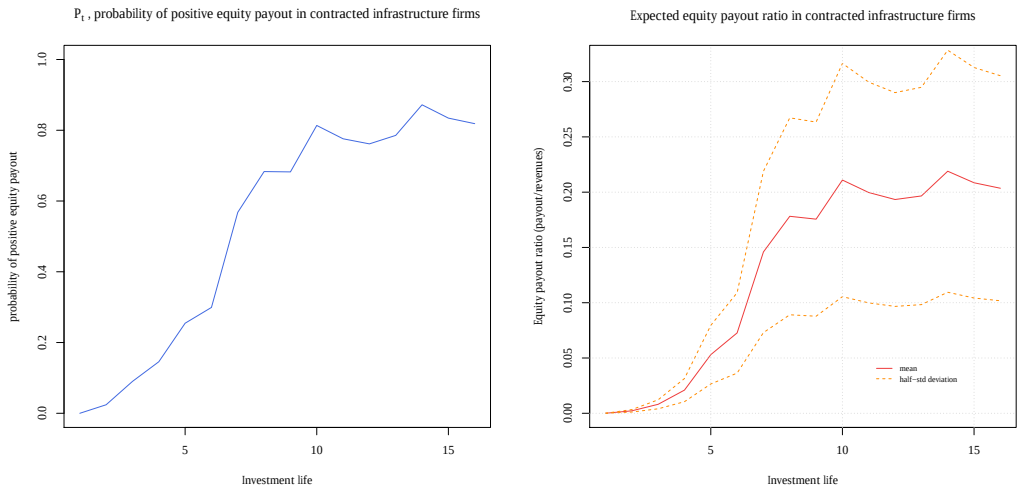
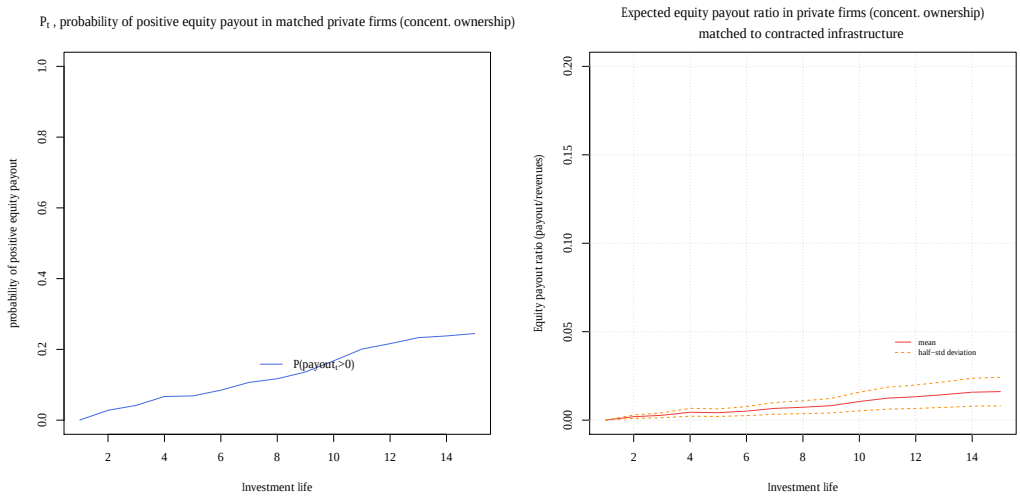



*Figure 23: Estimated probability of positive payouts and payout ratio density in* ***private firms with concentrated ownership****, matched to* ***Contracted Infrastructure***




stagnates around 60%, illustrating the fact that a handful of projects may not succeed in generating a steady stream of equity payouts if they have not managed to begin doing so by year 10 of the investment i.e. the probability of staying in the zero payout state conditional on having been in that state at the previous periods ($\pi_{00}$) starts to increase again after year 10.

The combination of the probability to stay in the positive and zero payout states gives us the probability of observing positive payouts as per equation 4.4. The left panel of figure 22 show estimated probability of positive payout at time *t* in the life of the investment for Contracted Infrastructure (left panel) and the expected payout ratios during the investment period (right panel).

# 4. Equity Payout Ratio Dynamics

*Figure 24: Estimated probability of positive payouts and payout ratio density in **private firms with dispersed ownership**, matched to **Contracted Infrastructure***

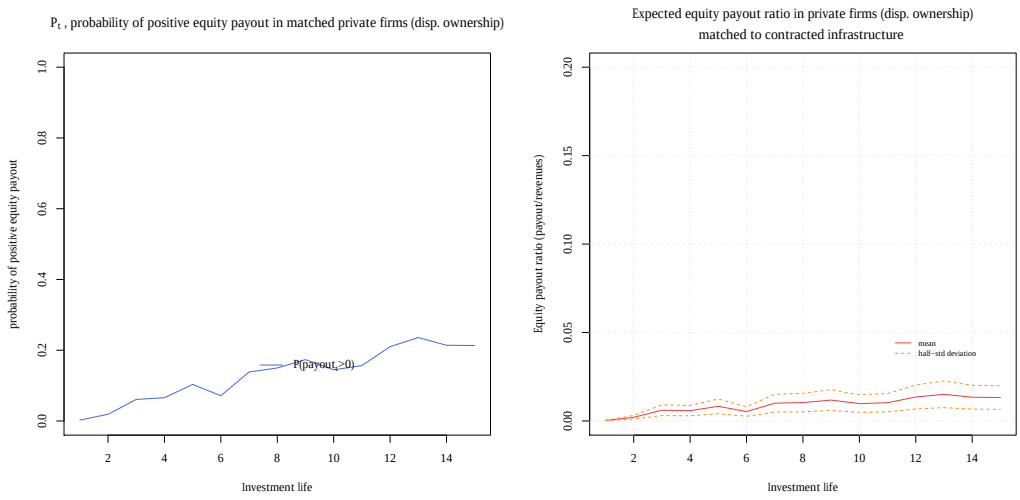
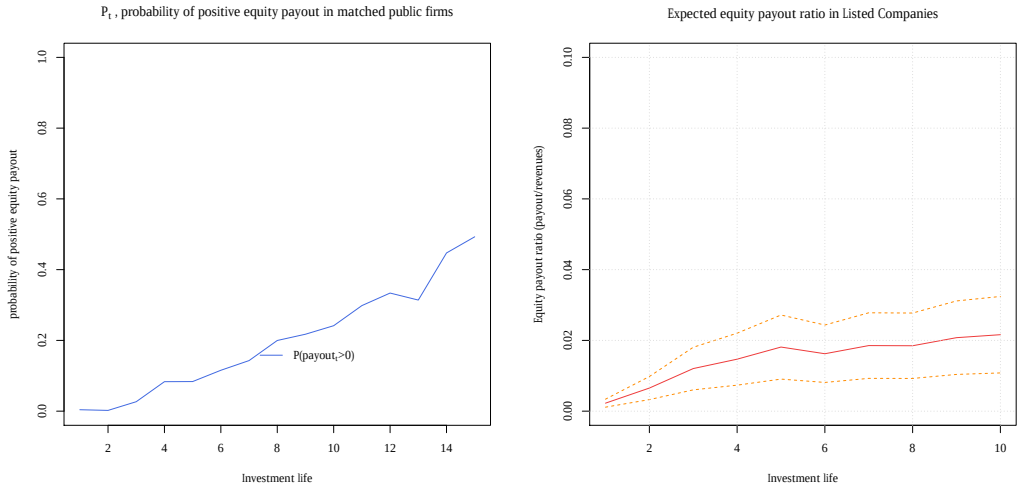



*Figure 25: Estimated probability of positive payouts and payout ratio density in **public firms**, matched to **Contracted Infrastructure***




These results confirm the dynamic equity payout profile of infrastructure investments. Contracted infrastructure firms can thus be expected to pay positive equity payouts with a probability of more 80% by year 10 of their investment lives.

By contrast, figures 23, 24 and 24 show the probability of equity payout and the expected payout ratios over the investment lifecycle for the firms in the three control groups **matched to Contracted Infrastructure**. As for infrastructure firms, detailed payout state counts and transition counts, state transition probabilities and payout distribution parameters estimates are reported in the appendix.

The variance of equity payout ratios tends to be higher in Contracted infrastructure firms than in the control group, suggesting a number of possible paths for each firm:

# 4. Equity Payout Ratio Dynamics

as predicted, dividends are not smoothed like in public firms. However, even the lower bound of the Contracted Infrastructure payout ratio tends to be higher than the high end of the payout ratios of the control groups.

We can thus conclude that equity payouts in Contracted infrastructure are more frequent and higher than in the control groups.

Turning to figure 26, Merchant Infrastructure firms exhibit an equally dynamic profile but do not reach an equally high likelihood of equity payouts. They trend towards a 50% probability of equity payout after 10 years of investment. Still, results control groups matched to Merchant Infrastructure showed on figures 27 to 29 do no manage to achieve such likelihood of payout and expected value of payout ratios for any kind of ownership structure.

Similar results for Regulated Infrastructure are reported in figures 30 to 33. Regulated Infrastructure equity payouts are dynamic and trend towards an expected value of 10%, which none of the control groups get close to.

### 4.3.1 Calendar Time

The same payout analysis was repeated for the different infrastructure groups in calendar time. The results of the analysis are presented in figures 34, 35 and 36. For all infrastructure types, the expected payout ratio steadily increases from 2000 to 2014, the last year of analysis. We do not observe a decrease in the expected payout ratio for any infrastructure type during the recessions in the United Kingdom during this time period.

By way of comparison, the expected payout ratio for the three types of non-infrastructure firms are presented in **??**. In figures 37, 38 and 39 we observe that the expected payout in the matched firms is lower than contracted infrastructure firms. Furthermore, there is a downward trend for the private firms (both the concentrated dispersed ownership firms). The expected payout ratio for all firms in the control group exhibit a negative reaction to the 2008 financial crisis with the expected payout ratio decreasing. [17]

The evidence provided by the expected payout ratio in calendar time supports the previous conclusions that infrastructure payouts were little affected by the 2007-08 shocks and subsequent recession.

## 4.4 Conclusion

In conclusion, two stylised facts stand out from the analysis above:

1. There is strong evidence of path-dependency in the equity payout process of infrastructure firms: those firms that begin to pay dividends early in their life are more likely to be paying dividends later on. As these are private firms with concentrated ownership, the usual explanation for dividend payout stickiness à la Lintner (1956) may be insufficient. Instead, given the

17 - The decrease for the private dispersed ownership firms is not as dramatic as the private concentrated and the listed firms. However, there is a constant trend downwards in expected payout ratio from 2008.

# 4. Equity Payout Ratio Dynamics

*Figure 26: Probability of positive payouts and expected payout ratio in* ***Merchant Infrastructure****, investment time*

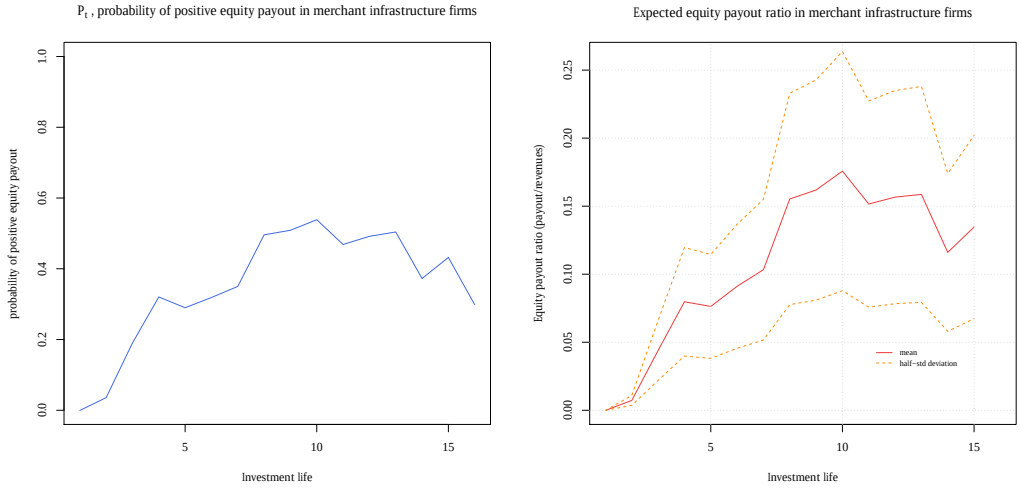
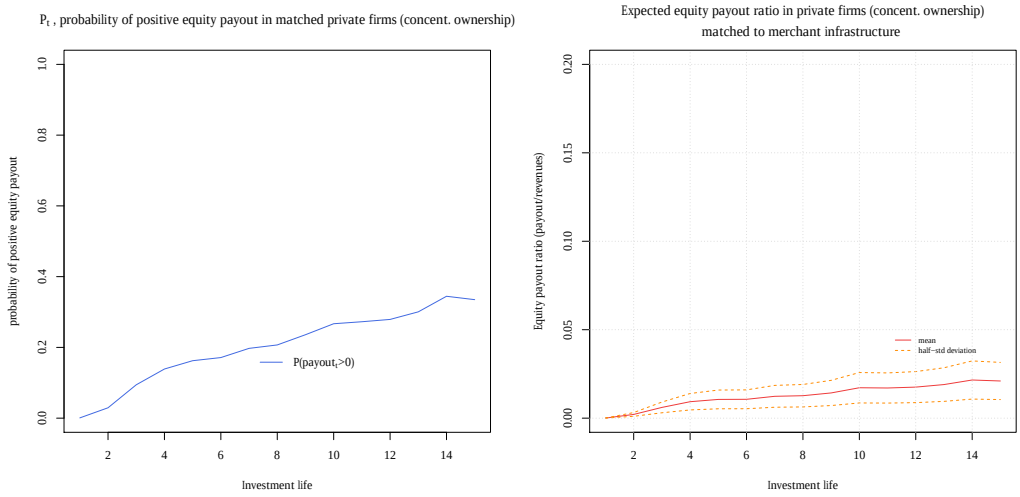



*Figure 27: Estimated probability of positive payouts and payout ratio density in* ***private firms with concentrated ownership****, matched to* ***Merchant Infrastructure***




standalone nature of most infrastructure investment and limited opportunities for the re-investment of retained earning (with the exception of regulated utilities), the dividend payout path of individual infrastructure firm could be interpreted as a measure of their "success" or "failure";

2. Infrastructure firms are more likely to pay a dividend than the different control groups, and are characterised by significantly higher payout ratios.

These results, combined with those of the previous chapter highlighting the significant difference of revenue volatility between infrastructure and non-infrastructure firms, strongly suggest that infrastructure firms are in a league of their own when it comes to both their business model (lower revenue volatility

# 4. Equity Payout Ratio Dynamics

*Figure 28: Estimated probability of positive payouts and payout ratio density in* ***private firms with dispersed ownership****, matched to* ***Merchant Infrastructure***

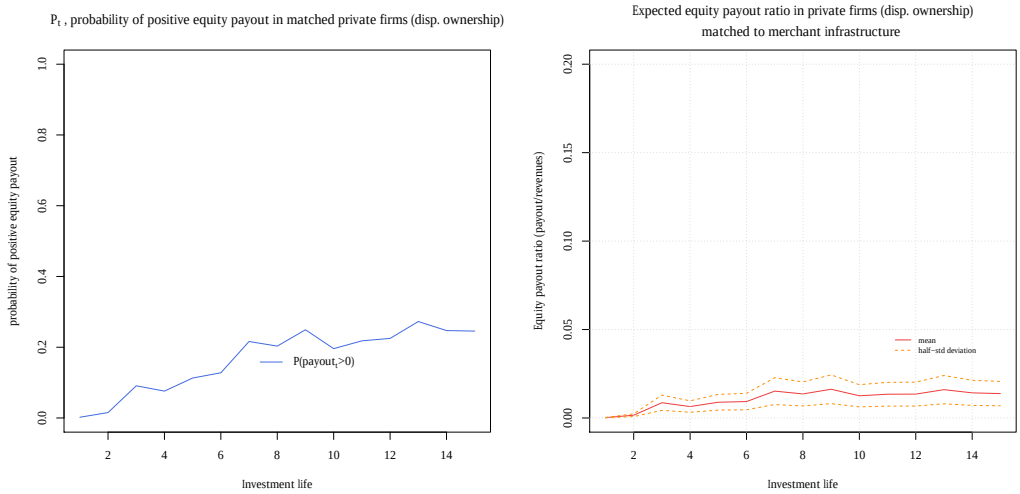
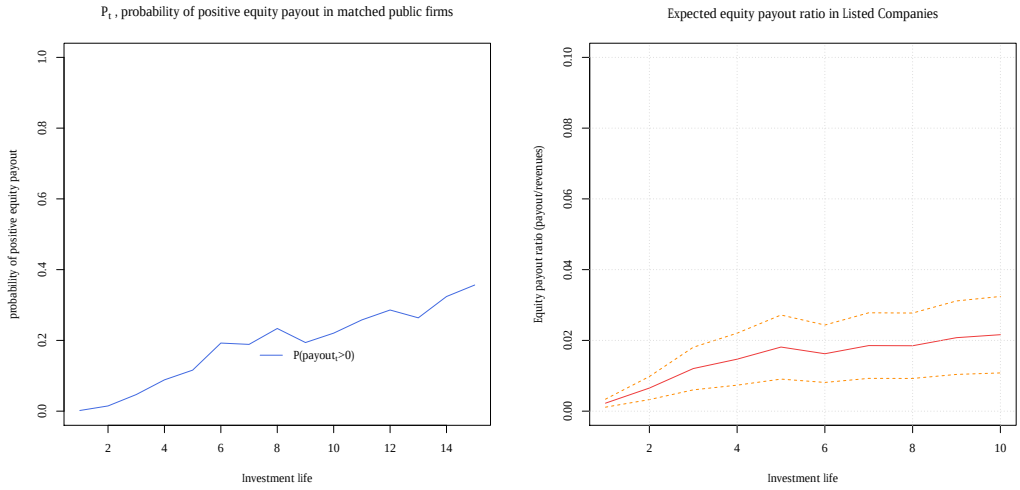



*Figure 29: Estimated probability of positive payouts and payout ratio density in* ***public firms****, matched to* ***Merchant Infrastructure***




and correlation with the business cycle) and their dividend payout behaviour.

# 4. Equity Payout Ratio Dynamics

*Figure 30: Probability of positive payouts and payout ratio density in* ***Regulated Infrastructure****, investment time*

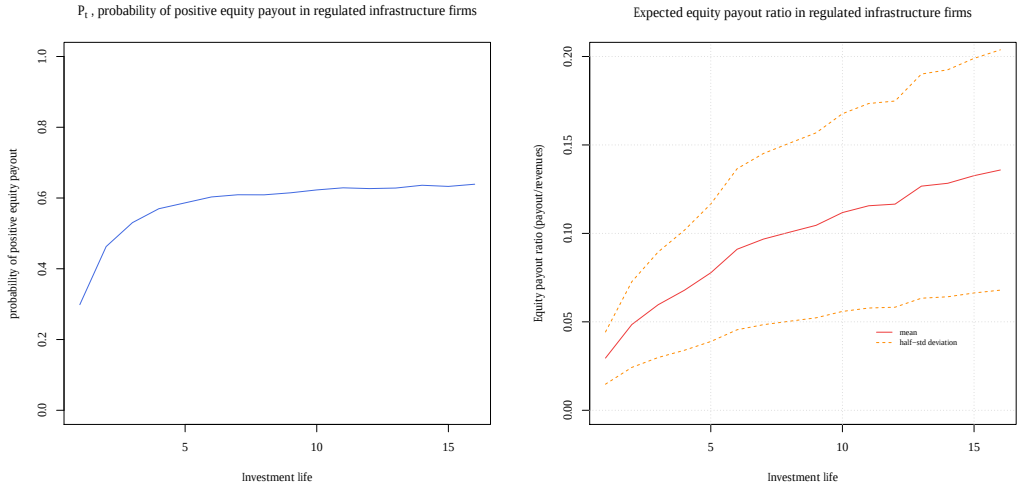
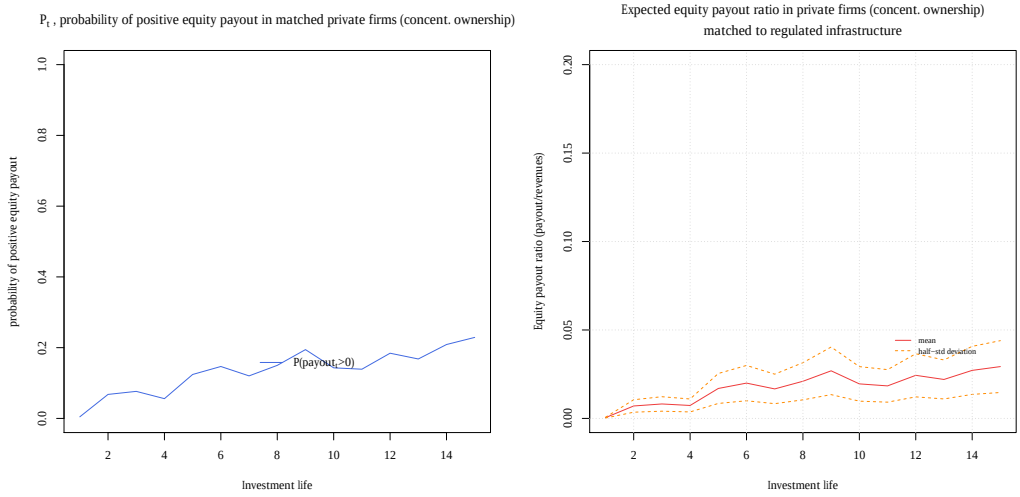



*Figure 31: Estimated probability of positive payouts and payout ratio density in* ***private firms with concentrated ownership****, matched to* ***Regulated Infrastructure***



# 4. Equity Payout Ratio Dynamics

*Figure 32: Estimated probability of positive payouts and payout ratio density in* ***private firms with dispersed ownership****, matched to* ***Regulated Infrastructure***

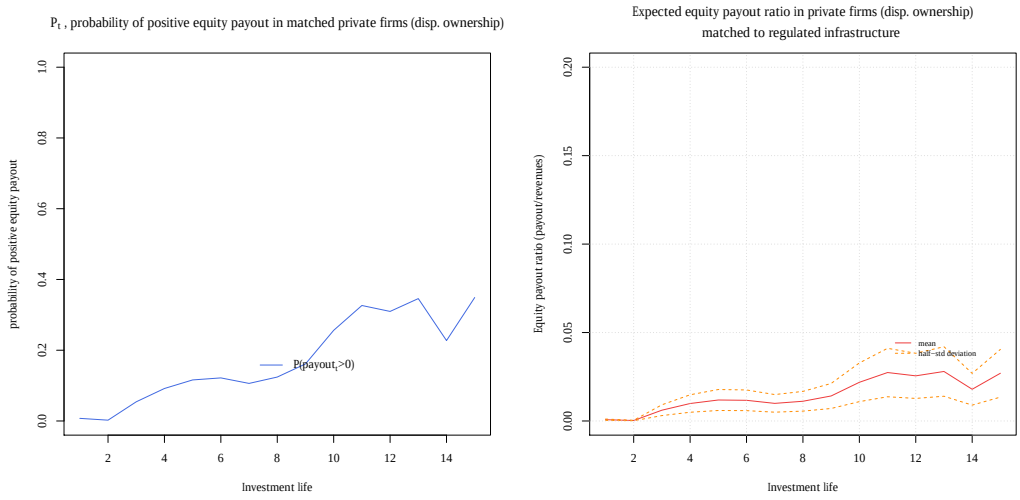
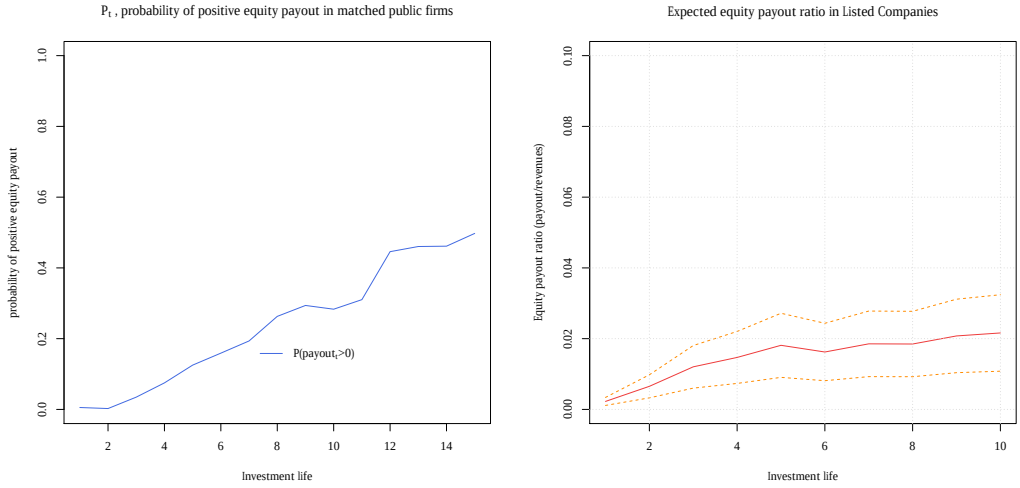



*Figure 33: Estimated probability of positive payouts and payout ratio density in* ***public firms****, matched to* ***Regulated Infrastructure***



# 4. Equity Payout Ratio Dynamics

*Figure 34: Probability of positive payouts and expected payout ratio in* ***Contracted Infrastructure****, calendar time*

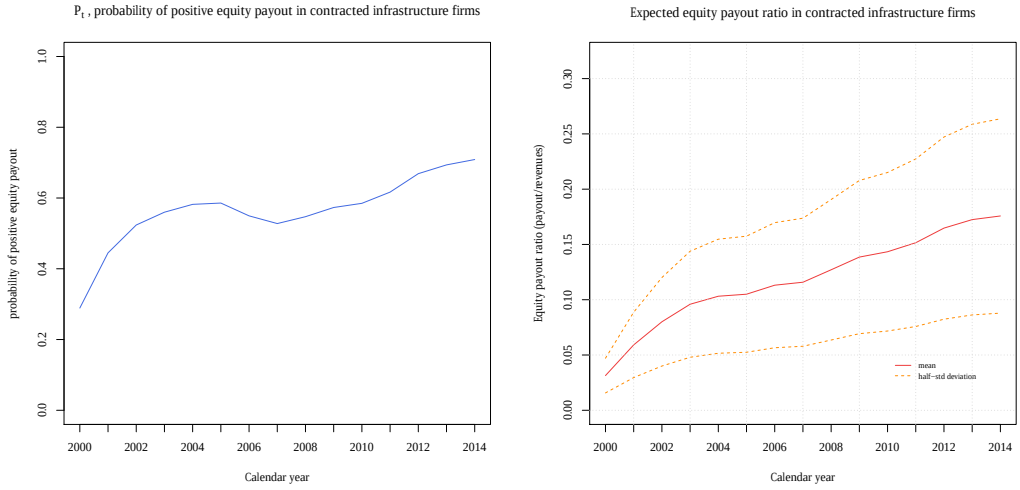
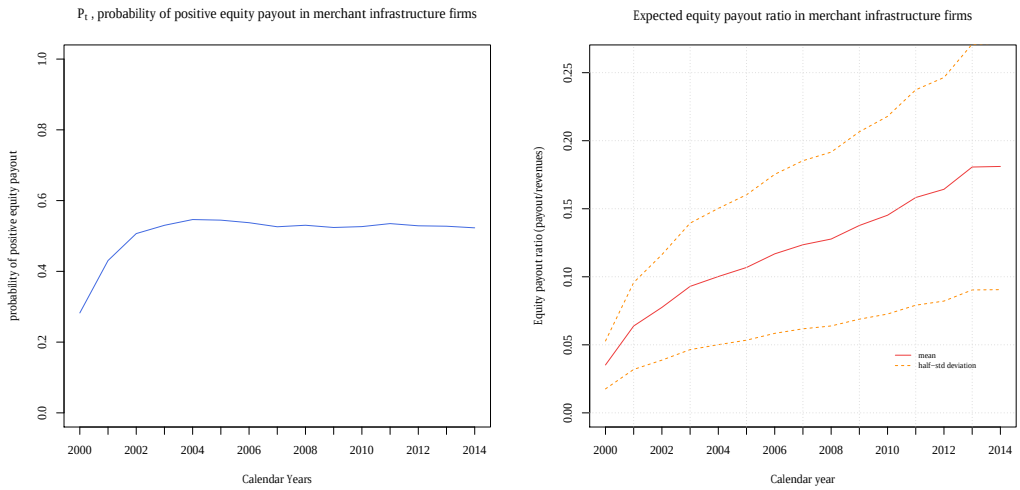



*Figure 35: Probability of positive payouts and expected payout ratio in* ***Merchant Infrastructure****, calendar time*



# 4. Equity Payout Ratio Dynamics

*Figure 36: Probability of positive payouts and expected payout ratio in* ***Regulated Infrastructure****, investment time*

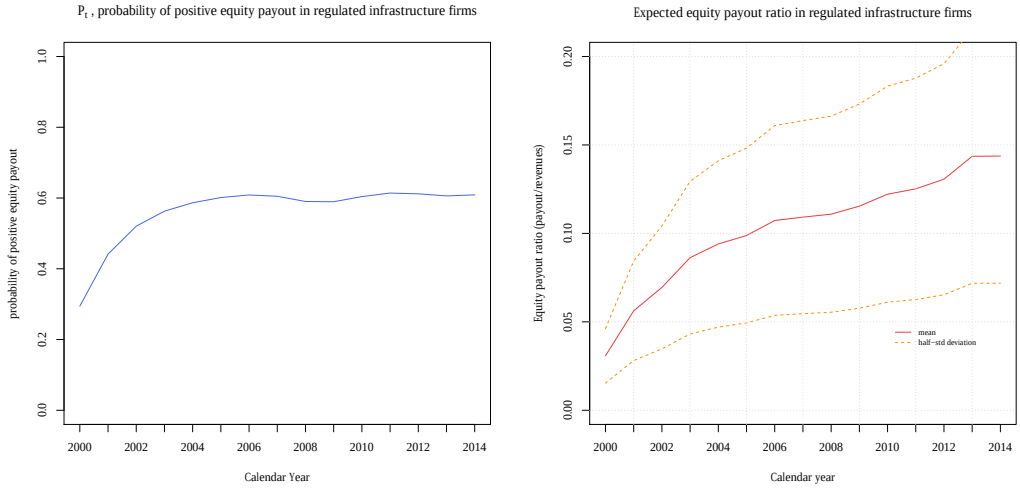
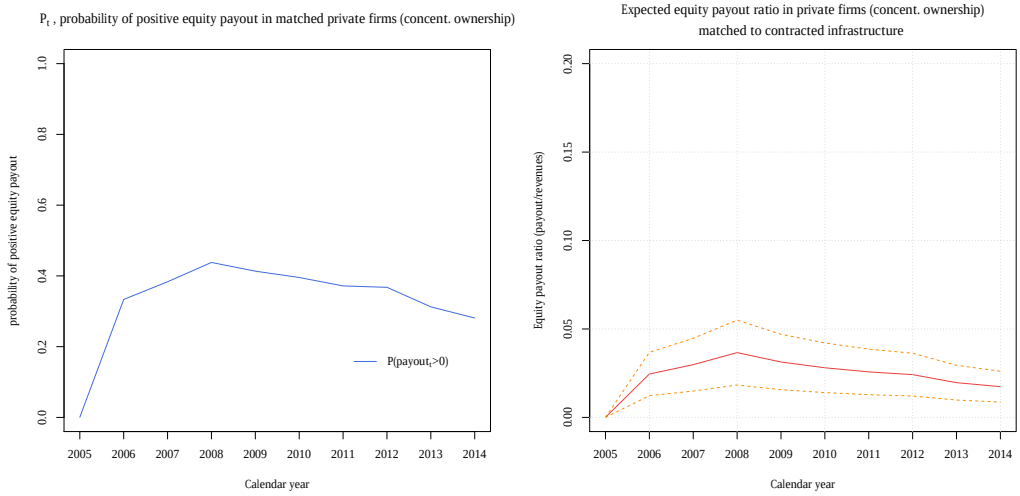


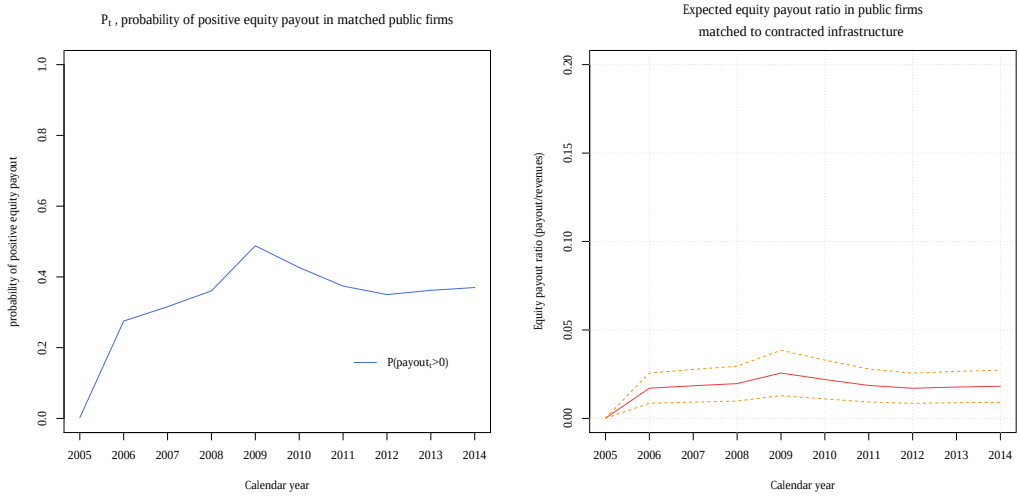

*Figure 37: Probability of positive payouts and expected payout ratio in* ***private firms with concentrated ownership****, matched to* ***Contracted Infrastructure*** *calendar time*



# 4. Equity Payout Ratio Dynamics

*Figure 38: Probability of positive payouts and expected payout ratio in* ***private firms with dispersed ownership****, matched to* ***Contracted Infrastructure*** *calendar time*


*Figure 39: Probability of positive payouts and expected payout ratio in* ***public firms****, matched to* ***Contracted Infrastructure*** *calendar time*



# 5. Conclusions

# 5. Conclusions

## 5.1 A Unique and Robust Dataset

In this paper, we use a new and unique dataset that has been hand-collected and analysed and cover the cash flows of more than 330 UK infrastructure firms over the past 15 to 20 years, and categorised by "infrastructure business model".

We also build a set of control groups that allows conducting robust statistical tests: we collect the equivalent cash flow data for a large sample of UK public and private firms and build "matched" control groups that take into account 1/ ownership nature (public/private) and structure (concentrated/dispersed) 2/ firm characteristics (size, leverage and profitability) and 3/ the "investment lifecycle" (time since its creation date).

Hence, the robustness of our analysis of the revenues, profits and payout ratios of infrastructure firms is greatly improved, and by matching firms in this manner, we effectively test whether or not the statistical characteristics of the cash flows of infrastructure firms cannot simply be replicated by selecting and combining firms that have certain characteristics, but do not correspond to what have called an infrastructure "business model."

## 5.2 The Unique Characteristics of Infrastructure Firms

We test two important ideas for investors in privately-held infrastructure firms:

1. Whether infrastructure firms are characterised by a unique business model: is there a **persistent** difference between these firms and the rest of the corporate universe, which suggests an exposure to a unique exposure to certain investment factors;
2. Given, this difference, whether the payout behaviour of such firms (which ultimately determines the value and performance of the investment) differs from other firms.

We find that, as far as UK data show over the past 15 years, infrastructure firms are indeed truly unique: that is, after controlling for size, leverage and profitability, as well as the impact of the investment "lifecycle", infrastructure firms exhibit lower revenue volatility and higher payout ratios (dividends to revenue) than any other group of private or public firms.

1. Compared to their control groups, infrastructure firms have **lower revenues and profits per dollar invested**, highlighting the **capital-intensive and long-term nature** of their business;
2. They are also characterised by **significantly lower volatility of revenues and profits** compared to their matched control groups, both at the aggregate level (all periods) and at each point in investment and calendar time;
3. Infrastructure firms also exhibit a very **dynamic lifecycle** compared to control groups, with unit revenues and profits evolving by an order of magnitude over the investment cycle;

# 5. Conclusions

4. **Regression analyses** show that different proxies of the "business cycle" have a strong statistical effect on profits and revenues in non-infrastructure firms, but that this effect is absent in the different infrastructure firm test groups i.e. **infrastructure firm revenues and profits are less or not linked to the business cycle.** Instead, the effect of the "investment lifecycle" is what tends to explains the change in unit revenues and profits of infrastructure firms.
5. The **probability of positive equity payouts** in infrastructure firms is also significantly higher than in any of the control groups, reaching as high as 80% after investment year 10 in Contracted infrastructure and the 60-70% range in Merchant and Regulated infrastructure. Control groups never reach a (conditional) probability of payout higher than 40%. These results are illustrated in figures 2 to 4.
6. Finally, equity **payout ratios in infrastructure firms are considerably higher** than in the relevant control groups, reaching expected values of between 10% and 15% of revenues when matched controls never payout more than 3-5% of revenues. Infrastructure firms payout more often and significantly higher proportions of their revenues than other firms once the lifecycle of the firm is taken into account, as shown in figures 5 to 10, which show the equity payout probability and payout ratio for each of our infrastructure test groups compared to the matched "private concentrated" group. Similar results for other control groups are presented in chapter 4.

The combination of these findings suggests that infrastructure firms exhibit a unique business model in terms of revenues and profits dynamics compared to a large control group of public and private firms. **Infrastructure firms have significantly lower volatility of revenues and profits and pay a much higher proportion of their revenues much more frequently to their owners, independent of the business cycle.**

Another significant result is that each of the three types of infrastructure firms that we define (according to a typology we first described in Blanc-Brude (2013)) corresponds to a unique infrastructure business model as well i.e. albeit more alike amongst themselves then compared with the rest of the corporate universe, Contracted, Merchant and Regulated infrastructure firms have their own different cash flow dynamics.

## 5.3 Implications and Next Steps

These results have implications for investment management and prudential regulation:

1. While these results are not about investment returns *per se*, a financial asset that pays more frequently a larger proportion of the free cash flow of the firm can be expected to have a different pricing dynamic compared to the instru-

# 5. Conclusions

ments in the control group. Importantly, it can be expected to provide diversification benefits compared to other private and public equity investments because of the low covariance between revenues and profits of infrastructure and non-infrastructure firms. In other words, from the unique business model of infrastructure firms may well spring **a unique combination of factor exposures** that are relevant to investors.

2. Likewise, the quasi-absence of impact of discrete financial or economic shocks, or of the business cycle captured by macro or market factors, suggests non only low correlations but also **a form drawdown protection in bad times** from holding infrastructure firms.
3. Hence, it is also likely that a large basket of infrastructure firm equity can claim to be treated differently from a regulatory perspective than the rest of available public and private investment opportunities. Of course, the metrics presented here are not directly compatible with the ones required to calibrate a prudential framework such as Solvency-II (which requires computing the 99.5% VaR) but they suggest strongly that **infrastructure firms, with their lower revenue volatility and lesser sensitivity to the business cycle are a good candidate for a specific treatment**.

Next steps, include using these findings to calibrate cash flow models to derive valuations of individual infrastructure assets (see for example Blanc-Brude and Hasan, 2015b) and to build reference portfolios that can be used as benchmarks by investors and regulators alike.

# 6. Appendix: Dataset

# 6. Appendix: Dataset

## 6.1 Cash flow calculations

For the most part the annual accounts are represented faithfully from the statements provided. However, the statements do not include a cash flow statement which is required to understand the underlying cash flows of infrastructure assets. As a result, the cash flow statement is estimated from the income statement and balance sheet. This section will explain how this is conducted and the assumptions inherent in this estimation.

The starting point for all calculations is the operating profit after tax. This value is the accrual profit and does not reflect the actual cash flows the firm experienced over the year. As a result, adjustments are made to take into account the non-cash impacts of the accrual accounts.

## 6.2 Operating Cash Flows

To obtain operating cash flows the following adjustments are conducted"

1. Operating profit after tax
2. add Depreciation and amortisation - these are non-cash charges so are added back
3. add Changes in Finance Receivable - This is the main investment for project financed companies with off-take arrangements. This is because they have to be accounted for as a finance lease. Any change in this amount represents cash received on top of the interest recognised in the income statement.
4. add Interest Expense - this is added back as it is not an operating cash flow, instead this is a financing item
5. add (Increase)/Decrease in receivables and prepayments - any increase (decrease) in receivables and payments means that revenue is recognised (not recognised), but the cash has not be received (cash has been received). As a result the operating profit needs to be adjusted.
6. add Increase/ (Decrease) in payables - any increase in payables means that expenses have been recognised but not paid (a decrease means a liability has been paid, but no expense recognised).
7. add Movement in Taxes - for the same reason as accounts receivables and payables, if this goes up the tax expense has been recognised but not paid, if it is negative, then the tax has been paid, but not recognised.
8. add Increase/ (Decrease) in Non Current Provisions - any increase in provisions means that expenses have been recognised but not paid (a decrease means a liability has been paid, but no expense recognised).
9. add Increase/ (Decrease) in Unearned Income any increase in unearned income means that cash has been received but not recognised as revenue, instead it is an obligation to provide services in the future. (a decrease means the services have been provided and revenue recognised but no cash received).

# 6. Appendix: Dataset

## 6.3 Investment Cash Flows

The investing cash flows are made up of two line items. These are:

1. Change in Investments - takes into account any changes in the short term investments
2. Investment in Project - measures any change in PP&E and increases in the finance debtor. But subtracts any increase in the Asset Revaluation Reserve.

## 6.4 Financing Cash Flows

1. Repayment of Senior Debt - any decrease in the non-current and current senior debt is assumed to be a repayment.
2. Repayment of Mezzanine Debt - any decrease in the non-current and current mezzanine debt is assumed to be a repayment.
3. Repayment of Equity Bridge - any decrease in the non-current and current equity bridge is assumed to be a repayment.
4. Repayment of Shareholder Loans - any decrease in the non-current and current shareholder loans is assumed to be a repayment.
5. Repayment of Bonds - any decrease in the non-current and current bonds is assumed to be a repayment.

The working assumption for all interest is that any that is recognised as an expense during the period in the income statement, is paid in the same period. This is not an issue for capitalised interest during construction, but for projects where interest is capitalised as a result of an inability to pay, it may create some issues.

1. Interest Expense-Senior Bank Loans - any interest recognised as an expense during the period is treated as a cash outflow during the period.
2. Interest Expense-Mezzanine Bank Loans - any interest recognised as an expense during the period is treated as a cash outflow during the period.
3. Interest Expense-Bonds - any interest recognised as an expense during the period is treated as a cash outflow during the period.
4. Interest Expense-Other Interest Bearing - any interest recognised as an expense during the period is treated as a cash outflow during the period.
5. Interest Expense-Share Holder Loans - any interest recognised as an expense during the period is treated as a cash outflow during the period.

Debt draw downs are all calculated the same way. If the difference between the sum of current and non-current debt of this year is greater than the sum of the current and non-current debt of last year it is assumed that the debt has increased. This assumption is poor when dealing with index linked debt securities like RPI linked bonds. However without the necessary detail supplied in the accounts, it is the best alternative at the moment.

1. Drawdown of Senior Debt

# 6. Appendix: Dataset

2. Drawdown of Mezzanine Debt
3. Drawdown of Shareholder Loans
4. Drawdown of Bonds
5. Drawdown of Equity Bridge
6. Initial Equity Investment - this is calculated as the difference between the prior year's paid up capital and the current year's paid up capital. Any increase is assumed to be an inital equity investment.
7. Dividends Paid - is calculated by summing of the prior year's retained earnings and the current year's profit and subtracting the current year's retained earnings. If there's a different, it is assumed to be the dividend paid for the year. Dividends can be declared and not paid so in addition to this, any change in the dividend declared account from the prior year to this year is added.

# 7. Appendix: Control Group Matching

# 7. Appendix: Control Group Matching

*Table 23: Contracted infrastructure matched with private firms, concentrated ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −4.897 | 0.052 |
| p-value | 0.000 | 0.812 |
| Log(Assets) | 0.302 | −0.040 |
| p-value | 0.000 | 0.020 |
| Leverage | 0.690 | 0.431 |
| p-value | 0.000 | 0.000 |
| Profitability | 0.000 | 0.000 |
| p-value | 0.150 | 0.778 |
| Age | −0.034 | 0.021 |
| p-value | 0.000 | 0.000 |
| Treated Observations | 1,596.000 | 1,596.000 |
| Control Observations | 126,700.000 | 39,935.000 |
| Pseudo R-square | 0.248 | 0.032 |

*Table 24: Contracted infrastructure matched with private firms, dispersed ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −3.785 | 0.149 |
| p-value | 0.000 | 0.658 |
| Log(Assets) | 0.260 | 0.036 |
| p-value | 0.000 | 0.154 |
| Leverage | 1.843 | 0.522 |
| p-value | 0.000 | 0.004 |
| Profitability | 0.000 | 0.000 |
| p-value | 0.423 | 0.815 |
| Age | −0.020 | 0.007 |
| p-value | 0.000 | 0.350 |
| Treated Observations | 1,596.000 | 1,596.000 |
| Control Observations | 126,700.000 | 1,520.000 |
| Pseudo R-square | 0.398 | 0.024 |

*Table 25: Contracted infrastructure matched with public firms*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −2.787 | −1.104 |
| p-value | 0.000 | 0.002 |
| Log(Assets) | 0.023 | 0.181 |
| p-value | 0.136 | 0.000 |
| Leverage | 4.025 | 0.689 |
| p-value | 0.000 | 0.001 |
| Profitability | 0.000 | 0.000 |
| p-value | 0.711 | 0.769 |
| Age | −0.031 | −0.025 |
| p-value | 0.000 | 0.000 |
| Treated Observations | 1,596.000 | 1,596.000 |
| Control Observations | 126,700.000 | 3,813.000 |
| Pseudo R-square | 0.663 | 0.082 |

# 7. Appendix: Control Group Matching

*Table 26: Merchant infrastructure matched with private firms, concentrated ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −5.077 | −0.333 |
| p-value | 0.000 | 0.062 |
| Log(Assets) | 0.320 | 0.034 |
| p-value | 0.000 | 0.029 |
| Leverage | 0.094 | 0.004 |
| p-value | 0.000 | 0.905 |
| Profitability | 0.003 | 0.001 |
| p-value | 0.003 | 0.395 |
| Age | −0.013 | 0.000 |
| p-value | 0.000 | 0.880 |
| Treated Observations | 1,129.000 | 1,129.000 |
| Control Observations | 126,700.000 | 39,935.000 |
| Pseudo R-square | 0.162 | 0.002 |

*Table 27: Merchant infrastructure matched with private firms, dispersed ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −3.489 | −1.102 |
| p-value | 0.000 | 0.000 |
| Log(Assets) | 0.334 | 0.146 |
| p-value | 0.000 | 0.000 |
| Leverage | 0.061 | 0.003 |
| p-value | 0.027 | 0.919 |
| Profitability | 0.002 | 0.001 |
| p-value | 0.077 | 0.353 |
| Age | −0.018 | −0.003 |
| p-value | 0.000 | 0.325 |
| Treated Observations | 1,129.000 | 1,129.000 |
| Control Observations | 126,700.000 | 1,520.000 |
| Pseudo R-square | 0.185 | 0.030 |

*Table 28: Merchant infrastructure matched with public firms*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −0.715 | 0.049 |
| p-value | 0.000 | 0.765 |
| Log(Assets) | 0.021 | 0.016 |
| p-value | 0.024 | 0.268 |
| Leverage | 0.238 | 0.130 |
| p-value | 0.000 | 0.010 |
| Profitability | 0.001 | 0.001 |
| p-value | 0.261 | 0.478 |
| Age | −0.019 | −0.002 |
| p-value | 0.000 | 0.453 |
| Treated Observations | 1,129.000 | 1,129.000 |
| Control Observations | 126,700.000 | 3,813.000 |
| Pseudo R-square | 0.088 | 0.006 |

# 7. Appendix: Control Group Matching

*Table 29: Regulated infrastructure matched with private firms, concentrated ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −5.831 | −0.408 |
| p-value | 0.000 | 0.215 |
| Log(Assets) | 0.381 | 0.078 |
| p-value | 0.000 | 0.003 |
| Leverage | −0.228 | −0.369 |
| p-value | 0.010 | 0.038 |
| Profitability | −2.313 | −0.305 |
| p-value | 0.000 | 0.437 |
| Age | −0.013 | −0.014 |
| p-value | 0.000 | 0.000 |
| Treated Observations | 325.000 | 325.000 |
| Control Observations | 126,700.000 | 39,935.000 |
| Pseudo R-square | 0.389 | 0.024 |

*Table 30: Regulated infrastructure matched with private firms, dispersed ownership*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −4.406 | −1.660 |
| p-value | 0.000 | 0.000 |
| Log(Assets) | 0.394 | 0.182 |
| p-value | 0.000 | 0.000 |
| Leverage | −0.023 | 0.257 |
| p-value | 0.851 | 0.285 |
| Profitability | −3.407 | −0.919 |
| p-value | 0.000 | 0.064 |
| Age | −0.014 | −0.001 |
| p-value | 0.000 | 0.863 |
| Treated Observations | 325.000 | 325.000 |
| Control Observations | 126,700.000 | 1,520.000 |
| Pseudo R-square | 0.505 | 0.084 |

*Table 31: Regulated infrastructure matched with public firms*

| | Pre-Match | Post-Match |
|---|---|---|
| Intercept | −2.932 | −0.030 |
| p-value | 0.000 | 0.930 |
| Log(Assets) | 0.165 | −0.039 |
| p-value | 0.000 | 0.146 |
| Leverage | 0.876 | 1.047 |
| p-value | 0.000 | 0.000 |
| Profitability | −2.397 | 0.985 |
| p-value | 0.000 | 0.037 |
| Age | −0.018 | 0.013 |
| p-value | 0.000 | 0.029 |
| Treated Observations | 325.000 | 325.000 |
| Control Observations | 126,700.000 | 3,813.000 |
| Pseudo R-square | 0.227 | 0.055 |

# 8. Appendix: Revenues and Profits

# 8. Appendix: Revenues and Profits

*Table 32: Model 1: **Contracted infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Revenue/Average Assets | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Profitability | 0.240 | 0.210* | 1.200*** | 0.930*** |
| | (0.100) | (0.024) | (0.120) | (0.140) |
| Leverage | −0.011 | −0.021 | −0.007 | 0.059 |
| | (0.052) | (0.014) | (0.020) | (0.040) |
| logAssets | 0.200*** | 0.570*** | 0.660* | 0.590*** |
| | (0.027) | (0.022) | (0.050) | (0.057) |
| Year2001 | −0.043 | | | |
| | (0.063) | | | |
| Year2002 | −0.021 | | | |
| | (0.051) | | | |
| Year2008 | −0.009 | 0.008 | −0.180* | −0.038 |
| | (0.020) | (0.027) | (0.086) | (0.087) |
| Year2009 | 0.009 | −0.050* | −0.220*** | −0.038* |
| | (0.020) | (0.023) | (0.074) | (0.018) |
| Year2011 | −0.003 | −0.020 | −0.080 | 0.029 |
| | (0.020) | (0.020) | (0.064) | (0.088) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.046 | 0.170 | 0.420 | 0.200 |
| Adjusted $R^2$ | 0.040 | 0.130 | 0.330 | 0.170 |
| F Statistic | 7.900*** (df = 8; 1324) | 117.000*** (df = 6; 3465) | 49.000*** (df = 6; 405) | 20.000*** (df = 6; 477) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 33: Model 2: **Contracted infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with GDP index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Profitability | 0.240** | 0.210*** | 1.200*** | 0.940*** |
| | (0.100) | (0.024) | (0.120) | (0.140) |
| Leverage | −0.008 | −0.020 | −0.006 | 0.060 |
| | (0.052) | (0.014) | (0.020) | (0.040) |
| logAssets | 0.200*** | 0.570*** | 0.620*** | 0.600*** |
| | (0.027) | (0.022) | (0.050) | (0.059) |
| log(RealGDP) | 0.340 | 1.400*** | 4.400*** | −0.880 |
| | (0.220) | (0.380) | (0.980) | (1.200) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.047 | 0.170 | 0.430 | 0.200 |
| Adjusted $R^2$ | 0.041 | 0.140 | 0.340 | 0.170 |
| F Statistic | 16.000*** (df = 4; 1328) | 177.000*** (df = 4; 3467) | 78.000*** (df = 4; 407) | 30.000*** (df = 4; 479) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 34: Model 3: **Contracted infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with RPI index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Profitability | 0.230** | 0.210*** | 1.100*** | 0.940*** |
| | (0.100) | (0.024) | (0.130) | (0.140) |
| Leverage | −0.010 | −0.021 | −0.012 | 0.058 |
| | (0.052) | (0.014) | (0.020) | (0.040) |
| logAssets | 0.200*** | 0.570*** | 0.570*** | 0.590*** |
| | (0.027) | (0.022) | (0.053) | (0.059) |
| log(RPI) | −0.245 | 0.880 | 1.700*** | −0.023 |
| | (0.490) | (0.650) | (0.360) | (0.350) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.048 | 0.170 | 0.430 | 0.200 |
| Adjusted $R^2$ | 0.042 | 0.130 | 0.340 | 0.170 |
| F Statistic | 17.000*** (df = 4; 1328) | 174.000*** (df = 4; 3467) | 78.000*** (df = 4; 407) | 30.000*** (df = 4; 479) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 35: Model 4:* ***Contracted infrastructure*** *firms and matched control groups* ***revenues scaled by assets****, investment time fixed effects, with market factors*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Profitability | 0.230** | 0.210*** | 1.100*** | 0.950*** |
| | (0.100) | (0.024) | (0.120) | (0.140) |
| Leverage | −0.013 | −0.019 | −0.011 | 0.070* |
| | (0.052) | (0.014) | (0.020) | (0.040) |
| logAssets | 0.200*** | 0.570*** | 0.610*** | 0.620*** |
| | (0.027) | (0.022) | (0.052) | (0.060) |
| log(market.ind) | −0.007 | 0.013 | −0.110 | −0.320* |
| | (0.034) | (0.053) | (0.150) | (0.180) |
| log(SMB.ind) | −0.240 | 0.061 | 0.950*** | 0.075 |
| | (0.420) | (0.220) | (0.210) | (0.230) |
| log(HML.ind) | 0.200*** | 0.220 | 0.180 | 0.380 |
| | (0.072) | (0.170) | (0.290) | (0.260) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.051 | 0.170 | 0.440 | 0.210 |
| Adjusted $R^2$ | 0.045 | 0.140 | 0.340 | 0.170 |
| F Statistic | 12.000*** (df = 6; 1326) | 118.000*** (df = 6; 3465) | 54.000*** (df = 6; 405) | 21.000*** (df = 6; 477) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 36: Model 1:* ***Merchant infrastructure*** *firms and matched control groups* ***revenues scaled by assets****, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Profitability | 0.003*** | 0.350*** | 0.280*** | 0.720*** |
| | (0.0003) | (0.058) | (0.053) | (0.066) |
| Leverage | 0.031*** | 0.008 | 0.013 | 0.077*** |
| | (0.012) | (0.021) | (0.024) | (0.027) |
| logAssets | 0.220*** | 0.990*** | 0.970*** | 0.660*** |
| | (0.014) | (0.036) | (0.050) | (0.023) |
| Year2001 | −0.200*** | | | |
| | (0.052) | | | |
| Year2002 | −0.130** | | | |
| | (0.052) | | | |
| Year2008 | 0.029 | −0.028 | −0.180*** | −0.061* |
| | (0.027) | (0.035) | (0.068) | (0.033) |
| Year2009 | 0.034 | −0.077** | −0.280*** | −0.032 |
| | (0.027) | (0.031) | (0.063) | (0.033) |
| Year2011 | 0.038 | 0.023 | −0.091 | −0.010 |
| | (0.026) | (0.028) | (0.057) | (0.033) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.250 | 0.160 | 0.340 | 0.280 |
| Adjusted $R^2$ | 0.220 | 0.130 | 0.270 | 0.240 |
| F Statistic | 40.000*** (df = 8; 962) | 127.000*** (df = 6; 4089) | 73.000*** (df = 6; 841) | 134.000*** (df = 6; 2015) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 37: Model 2:* ***Merchant infrastructure*** *firms and matched control groups* ***revenues scaled by assets****, investment time fixed effects, with GDP index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Profitability | 0.003*** | 0.350*** | 0.300*** | 0.710*** |
| | (0.0003) | (0.058) | (0.051) | (0.066) |
| Leverage | 0.029** | 0.007 | 0.011 | 0.070*** |
| | (0.012) | (0.021) | (0.024) | (0.027) |
| logAssets | 0.190*** | 0.990*** | 0.880*** | 0.630*** |
| | (0.015) | (0.036) | (0.050) | (0.025) |
| log(RealGDP) | 0.100 | 0.850* | 6.900*** | 1.200*** |
| | (0.120) | (0.510) | (0.800) | (0.430) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.260 | 0.160 | 0.380 | 0.290 |
| Adjusted $R^2$ | 0.230 | 0.130 | 0.300 | 0.240 |
| F Statistic | 87.000*** (df = 4; 966) | 190.000*** (df = 4; 4091) | 128.000*** (df = 4; 843) | 202.000*** (df = 4; 2017) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 38: Model 3: **Merchant infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with RPI index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Profitability | 0.003*** | 0.380*** | 0.300*** | 0.680*** |
| | (0.0003) | (0.057) | (0.051) | (0.066) |
| Leverage | 0.032*** | 0.006 | −0.002 | 0.059** |
| | (0.012) | (0.021) | (0.024) | (0.027) |
| logAssets | 0.200*** | 0.990*** | 0.780*** | 0.590*** |
| | (0.015) | (0.036) | (0.052) | (0.026) |
| log(RPI) | 0.0500 | 1.400*** | 2.600*** | 0.760*** |
| | (0.069) | (0.130) | (0.270) | (0.130) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.270 | 0.230 | 0.390 | 0.290 |
| Adjusted $R^2$ | 0.240 | 0.190 | 0.310 | 0.250 |
| F Statistic | 90.000*** (df = 4; 966) | 319.000*** (df = 4; 4201) | 135.000*** (df = 4; 843) | 211.000*** (df = 4; 2017) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 39: Model 4: **Merchant infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with market factors*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Profitability | 0.003*** | 0.380*** | 0.290*** | 0.700*** |
| | (0.0003) | (0.057) | (0.051) | (0.067) |
| Leverage | 0.036*** | 0.008 | 0.003 | 0.067** |
| | (0.012) | (0.021) | (0.024) | (0.027) |
| logAssets | 0.190*** | 1.000*** | 0.830*** | 0.610*** |
| | (0.015) | (0.036) | (0.052) | (0.026) |
| log(market.ind) | 0.060 | −0.091 | 0.050 | −0.058 |
| | (0.033) | (0.066) | (0.130) | (0.067) |
| log(SMB.ind) | 0.020 | 0.870*** | 1.500*** | 0.440*** |
| | (0.058) | (0.079) | (0.160) | (0.086) |
| log(HML.ind) | −0.080 | −0.270** | −0.230 | −0.026 |
| | (0.058) | (0.110) | (0.220) | (0.100) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.280 | 0.230 | 0.390 | 0.290 |
| Adjusted $R^2$ | 0.250 | 0.190 | 0.310 | 0.240 |
| F Statistic | 62.000*** (df = 6; 964) | 212.000*** (df = 6; 4199) | 91.000*** (df = 6; 841) | 139.000*** (df = 6; 2015) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 40: Model 1: **Regulated infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Profitability | −0.110 | 0.100** | 0.150* | 0.770*** |
| | (0.069) | (0.040) | (0.078) | (0.100) |
| Leverage | −0.015 | −0.034 | 0.078 | 0.100*** |
| | (0.031) | (0.064) | (0.110) | (0.030) |
| logAssets | 0.200*** | 0.420*** | 0.610*** | 0.300*** |
| | (0.016) | (0.033) | (0.072) | (0.019) |
| Year2001 | −0.011 | | | |
| | (0.029) | | | |
| Year2002 | −0.022 | | | |
| | (0.029) | | | |
| Year2008 | −0.022 | −0.040 | −0.059 | −0.010 |
| | (0.018) | (0.035) | (0.073) | (0.028) |
| Year2009 | −0.026 | −0.100*** | −0.100 | −0.008 |
| | (0.017) | (0.031) | (0.070) | (0.027) |
| Year2011 | −0.038** | 0.009 | −0.130** | 0.023 |
| | (0.018) | (0.030) | (0.062) | (0.027) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.520 | 0.170 | 0.240 | 0.270 |
| Adjusted $R^2$ | 0.460 | 0.140 | 0.180 | 0.230 |
| F Statistic | 37.000*** (df = 8; 274) | 30.000*** (df = 6; 849) | 14.000*** (df = 6; 259) | 46.000*** (df = 6; 741) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 41: Model 2: **Regulated infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with GDP index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Profitability | −0.150** | 0.120*** | 0.170** | 0.750*** |
| | (0.067) | (0.040) | (0.076) | (0.100) |
| Leverage | 0.039 | −0.011 | 0.052 | 0.090*** |
| | (0.033) | (0.063) | (0.100) | (0.029) |
| logAssets | 0.260*** | 0.380*** | 0.540*** | 0.280*** |
| | (0.020) | (0.033) | (0.072) | (0.019) |
| log(RealGDP) | −0.090 | 2.400*** | 3.800*** | 1.700*** |
| | (0.089) | (0.420) | (0.870) | (0.340) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.540 | 0.190 | 0.270 | 0.290 |
| Adjusted $R^2$ | 0.480 | 0.160 | 0.210 | 0.250 |
| F Statistic | 80.000*** (df = 4; 278) | 51.000*** (df = 4; 851) | 25.000*** (df = 4; 261) | 77.000*** (df = 4; 743) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 42: Model 3: **Regulated infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with RPI index*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Profitability | −0.170** | 0.110*** | 0.180** | 0.700*** |
| | (0.072) | (0.040) | (0.078) | (0.097) |
| Leverage | 0.007 | −0.024 | 0.035 | 0.072** |
| | (0.032) | (0.063) | (0.100) | (0.029) |
| logAssets | 0.250*** | 0.360*** | 0.520*** | 0.250*** |
| | (0.024) | (0.034) | (0.076) | (0.019) |
| log(RPI) | −0.090 | 0.790*** | 0.970*** | 0.850*** |
| | (0.070) | (0.130) | (0.290) | (0.100) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.520 | 0.200 | 0.250 | 0.330 |
| Adjusted $R^2$ | 0.460 | 0.160 | 0.200 | 0.280 |
| F Statistic | 74.000*** (df = 4; 278) | 52.000*** (df = 4; 851) | 22.000*** (df = 4; 261) | 93.000*** (df = 4; 743) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 43: Model 4: **Regulated infrastructure** firms and matched control groups **revenues scaled by assets**, investment time fixed effects, with market factors*

| | Dependent variable: Revenue/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Profitability | −0.100 | 0.110*** | 0.170** | 0.700*** |
| | (0.070) | (0.040) | (0.078) | (0.098) |
| Leverage | 0.021 | −0.013 | 0.051 | 0.072** |
| | (0.032) | (0.063) | (0.100) | (0.029) |
| logAssets | 0.220*** | 0.370*** | 0.520*** | 0.250*** |
| | (0.022) | (0.035) | (0.075) | (0.020) |
| log(market.ind) | −0.052 | 0.018 | 0.290** | 0.072 |
| | (0.120) | (0.069) | (0.140) | (0.054) |
| log(SMB.ind) | 0.065* | 0.470*** | 0.520*** | 0.410*** |
| | (0.039) | (0.081) | (0.170) | (0.066) |
| log(HML.ind) | −0.064* | −0.140 | 0.160 | −0.370*** |
| | (0.036) | (0.120) | (0.240) | (0.081) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.530 | 0.200 | 0.290 | 0.330 |
| Adjusted $R^2$ | 0.480 | 0.160 | 0.220 | 0.280 |
| F Statistic | 52.000*** (df = 6; 276) | 35.000*** (df = 6; 849) | 17.000*** (df = 6; 259) | 60.000*** (df = 6; 741) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 44: Model 1:* ***Contracted infrastructure*** *firms and matched control groups* ***profits scaled by average assets****, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Rev2Assets | −0.005 | 0.100*** | 0.300*** | 0.082*** |
| | (0.005) | (0.005) | (0.024) | (0.008) |
| Leverage | −0.100*** | −0.014*** | 0.016** | −0.009 |
| | (0.008) | (0.004) | (0.008) | (0.008) |
| logAssets | 0.027*** | 0.180*** | 0.280*** | 0.170*** |
| | (0.005) | (0.007) | (0.020) | (0.011) |
| Year2001 | 0.003 | | | |
| | (0.010) | | | |
| Year2002 | 0.002 | | | |
| | (0.008) | | | |
| Year2008 | −0.002 | −0.018** | −0.110*** | 0.0001 |
| | (0.003) | (0.008) | (0.035) | (0.017) |
| Year2009 | −0.004 | −0.024*** | −0.100*** | −0.018 |
| | (0.003) | (0.007) | (0.030) | (0.017) |
| Year2011 | 0.004 | −0.006 | −0.033 | 0.003 |
| | (0.003) | (0.006) | (0.026) | (0.017) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.180 | 0.200 | 0.500 | 0.390 |
| Adjusted $R^2$ | 0.150 | 0.160 | 0.390 | 0.320 |
| F Statistic | 35.000*** (df = 8; 1324) | 150.000*** (df = 6; 3523) | 66.000*** (df = 6; 405) | 51.000*** (df = 6; 477) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 45: Model 2:* ***Contracted infrastructure*** *firms and matched control groups* ***profits scaled by average assets****, investment time fixed effects, with GDP index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Rev2Assets | −0.005 | 0.100*** | 0.290*** | 0.081*** |
| | (0.005) | (0.005) | (0.023) | (0.008) |
| Leverage | −0.100*** | −0.015*** | 0.017** | −0.011 |
| | (0.008) | (0.004) | (0.008) | (0.008) |
| logAssets | 0.027*** | 0.170*** | 0.250*** | 0.160*** |
| | (0.005) | (0.007) | (0.020) | (0.011) |
| log(RealGDP) | −0.038 | 0.570*** | 2.500*** | 0.490** |
| | (0.034) | (0.094) | (0.390) | (0.220) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.170 | 0.210 | 0.520 | 0.400 |
| Adjusted $R^2$ | 0.150 | 0.170 | 0.410 | 0.330 |
| F Statistic | 70.000*** (df = 4; 1328) | 232.000*** (df = 4; 3525) | 110.000*** (df = 4; 407) | 79.000*** (df = 4; 479) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 46: Model 3:* ***Contracted infrastructure*** *firms and matched control groups* ***profits scaled by average assets****, investment time fixed effects, with RPI index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Rev2Assets | −0.005 | 0.098*** | 0.270*** | 0.079*** |
| | (0.005) | (0.005) | (0.024) | (0.008) |
| Leverage | −0.100*** | −0.015*** | 0.012 | −0.012 |
| | (0.008) | (0.004) | (0.008) | (0.008) |
| logAssets | 0.027*** | 0.160*** | 0.220*** | 0.160*** |
| | (0.005) | (0.007) | (0.020) | (0.011) |
| log(RPI) | 0.098 | 0.210*** | 1.000*** | 0.210*** |
| | (0.076) | (0.031) | (0.140) | (0.067) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.170 | 0.210 | 0.530 | 0.400 |
| Adjusted $R^2$ | 0.150 | 0.170 | 0.420 | 0.330 |
| F Statistic | 70.000*** (df = 4; 1328) | 236.000*** (df = 4; 3525) | 115.000*** (df = 4; 407) | 81.000*** (df = 4; 479) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 47: Model 4: **Contracted infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with market factors*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Contracted | Concentrated | Dispersed | Public |
| Rev2Assets | −0.004 | 0.098*** | 0.270*** | 0.079*** |
| | (0.005) | (0.005) | (0.023) | (0.008) |
| Leverage | −0.100*** | −0.015*** | 0.013* | −0.012 |
| | (0.008) | (0.004) | (0.008) | (0.008) |
| logAssets | 0.028*** | 0.160*** | 0.240*** | 0.160*** |
| | (0.005) | (0.007) | (0.020) | (0.011) |
| log(market.ind) | −0.012 | 0.013 | −0.003 | 0.011 |
| | (0.015) | (0.015) | (0.060) | (0.035) |
| log(SMB.ind) | −0.002 | 0.130*** | 0.590*** | 0.100** |
| | (0.018) | (0.019) | (0.082) | (0.044) |
| log(HML.ind) | −0.002 | −0.040 | −0.067 | −0.072 |
| | (0.011) | (0.027) | (0.110) | (0.051) |
| Number of Firms | 170 | 835 | 109 | 101 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,520 | 4,364 | 520 | 584 |
| $R^2$ | 0.180 | 0.210 | 0.540 | 0.400 |
| Adjusted $R^2$ | 0.150 | 0.170 | 0.420 | 0.330 |
| F Statistic | 48.000*** (df = 6; 1326) | 158.000*** (df = 6; 3523) | 80.000*** (df = 6; 405) | 53.000*** (df = 6; 477) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 48: Model 1: **Merchant infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Rev2Assets | 0.002*** | 0.026*** | 0.310*** | 0.068*** |
| | (0.0001) | (0.004) | (0.049) | (0.006) |
| Leverage | −0.088*** | 0.005 | 0.011 | −0.023*** |
| | (0.007) | (0.005) | (0.021) | (0.007) |
| logAssets | 0.091*** | 0.200*** | 0.390*** | 0.180*** |
| | (0.008) | (0.009) | (0.050) | (0.007) |
| Year2001 | −0.066** | | | |
| | (0.029) | | | |
| Year2002 | −0.063** | | | |
| | (0.029) | | | |
| Year2008 | 0.007 | −0.030*** | −0.120* | 0.008 |
| | (0.015) | (0.009) | (0.067) | (0.009) |
| Year2009 | −0.011 | −0.033*** | −0.190*** | −0.016* |
| | (0.015) | (0.008) | (0.059) | (0.009) |
| Year2011 | −0.009 | −0.017** | −0.072 | −0.001 |
| | (0.014) | (0.007) | (0.053) | (0.009) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.330 | 0.130 | 0.110 | 0.280 |
| Adjusted $R^2$ | 0.290 | 0.100 | 0.078 | 0.230 |
| F Statistic | 60.000*** (df = 8; 962) | 101.000*** (df = 6; 4199) | 15.000*** (df = 6; 746) | 126.000*** (df = 6; 1954) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 49: Model 2: **Merchant infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with GDP index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Rev2Assets | 0.002*** | 0.025*** | 0.310*** | 0.068*** |
| | (0.0001) | (0.004) | (0.049) | (0.006) |
| Leverage | −0.088*** | 0.004 | 0.012 | −0.023*** |
| | (0.007) | (0.005) | (0.021) | (0.007) |
| logAssets | 0.086*** | 0.190*** | 0.380*** | 0.180*** |
| | (0.009) | (0.009) | (0.050) | (0.007) |
| log(RealGDP) | 0.130 | 0.660*** | 1.600* | 0.320** |
| | (0.167) | (0.100) | (0.950) | (0.140) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.330 | 0.130 | 0.099 | 0.280 |
| Adjusted $R^2$ | 0.290 | 0.110 | 0.070 | 0.230 |
| F Statistic | 118.000*** (df = 4; 966) | 155.000*** (df = 4; 4201) | 21.000*** (df = 4; 748) | 190.000*** (df = 4; 1956) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 50: Model 3: **Merchants infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with RPI index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Rev2Assets | 0.002*** | 0.023*** | 0.310*** | 0.067*** |
| | (0.0001) | (0.004) | (0.049) | (0.006) |
| Leverage | −0.087*** | 0.004 | 0.011 | −0.022*** |
| | (0.007) | (0.005) | (0.021) | (0.007) |
| logAssets | 0.086*** | 0.180*** | 0.370*** | 0.180*** |
| | (0.008) | (0.009) | (0.050) | (0.007) |
| log(RPI) | 0.096 | 0.220*** | 2.600 | 0.330*** |
| | (0.139) | (0.033) | (1.700) | (0.036) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.330 | 0.130 | 0.099 | 0.400 |
| Adjusted $R^2$ | 0.290 | 0.110 | 0.070 | 0.340 |
| F Statistic | 119.000*** (df = 4; 966) | 155.000*** (df = 4; 4201) | 21.000*** (df = 4; 748) | 337.000*** (df = 4; 2017) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 51: Model 4: **Merchant infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with market factors*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Merchant | Concentrated | Dispersed | Public |
| Rev2Assets | 0.002*** | 0.024*** | 0.320*** | 0.068*** |
| | (0.0001) | (0.004) | (0.048) | (0.006) |
| Leverage | −0.087*** | 0.004 | 0.012 | −0.022*** |
| | (0.007) | (0.005) | (0.021) | (0.007) |
| logAssets | 0.085*** | 0.190*** | 0.400*** | 0.190*** |
| | (0.009) | (0.009) | (0.049) | (0.007) |
| log(market.ind) | 0.021 | −0.010 | −0.460*** | 0.015 |
| | (0.019) | (0.017) | (0.130) | (0.018) |
| log(SMB.ind) | 0.046 | 0.140*** | −1.300** | 0.170*** |
| | (0.033) | (0.020) | (0.540) | (0.023) |
| log(HML.ind) | −0.047 | 0.064** | 2.000*** | −0.091*** |
| | (0.033) | (0.028) | (0.420) | (0.027) |
| Number of Firms | 121 | 825 | 212 | 392 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 1,091 | 5,030 | 1,059 | 2,413 |
| $R^2$ | 0.330 | 0.130 | 0.140 | 0.400 |
| Adjusted $R^2$ | 0.290 | 0.110 | 0.097 | 0.330 |
| F Statistic | 79.000*** (df = 6; 964) | 108.000*** (df = 6; 4199) | 20.000*** (df = 6; 746) | 222.000*** (df = 6; 2015) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 52: Model 1: **Regulated infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with calendar year dummies*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Rev2Assets | 0.180*** | 0.098** | 0.230*** | 0.120*** |
| | (0.038) | (0.040) | (0.071) | (0.015) |
| Leverage | −0.013 | −0.006 | −0.020 | −0.077*** |
| | (0.011) | (0.062) | (0.081) | (0.010) |
| logAssets | 0.047*** | 0.066** | 0.260*** | 0.092*** |
| | (0.007) | (0.033) | (0.057) | (0.007) |
| Year2001 | −0.021* | | | |
| | (0.011) | | | |
| Year2002 | −0.027** | | | |
| | (0.011) | | | |
| Year2008 | 0.001 | −0.033 | −0.031 | −0.003 |
| | (0.008) | (0.033) | (0.056) | (0.010) |
| Year2009 | −0.007 | −0.024 | −0.059 | −0.024** |
| | (0.008) | (0.030) | (0.054) | (0.010) |
| Year2011 | −0.014* | −0.006 | −0.029 | 0.004 |
| | (0.008) | (0.029) | (0.048) | (0.010) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.350 | 0.012 | 0.094 | 0.280 |
| Adjusted $R^2$ | 0.290 | 0.010 | 0.072 | 0.240 |
| F Statistic | 17.000*** (df = 8; 250) | 1.700 (df = 6; 849) | 4.500*** (df = 6; 259) | 49.000*** (df = 6; 741) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 8. Appendix: Revenues and Profits

*Table 53: Model 2: **Regulated infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with GDP index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Rev2Assets | 0.180*** | 0.110*** | 0.240*** | 0.120*** |
| | (0.039) | (0.040) | (0.071) | (0.015) |
| Leverage | −0.013 | −0.014 | −0.032 | −0.080*** |
| | (0.011) | (0.062) | (0.081) | (0.010) |
| logAssets | 0.049*** | 0.080** | 0.270*** | 0.085*** |
| | (0.007) | (0.034) | (0.059) | (0.007) |
| log(RealGDP) | −0.021 | −0.700* | −0.430 | 0.420*** |
| | (0.054) | (0.420) | (0.680) | (0.120) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.320 | 0.014 | 0.090 | 0.290 |
| Adjusted $R^2$ | 0.260 | 0.011 | 0.070 | 0.240 |
| F Statistic | 30.000*** (df = 4; 254) | 2.900** (df = 4; 851) | 6.400*** (df = 4; 261) | 75.000*** (df = 4; 743) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

*Table 54: Model 3: **Regulated infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with RPI index*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Rev2Assets | 0.160*** | 0.110*** | 0.240*** | 0.120*** |
| | (0.039) | (0.040) | (0.071) | (0.015) |
| Leverage | −0.012 | −0.010 | −0.026 | −0.080*** |
| | (0.011) | (0.062) | (0.080) | (0.010) |
| logAssets | 0.050*** | 0.083** | 0.290*** | 0.084*** |
| | (0.007) | (0.035) | (0.061) | (0.007) |
| log(RPI) | 0.280 | −0.180 | −0.320 | 0.120*** |
| | (0.240) | (0.130) | (0.230) | (0.039) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.330 | 0.013 | 0.095 | 0.280 |
| Adjusted $R^2$ | 0.270 | 0.010 | 0.074 | 0.240 |
| F Statistic | 32.000*** (df = 4; 254) | 2.700** (df = 4; 851) | 6.900*** (df = 4; 261) | 74.000*** (df = 4; 743) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

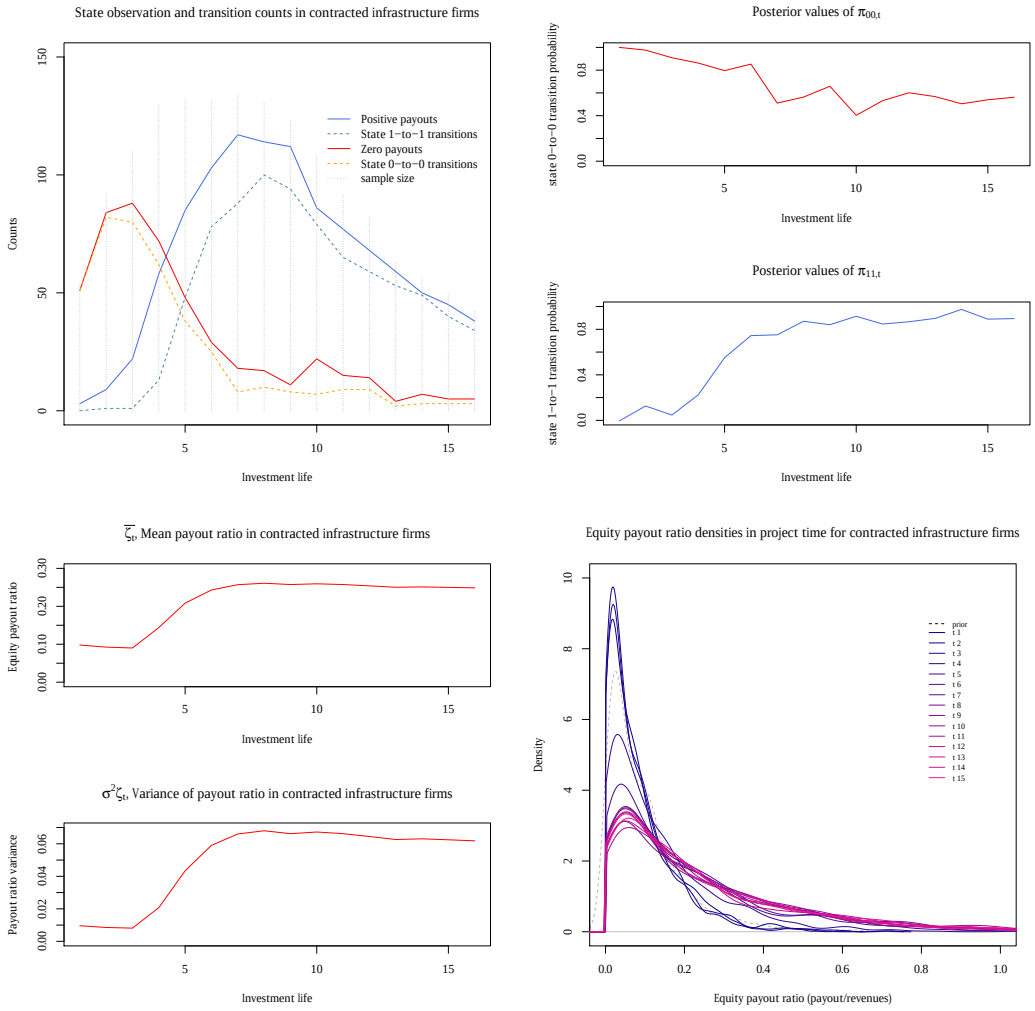
*Table 55: Model 4: **Regulated infrastructure** firms and matched control groups **profits scaled by average assets**, investment time fixed effects, with market factors*

| | Dependent variable: Profit/Average Assets Ratio | | | |
|---|---|---|---|---|
| | Regulated | Concentrated | Dispersed | Public |
| Rev2Assets | 0.160*** | 0.110*** | 0.220*** | 0.120*** |
| | (0.038) | (0.040) | (0.071) | (0.015) |
| Leverage | −0.006 | −0.015 | −0.003 | −0.079*** |
| | (0.010) | (0.062) | (0.079) | (0.010) |
| logAssets | 0.053*** | 0.100*** | 0.320*** | 0.085*** |
| | (0.007) | (0.035) | (0.060) | (0.007) |
| log(market.ind) | 0.032* | −0.170** | −0.230** | −0.007 |
| | (0.022) | (0.067) | (0.110) | (0.020) |
| log(SMB.ind) | 0.087* | −0.075 | −0.130 | 0.070*** |
| | (0.063) | (0.081) | (0.130) | (0.025) |
| log(HML.ind) | −0.057 | 0.230** | 0.630*** | −0.023 |
| | (0.067) | (0.110) | (0.190) | (0.030) |
| Number of Firms | 27 | 168 | 72 | 132 |
| Calendar Years | 1999-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Observations | 309 | 1,023 | 337 | 879 |
| $R^2$ | 0.370 | 0.022 | 0.140 | 0.280 |
| Adjusted $R^2$ | 0.300 | 0.018 | 0.100 | 0.240 |
| F Statistic | 25.000*** (df = 6; 252) | 3.100*** (df = 6; 849) | 6.700*** (df = 6; 259) | 49.000*** (df = 6; 741) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

# 9. Appendix: Payout Ratios

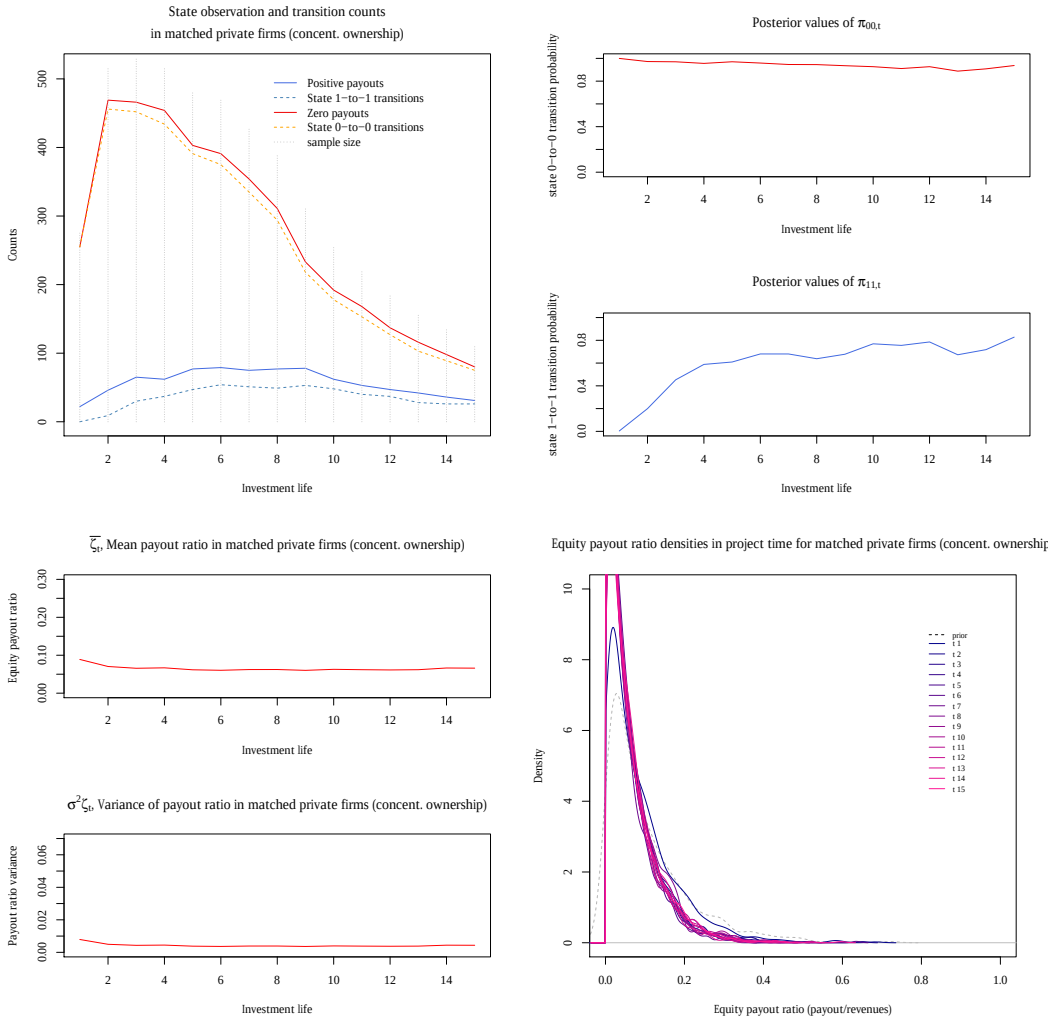
# 9. Appendix: Payout Ratios

*Figure 40: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* Contracted Infrastructure



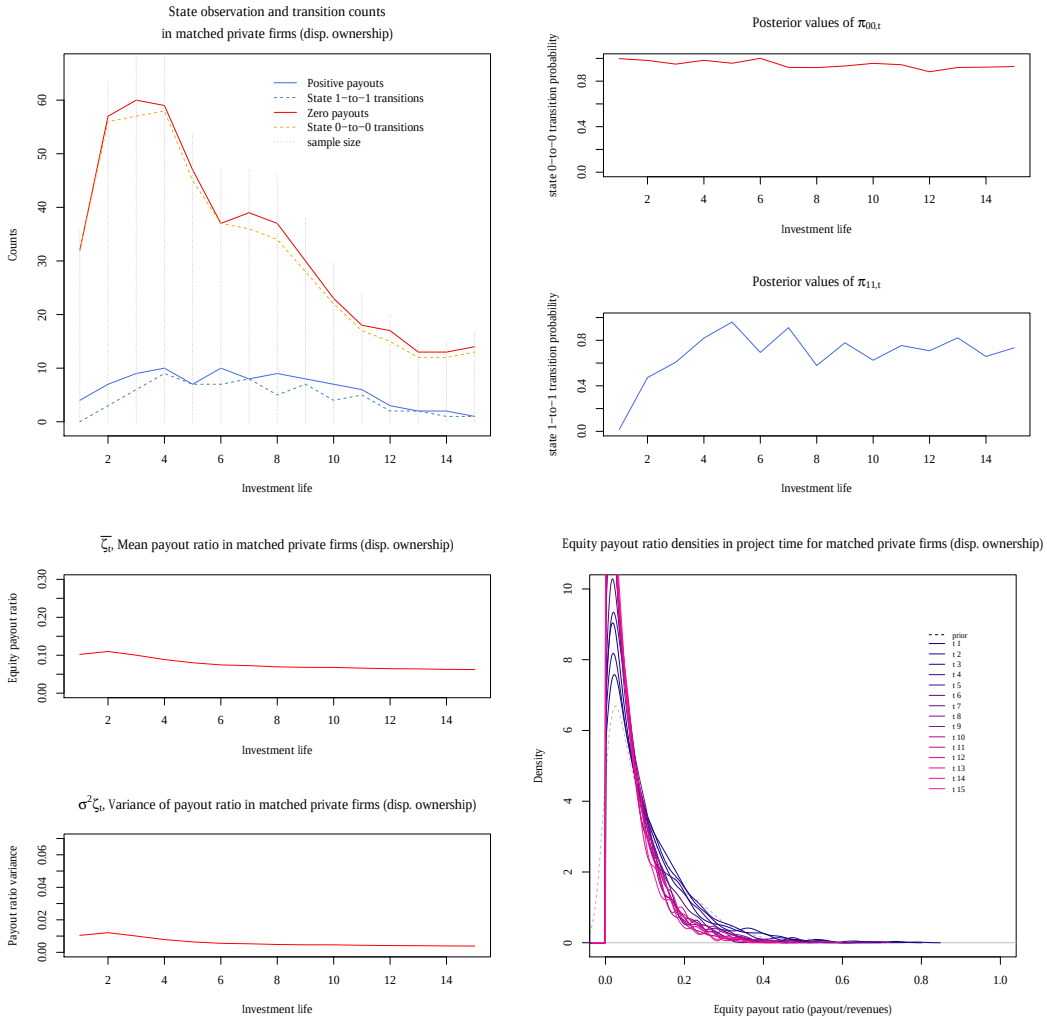
# 9. Appendix: Payout Ratios

*Figure 41: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* **Private Firms with Concentrated Ownership**, *matched to* **Contracted Infrastructure**



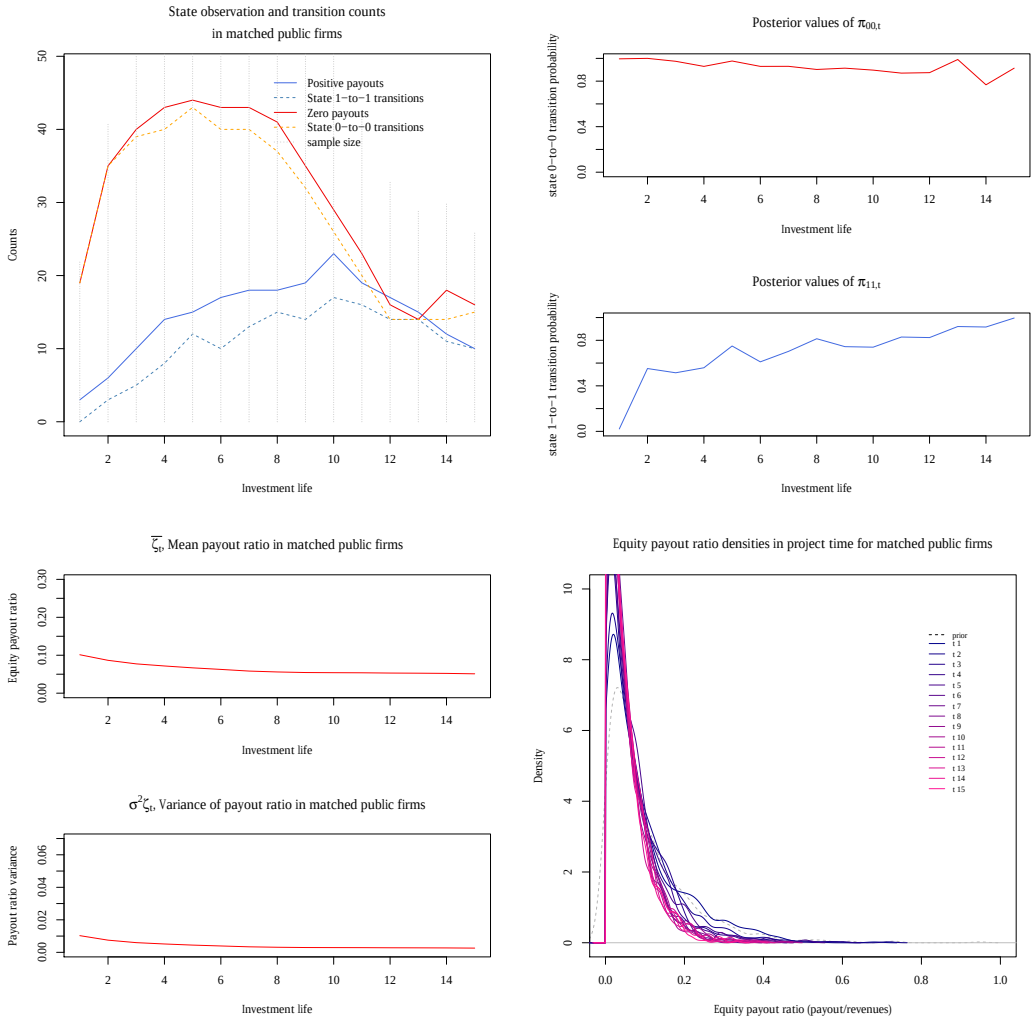
# 9. Appendix: Payout Ratios

*Figure 42: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* **Private Firms with Dispersed Ownership**, *matched to* **Contracted Infrastructure**



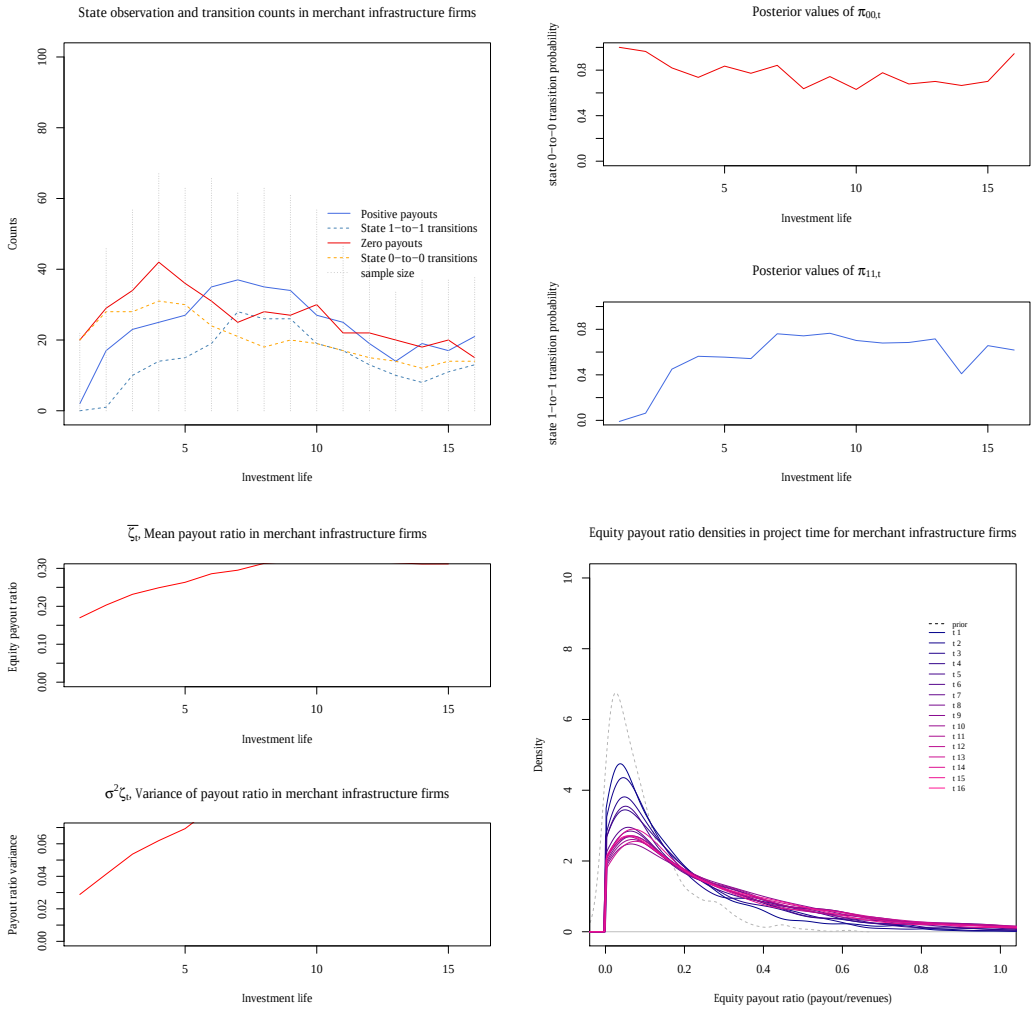
# 9. Appendix: Payout Ratios

*Figure 43: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* **Public Firms**, *matched to* **Contracted Infrastructure**



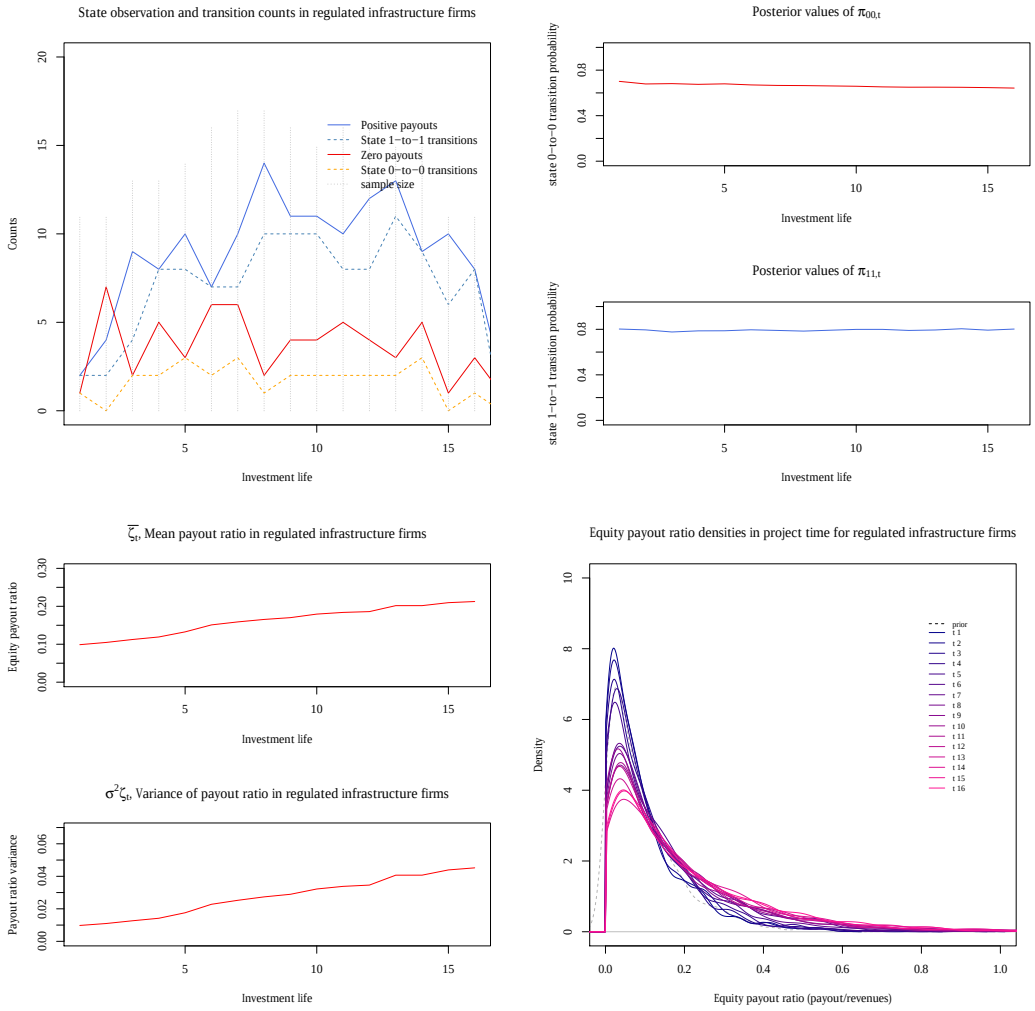
# 9. Appendix: Payout Ratios

*Figure 44: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* **Merchant Infrastructure**



# 9. Appendix: Payout Ratios

*Figure 45: Payout state counts and parameter estimates of the probability of positive equity payout (top panel) and mean, variance estimates and density of payout ratios in the payment state (bottom panel) in* **Regulated Infrastructure**



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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.

# About Meridiam

# About Meridiam

Founded in 2005, Meridiam is an independent investment firm specialised in the development, financing, and management of long-term public infrastructure projects.

With offices in Paris, New York, Toronto, Dakar and Istanbul, Meridiam is a leading investor in public infrastructure.

Currently managing EUR3.5 billion (USD3.8 billion) of assets, the firm has to date invested in 46 projects.

Meridiam is one of the first investors and asset managers to receive ISO 9001 certification for its responsible investment process and is a founding member of the Long Term Infrastructure Investors Association (LTIIA).

www.meridiam.com

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INVESTING FOR THE COMMUNITY

# About Campbell Lutyens

# About Campbell Lutyens

Campbell Lutyens is an independent advisory firm founded in 1988 focused on fund placement and secondary advisory.

In its fund placement practice, it focuses on raising capital globally from limited partners and providing specialist advice to general partners. In its secondary advisory practice, it advises limited partners and general partners on providing liquidity solutions through the sale or restructuring of portfolios of fund or direct investments.

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# About the EDHEC Infrastructure Institute-Singapore

# About the EDHEC Infrastructure Institute-Singapore

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.

## A Profound Knowledge Gap

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

Capturing these benefits, however, requires answering a number of difficult questions:

1. **Risk-adjusted performance measures** are needed to inform strategic asset allocation decisions and monitoring 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 amongst 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 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 investors with important insights about their strategic asset allocation choices to infrastructure, as well as 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 EDHECinfra 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 EDHECinfra'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

# About the EDHEC Infrastructure Institute-Singapore

more efficient and reporting more transparent.
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 investors' investment decisions.

## Partners of EDHEC*infra*

### Monetary Authority of Singapore

In October 2015, the 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:

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 organisation have already recognised the value of this project and have joined or are committed to join the data collection effort. They include:

- The European Investment Bank;
- The World Bank Group;
- The European Bank for Reconstruction and Development;
- The members of the Long-Term Infrastructure Investor Association;

# About the EDHEC Infrastructure Institute-Singapore

- 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

### Origins and Recent Achievements

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.

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-2 framework to long-term investments in infrastructure.

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

# About the EDHEC Infrastructure Institute-Singapore

Significant **empirical findings** already include:

- The first empirical estimates of construction risk for equity and debt investors in infrastructure project finance;
- The only empirical tests of the statistical determinants of credit spreads in infrastructure debt since 2008, allowing controlling for the impact of market liquidity and isolating underlying risk factors;
- The first empirical evidence of the diversification benefits of investing in greenfield and brownfield assets, driven by the dynamic risk and correlation profile of infrastructure investments over their lifecycle;
- The first empirical documentation of the relationship between debt service cover ratios, distance to default and expected default frequencies;
- The first measures of the impact of embedded options in senior infrastructure debt on expected recovery, extreme risk and duration measures;
- The first empirically documented study of cash flow volatility and correlations in underlying infrastructure investment using a large sample of collected data covering the past fifteen years.

Key **methodological advances** include:

- A series of Bayesian approaches to modelling cash flows in long-term investment projects including predicting the trajectory of key cash flow ratios in a mean/variance plane;
- The first fully-fledged structural credit risk model of infrastructure project finance debt;
- A robust framework to extract the term structure of expected returns (discount rates) in private infrastructure investments using conditional volatility and initial investment values to filter implied required returns and their range at one point in time across heterogenous investors.

Recent **contributions to the regulatory debate** include:

- A parsimonious data collection template to develop a global database of infrastructure project cash flows;
- Empirical contributions to adapt prudential regulation for long-term investors.

# Infrastructure Research Publications at EDHEC (2012-16)

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## EDHEC Publications

- 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).
- Blanc-Brude, F., M. Hasan and O.R.H. Ismail. Performance and Valuation of Private Infrastructure Debt (July 2014).
- Blanc-Brude, F., Benchmarking Long-Term Investment in Infrastructure (June 2014).
- Blanc-Brude, F., and D. Makovsek. How Much Construction Risk do Sponsors take in Project Finance. (August 2014).
- Blanc-Brude, F. and O.R.H. Ismail. Who is afraid of construction risk? (March 2013)
- Blanc-Brude, F. Towards efficient benchmarks for infrastructure equity investments (January 2013).
- Blanc-Brude, F. Pension fund investment in social infrastructure (February 2012).

## Books

- Blanc-Brude, F. and M. Hasan, Valuation and Financial Performance of Privately-Held Infrastructure Investments. London: PEI Media, Mar. 2015.

## Peer-Reviewed Publications

- F. Blanc-Brude, S. Wilde, and T. Witthaker, "Looking for an infrastructure asset class Definition and mean-variance spanning of listed infrastructure equity proxies", 2016 (*forthcoming*)
- Blanc-Brude, F., M. Hasan, and T. Witthaker, "Benchmarking Infrastructure Project Finance - Objectives, Roadmap and Recent Progress", Journal of Alternative Investments, 2016 (*forthcoming*)
- R. Bianchi, 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, vol. 3, pp. 57–65, 2014.
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- Blanc-Brude, F. , H. Goldsmith, and T. Valila, "A comparison of construction contract prices for tradition- ally procured roads and public–private partnerships," Review of Industrial Organization, vol. 35, no. 1-2, pp. 19–40, 2009, ISSN: 0889-938X. DOI: 10.1007/s11151-009-9224-1.
- Blanc-Brude, F. , H. Goldsmith, and T. Valila, "Public-private partnerships in europe: an update," EIB Economic & Financial Reports, p. 24, 2007.
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- O. Jensen and F. Blanc-Brude, "The handshake: why do governments and firms sign private sector participation deals? evidence from the water and sanitation sector in developing countries," World Bank Working Papers, Wold Bank Working Paper Series, no. October 2005, p. 25, 2006.

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