The Subsidy to Infrastructure as an Asset Class*

Aleksandar Andonov
University of Amsterdam

Roman Kräussl
Luxembourg School of Finance

Joshua Rauh
Stanford University, Hoover Institution, and NBER

May 2019

Abstract

We investigate the characteristics of infrastructure as an asset class from the perspective of a limited partner. The stream of cash flows and riskiness of performance delivered by private infrastructure funds to institutional investors is very similar to that delivered by other types of private equity, as reflected by the frequency and amounts of net cash flows as well as by the volatility of performance measures. Public investors, such as public pension funds, government agencies, and sovereign wealth funds perform worse than private institutional investors in their infrastructure fund investments, although they are exposed to underlying deals with very similar project stage, concession terms, ownership structure, industry, and geographical location. By selecting funds that invest in projects with poor financial performance, public investors have created an implicit subsidy to infrastructure as an asset class, which we estimate at a minimum of $1.3-$1.5 billion per year if the alternative opportunity is the S&P 500 or real estate funds, $3.3 billion per year if compared to listed infrastructure funds, and $8.5 billion per year if compared to private equity buyout funds. The public subsidy is not primarily driven by local investments.

JEL Codes: G11, G23, G28, H54, H75.

Keywords: Infrastructure, Public pension funds, Institutional investors

* Andonov: a.andonov@uva.nl. Kräussl: roman.kraussl@uni.lu. Rauh: rauh@stanford.edu. We are grateful to seminar, workshop and conference participants at the University of Amsterdam, HEC Liege, NBER Economics of Infrastructure Meeting, University of Neuchatel, SACRS Program for Public Investment Management, and Stanford GSB for helpful comments and suggestions.

I. Introduction

An adequate supply of infrastructure is an essential ingredient for competitiveness and long run potential growth in any economy (Fernald, 1999; Roller and Waverman, 2001; Esfahani and Ramírez, 2003; Donaldson, 2018). Indeed, the stock of infrastructure plays a critical role in enhancing the productivity of individuals and firms by lowering the costs of combining different productive inputs, accessing markets, and increasing mobility and competition. International organizations such as the OECD and World Bank have called attention to an acute need for new or modernized infrastructure and pointed to a disparity between this need and the current level of infrastructure investment.[1] This globally increasing gap between the demand for infrastructure investment and the provision of resources has led to calls for greater recourse to private capital in the infrastructure sector.

Institutional investors, such as pension funds, insurance companies and sovereign wealth funds, are becoming increasingly active alongside governments in the provision of capital to infrastructure funds and projects. Infrastructure asset class includes investments in renewable energy, traditional energy, transportation, utilities, telecoms and social infrastructure. The financial industry presents infrastructure as a new alternative asset class – in contrast to standard assets such as equities and bonds and established alternative asset classes such as buyout, venture capital and real estate – which would deliver new sources of stable return and better diversification of risk.[2] In the past two decades, public and private investors have expressed growing interest in real assets that were perceived as more transparent and stable than complex products presented to them, with a more direct connection to underlying value. Further, infrastructure investments may offer a wide range of social and political benefits in their regions (Castells and Solé-Ollé, 2005; Cadot, Röller and Stephan, 2006).

The stated value proposition of infrastructure as an investment is generally that it has attractive financial attributes such as strong returns, a low sensitivity to swings in the business

[1] According to estimates of the Infrastructure 2030 OECD study, the need for infrastructure investments amounts to $60 trillion by 2030, or 3.5% annually of global GDP. The World Bank's Global Infrastructure Outlook forecasts a global infrastructure investment need of $94 trillion by 2040, and a $15 trillion gap between that need and projected infrastructure investment under current trends.

[2] For example, according to Deutsche Bank Asset Management (2017), "Infrastructure offers relatively low long-term cash flow volatility compared with other asset classes and can also provide attractive, inflation-hedged total returns." J.P. Morgan Asset Management (2017) bases its case for infrastructure on "benefits of diversification, inflation protection, and yield, along with a strong focus on environmental, social, and governance (ESG) principles."

cycle, little correlation with equity markets, long-term stable and predictable cash flows, inflation hedging properties, and low default rates. Based on their economic and financial characteristics, infrastructure investments are supposed to offer investors long-term, low-risk, inflation-protected and acyclical returns. As such, they would be a natural fit with long-duration pension liabilities that are often inflation linked (see Della Croce, 2012). Infrastructure has thus been marketed as a useful alternative asset for public pension funds.[3]

Public pension investors also share this view. For example, according to the California Public Employees' Retirement System (CalPERS) website as of August 2018: "Infrastructure targets stable, defensive investments within the water, energy, waste, transportation, technology, and communications sectors."[4] But do the infrastructure investments that public pension funds and other institutional investors make live up to this promise? One challenge to answering this question has been the difficulty of assembling data series of unlisted infrastructure investments that include data on fund cash flows and fundamental risk properties of the underlying assets in these funds.

In this paper, we use the Preqin database to study the risk and return characteristics of infrastructure investments. The sample covers 1,594 institutional investors form 61 countries, who make 4,493 investments in funds and 1,721 direct investments in infrastructure assets over the period of 1991–2018. Through these fund placements and direct investments, institutional investors gain exposure to 4,825 unique assets located in 125 countries. We directly observe the industry, project stage, concessional agreements, and ownership structure in the underlying assets. Infrastructure is a fast growing asset classes and we estimated that the assets under management have increased from $58 billion in 2008 to $404 billion in 2018.

Even though G20, World Bank and OECD help to establish infrastructure as an asset class in order to attract private capital and reduce fiscal pressure on governments (see OECD, 2017; G20/OECD/World Bank, 2018), public investors still provide a lot of funding even to infrastructure assets designed to remove barriers to private sector investment. Public institutional investors, like public pension funds, sovereign wealth funds and government agencies, account for 45.52% of the commitments to funds (2,045 out of 4,493) and for 70.95% of the direct investments (1,221 out of 1,721).

[3] According to Deutsche Bank Asset Management (2017), "The cash flows of infrastructure assets with inherently long lives and strong intrinsic value, can provide a good match for the long-term liabilities of certain investors, such as pension funds for example."

[4] Appendix 1 contains similar statements made by other U.S. public pension funds.

The majority of investments by public and private institutional investors in our sample are made through closed infrastructure funds that have a private equity type structure.[5] We find that closed infrastructure funds deliver very similar payout profiles to traditional buyout private equity funds and private real estate funds. Specifically, we find a similar frequency of capital calls and distributions over time, as well as similar amounts. Infrastructure funds do not provide more stable cash flows to institutional investors than other private funds. Infrastructure funds also do not provide less risky returns and the distribution of returns delivered by infrastructure funds is as wide as the distribution of returns delivered by buyout and real estate funds. As is the case with buyout and venture funds, closed infrastructure funds also have a finite life of approximately 10–12 years and generate their cash flows and returns primarily by selling assets in order to be fully liquidated over this horizon. Overall, we find no economic or statistical difference between the payouts over time and riskiness of returns offered by infrastructure funds and other private funds.

We also find substantial heterogeneity in performance by the type of institutional investor. Specifically, public investors – defined as public pension funds, sovereign wealth funds, and government agencies – display worse performance on a number of measures. First, the *deals* to which public investors have exposure have substantially worse exit rates, and we show that in the fund context these lower exit rates are correlated with worse fund performance. The underlying deal data allow us to demonstrate that this underperformance is not due to differences in deal type, as the differences in exit rates persists even when controlling for deal characteristics such as project stage (greenfield, brownfield, secondary), the region, the existence of a concession agreement with a government, and the industry of the investment (e.g., renewable energy, traditional energy, social, information and communication technology, transport, and utilities sectors). Second, the *funds* in which public investors invest underperform on a net internal rate of return (IRR), multiple of invested capital, and public market equivalent (PME) basis, even when controlling for the percentage of deals in the funds that are in each specific region and industry.

One potential hypothesis that could explain these findings would be that public investor infrastructure investments are less risky than those of other institutional investors. However, we

[5] U.S. investors in particular predominantly invest in infrastructure through closed infrastructure funds, while non U.S. institutional investors gain exposure to infrastructure assets through a mix of direct investments and fund vehicles. For example, only 5 out of 157 U.S. public investors in our sample make direct investments, while 104 out of 361 non U.S. public investors in our sample have direct investments. In total, the 5 U.S. public investors hold 15 direct deals, while the 104 non U.S. public investors hold 1,206 direct deals.

find no evidence of this. The ability to measure deal characteristics allows us in both the deal-level and fund-level analysis to control for factors that capture the riskiness of the underlying assets. Furthermore, when we examine the cash flows of closed funds, we find that the frequency of distributions is equivalent for public investors and private investors, with the underperformance reflected in a lower public market equivalent (PME) of public investments. Public investors therefore either have access to worse funds than private investors but nonetheless choose to invest in the asset class, or they select worse-performing funds.

By selecting funds that invest in projects with poor financial performance, public investors have created an implicit subsidy to infrastructure as an asset class. For example, worse performance of infrastructure investments made by public pension funds, which drive most of our results and constitute over two-thirds of the public investors in our sample, leads to a lower funding status of promised benefits. Either taxpayers will have to remedy the underfunding through increased contributions, or pension plan members will receive reduced pension benefits. Therefore either taxpayers or pension plan members are subsidizing infrastructure investments through lower returns. Furthermore, the subsidy is not directly targeted to local deals. While the government agencies that make up around one-fifth of our sample of public investors are exposed to deals that are 42% "home deals" (in the same country or U.S. state of the investor), the deals to which public pension funds gain exposure through infrastructure funds are in less than 20% of instances home-country or home-state deals. Most of the public investors also claim that they do not have non-financial objectives when making infrastructure investments. For example, the mandate of Norwegian sovereign wealth fund to invest in infrastructure states that "allowing for unlisted renewable energy infrastructure is not a climate policy measure, but is a part of the investment strategy for the Fund. These investments shall be subject to same profitability and transparency requirements as the other investments of the Fund" (Norwegian Ministry of Finance, 2019).

We estimate the public subsidy to infrastructure in three ways. First, we consider the estimated net IRR performance of public institutional investors relative to private institutional investors, and assume this performance differential is stable over the approximately $173 billion of public investor exposure to infrastructure assets. This first calculation requires an assumption that IRR equals the effective rate of return.[6] It implies an annual subsidy of $2.25 billion per year.

[6] IRR equals the effective rate of return if and only if dividends generated by the investment are reinvested at the IRR rate. See Phalippou (2008) and Kaplan and Sensoy (2015) for a further discussion.

Second, we consider the PME of infrastructure funds relative to both the S&P 500 and a listed infrastructure index, treating listed infrastructure as the alternative asset that pension funds could have invested in. Estimates here imply a 7.5% underperformance over the life of the fund relative to the S&P 500 and a 16% underperformance in listed infrastructure. Based on our estimates of new annual invested (or called) capital into infrastructure funds, these PME estimates translate into an annual subsidy of $1.34 billion if the alternative investment opportunity is the S&P 500, or $2.86 billion if the alternative investment opportunity is listed infrastructure. Third, we consider how infrastructure fund investments performed relative to the general private equity buyout and real estate investments by the same investors in the same vintage year. Relative to these alternatives we observe an even more substantial underperformance and calculate an implicit annual loss relative to real estate funds again of $1.48 billion per year, but relative buyout funds of as much as $8.45 billion per year. Given our documented fact that the cash flow profiles of infrastructure funds are somewhere between real estate and infrastructure funds, this performance differential is unlikely to be attributable to differential risk, and very likely amounts to over $2 billion per year.

Our paper contributes to several literatures. First, we contribute to the literature on alternative asset classes that focuses primarily on institutional investors' performance in private equity and real estate assets (see Kaplan and Sensoy (2015) for a recent survey). We extend this work by studying infrastructure, which is a fast-growing asset class, and we describe the underlying assets as well as its performance. Prior research on infrastructure finance has focused primarily on Australian funds and assets.[7] We provide a global overview that covers a longer time period and multiple investment approaches, and we measure differences in underlying assets, contractual terms under which the assets are operated, and the contribution of these assets to fund performance.

Second, our paper contributes to the literature on the performance and incentives of public institutional investors. Previous research suggests that public pension funds (Hochberg and Rauh, 2013; Bradley, Pantzalis and Yuan 2016; Andonov, Hochberg and Rauh, 2018) and sovereign wealth funds (Bernstein, Lerner and Schoar, 2013; Bortolotti, Fotak and Megginson, 2015) do not

[7] Peng and Newell (2007) were the first to analyze infrastructure investments, using data on listed infrastructure companies, listed funds and closed funds from Australia. They find that for listed infrastructure the average return was 22.4% with a volatility of 16%, which compared to a 14.1% return with a 5.8% volatility for unlisted infrastructure. Focusing also on Australia, but analyzing a longer time period that includes the financial crisis of 2008/09, Newell, Peng and de Francesco (2011) and Finkenzeller, Dechant and Shepherd (2010) report a lower performance.

always pursue pure value maximization. Infrastructure is an asset class over which government policy has a large influence. Our finding that public investors, like public pension funds and sovereign wealth funds, achieve lower performance suggests that they are susceptible to pressure to subsidize the economy and infrastructure sector. That is, at least in asset classes closely linked to government policies, it seems that public investors are not pursuing strategies whose goals are pure value maximization. However, given the relatively low share of local investments, much of the subsidy is going to regions and countries that are outside of the institutional investor's home state or country.

Third, we add to the literature on the drivers of differences in performance across types of institutional investors. Lerner, Schoar and Wongsunwai (2007) find that endowments invest in private equity funds that deliver greater performance, but Sensoy, Wang and Weisbach (2014) show that the outperformance of endowments disappears over time as the private equity industry matured and the persistence in performance declined. Our result that endowments and foundations select infrastructure funds that deliver higher returns, while public investors underperform, shows that private investors such as endowments and foundations still are better equipped to identify, access, and invest in the relatively stronger opportunities in young, growing asset classes.

The remainder of this paper is organized as follows. Section II describes the data and our sample. Section III compares the cash flows delivered by infrastructure funds with the cash flows delivered by private equity buyout, venture capital, and real estate funds. Section IV provides results on institutional investors' performance in infrastructure. Section V examines exit patterns within infrastructure deal types. Section VI measures the implicit subsidy to infrastructure as an asset class. Section VII concludes.

II. Data

There are numerous reasons why data in the field of infrastructure investing poses challenges for researchers. First and foremost, it is the lack of transparency that is typical of unlisted investments due to their proprietary nature. The practical result of this is that the characteristics and performance of such assets are often not publicly disclosed. Second, owing to both the usual annual reporting of unlisted investment vehicles plus the overall, still relatively short, history of infrastructure investments, only recently has the asset class generated a body of data that is large enough to conduct substantive multivariate analysis.

In this paper, we focus on equity positions of institutional investors in infrastructure assets.[8] We obtain data on infrastructure investments from Preqin. Figure 1 depicts the investment approaches through which investors can gain equity exposure to infrastructure projects. Investors can invest in infrastructure assets directly or through different types of funds run by professional managers, referred to as general partners (GPs). Few investors decide to invest directly in assets as it requires a greater financial commitment to a single asset, as well as specialized human capital to select, manage, and monitor these assets. Our sample covers 4,493 commitments of investors to infrastructure funds and 1,721 direct investments in assets. The 4,493 commitments to funds consist of 3,983 to closed funds, 181 to listed funds, and 329 to open-ended funds.

When investing through infrastructure funds, institutional investors can select between three fund types: closed, listed, and open-ended funds. The vast majority of institutional investors gain exposure to infrastructure assets through closed funds. Closed funds are organized in a similar way as buyout and venture capital. These funds are raised for a specified period (typically 10 to 12 years, with possible short extensions) and are governed by partnership agreements between the investors and the fund's principals. Investments are made by the limited partners (LPs) at the start of the fund's life, often referred to as the vintage year. Closed funds account for 46,477 investor-deal observations.

The remaining observations are split between listed and open-ended funds. Listed infrastructure funds have publicly traded shares. Institutional investors can gain exposure to their underlying assets by buying shares of listed funds instead of signing a separate partnership agreement. Open-ended (evergreen) funds are not publicly traded, but they also offer more liquidity to the investors through periodic subscriptions and redemptions. Importantly, unlike closed funds, both listed and open-ended funds do not have a clear termination date and may be better designed to provide long-term exposure to infrastructure assets. Closed funds are expected to focus more on exiting positions in assets as they need to distribute cash back to the LPs.

Investors can also access infrastructure projects through funds-of-funds. In Preqin, we do not observe the portfolio of funds selected by funds-of-funds and we cannot link the investor to the underlying infrastructure assets. Therefore, we exclude pure funds-of-funds from the analysis

[8] We do not analyze institutional investors acting as debt providers in infrastructure projects.

but we keep in the sample a small number of funds-of-funds that have some direct exposure to infrastructure assets in addition to the portfolio of fund investments.

Infrastructure has emerged as an asset class in the last decade and it has experienced a steady increase in the flow of funds. To show this increasing trend, we rely on the reported unrealized value of assets when estimating the value of assets under management by closed infrastructure funds. Specifically, we download the time-series of annual performance snapshots for the time period 2008–2018 from Preqin and use the ratio of residual value to paid-in capital to estimate the time-series of assets under management. We transform the ratio of residual value to paid-in capital to dollar amounts using the percentage of capital called and fund size.

Figure 2 shows the unrealized value of assets managed by closed infrastructure funds over time. We estimate that over the past ten years, the amount of assets under management by infrastructure funds with performance reported in Preqin increased from $23 to $235 billion. On the one hand, this estimate could overstate the asset under management if infrastructure funds overestimate the value of their unrealized assets (Phalippou and Gottschalg, 2009). On the other hand, this estimate significantly understates the assets under management because it considers only the assets managed by infrastructure funds that report performance in the Preqin database. For example, in 2018, we have performance statistics of 290 closed funds, while in the period 2007–2018 there are 986 closed (but not yet liquidated) funds in the Preqin database.

We attempt to remedy this by making additional imputations in the upper bars of Figure 2. Specifically, we assume that every fund that does not report performance holds 25% of the average assets of reporting funds from the same vintage, yielding $169 billion in unrealized value in non-reporting funds and a total of $404 billion in total unrealized value across all funds. Note that this total does not include the assets held by listed and open-ended funds, nor does it include the infrastructure assets held directly by institutional investors.

The increasing trend in infrastructure assets under management presented in Figure 2 is likely to continue in the coming years as many investors are targeting higher allocation weights to infrastructure than their current actual asset allocation. For example, in 2017, the Employees Retirement System of Texas (2017) reported in their annual report a target allocation of 4%, compared to an actual allocation of 1.7%, while the Maine Public Employees Retirement System (2017) reported in the annual report a target allocation of 10%, compared to an actual allocation of 7.2%. Looking at the sovereign wealth funds, the Norwegian Government Pension Fund Global

received an approval from the government in 2019 to start investing up to 2% (around $20 billion) of the fund's value in unlisted renewable energy infrastructure. Importantly, the Norwegian government stated in the announcement that "Allowing for unlisted renewable energy infrastructure is not a climate policy measure, but is a part of the investment strategy for the Fund. These investments shall be subject to the same profitability and transparency requirements as the other investments of the Fund" (Norwegian Ministry of Finance, 2019).

We collect the investments made by six types of institutional investors. Three types of investors belong to the public sector: public pension funds, government agencies, and sovereign wealth funds.[9] The other three types of investors come from the private sector: private pension funds, insurance firms and banks, and university endowments and foundations. Table 1 presents summary statistics by institutional investor. Our sample contains 1,594 institutional investors from 61 countries, plus several international financial institutions which are classified as international instead of being assigned to one country.[10] In Panel A we present statistics for all institutional investors, while in Panel B we limit attention to U.S. investors only, which account for 40% of our sample. These investors make commitments to 484 unique funds (421 closed, 34 listed, and 29 open-ended funds) managed by 234 unique GPs. Directly and through funds, they gain exposure to 4,825 unique infrastructure assets. There can be multiple deals (transactions) in one asset during the sample period. As noted in the discussion of Figure 1, we observe 4,493 investor-fund observations and 1,721 direct investments in infrastructure assets. Since an infrastructure fund invests in multiple assets, our sample contains 62,106 investor-deal observations.

Table 1 and Figure 3 show that the largest groups of institutional investors are public and private pension funds, with a share of 33.3% (20,661 out of 62,106) and 32.6% (20,233 out of 62,106) of the investor-deal observations respectively. Government agencies and sovereign wealth funds account for 4.7% and 2.0% of our sample of investor-deal pairs. Insurance firms and banks represent 16.3% of the sample, and endowments and foundations represent the remaining 11.3%. Panel A of Table 1 shows that the institutional investors in our sample have an average of $47.02

[9] We classify also development banks as government agencies. Our sample of government agencies includes investments made by the International Finance Corporation (IFC), European Investment Bank (EIB), African Development Bank, U.S. Overseas Private Investment Corporation, and U.K. CDC Group, among others.

[10] In Internet Appendix Table IA.1, we list the number of investors by country and split them into public and private investors. U.S. investors are the largest group in the sample with 647 unique institutions, followed by 177 U.K, 84 Australian, 68 Canadian, 49 German, 47 Italian, 46 South Korean, 42 Swiss, 41 Dutch and 34 Indian investors.

billion in assets under management (AUM), and invest on average in 3.16 funds and 1.08 direct deals. Through the funds and direct investments, institutional investors gain exposure to an average of 43.5 deals. We observe substantial cross-sectional variation in investor size. Sovereign wealth funds are the largest institutional investors, while endowments and foundations are the smallest.

Figure 3 presents also the investment approach by investor type. In general, institutions invest primarily through closed infrastructure funds, but sovereign wealth funds and government agencies are more likely to invest directly in infrastructure assets. There is no large cross-sectional dispersion in the investment approach choices of the other types of institutional investors. Public pension funds gain exposure to assets in a similar way as private pension funds, insurance firms, banks, endowments and foundations.

Infrastructure deals can be classified into three categories based on the project stage: greenfield, brownfield, and secondary stage. The greenfield stage designation refers to physical assets that do not exist and need to be constructed. Investors finance the building of the asset as well as the maintenance after it is designed, built, and became operational. The brownfield stage designation provides exposure to assets that require improvements, repairs or expansion. These assets are usually partially operational and may already be generating income. Secondary stage assets provide exposure to fully operational assets that require no further investment for development. The key difference lies in the maturity of the asset and the available asset-specific experience, which is substantially less in the case of greenfield and brownfield investments. This difference might lead to a significantly higher degree of uncertainty and risk in greenfield and brownfield compared to secondary stage projects. Indeed, compared to investments in secondary projects, investments in greenfield and brownfield projects do not generally distribute profit in the first years but instead require capital commitments, which results in a so-called J-curve effect. In our sample, around 66.2% of the investor-deal observations provide exposure to secondary deals. Greenfield projects account for 23.0% of the deals and brownfield projects account for 10.8% of the deals. The exposure to different projects does not differ across the larger types of institutional investors. The only exception is government agencies which are more likely to invest in greenfield and brownfield projects.

We next present summary statistics on the contractual agreements of the deal. The concession variable is an indicator for whether a deal involves either a concession or a privatization agreement with the government or other public entity. In the case of a concession, an investor

enters into an agreement with the government to have the exclusive right to operate, maintain and invest in an infrastructure asset for a given number of years. We classify as a concession only a transaction in which the government is involved as a counterparty. We do not consider resale transactions when one investor exits and sells a position in a concession deal to another investor to be a concession deal, as the government is not directly involved in the transaction.[11] We find that on average 9.1% of the deals in an investor portfolio are backed by a concession agreement.

Table 1 also presents summary statistics on the ownership structure in deals. *#Investors* counts the average number of investors in the same deal. When constructing this variable, we count multiple LPs investing through the same infrastructure fund only once. Many infrastructure deals are relatively large transactions and, on average, 1.69 investors jointly execute a deal. *Investment Stake* measures the average investment stake of the infrastructure fund through which the LPs accessed the deal. *Total Stake* is the average stake of all investors in the deal. Investors on average obtain 60.8% ownership in the underlying asset and all investors jointly have 76.4% ownership in the underlying asset.

Figure 4 presents the distribution of deals by industry for each investor type. We classify the deals into seven industries. The largest industry is traditional energy and it includes investments in coal and nuclear power plants, natural resources pipelines, refineries, and natural resource storage facilities. Renewable energy captures investments in wind, solar, hydro, biomass, and geothermal power facilities. The transportation industry includes investments in toll roads, parking lots and service stations, tunnels, bridges, railroads and rolling stocks, airports and aircraft, sea ports, cargo shipping vessels, and logistics. Social infrastructure combines investments in hospitals, medical facilities, senior homes, student accommodation, education facilities, public buildings, prisons, defense accommodation, and police stations. The utilities industry includes investments in water treatment plants, water distribution, power distribution, sewage treatment plants, sewage networks, and waste management. The telecom industry covers investments in mobile phone, landline phone, wireless, internet, cable television, and satellite networks. The final category covers diversified infrastructure projects. Overall, the infrastructure asset class encompasses projects from different industries, highlighting the importance of controlling for industry type in our analysis.

[11] Our results are robust to alternative concession definitions.

Our sample includes infrastructure assets located in 125 countries.[12] In our analysis, we account for differences in geographical location by classifying the assets into seven regions: Northern America (USA and Canada), Latin America and Caribbean, Western Europe, Eastern Europe, Asia, Africa, and Oceania. Panel A of Figure 5 shows the distribution of deals by region for each investor type. Around 86% of the exposure of public pension funds, private pension funds, insurance firms, banks, endowments and foundations is to deals in developed markets and 14% is to deals in emerging markets. Government agencies and sovereign wealth funds invest relatively more in projects located in emerging markets. Panel B focuses on the subsample of U.S. investors only. U.S. institutions allocate a similar proportion of their capital to assets in emerging markets, but within developed markets they invest relatively more in their home country. For instance, U.S. public pension funds invest 53.2% of their capital in assets located in Northern America, while for endowments and foundations this percentage increases to 75.8% of their investments.

We generate a *%Home deals* variable based on the location of the deal relative to the location of the institutional investor. Since the U.S. is a very large country in our sample with a geographically disperse network of institutional investors, we define the *%Home deals* variable for U.S. investors as deals located in the same state (not country) as the institutional investor.[13] Panel A of Table 1 shows that institutional investors allocate around 25% of their capital to projects located in their home state or country under this definition, with public pension funds' local allocation at only 19%. Within the U.S., only 3.2% of infrastructure deals that public pension funds are exposed to are home deals.

III. Comparison of Infrastructure Funds with Other Private Funds

Institutional investors often incorporate infrastructure as an alternative asset class in their portfolio, under the expectation that it will deliver steady cash flows and diversification benefits due to low correlation with other asset classes. Indeed, investors often describe infrastructure assets

[12] In Internet Appendix Table IA.2, we tabulate the 4,825 unique infrastructure assets by country. These are the ten countries with most deals: 1,174 in U.K., 916 in U.S., 260 in France, 241 in Australia, 215 in Canada, 182 in Germany, 172 in Italy, 146 in India, 135 in Spain, and 131 in Brazil.

[13] In Internet Appendix Table IA.3, we tabulate the number of unique U.S. infrastructure assets by state and industry. The five states with most deals are Texas with 168, California with 102, Pennsylvania with 47, Illinois with 46, and Massachusetts with 38 assets. Renewable and traditional energy projects dominate in the sample of U.S. assets.

as a match for their long-term inflation-linked liabilities.[14] The asset management industry promotes infrastructure as a new asset class that will deliver stable cash flows with a low correlation with the business cycle (Deutsche Bank Asset Management, 2017; J.P. Morgan Asset Management, 2017). Furthermore, recent literature has recognized the importance of cash flow data for achieving a complete picture of the performance of vehicles with a private equity structure (Ang, Chen, Goetzmann and Phalippou, 2018).

In Panel A of Table 2, we compare the riskiness of investments in closed infrastructure funds with investments in buyout, venture capital (VC), and real estate (RE) funds. The comparison is based on three performance measures: the public market equivalent (PME) calculated as in Kaplan and Schoar (2005), the net IRR, and the net multiple of invested capital. We use the returns on the S&P 500 stock market index to calculate the PMEs and find that infrastructure funds have underperformed the public market with an average PME of 0.928, or a present value of the underperformance equal to 7.2% of the total present value of paid-in capital over the life of the fund.[15] The PMEs delivered by buyout, VC and real estate funds in the same time period are 1.052, 0.972, and 0.942, respectively. The other performance measures, net IRR and multiple of invested capital, also suggest that infrastructure delivers relatively low returns compared to the other private asset classes.

More importantly, even though investors may incorporate infrastructure in their portfolios due to expected stable (less risky) cash flows, the standard deviations of the performance of infrastructure funds are very similar to the standard deviations of buyout and real estate funds. For example, the PME of infrastructure funds has a standard deviation of 0.336, which is comparable with the standard deviation of 0.387 and 0.290 that buyout and real estate funds provide. Only VC funds stand out as a riskier asset class with higher standard deviations on all performance measures.

Figure 6 extends the risk analysis by analyzing the distribution of performance. If infrastructure delivers more stable cash flows by providing exposure to less risky investments, it should have a narrower distribution of performance and the lowest and highest performance percentiles should be closer to the mean (or median) performance. However, Figure 6 shows that the distribution of returns delivered by infrastructure funds is as wide as the distribution of returns

[14] In Appendix 1, we quote several statements made by U.S. public pension funds that explain their expectations and motives for investing in infrastructure.

[15] PME values greater than 1 indicate outperformance of the benchmark, and less than 1 indicate underperformance.

delivered by buyout and real estate funds. Only VC funds appear to be riskier, while the returns of the other types of private funds appear to have a similar dispersion to that of infrastructure funds.

One reason the risk of infrastructure investments may be high even though they might be backed by stable concession agreements or tangible assets relates potentially to the fact that these assets are financed with a high degree of leverage. For a small subsample of 6,273 investor deal observations, Preqin provides information on the total deal size as well as the proportion of deal financed by equity and debt. For these observations, we can calculate the leverage ratio as of the time of the deal. In Internet Appendix Table IA.4, we show that the median infrastructure transaction is financed by 66% debt and 34% equity. The median leverage ratio for social infrastructure is the highest and equals 89%. Social infrastructure is the industry with the highest proportion of concession agreements backing the deals, so the stability of cash flows seems to be used to increase the amount of leverage.

In Panel B of Table 2 and in Figure 7, we compare the cash flows delivered by closed infrastructure funds with the cash flows delivered by buyout, VC, and real estate funds. We use cash flow data from Preqin for funds with a 2002 vintage or later and focus on the annual frequency of capital calls and distributions as well as on the annual amounts of these capital calls and distributions. If closed infrastructure funds deliver more stable cash flows, as argued by the finance industry and expected by investors, their payouts would be expected to have more stable frequency and amounts over the entire life of a fund. We standardize the cash flows over the life of a fund, so that time period $t=1$ corresponds to the vintage year of the fund. We present the timeline of cash flows for the first 12 years of the fund life, as most closed funds are designed to exist for approximately 12 years and are fully divested by that time.

Table 2 and Figure 7 show that the payout profile provided by infrastructure funds does not differ from the payout profile provided by buyout funds. The only significant difference is in the frequency of capital calls as buyout funds draw on capital commitments more frequently. Buyout funds also distributed higher amounts which corresponds to their better performance observed in the Panel A. The amount of capital calls and the dollar amount of distributions over time provided by infrastructure funds seem to be between the dollar amount of capital calls and the amount of distributions over time delivered by buyout and real estate funds. Even compared to VC funds, infrastructure funds have a similar timeline of capital calls but more frequent distributions.

Table 2 shows that the number of buyout and VC funds raised since 2002 is significantly greater than the number of infrastructure funds raised in the same time period. One potential worry is that infrastructure funds differ in their focus from the other private funds, because they invest more outside of U.S., and are relatively larger than the average buyout, VC, or real estate fund. In Appendix Figure IA.1, we replicate the analysis from Figure 7, but instead of using the cash flows of the entire sample of buyout, VC and real estate funds with available cash flow data, we use only the cash flows of a matched subsample. We create this subsample by matching infrastructure funds with buyout, VC and real estate funds based on three criteria: vintage year, geographical focus (U.S., Europe and Rest-of-World), and fund size (closest match). The results with the matched subsample confirm that infrastructure, buyout, and real estate funds have a similar profile of capital distributions over time. Moreover, in the matched subsample, we also observe that infrastructure and VC funds have a similar (statistically and economically) profile of capital calls and distributions.

Overall, the typical structure of cash flows over time provided by infrastructure funds does not differ from the payout policy offered by more established alternative assets, like buyout, VC, and real estate funds. Based on the distribution of returns and payout profiles, we conclude that it will be difficult for closed infrastructure funds to meet investor expectations for stable cash flows with diversification benefits.

IV. Performance Differences across Institutional Investors

In this section, we move the analysis from an asset class level to an investor level and study the investor experience in infrastructure. First, we analyze performance on an investor-fund level using PME, net IRR and multiple of invested capital as performance measures. In this analysis, we limit attention to closed funds, as Preqin collects performance data only for these funds. Second, we analyze performance on an investor-deal level by examining the probability of exiting an infrastructure investment. When analyzing the exit probabilities we can include deals accessed not only through closed funds, but also through listed and open-ended funds as well as direct deals. The fraction of exited investments has been used a proxy for performance in the private equity literature when analyzing the performance of buyout and venture capital funds (Hochberg, Ljungqvist and Lu, 2007; Sorensen, 2007; Phalippou and Gottschalg, 2009). Exiting a deal is an

informative indicator of performance in our setting because the majority of infrastructure deals are made by closed funds organized in the same way as private equity funds.

In Table 3 we link the two performance analyses and verify that exit rates are indeed related to performance, as they could in theory also capture differences in the investment horizon or other preferences. We analyze four performance measures: the probability of reporting any performance statistics in Preqin; the net IRR; the net multiple of invested capital; and the public market equivalent (PME). This analysis is on a fund level and covers only closed funds, as Preqin collects performance data only for these funds and closed funds have clear objectives to exit deals faster. The other investment approaches (listed funds, open-ended funds, and direct deals) do not have a predefined ending term and thus do not face an incentive to exit deals quickly.

Columns (1) and (2) present the results of logit regressions and the dependent variable equals one if a closed infrastructure fund reports either the net IRR, multiple of invested capital, or cash flows (which allow for a PME calculation) in the Preqin database. Infrastructure is a relatively new asset class and many funds still do not report any return measures. However, this argument may justify lack of performance disclosure for funds started in recent years, but not for funds that have existed for a longer time period. Therefore, in Table 3, we control for vintage year of the fund as well as the percentage allocated to projects in difference industries and geographical regions. The vintage year indicators are designed to control for a truncated distribution of deal exits. In Column (1), we find that a 10 percentage point increase in the percentage of exited deals is associated with a 2.99 percentage point higher probability of reporting performance. We also observe that larger funds are more likely to report performance.

In Columns (3) to (8), we find more direct evidence that exiting a deal proxies for better performance. Based on Column (3), a 10 percentage point increase in the percentage of exited deals is associated with a 2.84 percentage point higher net IRR. Based on Columns (5) and (7), a 10 percentage point increase in the percentage of exited deals is associated with an increase in the multiple of invested capital by 0.09 and an increase in the PME by 0.11.

Within infrastructure, the percentage of exited deals proxies well for performance because many funds were raised recently and are still not fully liquidated. If there are many liquidated funds, the percentage of exited deals will be a weaker proxy of performance because liquidated funds by definition have already exited all their investments. Therefore, in Columns (4), (6) and (8), we split the percentage of exited deals based on the holding period. We examine separately

the relation between performance and the percentage of exited deals in the first five years after the transaction date, in five to ten years after the transaction, and in more than ten years after the transaction date. We find that the positive relation between performance and exit rates is driven primarily by relatively quick exits within the first five years after the investment date and to a lesser extent by exits in the period from year 5 to year 10. Investments held for a period of longer than 10 years seem to be negatively related (or at least not related) to performance, even after controlling for the share of fund investments in different deal regions and deal industries. This result further confirms that for closed infrastructure funds, a quick exit might well be the objective when making investment decisions and that exit rates are a valid proxy for analyzing the performance of different institutional investors in this asset class.

In Table 4, we start the analysis on investor experience in infrastructure by examining the performance on an investor-fund level. The advantage of this analysis is that we can directly include return measures, like IRR, PME and multiple of invested capital, as dependent variables. The disadvantage is that we can analyze only the performance of investments through closed funds, but not to listed funds, open-ended funds, and direct deals.

As explanatory variables, we use indicators for institutional investors from the public sector: U.S. public pension funds, non U.S. public pension funds, government agencies, and sovereign wealth funds. The omitted category is investors from the private sector. We control for the natural logarithm of the LP's AUM and for the year of their first infrastructure investment. These two variables could capture negotiating power, experience, or ability to access higher-performing GPs for reasons unrelated to investor type. *#Funds* measures the total number of investments in infrastructure funds by investor.

We also include two additional control variables for infrastructure fund type. *FOF* is an indicator variable equal to one for infrastructure funds labeled primarily as funds-of-funds but still holding few deals directly. The coefficient on this variables does not inform us about the performance of funds-of-funds as pure funds-of-funds that do not hold deals directly are excluded from our sample. *Debt fund* is an indicator variable that captures infrastructure funds investing in both debt and equity securities related to infrastructure. The negative performance coefficient could be explained if such funds previously held an underperforming loan and were forced to restructure it in an equity stake. The best-performing debt funds will likely not have any direct equity stakes and will not be in our sample.

The results in Table 4 show that public investors exhibit lower performance. Public investors hold infrastructure funds that have 2.90 percentage points lower exit rates, 1.28 percentage points lower net IRR, 0.061 lower multiple of invested capital, and 0.041 lower PME. Within the sample of public investors, all four categories exhibit negative coefficients. U.S. public pension funds invest in infrastructure funds that have significantly lower exit rates, multiples of invested capital, and PMEs. Non U.S. public pension funds invest in infrastructure funds with significantly lower net IRR and multiple of invested capital. Government agencies and sovereign wealth funds also seem to underperform compared to private institutional investors, although the coefficients are significant only when using the net IRR as a performance measure. That said, the coefficients in Columns (3) to (8) could underestimate the underperformance of public investors if there is selection bias in the availability of performance data. For example, U.S. public pension funds hold more infrastructure funds with lower exit rates, and these funds deliver on average lower returns and are less likely to report performance in Preqin. Indeed, Table 3 shows that the performance measures are more likely to be missing for funds with lower exit rates.

One possible explanation for these results might be that public institutional investors gain exposure to less risky infrastructure investments than private institutional investors and that these safer assets will deliver lower returns. We test for this hypothesis in two ways. First, in Table 5, we examine the cash flows delivered by closed funds to their investors. If public investors are exposed to less risky assets, then they should receive steadier cash flows over time from these assets. We find that the frequency of distributions is equivalent for public investors and other types of institutional investors. However, public investors receive more frequent capital calls. The lower PME obtained by public investors shows that the similar frequency of distributions over time is not compensated by higher distribution amounts. Therefore, we do not find support for the lower-risk hypothesis.

Second, we use deal characteristics, like project stage, location, and concession agreement, as proxies for factors that capture the riskiness of the underlying assets. In Table 6, we move the analysis from an investor-fund level to an investor-deal level and study the probability of exiting an infrastructure investment while controlling for the characteristics of the infrastructure asset. To examine performance differences across types of institutional investors, we estimate Cox proportional hazard models. The hazard event of interest is defined as a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset during a year. We estimate

the hazard rate of exiting an asset, defined as the probability that an exit will come to fruition in year *t* conditional on it not becoming complete prior to year *t*. In this setting, *t* refers to the number of years after the purchase transaction and it measures event time rather than calendar time. Estimation of the model delivers coefficients that can be interpreted as hazard ratios. A hazard ratio lower than one indicates that as the value of the covariate increases, the hazard rate of exiting a deal decreases.

In the analysis, we focus on the indicators for institutional investors from the public sector and the omitted category is investors from the private sector. In addition to the control variables on an investor level introduced already in the previous analysis, we also include an indicator variable for direct investments (*Direct deal*) in infrastructure deals. In each model we include deal industry and deal region fixed effects. We cluster standard errors by institutional investor.[16] In the Cox proportional hazard model the coefficient estimates are robust to any baseline hazard function, which implies that the specification is robust to time-specific common factors, analogous to controlling for year fixed effects (Dinc and Gupta, 2011).

Our results show that public investors have a lower probability (based on the hazard ratio) of they or their GPs exiting an infrastructure deal. As shown in Column (1) – which includes fixed effects at the level of the deal region as well as deal industry – public investors have a 15.2% lower probability of exiting an infrastructure deal as compared to institutional investors from the private sector. Based on column (2), all groups of public investors have a lower probability of exiting a deal. The hazard ratios are significantly lower for U.S. public pension funds, non U.S. public pension funds and sovereign wealth funds. Non-U.S. public pension funds have statistically significant lower exit rates compared to private sector institutional investors only when we do not include LP country fixed effects. The LP country fixed effects absorb a lot of variation in the sample of countries with fewer investors, especially when a country has either only public or only private investors.

We view exit rates as a proxy for performance, but the infrastructure asset class includes heterogeneous projects. Recognizing that the differences in exit rates could potentially be due to differences in the selection of projects, we take several approaches. First, we control for project industry and geographical location through the inclusion of fixed effects. Second, we include an

[16] In Internet Appendix IA.5, we show that our results are robust to clustering standard errors by infrastructure asset. This robustness test accounts for the fact that multiple institutional investors can invest in the same asset.

indicator control variable for *direct deals*, which offer more flexibility in the exit decisions. When investing through funds, institutional investors generally do not have the power to influence the timing of exit decisions, whereas when they invest directly they can make such decisions. We observe that direct deals in infrastructure have economically significantly longer holding periods and around 50% lower exit rates, as institutional investors who devote substantial financial and human capital to direct investing are willing to make long-term commitments.

Third, in Columns (5) and (6), we add controls for concession agreement, project stage, and location of the deal in the same country (state) as the LP. As expected, the coefficients on the greenfield and brownfield variables are below one, indicating that these (riskier) projects require a longer time for development before they can be sold to other parties. Secondary deals that are fully operational are more liquid and transact faster. Deals backed by a concession agreement exhibit a higher probability of exit. This implies that a concession agreement has the potential to reduce risk and increases the liquidity of a deal. Institutional investors also see lower exit rates for deals located in their country. The inclusion of these deal-level controls does not affect the hazard ratio on public investors as institutional investors from the public sector continue to exhibit 13.2% lower probability of exiting an infrastructure deal.

Fourth, in Columns (7) and (8), we add controls for the total number of investors in the same deal and the ownership position. We observe a lower probability of exiting a deal when multiple investors are involved and when they obtain a lower ownership stake.

In the Internet Appendix, we estimate two robustness tests of our results. First, in Internet Appendix Table IA.6, we include an indicator variable for all private institutional investors. We find that private institutional investors have hazard ratios above one, but particularly U.S. private sector pension funds, endowments and foundations display a higher probability of exiting deals. Based on Column (6), U.S. private pension funds have a 22.0% higher probability of exiting an infrastructure deal and endowments and foundations have a 26.6% higher probability of exiting an infrastructure deal in year *t*, if they have not been exited it previously, than public pension funds. Second, in Internet Appendix Table IA.7, we focus on the subsample of investor-deal observations accessed through closed funds, because closed funds have an ending term and stronger incentive to exit a deal faster. We exclude deals accessed directly or through listed and open-ended funds as these investment approaches do not have a clear ending term and have more flexibility in the exit decisions. The results in Internet Appendix Table IA.7 are similar to the results in Table 6: public

investors (and in particular U.S. public pension funds and sovereign wealth funds) have a significantly lower probability of exiting deals.

Overall, we document that public investors display lower exit rates relative to other institutional investors even after controlling for deal characteristics. While differences in allocation to specific deal types could be driven by variation in objectives, beliefs or preferences about the properties of different deals, the fact that the coefficients on public investors remain unchanged after controlling for deal type (industry, location, stage, concession, and ownership stake) suggests that the differences in exit rates between public and private institutional investors do in fact proxy for differences in performance.

Our results indicate that public investors hold infrastructure deals longer, and that their lower exit rates proxy for lower performance. There are four potential explanations for the underperformance of public investors.

First, the differences in exit rates and performance could be due to differences in preferences for gaining long-term exposure to infrastructure assets. However, as shown in Figure 3, public investors account for 43% (1,707 out of 3,983) of the investments in closed funds, the investment approach with the strongest incentive to exit deals faster, and are no more likely to invest through listed and open-ended funds, which offer more flexibility to hold deals longer. The underperformance of public investors also does not seem to be due to preferences for different projects, as controlling for detailed deal characteristics does not attenuate the coefficient of their underperformance. Thus, we observe limited support for the explanation based on different preferences.

Second, public investors could gain exposure to less risky infrastructure investments than other institutional investors and these safer assets will deliver lower returns. We test for this hypothesis in two ways. First, we use deal characteristics, like project stage, location, and concession agreement, as proxies for factors that capture the riskiness of the underlying assets. Second, we examine the cash flows delivered by closed funds to their investors. If public pension funds are exposed to less risky assets, then they should receive steadier cash flows over time from these assets. We find that the frequency of distributions is equivalent for public and private investors, but public investors receive more frequent capital calls. Therefore, we do not find support for the lower-risk hypothesis.

Third, public investors frequently state that they expect stable long-term cash flows, while our results suggest that their infrastructure fund managers look for capital appreciation and sales during the limited life of the fund. However, this misalignment of objectives is unlikely to explain lower performance, as especially public pension funds are making the decision to invest in closed infrastructure funds with limited life even though they are familiar with this business model based on extensive prior experience with buyout, VC, and real estate funds.

Finally, the underperformance of public investors could be due to lower skill in the selection of funds, or continued investment in infrastructure despite perhaps only having access to worse-performing funds. U.S. public pension funds may also have different objectives, such as finding back-door ways to increase allocation to alternative assets in order to maintain high expected returns on their plan assets. If some pension funds have a higher target allocation to infrastructure, and if the universe of good investments available to them is limited, those with higher target allocations may take on more marginal investments in order to meet the target.

Our results seem to be in line with the last of these interpretations – that public investors either have lower skill in manager selection or worse access to funds, but that they continue to invest in the asset class in order to justify increased exposure to private markets more generally. The performance differences in infrastructure across types of institutional investors are similar to the literature on performance of institutional investors in private equity. The evidence that endowment funds perform better in infrastructure at present, when this asset class is still in a growth stage, is in line with the evidence that endowments performed better than other investors in private equity investments in the 1990s, before the private equity industry matured (Lerner, Schoar and Wongsunwai, 2007; Sensoy, Wang and Weisbach, 2014). Our results suggest that university endowments still possess an information advantage and are able to identify and access well-performing managers in young asset classes.

V. Exit Rates and Deal Characteristics

In this section, we extend the performance analysis by examining deal exit patterns within deal types. We limit our attention to the subsample of U.S. institutional investors as they represent the largest group in our sample and most of the variation in performance comes from U.S. public pension funds. Table 7 presents results of a survival analysis using Cox proportional hazard model. The event of interest is again the decision to exit a deal in year *t* conditional on not exiting the deal

prior to year *t*. We start with the entire sample of all deals to which U.S. investors are exposed, and afterwards we focus on smaller subsamples based on industry, location, project stage, and concession. Public pension funds are the dominant group of investors from the U.S. public sector and they represent 150 out of 157 U.S. public investors. There are four U.S. state investment funds (sovereign wealth funds) investing in infrastructure: Alaska Permanent Fund Corporation, New Mexico State Investment Council, North Dakota Legacy Fund, and Texas Permanent School Fund General Land Office. There are also three U.S. government agencies investing in infrastructure: Overseas Private Investment Corporation, Office of Hawaiian Affairs, and Utah School and Institutional Trust Funds Office (SITFO).

The results in Column (1) confirm that U.S. public investors have a 29.6% lower probability of exiting an infrastructure deal as compared to U.S. institutional investors from the private sector. In Columns (2) to (4), we analyze the exit rates within the three largest industries based on the number of deals: traditional energy, renewable energy, and transportation.[17] The other industrial categories are too small for a separate analysis. We find that U.S. public investors have lower exit rates within all three industries. The magnitude of the coefficients seems to be relatively larger within traditional energy deals.

In Columns (5) and (6), we split the deals based on location into home (U.S.) deals and international deals. Public investors have a significantly lower exit rate only on their portfolio of domestic deals, while the coefficient on international deals is insignificant and closer to one. Public investors have a 36.7% lower probability of exiting a domestic deal as compared to private investors.

In Columns (7) and (8), we split the sample based on project stage. We combine greenfield and brownfield deals as both of them provide exposure to assets that are not fully operational and require significant investments. We observe that public investors have lower exit rates for both greenfield/brownfield and secondary deals. Therefore, their underperformance does not arise from exposure to deals associated with differential risk. In Columns (9) and (10), we split the sample based on whether the deal is backed by a concession agreement as additional measure of the riskiness of the project. The sample of concession deals in the portfolio of U.S. investors is small

[17] When examining deals within traditional and renewable energy, we cannot control for a concession indicator because there are almost no concessions in these industries. The vast majority of the concessions is offered for deals in the transportation, social, and utilities industries.

and covers only 927 investor-deal observations. We find that U.S. public investors have lower exit rates for both deals with and without a concession agreement.

Overall, we find that the lower exit rates and underperformance of U.S. public investors are not driven by a specific subsample of infrastructure deals. They display lower rates in all major industries, locations, and project types. The lower exit rates and underperformance seem to be relatively larger within domestic projects, but they are not entirely driven by these deals.

VI. The Implicit Subsidy

By selecting funds that invest in projects with poor financial performance, public investors have created an implicit subsidy to infrastructure as an asset class. This underperformance will negatively affect public pension funds in particular as they have explicit liabilities and need to report their funding status, while government agencies and sovereign wealth funds typically do not have well-defined liabilities. Depending on whether unfunded pension liabilities will ultimately be remediated through contribution increases from taxpayers or benefit cuts, this subsidy is provided by either taxpayers or pension plan members, or a mix of both. The subsidy for the underperforming government agencies and sovereign wealth funds is provided directly by taxpayers. We measure the value of this subsidy by public investors to infrastructure as an asset class in three ways.

First, relative to private infrastructure investors, we estimate an underperformance in terms of net IRR of 1.3% of the value of the investment each year (see Table 4). If the share of public investors in the total value of infrastructure fund assets under management is given by their share in the number of commitments to closed funds (1,707 out of a total of 3,983 investor-closed fund observations, i.e., 42.9%), then public investors have a total $173.1 billion under management in infrastructure funds.[18] If held stable, and if IRR can be taken as a proxy for effective rate of return experienced by investors, then the 1.3% lower net IRR would imply an annual subsidy of $2.25 billion. With public investors' assets under management rising at a rate of 23% per year, this subsidy would be expected to double every three and a half years.[19]

[18] $173.1 billion is 42.9% of the $404 billion in assets under management in Figure 2.

[19] Several large public pension fund investors foresee substantial increases in their allocations to infrastructure. For example, Pennsylvania Public School Employees' Retirement System (2014; 2017) increased its infrastructure allocation target from 3% in 2014 to 8% in 2017. In 2017, Employees Retirement System of Texas (2017) has a target allocation of 4%, compared to actual allocation of 1.7%, and Maine Public Employees Retirement System (2017)

This first calculation has several potential drawbacks. The net IRR equals the rate of return experienced by investors if and only if dividends generated by the investment are reinvested and earn that same rate of return. In addition, a calculation of the subsidy based on the estimated performance differential between the investments of public and private institutional investors implicitly assumes that global infrastructure fund investments made by private investors are on the efficient frontier and therefore are an appropriate benchmark. Finally, the application of net IRR to assets under management reflects the impact of decisions that have already been made to commit capital to funds, in some cases several years ago, as opposed to the subsidy inherent in new decisions to commit capital to funds and their underlying assets.

To address these points, we develop a second measure of the underperformance of U.S. public pension funds in the infrastructure asset class, based on the Public Market Equivalent (PME) approach. The PME as defined by Kaplan and Scholar (2005) represents the ratio of the present value of capital distributions to the present value of capital calls, where the discounting is performed based on index returns. We reason that if an institutional investor makes a new fund investment, the PME can be applied to this new investment to estimate the expected present value of total net gain or loss relative to the index over the lifetime of the fund.

We begin these calculations with an estimate that net new capital invested in infrastructure funds by public investors through called capital amounts to $17.9 billion per year. This estimate is based on decomposing the rise in total infrastructure assets shown in Figure 2 into returns generated on the underlying assets and new investments by institutional investors. Figure 2 shows that infrastructure fund assets over the three years 2015-2018 grew by a constant annualized growth rate of 18.96%. Based on the PME in Table 2 of 0.93 and the realized total returns of the S&P 500, we calculate that asset returns would have generated 8.64 percentage points of the 18.96 percentage points, leaving 10.31 percentage points to new contributions. Applying this to the $404 billion estimated AUM as of 2018 yields an estimate of $41.7 billion in new investments, of which 42.9% or $17.9 billion are from public investors.

Panel A of Table 8 shows that relative to the S&P 500, public investors' infrastructure investments have a PME of 0.925, implying a 7.5% underperformance subsidy on the invested

targets 10%, compared to actual allocation of 7.2%. Similarly, the Norwegian sovereign wealth fund Government Pension Fund Global received an approval from the government to start investing up to 2% of the fund's value in unlisted renewable energy infrastructure, which corresponds to an allocation of around $20 billion (Norwegian Ministry of Finance, 2019).

capital over the life of the fund. Thus, for each new $17.9 billion invested or called in a given year, public investors will lose $1.34 billion (7.5%*$17.9 billion) in expected present value relative to the S&P 500 over the lifetime of the investment. Relative to a value-weighted index of listed infrastructure funds, the PME of public investors' infrastructure fund investments is only 0.840, implying a 16% underperformance over the life of the fund.[20] For each new $17.9 billion invested or called in a given year, public investors lose $2.86 billion (16%*$17.9 billion) in present value over the lifetime of the fund relative to what they could have achieved if investing in this listed infrastructure index. These estimates have the benefit of not relying on an assumption about the validity of IRR as a performance measure.[21]

Our final measure of the underperformance of public investors considers how their infrastructure fund investments performed relative to their own investments in other private markets. Given our findings that the shape of the cash flow profiles of infrastructure fund investments are similar to the profiles of general private equity buyout fund investments and real estate investments, we argue that these are appropriate comparisons. In Panel B of Table 8 we compare the performance of investments in infrastructure funds with the investments in buyout funds made by the same investor and in the same vintage year. We present the average net IRR and multiple of invested capital delivered by infrastructure and buyout funds. We find that public investors invest in buyout funds that deliver a 4.88 percentage point (14.954 – 10.074) higher net IRR than their infrastructure funds. Based on our estimation, public investors have $173.1 billion invested in infrastructure assets and the difference in net IRR relative to buyout funds would imply an annual loss of $8.45 billion. The difference in net IRR relative to VC funds would imply only a slightly smaller annual loss, although the properties of VC investments and infrastructure investments are sufficiently different that this is not an appropriate comparison. The difference in

[20] We calculate the value-weighted return index of listed infrastructure funds using an international sample of 52 listed funds. We download the return series from Datastream. The weights assigned to the returns of each fund are based on the market capitalization of the fund. We update the weights monthly. The number of listed funds in the value-weighted index increases over time from 2 funds in 1994 to 10 funds in 2002 and further to 46 funds in 2016. This increase matches well the number of closed funds reporting cash flow data: 1 fund in 1994, 4 funds in 2002, and 89 funds during the entire sample period. We estimate two robustness tests of the PME results. First, our results are robust to comparing the performance of listed and closed funds only in the later subperiod 2004-2016 when the number of both listed and closed funds is higher. Second, our results are robust to annual instead of monthly adjustment of the weights in the value-weighted return index.

[21] Unlike the net IRR measure, the PME approach adjusts for market movements and is robust to variations in the timing and systematic risks of the underlying cash flows as well as potential GP manipulations (Kaplan and Schoar, 2005; Kaplan and Sensoy, 2015; Sorensen and Jagannathan, 2015).

net IRR relative to RE funds is much smaller, and would imply an annual loss of only $1.48 billion relative to what public investors could have achieved if they could have committed more capital to their existing RE funds instead of investing in infrastructure funds.

Which of these subsidy measures is the most accurate depends on the financial properties of infrastructure funds. The net IRR analysis in the first approach points to a subsidy of $2.25 billion per year. Considering the second approach, while private infrastructure surely has different risk and return properties than the S&P 500, listed infrastructure may also have a quite different composition of underlying asset types (see Amenc, Blanc-Brude, Chreng, and Tran, 2017), and therefore that the subsidy is between the $1.34 billion and $2.86 billion figures that emerge from this approach. Finally, our analysis of cash flows suggests that the properties of infrastructure funds lie somewhere between that of buyout funds and that of real estate funds, and thus that the subsidy based on the private asset class comparison is somewhere between the $1.48 billion and $8.45 billion figures that emerge. While the exact amount of the subsidy depends on which are the most comparable assets to the private infrastructure fund investments, we conclude that the subsidy is most likely over $2 billion per year.

VII. Conclusion

In this paper, we analyze infrastructure as an asset class available to institutional investors. We find that closed infrastructure funds have payout profiles similar to traditional buyout and real estate private funds. When analyzing the riskiness of performance, we find that the standard deviations of returns provided by closed infrastructure funds are similar to the standard deviations of returns provided by buyout or real estate funds. Based on the frequency and amounts of capital calls and distributions, we also do not no evidence that infrastructure funds deliver more stable and less volatile cash flows than buyout or real estate funds. We conclude that closed infrastructure funds, typically structured with a finite life of around 10-12 years, generate most of their returns through capital gains and relatively quick exits. Infrastructure funds do not provide more stable cash flows to institutional investors than other private funds, even though many institutional investors justify the inclusion of the infrastructure asset class in their portfolio on the grounds that they expect infrastructure investments to deliver stable cash flows over a long horizon.

We examine also the experience of various types of institutional investors within the infrastructure asset class. We find that public investors, like public pension funds, government

agencies and sovereign wealth funds, hold infrastructure deals longer. However, their lower exit rates proxy for lower performance and do not capture differences in preferences for gaining long-term exposure to infrastructure assets. First, public investors prefer investing through closed funds and their investment approaches choices are similar to private sector pension funds, insurance firms, banks, endowments and foundations. Second, the underperformance of public investors also is not due to preferences for different projects as controlling for deal characteristics does not attenuate the coefficient of their underperformance. We control for project stage and the inclusion of concession agreements as proxies for riskiness of the deal, as well as industry and location as proxies for different preferences. While our evidence on performance comes from investments through a closed fund structure, we note that there would be no a priori reason to expect that agency problems or governance issues that contribute to the underperformance of public investors would disappear in a direct investment context.

The underperformance of public investors is economically and statistically significant. We find that public investors obtain around 1.28 percentage points lower net IRR, a multiple of invested capital that is lower by 0.061, and a public market equivalent that is lower by 0.041. The underperformance of public investors persists across different industry types as well as across different project stages.

The finding that public investors' infrastructure investments are not on the efficient frontier of infrastructure investments has important implications if public investors are planning to scale up the extent of their infrastructure investing. Among the public investors, public pension funds have clearly defined liabilities, while most of the government agencies and sovereign wealth funds do not. The underperformance of government agencies and sovereign wealth funds clearly represents a taxpayer subsidy, as the foregone returns could be used for other public purposes. Whether the underperformance of public pension funds will be borne by taxpayers or pension beneficiaries depends on which party will be called upon to remediate or pay unfunded pension liabilities.

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Table 1: Summary Statistics

We collect data for 1,590 institutional investors in infrastructure. In Panel A we report summary statistics for all institutional investors in our sample, whereas in Panel B we limit attention to the subsample of U.S. institutional investors. Investor size presents the average assets under management ($ bil.) and Year first infra is the year of the LP's first investment in infrastructure. #Funds and #Direct deals measure the average number of investments in infrastructure funds and direct deals by investor. #Deals reports the the average number of deals to which an investors gains exposure (investing through funds exposes an investor to multiple deals). %Greenfield, %Brownfield, and %Secondary capture the project stage and report the percentage of greenfield, brownfield, and secondary deals, respectively. %Concession is the percentage of deals that are a concession or privatization agreements with the government or other public institution. %Home deals measures the percentage of deals located in the same country as the institutional investor. For U.S. investors, we define this variable as located in the same state as the institutional investor. *#Investors* counts the average number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). *Investment stake* measures the average investment stake of the infrastructure fund through which the LPs accessed the deal. *Total Stake* is the average stake of all investors in the deal.

	All	**Public Investors**			**Private Investors**		
		Public Pension Funds	Government Agencies	Sovereign Wealth Funds	Private Pension Funds	Insurance Firms and Banks	Endowments and Foundations
Panel A: Institutional Investors from All Countries							
#Investors	1,594	353	138	27	497	280	299
Investor Size	47.023	26.467	90.135	217.220	10.976	146.291	2.981
Year First Invest	2007.344	2007.822	2008.464	2009.370	2006.584	2008.250	2006.495
#Funds	3.164	4.641	2.542	3.750	3.106	3.128	1.952
#Direct Deals	1.080	1.816	2.572	8.333	0.266	1.289	0.023
#Deals	43.492	63.183	24.974	44.926	44.566	41.298	26.965
%Greenfield	0.230	0.211	0.398	0.203	0.194	0.241	0.238
%Brownfield	0.108	0.101	0.111	0.072	0.097	0.098	0.150
%Secondary	0.662	0.688	0.491	0.726	0.709	0.661	0.612
%Concessions	0.091	0.076	0.107	0.144	0.105	0.105	0.058
%Home Deals	0.248	0.195	0.420	0.239	0.280	0.289	0.143
#Investors	1.693	1.741	1.860	2.102	1.730	1.722	1.420
Investment Stake	0.608	0.623	0.455	0.513	0.590	0.614	0.692
Total Stake	0.764	0.774	0.688	0.694	0.751	0.774	0.802
Panel B: U.S. Institutional Investors							
#Investors	647	150	3	4	191	66	233
Investor Size	24.134	24.754	3.982	25.015	12.972	131.492	2.719
Year First Invest	2006.425	2008.153	2009.667	2008.500	2005.796	2005.788	2005.931
#Funds	3.665	5.308	3.667	9.333	3.851	5.082	2.013
#Direct Deals	0.088	0.093	0.000	0.250	0.073	0.348	0.021
#Deals	46.319	57.074	11.667	103.250	54.286	66.377	25.837
%Greenfield	0.184	0.139	0.250	0.135	0.160	0.174	0.234
%Brownfield	0.144	0.127	0.063	0.100	0.131	0.147	0.167
%Secondary	0.672	0.734	0.688	0.765	0.709	0.679	0.600
%Concessions	0.038	0.034	0.125	0.090	0.047	0.025	0.036
%Home Deals	0.032	0.027	0.000	0.017	0.033	0.026	0.038
#Investors	1.499	1.611	1.131	1.742	1.584	1.482	1.361
Investment Stake	0.682	0.660	0.776	0.666	0.659	0.680	0.716
Total Stake	0.798	0.788	0.812	0.795	0.789	0.797	0.812

Table 2: Comparison of the Performance and Cash Flows of Infrastructure Funds with Other Private Funds

We compare the performance and cash flows of closed infrastructure funds with buyout, venture capital (VC) and real estate (RE) funds. The sample includes funds raised in the period 2002–2018. Panel A summarizes three performance measures on private funds: public market equivalent (PME) relative to the total return on the S&P500 index, net IRR, and multiple of invested capital. For each measure, we present the mean, median, and standard deviation by fund type. For the PME measure, we follow Kaplan and Schoar (2005) and calculate PME as the ratio of the sum of discounted distributions to the sum of discounted capital calls. In Panel B, we standardize the cash flows over time. Row *Funds* presents the number of funds that provide cash flow data. Year 1 captures the first year when a GP calls capital from LPs. We present the number of capital calls and distribution per year as well as the amounts of capital calls and distributions per year in $ mil. The t-tests measure whether the timeline of cash flows delivered by infrastructure funds differs from the timeline of cash flows delivered by other private funds. All cash flows are based on a $10 mil. initial commitment.

	Infrastructure				**Buyout**				**Venture Capital (VC)**				**Real Estate (RE)**			
Panel A: Performance Summary Statistics																
	Mean	Median	SD		Mean	Median	SD		Mean	Median	SD		Mean	Median	SD	
PME	0.928	0.922	0.336		1.052	0.998	0.387		0.972	0.930	0.558		0.942	0.965	0.290	
IRR	11.421	10.500	13.988		13.486	13.000	13.022		10.682	9.300	23.270		11.442	11.800	12.324	
Multiple	1.286	1.210	0.456		1.494	1.400	0.522		1.475	1.290	0.972		1.313	1.255	0.416	
Panel B: Cash Flows over Time																
Funds	134				975				743				611			
Year	Number Calls	Number Distri.	Amount Calls	Amount Distri.	Number Calls	Number Distri.	Amount Calls	Amount Distri.	Number Calls	Number Distri.	Amount Calls	Amount Distri.	Number Calls	Number Distri.	Amount Calls	Amount Distri.
1	1.915	0.699	2.272	0.088	2.091	0.464	1.770	0.091	2.039	0.170	1.746	0.047	1.942	0.681	2.720	0.178
2	2.523	1.592	1.860	0.291	2.692	1.121	1.860	0.249	2.681	0.427	1.882	0.108	2.533	1.746	2.534	0.460
3	2.781	1.714	1.939	0.434	2.778	1.438	1.863	0.490	2.842	0.689	1.866	0.250	2.432	2.201	1.929	0.926
4	2.518	2.341	1.522	1.139	2.728	1.778	1.613	0.853	2.714	0.891	1.511	0.519	1.953	2.551	1.131	1.494
5	2.608	2.297	1.164	1.652	2.607	2.104	1.244	1.392	2.519	1.152	1.140	0.670	1.612	2.556	0.689	1.732
6	2.328	2.230	0.749	1.464	2.349	2.373	0.857	1.718	2.132	1.312	0.766	1.176	1.313	2.589	0.295	1.633
7	1.694	2.102	0.347	1.383	2.102	2.447	0.468	1.937	1.698	1.373	0.468	1.176	1.117	2.555	0.213	1.395
8	1.600	1.933	0.209	1.241	1.754	2.487	0.285	1.893	1.373	1.439	0.295	1.322	0.932	2.663	0.142	1.315
9	1.194	1.871	0.165	1.498	1.632	2.368	0.164	1.962	1.077	1.419	0.210	1.526	0.776	2.533	0.067	1.306
10	1.409	1.955	0.165	0.931	1.388	2.277	0.124	1.634	0.712	1.248	0.095	1.218	0.649	2.336	0.130	1.549
11	0.611	1.167	0.015	1.138	1.115	1.974	0.115	1.437	0.550	1.099	0.058	1.189	0.619	2.053	0.044	0.945
12	0.909	1.364	0.014	0.448	0.846	1.631	0.070	0.917	0.350	0.927	0.028	0.848	0.456	1.392	0.045	0.635
T-tests																
Buyout	-2.965**	-0.789	-0.020	-2.420**												
VC	1.473	6.717***	0.618	1.268												
RE	4.592***	-4.761***	0.412	-2.214**												

Table 3: Percentage Exited Deals and Performance

In this table we analyze the subsample of closed infrastructure funds, and exclude listed and open-ended funds as well as direct investments in infrastructure assets, because Preqin provides performance data only for closed funds. Observations are at the infrastructure fund level. Columns (1) and (2) presents results of logit regressions in which the dependent variable equals one if a closed infrastructure fund reports either the net IRR, multiple of invested capital or cash flows in the Preqin database. We present the marginal effects (elasticities) at the means of the independent variables. In the other columns, we limit attention to infrastructure funds reporting performance. In columns (3) and (4) performance is measured using the net internal rate of return (IRR), in columns (5) and (6) performance is measured using net multiple of invested capital, and in columns (7) and (8) performance is measured using the public market equivalent (PME). *%Exited deals* measures the percentage of exited deals from the total deals made by the fund. %Exited deals in years 0-5, 5-10, and >10 capture the percentage of exited deals in the first five years after the transaction date, in five to ten years after the transaction, and in more than ten years after the transaction date. *Fund size* is the natural logarithm of the assets managed by the infrastructure fund. We include vintage year fixed effects and control for the percentage allocated to different infrastructure industries and geographical regions. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	Reporting		**Net IRR**		**Multiple**		**PME**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
%Exited deals	0.299**		28.435***		0.915***		1.125***	
	[0.130]		[3.972]		[0.156]		[0.124]	
%Exited deals in years 0-5		0.325*		35.105***		1.197***		1.215***
		[0.169]		[4.404]		[0.186]		[0.129]
%Exited deals in years 5-10		0.246		15.083**		0.489*		0.749***
		[0.193]		[6.961]		[0.253]		[0.279]
%Exited deals in years >10		0.589		-5.440		0.112		-1.180
		[0.513]		[14.411]		[0.572]		[1.347]
Fund Size	0.213***	0.210***	-0.811	-0.242	-0.034	-0.024	0.002	-0.005
	[0.033]	[0.033]	[0.954]	[0.931]	[0.034]	[0.034]	[0.026]	[0.026]
Vintage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Deal region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Deal industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	388	388	147	147	211	211	98	98
R^2			0.494	0.544	0.461	0.486	0.755	0.772

Table 4: Investor Type and Performance

This table presents results of regressions in which the dependent variable is the performance in closed infrastructure funds. Observations are at the investor-fund level. In columns (1) and (2) performance is measured using the percentage exited deals. In columns (3) and (4) performance is measured using the net internal rate of return (IRR), in columns (5) and (6) performance is measured using net multiple of invested capital, and in columns (7) and (8) performance is measured using the public market equivalent (PME). *Public Investor* is an indicator variable for institutional investors from the public sector. We also split the public investors by type and include separate indicator variables: *U.S. Public PF* captures U.S. public pension funds, *Non U.S. Public PF* refers to non U.S. public pension funds, government agencies, and sovereign wealth funds. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *FOF* and *Debt Fund* are indicator variables for infrastructure funds that do not take only equity positions in infrastructure deals, but that also act as fund-of-funds or debt fund. We include investor (LP) country fixed effects and control for the percentage of deals in the portfolio of each infrastructure fund in different industries and geographical regions. We cluster standard errors by institutional investor and report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	%Exited deals		**Net IRR**		**Multiple**		**PME**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public Investor	-0.029***		-1.277***		-0.061***		-0.041***	
	[0.011]		[0.479]		[0.015]		[0.014]	
U.S. Public PF		-0.060***		-0.854		-0.048**		-0.054***
		[0.016]		[0.656]		[0.019]		[0.017]
Non U.S. Public PF		-0.002		-1.654**		-0.086***		-0.011
		[0.014]		[0.707]		[0.025]		[0.023]
Government agencies		-0.015		-3.057**		-0.011		-0.090
		[0.024]		[1.341]		[0.063]		[0.062]
Sovereign wealth funds		-0.045*		-2.839*		-0.033		-0.035
		[0.024]		[1.585]		[0.056]		[0.038]
Log Investor Size	0.006**	0.007**	-0.133	-0.149	0.005	0.004	0.003	0.005
	[0.003]	[0.003]	[0.158]	[0.164]	[0.004]	[0.005]	[0.004]	[0.004]
Year First Invest	-0.011***	-0.010***	0.133***	0.128**	-0.007***	-0.007***	-0.000	0.000
	[0.001]	[0.001]	[0.049]	[0.051]	[0.002]	[0.002]	[0.001]	[0.001]
#Funds	-0.002***	-0.003***	0.124***	0.126***	-0.001	-0.001	0.002***	0.002***
	[0.001]	[0.001]	[0.031]	[0.031]	[0.001]	[0.001]	[0.001]	[0.001]
FOF	-0.115***	-0.121***	2.367**	2.470**	-0.087***	-0.085**	0.063**	0.057**
	[0.024]	[0.024]	[1.022]	[1.021]	[0.033]	[0.033]	[0.025]	[0.025]
Debt Fund	-0.122**	-0.118**	-3.312**	-3.411**	-0.199***	-0.199***	-0.115**	-0.110*
	[0.054]	[0.054]	[1.371]	[1.376]	[0.032]	[0.032]	[0.058]	[0.058]
LP country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Deal region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Deal industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,493	4,493	2,523	2,523	3,385	3,385	1,968	1,968
R-squared	0.139	0.141	0.079	0.080	0.111	0.112	0.123	0.124

Table 5: Frequency of Cash Flows

This table presents results of regressions in which the dependent variables measure different aspects of the cash flows experienced by institutional investors holding closed infrastructure funds. Observations are at the investor-fund level. In columns (1) and (2), #Calls measures the number of capital calls (transfers from LP to GP) per year. In columns (3) and (4), #Distributions is the number of capital distributions from GP to LP per year. *Public Investor* is an indicator variable for institutional investors from the public sector. We also split the public investors by type and include separate indicator variables: *U.S. Public PF* captures U.S. public pension funds, *Non U.S. Public PF* refers to non U.S. public pension funds, government agencies, and sovereign wealth funds. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. We include investor (LP) country fixed effects and control for the percentage of deals in the portfolio of each infrastructure fund in different industries and geographical regions. We cluster standard errors by institutional investor and report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	#Calls		**#Distributions**	
	(1)	(2)	(3)	(4)
Public Investor	0.112***		0.053	
	[0.034]		[0.041]	
U.S. Public PF		0.131***		0.077
		[0.041]		[0.049]
Non U.S. Public PF		0.044		0.013
		[0.061]		[0.073]
Government agencies		0.320		-0.049
		[0.213]		[0.203]
Sovereign wealth funds		0.290***		0.051
		[0.093]		[0.215]
Log Investor Size	0.002	-0.001	0.019*	0.017
	[0.009]	[0.009]	[0.011]	[0.011]
Year First Invest	-0.010***	-0.012***	-0.007	-0.007*
	[0.004]	[0.004]	[0.004]	[0.004]
#Funds	-0.001	-0.001	0.003	0.004
	[0.002]	[0.002]	[0.003]	[0.003]
FOF	0.222***	0.230***	-0.302**	-0.296**
	[0.085]	[0.089]	[0.134]	[0.135]
Debt Fund	-0.821***	-0.829***	0.220*	0.219
	[0.136]	[0.137]	[0.132]	[0.133]
LP country FE	Yes	Yes	Yes	Yes
%Deal industry	Yes	Yes	Yes	Yes
%Deal region	Yes	Yes	Yes	Yes
Observations	1,968	1,968	1,968	1,968
R-squared	0.390	0.392	0.446	0.446

Table 6: Exiting a Deal and Investor Type

This table presents results of a survival analysis using Cox proportional hazard model. The event of interest is a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset. We present the hazard ratios. *Public Investor* is an indicator variable for institutional investors from the public sector. We also split the public investors by type and include separate indicator variables: *U.S. Public PF* captures U.S. public pension funds, *Non U.S. Public PF* refers to non U.S. public pension funds, government agencies, and sovereign wealth funds. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *Direct deal* is an indicator variable for direct investments in infrastructure deals. *Concession* is an indicator variable equal to one if an investor enters a concession deal with the government. *Greenfield* and *Brownfield* are indicators for project stage (the omitted category is secondary stage). *Home deal* is an indicator for deals located in the same country (state) as the investor. *#Investors* counts the total number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). *Total Stake* is the total stake of all investors in the deal. We control for LP country, deal industry, and deal region fixed effects. We cluster standard errors by institutional investor. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public Investor	0.848***		0.871***		0.868***		0.887***	
	[0.038]		[0.036]		[0.036]		[0.036]	
U.S. Public PF		0.835***		0.744***		0.741***		0.758***
		[0.046]		[0.040]		[0.041]		[0.039]
Non U.S. Public PF		0.839***		0.976		0.973		0.978
		[0.052]		[0.063]		[0.063]		[0.064]
Government agencies		0.946		1.144		1.174		1.371
		[0.108]		[0.229]		[0.228]		[0.272]
Sovereign wealth funds		0.833*		0.818**		0.791**		0.765***
		[0.091]		[0.075]		[0.072]		[0.075]
Log Investor Size	1.041***	1.040***	1.045***	1.049***	1.046***	1.050***	1.045***	1.049***
	[0.013]	[0.013]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]
Year First Invest	1.003	1.003	1.005	1.007*	1.003	1.006	1.006	1.008*
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
#Funds	1.003	1.003	1.000	1.000	1.000	1.000	0.999	0.999
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Direct deal	0.479***	0.475***	0.490***	0.473***	0.488***	0.469***	0.527***	0.500***
	[0.101]	[0.099]	[0.098]	[0.090]	[0.099]	[0.090]	[0.105]	[0.093]
Concession					1.638***	1.641***	1.773***	1.774***
					[0.100]	[0.100]	[0.103]	[0.103]
Greenfield					0.752***	0.749***	0.700***	0.696***
					[0.028]	[0.028]	[0.028]	[0.028]
Brownfield					0.678***	0.676***	0.665***	0.663***
					[0.027]	[0.027]	[0.028]	[0.028]
Home Deal					0.801***	0.803***	0.846**	0.850**
					[0.052]	[0.052]	[0.055]	[0.054]
#Investors							0.937***	0.938***
							[0.008]	[0.008]
Total Stake							1.207***	1.206***
							[0.051]	[0.050]
LP country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Deal region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deal industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor
Observations	62,106	62,106	62,106	62,106	62,106	62,106	55,245	55,245

Table 7: U.S. investors: Exiting a deal by industry, location and project type

This table presents results of a survival analysis using Cox proportional hazard model. The event of interest is a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset. We present the hazard ratios. We limit attention to the subsample of U.S. institutional investors. In column (1) we analyze all infrastructure deals made by U.S. investors. In Columns (2), (3),a nd (4) we analyze separately deals in the three main industries - traditional energy, renewable energy, and transportation. In Columns (5 and (6) we split the sample based on geographical location into domestic U.S. deals and outside non U.S. deals. In Columns (7) and (8) we split the sample based on project stage into deals in greenfield and brownfield stage, and deals in secondary stage. In columns (9) and (10) we split the sample into deals with and without concession agreement. *Public Investor* is an indicator variable for U.S. institutional investors from the public sector and covers 150 public pension funds, 3 government agencies and 4 sovereign wealth funds (state investment funds). We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *Concession* is an indicator variable equal to one if an investor enters a concession deal with the government. *Greenfield* and *Brownfield* are indicators for project stage (the omitted category is secondary stage). *Home deal* is an indicator for deals located in the same state as the investor. *#Investors* counts the total number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). We control for deal industry and deal region fixed effects. We cluster standard errors by institutional investor. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	All deals (1)	Traditional energy (2)	Renewable energy (3)	Transport (4)	U.S. deals (5)	non U.S. deals (6)	Greenfield brownfield (7)	Secondary (8)	Without concession (9)	With concession (10)
Public Investor	0.704***	0.689***	0.772*	0.802*	0.633***	0.936	0.721***	0.696***	0.719***	0.376***
	[0.041]	[0.051]	[0.102]	[0.091]	[0.044]	[0.101]	[0.057]	[0.045]	[0.041]	[0.117]
Log Investor Size	1.042***	1.052***	1.004	0.995	1.031**	1.040	1.065***	1.032*	1.038**	1.116**
	[0.016]	[0.018]	[0.028]	[0.024]	[0.015]	[0.033]	[0.020]	[0.018]	[0.016]	[0.059]
Year First Invest	1.020***	1.025***	1.030**	0.986*	1.023***	1.003	1.019***	1.024***	1.021***	0.974
	[0.005]	[0.005]	[0.012]	[0.008]	[0.005]	[0.009]	[0.006]	[0.006]	[0.005]	[0.020]
#Funds	1.002	1.009**	0.994	0.994	1.009**	0.987*	1.003	1.002	1.004	0.954***
	[0.004]	[0.004]	[0.007]	[0.006]	[0.004]	[0.008]	[0.004]	[0.005]	[0.004]	[0.015]
Direct deal	0.193***	0.332	0.116**	0.000	0.156***	0.755	0.211***	0.200***	0.214***	0.000
	[0.088]	[0.261]	[0.103]	[0.000]	[0.077]	[0.260]	[0.123]	[0.120]	[0.101]	[0.000]
Concession	1.832***			0.834	0.825**	2.418***	0.866	1.777***		
	[0.177]			[0.129]	[0.073]	[0.295]	[0.170]	[0.141]		
Greenfield	0.653***	0.630***	0.555***	1.112	0.552***	1.013			0.640***	1.374*
	[0.031]	[0.032]	[0.051]	[0.117]	[0.030]	[0.085]			[0.032]	[0.238]
Brownfield	0.518***	0.565***	0.335***	0.882	0.432***	1.093			0.514***	0.705
	[0.024]	[0.025]	[0.035]	[0.121]	[0.019]	[0.120]			[0.024]	[0.150]
Home Deal	1.050	1.148*	1.026	1.358			0.912	1.113	1.055	0.647
	[0.072]	[0.094]	[0.134]	[0.363]			[0.108]	[0.089]	[0.075]	[0.416]
#Investors	0.885***	0.940*	0.448***	1.063	0.883***	0.893***	1.012	0.864***	0.858***	1.379***
	[0.016]	[0.029]	[0.041]	[0.064]	[0.018]	[0.021]	[0.024]	[0.020]	[0.017]	[0.080]
Deal region FE	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Deal industry FE	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No
Cluster	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor
Observations	26,541	12,727	6,609	3,636	15,858	10,683	7,030	19,511	25,614	927

Table 8: Analyzing the Performance of Investors

This table summarizes the performance of the main types of U.S. investors. Panel A presents the average public market equivalent (PME) by investor type. We estimate the PME relative to the S&P 500 stock market index and a value-weighted index of listed infrastructure funds. In Panels B, C and D, we compare the performance of investments in infrastructure funds with the investments in buyout, VC and real estate funds made by the same investor. We match the infrastructure investments with buyout, VC and real estate investments made by the same investor and in the same vintage year. We present the average net IRR and multiple of invested capital delivered by infrastructure, buyout, VC, or real estate funds. The number of observations changes because it depends on making investments in infrastructure, buyout, VC or real estate in the same vintage year and on the availability of performance data for these investments.

Panel A: Average Public Market Equivalent (PME)

Investor type	Obs.	S&P500 PME	VW Listed Infra PME
Public investors	871	0.925	0.840
Private investors	1,129	0.935	0.851

Panel B: Comparison of Infrastructure Funds with Buyout Funds

Investor type	Obs.	Infra Net IRR	Buyout Net IRR	Obs.	Infra Multiple	Buyout Multiple
Public investors	655	10.074	14.954	893	1.281	1.459
Private investors	698	10.783	13.888	818	1.380	1.560

Panel C: Comparison of Infrastructure Funds with VC Funds

Investor type	Obs.	Infra Net IRR	VC Net IRR	Obs.	Infra Multiple	VC Multiple
Public investors	408	9.642	13.950	578	1.270	1.682
Private investors	390	10.976	12.494	471	1.394	1.533

Panel D: Comparison of Infrastructure Funds with Real Estate Funds

Investor type	Obs.	Infra Net IRR	RE Net IRR	Obs.	Infra Multiple	RE Multiple
Public investors	477	10.292	11.146	618	1.270	1.269
Private investors	519	10.662	9.812	585	1.382	1.322

Figure 1: Investing in Infrastructure

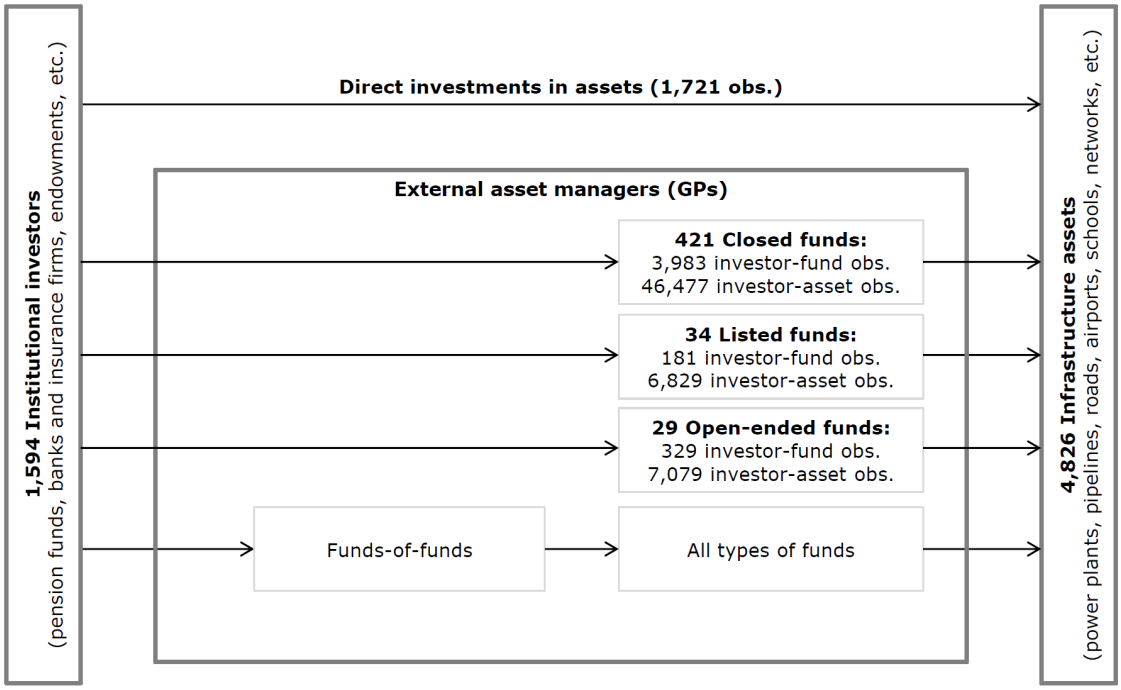


Figure 2: Closed Infrastructure Funds: Unrealized Value as a Proxy of AUM ($ bil)

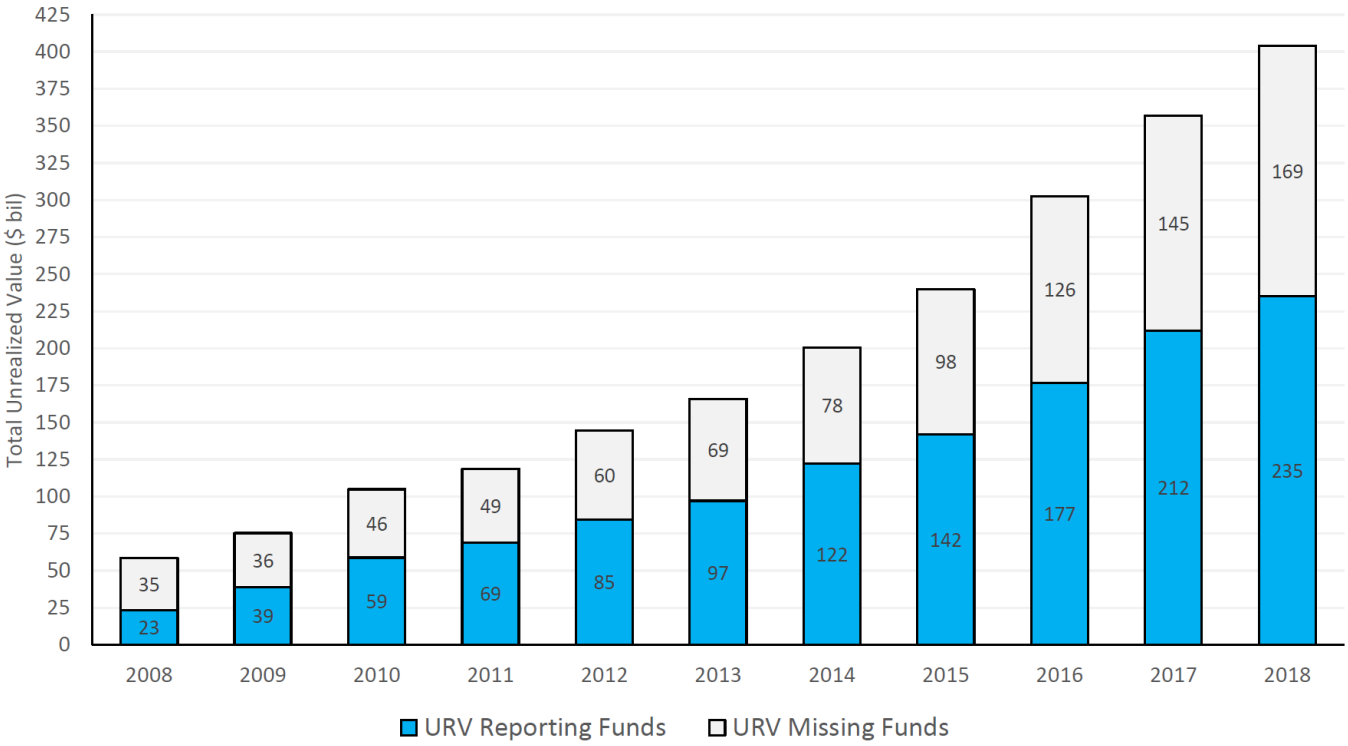


Figure 3: Institutional Investors and Investment Approach

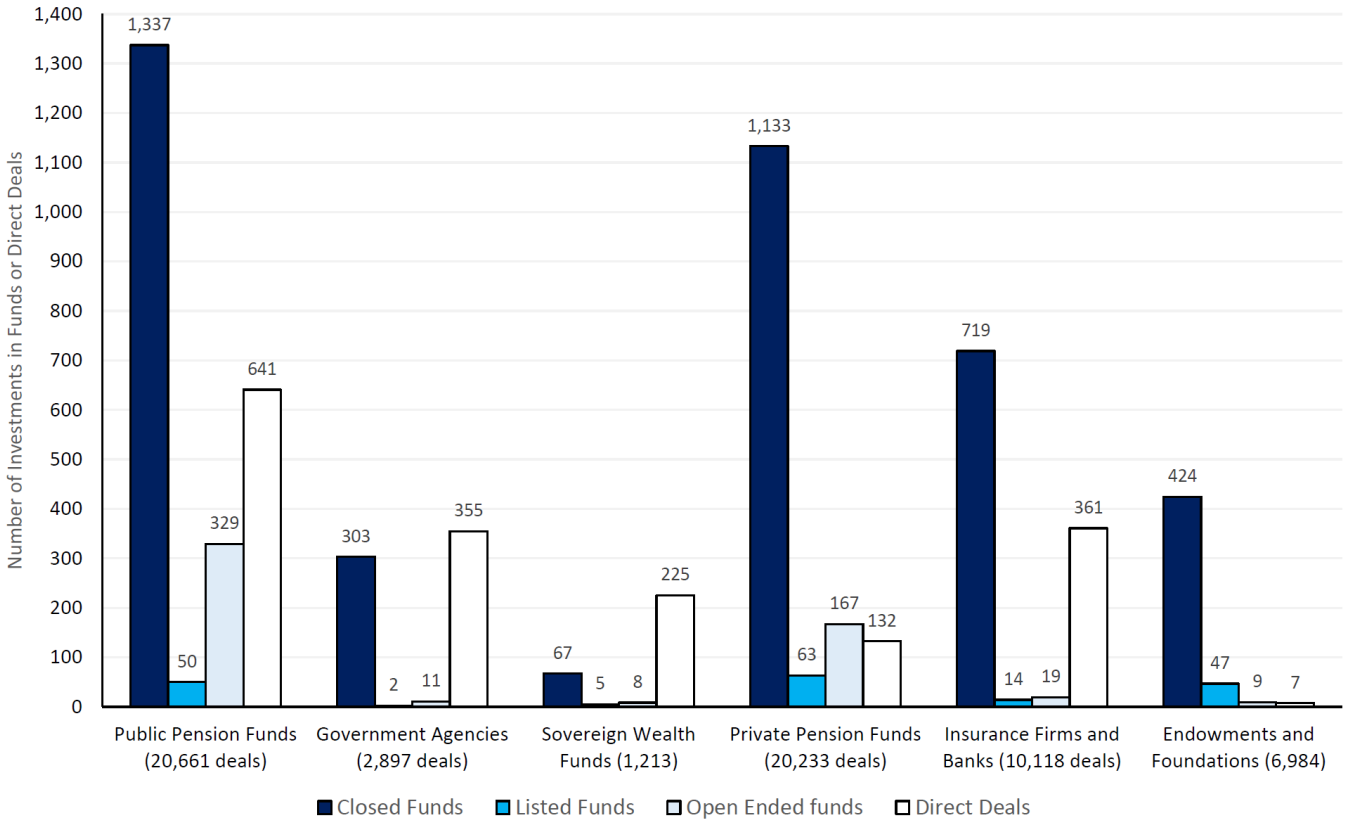


Figure 4: Institutional Investors and Industry of the Deal

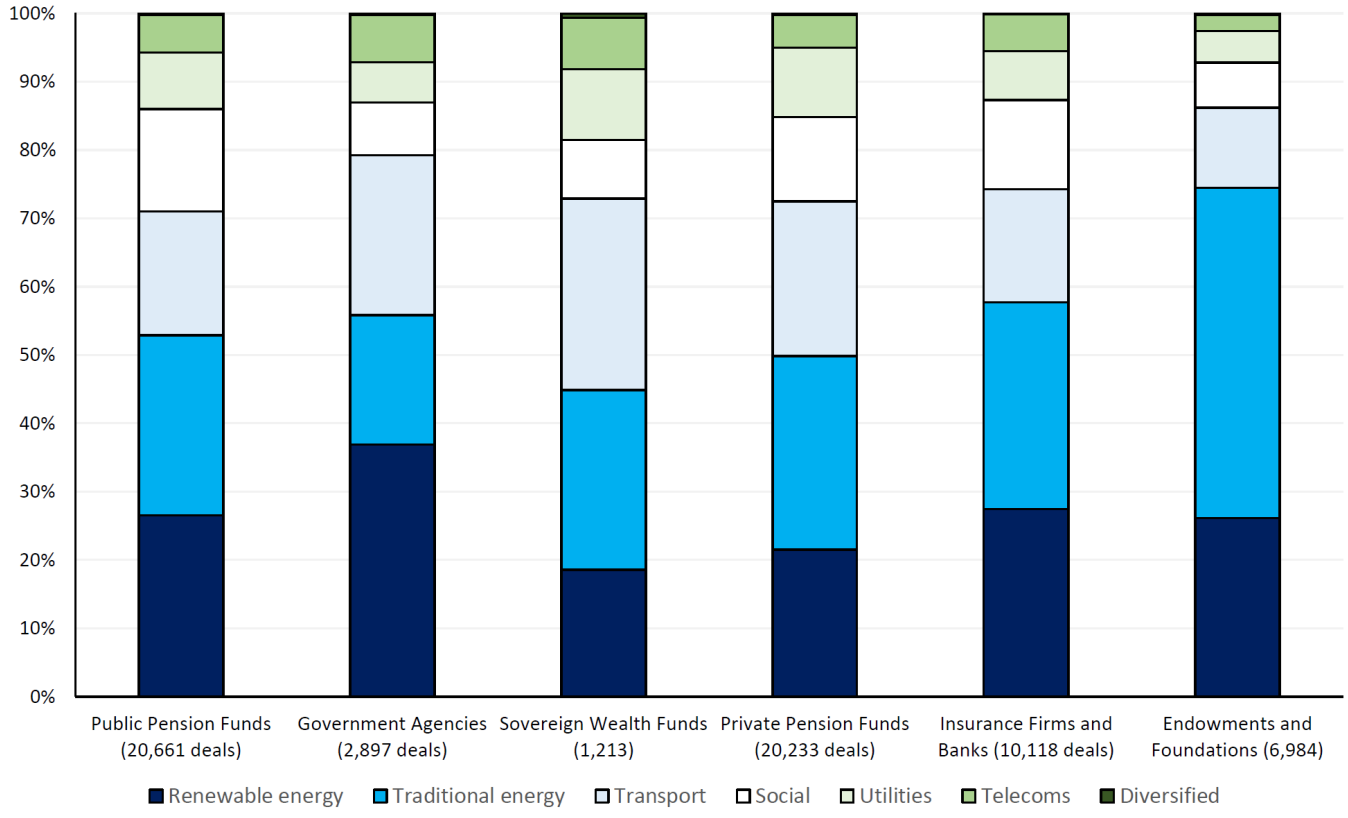
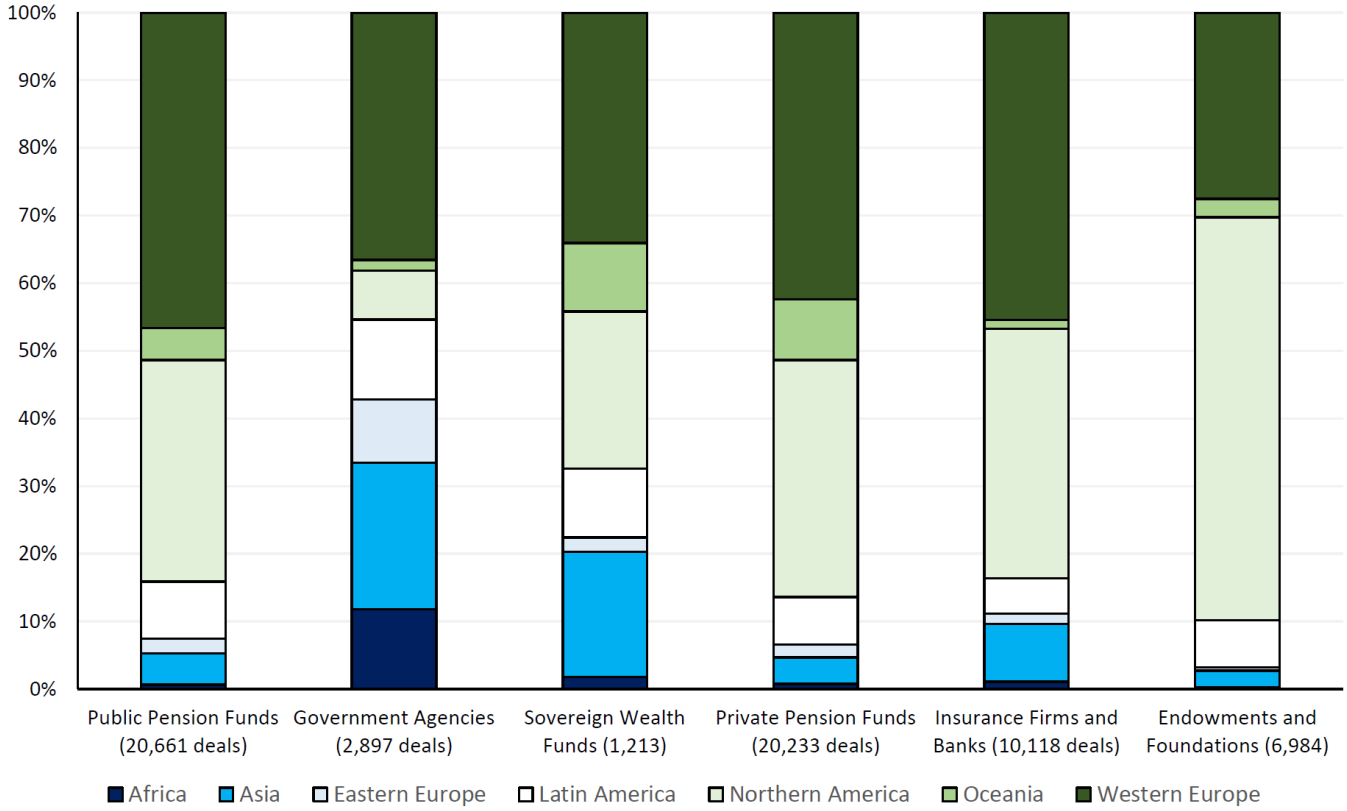


Figure 5: Institutional Investors and Regional Location of the Deal

Panel A: All Institutional Investors



Panel B: U.S. Institutional Investors

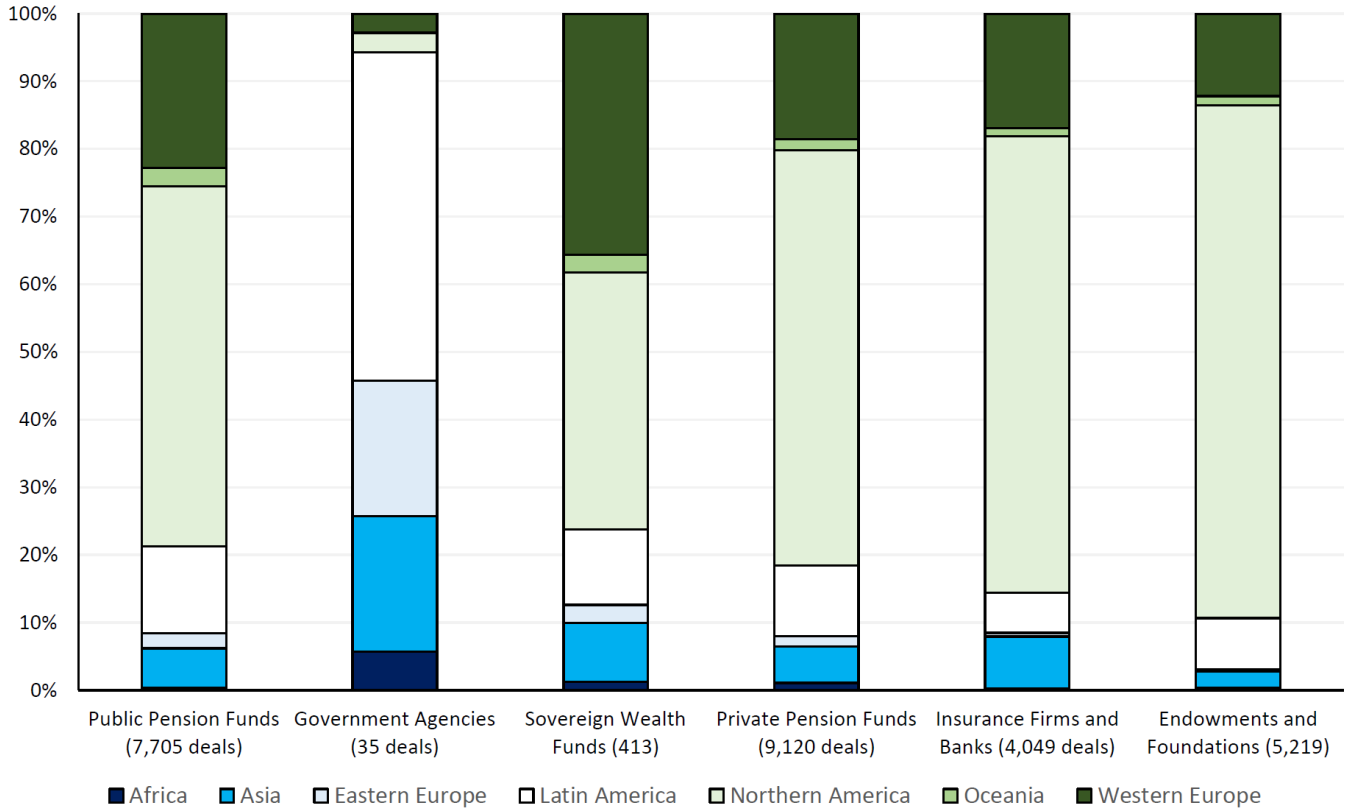


Figure 6: Fund Type and Performance Distribution

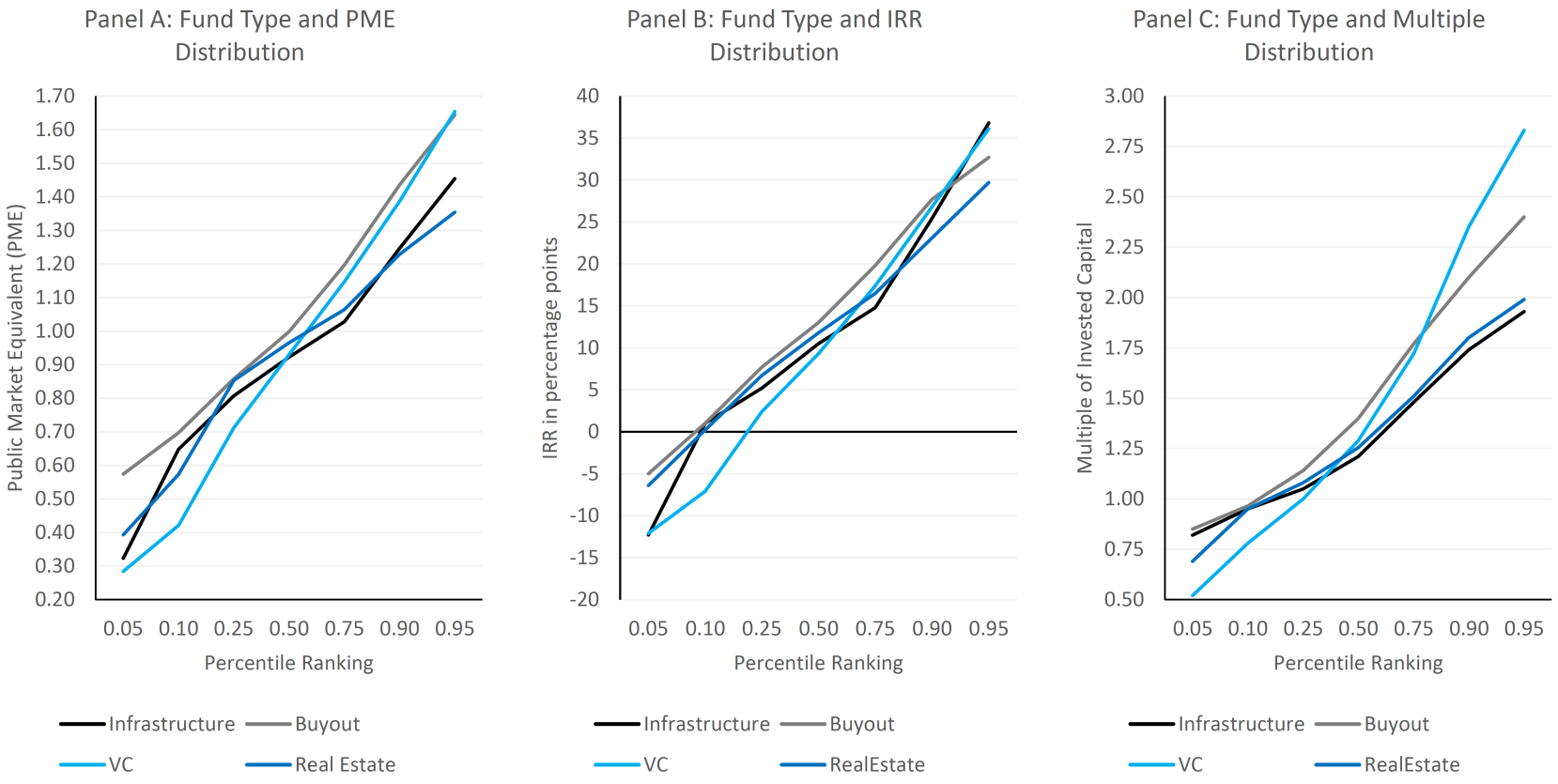
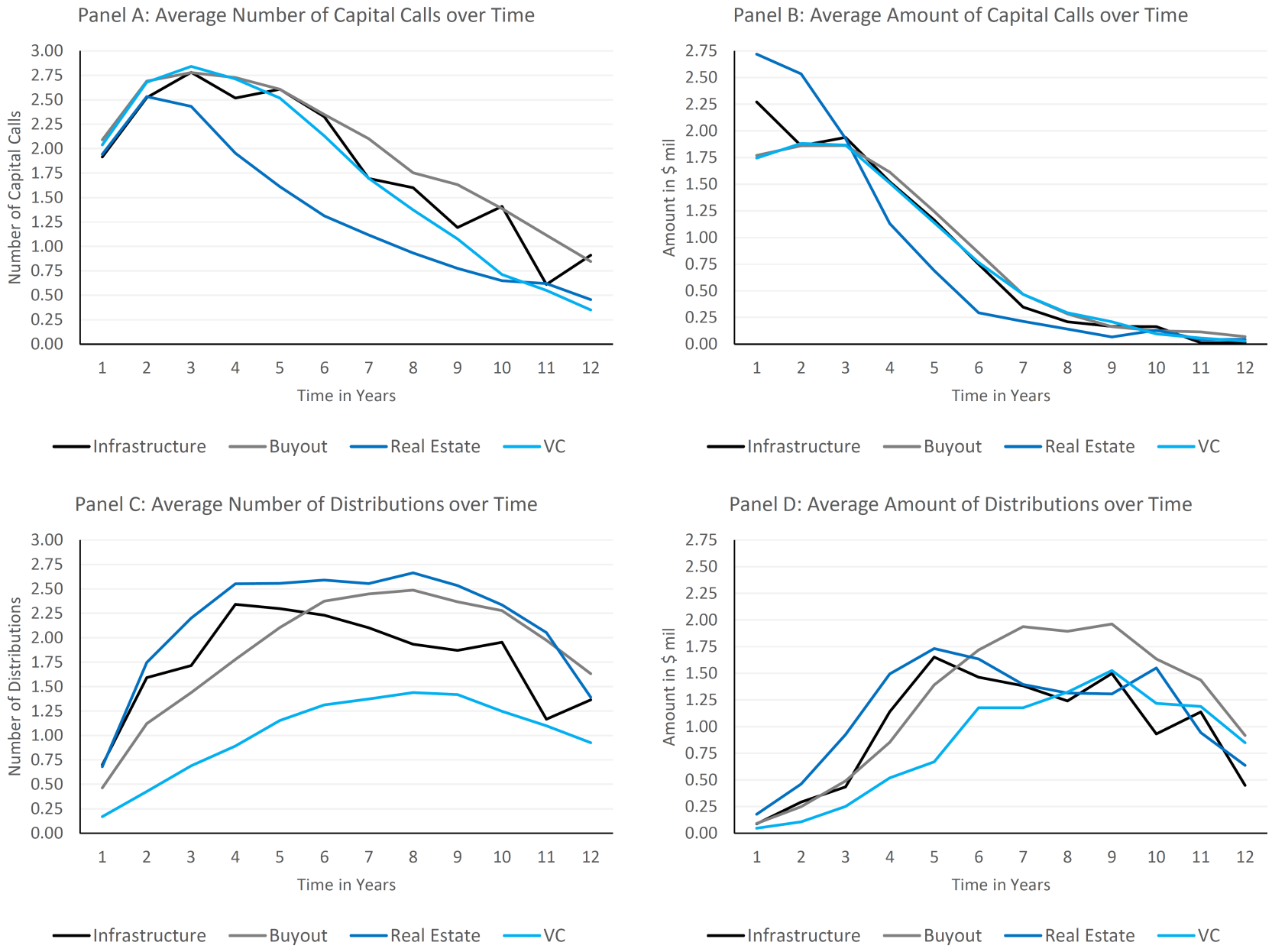


Figure 7: Comparison of the Cashflows of Infrastructure Funds with Other Private Funds



Online Appendix:

The Subsidy to Infrastructure as an Asset Class

May 2019

Appendix 1: Statements of U.S. Public Pension Funds about Infrastructure

California State Teachers' Retirement System 2017 CAFR: "Short-term results for the Infrastructure Portfolio are not particularly significant, as performance expectations will be better measured over the long term as investments mature and achieve their full cash flow potential. The Infrastructure Portfolio has begun to enter a more mature phase and is beginning to achieve greater cash flow potential."

Iowa Public Employees' Retirement System 2017 CAFR: "Private real assets investments include direct equity investments in commercial real estate properties, or investment in partnerships or funds that invest in real estate and other real assets including, but not limited to, farmland, timberland, or infrastructure. The purpose of investing in private real assets is to provide income, diversification, and inflation protection." Iowa PERS 2017 Private Markets Investment Policy: "Given their stable cash flow and low variability of revenue, infrastructure assets can support more debt. For this reason, infrastructure investments may utilize up to 65 percent debt at the fund level and will be expected to use no more than 70 percent on any given asset. These limits will be reviewed on a case by case basis and determination of the debt level will be dependent on the investment type and risk characteristics of the investment."

New York State Common Retirement Fund 2017 CAFR: "Currently, most of our activity [in real assets] is focused on infrastructure transactions, given the size and risk profile of the opportunity set. Real asset investments offer exposure to varied return sources, including capital appreciation and cash flow from income. The diversified approach reduces realized volatility and allows the portfolio to benefit from long-term growth investment themes. These themes, such as the global growth in protein-based diets, will play out over multiple economic cycles. These investments will have a longer duration and an implicit focus on sustainable practices."

Oregon Public Employees Retirement System 2017 CAFR: "Alternative Equity investments seek to provide diversification and inflation hedging characteristics to the Fund and include investments with a focus on infrastructure and natural resources."

Pennsylvania State Employees' Retirement System 2017 CAFR: "Natural Resources/Infrastructure differ from real estate in that they focus on other real assets other than real estate, but maintain the characteristics of collateralization by hard assets and income-producing potential."

Employees' Retirement System of the State of Rhode Island 2017 CAFR: "Infrastructure – These four funds provide inflation-protection and current income to the portfolio through investments in facilities and services required for an economy to function including electricity production and distribution, pipelines, sewers and waste management, airports, roads, bridges, ports, railroads, telephone and cable networks, and hospitals."

Employees Retirement System of Texas 2017 CAFR: "The System's private infrastructure investments are in large-scale public systems, services and facilities that are necessary for economic activity. These types of relatively illiquid investments are often made in essential services with high barriers to entry and predictable cash flows and have expected life from ten to twelve years, with the option of one to three-year extension."

Washington State Department of Retirement Systems 2017 CAFR: "Tangible Assets [includes Infrastructure]: This includes 40 limited liability structures and funds. The primary goals of the tangible asset portfolio are to generate a long-term sustainable and stable income stream as well as generate appreciation at least commensurate with inflation."

Table IA.1: Number of Investors by Country and Public/Private Status

Country	Private	Public	Total	Country	Private	Public	Total
Andorra	1	0	1	Kuwait	0	6	6
Angola	0	1	1	Luxembourg	1	0	1
Australia	66	18	84	Macau	0	1	1
Austria	2	1	3	Malaysia	2	2	4
Azerbaijan	0	1	1	Malta	1	0	1
Belgium	11	3	14	Mexico	2	3	5
Bermuda	2	0	2	Morocco	5	4	9
Brazil	10	23	33	Netherlands	35	6	41
Brunei	0	1	1	New Zealand	5	2	7
Canada	41	27	68	Norway	5	7	12
Chile	4	0	4	Oman	0	1	1
China	2	18	20	Papua New Guinea	0	1	1
Colombia	4	1	5	Peru	3	1	4
Denmark	13	10	23	Philippines	0	1	1
Estonia	2	0	2	Portugal	8	1	9
Fiji	0	1	1	Qatar	1	1	2
Finland	11	5	16	Russia	0	1	1
France	17	10	27	Saudi Arabia	1	3	4
Germany	38	11	49	Singapore	2	3	5
Ghana	0	1	1	South Africa	7	4	11
Greece	1	0	1	South Korea	29	17	46
Hong Kong	2	1	3	Spain	8	2	10
Iceland	0	1	1	Sweden	14	8	22
India	10	24	34	Switzerland	28	14	42
International	0	16	16	Taiwan	6	0	6
Ireland	5	2	7	Thailand	3	2	5
Israel	9	1	10	Togo	0	1	1
Italy	42	5	47	UK	106	71	177
Japan	17	5	22	US	490	157	647
Jersey	0	2	2	United Arab Emirates	3	5	8
Kazakhstan	0	3	3	Vietnam	1	1	2
				Total	**1,076**	**518**	**1,594**

Table IA.2: Number of Unique Assets by Country

Country	Assets	Country	Assets	Country	Assets
Africa	1	Germany	182	Panama	8
Albania	1	Ghana	3	Peru	25
Algeria	1	Greece	17	Philippines	24
Angola	3	Guatemala	8	Poland	23
Argentina	6	Guernsey	1	Portugal	15
Armenia	1	Guinea	2	Puerto Rico	4
Aruba	2	Guyana	1	Qatar	7
Australia	241	Honduras	6	Reunion	7
Austria	7	Hong Kong	9	Romania	4
Bahamas	1	Hungary	6	Russia	12
Bahrain	3	India	146	Rwanda	1
Bangladesh	4	Indonesia	25	Saint Lucia	1
Belgium	39	Ireland	69	Saudi Arabia	8
Bolivia	6	Israel	26	Senegal	4
Botswana	1	Italy	172	Serbia	1
Brazil	131	Ivory Coast	2	Sierra Leone	2
Bulgaria	4	Jamaica	5	Singapore	35
Cambodia	2	Japan	32	Slovakia	4
Cameroon	4	Jordan	5	Slovenia	3
Canada	215	Kazakhstan	3	South Africa	48
Cape Verde	4	Kenya	11	South Korea	41
Central African Republic	1	Laos	2	Spain	135
Chile	54	Latvia	3	Sri Lanka	5
China	75	Lithuania	1	Sudan	2
Colombia	21	Luxembourg	6	Sweden	33
Costa Rica	6	Malaysia	14	Switzerland	8
Croatia	4	Mali	2	Taiwan	7
Curacao	1	Mauritania	1	Tanzania	6
Cyprus	1	Mauritius	1	Thailand	19
Czech Republic	7	Mexico	52	Trinidad and Tobago	6
Denmark	20	Mongolia	1	Tunisia	1
Dominica	1	Morocco	11	Turkey	20
Dominican Republic	3	Mozambique	2	Turks and Caicos Islands	1
Ecuador	1	Myanmar	1	UK	1,174
Egypt	7	Nepal	3	US	916
El Salvador	3	Netherlands	71	Uganda	7
Equatorial Guinea	1	New Zealand	34	United Arab Emirates	23
Estonia	6	Nicaragua	4	Uruguay	1
Finland	19	Nigeria	11	Venezuela	4
France	260	Norway	12	Vietnam	29
French Caribbean	2	Oman	8	Zambia	1
Georgia	2	Pakistan	7		
				Total	**4,825**

Table IA.3: U.S. Infrastructure Projects: Number of Unique Assets by State and Industry

The total number of assets is lower than the sum of assets by state as one asset can be located in multiple states.

State	Renewable energy	Social	Telecoms	Traditional energy	Transport	Utilities	Total
Alaska							0
Alabama	1	1		4	1		7
Arizona	8			4		1	13
Arkansas		1		1			2
California	55	2	1	29	5	10	102
Colorado	4		1	16	2	1	24
Connecticut	14			10	3	3	30
DC				1	1		2
Delaware	2			1			3
Florida	2	9	4	10	7	1	33
Georgia				10	2	1	13
Hawaii			1	3			4
Idaho	13			1			14
Illinois	10	2	1	22	8	3	46
Indiana	4	3	1	2	1		11
Iowa	6						6
Kansas	5			1			6
Kentucky				3			3
Louisiana	2	1		13	1	1	18
Maine	13			5		1	19
Maryland	2			9			11
Massachusetts	17			19		2	38
Michigan	3			9	4	2	18
Minnesota	2			2			4
Mississippi				6			6
Missouri			1	2			3
Montana	1						1
Nebraska	1	1		1			3
Nevada	10			5		3	18
New Hampshire	5			3			8
New Jersey	8			16	7	5	36
New Mexico	5			6			11
New York	11		2	15	5	4	37
North Carolina	12	1	2	3	1	1	20
North Dakota				8			8
Ohio	2	1		10	4		17
Oklahoma	8			21			29
Oregon	17		1	2			20
Pennsylvania	13	1		24	2	7	47
Rhode Island				2			2
South Carolina	13		1	2			16
South Dakota	1			1			2
Tennessee	2						2
Texas	35	2	3	112	7	9	168
Utah	1			4			5
Vermont						1	1
Virginia	6	1	3	5	7		22
Washington	1	1		5	2	3	12
West Virginia	4			4			8
Wisconsin	1	2		1		1	5
Wyoming	1			4			5
Multiple States	5	1		1	7		14
Total	316	30	21	424	72	53	916

Table IA.4: Leverage of Infrastructure Transactions by Industry

This table presents summary statistics on the proportion of leverage used in infrastructure transactions. For 6,273 investor-deal observations, Preqin provides information on the total deal size as well as the proportion of deal financed by equity and debt. The leverage ratio is estimated as the total amount of debt divided with the total deal size. We summarize the leverage ratio and present the mean, 25 percentile, median, and 75 percentile. We present summary statistics separately for each industry as well as for all asset together.

Industry	**N**	**Mean**	**p25**	**Median**	**p75**
Renewable Energy	970	0.710	0.638	0.713	0.803
Social	659	0.796	0.714	0.888	0.911
Telecoms	501	0.479	0.365	0.462	0.534
Traditional Energy	1,420	0.643	0.500	0.678	0.782
Transport	1,745	0.587	0.457	0.585	0.795
Utilities	978	0.496	0.203	0.521	0.678
Total	6,273	0.618	0.478	0.660	0.802

Table IA.5: Exiting a Deal and Investor Type (Cluster by Asset)

Robustness check of Table 6: We cluster the standard errors by infrastructure asset instead of investor.

This table presents results of a survival analysis using Cox proportional hazard model. The event of interest is a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset. We present the hazard ratios. *Private Investor* is an indicator variable for institutional investors from the private sector. We also split the private investors by type and include separate indicator variables: *U.S. Private PF* captures U.S. private pension funds, *Non U.S. Private PF* refers to non U.S. private pension funds, insurance firms and banks, and endowments and foundations. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *Direct deal* is an indicator variable for direct investments in infrastructure deals. *Concession* is an indicator variable equal to one if an investor enters a concession deal with the government. *Greenfield* and *Brownfield* are indicators for project stage (the omitted category is secondary stage). *Home deal* is an indicator for deals located in the same country (state) as the investor. *#Investors* counts the total number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). *Total Stake* is the total stake of all investors in the deal. We control for LP country, deal industry, and deal region fixed effects. We cluster standard errors by asset. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public Investor	0.848***		0.871***		0.868***		0.886***	
	[0.026]		[0.027]		[0.027]		[0.029]	
U.S. Public PF		0.835***		0.744***		0.741***		0.758***
		[0.051]		[0.044]		[0.043]		[0.047]
Non U.S. Public PF		0.839***		0.976		0.973		0.977
		[0.027]		[0.028]		[0.028]		[0.029]
Government agencies		0.946		1.144		1.174*		1.371***
		[0.063]		[0.094]		[0.099]		[0.124]
Sovereign wealth funds		0.833**		0.818*		0.791**		0.765**
		[0.074]		[0.091]		[0.089]		[0.090]
Log Investor Size	1.041***	1.040***	1.045***	1.049***	1.046***	1.050***	1.045***	1.049***
	[0.007]	[0.008]	[0.007]	[0.008]	[0.007]	[0.008]	[0.008]	[0.008]
Year First Invest	1.003	1.003	1.005	1.007	1.003	1.006	1.006	1.009
	[0.005]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.007]	[0.007]
#Funds	1.003*	1.003*	1.000	1.000	1.000	1.000	0.999	0.999
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Direct deal	0.479***	0.475***	0.490***	0.473***	0.489***	0.470***	0.527***	0.501***
	[0.047]	[0.046]	[0.049]	[0.046]	[0.048]	[0.046]	[0.061]	[0.057]
Concession					1.641***	1.644***	1.775***	1.776***
					[0.188]	[0.188]	[0.221]	[0.220]
Greenfield					0.745***	0.742***	0.693***	0.689***
					[0.078]	[0.077]	[0.080]	[0.079]
Brownfield					0.689***	0.687***	0.677***	0.675***
					[0.092]	[0.092]	[0.097]	[0.097]
Home Deal					0.801***	0.803***	0.846**	0.850**
					[0.059]	[0.059]	[0.066]	[0.066]
#Investors							0.937	0.938
							[0.047]	[0.047]
Total Stake							1.208	1.208
							[0.215]	[0.214]
LP country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Deal region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deal industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor
Observations	62,106	62,106	62,106	62,106	62,106	62,106	55,222	55,222

Table IA.6: Exiting a Deal and Investor Type (Private Investors)

Robustness check of Table 6: We control for private investor types instead of public investors.

This table presents results of a survival analysis using Cox proportional hazard model. The event of interest is a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset. We present the hazard ratios. *Private Investor* is an indicator variable for institutional investors from the private sector. We also split the private investors by type and include separate indicator variables: *U.S. Private PF* captures U.S. private pension funds, *Non U.S. Private PF* refers to non U.S. private pension funds, insurance firms and banks, and endowments and foundations. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *Direct deal* is an indicator variable for direct investments in infrastructure deals. *Concession* is an indicator variable equal to one if an investor enters a concession deal with the government. *Greenfield* and *Brownfield* are indicators for project stage (the omitted category is secondary stage). *Home deal* is an indicator for deals located in the same country (state) as the investor. *#Investors* counts the total number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). *Total Stake* is the total stake of all investors in the deal. We control for LP country, deal industry, and deal region fixed effects. We cluster standard errors by institutional investor. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Private Investor	1.180***		1.148***		1.152***		1.128***	
	[0.053]		[0.048]		[0.048]		[0.046]	
U.S. Private PF		1.332***		1.218***		1.220***		1.170**
		[0.080]		[0.076]		[0.078]		[0.075]
Non U.S. Private PF		1.124*		1.092		1.091		1.080
		[0.074]		[0.075]		[0.075]		[0.074]
Insurance firms and banks		1.086		1.128*		1.129*		1.097
		[0.068]		[0.071]		[0.071]		[0.069]
Endowments and foundations		1.317***		1.234***		1.266***		1.277***
		[0.096]		[0.090]		[0.093]		[0.091]
Log Investor Size	1.041***	1.059***	1.045***	1.052***	1.046***	1.055***	1.045***	1.056***
	[0.013]	[0.015]	[0.014]	[0.016]	[0.014]	[0.016]	[0.014]	[0.016]
Year First Invest	1.003	1.004	1.005	1.005	1.003	1.004	1.006	1.007
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
#Funds	1.003	1.002	1.000	1.000	1.000	1.000	0.999	0.999
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Direct deal	0.479***	0.478***	0.490***	0.486***	0.489***	0.484***	0.527***	0.522***
	[0.101]	[0.098]	[0.098]	[0.097]	[0.099]	[0.098]	[0.105]	[0.103]
Concession					1.641***	1.640***	1.775***	1.775***
					[0.100]	[0.100]	[0.103]	[0.103]
Greenfield					0.745***	0.743***	0.693***	0.690***
					[0.028]	[0.028]	[0.028]	[0.028]
Brownfield					0.689***	0.687***	0.677***	0.673***
					[0.027]	[0.027]	[0.028]	[0.028]
Home Deal					0.801***	0.799***	0.846**	0.844***
					[0.052]	[0.051]	[0.055]	[0.055]
#Investors							0.937***	0.938***
							[0.008]	[0.008]
Total Stake							1.208***	1.205***
							[0.051]	[0.050]
LP country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Deal region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deal industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor
Observations	62,106	62,106	62,106	62,106	62,106	62,106	55,222	55,222

Table IA.7: Robustness: Exiting a Deal and Investor Type (Only Closed Funds)

Robustness check of Table 6: We analyze only the subsample of deals accessed through closed funds.

This table presents results of a survival analysis using Cox proportional hazard model. The event of interest is a sale transaction that results in a full (not partial) exit of an equity position in an infrastructure asset. We present the hazard ratios. *Private Investor* is an indicator variable for institutional investors from the private sector. We also split the private investors by type and include separate indicator variables: *U.S. Private PF* captures U.S. private pension funds, *Non U.S. Private PF* refers to non U.S. private pension funds, insurance firms and banks, and endowments and foundations. We control for the natural logarithm of LP AUM and year of first infrastructure investment. *#Funds* measures the number of investments in infrastructure funds by investor. *Concession* is an indicator variable equal to one if an investor enters a concession deal with the government. *Greenfield* and *Brownfield* are indicators for project stage (the omitted category is secondary stage). *Home deal* is an indicator for deals located in the same country (state) as the investor. *#Investors* counts the total number of investors in the same deal (multiple LPs investing through the same infrastructure fund are not counted multiple times). *Total Stake* is the total stake of all investors in the deal. We control for LP country, deal industry, and deal region fixed effects. We cluster standard errors by institutional investor. We report standard errors in brackets. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public Investor	0.860***		0.883***		0.887***		0.926*	
	[0.040]		[0.037]		[0.037]		[0.037]	
U.S. Public PF		0.826***		0.793***		0.805***		0.855***
		[0.046]		[0.043]		[0.045]		[0.041]
Non U.S. Public PF		0.870**		0.946		0.940		0.949
		[0.054]		[0.058]		[0.057]		[0.057]
Government agencies		0.963		1.049		1.089		1.361*
		[0.100]		[0.188]		[0.190]		[0.240]
Sovereign wealth funds		0.741*		0.894		0.874		0.857
‘		[0.120]		[0.134]		[0.126]		[0.139]
Log Investor Size	1.007	1.008	1.001	1.004	1.002	1.005	0.991	0.993
	[0.010]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.010]	[0.010]
Year First Invest	0.982***	0.982***	0.980***	0.982***	0.980***	0.981***	0.971***	0.972***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
#Funds	1.001	1.001	0.998	0.998	0.998	0.998	0.995*	0.995*
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Concession					1.600***	1.599***	1.691***	1.688***
					[0.104]	[0.104]	[0.105]	[0.105]
Greenfield					0.671***	0.671***	0.587***	0.586***
					[0.026]	[0.026]	[0.023]	[0.023]
Brownfield					0.662***	0.662***	0.674***	0.673***
					[0.026]	[0.026]	[0.029]	[0.029]
Home Deal					0.878**	0.880**	0.944	0.949
					[0.054]	[0.055]	[0.059]	[0.058]
#Investors							0.973***	0.972***
							[0.007]	[0.007]
Total Stake							1.207***	1.213***
							[0.056]	[0.056]
LP country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Deal region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deal industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Investor	Investor	Investor	Investor	Investor	Investor	Investor	Investor
Observations	46,477	46,477	46,477	46,477	46,477	46,477	40,435	40,435

Figure IA.1: Comparison of the Cashflows of Infrastructure Funds with Other Private Funds (Matched Subsamples)