Institutional Infrastructure Investment

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Abstract

Infrastructure is increasingly important for institutional investors worldwide. Larger pension funds, public funds, and funds with a larger allocation to alternatives are more likely to invest in infrastructure, and to manage it internally. Smaller pension funds more often use intermediated investment approaches, face higher investment costs, and realize lower returns. We observe economies of scale for pension funds' investment performance in infrastructure, while financial intermediation does not affect performance significantly. As an institutional investment, infrastructure performed well over the 2007-2018 period, with a 10.1% return, second only to private equity, and a standard deviation of 8.4%, second only to bonds.

***Keywords*:** Infrastructure, alternative assets, pension fund, institutional investment performance

JEL codes: G20, G11, G23

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1. Introduction

The link between infrastructure investments and long-term economic growth has been well-established (see Duclos et al., 2013; Roller & Waverman, 2001). It is therefore not surprising that governments spend significant amounts of capital on all sorts of public infrastructure, varying from social infrastructure such as schools and hospitals to roads, airports, and harbors. In addition to regular infrastructure spending, infrastructure investments are also used as part of long-term economic stimulus packages, including China's Belt and Road Initiative plan, the recent Biden infrastructure package, and Europe's COVID recovery plan, NextGenerationEU.

Even though government spending on infrastructure is sizeable, the World Bank's Global Infrastructure Outlook (2017)[1] forecasts a global infrastructure investment need of USD94 trillion by 2040, and more importantly, it forecasts a USD15 trillion gap between the projected and needed infrastructure investments. One important reason for the struggle of governments to meet infrastructure needs is that the amount of capital required to close the infrastructure gap far exceeds the resources that countries can raise in a fiscally and macroeconomically responsible manner (Schwartz et al., 2020). As a result, calls for institutional investors, pension funds and insurance companies to invest in public infrastructure projects have intensified. As an example, half of the European Green Deal´s USD1.2 trillion investment plan to eliminate or offset all EU greenhouse gas emissions by 2050 is expected to come from institutional capital.[2]

While the recent interest in the asset class seems new, infrastructure investment is old. A majority of the first stocks ever listed on stock exchanges were railway and infrastructure

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[1] Global Infrastructure Outlook (2017). Infrastructure investment needs: 50 countries, 7 sectors to 2040. Global Infrastructure Hub. Accessible here: https://cdn.gihub.org/outlook/live/methodology/Global+Infrastructure+Outlook+-+July+2017.pdf

[2] The Economist. (2021, June 2). What is the European Green Deal?

companies. For example, the Philadelphia Stock Exchange, which was the first stock exchange in the United States, was essential in raising funds for multiple paramount public work projects. Examples of these initial public projects funded by the stock exchange include the first toll road by the Philadelphia and Lancaster Turnpike company in the year 1796, the Pennsylvania Railroad, the Philadelphia Railway, and the Reading Railway in 1840[3]. This prevalence of infrastructure investments was reflected in the composition of the original stock indices. For example, the original S&P500 index was composed of 425 industrial stocks, 15 rail stocks, and 60 utility stocks[4].

Yet, infrastructure was only recently re-discovered as a distinct asset class, starting in the 1990s in Australia (Inderst, 2020). Over the past two decades, pension funds, sovereign wealth funds, and insurance companies have started allocating significant resources to infrastructure (Andonov, Kräussl, & Rauh,2021). Institutional interest is furthered by the current low-yield environment and the supposedly attractive investment characteristics of infrastructure. Supposedly infrastructure offers long-term stable returns, low risk, low correlation with other asset classes, and a natural fit with long-lasting and often inflation-linked pension liabilities. But the empirical foundations for these claims are weak (Wurstbauer & Schäfers, 2015), and mostly limited to listed infrastructure investment, due to lack of credible and accessible performance data for direct investments. For example, Markuzi and Newell (2020) examine the MSCI global infrastructure benchmark series, a composite index of publicly traded infrastructure companies, over the 2008-2019 time period and document that infrastructure delivered returns of 12.27% per year with a volatility rate of 9.75%. In addition, the authors document that infrastructure outperformed other

[3] https://philadelphiaencyclopedia.org/essays/philadelphia-stock-exchange/#:~:text=These%20included%20The%20First%20Bank,Insurance%20Company%20of%20North%20America.

[4] https://globalfinancialdata.com/the-sp-composite-before-1957

asset classes, delivered inflation-linked returns, and find that the inclusion of infrastructure in a mixed-asset portfolio enhanced performance.

To our knowledge, the only recent paper investigating private infrastructure investments is Andonov, Kraussl, and Rauh (2021), who examined the private infrastructure investments of 650 institutional investors. They find that unlisted infrastructure funds do not provide more stable returns to institutional investors as compared to other "alternative" asset classes, while many institutional investors include infrastructure in their portfolios based on the expectations of stable cash flows. They conclude that investment in infrastructure via the private fund channel does not deliver on the promises often made about infrastructure as an asset class.

This very limited body of research compares starkly with the ongoing allocation to infrastructure by pension funds all over the world. Whereas investor characteristics, investment approaches, costs, and performance of alternative assets like real estate, private equity, and hedge funds have been widely researched (see, for example, Andonov, Eichholtz, & Kok, 2015; Harris, Jenkinson & Kaplan, 2015, Capocci & Hubner, 2004, and Jorion, 2021), this is not the case for infrastructure investments.

This paper provides detailed empirical insight into the choices and consequences of pension funds investing in the infrastructure asset class, including investment strategy, costs, and investment performance. We exploit the CEM database, the leading global database with respect to pension fund investments, covering more than 1,100 pension funds. The CEM database provides detailed information on pension fund characteristics and the investment choices they make across asset classes, including alternatives such as infrastructure.

The results show that in 2018, about 48% of all pension funds in the CEM database invested in infrastructure, with an average allocation of 4.1% of total assets for those who do. Larger pension funds and pension funds with a higher percentage allocation to other alternative assets in their

portfolios are more likely to invest in infrastructure. When pension funds decide to invest in infrastructure assets they must choose an investment approach. Pension funds generally employ five distinct investment approaches to gain exposure to infrastructure assets: internal management, co-investing, external management, limited partnerships, and fund of funds[5]. We find that in 2018 only 13% of the pension funds in our sample chose to manage infrastructure investments internally. Smaller pension funds are more likely to rely on financial intermediaries, whereas larger pension funds are more likely to invest internally. However, even among the 20% largest pension funds investing in infrastructure, with on average USD115 billion in assets under management, just 27.6% chose to manage their infrastructure investments internally.

The choice of investment approach has significant effects on the investment costs of pension funds' infrastructure holdings. The average fee of a pension fund investment in infrastructure is 110bps. The fee is substantially higher for investments made through external vehicles (166 bps) as compared to internal channels (46 bps). In comparison to other alternative assets, the average investment costs of infrastructure are considerably lower than private equity (260 bps) and hedge funds (200 bps), and similar to real estate (89 bps). We document economies of scale in the cost of infrastructure investments of pension funds, with a doubling of the infrastructure mandate size leading to a reduction in costs by 3.85 bps.

Investigating net returns to infrastructure investments, we document that infrastructure, alongside private equity, has been the best-performing asset class over the 2007-2018 time period. With a net return of 10.1% and a volatility rate of 8.4%. Only bonds exhibited a lower volatility rate (7.8%) over the same period. Furthermore, we do *not* find evidence that financial intermediation leads to significantly lower net returns in comparison to internal management,

[5] We will provide clarity on CEM's definition of these approaches in the data section.

contrasting much of the literature on intermediation (e.g., Andonov, Eichholtz, & Kok, 2015). Larger mandate size leads to better net performance, with a doubling of the infrastructure mandate size increasing net returns by 84bps.

Clearly, infrastructure has become a well-established component of the institutional mixed-asset portfolio, at least for the larger pension funds across the globe. Our findings support the increased interest, both at the extensive and intensive margin, showing favorable risk/return characteristics for infrastructure investments over the past two decades, with significant economies of scale in the infrastructure allocation. Of course, like any alternative asset, investing in infrastructure requires skill and local knowledge. For most pension funds this implies a need for intermediaries. Importantly, our results regarding the impact of the investment approach only partially support Stoughton, Wu, and Zechner's (2011) theory of financial intermediation, according to which high-net-worth institutions do not invest through funds of funds and achieve superior returns because underperforming assets are sold indirectly through these funds. While we document that larger pension funds make less use of funds-of-funds and that funds-of-funds exhibit significantly higher investment costs and marginally lower net returns than alternative investment approaches, we do not find evidence that the use of funds-of-funds leads to significant underperformance compared to internal investment management.

Even though infrastructure seems to develop quite rapidly as an asset class, it still lags behind other "alternatives" such as real estate and private equity, both in terms of overall allocation and from the perspective of institutionalization. There is a dearth of performance data at the infrastructure asset level, and with that a lack of appropriate benchmarks to assess the relative performance of fund managers[6]. Liquid infrastructure offerings can be found in the publicly traded

[6] Therefore, we study net returns instead of benchmark-adjusted returns.

realm, but the universe of infrastructure companies is still limited, and there is no "core," easy-to-access infrastructure offering in the private space as of yet (compared to the ODCE universe in real estate). Also, the siren song on the investment characteristics of infrastructure may slowly fade. As the infrastructure industry continues to develop and institutionalize, capital inflows may reduce the relatively attractive returns achieved over the past years (although asset values may inflate further, boding well for existing investors).

The remainder of this paper is structured as follows. The next section describes the dataset, which is followed by an investigation of the determinants of infrastructure allocations by pension funds in section 3 and 4. Section 5 shows the analysis of the effect of fund characteristics and investment choices on investment costs. Section 6 presents the performance outcomes of pension funds in infrastructure on a net return basis and investigates performance persistence in infrastructure investments. Section 7 concludes.

2. Data

We employ the CEM Benchmarking global pension fund database, the broadest global database reporting on pension fund asset allocation and investment, which includes detailed information on investment approach, costs, performance, and benchmarking choices for each separate asset class. The CEM database has been used previously in a variety of studies of pension fund investments (see Carlo, Eichholtz & Kok, 2021 for a discussion). Since reporting to CEM is done on a voluntary basis, the database could be liable to self-reporting bias. Andonov, Bauer, and Cremers (2012) address this issue and document that there is no evidence that pension funds enter or exit the CEM database based on their performance, yet they do note that larger funds are more likely to remain in the database.

The CEM database covers 1,132 defined benefit pension funds over the 1991-2018 time period. The total pension fund assets under management included in the CEM database have grown from USD612 billion in 1991 to USD9.9 trillion in 2018, thereby representing almost 25% of total global pension fund assets in 2018.[7]

While CEM gathers data on pension funds' investments in several asset classes, this paper concentrates on the infrastructure allocations by pension funds. Pension funds can get exposure to infrastructure in various ways, such as municipal bonds, tax increment bonds (TIF), and listed and unlisted infrastructure equity funds. In the CEM database, infrastructure data solely includes pension fund investments in unlisted infrastructure, distinguishing between internal and external infrastructure holdings. Investments in publicly traded infrastructure assets are not separately captured and included in public equity mandates. As we do not have asset-level data, we are unable to identify whether the infrastructure investments are economic infrastructure investments (e.g., transportation, communication, and energy assets) or social infrastructure investments (e.g., hospitals, prisons, and administrative buildings); nor do we know if they concern greenfield or brownfield investments, and nor the ex-ante risk profile of the investment (i.e., core versus opportunistic).

Before 2007, pension fund allocations to the infrastructure asset class were very limited. The last year for which we have data is 2018. Therefore, we focus our analysis on the 2007-2018 period. We provide descriptive statistics of our sample coverage in Table A1 and A2 in the Appendix. As the tables show, most of the pension funds represented in the database are from the North American region, including 534 out of the 782 funds in the sample. There are also many

[7] Comparison based on the Towers Watson Global Pension Assets Study 2018. (See https://www.willistowerswatson.com/en-CA/insights/2019/02/global-pension-assets-study-2019.)

European funds in our sample, with a total of 219 unique pension funds, primarily covering the UK and the Netherlands.

3. Infrastructure allocations and costs

Figure 1A shows the percentage of pension funds in the CEM database investing in infrastructure assets. Clearly, infrastructure investment has been rising steadily over time, from 12% of pension funds in 2007 to 47.5% in 2018. To put this into perspective, the percentage of pension funds investing in other alternative, but more established alternative assets, was 88.3% for real estate, 74.2% for private equity, and 57.1% for hedge funds in that same year. In dollar terms, the total value of pension fund infrastructure holdings in the CEM database increased from less than USD29 billion in 2007 to almost USD245 billion in 2018, illustrating the rapid rise of institutional infrastructure investments worldwide. When looking at regional differences, Figure 1A shows that U.S. pension funds are less likely to invest in infrastructure as compared to their peers in Canada, Europe, and the rest of the world.

For the pension funds that do invest in infrastructure, we observe an increasing trend in average holdings, as illustrated in Figure 1B. The solid line depicts the global average infrastructure allocation for the group of pension funds investing in the asset class, as a percentage of total pension fund assets (i.e., weighted average). This rises from 2.4% in 2007 to 4.1% in 2018. In addition, the figure shows that the infrastructure allocations differ significantly across regions, with Canadian pension funds showing the strongest growth and the highest allocations. In 2018, the Canadian pension funds with infrastructure exposure allocated an average of 8.4% of total assets. On the other hand, the more hesitant approach towards infrastructure investments by U.S. pension funds illustrated in Figure 1A is also apparent for pension funds that decided to invest in infrastructure -- on average, allocations were “just” 1.2% of total assets in 2018.

Table 1 provides more detailed information about infrastructure allocations, with information on portfolio holdings in U.S. dollars. Panel A provides a regional perspective and panel B provides data across investment approaches. All numbers relate to 2018. Panel A demonstrates that the differences in percentage allocation to infrastructure across regions lead to substantial variation in the average infrastructure holding size of pension funds. For example, Canadian funds with infrastructure exposure have substantially larger average infrastructure holdings than European and U.S. pension funds in 2018, but the table also shows that this is mainly caused by a few very large outliers: in terms of median holdings per pension fund, the U.S. trumps Canada and Europe.

A. Investment Approaches

Pension funds use five distinct investment approaches for their infrastructure investments. CEM Benchmarking reports infrastructure investment either as internal, co-investment, external, limited partnership, or fund-of-funds. The internal category means that the portfolio of infrastructure investments is managed by a dedicated in-house investment department. On the other hand, the external category stands for private infrastructure funds with an infinite life (i.e., open-ended funds), while limited partnerships refer to closed-end funds with predetermined holding period. Co-investments sit between internal and external, with a pension fund taking a direct stake in an infrastructure investment, but the investment is managed externally. Pension funds that allocate capital to infrastructure via fund-of-funds rely on intermediaries to select limited partnerships (i.e., infrastructure funds).

Panel B of Table 1 shows that there are considerable differences in the size of infrastructure holdings by investment approach. As an illustration: the average capital allocated through internal infrastructure investment is approximately twice as much as the other four investment approaches

combined (both in terms of mean and median). Funds-of-funds are the least chosen route to acquire infrastructure exposure.

To investigate which investment approaches are taken by pension funds over time, Figure 2 displays the development of the investment approach used by pension funds for their infrastructure investments over the 2007-2018 period. Internal and external management were the dominant investment approaches in the early years of infrastructure investing. Contrasting Figure 2 with Panel B of Table 1, it is apparent that the internal approach is not used often in our sample, however, when used, pension funds have a large mandate allocated. This is not surprising, as only big pension funds have the resources and expertise to have an in-house infrastructure management team (similar to real estate, see Andonov et al., 2015).

Over time, the rise of infrastructure investing has led to the emergence of the fund-of-funds, co-investment vehicles, and especially limited partnerships, which now represent the largest channel to gain infrastructure exposure, rising from 15% in 2007 to 40.7% of infrastructure investment approaches in 2018.

B. Investment costs

CEM provides detailed information about pension funds' investment costs. The investment costs for internal management consist of compensation and benefits for the employees that manage the investments as well as support staff, overhead costs, and research expenses. The investment costs for external management include payment of management fees to external money managers and investment consultants. In addition, the costs for internal employees who oversee the external investments in infrastructure assets are also included. Historically, CEM directly subtracted performance fees, carried interest, and rebates from gross returns and did not incorporate these fees in the overall cost figures. Even though CEM has separately captured and reported performance

fees, carried interest and rebates for the past 7 years, we subtract these fees directly from gross returns to ensure consistency for the full sample period. The same applies for funds of funds, where the cost figures pertain only to the base management fee paid to the fund of funds manager as well as the underlying managers, not to the performance fees and carried interest on either of those layers.

Panel A of Figure 3 shows that pension funds from Europe and the U.S. consistently pay higher fees as compared to their global peers, based on asset-weighted cost numbers. Especially U.S. pension funds face high fees, albeit with a slightly downward trend: 2018 investment fees for infrastructure investments were about 180bps, compared to 114bps for European funds, and slightly over 80bps for Canada. Canadian funds' low fees are consistent over time. When looking at the unweighted investment costs across regions and by investment approach (not shown in the graph), which avoids the dominance of large pension funds in the cost figures, we find that the investment cost levels across regions were much closer to each other and substantially higher, with all funds paying on average 190bps in infrastructure investment fees in 2018. Pension funds in Europe and the U.S. still have the highest average costs (189bps and 201bps respectively), but Canadian funds are not served much more economically when looking at the cost data in this way: unweighted average costs are 172bps.

As noted in Panel B of Table 1, pension funds invest in infrastructure through five different channels, each having their own distinct cost profiles. Panel B of Figure 3 illustrates this. The difference in cost levels between investment approaches has been rather consistent over time, apart from the volatility of the investment costs for funds of funds, which can be partly explained by the small number of fund-of-fund observations at the start of the sample period. The differences can be summed up by noting that more internally focused investment approaches are least expensive, and external approaches are more expensive. That holds especially for limited partnerships and

funds-of-funds, with cost levels above 200bps. Internal investment and co-investment are associated with fees around 50bps.

4. Pension fund characteristics and infrastructure investments

This section empirically assesses the decision of pension funds whether to invest in infrastructure, and once they invest, the choice of investment approach. First, we investigate which pension fund characteristics affect the choice to invest in infrastructure, estimating the following logit model:

$$\Pr(y_{i,t} = 1|X) = F(\beta_1 Size_{i,t} + \beta_2 \%Alter_{i,t} + \beta_3 Public_i + \beta_4 Region_i + \beta_5 YD_t + v_{i,t}) \quad (1)$$

where F is a logit function taking on values between zero and one, with $y_{i,t}$ the dependent binary variable. The probabilities are modeled as a function of pension fund characteristics (X), which consists of total pension fund size ($Size$), measured by the natural logarithm of pension fund assets under management in U.S. dollars, and the percentage allocation to other alternative asset classes ($\%Alter$) of pension fund i in year t (other alternatives include real estate, private equity, hedge funds, commodities and natural resources). We use a dummy variable ($Public$) to control for plan type, which takes a value of one when a pension plan is public and zero when it is corporate. In addition, we also incorporate regional dummies ($Region$), where the base refers to U.S. pension funds, as well as year dummies (YD). We cluster the standard errors by pension fund to allow for intragroup correlation of standard errors.

Table 2 displays the results. Panel A shows which pension fund characteristics determine whether a pension fund invests in infrastructure or not. Larger pension funds are more likely to

invest in infrastructure: a one-unit increase in the logarithm of assets under management – meaning a doubling of the fund size – increases the likelihood that a pension fund invests in infrastructure by 17%. In addition, pension funds with a higher allocation to other alternative assets are more likely to have infrastructure exposure in their portfolio. Interestingly, public pension funds are also more likely to invest in infrastructure assets, although the effect is not statistically significant. This is in line with Andonov, Kräussl, and Rauh (2021), who find that public institutional investors have exposure to a higher number of infrastructure investments, which is partially explained by the public nature of infrastructure assets and the Environmental, Social, and Governance (ESG) considerations of public investors. Panel A of Table 5 also shows that, based on the regional dummies, pension funds from Canada, Europe, and the Rest of World group are significantly more likely to invest in infrastructure than U.S. pension funds.

Panel B of Table 2 provides results with regards to the characteristics determining the investment channel chosen to gain infrastructure exposure, either through an internal department, a co-investment vehicle, an external manager, a limited partnership structure, or a fund-of-funds. We find that larger pension funds are more likely to manage their infrastructure investments internally. A one-unit increase in the log size (i.e., doubling the fund size) increases the likelihood that a pension fund invests in infrastructure internally by 65.3%. On the other hand, fund-of-funds investment is more strongly associated with smaller pension funds. The likelihood that a pension fund invests through this most "intermediated" channel drops by 43 percent for every one unit increase in the logarithm of assets. Although the percentage of internal infrastructure investments increases as pension fund size increases, we observe that even among the 20% largest pension funds, 72.4% of investments are made through external vehicles in 2018.

Public pension funds are far more likely to choose the internal management route and are less likely to choose external funds for their infrastructure investments. Pension funds from

Canada, Europe, and the Rest of World are significantly more likely to invest in infrastructure assets through internal channels than U.S. pension funds, even after controlling for pension fund size, investments in other alternative asset classes, and plan type. In addition, Canadian pension funds are less likely than their U.S. peers to employ funds-of-funds.

In sum, larger pension funds, pension funds with a higher allocation to other alternative assets and public pension funds are significantly more likely to have exposure to infrastructure assets and are more likely to invest in these assets through internal channels. The significant resources required to set up an internal or "at-arms-length" operating division that manages infrastructure investments could drive the choices of pension funds to invest mostly through external vehicles. On the other hand, it is possible that pension funds opt for external vehicles because specialized external managers bring more expertise and years of experience to the table than internal teams and may be able to achieve better results[8]. The next two sections investigate cost and performance differences between internal and external investment approaches.

5. The cost of pension fund infrastructure investments

This section investigates the relationship between investment approach, mandate size, and investment costs of pension fund infrastructure investments. We estimate pooled panel regressions, similar to Andonov, Eichholtz, and Kok (2015), to disentangle the effects of infrastructure portfolio size and investment approach:

$$C_{i,t} = \gamma_0 + \gamma_1 Mandate_{i,t} + \gamma_2 Approach_{i,t} + \gamma_3 Region_i + \gamma_4 YD_t + u_{i,t}. \qquad (2)$$

[8] Of course, external managers are also easier to hire and fire, see Goyal and Wahal (2008).

where $C_{i,t}$ stands for investment costs in basis points, $Mandate$ represents the logarithm of the dollar value of the infrastructure investment portfolio and $Approach$ captures dummy variables representing the four investment approaches, with the base dummy referring to internal investments. $Region_i$ represents dummy variables with the base dummy referring to U.S. pension funds, YD_t concerns the year dummies and $u_{i,t}$ are the idiosyncratic errors. The standard errors are double clustered independently at the fund as well as the year level to control for any potential correlation of performance shocks within pension funds and across years.

Table 3 shows the results of the pooled panel regressions. The regression including all assets suggests pension funds that allocate more resources to infrastructure realize small but significant scale advantages on their investment costs. While controlling for the chosen investment approach, year, and region, a one-unit increase in the logarithm of the infrastructure mandate (i.e., doubling the mandate size) results in a 3.85bps reduction in costs. The results from the pooled panel regression on all assets also imply that the use of external and more intermediated investment approaches leads to higher cost levels. Delegating asset management to a general partner within a limited partnership structure increases the investment costs by 162bps compared to the cost levels in a situation where a pension fund manages its investments internally. Not surprisingly, a pension fund that chooses funds-of-funds, the most layered investment approach, faces the highest cost levels: 222bps higher as compared to internal investment. At the other end of the spectrum, pension funds engaging in co-investment face costs that do not significantly differ from internal investment. Overall, controlling for investment approach and size, only pension funds from the Rest of World group have significantly lower non-listed infrastructure investment costs as compared to U.S. pension funds (22bps).

When separating the sample into the different regions, we observe that the previously reported relations between financial intermediation and investment costs applies for each region. Although the exact cost levels differ across regions, the more intermediated investment approaches are associated with significantly higher costs. Interestingly, co-investment is associated with lower investment costs in the U.S. and Canada, with 39bps and 30bps lower costs respectively as compared to internal investment.

Overall, these results indicate that pension funds with a larger infrastructure mandate can achieve somewhat lower cost levels. The most obvious finding is that additional layers of financial intermediation are associated with significantly higher investment costs as compared to internal investments. This holds for all four regions in a comparable manner, contrasting the findings of Andonov, Eichholtz, and Kok (2015) for real estate, where U.S. pension funds face substantially higher real investment cost levels than their global peers. When it comes to infrastructure, U.S. pension funds take an approach that is more oriented towards external management, which is more expensive, but the cost levels of the external approach are similar to those in other regions.

Of course, one can argue that additional layers of infrastructure investment expertise are indeed expensive, but that they add value in finding the best assets at the most attractive price, translating into superior net-of-cost returns. Indeed, that is the sales pitch that is invariably given by the purveyors of these investment vehicles. We will now turn to the question of whether there is merit in such arguments.

6. Pension fund performance in infrastructure investments

In this section, we first analyze whether pension fund infrastructure returns justify the increased allocations to the asset class, and then investigate whether the increasing preference of pension funds to use more expensive, delegated investment approaches in infrastructure is

associated with superior performance. We first address the net returns to infrastructure investments over time, without controlling for pension fund characteristics, comparing pension funds' infrastructure investment performance with other asset classes in their portfolios. After these non-parametric comparisons, we provide the results of pooled panel regressions of net returns, controlling for pension fund characteristics, region, and investment approach.

Note that "net returns" are returns net of costs, not benchmark-adjusted returns. In the CEM database, pension funds report benchmarks against which performance is measured. The main advantage of using these performance benchmarks is that they likely reflect the risk exposure of the infrastructure allocations more precisely. A disadvantage of these self-declared performance benchmarks is that pension funds can strategically select the more easily outperformed benchmarks, especially since the appropriate benchmarks for infrastructure investments are still unclear. This is an inherent problem for investments in private markets. For example, Phalippou (2020) shows that private equity funds engage in "benchmark shopping behavior" over time, to report outperformance with respect to their respective benchmark. To avoid this endogeneity trap, we focus our analysis on returns net of cost, so the return accruing to the pension fund, without a comparison to self-reported benchmarks.

A. Descriptive analysis of net returns

Table 4 Panel A shows that infrastructure provided the second-highest net return over the entire sample period -- 10.1% on average. Only private equity investments delivered higher net returns over the 2007-2018 sample period, with an average net return of 12.6%. Infrastructure

assets exhibit lower volatility as compared to other alternative asset classes for the full sample period, with bonds the only asset class showing a lower standard deviation than infrastructure. When we divide the sample into two sub-periods, with the first covering the global financial crisis and the second the subsequent global economic boom, we observe that infrastructure delivered its stellar relative investment performance especially in the second period.

Panel B of Table 4 shows substantial variation in infrastructure net returns across regions, with Canada and the Rest of the World group (which includes Australia) exhibiting the highest net returns over the sample period. The infrastructure investments of European and U.S. pension funds tend to deliver lower net returns with higher volatility. Panel C of Table 4 provides net infrastructure performance by investment approach. We observe that the investment approaches that are more externally oriented deliver somewhat lower net returns as compared to internal investment, with a higher standard deviation. Panel C of Table 4 also shows that the recent rise of co-investments seems to be justified by their higher net returns than other investment approaches, while exhibiting similar volatility levels. Over the 2013-2018 time period, co-investments in infrastructure delivered the highest annual net returns as compared to other investment approaches, 13.3% on average, with the lowest standard deviation. It is important to note, however, that the number of observations for co-investments is small.

B. Explaining net returns by fund characteristics

Table 5 reports the results of the pooled panel regressions of the net returns on pension fund characteristics, region, and investment approach. These regressions are comparable to those employed for the investment cost analysis (see Equation 2), and as before, we double-cluster the standard errors and include time-fixed effects.

The results show a significant and positive relationship between infrastructure mandate size and the infrastructure investment performance of pension funds. A one-unit increase in the log of infrastructure holdings (i.e., doubling the mandate size) increases the net returns by 84 basis points. In addition, investing in infrastructure through co-investments leads to significantly higher net benchmark-adjusted returns than investing internally. However, the number of observations for co-investments is fairly small, and the results, therefore, need to be interpreted with some caution. The other external investment approaches -- limited partnerships and fund of funds -- do not lead to significantly lower or higher net returns than internally managed infrastructure investments. Investigating possible regional heterogeneity, we document no significant differences between the net returns of U.S. pension funds and their global peers.

We then split the infrastructure assets by region and study the relation between mandate size, investment approach, and performance for pension funds from the U.S., Canada, Europe, and the Rest of World group separately. Panel B of Table 5 shows statistically significant economies of scale for U.S. and Rest of World pension funds. A doubling of the infrastructure mandate size for U.S. and Rest of World pension funds increases net returns by 92 and 199 basis points respectively. The results are statistically insignificant in all other regions. Importantly, financial intermediation does not seem to harm net returns significantly in any of the regions.

We also investigate the relation between mandate size, region, and performance for each investment approach separately, and find significant scale economies for infrastructure investments through external, limited partnerships and fund of funds. For example, doubling the mandate size increases the net returns by 89 basis points for limited partnership investments. As previously mentioned, this paper solely looks at the effect of pension fund characteristics, region, and investment approach on the performance of infrastructure investments by pension funds. The unavailability of data on the underlying infrastructure assets and their risk profile makes that these

risk factors are not controlled for. Therefore, differences in the risk profiles of the underlying assets may be driving any difference in the results across regions and by investment approach.

To sum up, we do not observe much heterogeneity across regions regarding net investment performance, but we do find that size matters, with a doubling of the infrastructure mandate size leading to an 84bps increase in net returns. More importantly, financial intermediation does not seem to lead to significantly lower or higher net returns than internally managed investments for infrastructure -- external infrastructure fund managers deliver a gross performance that compensates for their added costs, but not more than that.

C. Persistence

Finally, we investigate persistence in the infrastructure investment performance of pension funds. We split pension fund investment performance into five quintiles based on the net benchmark-adjusted returns achieved by these pension funds. Table 6 shows the transition matrixes, which indicate the probabilities that a pension fund ranked in one of the quintiles in year *t* ends up in any of the five quintiles in year $t + 1$. In addition, we investigate the difference between returns in year $t + 1$ of pension funds that are ranked in the lowest and highest quintile in year *t*. With a null hypothesis of "no persistence," the value representing the difference in returns in year $t + 1$ is expected to be zero, implying that performance in the past is no prediction for performance in the future. Carpenter and Lynch (1999) demonstrate that a *t*-test investigating the difference between the bottom and top portfolios ranked by performance in the past is best specified with a null hypothesis of no persistence, as this is the most robust method compared to alternatives considered.

Table 6 Panel A shows strong persistence in the infrastructure investment performance of pension funds, using a one-year horizon. Pension funds are more likely to be among the best performing funds in the next year when performance is good this year. As an illustration, a pension fund that performed among the best-performing pension funds in year *t* had a 33.16 percent chance of being among the best-performing funds one year later. Similarly, funds that perform relatively poorly this year are more likely to end up with a low ranking in the next year. Panel A's last columns provide the average net benchmark-adjusted return in year $t + 1$ for pension funds in the lowest and highest ranked quintiles in year *t* and the *t*-statistic for the difference in performance between these two groups. The net benchmark-adjusted return for the lowest quintile is -0.63%, whereas the return for the highest quintile is 4.42%. The difference between these two groups is statistically significant, with a *t*-statistic of 4.56, implying strong persistence in pension funds' infrastructure investment performance.

We then investigate whether this performance persistence in infrastructure is also visible at a two-year horizon, to mitigate a potential valuation smoothing effect, which is well documented for real estate but not for infrastructure. Over a two-year time horizon, any appraisal smoothing effect should have lapsed. Panel B of Table 6 demonstrates that 21.71% of pension funds that belong to the highest-ranked quintile in year *t* end up in that same best performing quintile two years later. When looking at the difference in returns in year $t + 2$ between the worst and the best-ranked pension funds in year t, there is no significant difference: the *t*-statistic is 1.52, so the persistence is rather short lived or caused by valuation smoothing.

These findings are partially in line with earlier results on performance persistence for other alternative investment categories, such as real estate, private equity funds, and hedge funds. Andonov, Eichholtz, and Kok (2015) document substantial persistence in the direct real estate performance of pension funds. Kaplan and Schoar (2005) show performance persistence in venture

capital and leveraged buyout fund performance. Fung et al. (2008) document that hedge funds that perform better are less likely to be liquidated and simultaneously have a higher propensity to deliver alpha persistently.

7. Conclusions

Over the last three decades, institutional investors have increased their exposure to alternative assets, and infrastructure allocations have increased accordingly, albeit belatedly (Andonov, Bauer and Cremers, 2017; Carlo, Eichholtz and Kok, 2021). Pension funds across the globe increasingly face the choice whether, and if yes, how they can gain exposure to infrastructure.

This paper shows that larger pension funds, public pension funds, and pension funds with a higher percentage allocation to other alternative assets are more likely to invest in infrastructure. When making these investments, smaller pension funds are more likely to use external vehicles, while larger funds are more likely to invest in infrastructure internally. Overall, a substantial proportion of infrastructure investments is allocated through intermediaries, even by larger pension funds.

Regarding investment costs in infrastructure investment, pension funds across the globe experience quite similar investment costs, contrasting findings for other alternative asset classes, such as real state. This may reflect the global playing field of infrastructure investments. When looking at the performance of infrastructure over time, we find that, similar to other asset classes, the financial returns of infrastructure investments experienced a significant slump during the Global Financial Crisis, after which returns bounced back. Over the 2007-2018 time period, infrastructure has been the best-performing asset class in terms of Sharpe ratio, exhibiting the second-highest net returns (after private equity) and the second-lowest volatility rate (after bonds)

over this period. We document persistence in pension fund infrastructure investment performance within a particular investment approach over a one-year, but not over a two-year time horizon.

We further document that larger pension funds make more limited use of intermediaries such as fund-of-funds, which exhibit significantly higher investment costs. However, and contrasting general wisdom, we do *not* find evidence that the use of funds of funds leads to significant underperformance as compared to internal or other external investment management approaches. We do observe scale advantages in infrastructure investments, as larger pension funds exhibit lower investment costs, and higher net returns. These economies of scale are partially explained by the choices pension funds make regarding the investment approach, where larger pension funds are more likely to invest internally, and smaller pension funds are more likely to rely on externally oriented investment approaches. However, even when pension funds opt for the most intermediated investment approach, larger pension funds are able to perform significantly better on a net return basis as compared to smaller pension funds.

The findings of this paper have some implications for institutional investors with an existing allocation to infrastructure and for those contemplating to gain exposure to this rediscovered asset class. First, based on the data presented in this paper, the increase in infrastructure allocations seems to be justified from a risk/return perspective, and pension funds with no infrastructure exposure should consider investing in this alternative asset class. On the other hand, the externally oriented approach through which pension funds mainly invest in infrastructure is more expensive as compared to internally managing infrastructure assets (even though that does not seem to hurt net returns during our sample period). If the reliance on more intermediated external investment vehicles is motivated by the idea that these investment approaches deliver higher returns than internal teams could achieve, pension funds may need to reconsider their investment approach.

Of course, this paper does not provide the complete perspective on infrastructure as an asset class, with limited insight into the risk/return characteristics of individual infrastructure assets, and no insight into the optimal allocation from a portfolio optimization perspective. In addition, infrastructure investments are highly illiquid, and typically quite chunky. In addition to the risk/return profile, these considerations are important for pension funds. Further institutionalization of the asset class, both through the development of publicly traded vehicles and open-ended "core" private funds, may lead to increased allocation to infrastructure by pension funds. This development may help governments around the world reach infrastructure investment goals, in both "green" and more traditional sectors.

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Tables and Figures

Figure 1A: Percentage of funds investing in infrastructure (by region)

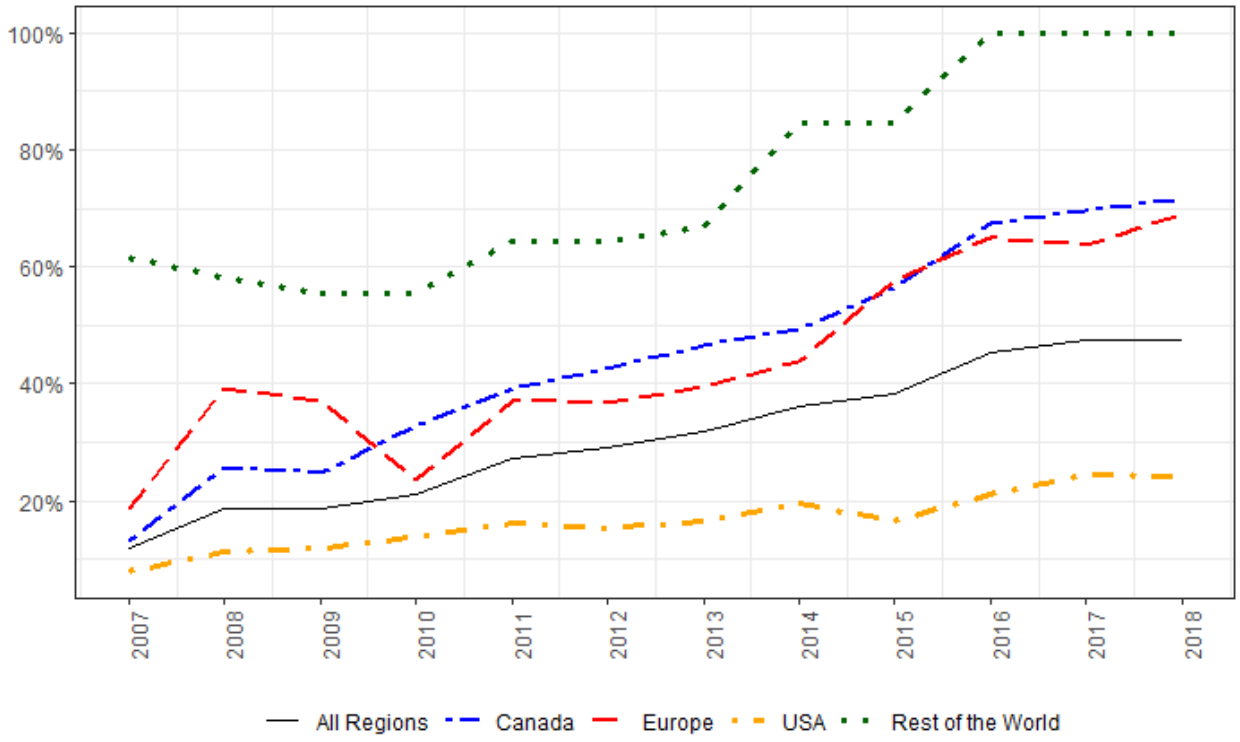

Figure 1B: Infrastructure as a percentage of total pension fund assets (by region)

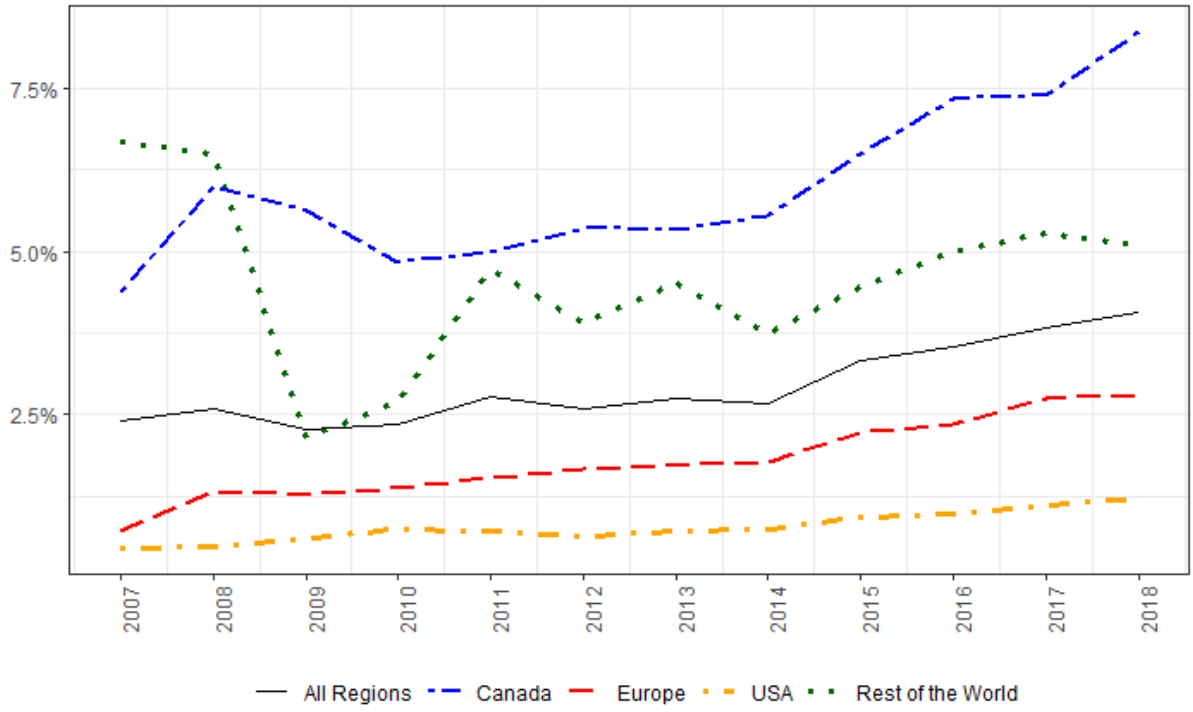

Table 1

Descriptive statistics infrastructure holdings

	Median	Mean	StDev	# Funds	# Obs
Panel A: Infrastructure holdings in million US$					
All Funds	250	1,063	2,856	155	231
Canada	226	1,423	3,955	56	84
Europe	230	711	1,788	51	74
U.S.	245	399	526	40	52
Rest of World	922	2,517	3,481	8	21
Panel B: Infrastructure holdings by investment approach in million US$					
Internal	1,345	4,506	6,034	30	30
Co-investment	268	457	678	22	22
External	263	809	2,081	61	61
Limited partnership	223	516	1,192	94	94
Fund-of-funds	56	111	159	24	24

Note: This table provides descriptive statistics on the infrastructure investments of pension funds with an existing allocation to infrastructure in 2018. We present the cross-sectional averages and display the following statistics: median, mean and standard deviation (StDev). The Columns # Funds and # Obs document the number of pension funds investing in infrastructure or through an investment approach as well as the number of observations. Panels A and B show the summary statistics of infrastructure holdings in million US$. In Panel A, the infrastructure assets descriptive statistics are displayed separately for pension funds from Canada, Europe, the U.S. and the Rest of World group. Panel B shows the infrastructure holdings descriptive statistics by investment approach.

Figure 2: Pension funds' investment approach in infrastructure

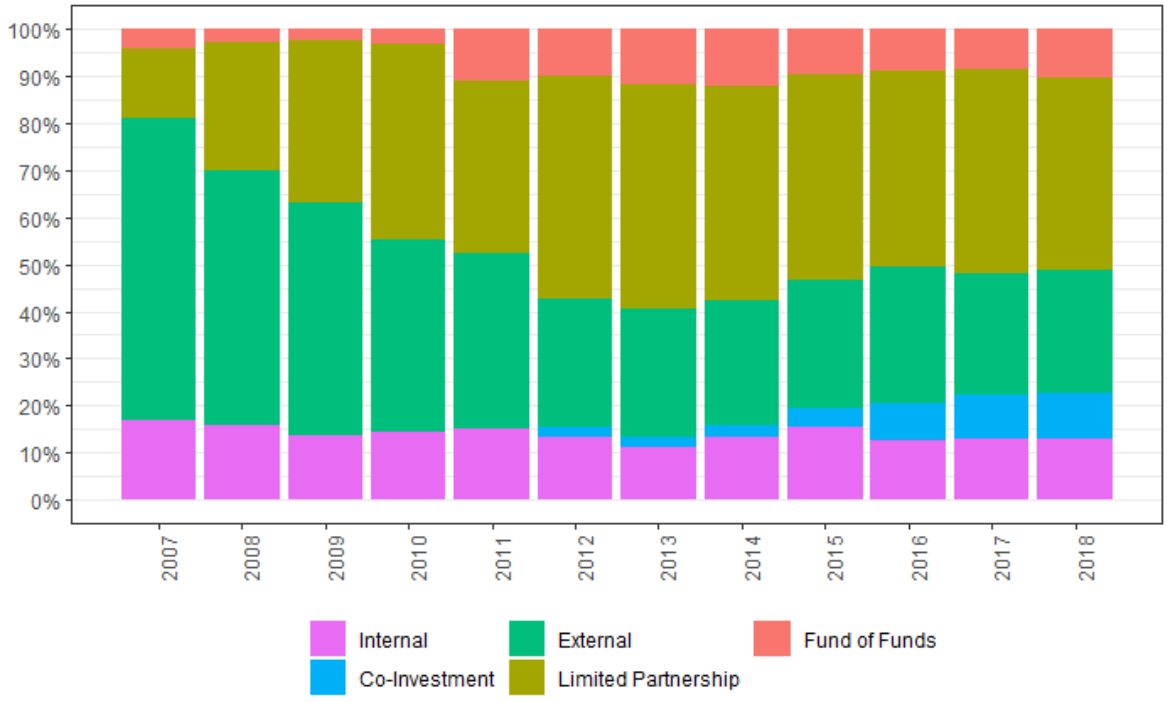

Figure 3A: Overall infrastructure investment costs by region (in bps)

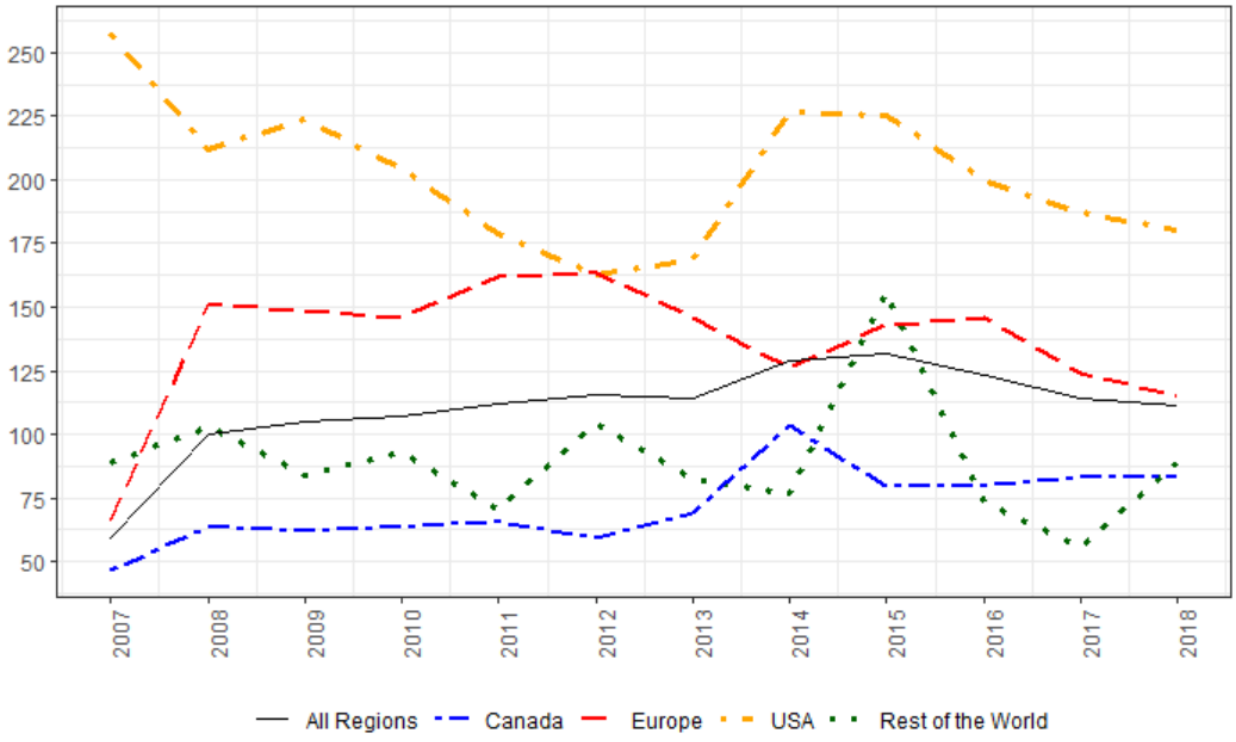

Figure 3B: Overall infrastructure investment costs by investment approach (in bps)

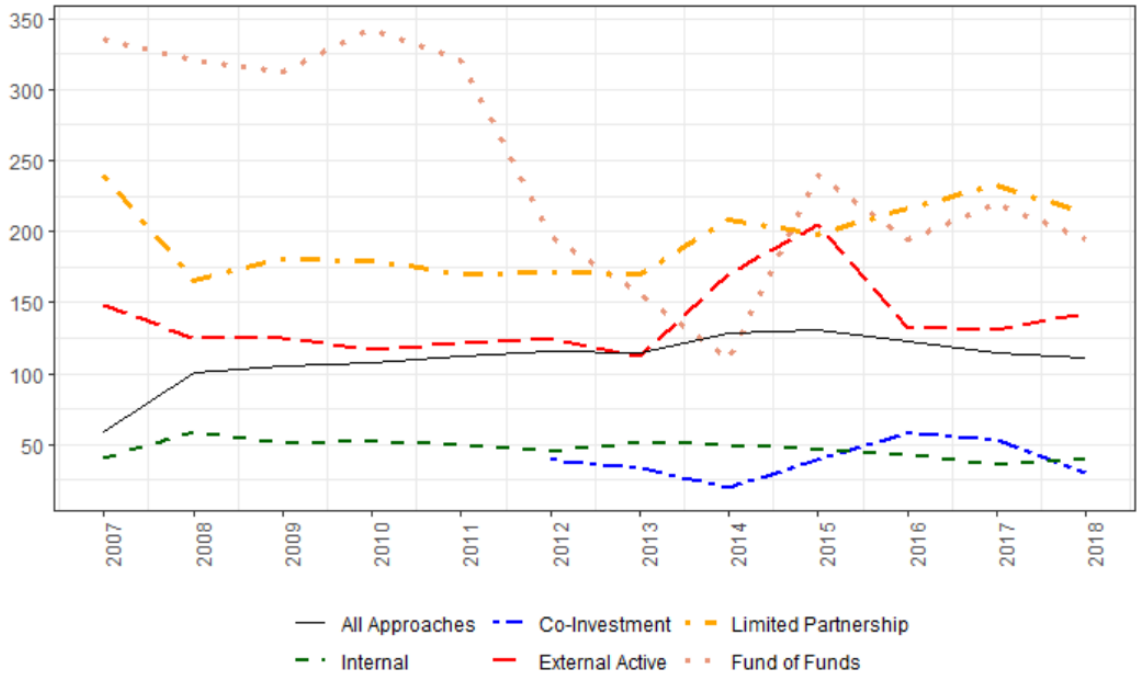

Table 2

Regression results infrastructure investments and fund characteristics

	Size	%Alter	Public	Canada	Europe	Rest of World	YD	# Obs	Pseudo R^2
Panel A: Logit regressions - pension fund allocations to infrastructure									
Infrastructure	0.1648**	0.0040					Yes	5,359	0.026
	(0.0342)	(0.0043)							
Infrastructure	0.1727**	0.0132*	0.1088	1.293**	1.004**	1.379**	Yes	5,359	0.074
	(0.0341)	(0.0045)	(0.1081)	(0.1421)	(0.1410)	(0.1673)			
Panel B: Logit regressions - pension fund allocations to investment approaches									
Internal	0.6114*	0.0085					Yes	1,821	0.111
	(0.0871)	(0.0120)							
Internal	0.6534*	0.0135	0.6078	2.792**	1.767**	2.654**	Yes	1,821	0.216
	(0.0876)	(0.0092)	(0.2687)	(0.5066)	(0.5272)	(0.5688)			
Co-investment	0.0922	-0.0118					Yes	1,821	0.067
	(0.0883)	(0.0154)							
Co-investment	0.1630	-0.0212	0.6912	0.8656	0.0599	0.0834	Yes	1,821	0.085
	(0.1158)	(0.0174)	(0.4135)	(0.6986)	(0.7020)	(0.7603)			
External	-0.0895	0.0054					Yes	1,821	0.020
	(0.0758)	(0.0103)							
External	-0.1001	0.0127	-0.8915**	-0.2299	-0.6733	0.0556	Yes	1,821	0.059
	(0.0793)	(0.0101)	(0.2382)	(0.3232)	(0.3070)	(0.3267)			
Limited partnership	-0.0828	-0.0059					Yes	1,821	0.007
	(0.0715)	(0.0098)							
Limited partnership	-0.0635	-0.0159	0.3457	-0.5398.	-0.1291	-0.9529*	Yes	1,821	0.023
	(0.0726)	(0.0112)	(0.2129)	(0.3149)	(0.2917)	(0.3605)			
Fund-of-funds	-0.4052*	-0.0041					Yes	1,821	0.047
	(0.1278)	(0.0120)							
Fund-of-funds	-0.4327**	-0.0186	-0.1571	-1.714*	0.2673	-0.8950	Yes	1,821	0.112
	(0.1314)	(0.0141)	(0.3898)	(0.5868)	(0.4841)	(0.7429)			

Note: In Panel A, the dependent variable is set up based upon the decision of a pension fund to invest in infrastructure or not. Panel B shows the results of logit regressions that explain whether a pension fund invests in infrastructure internally, through a co-investment vehicle, externally, via a limited partnership structure or through fund-of-funds. The independent variables included are *Size* – which is the log of total pension fund assets, *%Alter* – which is the percentage allocation to other alternative assets, *Public* – a dummy variable that captures whether a pension fund is public (where the base result refers to corporate funds), *Canada*, *Europe*, and *Rest of World* – regional dummy variables (where the base result refers to U.S. pension funds). At the means of the independent variables, we present the marginal effects (elasticities). For discrete changes from 0 to 1, the marginal effects for the dummy variables are estimated. Furthermore, we add year dummies (*YD*) and the standard errors are clustered by pension fund, in order to allow for intragroup correlation. Standard errors are shown in brackets and the significance levels are reported with *, and **, which match with 0.05, and 0.01, respectively.

Table 3

Panel regression results with double clustered standard errors: Infrastructure investment costs

	Mandate	Co	Ext	LP	FoF	Canada	Europe	Rest of World	YD	# Obs	R^2
Panel A: Pooled OLS regressions with double clustered standard errors – All Assets											
All Assets	-3.847 (1.83)	-16.32 (13.04)	119.2** (9.50)	162.3** (12.69)	221.9** (15.85)	-2.309 (7.72)	-5.162 (8.42)	-22.27 (9.47)	Yes	1828	0.40
Panel B: Pooled OLS regressions with double clustered standard errors – by region (year fixed effects)											
U.S.	-3.394 (4.65)	-38.56* (9.53)	133.6** (14.70)	164.12** (16.04)	234.49** (19.94)				Yes	432	0.22
Canada	-2.772 (2.58)	-29.89 (14.97)	118.6** (13.16)	155.8** (13.00)	268.3** (30.85)				Yes	623	0.53
Europe	-5.761 (4.01)	33.39 (21.49)	129.3** (15.26)	182.4** (13.22)	213.9** (26.81)				Yes	578	0.47
Rest of World	-0.6361 (2.57)	-27.18 (17.88)	97.30* (22.44)	167.5** (15.70)	283.8** (20.81)				Yes	195	0.65

Note: The investment costs in bps are the dependent variables. The investment costs for all infrastructure assets are the dependent variables in the regional regressions. For the investment approach regressions, the investment costs for all infrastructure assets managed internally, through a co-investment vehicle, externally, via a limited partnership structure or through fund-of-funds are the dependent variables. The table shows the results of pooled panel regressions with regional and year dummies (*YD*). The standard errors are independently double clustered by pension fund and by year in the pooled panel regressions. The following characteristics are included in the regressions: *Mandate* – log of total infrastructure holdings, log of holdings in one investment approach. *Co*, *Ext*, *LP*, and *FoF* are investment approach dummy variables (where the base result refers to internally managed infrastructure investments). *Canada*, *Europe*, and *Rest of World* are regional dummy variables (where the base result refers to U.S. pension funds). Standard errors are shown in brackets and the significance levels are reported with *, and **, which match with 0.05, and 0.01, respectively. The R^2 column shows the R-square.

Table 4

Infrastructure net returns

Panel A: Net returns by asset class and sub-period

Time Period		Asset Class						
		All Assets	**Stocks**	**Bonds**	**Infrastructure**	**Real Estate**	**Private Equity**	**Hedge Funds**
Full Sample	Return	7.0	8.1	5.0	10.1	7.7	12.6	4.2
	σ	13.7	17.8	7.8	8.4	11.5	10.1	8.8
2007-2012	Return	6.7	6.2	8.0	6.3	4.1	9.7	4.1
	σ	17.0	22.2	7.9	7.9	16.9	13.4	11.3
2013-2018	Return	7.2	9.5	3.0	11.5	9.8	14.4	4.2
	σ	11.1	13.7	7.1	8.3	5.6	6.7	7.2

Panel B: Infrastructure net returns by region and sub-period

Time Period		Region			
		Canada	**Europe**	**U.S.**	**Rest of World**
Full Sample	Return	10.8	9.5	9.3	10.8
	σ	7.1	9.5	10.0	7.2
2007-2012	Return	7.1	4.4	6.5	7.2
	σ	6.0	8.4	11.5	9.1
2013-2018	Return	12.5	10.8	10.1	12.7
	σ	6.9	9.3	9.5	5.3

Panel C: Infrastructure net returns by investment approach and sub-period

Time Period		Approach				
		Internal	**Co-investment**	**External**	**Limited partnership**	**FoF**
Full Sample	Return	11.1	13.3	9.3	9.1	8.9
	σ	7.4	6.0	9.5	9.3	7.8
2007-2012	Return	7.4	8.7	5.8	4.9	5.4
	σ	6.0	2.2	9.3	9.3	9.4
2013-2018	Return	12.5	13.3	10.9	10.4	9.8
	σ	7.5	6.1	9.2	8.9	7.3

Note: In Panel A, B, and C, we present the time-series averages of cross-sectional value-weighted net mean returns in percentages over the whole sample period as well as two sub-periods. Underneath the returns, the standard deviations of the returns are displayed.

Table 5

Regression results infrastructure investment performance and characteristics

	Mandate	Co	Ext	LP	FoF	Canada	Europe	Rest of World	YD	# Obs	R^2
Panel regressions with double clustered standard errors											
All Assets	0.0084* (0.0023)	0.0561* (0.0171)	-0.0064 (0.0118)	0.0009 (0.0156)	6.88e-5 (0.0154)	0.0121 (0.0174)	-0.0127 (0.0208)	-0.0006 (0.0153)	Yes	1,678	0.157
Panel B: Pooled OLS regressions with double clustered standard errors – by region											
U.S.	0.0092 (0.0050)	0.0576 (0.050)	-0.0434 (0.0322)	-0.0420 (0.0353)	-0.0072 (0.0357)				Yes	383	0.245
Canada	0.0028 (0.0028)	0.0478 (0.0220)	-0.0072 (0.0212)	0.0099 (0.0241)	-0.0168 (0.0331)				Yes	576	0.165
Europe	0.0072 (0.0042)	0.0313 (0.0171)	-0.0169 (0.0174)	-0.0123 (0.0147)	-0.0200 (0.0121)				Yes	529	0.295
Rest of World	0.0199 (0.0089)	0.0881 (0.0300)	0.0055 (0.0257)	0.0149 (0.0421)	-0.0055 (0.0378)				Yes	190	0.277
Panel C: Pooled OLS regressions with double clustered standard errors – by investment approach											
Internal	0.0040 (0.0031)					-0.0330 (0.0470)	-0.0209 (0.0431)	-0.0290 (0.0502)	Yes	235	0.147
Co-investment	-0.0014 (0.0046)					-0.0202 (0.0408)	-0.0421 (0.0469)	-0.0282 (0.0358)	Yes	75	0.103
External	0.0141 (0.0063)					0.0140 (0.0203)	-0.0099 (0.0310)	0.0013 (0.0301)	Yes	517	0.166
Limited partnership	0.0089 (0.0030)					0.0272 (0.0171)	-0.0093 (0.0194)	-0.0071 (0.0139)	Yes	703	0.219
Fund-of-funds	0.0127* (0.0036)					-0.0154 (0.0392)	-0.0446 (0.0296)	-0.0721 (0.0311)	Yes	148	0.194

Note: By subtracting the costs from pension fund infrastructure returns, the net returns are calculated. The net return on all infrastructure assets is used as a dependent variable in all assets and regional regressions. In the regressions by investment approach, the net return on the infrastructure assets invested through the channels internal, co-investment, external, limited partnership, and fund-of-funds is the dependent variable. Panel A shows the results of pooled panel regressions with regional and year dummies (*YD*). The standard errors are independently double clustered by pension fund and by year in the pooled panel regressions. The following characteristics are included in the regressions: *Mandate* – log of total infrastructure holdings, log of holdings in one investment approach. *Co*, *Ext*, *LP*, and *FoF* are investment approach dummy variables (where the base result refers to internally managed infrastructure investments). *Canada*, *Europe*, and *Rest of World* are regional dummy variables (where the base result refers to U.S. pension funds). Standard errors are shown in brackets and the significance levels are reported with *, and **, which match with 0.05, and 0.01, respectively. The R^2 column shows the R-square.

Table 6

Performance persistence in pension fund infrastructure investments: net benchmark-adjusted returns

Panel A: Infrastructure (one-year persistence) (n=951)

		Year t + 1 ranking					Returns in t + 1		Test
		Low	2	3	4	High	Low	High	Diff
Year t ranking	Low	**35.08%**	13.61%	21.99%	15.71%	13.61%	-0.63	4.42	-4.56*
	2	17.89%	**34.21%**	17.37%	16.84%	13.68%			
	3	12.63%	**27.89%**	26.32%	20.53%	12.63%			
	4	14.21%	13.16%	22.11%	23.68%	**26.84%**			
	High	20.53%	11.05%	12.11%	23.16%	**33.16%**			

Panel B: Infrastructure (two-year persistence) (n=760)

		Year t + 2 ranking					Returns in t + 2		Test
		Low	2	3	4	High	Low	High	Diff
Year t ranking	Low	**23.68%**	16.45%	17.76%	23.68%	18.42%	2.23	3.83	-1.52
	2	24.34%	**30.92%**	16.45%	11.18%	17.11%			
	3	18.42%	**27.63%**	19.08%	19.08%	15.79%			
	4	17.11%	12.50%	20.39%	23.03%	**26.97%**			
	High	16.45%	12.50%	**26.32%**	23.03%	21.71%			

Note: Based on their net benchmark-adjusted returns in infrastructure within a given investment approach, pension funds are categorized into five performance quintiles. The quintile with the highest return is represented by the High row or column. In panel A, the percentages in exhibit the likelihood that a pension fund ranked in one of the five quintiles in year t will be in any of the quintiles in year t + 1. The returns in t + 1 column provide the average net benchmark-adjusted return in year t + 1 for pension funds that are in the lowest and highest ranked quintiles in year t. The Test Diff column shows a t-statistic of the difference in net benchmark-adjusted returns between the low and high quintiles. In Panel B, I look at performance persistence over a two-year timespan in order to control for any potential short-term smoothing of the infrastructure net benchmark-adjusted returns. In panel B, the percentages in exhibit the likelihood that a pension fund ranked in one of the five quintiles in year t will be in any of the quintiles in year t + 2. The returns in t + 2 column provide the average net benchmark-adjusted return in year t + 2 for pension funds that are in the lowest and highest ranked quintiles in year t. The significance levels are reported with *, and **, which match with 0.05, and 0.01, respectively.

Appendix

Table A1: The CEM Database (2007-2018)

	# Funds	# Observations	Average Size Pension Fund (US$ Billion)	Infrastructure Average Holdings (US$ Billion)
U.S.	382	2,304	17.56	0.26
Canada	152	1,052	11.69	1.03
Europe	219	965	28.18	0.48
Rest of World	29	142	67.40	1.96
Total	782	4,463	29.38	0.77

Table A2: The CEM Database (2007-2018)

	# Funds	# Observations	Average Size Pension Fund (US$ Billion)	Infrastructure Average Holdings (US$ Billion)
North America				
U.S.	382	2,304	17.56	0.26
Canada	152	1,052	11.67	1.03
Europe				
U.K.	126	530	7.76	0.30
Netherlands	66	299	35.14	0.89
Finland	8	41	34.61	0.23
Sweden	6	46	36.33	0.36
Denmark	5	14	12.38	0.16
France	3	6	19.06	0.01
Norway	2	24	378.84	0
Switzerland	2	4	21.31	0.14
Germany	1	1	0.76	0
Rest of World				
Australia	16	55	27.37	2.31
New Zealand	3	28	8.53	0.31
Saudi Arabia	2	11	69.62	0.22
South Korea	2	15	280.95	5.90
China	1	8	207.67	2.44
Emirates	1	2	15.43	0.15
Other	4	23	50.19	0.36
Total	782	4,463	29.38	0.77