Risk, Return and Cash Flow Characteristics of Infrastructure Fund Investments*

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Abstract

We analyze the risk, return and cash flow characteristics of infrastructure investments by using a unique dataset of deals done by private-equity-like investment funds. We show that infrastructure deals have a performance that is higher than that of non-infrastructure deals, despite lower default frequencies. However, we do not find that infrastructure deals offer more stable cash flows. Our paper offers some evidence in favour of the hypothesis that higher infrastructure returns could be driven by higher market risk. In fact, these investments appear to be highly levered and their returns are positively correlated to public equity markets, but uncorrelated to GDP growth. Our results also indicate that returns could be influenced by the regulatory framework as well as by defective privatization mechanisms. By contrast, returns are neither linked to inflation nor subject to the 'money chasing deals' phenomenon.

JEL Classification: G23, G24

1 Introduction

In this paper, we analyze the risk, return and cash flow characteristics of infrastructure investments and compare them to non-infrastructure investments. It is generally argued in the literature that infrastructure investments offer typical characteristics such as long-term, stable and predictable, inflation-linked returns with low correlation to other assets (Inderst 2009, p. 7). However, these characteristics attributed to infrastructure investments have not yet been proven empirically. The goal of this paper is to fill this gap and provide a more thorough understanding of infrastructure returns and cash flow characteristics.

One of the main obstacles in infrastructure research has been the lack of available data. In this paper we make use of a unique and novel dataset of global infrastructure and non-infrastructure investments done by unlisted funds. Overall, we have information on 363 fully-realized infrastructure and 11,223 non-infrastructure deals. The special feature of the data is that they contain the full history of cash flows for each deal. This enables us to study the risk, return and cash flow characteristics of infrastructure investments and to draw comparisons between infrastructure and non-infrastructure investments.

Our results indicate that infrastructure deals have a performance that is uncorrelated to macroeconomic development and that is higher than that of non-infrastructure deals despite lower default frequencies. However, we do not find that infrastructure deals offer cash flows that are more stable, longer term, inflation-linked or uncorrelated to public equity markets. To measure 'stability', we introduce a measure of the variability of cash outflows from the portfolio company to the fund. We also find evidence that infrastructure assets are higher levered but that they have not been exposed to overinvestment as often stated. Finally, we offer some evidence that higher returns might be driven by higher market risk or higher political risk. However, returns in the infrastructure sector might also be driven by defective privatization mechanisms.

This article contributes to the emerging literature on infrastructure financing. Recent publications in this area include Newell and Peng (2007; 2008), Dechant and Finkenzeller (2009) or Sawant (2010a). These previous studies exclusively focus on data from listed infrastructure stocks, indices of unlisted infrastructure investments or infrastructure project bonds. In contrast, we are the first to use data of unlisted infrastructure fund investments.

The article is structured as follows. Section 2 highlights the importance and need for infrastructure assets and summarizes what forms of infrastructure investments are available for investors. Section 3 describes the main investment characteristics that are assumed to be infrastructure-specific and derives the hypotheses on infrastructure fund investments to be tested in this paper. Section 4 describes our database and sample selection. Section 5 presents and discusses the empirical results. Section 6 summarizes the findings and gives an outlook on future research in this area.

2 Infrastructure investments

2.1 The infrastructure investment gap

Several studies estimate that in the course of the 21^{st} century, increasing amounts of money need to be spent on infrastructure assets globally. In this context, infrastructure is generally understood as assets in the transportation, telecommunication, electricity and water sectors (OECD 2007, p. 21). Sometimes other energy-related assets such as oil and gas transportation and storage or social institutions such as hospitals, schools or prisons are included as well.

These estimates are based on an increasing need for such assets in developing countries due to population growth but also economic development. More people need more of the existing infrastructure but they also need new infrastructure, such as better telecommunication or transportation systems when entering globalized markets. But also the developed markets will show an increasing demand for infrastructure assets based on these studies: despite a rather decreasing population, existing but aging infrastructure systems need to be replaced. Moreover, technological progress is an important factor for emerging and developed countries alike as it enables and partly requires more spending on infrastructure assets. This is the case when, for example, upgrading the power grids to match the special requirements of the newly installed offshore wind energy parks. Taken together, needs of worldwide infrastructure investments between 2005 and 2030 could be as high as USD 70,000 billion according to the OECD (OECD 2007, p. 22 and p. 97).

Although high needs and future demands for infrastructure assets are generally recognized, the factor that typically constrains the provision of these goods is the lack of financing resources: The governments of the emerging countries often have not yet established the capabilities to finance and administer the high number and volumes of projects targeted, whereas the governments of the developed countries are struggling with rising social expenditures - partly due to an ageing population - and thus limited budgets for infrastructure (OECD 2007, p. 24). While infrastructure assets have historically been, and still are to a large extent, financed by the public sector, this traditional financing source is unlikely to cover the large estimated investment needs (OECD 2007, p. 29). This gap between the projected needs for infrastructure assets and the supply thereof has found a popular description as the 'infrastructure investment gap' (OECD 2007, p. 14).

A natural idea to solve this problem is to make the infrastructure sectors more accessible for private investors to cover a fraction of the investment needed. Considering assets under management of about USD 25,000 billion (OECD 2010, p. 2) or a weighted average asset-to-GDP ratio for pension funds of 67.1 percent in 2009 (OECD 2010, p. 8) in the funded-pension markets of OECD countries only, suggests that institutional investors, such as pension funds or insurance companies, could narrow the infrastructure investment gap to a large extent if they invested a proportion of their assets in infrastructure assets. Some pension funds have already started doing this with some individual funds showing an infrastructure share of over 10 percent (Inderst 2009, p. 3 and p. 13; Beeferman 2008, p. 16). Nevertheless, only a small proportion of overall pension assets are allocated to infrastructure (OECD 2010, p. 37).

Whatever the amount of capital that could be invested by institutional investors, it is not even clear yet to what extent infrastructure assets are suitable investments for private investors. To analyze this, we next give an overview of the forms of investment into infrastructure that are available to investors.

2.2 Forms of investment

Investors not only have to decide on the optimal share of infrastructure assets in their portfolio but also on the form of investment within the infrastructure sector. The various forms of investment have different profiles regarding minimum-capital requirement or time horizon on the one hand and the various risks associated, such as liquidity or political risk, on the other hand. Figure 1 gives a schematic overview.[1]

[Insert Figure 1 about here]

Making **direct investments** into infrastructure assets such as toll roads or power plants usually requires the longest time horizon for an investor since infrastructure assets have a long life of up to 60 years on average (Rickards 2008). Some concessions can even last as long as 99 years (Beeferman 2008, p. 7). Due to the physical nature of these assets, direct investments cannot easily be sold on and thus bear a high liquidity risk as well. Since infrastructure assets are, on average, very capital-intensive, there are also large capital requirements for single investors as well as the (usually small) group of co-investors. Furthermore, committing a high amount of capital over a long period of time into a single infrastructure asset exposes the investor to high political and regulatory risk. In case a country in which the asset is located changes the legal framework or even attempts an expropriation, investors can hardly react flexibly. Overall, only a few investors like insurance companies or pension funds would be capable of making investments with such characteristics and only recently have these investments become more popular with them (Inderst 2009, p. 3). There are special forms of direct infrastructure investments, the most prominent being those using Public Private Partnerships (PPPs) or project finance structures (see Välilä 2005 and Esty 2003 and 2010, respectively, for overviews of these forms of investment).

The disadvantage of a high capital requirement can be eliminated to a large extent by investing in direct and indirect **listed securities** of companies that operate in sectors relevant to infrastructure, where the amount of capital committed can be s*et al*most arbitrarily. This makes portfolio diversification easier, reducing exposure to single-country political and regulatory risk. Moreover, the high fungibility of listed securities reduces the liquidity risk. Also, the time horizon is lower for listed securities, typically a couple of years. Indexes of listed infrastructure securities and listed infrastructure funds inherently provide for an even better diversification of the business risk of a single company.

[1] For an overview of additional categories refer to Beeferman (2008, pp. 18-23).

Unlisted infrastructure funds also provide less concentrated business risk through diversification effects and enable smaller investors to participate in unlisted infrastructure assets through a smaller minimum capital requirement than for unlisted direct investments. Starting with the launch of the first fund of this kind in 1993, this form of investment has become one of the most specialized and rapidly growing ones, comprising over 70 funds with an average fund size of USD 3.3 billion in 2008 (Preqin 2008; Orr 2007; and Inderst 2009, p. 11).

Such funds are usually structured as Limited Partnerships like in the private-equity industry. The fund manager - called General Partner - collects money from investors, the Limited Partners, and invests it in portfolio companies on their behalf over a specified period of time. The committed capital is returned to the investor in the form of distributions (cash outflows from the point of view of the fund manager) once portfolio companies could be sold off at prices above those at which they were originally bought. In the following, we refer to 'deal' as a single investment by the fund through which the fund participates in the underlying portfolio company. Thereby the deal size can range between 0 percent and 100 percent of the asset value. However, cash flows between portfolio companies and the fund usually differ from cash flows between the fund and investors for at least two reasons: first, a fund participates in more than one investment; and second, the manager receives fees for administration and management of the fund which are deducted from the fund's assets.

In our analysis, we concentrate on single deals by such funds and on the cash flow between the portfolio company and the fund. To the best of our knowledge, we are the first to provide empirical evidence on this form of investment from an academic point of view.

Almost all forms of investment mentioned before can be carried out using **debt or equity financing**. Our sample of infrastructure fund investments contains only equity investments since in this way the risk profile of infrastructure investments can be better traced.[2] Equity funds dominate the market for infrastructure fund investments. Debt financing through private investment vehicles is still quite uncommon.

[2]Infrastructure funds also use mezzanine or debt financing for their assets. The latter is primarily lent by banks and not provided by the funds themselves. The first infrastructure fund that invests exclusively in infrastructure debt was launched in 2009 (Sawant 2010b, p. 93).

From a theoretical perspective, however, infrastructure projects are expected to be debt-financed to a significant extent as *ceteris paribus*, the agency cost of debt is lower compared to non-infrastructure projects. According to the Free Cash Flow Hypothesis, a high level of debt has a disciplinary effect on managers and prevents them from investing in negative net-present-value (NPV) projects (Jensen 1986). Sawant (2010b, pp. 73-81) argues that this mechanism is particularly relevant for infrastructure assets. First, they allegedly provide stable cash flows that can be used to cover a higher level of debt obligations. Second, infrastructure assets have fewer growth options. This further hinders management from over-investing in negative NPV projects, as investment decisions can be monitored more easily by external claimholders.

In the next section we propose eight hypotheses on allegedly infrastructure-specific characteristics that we will test with our data of equity fund investments in Section 5.

3 Hypotheses

When analyzing equity infrastructure *fund* investments we question whether this form of investment offers alleged infrastructure-specific investment characteristics. So far, infrastructure is often referred to as a new asset class in the context of ass*et al*location. For example, large investors such as pension funds have dedicated specific allocation targets for infrastructure, be it separately or within the budget of real assets, inflation-sensitive investments or alternative investments (Orr 2007, p. 81, Beeferman 2008, p. 15). But there is a large variance in how to practically treat these assets in a portfolio context even disregarding the fact that there is no academic consensus on the exact definition of an 'asset class' and its constituting characteristics.

We therefore do not take a stance on the question of an asset class for the reasons mentioned above.[3]

However, what most publications and comments on infrastructure investments agree on is that such investments exhibit special investment characteristics. Therefore, it is the goal of this paper to analyze whether the most commonly postulated characteristics can be observed empirically at the deal level.

[3]For a discussion on infrastructure investments as an asset class, see Inderst (2010).

Infrastructure companies often operate in monopolistic markets or show properties of natural monopolies. Following from here, it is intuitive that such companies also exhibit specific financing and investment characteristics based on their special economic characteristics. We group our eight infrastructure-specific hypotheses (*H1, H2, ... , H8*) into three classes: asset characteristics, risk-return profile, and performance drivers.

3.1 Asset characteristics

> *H1: Infrastructure investments have a longer time horizon than non-infrastructure investments.*

This intuitive hypothesis is based on the aforementioned long life spans of the underlying infrastructure assets (see Section 2.2). Thus we expect that on average, investors hold infrastructure investments for longer than non-infrastructure investments to mimic the long-term asset characteristic.

> *H2: Infrastructure investments require more capital than non-infrastructure investments.*

Infrastructure assets are large and require a high amount of capital when being acquired (Sawant 2010b). Therefore one would expect that on average, investments in such assets require a high amount of capital, too. Specifically, we expect that investors commit more capital per infrastructure deal than per non-infrastructure deal.

3.2 Risk-return profile

> *H3: Infrastructure investments provide stable cash flows.*

The special economic characteristics result in inelastic and stable demand for infrastructure services (Sawant 2010b, p. 35). This intuitively supports the claim that infrastructure assets are bond-like investments with stable and thus predictable cash flows. We would like to stress that the economic characteristics of infrastructure assets also imply special regulatory and legal characteristics. For example, a regulated natural monopoly with rate-of-return regulation may provide stable cash flows and returns by law (Helm and Tindall 2009, p. 414). A similar case is that of a contract-led project, for example for a power plant, whereby a long-term power purchase agreement enables the operator of the plant to forecast output and cash flows well ahead (Haas 2005, p. 8). Of course, this stability only holds if the contract partner does not default and if the legal or regulatory conditions do not change. This shows the inherently high degree of political risk of infrastructure assets.

H4: Infrastructure investments are low-risk and low-return investments.

Despite high political risk, it is often stated that infrastructure investments have low risk from an investor‘s point of view and thus low default rates (Inderst 2009, p. 7). Due to low risk, investors require a low return in compensation. We measure risk by historical default frequency since an investment is risky if the probability of a large decrease in value or failure of the project is high. The multiple and total internal rates of return (IRR) are applied as measures of return. Therefore, we expect lower default frequencies and lower multiples and IRRs for infrastructure deals than for non-infrastructure deals.

H5: Within infrastructure investments there is a different risk-return profile between greenfield and brownfield investments.

This is because greenfield investment assets face a relatively high level of business risk, including construction risk, uncertain demand, and specific risks in the early years after privatizations. For development projects or projects in emerging markets, total return consists mostly of capital growth with a premium for associated risk factors. Investment in the construction phase of a toll road is one example of a development stage infrastructure asset, with initial investors taking construction and, possibly, traffic demand risk.

In contrast, brownfield investments - referring to infrastructure assets that are established businesses with a history of consistent and predictable cash flows - are perceived to be the lowest-return and lowest-risk sector of infrastructure investing. Demand patterns, regulatory conditions and industry dynamics are well understood or at least predictable. An existing toll road is a good example of this kind of infrastructure investments. Once it has been in operation for two or three years, it is likely to have an established, steady traffic profile (Buchner *et al.* 2008, p. 46). Therefore we expect brownfield investments to offer lower default frequencies as well as lower returns on average.

3.3 Performance drivers

H6: Overinvestment has lowered returns on infrastructure investments.

There is empirical evidence for an effect called 'money chasing deals' in private-equity investments at the deal level (Gompers and Lerner 2000) as well as at the fund level (Diller and Kaserer 2009). It means that private equity can be subject to overinvestment, so that asset prices go up and performance goes down. Since the infrastructure deals in our data are made by private-equity funds, we expect that overinvestment in the broader private equity market entails overinvestment for infrastructure deals. We therefore expect that capital inflows into the private equity market lower the subsequent returns not only of non-infrastructure but also of infrastructure deals.

H7: Infrastructure investments provide inflation-linked returns.

Owners or operators of infrastructure assets often implement *ex ante* an inflation-linked revenue component. This enables them to quickly pass through cost increases to the users of the infrastructure assets and thus maintain profit margins and levels of returns. If non-infrastructure companies do so less quickly, we expect infrastructure deals to be more positively influenced by the level of inflation. In the case of natural monopolies, pricing power can also be a source of inflation-linked returns (Martin 2010, p. 23). However, due to regulation it is not totally clear to what extent infrastructure providers are allowed to adjust prices for inflation or exert market power.

H8: Infrastructure investments provide returns uncorrelated with the macroeconomic environment.

Due to the stable demand for infrastructure services outlined in *H3* above, revenues from infrastructure services are not correlated to fluctuations in economic growth. Therefore we expect infrastructure investments to provide returns that are less correlated with macroeconomic developments than non-infrastructure investments. As a corollary, we expect infrastructure investments to be uncorrelated to the performance of other asset classes such as public equity markets. The latter correlation also gives an indication of the market risk of the investment. The sensitivity of returns to a market index as a proxy for the overall investable market is an important parameter in the choice of financial portfolios. Once again, regulation can influence both relationships, though it is not clear in what direction.

3.4 Other performance drivers

Apart from infrastructure-specific hypotheses we also examine differences in regions of investment and industry sectors. Within the infrastructure sector, these variables can, for example, show the differing regional characteristics of the infrastructure market or show how homogenous the sector is across infrastructure assets. Since infrastructure assets have special economic characteristics, we also expect that these and other factors show different impacts on performance compared to non-infrastructure assets.

4 Data

Before testing our hypotheses as well as regional and sectoral characteristics, we give a comprehensive overview of the underlying data.

4.1 Data source

The dataset used for the empirical analysis is provided by the Center for Private Equity Research (CEPRES), a private consulting firm established in 2001 as a spin-off from the University of Frankfurt. Today it is supported by Technische Universität München and Deutsche Bank Group. A unique feature of CEPRES is the collection of information on the monthly cash flows generated by private equity deals.

CEPRES obtains data from private-equity firms that make use of a service called 'The Private Equity Analyzer'. Participating firms sign a contract that stipulates that they are giving the correct cash flows (before fees) generated for each investment they have made in the past. In return, the firm receives statistics such as risk-adjusted performance measures. These statistics are used by the firm internally for various purposes like bonus payments or strengths/weaknesses analysis. Importantly, and unlike other data collectors, CEPRES does not benchmark private equity firms to peer groups. This improves data accuracy and representativeness as it eliminates incentives to manipulate cash flows or cherry-pick past investments. In 2010, this programme has reached coverage of around 1,200 private-equity funds including more than 25,000 equity and mezzanine deals worldwide.

Earlier versions of this dataset have been utilized in previous studies.[4] For this paper, CEPRES granted us access to all liquidated investments in their database as of September 2009. We thus have access to a comprehensive and accurate panel of total cash flow streams generated by infrastructure and non-infrastructure private-equity investments. This unique feature enables us to construct precise measures of the investment performance, which is essential for comparing the risk, return and cash flow characteristics of infrastructure and non-infrastructure investments.

4.2 Sample selection

We eliminate mezzanine deals and all deals that are not fully realized yet. By doing this we can concentrate on cash flows of pure equity deals that actually occurred and do not have to question the validity of valuations for deals that have not had their exit yet. Our data contain deals that have had their initial investment and final exit between January 1971 and September 2009.[5] We split the remaining sample into infrastructure and non-infrastructure deals according to an infrastructure definition following Bitsch *et al.* (2010). Hereby, infrastructure deals are defined as investments in physical networks within the sectors Transport (including aviation, railway, road and marine systems), Telecommunication (including data transmission and navigation systems), Natural re-

[4] A subset of the database covering mainly venture capital investments is used by Cumming *et al.* (2009), Cumming and Walz (2009), and Krohmer *et al.* (2009). A subset covering buyout investments is used by Franzoni *et al.* (2010).

[5] The sample also contains infrastructure deals by funds that are not exclusively dedicated to infrastructure investments. This explains why deals are included that had their initial date of investment before the emergence of specialized infrastructure funds in the 1990s.

sources and energy (including oil, gas, tele-heating and electricity) and Renewable energy (renewable electricity). Social infrastructure such as schools, hospitals *etc.* are not included in our definition.

4.3 Variables

Table 1 gives an overview of the most important variables included in the analysis. A full list and description of variables used in the regressions can be found in Table 2. Table 1 also summarizes which hypotheses the variables serve to test and what outcome is expected based on the corresponding hypothesis.

[Insert Tables 1 and 2 about here]

4.4 Descriptive statistics

After the sample selection process, the final sample contains 363 infrastructure and 11,223 non-infrastructure deals. As Franzoni *et al.* (2010) point out, the total CEPRES database can be considered representative for the global private-equity market. Differences between the infrastructure and non-infrastructure sample could thus reveal specifics of the infrastructure market.

[Insert Table 3 about here]

Table 3 above and Table 4 below give information on industry sectors, stages of investment and regions of investment. Table 3 shows that within the infrastructure subsample, the sector Telecommunication dominates (58.7 percent) followed by Natural resources & energy (24.8 percent), Transport (12.9 percent), whereas the number of Alternative energy deals is rather marginal (3.6 percent).

[Insert Table 4 about here]

Table 4 shows a slight majority of venture capital (VC) over private equity (PE)[6] deals (52.9 percent *versus* 47.1 percent) in the infrastructure sample. The dominance

[6]In the following, we refer to 'Venture Capital' as assets that are classified being in the Seed, Start Up, Early, Expansion, Later or Unspecified VC stage. We refer to 'Private Equity' as assets that

of venture capital is stronger in the non-infrastructure sectors (58.1 percent *versus* 41.9 percent). From Table 4 we also see that for the infrastructure market, European deals are as frequent as North American deals in our sample, whereas North-American deals clearly outnumber European deals in the non-infrastructure sub-sample. For comparison, the most comprehensive publicly-available private equity datasets Thomson Venture Expert and Capital IQ show that the overall private-equity market is largely dominated by North American deals (Lopez de Silanes *et al.* 2009, p. 9). Compared to that, European deals occur relatively more frequently in the infrastructure market as shown in Table 4, which reflects that the European market for infrastructure is more mature than the US market (OECD 2007, p. 32).

Finally, Figure 2 shows the frequencies of deals per year as a percentage of the total number of deals, thereby distinguishing between infrastructure and non-infrastructure deals.

[Insert Figure 2 about here]

5 Empirical results

We now turn to the empirical results. We use the data described above to test the hypotheses outlined in Section 3.

5.1 Asset characteristics

H1: In order to test the hypothesis that infrastructure investments have longer time horizons, we look at the differences in duration of the deals. We expect that infrastructure deals have longer average durations compared to the non-infrastructure deals. The results in Table 5 show, however, that this is not the case, so we reject the hypothesis. We even find a shorter average duration for infrastructure deals (48.90 months) than for non-infrastructure deals (50.83 months) but the difference is not statistically significant. The finding that the time horizon of infrastructure deals is generally no longer than

are classified being in the Growth, Management buy-out/Management buy-in (MBO/MBI), Recapitalization, Leveraged buy-out (LBO), Acquisition Financing, Public to Private, Spin-Off or Unspecified Buyout stage.

that of non-infrastructure deals also holds for the median. It also holds across stages of investment as illustrated in Table 6.

[Insert Tables 5 and 6 about here]

This finding is surprising, considering the long average life span of infrastructure assets (Rickards 2008). In this regard, it is worth pointing out that our sample contains deals done by private-equity-type funds which typically have a duration of 10 to 12 years (Metrick and Yasuda 2010, p. 2305), constraining the time horizon of the investment. Typically, the life of an infrastructure asset will continue after the exit of the fund and thus can be much longer. Nevertheless, our finding is important. As most infrastructure funds raised nowadays have a typical private equity-type construction, the average duration of infrastructure deals of around four years shows that these funds do not typically incorporate the longevity of infrastructure assets.

H2: As frequently stated, infrastructure assets require large and often up-front investments (Sawant 2010b, p. 32). As we do not have information on the total size of the infrastructure assets in our data, we approximate capital requirement by deal size of the investments. Thereby, deal size measures the sum of all cash injections of a fund into the portfolio company between the initial investment and the exit. This is not equal to the size of the whole infrastructure asset. It just measures the size of the stake a single fund takes in the asset. Deal size provides a good indication for capital requirement assuming that on average, deal size increases with the size of an asset.

The results in Tables 7 and 8 show that infrastructure deals are, on average, almost five times the size of non-infrastructure deals.[7] The larger size of infrastructure deals holds individually in each stage sub-sample, *i.e.*, for venture capital and private equity deals. We therefore do not reject the hypothesis that infrastructure deals are larger than non-infrastructure deals.

[Insert Tables 7 and 8 about here]

[7]The median size of infrastructure deals is almost twice the size of non-infrastructure deals, which shows that the average size of infrastructure deals is inflated by outliers.

5.2 Risk-return profile

H3: We now turn to the analysis of the variability of the infrastructure and non-infrastructure deal cash flows. In general, it is argued that infrastructure assets are bond-like investments that provide stable and predictable cash flows. Therefore, we would expect the sub-sample of infrastructure deals to exhibit lower cash flow variability than the non-infrastructure deals.

In order to analyze this hypothesis, we first need to construct an appropriate measure of cash flow variability. A very simple approach would be to measure cash flow variability by the volatility of cash outflows of an investment (see *e.g.* Cumming and Walz 2009). However, this simple approach would neglect the fact that cash outflows of infrastructure and non-infrastructure deals are typically not identically distributed over time.

This is illustrated in Figures 3a and 3b by the S-shaped structure of the average cumulated capital outflows of the infrastructure and non-infrastructure deals over time. This S-shaped structure implies that average capital outflows are not stable over time; otherwise the function would be linear. Therefore, the dispersion around a constant mean is not an appropriate measure of cash flow variability.

[Insert Figures 3a and 3b about here]

A more appropriate measure of variability must account for the time-dependent means. We do this by measuring the cash flow volatility by the dispersion of the deal cash flows around the average structures given in Figures 3a and 3b.[8] We do this by using the infrastructure-specific average structure for calculating the variability of cash flows of infrastructure deals and using the non-infrastructure-specific average structure for non-infrastructure deals. This approach is only valid if the average structures shown in Figures 3a and 3b are representative of the sample deals. We verify this by a bootstrap simulation. The simulation results show that the mean structures can be measured with high precision, as indicated by the confidence bounds in Figures 4a and 4b.

[Insert Figures 4a and 4b about here]

[8] At first glance, Figures 3a and 3b seem to suggest that infrastructure deals provide slightly faster outflows than non-infrastructure deals. However, these differences are not statistically significant.

Table 9 shows the empirical results. To account for the different durations of our sample deals, we construct two different cases: 1-100 denotes sample deals that have a duration between 1 and 100 months; 101-200 denotes sample deals with a duration between 101 and 200 months. Using our measure of cash flow variability introduced above, we calculate the cash flow volatility for each of the deals in our samples. The cross-sectional means reported in Table 9 do not indicate that infrastructure investments offer more stable (in the sense of predictable) cash (out-) flows than non-infrastructure investments. In fact, the average and median variability of the infrastructure deals is even slightly higher for most sub-samples. But these differences are not statistically significant. Also, in a regression with the measure of variability as dependent variable, we could not find evidence for a statistically significant difference between infrastructure and non-infrastructure deals. Therefore, we reject the hypothesis that infrastructure fund investments offer more stable cash flows than non-infrastructure fund investments.

[Insert Table 9 about here]

H4: Infrastructure assets are generally regarded as investments that exhibit low levels of risk. We analyze this hypothesis by comparing the default frequencies of infrastructure investments with those of non-infrastructure investments. We measure default frequencies by the fraction of sample deals with a multiple equal to zero and by the fraction of deals with a multiple smaller than one.[9] The first variable gives the proportion of complete write-off deals in the samples. The second variable indicates the proportion of deals where money was lost, *i.e.*, the cash return from the investment was smaller than the cash the fund had injected into the portfolio company.

[Insert Tables 10 and 11 about here]

Overall, our results suggest that infrastructure deals show lower default frequencies. Table 10 reveals that there is a significant difference in default rates between infrastructure and non-infrastructure deals for both measures applied. In addition, Table 11 shows that this is also the case for sub-samples of venture capital and private equity deals. These findings support the hypothesis that infrastructure investments show relatively low default rates (Inderst 2009, p. 7).

[9] The multiple of a transaction, in the context of this paper, measures the cumulated distributions returned to the investors as a proportion of the cumulative paid-in capital.

As infrastructure deals show relatively low levels of risk compared to non-infrastructure deals, the traditional view is that their returns tend to be lower, too. Interestingly, the descriptive statistics in Tables 12 and 13 show higher average and median returns for the infrastructure deals, as measured by the investment multiples and internal rates of return (IRR).[10] This result also holds for each of the VC and PE sub-samples, and most differences are statistically highly significant.

[Insert Tables 12 and 13 about here]

To further scrutinize these findings on differences in risk and return, we perform a regression of the IRR (Table 14, Model 1) and of the dummy variable DEFAULT (Table 14, Model 2) on several fund- and deal-specific variables as well as macroeconomic factors. For this purpose we eliminate deals at and above the 95^{th} percentile of the IRR due to the high dispersion as can be seen in Tables 12 and 13. The reasoning is that these outliers might be subject to data errors. Both regressions meet the standard OLS conditions and have high explanatory power with an R^2 of 34.70 percent and a Pseudo R^2 of 48.95 percent, respectively.

[Insert Table 14 about here]

Model 1 confirms that infrastructure deals significantly outperform non-infrastructure deals, as can be seen in the positive coefficient of variable INFRA. In turn, Model 2 confirms that the likelihood of default is significantly smaller for infrastructure deals than for non-infrastructure deals (negative coefficient of variable INFRA).[11]

One reason why we find higher return and lower risk might be that, in our analyses, we apply total cash flows and not operating cash flows and thus, we measure equity and not asset risk. As we will show later, there is evidence that infrastructure assets have higher leverage than non-infrastructure assets. Higher leverage, in turn, implies increased market risk and thus requires higher equity returns. However, as we do not

[10]The IRR, sometimes also called money-weighted rate of return, is defined as a measure that calculates the rate of return at which cash flows are discounted so that the net present value amounts to zero.

[11]This result is robust to applying a Tobit regression or taking the dummy variable PARTIAL_DEFAULT as dependent variable.

know deal-specific leverage levels, we cannot infer whether the higher returns observed for infrastructure deals are just a fair compensation for higher market risk or whether they indicate true out-performance. It is nevertheless striking that we find higher returns and lower stand-alone risk for infrastructure investments.

H5: After having seen significant differences in risk and return between infrastructure and non-infrastructure deals, we now test whether greenfield and brownfield investments within the infrastructure universe exhibit different risk and return profiles. Our data do not contain the explicit information whether a portfolio company is a greenfield or brownfield investment. We approximate this by using the information whether a deal is a venture capital or private equity deal. Venture capital typically refers to deals involving portfolio companies at an early development stage. In contrast, private equity refers to deals involving portfolio companies at a later development stage. This approximation matches the typical descriptions of greenfield and brownfield investments (see Section 3 above). Beeferman (2008, p. 6) even defines greenfield and brownfield investments as early and late-stage investments, which makes the analogy to venture capital and private equity even more obvious. Therefore, taking VC and PE as an approximation for greenfield and brownfield seems to be a reasonable assumption.

We find that brownfield investments are less risky than greenfield investments. This is expressed by consistently and significantly lower default frequencies across sub-samples in Tables 10 and 11 above. In addition, it is interesting to observe the significant difference in performance between greenfield and brownfield investments, as shown in Tables 12 and 13 above. Brownfield investments show higher average and median performance, regardless whether measured by IRR or the multiple. The differences are statistically significant across sub-samples, too. These findings are consistent with other studies on private equity (*e.g.* the studies at fund level by Kaplan and Schoar 2005 and Ljungqvist and Richardson 2003). Similar to the comparison between infrastructure and non-infrastructure deals above, we find higher returns for the assets with lower risk.

The regression analysis in Table 14 enables us to check whether these significant differences remain when controlling for a number of deal, fund and macroeconomic characteristics. Model 1 confirms that PE deals significantly outperform VC deals, as reflected by the positive coefficient of variable PE. Likewise, Model 2 confirms that the likelihood of default is significantly smaller for PE deals than for VC deals (negative coefficient of variable PE).[12]

5.3 Performance drivers

As shown in Sub-section 5.2, we find significant differences in the performance of infrastructure and non-infrastructure deals. We now turn to the question which variables drive these results and how the drivers of performance differ between the infrastructure and non-infrastructure sub-samples. In order to address these questions, we again eliminate deals at the 95^{th} percentile of the IRR and regress the IRR on several fund- and deal-specific variables as well as macroeconomic factors. However, we now perform separate regressions for the infrastructure and non-infrastructure sub-samples. For each sub-sample we include infrastructure- and non-infrastructure-specific dummy variables that control for the sector. The results of this exercise are shown in Models 3 and 4 in Table 15. Both regressions meet the standard OLS conditions and have high explanatory power with an R^2 of 46.2 percent and 34.6 percent, respectively.

[Insert Table 15 about here]

H6: It has been shown in the literature that a high inflow of capital into the market for private equity at the time of investment drives up asset prices because of the increased competition for attractive deals. This, in turn, results in a poor performance of the deals, an effect that is often referred to as the money chasing deals phenomenon (Gompers and Lerner 2000; Diller and Kaserer 2009). In our regressions, capital inflows are measured by the variable LN_COMMITTED_CAP. Interestingly, the regression results indicate a clear difference between the two sub-samples. In particular, the coefficient for non-infrastructure deals (-13.30) is highly significant and negative, whereas the coefficient for infrastructure deals (3.82) is not significantly different from zero. This confirms that the capital inflows into private equity markets at the time of initial investment have a strong adverse influence on the performance of non-infrastructure deals. Since the same does not hold for infrastructure deals, we do not observe overinvestment in infrastructure fund investments caused by capital inflows into the private-equity market.

[12] This result is also robust when applying a Tobit regression or taking the dummy variable PARTIAL_DEFAULT as dependent variable.

H7: It is commonly argued that infrastructure investments provide inflation-linked returns. The coefficient of the variable INFLATION is positive for the infrastructure sample (3.29) whereas it is negative for the non-infrastructure sample (-1.73). This would indicate evidence in favour of the hypothesis that infrastructure fund investments would provide a better inflation-linkage of returns than non-infrastructure investments. However, neither coefficient is statistically significant. This is in line with Sawant (2010b) who does not find a significant correlation between inflation and return for listed infrastructure stocks either. By contrast, Martin (2010, p. 24) finds that infrastructure can provide a long-term hedge against inflation for an investor provided the ongoing cash flows are at least partially linked to the price level.

H8: We can clearly reject the hypothesis that returns on infrastructure fund investments are uncorrelated to the performance of public equity markets. Models 3 and 4 in Table 15 show that the coefficient of the variable PUBL_MKT_PERF is positive (0.13) and statistically significant for the infrastructure sub-sample, whereas it is negative and not statistically significant for the non-infrastructure sub-sample. Therefore, the hypothesis of returns uncorrelated to equity markets would rather hold for non-infrastructure deals. A special diversification benefit of infrastructure fund investments in the context of financial portfolio choice can thus not be confirmed.

On the other hand, the coefficient of the variable GDP is not statistically significant (albeit positive at 1.74) for the infrastructure sub-sample (Model 3) while it is positive (2.09) and statistically significant for the non-infrastructure sample (Model 4). This supports the hypothesis that infrastructure fund investments offer returns that are uncorrelated to the macroeconomic development.

5.4 Other performance drivers

Having tested all our infrastructure-specific hypotheses stated in Section 3, we now outline several other interesting findings from our regressions in Table 15.

Interest rate sensitivity. We find a negative influence of the short-term interest rate at the date of investment on performance. The coefficients for the variable RISKFREERATE are negative and statistically highly significant for both samples. This negative relationship has also been pointed out in earlier studies (*e.g.* Ljungqvist and

Richardson 2003). In addition, we find that the coefficient for the infrastructure sample (-4.92) is more negative compared with that of the non-infrastructure sample (-3.96). That is, the performance of infrastructure deals reacts more sensitive to interest rate changes.

A possible explanation for this is that infrastructure investments have higher leverage ratios than non-infrastructure investments. This is intuitive since the cost of debt is usually directly related to the risk-free rate while this may not necessarily be true for the cost of equity. A higher cost of debt implies a higher cost of capital for a levered portfolio company, which implies a lower return, expressed by a lower IRR in our regression. Unfortunately, we do not have explicit information on leverage ratios in our data. However, the view that the higher regression coefficient for infrastructure deals reflects higher leverage ratios is supported by several other studies. For example, Bucks (2003) reports an average leverage of up to 83 percent in the water and energy sectors compared with 57 percent in other sectors in 2003. Ramamurti and Doh (2004, p. 161) report leverage of up to 75 percent in the infrastructure sector in general and Beeferman (2008, p. 9) lists average leverage ranging from 50 percent for toll roads and airports to 65 percent for utilities and even 90 percent for social infrastructure, all of which refer to the level of individual assets. Orr (2007, p. 7) reports an additional leverage of up to 80 percent at fund level whereby the source of returns comes, to a large proportion, from financial structuring. Helm and Tindall (2009, p. 415) identify the late 1990s as a time where the scale of leverage and financial engineering peaked, especially in the utilities sector. The following time of historically low interest rates combined with the benefit of tax shield effects and thus, a lower weighted average cost of capital also benefited the use of debt.

Fund manager experience. At fund level, the variable LN_GENERATION measures the number of funds the investment manager has operated prior to the current fund that invests in the specific deal. It may be seen as a proxy for the experience of the investment manager, which may be an important performance driver as several studies on private equity suggest (Achleitner *et al.* 2010). In contrast, our regression results reveal that the experience of the investment manager has no significant influence on either of the sub-samples in Models 3 and 4 in Table 15.

Duration of deals. At deal level, we can see that the duration of deals has a significant effect on returns in both sub-samples. The coefficients of the variable LN_DURATION are significant, positive and similarly large in value. The economic rationale behind this result is that badly-performing deals are typically exited more quickly than well-performing deals, such that deals with a longer duration also show a higher IRR (Buchner *et al.* 2010; Krohmer *et al.* 2009).

Number of financing rounds. A similar result is found for the variable LN_NUMBER. This variable measures the total number of cash injections a portfolio company has received from the fund and may be seen as a proxy for the number of financing rounds. In our regression, the number of financing rounds has a significantly negative influence on performance in both sub-samples, *i.e.*, the more often the fund manager invests additional equity into a deal, the lower the IRR. This is referred to as 'staging' and is extensively discussed in the literature (Sahlmann 1990; Krohmer *et al.* 2009). Consistent with our results, Krohmer *et al.* (2009) argue that badly-performing companies need to 'gamble for resurrection' more often in order to get additional cash injections from fund managers. Therefore, there is a negative relationship between number of financing rounds and performance.

Deal size. Models 3 and 4 in Table 15 show that the size of a non-infrastructure *deal* has a significant positive influence on its IRR, despite controlling for the *fund* size, whereas this is not the case for infrastructure deals. This is shown by a highly significant coefficient for LN_SIZE of 2.81 for the non-infrastructure and by an insignificant coefficient of 2.24 for the infrastructure sub-sample. Also Franzoni *et al.* (2010) find a positive influence of deal size on performance. They explain this effect with an illiquidity premium that is increasing in deal size. From a theoretical perspective, it is unclear why deal size should have an impact on performance. In this paper we cannot control for the illiquidity premium hypothesis mentioned by Franzoni *et al.* (2010). Furthermore, we cannot control to what extent deal size is a proxy for other performance-related variables such as deal risk or management experience. Hence, we can hardly explain this finding. Still, it is noteworthy that the size effect is not present in infrastructure deals.

Regional differences. In terms of regional influences, we observe that deals made in Europe - one of the most mature infrastructure markets besides Australia and Canada (OECD 2007, p. 32) - significantly outperform deals in other regions. Infrastructure deals show an even larger spread, with European infrastructure deals, on average, having an IRR that is 35.40 percentage points higher than in other regions as indicated by the dummy variable EUROPE. This effect is much smaller for European non-infrastructure deals with 19.57 percentage points. Lopez de Silanes *et al.* (2009) also report a higher performance for private-equity deals in Europe excluding the UK.

A rationale for this difference might be that Europe has seen the largest volume in privatizations, especially in the infrastructure sectors (*e.g.* Brune *et al.* 2004; Clifton *et al.* 2006, pp. 745-751). Therefore, the proportion of deals involving privatization is likely to be much higher in the sub-sample of European infrastructure deals than in the other sub-samples. Three explanations why such sales of assets from the public to private investors could have delivered higher returns include that *i)* a government or municipality might not have the objective to maximize the sale price of an asset, but instead tries to make the sale succeed in the first place; *ii)* management of newly privatized companies often negotiated large capital and operational expenditures with regulators before privatization but cut these expenditures back afterwards (Helm and Tindall 2009, pp. 420-421); and *iii)* after the formerly state-owned companies with low leverage were privatized, the new owners increased the leverage to lower the weighted average cost of capital and thus the return on the asset instead of using it for real capital investments (Helm 2009, p. 319).

Privatizations usually take place via private placements, tenders or fixed-price sales. Regarding the latter, there is empirical evidence that under-pricing is larger at privatizations than at private-company IPOs and larger in regulated than in unregulated industries (Dewenter and Malatesta 1997). These empirical and theoretical findings support the idea that there are higher returns for privatizations of infrastructure assets in Europe in general.

The same line of argument might also hold for our empirical finding of high returns of private equity-type infrastructure deals. Hall (2006, p. 8) points out the increasing importance of private equity and infrastructure funds as buyers of privatized companies in Europe, strengthening the link between our empirical findings and the mechanisms of privatization mentioned above.

Differences in returns within the infrastructure sector. The highly significant and positive coefficient of the variable TRANSPORT in Model 3 reveals that transport infrastructure assets (*e.g.* airports, marine ports or toll roads) exhibit IRRs above the average - and by a wide margin - while assets in Natural resources and energy do not. On average, deals in the transportation sector yield an IRR that is 24.32 percentage points higher than other infrastructure deals. The reason for this might be that the transportation sector is subject to a high degree of government intervention and thus, discretionary power (Yarrow *et al.* 1986, p. 340), while at the same time being less subject to independent regulation than other infrastructure sectors such as utilities. Indeed, Égert *et al.* (2009, p. 70) show in a survey that independent regulators are far less common in the transportation sector than in the electricity, gas, water or even telecommunication sectors. Less stability and credibility given by a regulatory framework, in turn, leads to higher investment uncertainty - including higher price and quantity risk - for which an investor requires a higher rate of return (Égert *et al.* 2009, pp. 31-32). The latter is in line with our empirical finding.

Within the non-infrastructure sample, we can see that a wider range of industries has a significantly higher IRR as shown by the variable INDUSTRIAL in Model 4. However, the coefficient is economically rather small.

6 Summary

We have scrutinized the risk- and return profile of unlisted infrastructure investments and have compared them to non-infrastructure investments. It is widely believed that infrastructure investments offer some typical financial characteristics such as long-term, stable and predictable, inflation-linked returns with low correlation to other assets. To some extent, our findings corroborate this view. However, we also document some results that are not in accordance with parts of this perception.

By using a unique dataset of infrastructure and non-infrastructure deals made by private-equity-like investment funds, we have come up with the following results. First, in terms of risk differences between infrastructure and non-infrastructure deals, results are a bit mixed. We do not find any evidence supporting the hypothesis that infrastructure investments offer more stable cash (out-) flows than non-infrastructure investments. It appears to be true, however, that default risk - or downside risk more generally - is significantly lower in infrastructure investments than in non-infrastructure investments.

Second, as far as returns are concerned, we do find higher average and median returns for infrastructure deals, as measured by the investment multiples and internal rates of return. This result also holds when separating the sample into venture capital and private-equity deals, and most differences are statistically significant. This is an interesting finding as it contradicts the traditional view that infrastructure investments exhibit low levels of risk and, consequently, provide only moderate returns.

Third, there is some evidence that the higher average returns reflect higher market risk. For one thing, our sample contains only equity investments, and leverage ratios of infrastructure portfolio companies are higher than for their non-infrastructure counterparts. For another, returns to infrastructure fund investments are more strongly correlated with the performance of public-equity markets than returns to non-infrastructure fund investments.

Fourth, European infrastructure investments are found to have consistently higher returns than their non-European counterparts. We hypothesize that this might be related to the fact that Europe has seen the largest volume of privatizations, especially in the infrastructure sectors. It could well be that the *ex ante* return expectation in privatization transactions is higher, either because of defective privatization mechanisms or because of higher political risk. Concerning the latter, we find some evidence that the regulatory environment has an impact on returns. Specifically, deals in the transportation sector have significantly higher returns than those in other infrastructure sectors, probably reflecting less independent regulation and hence, higher political risk in transportation as compared to the utilities or energy sectors.

Fifth, our empirical results do not support some other claims made in the literature. In particular, returns to infrastructure deals are not linked to inflation and do not depend on management experience, and their cash flow durations are not any different from those of non-infrastructure deals. It is also interesting to see that, unlike venture capital and private-equity transactions at large, infrastructure investments do not appear to be subject to the so-called money chasing deals phenomenon.

Thus, the allegedly bond-like characteristics of infrastructure deals have not been confirmed. This is shown by the fact that infrastructure investments do not offer longer-term or more stable cash flows than non-infrastructure investments. The returns showing a positive correlation to public-equity markets and no inflation linkage also point to equity-like rather than bond-like characteristics.

Summing up, our paper supports the perception that infrastructure investments do have special characteristics that are of interest for institutional investors. Lower downside risk is certainly an important feature in this context. However, it is unlikely that the infrastructure market offers a free lunch. Even though it is true that returns have been attractive in the past, it cannot be ruled out that these returns are driven by higher market risk. Our results, at least, offer some evidence in favour of this hypothesis. But a more general picture of the infrastructure market is still needed. Especially the influence of regulatory and political risk needs to be better understood. In this regard, our paper offers some limited evidence that can be used as a starting point for future research.

Tables

Table 1: Empirical variables and their expected results

Level	Variable	Description	Hypothesis	Expected result
Deal	Duration	Number of months between initial investment and exit	*H1*	Longer average duration for infra deals
Deal	Size	Dealsize measured in USD	*H2*	Larger size for infra deals
Deal	Variability	Volatility of cash outflows	*H3*	Lower variability for infra deals
Deal	(PARTIAL_)DEFAULT	(Partial) default rate	*H4*	Lower default rate for infra deals
			H5	Lower default rate for brownfield deals
Deal	IRR	Internal rate of return	*H4*	Lower performance for infra deals
			H5	Lower performance for brownfield deals
Deal	Multiple	Cumulative paid-out relative to cumulative paid-in capital	*H4*	Lower performance for infra deals
			H5	Lower performance for brownfield deals
Macro	LN_COMMITTED_CAP	Committed capital in the overall private equity market	*H6*	Negative influence on performance of infra deals
Macro	INFLATION	Average inflation rate	*H7*	Positive influence on performance of infra deals
Macro	PUBL_MKT_PERF	Average growth of public equity market index	*H8*	Non-positive influence on performance of infra deals
Macro	GDP	Average GDP growth	*H8*	Non-positive influence on performance of infra deals

Note: Column 'Level' shows if the variable refers to a deal characteristic or if it is a macroeconomic variable. Column 'Hypothesis' states which of the eight hypotheses outlined in Section 3 each variable serves to test. 'Expected result' specifies the expected results based on the hypotheses. 'Infra' and 'non-infra' refer to infrastructure and non-infrastructure deals, respectively.

Table 2: Definition of variables

Level	Variable name	Description
Dependent	IRR	Internal rate of return based on the investment cash flows
Fund	LN_FUNDSIZE	Natural logarithm of total amount invested by the fund up to the date of exit in USD
	LN_GENERATION	Natural logarithm of the number of funds the fund manager has managed
Deal	LN_DURATION	Natural logarithm of total duration between the initial investment and the exit date in months
	ASIA	Dummy variable equal to 1 for portfolio companies from Asia and 0 otherwise
	EUROPE	Dummy variable equal to 1 for portfolio companies from Europe and 0 otherwise
	NAMERICA	Dummy variable equal to 1 for portfolio companies from the USA and Canada and 0 otherwise
	INVEST00	Dummy variable equal to 1 for portfolio companies that had their initial investment between the years 2000 and 2009
	DEFAULT	Dummy variable equal to 1 for portfolio companies with a multiple equal to zero
	PARTIAL_DEFAULT	Dummy variable equal to 1 for portfolio companies with a multiple smaller than one
	LN_SIZE	Natural logarithm of the deal size measured by the sum of cash injections the company received in USD
	LN_NUMBER	Natural logarithm of the total number of cash injections the company received
	NAT_RES_ENERGY	Dummy variable equal to 1 for portfolio companies in the following businesses: oil and gas equipment, services, platform construction; companies distributing conventional electricity (produced by burning coal, petroleum and gas and by nuclear energy; excluding Alternative electricity)
	INDUSTRIAL	Dummy variable equal to 1 for portfolio companies within the sectors Automobiles, Business support services, Construction, Consumer industry and services, Food and beverages, General industrials, Materials, Media, Pharmaceutical, Retail, Textiles, Travel, Waste/recycling
	INFRA	Dummy variable equal to 1 for portfolio companies within the sectors Alternative-energy infrastructure, Transport infrastructure, Natural resources & energy infrastructure, and Telecommunication infrastructure

	HEALTHCARE	Dummy variable equal to 1 for portfolio companies in the following businesses: Medical devices (*e.g.* scanners, x-ray machines, pacemakers) and Medical supplies (*e.g.* eyeglasses, bandages)
	TELECOM	Dummy variable equal to 1 for portfolio companies in the following businesses: Makers and distributors of high-tech communication products (satellites, telephones, fibre optics, networks, hubs and routers); Telecom-related services
	PE	Dummy variable equal to 1 for portfolio companies that are classified into the following stages: Growth, MBO/MBI, Recapitalization, LBO, Acquisition financing, Public to private, Spin-off, Unspecified buyout
	INFRA_TRANSPORT	Dummy variable equal to 1 for portfolio companies in the following businesses: companies managing airports, train stations and depots, roads, bridges, tunnels, car parks, and marine ports
	INFRA_NAT_RES_EN	Dummy variable equal to 1 for portfolio companies in the following businesses: Oil and gas producers and distributors (production, refining, pipelines); companies generating conventional electricity (see NAT_RES_ENERGY above)
Macroeconomy	INFLATION	Average annualized change in monthly consumer price index between the date of initial investment and the date of exit for each portfolio company. For companies from Europe: annualized change in monthly consumer prices for West Germany between October 1971 and December 1990 (source: Statistisches Bundesamt) and for EU from January 1991 onwards (source: Eurostat); for companies from Canada, the US and rest of the world: annualized change in monthly US consumer prices (CPI-U; source: U.S. Department Of Labor, Bureau of Labor Statistics)
	LN_COMMITTED_CAP	Natural logarithm of committed capital on the global private-equity market at date of investment in million USD (source: Thomson Reuters, European data backed up by EVCA)
	RISKFREERATE	Risk free rate at date of investment for each portfolio company. For companies from Europe: monthly average of the daily quotes BBA Historical Libor Rates - 1 Month (in GBP) (source: British Bankers' Association). For companies from the US, Canada and rest of the world: monthly average of 4-week Treasury bill secondary market rate at discount basis (source: U.S. Federal Reserve)

	GDP	Average GDP growth rates between the date of initial investment and the date of exit for each portfolio company. For companies from Europe: average annualized percentage change in quarterly (West) German GDP between October 1971 and December 1995 (seasonally adjusted, source: Statistisches Bundesamt). Average annualized percentage change in quarterly EU GDP from January 1996 onwards (seasonally adjusted, source: Eurostat). For companies from Canada, US and rest of the world: average annualized percentage change in quarterly US GDP (seasonally adjusted, source: U.S. Department of Commerce, Bureau of Economic Analysis)
	PUBL_MKT_PERF	Total return of benchmark stock index between the date of initial investment and the date of exit for each portfolio company. For companies from Europe: MSCI Europe Total Return Index. For companies from Canada and USA: MSCI USA Total Return Index. For companies from Asia: MSCI World Total Return between October 1971 and December 1987, MSCI AC Asia Pacific Total Return from January 1988 onwards. For companies from rest of the world: MSCI World Total Return Index.

Note: Column 'Level' shows if the variable refers to a deal or fund characteristic or if it is a macroeconomic variable.

Table 3: Split of infrastructure sample into industry sectors and stages of investment

Sector (sub-sector)	**Region / stage of investment**	**Percentage of total within infrastructure sample** (broken down by region / stage)
Alternative energy (renewable electricity)		**3.6**
	Asia	7.7
	Europe	46.2
	North America	30.8
	Rest of World / Unspecified	15.4
		100.0
	Venture capital	23.1
	Private equity	76.9
Natural resources & energy (oil, gas, tele-heating, electricity)		**24.8**
	Asia	6.7
	Europe	53.3
	North America	23.3
	Rest of World / Unspecified	16.7
		100.0
	VC	46.7
	PE	53.3

Sector (sub-sector)	**Region / stage of investment**	**Percentage of total within infrastructure sample** (broken down by region / stage)
Transport (aviation, railway, road- and marine systems)		**12.9**
	Asia	23.4
	Europe	48.9
	North America	23.4
	Rest of World / Unspecified	4.3
		100.0
	VC	17.0
	PE	83.0
Telecommunication (data transmission, navigation systems)		**58.7**
	Asia	4.7
	Europe	37.1
	North America	56.3
	Rest of World / Unspecified	1.9
		100.0
	VC	65.3
	PE	34.7

Table 4: Split of samples into regions and stages of investment (percent of total)

Region of investment	**Percentage of deals within infrastructure sample** (broken down by stage)	**Percentage of deals within non-infrastructure sample** (broken down by stage)
All regions	**100.0**	**100.0**
Venture capital	52.9	58.1
Private equity	47.1	41.9
Asia	**7.7**	**6.1**
VC	39.3	57.2
PE	60.7	42.8
Europe	**43.0**	**34.3**
VC	50.6	33.9
PE	49.4	66.1
North America	**43.0**	**57.8**
VC	61.5	73.4
PE	38.5	26.6
Rest of World / Unspecified	**6.3**	**1.84**
VC	26.1	30.4
PE	73.9	69.6

Table 5: Duration of deals (in months)

Measure	Infra deals	Non-infra deals	Significance
Average	48.90	50.83	-
Median	41.00	46.00	*
Standard deviation	33.67	33.72	
Minimum	1.00	1.00	
Maximum	187.10	339.00	

Note: Column 'Significance' indicates whether the difference between the infrastructure and the non-infrastructure sample is significant, as measured by the test for difference in mean as well as on the non-parametric test for the equality of medians. *, **, *** denote significance at the 10-, 5- and 1-percent levels, respectively; - denotes non-significance.

Table 6: Duration of deals by stage (in months)

	Venture capital			Private equity		
Measure	**Infra**	**Non-infra**	**Significance**	**Infra**	**Non-infra**	**Significance**
Average	45.85	48.04	-	52.46	54.70	-
Median	37.00	43.00	-	45.00	49.00	-
Standard deviation	33.30	33.24		33.85	34.00	
Minimum	1.00	1.00		1.00	1.00	
Maximum	187.00	219.00		150.00	339.00	

Note: See Table 5.

Table 7: Size of deals (in million USD)

Measure	Infra deals	Non-infra deals	Significance
Average	48.8	10.3	*
Median	6.9	3.9	***
Standard deviation	525.0	24.9	
Minimum	0.0	0.0	
Maximum	9,920.0	952.0	

Note: Column 'Significance' indicates whether the difference between the infrastructure and the non-infrastructure sub-sample is significant, as measured by the test for difference in mean as well as on the non-parametric test for the equality of medians. *, **, *** denote significance at the 10-, 5- and 1-percent levels, respectively; - denotes non-significance.

Table 8: Size of deals by stage of investment (in million USD)

	Venture capital			Private equity		
Measure	**Infra**	**Non-infra**	**Significance**	**Infra**	**Non-infra**	**Significance**
Average	11.6	5.7	***	90.6	16.7	-
Median	4.5	2.9	**	8.9	6.1	***
Standard deviation	18.0	9.4		764.0	35.9	
Minimum	0.0	0.0		0.03	0.0	
Maximum	107.0	148.0		9,920.0	952.0	

Note: See Table 7.

Table 9: Variability of infrastructure and non-infrastructure cash outflows (in percent), by duration of deals

	Full sample			Duration 1-100 months			Duration 101-200 months		
Measure	**Infra**	**Non-infra**	**Sign.**	**Infra**	**Non-infra**	**Sign.**	**Infra**	**Non-infra**	**Sign.**
Average	13.21	12.96	-	13.44	13.25	-	11.63	10.95	-
Median	8.60	9.07	-	8.71	9.44	-	7.95	7.04	-
Standard deviation	11.15	10.67		11.37	10.77		8.82	10.09	
Minimum	0.26	0.22		0.26	0.22		1.41	0.38	
Maximum	81.93	75.10		81.93	75.10		37.71	63.14	

Note: The table displays the variability of cash outflows (in percent) for the full sample as well as separately for the sub-samples of shorter deals and longer-lasting deals. Column 'Sign.' indicates whether the difference between the infrastructure and non-infrastructure samples is significant, as measured by the test for difference in mean as well as on the non-parametric test for the equality of medians. *, **, *** denote significance at the 10-, 5- and 1-percent levels, respectively; - denotes non-significance.

Table 10: Historical default frequencies (in percent)

Measure	Infra	Non-infra	Sign.	VC	PE	Sign.
Multiple = 0	14.60	18.84	***	25.85	8.87	***
Multiple < 1	33.06	46.74	***	58.60	29.82	***

Note: 'Multiple = 0' is the percentage of deals that were complete write-offs. 'Multiple < 0' is the percentage of all loss-making deals. Column 'Sign.' displays the significance of the Chi-squared test for independence between the infrastructure and the non-infrastructure sub-sample and between the VC and the PE sub-sample, respectively. *, **, *** denote significance at the 10-, 5- and 1-percent levels, respectively.

Table 11: Historical default rates (in percent), by sector and investment stage

Investment stage	Venture capital			Private equity			Significance VC *versus* PE	
Sector	Infra	Non-infra	Sign.	Infra	Non-infra	Sign.	Infra	Non-infra
Multiple = 0	22.92	25.93	***	5.26	9.00	***	***	***
Multiple < 1	45.31	58.95	***	19.30	30.20	***	***	***

Note: See Table 10. The last two columns display, separately for infrastructure and non-infrastructure deals, the significance of the Chi-squared test for independence between the VC and the PE sub-samples.

Table 12: Returns on investment

IRR (percent)	Infra	Non-infra	Sign.	VC	PE	Sign.
Average	66.88	20.15	***	7.41	41.36	***
Median	18.74	6.02	***	-20.01	25.47	***
Standard deviation	299.71	197.21		224.34	162.33	
Minimum	-100.00	-100.00		-100.00	-100.00	
Maximum	3,503.80	4,870.08		4,870.00	4,533.97	
Multiple						
Average	2.69	2.46	-	2.13	2.93	***
Median	1.69	1.13	***	0.40	1.98	***
Standard deviation	3.71	4.55		4.73	4.18	
Minimum	0.00	0.00		0.00	0.00	
Maximum	40.26	50.00		49.92	50.00	

Note: Descriptive statistics on IRR and multiple of infrastructure (infra) *versus* non-infrastructure (non-infra) deals and venture capital (VC) *versus* private equity (PE) deals. Column 'Sign.' displays the significance of the test for difference in mean as well as of the non-parametric test for the equality of medians between the infrastructure and the non-infrastructure sub-sample and between the VC and the PE sub-sample, respectively. *, **, *** denote significance at the 10-, 5- and 1-percent levels, respectively; - denotes insignificance.

Table 13: Returns on investment by sector and investment stage

	Venture capital			Private equity			Significance VC *versus* PE	
IRR (percent)	**Infra**	**Non-infra**	**Sign.**	**Infra**	**Non-infra**	**Sign.**	**Infra**	**Non-infra**
Average	45.73	6.27	*	90.68	39.54	**	*	***
Median	5.00	-21.94	***	36.06	25.16	***	***	***
Standard deviation	305.93	221.39		291.64	155.28			
Minimum	-100.00	-100.00		-100.00	-100.00			
Maximum	2,224.88	4,870.08		3,503.79	4,533.97			
Multiple								
Average	2.17	2.13	-	3.27	2.92	*	***	***
Median	1.15	0.38	***	2.47	1.96	**	***	***
Standard deviation	4.14	4.75		3.03	4.21			
Minimum	0.00	0.00		0.00	0.00			
Maximum	40.26	49.92		22.78	50.00			

Note: See Table 12. The last two columns display, separately for infrastructure and non-infrastructure deals, the significance of the tests for difference in mean and for the equality of medians between the VC and the PE sub-sample.

Table 14: Regression results: All deals

Model 1	OLS (all deals)		Model 2	Probit (all deals)	
Dependent variable	**IRR**		**Dependent variable**	**DEFAULT**	
Variable	**Coefficient (t-statistic)**		**Variable**	**Coefficient (z-statistic)**	
LN_GENERATION	0.67		LN_GENERATION	0.02	
	(0.91)			*(0.93)*	
LN_FUNDSIZE	-1.64	**	LN_FUNDSIZE	-0.06	**
	(-2.47)			*(-2.49)*	
PE	22.27	***	PE	-0.42	***
	(14.30)			*(-7.73)*	
LN_NUMBER	-31.58	***	LN_NUMBER	1.22	***
	(-35.35)			*(32.92)*	
LN_DURATION	26.74	***	LN_GENERATION	-1.23	***
	(52.25)			*(-38.90)*	
LN_SIZE	2.85	***	LN_SIZE	0.01	
	(4.91)			*(0.77)*	
ASIA	4.86	*	ASIA	-0.19	**
	(1.87)			*(-2.15)*	
EUROPE	20.77	***	EUROPE	-0.45	***
	(10.17)			*(-6.48)*	
INFRA	12.15	***	INFRA	-0.36	***
	(3.76)			*(-6.48)*	
INFLATION	-1.89		INFLATION	0.01	
	(-1.42)			*(0.16)*	

GDP	2.00	***	GDP	0.08	***
	(3.14)			*(3.21)*	
PUBL_MKT_PERF	-0.001		PUBL_MKT_PERF	-0.002	***
	(-0.20)			*(-4.16)*	
RISKFREERATE	-3.98	***	RISKFREERATE	0.09	***
	(-10.72)			*(32.92)*	
LN_COMMITED_CAP	-13.00	***	LN_COMMITED_CAP	0.05	*
	(-12.70)			*(1.66)*	
INVEST00	-0.91		INVEST00	0.23	***
	(-0.49)			*(3.67)*	
CONSTANT	40.05	***	CONSTANT	0.90	*
	(2.72)			*(1.82)*	
Number of observations	8,607		Number of observations	9,329	
F(16, 8,591)	513.15	***	LR chi-squared(15)	4,627.09	***
Max. VIF	3.31		Max. VIF	3.21	
R^2	34.70%		Pseudo R^2	48.95%	

Note: Results of the regressions for the full sample (infrastructure and non-infrastructure deals). Model 1 is an OLS regression with the IRR as dependent variable using White‘s heteroscedasticity-consistent estimators. Model 2 is a Probit regression with the dummy variable DEFAULT as dependent variable. DEFAULT equals 1 for deals with a multiple of zero; and 0 otherwise. The independent variables are listed in the first column. The second column shows the non-standardized coefficients of each exogenous variable and the associated t-/z-statistics. The asterisks indicate the level of significance (*, **, *** significant at the 10-, 5- and 1-percent levels, respectively).

Table 15: **Regression results: Infrastructure *versus* non-infrastructure deals**

Model 3	**OLS (infra deals)**		**Model 4**	**OLS (non-infra deals)**	
Dependent variable	**IRR**		**Dependent variable**	**IRR**	
Variable	**Coefficient (t-statistic)**		**Variable**	**Coefficient (t-statistic)**	
LN_GENERATION	3.35 *(0.77)*		LN_GENERATION	0.93 *(1.24)*	
LN_FUNDSIZE	-1.73 *(-0.47)*		LN_FUNDSIZE	-1.71 *(-2.55)*	**
PE	27.14 *(3.79)*	***	PE	20.92 *(12.75)*	***
LN_NUMBER	-29.81 *(-7.37)*	***	LN_NUMBER	-31.57 *(-34.20)*	***
LN_DURATION	26.50 *(9.02)*	***	LN_GENERATION	26.68 *(51.20)*	***
LN_SIZE	2.24 *(0.61)*		LN_SIZE	2.81 *(4.84)*	***
ASIA	0.37 *(0.04)*		ASIA	4.95 *(1.84)*	*
EUROPE	35.40 *(3.07)*	***	EUROPE	19.57 *(9.28)*	***
INFRA_NAT_RES_EN	1.55 *(0.19)*		-	-	
INFRA_TRANSPORT	24.32 *(2.18)*	**	-	-	
-	-		NAT_RES_ENERGY	8.21 *(1.01)*	
-	-		INDUSTRIAL	5.06 *(5.06)*	***

-	-		HEALTHCARE	3.17 *(1.05)*	
-	-		TELECOM	0.82 *(0.33)*	
INFLATION	3.29 *(0.42)*		INFLATION	-1.73 *(-1.28)*	
GDP	1.74 *(0.66)*		GDP	2.09 *(3.22)*	***
PUBL_MKT_PERF	0.13 *(3.74)*	***	PUBL_MKT_PERF	-0.005 *(-0.75)*	
RISKFREERATE	-4.92 *(-2.60)*	**	RISKFREERATE	-3.96 *(-10.52)*	***
LN_COMMITED_CAP	3.82 *(0.74)*		LN_COMMITED_CAP	-13.30 *(-12.67)*	***
INVEST00	-19.01 *(-1.67)*	*	INVEST00	0.26 *(0.14)*	
CONSTANT	-152.13 *(-1.55)*		CONSTANT	42.17 *(2.82)*	***
Number of observations	269		Number of observations	8,338	
F(16, 252)	23.05	***	F(18, 8, 319)	415.85	***
Max. VIF	4.66		Max. VIF	3.32	
R^2	46.23%		R^2	34.59%	

Note: Results of the OLS regressions for the infrastructure (Model 3) and the non-infrastructure sample (Model 4) with the IRR as dependent variable. Both use Whites heteroscedasticity-consistent estimators. The independent variables are listed in the first column. The second column shows the non-standardized coefficients of each exogenous variable and the associated t-statistics. The asterisks indicate the level of significance (*, **, *** significant at the 10-, 5- and 1-percent levels, respectively).

Figures

Figure 1: Most common forms of infrastructure investment

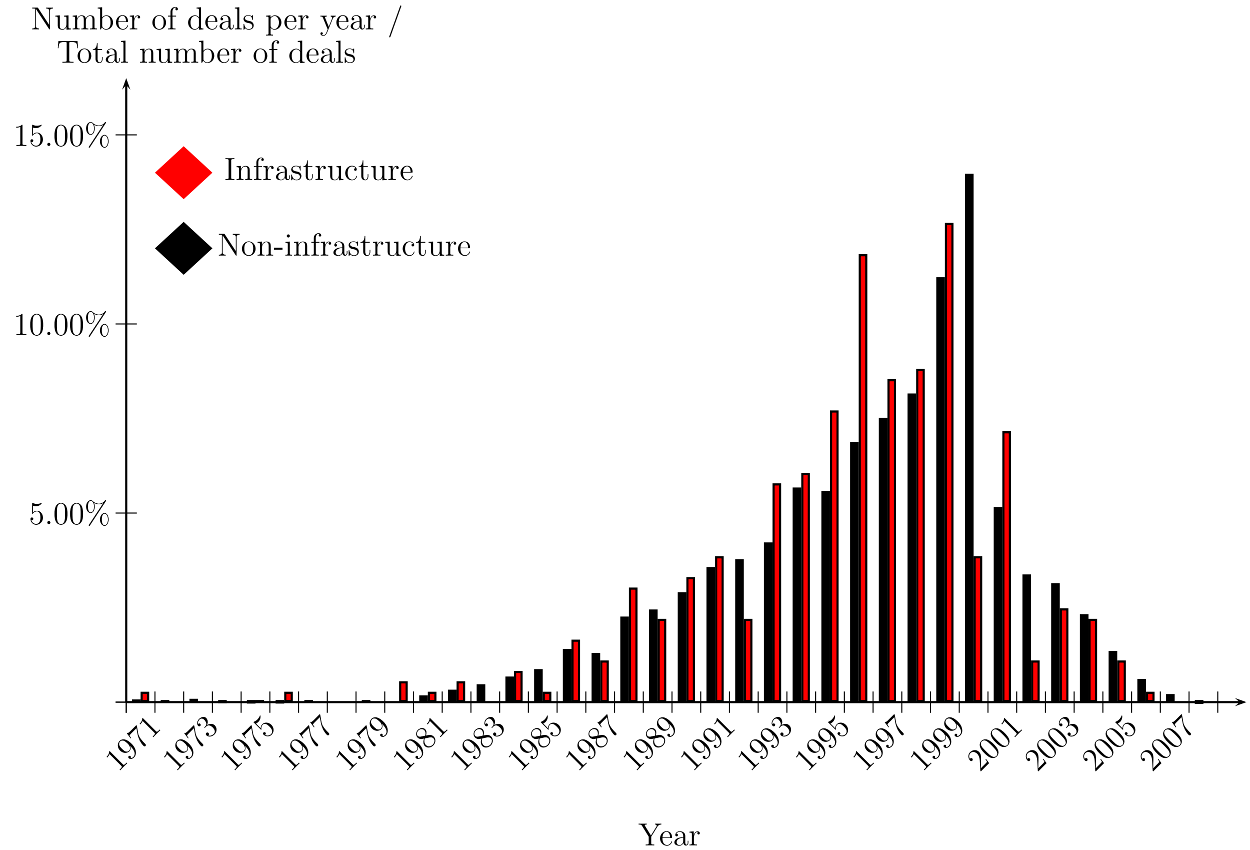
capital requirement, political and regulatory risk

liquidity risk
time horizon

	Direct	**Indirect**
Unlisted	Direct Investments PPP; Project Finance	Unlisted Infrastructure Funds
Listed	Stocks; Bonds	Listed Infrastructure Funds; Indexes

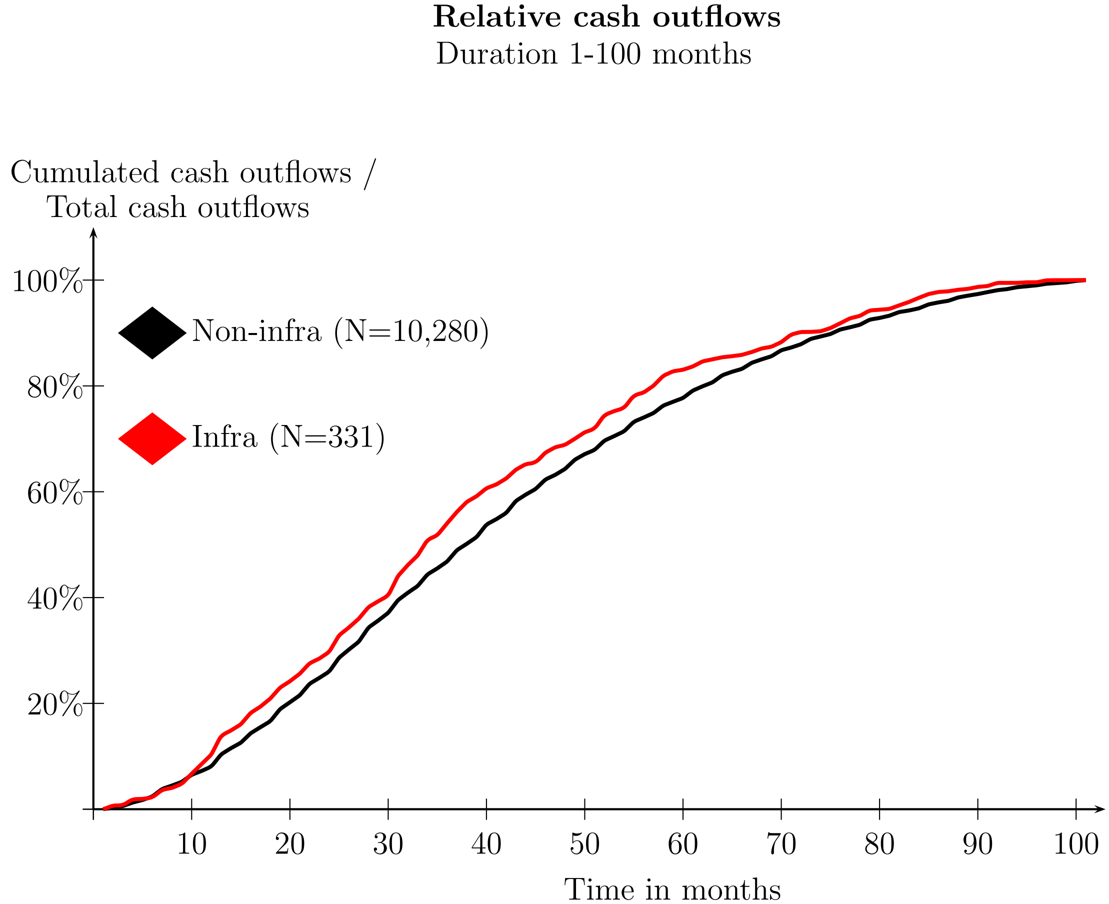
Note: The figure shows the most common forms of infrastructure investments grouped into the categories listed / unlisted and direct /indirect investments. It also shows schematically the exposure to the different risks associated with them.

Figure 2: Distribution of deals over the sample period



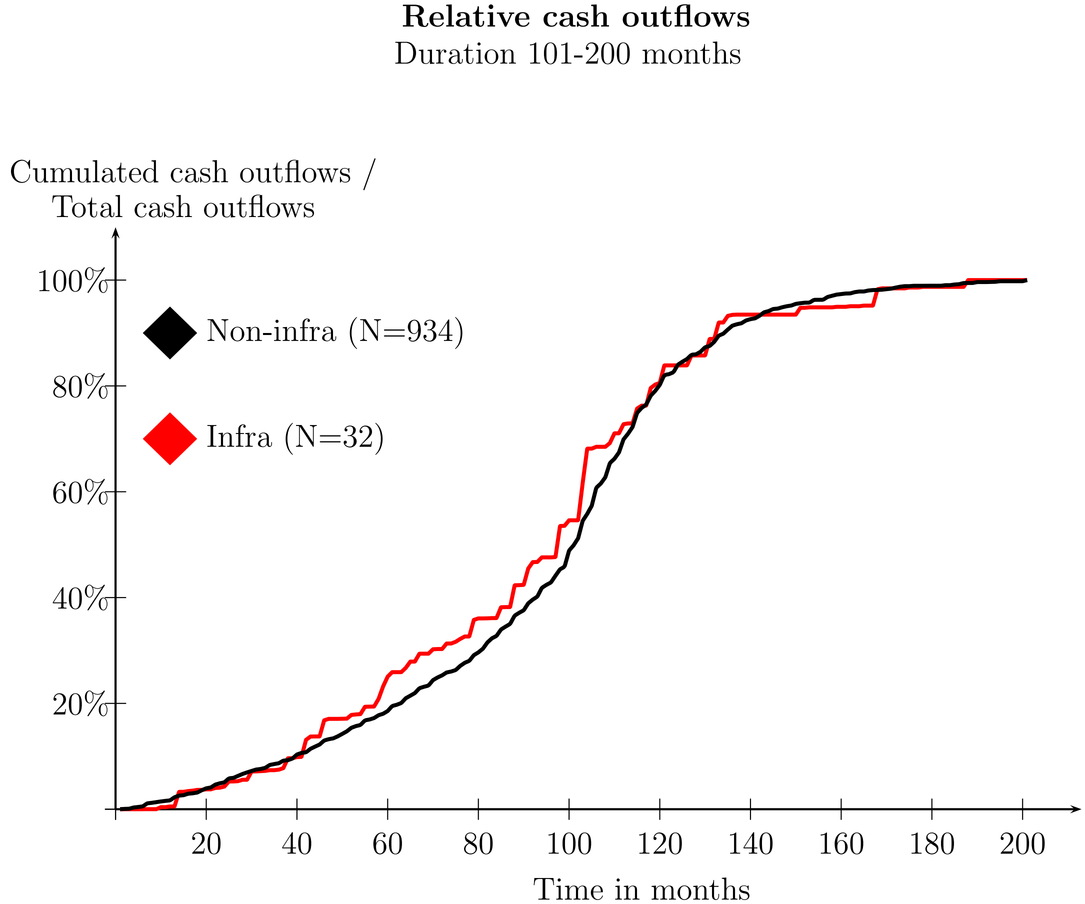
Note: The figure shows the number of deals per year of initial investment trelative to the total number of deals in the whole sample period, for each sub-sample (infrastructure and non-infrastructure deals).

Figure 3a: Time profile of cash outflows from infrastructure and non-infrastructure deals: Shorter deals (1-100 months)



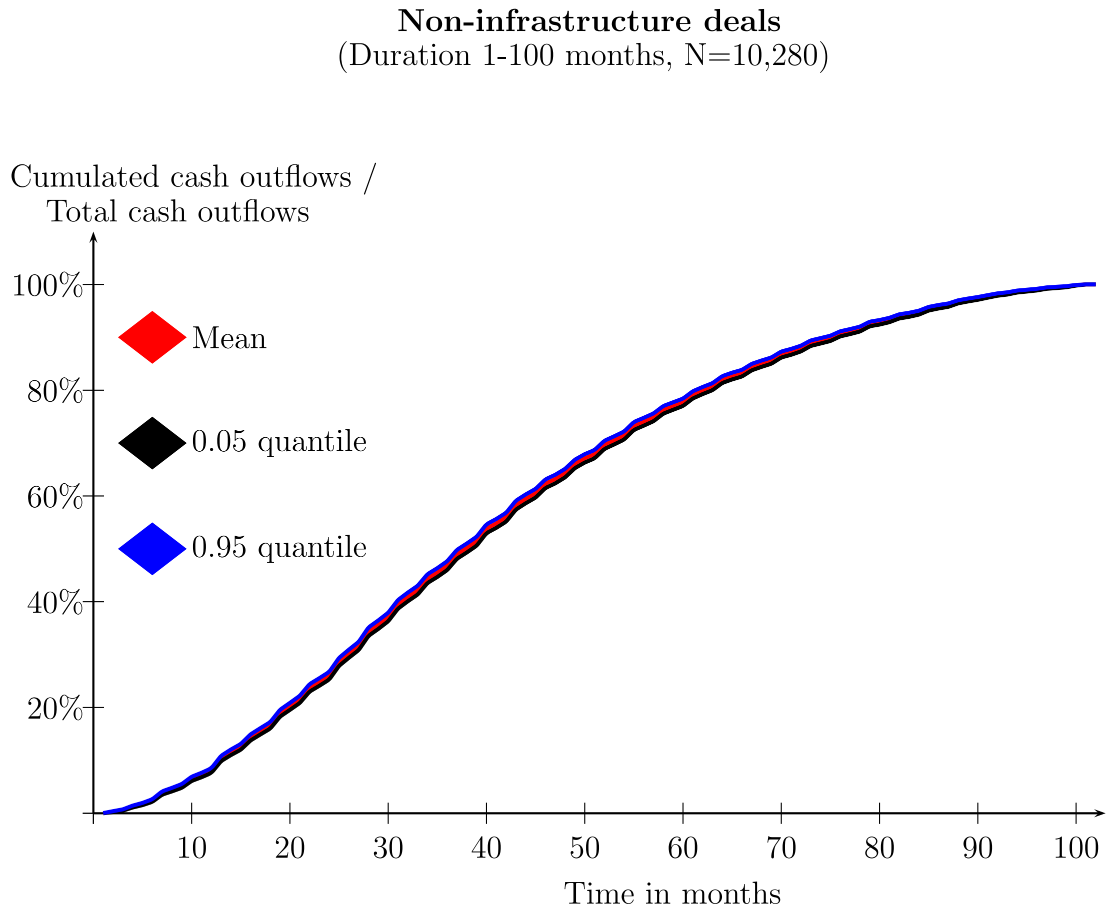
Note: The figure shows the structure of the average cumulated capital outflows of the infrastructure and non-infrastructure deals over time.

Figure 3b: Time profile of cash outflows from infrastructure and non-infrastructure deals: Longer deals (101-200 months)



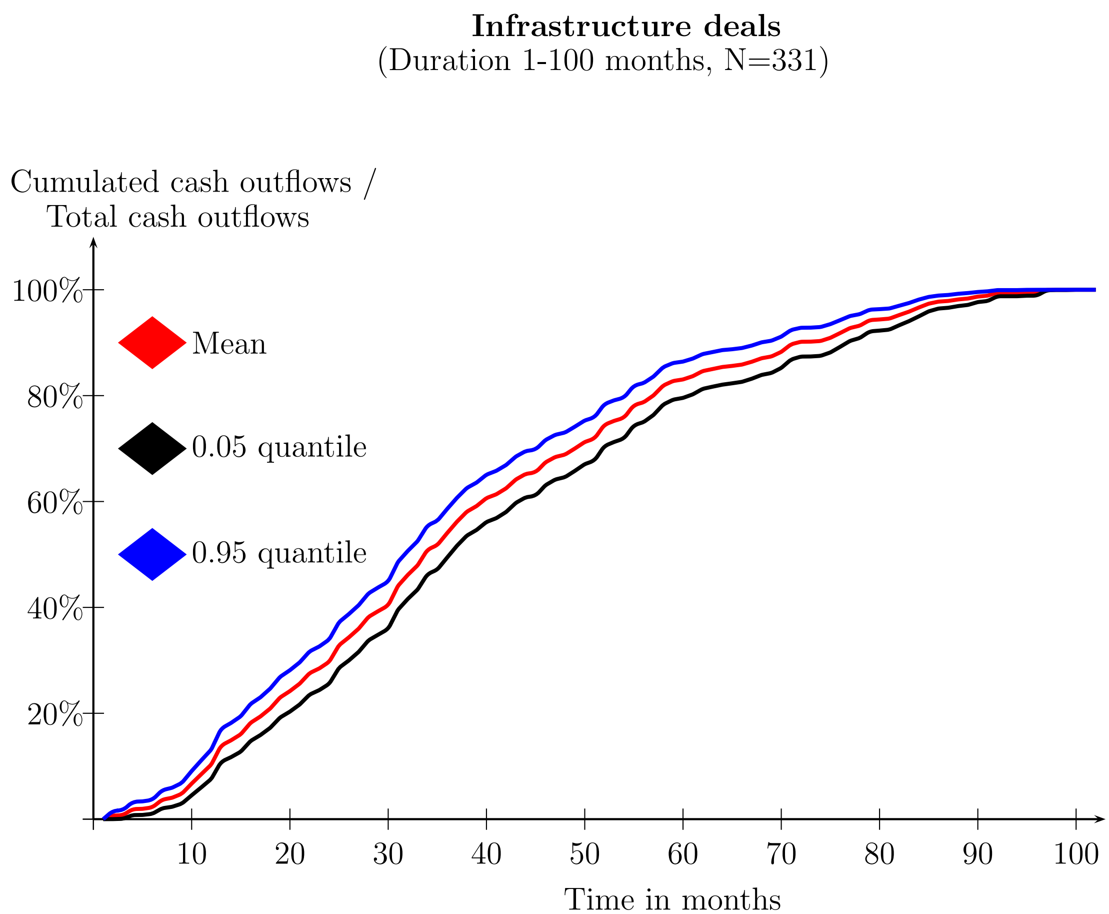
Note: See Figure 3a.

Figure 4a: Time profile of cash outflows from non-infrastructure deals: Bootstrapping results



Note: The figure shows the simulation results for the structure of the cumulated capital outflows over time applying a bootstrap simulation with 50,000 draws. The figure depicts the mean, the 5th percentile and 95th percentile for the sub-sample with duration of 1-100 months. The confidence bounds suggest that the average structures can be measured with high precision and hence, that the structures shown in Figures 3a and 3b are representative for the sample deals.

Figure 4b: Time profile of cash outflows from infrastructure deals: Bootstrapping results



Note: See Figure 4a.

References

Achleitner, A.-K., Braun, R. and Engel, N. (2010), 'Value Creation and Pricing in Buyouts: Empirical Evidence from Europe and North America', Technische Universität München - Center for Entrepreneurial and Financial Studies, CEFS Working Paper.

Beeferman, L. (2008), 'Pension Fund Investment in Infrastructure: A Resource Paper', Occasional Paper Series No. 3, pp. 1-78.

Bitsch, F., Kaserer, C. and Kasper, E. (2010), 'Infrastructure - An Approach Towards an Economic Based Definition', Technische Universität München - Center for Entrepreneurial and Financial Studies, CEFS Working Paper.

Brune, N., Garrett, G. and Kogut, B. (2004), 'The International Monetary Fund and the Global Spread of Privatization', *IMF Staff Papers*, (51:2), pp. 195-219.

Buchner, A., Kaserer, C. and Schmidt, D. (2008), 'Infrastructure Private Equity', Center of Private Equity Research, Discussion Paper.

Buchner, A., Krohmer, P., Schmidt, D. and Wahrenburg, M. (2010), 'Projection of Private Equity Fund Performance: A Simulation Approach' in: Cumming, D. (ed.), *Private Equity - Funds Types, Risks, Returns and Regulation*, pp. 197-228, Wiley & Sons, Hoboken, NJ, USA.

Bucks, P. (2003), 'Financial Leverage and the Regulator', *The Utilities Journal*, (6:10), pp. 38-39.

Clifton, J., Comin, F. and Fuentes, D. (2006), 'Privatizing Public Enterprises in the European Union 1960-2002: Ideological, Pragmatic, Inevitable?', *Journal of European Public Policy*, (13:5), pp. 736-756.

Cumming, D., Schmidt, D. and Walz, U. (2009), 'Private Equity Returns and Disclosure Around the World', *Journal of Business Venturing*, forthcoming.

Cumming, D. and Walz, U. (2009), 'Private Equity Returns and Disclosure Around the World', *Journal of International Business Studies*, (41:4), pp. 727-754.

Dechant, T. and Finkenzeller, K. (2009), 'Infrastructure - A New Dimension of Real Estate? An Asset Allocation Analysis', ERES Conference 2009, Conference Paper.

Dewenter, K. and Malatesta, P. (1997), 'Public Offerings of State-Owned and Privately-Owned Enterprises: An International Comparison', *The Journal of Finance*, (52:4), pp. 1659-1679.

Diller, C. and Kaserer, C. (2009), 'What Drives Private Equity Returns? - Fund Inflows, Skilled GPs, and/or Risk?', *European Financial Management*, (15:3), pp. 643-675.

Égert, B., Kozluk, T. and Sutherland, D. (2009), 'Infrastructure Investment: Links to Growth and the Role of Public Policies', OECD Economics Department Working Papers, No. 686.

Esty, B. (2003), 'The Economic Motivations for Using Project Finance', Harvard Business School, mimeo.

Esty, B. (2010), 'An Overview of Project Finance and Infrastructure Finance - 2009 Update', Harvard Business School Case No. 210-061.

Franzoni, F., Nowak, E. and Phalippou, L. (2010), 'Private Equity Performance and Liquidity Risk', Swiss Finance Institute, Research Paper No.09-43.

Gompers, P. and Lerner, J. (2000), 'Money chasing deals? The Impact of Fund Inflows on Private Equity Valuation', *Journal of Financial Economics*, (55:2), pp. 281-325.

Haas, C. (2005), *Vertragsstrukturen privat finanzierter Infrastrukturprojekte*, Peter Lang - Euopäischer Verlag der Wissenschaften, Frankfurt am Main, Germany.

Hall, D. (2006), 'Private Equity and Infrastructure Funds in Public Services and Utilities', University of Greenwich, PSIRU Working Paper.

Helm, D. (2009), 'Infrastructure Investment, the Cost of Capital, and Regulation: an Assessment', *Oxford Review of Economic Policy*, (25:3), pp. 307-326.

Helm, D. and Tindall, T. (2009), 'The Evolution of Infrastructure and Utility Ownership and its Implications', *Oxford Review of Economic Policy*, (25:3), pp. 411-434.

Inderst, G. (2009), 'Pension Fund Investment in Infrastructure', OECD Working Papers on Insurance and Private Pensions, No. 32.

Inderst, G. (2010), 'Infrastructure as an Asset Class', *EIB Papers*, (15:1), forthcoming.

Jensen, M. (1986), 'Agency Costs of Free Cash Flow, Corporate Finance, and the Market for Corporate Control', *American Economic Review*, (76:2), pp. 323-329.

Kaplan, S. and Schoar, A. (2005), 'Private Equity Performance: Returns, Persistence, and Capital Flows', *The Journal of Finance*, (60:4), pp. 1791-1823.

Krohmer, P., Lauterbach, R. and Calanog, V. (2009), 'The Bright and Dark Side of Staging: Investment Performance and the Varying Motivations of Private Equity', *Journal of Banking and Finance*, (33:9), pp. 1597-1609.

Ljungqvist, A. and Richardson, M. (2003), 'The Investment Behavior of Private Equity Fund Managers', London School of Economics, RICAFE Working Paper No. 005.

Lopez de Silanes, F., Phalippou, L. and Gottschalg, O. (2009), 'Giants at the Gate: Diseconomies of Scale in Private Equity', AFA 2010 Atlanta Meetings Paper; EFA 2009 Bergen Meetings Paper.

Martin, G. (2010), 'The Long-Horizon Benefits of Traditional and New Real Assets in the Institutional Portfolio', *The Journal of Alternative Investments*, (13:1), pp. 6-29.

Metrick, A. and Yasuda, A. (2010), 'The Economics of Private Equity Funds', *Review of Financial Studies*, (23:6), pp. 2303-2341.

Newell, G. and Peng, H. (2007), 'The Significance of Infrastructure in Investment Portfolios', Pacific Rim Real Estate Society Conference 2007, Conference Paper.

Newell, G. and Peng, H. (2008), 'The Role of U.S. Infrastructure in Investment Portfolios', *Journal of Real Estate Portfolio Management*, (14:1), pp. 21-32.

OECD (2007), *Infrastructure to 2030, Volume 2, Mapping Policy for Electricity, Water and Transport*, Organisation for Economic Co-operation and Development, Paris.

OECD (2010), 'Pension Markets in Focus', Issue 7, Organisation for Economic Co-operation and Development, Paris.

Orr, R. (2007), 'The Rise of Infra Funds', in *Project Finance International - Global Infrastructure Report 2007*, Supplement, pp. 2-12, Project Finance International, Zell am Harmersbach, Germany.

Prequin (2008), 'Preqin Infrastructure Review: An Examination of the Unlisted Infrastructure Fund Market', Prequin, London.

Ramamurti, R. and Doh, J. (2004), 'Rethinking Foreign Infrastructure Investment in Developing Countries', *Journal of World Business*, (39:2), pp. 151-167.

Rickards, D. (2008), 'Global Infrastructure - A Growth Story', in Davis, H. (ed.), Infrastructure Finance: Trends and Techniques, pp. 1-47, Euromoney Books, London, UK.

Sahlmann, W. (1990), 'The Structure and Governance of Venture-Capital Organizations', *Journal of Financial Economics*, (27), pp. 473 - 522.

Sawant, R. (2010a), 'Emerging Market Infrastructure Project Bonds: Their Risks and Returns', *The Journal of Structured Finance*, (15:4), pp. 75-83.

Sawant, R. (2010b), *Infrastructure Investing: Managing Risks & Rewards for Pensions, Insurance Companies & Endowments*, John Wiley and Sons, Hoboken, NJ, USA.

Välilä, T. (2005), 'How Expensive are Cost Savings? On the Economics of Public-Private Partnerships', *EIB Papers*, (10:1), pp. 94-119.

Yarrow, G., King, M., Mairesse, J. and Melitz, J. (1986), 'Privatization in Theory and Practice', *Economic Policy*, (1:2), pp. 323-377.