Asset allocations, returns, volatilities, Sharpe ratios, and investment costs experienced by large European institutional investors, 2005-2021

Alexander D. Beath, PhD
Reuben Blaff, MSc
CEM Benchmarking
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Executive Summary

Real estate is a significant element in the portfolios of large European institutional investors, with average allocations comprising around 8-9 percent of the typical portfolio. The benefits of the inclusion of real estate in portfolios is well known; the asset class provides diversity to the traditional equity / fixed income blends which provide the backbone of most institutional investor portfolios. Where real estate is one diversifying element, hedge funds, private equity, infrastructure, and increasingly private credit are advertised as being able to provide diversity to portfolios as well. How has real estate performed relative to other asset classes?

The CEM database

- This study includes 17-years of data (2005 – 2021) from on average 82 large, institutional investors spanning 9 European countries, with over €3 trillion in of assets under management at the end of 2021. In the Netherlands and the U.K. all are defined benefit pension funds or managers of defined benefit pension assets.
- Eight aggregated asset classes are studied: Listed and private equity, listed and private fixed income, listed and private real estate, infrastructure, and hedge funds.
- This update to a prior research report[1] includes an improved benchmarking model which enables estimates of marked-to-market returns for private

ES1. CEM Benchmarking Quick Facts

- 30+ years of data
- 1,100+ institutional investors
- 20+ countries
- €14+ trillion of assets
- 250+ asset class / implementation styles

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[1] See "Asset Allocation, Cost of Investing, and Performance of European DB Pension Funds: The Impact of Real Estate", Alexander D. Beath and Chris Flynn, CEM Benchmarking, September 2018.

equity, private real estate, and infrastructure, allowing for better performance comparisons across asset classes.

Asset allocation

- Listed equity and fixed income are the primary components of European institutional investor portfolios. The combined 2021 average allocation to listed equity and fixed income are 78 percent for Dutch investors, 75 percent for U.K. investors, and 79 percent for other Euro region investors.
- In the Netherlands, institutional investors have been on a long-term de-risking path, reducing exposure to equities (including private equity) and increasing exposure to fixed income (including private credit). The primary diversifier, real estate, has seen allocations decrease although listed real estate exposures have largely been maintained. Large investors are more likely than small investors to allocate to real estate through liquid, listed market channels.
- In the United Kingdom, investors have been moving assets from listed fixed income and hedge funds into private credit and infrastructure. The largest investors, however, have instead followed a de-risking strategy like their Dutch peers, moving out of equities into fixed income.
- In other European regions, a different trend is observed; fixed income allocations have declined as investors diversified their portfolios into risk-on assets with increased allocations to equities, real estate, hedge funds and infrastructure.
- Listed vs. private assets – investors across all regions of Europe preferentially allocate to listed equity and listed fixed income relative to their private counterparts. Ratios of listed equity to private equity are typically 14:1, and ratios of listed fixed income to private fixed income are between 16:1 to 34:1. By contrast, real estate investments are preferentially done through private markets, with ratios of listed to private real estate ranging from 1:2 (Netherlands) to 1:3 (elsewhere).

Performance comparisons and the impact of investment costs

- Performance comparisons across asset class implementation styles (i.e., listed market assets vs. private market assets) are complicated by the fact that returns from listed markets and private markets are not reported on the same basis; returns from listed markets are marked-to-market whereas returns from private markets are most often based on appraisals.
- To enable comparisons, we use a benchmarking method that captures lagged reporting, appraisal smoothing, and leverage differences in private equity, private real estate, and infrastructure. This provides, for private market portfolios of each investor, both:
    i. marked-to-market equivalent (or 'standardized') return, and
    ii. estimates of lag, smoothing, leverage, and net value added (alpha) generated in private markets relative to a risk matched, investible benchmark.
- Apples-to-apples comparisons of asset class performance are shown in ES2 for the Netherlands, in ES3 for the U.K., and in ES4 for other European countries for the longest periods available.
- Equity: Private equity returns over nearly all periods and regions was the highest performing asset class, but also the highest cost. The volatility of private equity is in most regions and for most eras higher than for listed equity, and so both produce similar risk adjusted returns.

ES2. Net Returns and Investment Costs
(Netherlands, 2005 – 2021)
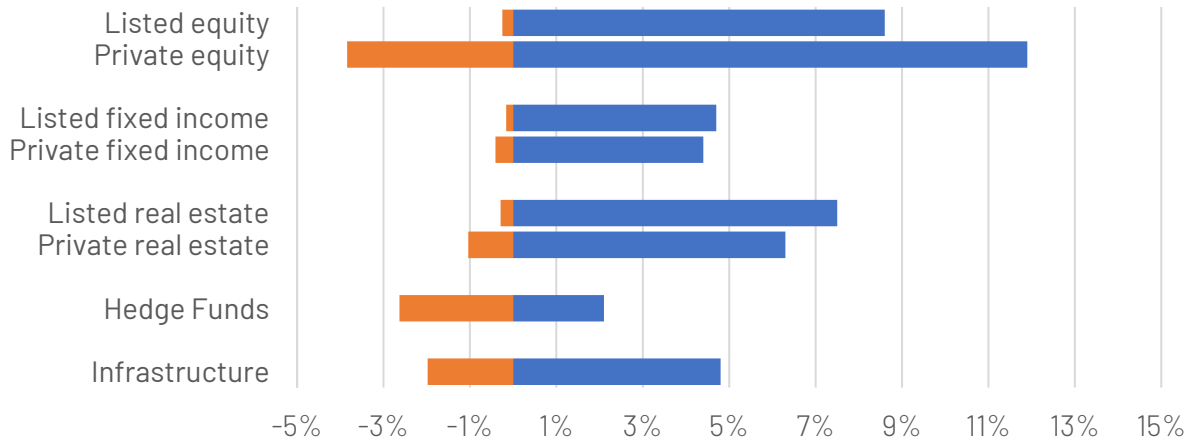
ES3. Net Returns and Investment Costs
(United Kingdom, 2008 – 2021)
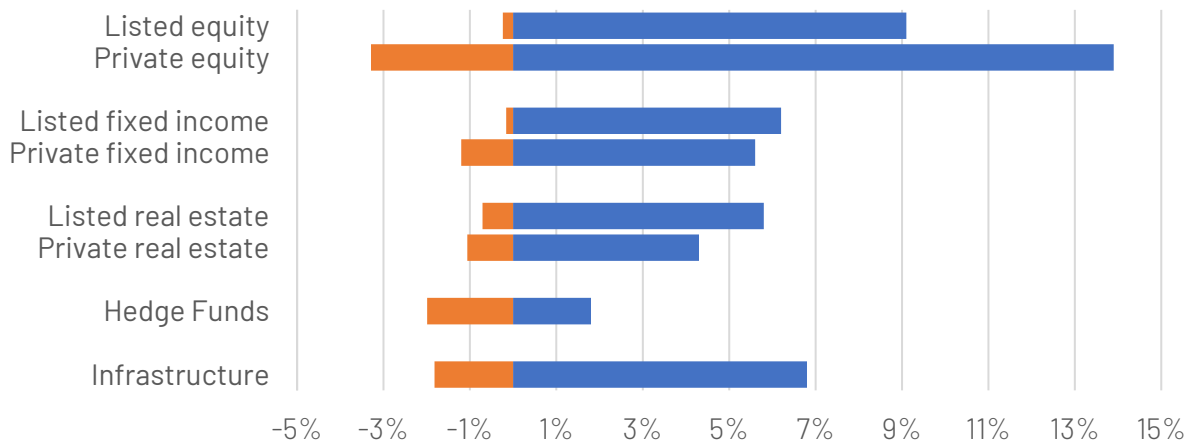
ES4. Net Returns and Investment Costs
(Other Europe, 2005 – 2021)

Cost   Net Return
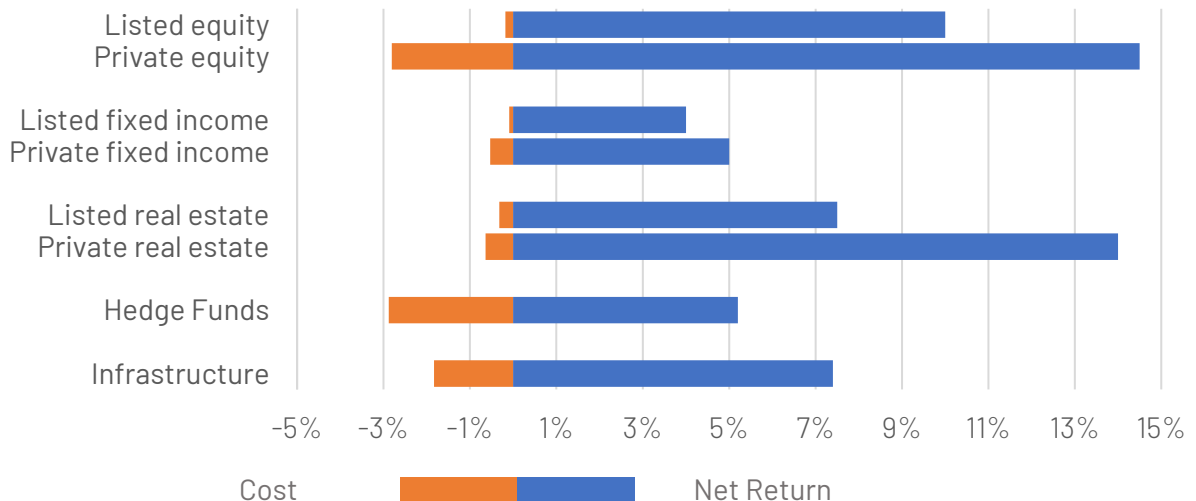
- In both the Netherlands and the U.K., listed and private fixed income perform comparably on a gross basis, but due to cost differential, listed fixed income (slightly) outperformed. The volatility of private credit is not comparable to other asset classes as CEM Benchmarking does not have a benchmarking model that allows an estimation of marked-to-market returns.
- Listed real estate outperformed unlisted real estate by approximately 1 to 1.5 percent in the Netherlands and the U.K. In Sweden private real estate significantly outperformed which saw very strong returns in the lead up to the Global Financial Crisis 2005-2006. The marked-to-market volatility of private real estate is not meaningfully different from listed real estate, and approximately double that reported by investors because of lag and appraisal smoothing.

Correlations and diversification

- Correlations between marked-to-market listed asset returns and appraised private market returns (i.e., returns 'as-reported') are predictably low due to lag and appraisal smoothing in private markets. As an example, the correlation between listed real estate and 'as-reported' private real estate in the Netherlands is only 0.27.
- Removing lag and smoothing from appraised returns provides better estimates of cross asset-class correlations. In contrast to the above, the correlation between listed real estate and 'standardized' private real estate in the Netherlands is much higher than recognized, 0.86.
- In all regions of Europe, private equity and private real estate are significantly correlated to listed equities, and thus significantly correlated to total-fund returns as well.
- In the Netherlands, where institutional investors have a long history of investing in listed real estate, correlations between listed real estate and total-fund returns is high. By contrast, outside of the Netherlands correlations between listed real estate and listed equities is low. It is likely that this is because listed real estate is used as a completion strategy with a broader real estate portfolio in order to access niche regions and sectors.

Introduction

The performance (e.g., return, volatility, etc.) of institutional investor portfolios are determined by several factors; the proportion of assets allocated to different asset classes, the returns generated within asset classes, the investment costs spent to implement the asset allocation, among others.

Research on institutional investor portfolio performance needs to address how comparable the performance across investors is. A simple issue that prevents comparability is reporting period; while most institutional investors report annual returns with a December 31st year end, as is common in the Netherlands, in the United Kingdom it is common to use a March 31st year end.

The covid crisis clearly illustrates the effect of reporting period. Institutional investor portfolios lost a quarter of their value over the span of weeks in March 2020, and so vanilla comparisons of 2019 annual returns between Dutch and U.K. Defined Benefit (DB) pension funds would have been non-sensical; without recourse to any research, Dutch funds had a better "2019".

The issue of portfolios having different year ends might seem trivial, yet often overlooked is the fact that the returns within asset classes themselves are complicated by the same issues total-fund return comparisons face. For example, the returns reported from private real estate portfolios can lag public market real estate by a year or more. Investors with outsized exposures to unlisted real estate appear to have better "down years" when public markets sell off, as in the global financial crisis of 2008. This lag produces distortions in the total-fund returns of institutional investors.

Another effect that distorts the total-fund returns reported by institutional investors is appraisal smoothing in private markets. Private equity, private real estate, and private infrastructure investments are not marked-to-market, except in the rare case where a transaction occurs, and so valuations by appraisers are relied upon to determine fair value. Appraisals introduce biases in returns for the very human reason that last quarter's / last year's appraisal exerts an influence on this quarter's / this year's appraisal. This appraisal smoothing produces distortions in reported volatility.

The lag and smoothing in private markets create two big-picture issues for institutional investors. The first is that by allocating assets to private markets, total-fund returns appear smoother than they in fact are (this is sometimes viewed as a positive). This smoothing is entirely fictitious however as the root cause are just accounting differences associated with how public and private market assets are valued.

A second issue is that institutional investors making decisions on where assets should be best allocated are often working with incomparable data. Risk-return optimizations rely on accurate estimates of expected returns, volatilities and correlations, and, without accurate inputs, determining optimal portfolios can become a futile and error prone exercise. This core problem is not only real but pervasive.

The CEM database

CEM Benchmarking is a Toronto based company specializing in benchmarking the investment costs incurred by institutional investors in the context of the performance and value they deliver. The CEM database dates to 1992, and in any given year over 300 institutional investors provide data to CEM such as asset class holdings, returns, benchmarks, costs, policy weights and more. An exceptional feature of the database is that CEM clients provide data themselves for the purpose of senior management and Board reporting rather than from annual reports or regulatory disclosures which are often unreliable.

Over the course of CEM Benchmarking's 30+ year history, 1,100+ unique institutional investors from 20+ countries have provided data at one time or another. As the primary data providers are DB pension funds or asset managers for pools of DB assets, geographic coverage tends to cluster into those countries with mature, funded DB histories such as (in Europe) the Netherlands and the United Kingdom (U.K.).

CEM has published a significant volume of research comparing the performance of institutional investors across asset classes and regions. Notable here is prior work on the performance of large European institutional investors spanning 2005 – 2016 (Beath 2018). There, returns, volatilities, Sharpe ratios, costs, correlations and more were shown 'as-reported' and 'standardized' to remove the most common bias, lag in private markets. This whitepaper is a significant update of this prior work, adding five years of data including a major economic event, the 2020 - 2021 covid-19 health crisis.

A second major improvement in this update is the removal of the bias in private market returns caused by appraisal smoothing. Smoothing of aggregate private-market returns has at least two distinct sources. First, since different investors often have different lags in their private market valuations, averaging returns across investors and years tends to smooth out the peaks and valleys that occur during market cycles. The prior version of this work focused on that effect, by removing the lag in each investors' private equity, private real estate, and private infrastructure portfolio.

The second source of smoothing is within portfolios themselves, the aforementioned 'appraisal smoothing' caused by appraisers themselves. Recent work by CEM Benchmarking established a new state-of-the-art private asset benchmarking model that accounts for not only differences in lag, but differences in appraisal smoothing, and leverage (see Beath 2022a). For the first time we show here regional comparisons of the degrees of appraisal smoothing across private markets as well as 'standardized' returns where the effects of lag and smoothing (but not leverage) are removed.

Prior research and significant updates

The improvements in how we estimate unbiased, standardized 'marked-to-market' returns for unlisted assets has not changed our understanding of the nature of listed and private equity returns. Correlations between the two equity implementation styles remain remarkably high, even with five new years of data and a new, more robust methodology. The correlation between listed and private equity remains higher in the Netherlands (0.95) than in the U.K. (0.78) or other Europe (0.67) while Sharpe ratios remains higher for private equity than listed equity, even after the

recognition that volatilities of private equity tend to be understated on an 'as-reported' basis on account of the lag and appraisal smoothing. As we found five years ago, private equity returns themselves tend to be superior to those of listed equity (see Exhibits 9 and 10 for a performance summary and correlations respectively).

In the case of listed and private real estate we find that outside of the Netherlands the two implementation styles of real estate are far more correlated than we previously understood. Where in the Netherlands we have always found a high correlation between listed and private real estate (now 0.86 down slightly from 0.88), our prior work showed that correlations were moderate in the other European regions (0.58) and non-existent or even negative in the U.K. (-0.09). We now find that listed and private real estate have a correlation of 0.78 in the U.K. and 0.67 in other European regions.

The increase in correlation is due to several competing factors. First, with more years of data, we are better able to estimate and remove the lag from the as-reported returns. Second, the inclusion of appraisal smoothing and leverage adjustments in our standardization method improve model fit. Third and perhaps most significantly, it appears that the use of listed real estate in the portfolios of institutional investors outside of the Netherlands has matured (the use of listed real estate in the Netherlands is widespread).

In terms of the performance of asset classes themselves, five years ago we found that the net returns achieved by institutional investors in private equity, listed equity, and listed real estate were comparable, and significantly higher than those for fixed income, hedge funds, private real estate over the period 2010-2016, the longest period for which returns were available for all asset classes and regions. For example, in the Netherlands where the performance data is cleanest[2], over the period 2010-2016 the annualized net returns from public equity (9.5 percent), private equity (10.2 percent), and listed real estate (10.5 percent) are all much higher than was achieved by infrastructure (7.1 percent), fixed income (6.4 percent), private real estate (2.3 percent), and hedge funds (2.2 percent).

Over the five added years included in this update (2017-2021), unremarkably, cross-asset class performance statistics have changed, but only somewhat. In the Netherlands, net returns from private equity (12.5 percent), listed equity (11.8 percent), and infrastructure (9.2 percent) have been above historical norms, while private real estate (8.6 percent) and listed real estate (8.2 percent) remained high as well. In comparison, returns from private fixed income (3.7 percent), listed fixed income (2.6 percent), and hedge funds (1.6 percent) were poor.

The impact of costs on net returns is consistent. Average investment costs in the Netherlands for listed equity, fixed income, and real estate 2017-2021 were all low at 16 basis points (1 basis point = 0.01 percent), 14 basis points, and 27 basis points respectively. In comparison, private equity at 528 basis points (on a net asset value basis), private real estate at 87 basis points, hedge funds at 252 basis points, and infrastructure at 181 basis points are all high cost. Investment costs for private

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[2] Dutch performance data is provided in the same currency and time frame by all CEM clients. U.K. performance data is provided with either December 31st or March 31st year end. Other Europe performance data is provided in multiple currencies.

fixed income at 47 basis points is surprisingly low for an illiquid asset class; in the U.K. and other Europe private fixed income costs were 136 basis points and 100 basis points respectively.

European institutional investors in the CEM database

Assets under management (Exhibit 1)

Exhibit 1 displays statistics on the total net assets under management (AUM) by year for the European sample of institutional investors in the CEM database and included in this study. In an average year, the sample includes data from 23 investors from the Netherlands, 46 from the U.K., and 12 from "other European" countries.

The Netherlands
Of the investors in the Netherlands (i.e., Dutch investors), all are DB pension funds or asset managers for pools of DB assets, with AUM in 2021 ranging from a 10th percentile of €0.5 billion to a 90th percentile of €130 billion, with an average AUM of €64 billion. Total AUM is trending upwards, with an average increase per year of over €50 billion.

The number of Dutch investors benchmarking with CEM is trending upwards as well, but peaked in 2011 at 43. Pension fund mergers in the Netherlands has reduced the number of DB plans from over 1,000 in 1997 to under 300 by 2015. Most of the largest Dutch pension funds report data to CEM Benchmarking.

The United Kingdom
Despite Brexit, we continue to include the U.K. in this research, referring to it as a "European" region even if the U.K. is no longer part of the European Union. CEM Benchmarking began collecting data from a small number of large U.K. DB plans in 2008, seeing significant uptick in participation 2012 with the inclusion of a large group of Local Government Pension Schemes (LGPS). At the end of 2021 the U.K. sample in the CEM database included 31 investors, all of which were DB pension funds or DB asset managers. A handful of the U.K investors also managing small pools of Defined Contribution (DC) assets on behalf of their members as well.

The average U.K. investor[3] in the CEM database at the end of 2021 held just under €14 billion in AUM, with a 10th percentile of €3 billion and a 90th percentile of nearly €27 billion. Thus, the investors included in the U.K. sample tends to be considerably smaller than those in the Dutch sample by a factor of approximately four. Despite the relatively smaller AUM of the average U.K. investor in the CEM database, U.K. investors allocate nearly twice the AUM to private markets (see Exhibit 4).

Other Europe
The sample of other Europe investors in the CEM database is comprised of a smaller number of large investors from an assortment of European countries which report in variety of home currencies. Countries included are (alphabetically): Denmark, Finland, France, Germany, Norway, Sweden, and Switzerland. In average year, the sample includes 12 investors, a number that remains relatively steady in terms of year-over-year participation with CEM Benchmarking.

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[3] AUM for investors in the CEM database from the U.K. and "Other Europe" not reporting in Euro (€) have been converted from local currency to Euro (€) using OECD purchasing power of parity to aid comparability.

Exhibit 1. Total net assets under management of the European sample used in this study, 2005 - 2021.

The CEM database is comprised of institutional investor portfolio data submitted voluntarily to CEM benchmarking on an annual basis. CEM clients are large institutional investors, primarily defined benefit (DB) pension funds or managers of DB pension fund assets, but also includes sovereign wealth funds, buffer funds, and managers of other large pools of institutional assets. At the end of 2021 the database contained €14 trillion in assets under management from more than 300 distinct investors in more than 20 countries. Over the past 30 years 1,100+ distinct institutional investors appear in the database.

Data collected by CEM include assets under management, investment costs, returns gross and net of investment costs, benchmark returns and benchmark descriptions. Data is collected by asset class (e.g., large cap. U.S. stock, U.K. government credits, unlisted real estate etc.) and by implementation style (e.g., internally or externally managed, actively or passively managed, investments in LP funds, co-investments alongside GPs) enabling attribution of cost to portfolio design decisions, and attribution of returns to outperformance or underperformance relative to benchmarks.

This study focuses on the European sample of pension funds in the CEM database, with statistics on assets under management (AUM) provided in Table 1 below. The sample of particiapting funds from the Netherlands is growing slowly, with an average AUM of €34 billion, adding on average about 1 fund every two years. In the United Kingdom the sample has shorter history, smaller average AUM at €10 billion, but experienced rapid growth in 2014 when a large pool of pension funds provided a three year history of data (2012-2014), about half of whom remained CEM clients in the following years. The 12 (on average) other Euro-area funds tend to be very large investors, with an average AUM of €77 billion. The countries included in the other Euro-area sample include Denmark, Finland, Sweden, Switzerland, Norway, France and Germany.
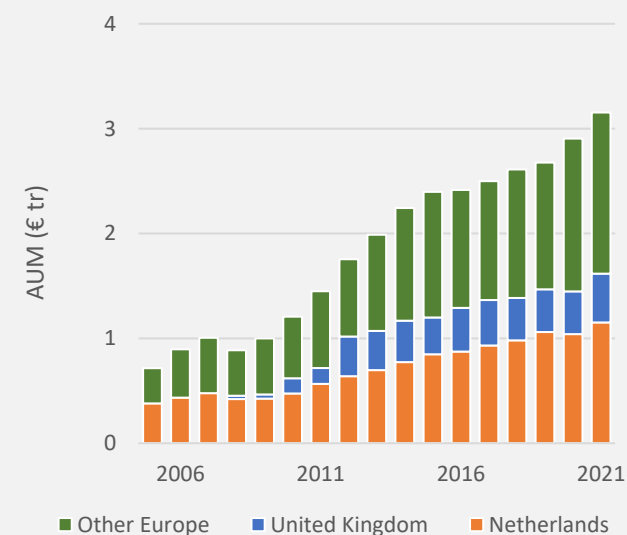
Net Asset Value (€ billions)

Year	Netherlands 10th	50th	90th	Avg.	Stdev.	Total	Count	United Kingdom† 10th	50th	90th	Avg.	Stdev.	Total	Count	Other Europe 10th	50th	90th	Avg.	Stdev.	Total	Count
2021	0.6	15.4	146.2	64.0	129.5	1152.7	18	3.0	7.9	25.0	13.3	17.0	464.5	35	3.3	35.5	87.4	128.0	314.2	1536.1	12
2020	0.5	15.7	133.1	57.8	115.1	1041.1	18	2.1	4.2	17.6	9.5	14.2	406.4	43	26.6	33.6	121.9	121.5	267.7	1457.5	12
2019	0.5	9.4	80.2	48.2	105.2	1061.0	22	1.9	4.8	18.7	9.2	13.1	406.6	44	25.7	29.7	232.4	134.2	301.5	1207.9	9
2018	0.5	12.9	70.8	44.6	95.6	980.7	22	2.1	4.5	17.0	8.8	12.0	404.9	46	23.6	27.9	181.9	122.5	264.5	1224.9	10
2017	0.4	7.3	65.3	38.9	88.5	932.8	24	1.9	4.1	18.5	8.5	12.1	432.6	51	0.6	26.3	49.4	80.9	220.3	1133.3	14
2016	0.4	6.7	62.2	36.5	82.8	875.1	24	1.8	4.1	20.7	8.5	11.6	415.9	49	18.3	26.7	102.1	102.2	224.9	1124.5	11
2015	0.4	3.9	49.4	25.7	68.9	849.2	33	1.6	3.2	17.2	7.6	10.7	350.2	46	12.0	25.5	84.7	85.5	202.1	1197.5	14
2014	0.3	4.6	49.1	26.7	66.6	773.1	29	0.6	1.8	6.6	3.8	7.5	396.0	103	17.6	26.2	87.8	82.6	173.6	1074.0	13
2013	0.3	3.2	33.9	18.4	50.7	697.5	38	0.5	1.6	6.7	3.7	7.0	373.5	102	11.7	23.3	74.3	70.6	150.8	917.2	13
2012	0.9	5.9	36.9	22.1	51.8	639.5	29	0.5	1.6	6.0	3.5	6.7	378.1	107	12.7	21.7	168.3	81.9	152.7	737.0	9
2011	0.2	1.3	21.7	13.2	39.3	566.3	43	0.8	12.5	37.3	13.7	14.7	151.2	11	3.5	16.1	54.3	40.7	92.1	732.0	18
2010	0.4	7.0	57.5	27.9	57.4	474.5	17	2.3	6.2	37.7	13.2	14.2	145.7	11	7.2	19.3	64.5	53.3	101.1	586.8	11
2009	2.6	13.4	66.9	32.8	58.7	426.3	13	6.0	19.7	33.4	19.7	24.3	39.4	2	12.1	20.6	46.1	41.0	67.8	533.2	13
2008	1.6	10.8	66.8	32.4	60.5	421.4	13	5.4	16.1	26.7	16.1	18.9	32.1	2	10.1	22.4	88.3	48.1	76.9	432.5	9
2007	3.9	11.9	60.1	29.8	53.8	477.5	16	-	-	-	-	-	-	0	15.4	23.3	50.3	44.0	62.7	528.0	12
2006	1.6	7.7	49.7	25.6	50.8	434.6	17	-	-	-	-	-	-	0	13.5	20.1	51.9	38.5	50.1	461.5	12
2005	1.4	8.4	54.1	25.3	49.0	379.7	15	-	-	-	-	-	-	0	16.9	19.8	49.9	33.5	40.3	335.4	10
Average:	1.0	8.6	64.9	33.5	72.0	716.7	23	2.2	6.6	20.7	9.9	13.1	314.1	47	13.6	24.6	93.9	77.0	162.5	895.2	12
Change/yr‡:	-0.1	0.2	3.8	1.9	4.5	50.6	0.4	-0.1	-0.7	-0.9	-0.4	-0.3	31.1	2.0	0.3	0.9	6.0	6.5	17.9	73.3	0.0

† Net asset values in the United Kingdom have been converted to Euros to allow for comparability across regions. Net asset value conversion is done using OECD purchasing power of parity.

‡ Change per year is estimated from the slope of a linear regression in order to smoothly interpolate between beginning-of- and end-of-sample data.

The average other-Europe investor[4] in the CEM database at the end of 2021 held €128 billion in AUM, with a 10th percentile of €3 billion and a 90th percentile of €87 billion, which is roughly twice as large as the average investor in the Netherlands sample, and nine times as large as the average investor in the U.K. sample.

Total-fund net returns, volatilities, and Sharpe ratios (Exhibit 2)

Exhibit 2 displays statistics on 'as-reported' total-fund net returns by year and in summary for the European sample of of institutional investors in the CEM database and included in this study. Sample periods include the most recent five years of new data included in this update (2017 – 2021), the 14-year period over which all three regions have data (2008-2021), and the full 17-year period over which only the Netherlands and the other European sample have complete data (2005-2021).

We remark that the returns reported here are 'as-reported' by the investors themselves and includes no standardization of private market data to make the returns, volatilities and Sharpe ratios more comparable. The data is provided for context; these are the returns the investors report and recognize as their own[5].

2017-2021
For the most recent five-year period, the average other Europe investor had the highest net return with a compound average net investment return (henceforth 'net return for brevity') of 9.1 percent, having outperformed both the average U.K. investor with a net return of 8.1 percent and the average Dutch investor with a net return of 6.8 percent.

Other European investors, however, reported having more volatile portfolios, with a volatility of 7.2 percent in comparison with a volatility of 6.2 percent in the U.K. and 6.7 percent in the Netherlands. U.K. investors however have far more private market assets (see Exhibit 4), a fact which we expect to reduce reported volatilities and lead to the above pattern.

The average Sharpe ratios reported for U.K. and other European funds are both 1.3, far greater than the average Sharpe ratio of 1.0 for Dutch investors, also in part due to smoothing of private market data (see Exhibit 6).

2008-2021
For the longer 14-year period, the average U.K. investor slightly outperformed the average other European investor (net return of 7.3 percent vs. 6.9), while the average other European investor slightly outperformed the average Dutch investor (net return of 6.9 percent vs. 6.5 percent). All three regions reported similar volatilities on average (9.6 percent), and thus similar Sharpe ratios. The average Sharpe ratio (0.7 – 0.8) is substantially lower than for the most recent 5-year period (1.0 – 1.3) due to the inclusion of the global financial crisis as the starting point of the period which reduces return and increases volatility.

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[4] Most investors in the "other Europe" sample report data to CEM Benchmarking in Euro (€).
[5] A sub-sample of U.K investors report data to CEM with a December year end. To aid comparability the returns from these funds have been converted to March year end to better match the majority of U.K. investors.

Exhibit 2. Total-fund net returns of the European sample used in this study, 2005 - 2021.

Total-fund returns net of all investment expenses are shown for funds comprising the three regions studied by year. Statistics shown by year include the 10th, 50th and 90th percentiles, the average, the standard deviation, and the standard error of total-fund net returns. Returns are net of all investment costs including manager base fees, performance fees, internal investment management costs, costs of overlays and derivatives, consulting costs, audit fees, building costs, explicit and implicit transaction costs. Summary statistics are shown for the compound average return, the volatility, and the Sharpe ratio for three periods, the most recent five-year period (2017-2021), the longest sub-period for which U.K. data is available (2008-2021), and the full period on display (2005-2021). Volatility

Total-Fund Net Return (%)
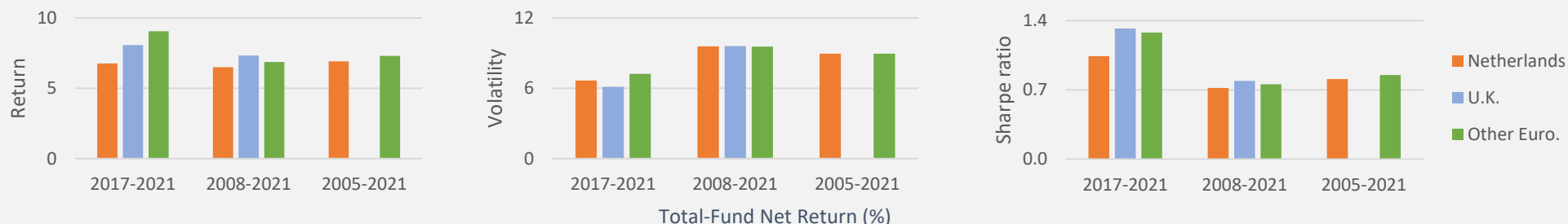
Year	Netherlands							United Kingdom							Other Europe						
	10th	50th	90th	Avg.	Stdev.	Stderr.	Count	10th	50th	90th	Avg.	Stdev.	Stderr.	Count	10th	50th	90th	Avg.	Stdev.	Stderr.	Count
2021	-1.2	4.6	8.8	4.3	4.2	1.0	18	3.1	11.1	14.9	9.9	4.4	0.7	36	14.4	16.4	20.5	16.9	2.4	0.7	12
2020	6.5	8.8	12.0	9.3	2.7	0.6	18	3.5	10.6	17.2	10.3	4.9	0.7	43	3.1	5.9	9.7	6.4	3.2	0.9	12
2019	13.9	17.3	20.9	17.2	3.5	0.7	22	8.3	11.2	15.6	11.8	3.2	0.5	44	12.3	15.1	20.3	15.7	3.4	1.1	9
2018	-2.5	-0.7	0.3	-0.9	1.3	0.3	22	-4.1	-1.8	0.6	-1.9	2.2	0.3	46	-3.7	-1.1	0.9	-1.4	2.5	0.8	10
2017	1.9	5.2	7.4	4.9	2.1	0.4	24	7.4	11.1	13.1	10.9	2.3	0.3	51	5.6	8.3	12.6	8.6	2.7	0.7	14
2016	7.4	10.3	12.2	10.1	1.9	0.4	24	16.0	19.3	23.0	19.1	2.6	0.4	49	4.8	7.4	10.0	7.6	2.2	0.7	11
2015	-1.6	1.0	3.1	0.8	1.8	0.3	33	1.5	3.2	5.0	3.2	1.6	0.2	46	1.8	4.5	6.9	4.6	2.3	0.6	14
2014	13.9	20.1	25.6	19.9	5.3	1.0	29	5.8	8.6	13.0	9.0	3.4	0.3	103	7.2	11.4	15.4	11.5	3.9	1.1	13
2013	-3.2	1.5	4.9	1.3	3.5	0.6	38	6.3	14.5	17.9	13.6	4.3	0.4	102	4.0	9.0	15.8	9.4	5.9	1.6	13
2012	11.6	13.4	15.9	13.7	1.7	0.3	29	8.0	9.8	11.9	9.9	1.9	0.2	107	10.2	12.1	13.3	11.8	1.6	0.5	9
2011	3.1	7.7	13.6	8.0	4.4	0.7	43	-1.3	2.2	10.8	3.8	5.6	1.7	11	-4.3	-2.3	1.9	-0.9	6.4	1.5	18
2010	8.4	11.2	13.0	10.8	2.1	0.5	17	10.9	12.1	14.7	13.2	4.8	1.5	11	8.9	11.7	14.6	11.4	2.6	0.8	11
2009	6.2	15.1	19.6	13.8	5.9	1.6	13	1.3	9.9	18.4	9.9	15.1	10.7	2	8.3	15.8	24.4	16.1	7.8	2.2	13
2008	-25.7	-18.7	-2.9	-16.6	11.0	3.0	13	-25.0	-15.4	-5.9	-15.4	16.9	11.9	2	-25.7	-20.8	-2.7	-16.5	13.7	4.6	9
2007	1.7	3.7	6.2	3.9	2.0	0.5	16	-	-	-	-	-	-	0	2.0	4.8	6.0	4.5	2.8	0.8	12
2006	5.4	8.4	11.1	8.7	3.1	0.7	17	-	-	-	-	-	-	0	7.1	9.6	11.2	9.0	3.0	0.9	12
2005	11.5	14.3	17.5	14.2	2.6	0.7	15	-	-	-	-	-	-	0	11.5	14.6	17.8	14.8	2.7	0.9	10
Net Returns:																					
2017-2021	3.6	6.9	9.7	6.8	n/a	n/a	n/a	3.6	8.3	12.1	8.1	n/a	n/a	n/a	6.1	8.7	12.5	9.1	n/a	n/a	n/a
2008-2021	2.3	6.5	10.7	6.5	n/a	n/a	n/a	2.5	7.3	11.9	7.3	n/a	n/a	n/a	2.8	6.2	11.4	6.9	n/a	n/a	n/a
2005-2021	2.9	6.9	10.9	6.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.5	6.8	11.4	7.3	n/a	n/a	n/a
Volatility:																					
2017-2021	6.6	6.6	7.2	6.7	n/a	n/a	n/a	5.5	6.1	6.9	6.1	n/a	n/a	n/a	7.1	7.0	7.8	7.2	n/a	n/a	n/a
2008-2021	10.4	10.0	8.6	9.6	n/a	n/a	n/a	10.6	9.7	9.0	9.6	n/a	n/a	n/a	10.5	10.3	8.7	9.6	n/a	n/a	n/a
2005-2021	9.7	9.3	8.1	9.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9.8	9.6	8.2	9.0	n/a	n/a	n/a
Sharpe ratio:																					
2017-2021	0.6	1.1	1.4	1.0	n/a	n/a	n/a	0.7	1.4	1.8	1.3	n/a	n/a	n/a	0.9	1.3	1.6	1.3	n/a	n/a	n/a
2008-2021	0.3	0.7	1.3	0.7	n/a	n/a	n/a	0.3	0.8	1.3	0.8	n/a	n/a	n/a	0.3	0.6	1.3	0.8	n/a	n/a	n/a
2005-2021	0.3	0.8	1.4	0.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.4	0.7	1.4	0.9	n/a	n/a	n/a

2005-2021

Over the full 17-year sample period, performance data is only available for the Dutch and other Europe investors. Net returns are only marginally different – slightly higher *on average* for other Europe investors in comparison to the Dutch (net return of 7.3 percent vs. 6.9 percent) but slightly lower *on median* for other Europe investors in comparison to the Dutch (6.8 percent vs. 6.9 percent). Given nearly identical volatilities, it is unsurprising that the Sharpe ratios are close, being slightly higher *on average* for other Europeans (0.9 vs. 0.8) and slightly higher *on median* for the Dutch (0.8 vs. 0.7).

Asset allocation

We present how investors allocate assets to various asset classes in two complementary ways. First, in Exhibit 3 we show total assets in each asset class divided by total AUM in the sample (i.e., asset weighting) for each of the three regions. Second, in Exhibit 4 we show the assets in each asset class divided by total-fund AUM for each investor, then averaged over all investors (i.e., fund weighting). The former method gives proportionally more weight in the average to investors with more AUM while the later method gives equal weight to all investors irrespective of AUM. Asset-weighting shows you cumulatively where assets are allocated while fund-weighting shows you where the average investor is allocating assets.

Before embarking on a discussion of the asset allocation for large European institutional investors we offer a brief discussion of asset classes used.

Aggregate asset classes

An exhaustive discussion of asset classes, implementation styles and the aggregation used here appeared in the initial version of this research. The interested reader is invited to explore the topic in detail there (see Beath 2018).

Briefly, CEM collects data at the asset class / implementation style level. Currently, 78 distinct asset classes are used including 20 'stock', 28 'fixed income', 8 'real asset', 4 'hedge fund', 4 'private equity', 2 'private credit', and 12 'derivative and overlay' asset classes. (Derivatives and overlays are excluded in what follows.) Each asset class is further sub-divided into implementation styles, which for public market assets include splits between active and passive, further divided into whether mandates are managed externally by third parties or managed internally by teams employed by investors.

All data presented here is aggregated fist by style, and then into the following eight aggregate asset classes.

1. Listed Equity (e.g., U.S. large cap. stock, U.K. small cap. stock, emerging market stock)
2. Private Equity (e.g., leveraged buy-out funds, internally managed private equity, VC funds.)
3. Listed Fixed Income (e.g., U.K. guilts, European treasuries, corporate bonds)
4. Private Fixed Income (e.g., private credit, mortgages)
5. Listed Real Estate (e.g., dedicated listed real estate stocks, U.S. REITs)
6. Private Real Estate (e.g., core real estate funds, direct real estate, real estate JVs)
7. Hedge Funds (e.g., global macro funds, funded TAA programs, hedge fund of funds)

Exhibit 3. Asset-weighted average asset class allocations in percent of total fund AUM of the CEM European universe, 2005 - 2021.

Listed equity includes investments in exchange traded stock, stock ETFs, preferred shares, and other exposures to listed equity gained through derivative markets either directly or through external manager mandates, either indexed or managed actively in an attempt to outperform an index. *Private equity* includes all investments in LP funds, either through funds or fund of funds, as well as co-investments in private equity alongside GPs. In addition, many large sophisticated funds invest in private equity internally via direct ownership stakes in private companies.

Listed fixed income includes investments in government credit, corporate debt, bundled LDI, convertibles, public mortgages and cash either directly or through external manager mandates. *Private fixed income* includes private credit, private debt, and private mortgages invested in either through funds, limited partnerships, co-investments or investments via wholly owned operating subsidiaries.

Listed real estate includes dedicated portfolios of investments in both real estate investment companies and real estate investment trusts (REITs) that have direct ownership stakes in commercial real estate openly traded on public stock exchanges. It also includes listed real estate embedded in listed equity portfolios. Listed real estate is held either directly or through external manager mandates, either indexed or managed actively in an attempt to outperform an index. *Private real estate* are investments in commercial real estate held either directly, via private joint venture, through external real estate funds or fund of funds, through operating subsidiaries, or via private equity style limited partnerships.

Hedge funds includes investments in externally managed hedge funds, hedge fund fund of funds, and internally managed global macro / funded tactical asset allocation portfolios. *Infrastructure* includes external (non-exchange traded) infrastructure managed by GPs, infrastructure fund of funds, and internally managed portfolios of (non-exchange traded) infrastructure. Asset allocation data does not add to 100% becuase niche investments such as timberland, natural resources etc. representing ~1% of portfolios are not shown.

Average Asset Allocations (%)

| | Netherlands | | | | | | | | United Kingdom | | | | | | | | Other Europe | | | | | | | |
| | Equity | | Fixed Income | | Real Estate | | Hedge | Infra- | Equity | | Fixed Income | | Real Estate | | Hedge | Infra- | Equity | | Fixed Income | | Real Estate | | Hedge | Infra- |
Year	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
2021	31.5	5.8	42.0	2.5	5.3	5.5	1.8	2.7	34.6	6.0	38.9	3.5	1.3	6.8	2.2	4.4	62.0	1.6	26.6	0.3	3.7	4.2	1.1	0.5
2020	29.7	4.8	45.5	2.0	4.9	5.6	2.3	2.5	39.5	5.7	34.0	3.6	1.5	7.2	2.6	4.2	55.5	1.8	30.8	1.5	3.0	4.6	1.4	0.6
2019	29.0	4.5	41.5	2.2	5.4	5.4	2.2	2.3	33.4	6.2	36.3	2.6	1.4	7.6	6.9	4.4	59.8	1.3	29.4	0.2	3.4	4.0	1.4	0.2
2018	29.7	4.3	41.6	1.8	5.6	5.5	2.4	2.2	35.2	6.0	33.7	2.0	2.0	7.8	8.2	3.8	52.9	1.4	34.5	1.0	3.6	4.0	1.4	0.6
2017	30.9	4.2	40.9	1.7	5.5	5.1	2.4	2.1	38.0	5.1	33.8	1.3	1.7	7.6	8.3	3.4	56.7	1.0	34.0	0.2	2.4	3.6	1.3	0.2
2016	28.9	4.2	42.8	1.3	5.7	5.0	2.7	1.8	39.8	6.0	31.2	0.9	1.7	7.5	8.6	2.9	49.2	1.3	39.4	0.9	2.2	4.1	1.5	0.4
2015	30.3	3.9	41.1	1.3	5.7	5.1	3.3	1.7	39.6	5.8	30.5	0.8	1.8	7.8	9.9	2.6	49.7	1.3	39.3	1.1	2.2	4.1	1.3	0.3
2014	30.9	4.0	41.5	1.1	5.1	4.8	3.4	1.4	46.8	5.3	23.9	0.4	2.1	7.9	10.7	1.9	48.1	1.5	41.5	0.6	2.0	3.4	1.4	0.3
2013	30.2	4.4	43.6	1.5	5.0	5.5	3.8	1.5	46.0	5.4	25.9	0.2	1.7	7.6	10.2	1.5	49.7	1.3	41.0	0.7	1.7	2.9	1.0	0.2
2012	28.7	4.6	42.8	1.7	5.0	6.1	4.0	1.4	45.8	5.7	25.9	0.3	1.9	7.4	10.0	1.3	47.4	1.1	45.1	0.7	1.8	2.0	0.4	0.2
2011	29.4	4.9	43.9	1.7	5.0	5.8	4.1	1.3	39.4	6.9	34.1	0.0	1.3	8.6	7.0	1.5	43.8	1.8	47.8	0.2	1.5	3.3	1.2	0.2
2010	30.0	4.7	42.5	1.9	5.3	5.3	5.4	1.0	48.2	7.3	24.8	0.0	1.5	9.2	6.3	1.3	48.9	1.2	44.9	0.3	1.5	1.9	0.4	0.2
2009	27.7	3.8	46.7	2.2	4.6	5.7	5.0	1.0	65.3	5.4	16.9	0.0	1.8	6.1	1.4	2.6	43.9	1.5	47.5	0.8	1.3	3.2	1.0	0.2
2008	27.7	3.8	47.1	2.4	5.0	6.1	4.8	0.9	61.1	5.7	21.0	0.0	1.4	6.2	1.4	2.8	42.5	1.0	51.0	1.8	1.0	2.0	0.3	0.2
2007	37.2	3.4	39.3	2.0	5.0	6.5	3.6	0.5	-	-	-	-	-	-	-	-	42.3	1.1	49.5	1.4	1.1	2.9	1.0	0.1
2006	38.7	3.0	38.3	1.8	7.1	5.7	2.7	0.0	-	-	-	-	-	-	-	-	41.6	0.9	50.9	1.8	1.3	2.8	0.6	0.0
2005	38.7	3.0	39.6	2.2	6.9	5.5	1.3	0.0	-	-	-	-	-	-	-	-	42.4	0.5	52.6	0.0	1.2	2.8	0.5	0.0
Average:	31.1	4.2	42.4	1.8	5.4	5.5	3.2	1.4	43.8	5.9	29.3	1.1	1.7	7.5	6.7	2.8	49.2	1.3	41.5	0.8	2.0	3.3	1.0	0.3
Change/yr†:	-0.36	0.10	0.06	-0.01	-0.04	-0.04	-0.10	0.15	-1.88	-0.02	1.28	0.28	0.00	0.00	0.05	0.22	1.17	0.04	-1.58	-0.02	0.16	0.13	0.06	0.03

† Change per year is estimated from the slope of a linear regression in order to smoothly interpolate between beginning-of- and end-of-sample data. Change per year in the U.K. excludes 2008 / 2009 due to small sample size.

Exhibit 4. Fund-weighted average asset class allocations in percent of total fund AUM of the CEM European universe, 2005 - 2021.

Fund-weighted averages shown here in Exhibit 4 display the average allocation to each asset class irrespective of asset size. For example, if the sample consists of one €100 billion investor with a 60% allocation to listed equity and one €10 billion investor with a 40% allocation to listed equity, the fund-weighted average allocation to listed equity is 50%. That is, the average allocation is not skewed towards the allocation of larger investors.

Asset-weighted averages shown in Exhibit 3 display the average allocation to each asset class dependant upon asset size. For example, if the sample consists of one €100 billion investor with a 60% allocation to listed equity and one €10 billion investor with a 40% allocation to listed equity and another, the asset-weighted average allocation to listed equity is 58% (i.e., it is skewed towards the allocation of larger investors).

Fund-weighted averages vs. asset-weighted averages: Comparisons of fund-weighted average allocations and asset-weighted average allocations provides information on size dependence of asset allocations. For example, in the Netherlands:
- Larger funds typically have higher allocations to *listed equity* than smaller funds (asset-weighted average allocation of 31% compared to a fund-weighted average allocation of 29%)
- Larger funds typically have higher allocations to *private equity* than smaller funds (asset-weighted average allocation of 4% compared to a fund-weighted average allocation of 2%)
- Larger funds typically have lower allocations to *listed fixed income* than smaller funds (asset-weighted average allocation of 42% compared to a fund-weighted average allocation of 51%)
- Larger funds typically have lower allocations to *private fixed income* than smaller funds (asset-weighted average allocation of 2% compared to a fund-weighted average allocation of 3%)
- Larger funds typically have higher allocations to *listed real estate* than smaller funds (asset-weighted average allocation of 5% compared to a fund-weighted average allocation of 3%)
- Large and small funds have similar allocations to private *real estate* (asset-weighted average allocation of 5.5% compared to a fund-weighted average allocation of 5.4%)

Average Asset Class Allocations (%)

	Netherlands								United Kingdom								Other Europe							
	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-
Year	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
2021	29.0	2.8	49.3	6.4	2.9	4.9	0.5	1.5	43.6	4.4	29.8	3.0	1.7	7.3	3.5	4.6	50.7	4.3	28.7	0.8	2.6	7.3	2.8	2.2
2020	27.1	2.0	51.4	5.6	2.9	4.6	0.5	1.3	50.7	4.2	23.7	2.6	2.0	7.7	4.2	3.7	41.0	4.5	34.2	2.6	1.9	8.3	3.8	1.4
2019	26.3	2.3	51.5	6.5	3.1	4.6	0.5	1.1	45.7	4.4	26.7	2.4	1.9	7.9	5.9	3.6	43.7	4.3	33.8	0.7	2.2	7.2	4.8	1.2
2018	27.4	2.1	50.2	6.0	3.4	4.9	0.9	1.2	46.6	4.2	26.0	1.6	2.8	7.5	6.5	2.7	39.5	3.8	39.1	1.5	2.5	6.9	4.2	1.4
2017	28.2	2.3	52.5	4.4	3.0	4.4	0.8	1.0	49.8	3.6	24.9	0.9	2.5	7.3	7.1	2.1	43.6	2.3	40.6	0.8	2.5	4.7	3.1	0.7
2016	25.4	2.2	56.4	2.9	2.7	3.9	1.1	1.1	50.8	4.1	24.4	0.7	2.4	7.4	7.5	2.0	37.8	3.3	40.1	2.6	1.9	6.5	4.3	1.0
2015	27.5	1.9	54.7	2.3	2.6	4.5	1.5	1.0	49.7	4.2	22.7	0.6	2.3	7.3	7.9	1.7	37.7	3.3	43.4	2.6	1.8	5.9	3.4	0.7
2014	25.8	1.7	56.7	1.8	2.1	4.5	1.6	0.7	53.8	3.1	21.5	0.3	2.6	6.6	10.1	0.9	38.9	3.3	42.5	1.3	1.7	6.1	3.6	0.6
2013	26.9	1.9	53.1	1.8	2.1	5.3	1.6	0.6	53.9	3.1	21.9	0.2	2.3	6.1	10.2	0.7	39.2	3.0	43.6	1.1	1.4	5.3	2.2	0.3
2012	27.6	2.5	49.1	2.0	2.3	6.7	1.9	0.6	53.4	3.2	22.9	0.2	2.5	6.0	9.4	0.7	39.9	3.0	46.5	0.7	1.7	4.8	1.0	0.3
2011	25.2	1.8	59.3	1.5	2.0	5.0	2.0	0.5	39.4	4.9	38.5	0.0	1.5	6.0	7.2	1.2	35.1	3.7	49.1	0.1	1.3	7.5	2.3	0.2
2010	29.5	2.8	48.7	1.3	3.8	5.8	3.2	0.3	47.5	5.2	31.4	0.0	1.5	8.6	4.4	0.6	40.1	2.8	48.1	0.5	1.3	4.5	0.8	0.2
2009	28.1	2.3	52.4	1.4	2.5	6.9	3.7	0.5	34.2	3.0	47.6	0.0	0.9	3.9	4.7	1.4	35.2	2.7	51.3	1.0	1.1	5.4	1.9	0.2
2008	30.8	2.2	47.1	4.0	2.5	6.4	3.9	0.3	33.4	3.1	51.6	0.0	0.8	4.0	5.3	1.5	43.1	1.7	46.9	1.7	1.0	3.6	0.7	0.2
2007	42.3	1.8	39.6	2.2	3.3	7.1	2.5	0.1	-	-	-	-	-	-	-	-	45.3	1.5	44.1	1.3	1.2	4.2	1.4	0.1
2006	41.9	1.6	41.1	1.0	4.3	6.4	1.6	0.0	-	-	-	-	-	-	-	-	45.3	1.3	45.7	1.3	1.5	4.0	0.9	0.0
2005	39.8	1.6	44.3	1.2	4.3	6.4	1.2	0.0	-	-	-	-	-	-	-	-	44.8	0.7	47.6	0.0	1.3	3.8	0.5	0.0
Average:	29.3	2.1	50.8	3.2	2.8	5.4	1.7	0.7	46.6	3.9	29.5	0.9	2.0	6.7	6.7	2.0	41.0	3.0	42.4	1.3	1.7	5.8	2.6	0.7
Change/yr†:	-0.67	0.03	0.50	0.33	-0.02	-0.17	-0.19	0.09	-0.15	0.00	-0.32	0.28	0.02	0.08	-0.31	0.36	0.15	0.17	-1.10	0.04	0.09	0.23	0.23	0.12

† Change per year is estimated from the slope of a linear regression in order to smoothly interpolate between beginning-of- and end-of-sample data. Change per year in the U.K. excludes 2008 / 2009 due to small sample size.

8. Infrastructure (e.g., private infrastructure funds, direct infrastructure investments, excludes publicly traded infrastructure stocks)

The eight asset classes include 98 percent of the assets reported to CEM and are chosen for the most part to contrast allocations and performance within analogous listed and private (i.e., unlisted) markets. In the initial versions of this work the asset class 'hedge funds' was not reported separately, aggregated instead into the catch-all asset class "other". In this follow-up version of this work 'hedge funds' is included as a stand-alone asset class, leaving aside niche asset classes such as timberlands and natural resources which contribute approximately 1 percent to average AUM.

Asset allocation by asset class (Exhibit 3 and 4)

Listed equity

Allocation to listed equity declined in both the Netherlands and the U.K. over the course of the study but increased in other Europe. The decline in allocation to listed equity was most pronounced in the Netherlands, where on a fund-weighted basis allocations dropped by -0.67 percent per year; in 2005 the average Dutch fund allocated 40 percent of their AUM to listed equity whereas by 2021 they allocated only 30 percent.

By contrast, in other Europe allocations to listed equity accelerated by 0.15 percent per year on a fund-weighted basis, and by 1.17 percent per year on an asset-weighted basis. Larger funds in other Europe allocated more assets to listed equity and increased their allocation at a faster pace than smaller funds.

In the U.K. the opposite occurred. Allocations to listed equity declined but did so much quicker on an asset-weighted basis (-1.88 percent per year) than on a fund-weighted basis (-0.15 percent per year). Larger funds in the United Kingdom allocated less to listed equity and divested from the asset class at a faster pace than smaller funds.

Private equity

Allocations to private equity increased in the Netherlands and other Europe but declined slightly in the U.K. Generally, private equity allocations by institutional investors have increased over the past two decades with few exceptions (de-risking U.S. corporate plans for example), and so the decrease in the United Kingdom is apparently at odds with the broader trend.

Private equity allocations in the U.K. are higher than the other two regions, at 6 percent on an asset-weighted basis and 4 percent on a fund weighted basis. In the Netherlands private equity allocations are 4 percent on an asset-weighted basis and 2 percent on a fund-weighted basis. The pattern of asset-weighted private equity allocations being larger than fund-weighted shows that larger investors in the Netherlands and the U.K. tend to allocate more to private equity. By contrast, in other Europe private equity allocations were 1 percent on an asset-weighted basis and 3 percent on a fund-weighted basis showing that bigger funds in other Europe allocate less to private equity than smaller funds and not more.

Listed fixed income

Listed fixed income allocations have increased in the Netherlands, increased on an asset-weighted basis but declined on a fund-weighted basis in the United Kingdom, and decreased (dramatically so) in other Europe. Where Dutch investors have embraced fixed income and allocated more to the

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asset class, other European investors have done the opposite. The high allocation to fixed income by Dutch investors on a fund-weighted basis together with the low returns provided by the asset class (see Exhibit 10) are the primary reasons Dutch investors underperformed their U.K. and other Europe peers.

In the U.K., on an asset-weighted basis, allocations to listed fixed income have risen from just over 20 percent of total AUM in 2008 to just under 40 percent in 2021, a near doubling. On a fund-weighted basis fixed income allocations have decreased from over 50 percent to under 30. Large investors in the U.K increased their allocation to fixed income while smaller investors are did the opposite.

Private fixed income

Private fixed income (i.e., private credit and mortgages) is a new, emerging asset class for most institutional investors. Large Dutch investors have been investing in the asset class for over 15 years, whereas investment in private fixed income only took hold in the U.K. in 2012. Allocations to private fixed income in other Europe are small, and because of sample changes and idiosyncratic allocations, it is hard to establish any broad trend there.

Listed real estate

Allocations to listed real estate are higher on an asset-weighted basis in the Netherlands than elsewhere, averaging over 5 percent compared to 2 percent or less in the United Kingdom and other Europe. On a fund-weighted basis the same trend holds, although the average allocation in the Netherlands is halved. Large Dutch investors are among the largest allocators to listed real estate globally.

Investors in the U.K. and other Europe are however increasing their allocations to listed real estate, whereas in the Netherlands investors are essentially at a steady state. The acceleration is much faster in other Europe where allocations have either tripled (asset-weighted basis) or doubled (fund-weighted basis) between 2005-2021. Large investors in other Europe are ramping up their exposure to the asset class and within 10 years will have similar allocations as the Dutch if historical trends hold.

Private real estate

Allocations to private real estate have decreased in the Netherlands (being replaced in part with more liquid listed real estate) and increased in other Europe. In the United Kingdom the situation is less clear, with an increase being seen on a fund-weighted basis. Generally, investors in the U.K. invest more in private real estate than other regions, although on an asset-weighted basis allocations have declined since peaking in 2010 at 9.2 percent of AUM. The high allocation in the U.K. in 2010 is in part due to a denominator effect in private real estate - following the Global Financial Crisis, a lag in valuations of private assets following a decline in listed counterparts causes investors to be over-weight illiquid assets relative to their target allocation.

Hedge funds

Allocations to hedge funds in the Netherlands and the U.K. share broad features. On both an asset-weighted basis and fund-weighted basis, allocations increased sharply in the years following the Global Financial Crisis, peaking in 2010 in the Netherlands at 4-5 percent before declining precipitously to 1-2 percent, depending on the method of averaging. In the U.K., allocations

increased as well but peaked around 2013 at over 10 percent of AUM. By 2021, allocations to hedge funds in the United Kingdom had dropped to 2-4 percent (depending on averaging method). The pattern is indicative of a brief embrace of hedge fund investments followed by a rapid divesture.

Investors in other Europe did not embrace hedge funds to the same degree, with average allocations of 1 percent on an asset-weighted basis and just under 3 percent on a fund-weighted basis. While these allocations are small, they are trending up over the entire sample period although the trend appears to have turned.

Infrastructure

(Private) infrastructure allocations are easy to describe. The asset class is relatively new to DB pension funds, emerging globally around 2005 and seeing increased allocations ever since. Allocations to infrastructure are increasing across the sample but remain small in comparison to other asset classes. For the most part, infrastructure investments are higher for larger investors because of the large ticket sizes required to invest in the asset class directly.

Asset allocation by region (Exhibit 3 and 4)

The Netherlands

Following the global financial crisis, asset allocations of DB pension funds in the Netherlands changed dramatically. Pre-2008, the average DB pension fund in the Netherlands allocated approximately 40 percent of their assets to listed equities and 40 percent to listed fixed income. The remaining 20 percent of assets were allocated to a combination of private markets, hedge funds, and listed real estate.

Following the global financial crisis, Dutch DB pension funds de-risked, cutting listed equity allocations from 40 to 30 percent while increasing allocations to listed and private fixed income, and also, initially, hedge funds. De-risking is the cause of the underperformance of Dutch investors on a net-return basis (see Exhibit 2) in comparison to investors in the U.K. and other Europe.

The United Kingdom

U.K. DB pension funds have historically allocated more assets to listed equity and less assets to listed fixed income than DB pension funds in the Netherlands. This behaviour explains the superior returns experienced by U.K. funds. Where a higher allocation to risky assets and lower allocation to risk mitigating / liability matching assets explains the difference in returns, it does not explain the lack of difference in risk – the average U.K. fund reported being just as volatile as the average Dutch fund (see Exhibit 2).

To explain this apparent contradiction, the allocation differences and nature of private markets needs to be properly understood. U.K. funds have traditionally allocated far more assets to private markets than their Dutch peers. In term of fund-weighting (Exhibit 4), U.K. funds allocated twice the assets to private equity, private real estate, and infrastructure than the Dutch (about 12.5 percent compared to 5.6 percent). As we will show, volatilities and correlation of private market assets – especially private real estate - tend to be understated on an 'as-reported' basis which serves to artificially suppress the volatility of portfolios, explaining the similar risk levels of Dutch and U.K. funds despite the riskier asset mix of U.K. funds.

Other Europe

Investors in other Europe distinguish themselves by having portfolios with a greater allocation to public market assets, with over 90 percent of assets allocated to listed equity, listed fixed income, and listed real estate on an asset-weighted basis compared to under 80 percent for Dutch and U.K. investors. On a fund-weighted basis, other Europe investors are still titled more towards listed assets relative to their U.K. and other European peers, but the contrast is less stark.

On a fund-weighted basis, other Europe investors sit between Dutch investors (lowest listed equity, highest listed fixed income) and U.K. investors (highest listed equity, lowest listed fixed income) in terms of allocation to core listed asset classes. Given the historic outperformance of listed equity to fixed income over the longest comparable period available (2008 – 2021) it is unsurprising that the returns of other Europe investors sit above those of Dutch investors and below those of U.K. investors over the same period as well (see Exhibit 2).

Listed vs. private market allocations (Exhibit 3 and 4)

In equity and fixed income markets, a larger proportion of assets are allocated to listed, liquid markets than to private, illiquid markets. By contrast, a smaller proportion of real estate assets are allocated to listed, liquid markets than to private, illiquid markets. On a fund-weighted basis, the ratio of listed to private market allocations in the Netherlands is 14:1, 16:1 and 1:2 for equity, fixed income, and real estate respectively. In the United Kingdom the ratios are 12:1, 34:1 and 1:3 while in other Europe the ratios are 14:1, 33:1 and 1:3. The low ratio of listed to private real estate is similar to what is observed in the United States where the ratio is even more extreme at 1:6.

Asset class performance comparisons

'As-reported' net returns, volatilities, and Sharpe ratios (Exhibit 5)

The average return net of all investment costs by year are shown in Exhibit 5 for eight asset classes and for the three regions, the Netherlands, the U.K., and other Europe. One notable detail in the data that complicates comparisons across regions is the fact that the returns for funds in the U.K. are for the most part March year end[6]. The effect of differing year ends is clear looking across 2019 returns. While calendar 2019 was a great year for public equity markets, if March 31 is used as the year end, as in the U.K., public equities showed a negative return on account of the market crash caused by the covid-19 pandemic in March 2020.

Also shown in Exhibit 5 are summary returns, volatilities, and Sharpe ratios for three periods, the most recent five-year period (2017-2021), the longest period for which data is available for all three regions (2008-2021), and the entire sample period (2005-2021). 'As-reported' standard deviations of average returns are shown in Appendix A1.

Over all periods and regions, the highest 'as-reported' net return was provided by private equity. The most volatile asset class over most periods and regions is typically private equity as well, and so the

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[6] For the handful of U.K. investors reporting data with a December year end, returns provided in Exhibit 5 have been adjusted to a March year end as described in Section XX.

Exhibit 5. 'As-reported' average asset class returns net of all investment expenses in percent, 2005 - 2021.

As-reported' average asset class returns net of all investment expenses by year are shown for funds comprising the three regions studied. Returns for all asset classes are true-time weighted estimates of portfolio returns. However, historical returns in the U.K. for private equity and some categories of private real estate are occassionally (and incorrectly) provided as internal rates of return which are known to over-estimate true-time-weighted returns and volatilities. Investment expense netted from returns include: base manager fees, performance fees, all transaction costs, internal front-office costs for internally managed assets, and oversight costs for externally managed assets.

Summary statistics are shown for the compound average net return, the volatility, and the Sharpe ratio for each of the by-year statistic categories (excluding standard deviation) for two periods, the full period on display (2005-2021) and the longest sub-period for which U.K. data is available. Volatility measures include contributions from in-year standard deviation (see text), while Sharpe ratios are measured using 1-month Euribor rates.

'As-reported' Asset Class Average Returns† (%)

	Netherlands								United Kingdom‡								Other Europe							
	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-
Year	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
2021	23.4	42.8	-3.0	4.8	29.7	14.6	16.4	16.8	8.3	30.9	0.0	6.9	12.3	17.3	6.5	11.6	26.6	64.2	0.3	12.4	21.4	16.8	14.9	13.0
2020	7.2	5.9	5.9	2.2	-9.7	2.3	-2.2	-0.4	39.7	17.9	8.1	9.3	8.8	0.8	12.1	3.5	8.5	12.2	2.9	2.9	-9.5	4.1	1.3	4.6
2019	26.3	10.1	9.5	6.7	24.9	8.1	0.9	9.2	-9.0	9.9	2.1	-2.5	-10.4	0.9	-6.4	6.6	26.5	16.9	6.9	1.8	28.9	12.5	7.3	12.1
2018	-7.7	8.4	1.0	1.8	-4.7	11.5	1.9	11.0	8.5	15.6	2.9	6.4	13.0	5.0	2.8	9.8	-6.3	18.3	1.2	12.8	-5.7	13.4	2.9	13.1
2017	13.5	7.3	0.0	3.1	6.4	9.2	-7.7	7.2	3.7	6.2	0.9	3.3	5.8	9.9	0.1	2.6	14.9	11.3	0.9	0.0	8.2	12.7	1.3	44.6
2016	10.6	9.6	8.1	5.0	3.1	8.7	-3.5	9.2	28.6	23.0	12.2	12.3	3.8	6.8	7.5	20.6	10.2	10.9	5.0	6.1	10.7	13.2	5.2	6.3
2015	5.4	14.5	0.0	4.9	7.7	9.9	1.0	17.4	-2.4	13.1	1.3	3.0	8.7	9.2	-0.1	12.1	7.1	14.1	1.2	-1.0	5.1	16.5	2.8	17.2
2014	12.9	15.9	17.1	5.5	25.3	6.8	6.1	14.0	14.9	12.8	12.8	5.6	18.0	11.5	9.0	12.3	15.2	18.5	9.0	13.8	28.8	9.6	9.8	9.5
2013	18.4	8.2	-2.6	4.1	3.1	1.6	1.0	1.7	7.2	11.1	-0.8	5.2	13.4	12.4	-0.8	-1.5	20.9	13.0	0.1	4.8	1.9	10.5	6.9	6.6
2012	15.8	6.6	11.4	6.3	25.6	0.8	1.2	5.1	18.5	11.7	10.2	-1.0	-7.4	-4.4	9.6	12.8	16.5	7.5	7.6	0.5	13.3	7.4	3.6	5.6
2011	-7.1	12.9	8.2	4.6	-0.9	4.0	-2.7	3.5	-0.1	-6.8	17.2	3.0	8.7	9.0	0.6	-2.7	-14.5	12.6	4.9	5.4	-6.1	5.2	-0.4	4.8
2010	16.7	19.4	8.3	5.1	18.1	7.9	9.7	4.3	7.3	31.3	4.1	5.1	26.9	11.4	-0.2	2.4	21.6	18.5	4.5	6.5	3.4	11.1	7.4	6.4
2009	35.3	-3.5	11.6	3.3	34.4	-12.4	12.6	-1.1	55.2	63.6	10.8	3.0	23.1	-8.0	9.8	14.8	35.4	-6.4	8.5	7.0	-8.0	-6.3	23.7	-2.5
2008	-41.3	-16.2	0.4	8.0	-42.1	-9.1	-14.2	-24.3	-24.4	-20.7	-3.5	4.1	-27.6	-25.0	-22.4	-20.8	-37.6	-12.7	7.6	7.3	-7.7	-2.1	-18.0	-12.2
2007	2.9	20.0	0.5	1.7	-18.2	10.6	2.0	-7.4	-	-	-	-	-	-	-	-	6.1	27.5	2.7	1.4	12.5	12.3	10.3	5.6
2006	13.8	21.8	-0.3	3.3	34.9	15.2	2.8	-18.7	-	-	-	-	-	-	-	-	17.3	32.6	0.3	1.7	12.2	21.0	5.3	8.8
2005	27.9	30.5	6.8	5.4	27.5	12.3	14.7	-2.5	-	-	-	-	-	-	-	-	30.1	26.3	5.0	2.8	31.1	23.8	9.3	6.5
Net Returns:																								
2017-2021	11.8	14.1	2.6	3.7	8.2	9.1	1.6	8.6	9.2	15.8	2.8	4.6	5.5	6.6	2.8	6.8	13.3	23.2	2.4	5.8	7.6	11.8	5.4	16.7
2008-2021	7.4	9.5	5.3	4.7	6.6	4.3	1.2	4.7	9.5	14.2	5.4	4.5	6.0	3.5	1.6	5.5	8.5	13.1	4.3	5.6	5.3	8.7	4.5	8.6
2005-2021	8.6	11.9	4.7	4.4	7.5	5.7	2.1	2.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10.0	15.7	4.0	5.0	7.5	10.5	5.2	8.3
Volatility:																								
2017-2021	12.6	18.0	4.9	2.8	17.1	5.1	9.6	7.8	16.6	15.1	5.4	7.8	14.6	7.2	8.2	8.4	12.9	22.1	3.6	10.2	17.4	7.6	9.0	26.6
2008-2021	18.2	16.9	6.8	3.3	20.3	9.2	11.0	12.6	19.6	21.0	9.5	7.4	16.1	11.7	9.7	13.8	19.1	17.9	4.2	10.2	16.0	9.5	10.9	17.6
2005-2021	17.3	19.8	6.5	3.2	21.3	9.5	10.9	13.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18.2	18.3	4.0	10.1	16.3	11.0	10.2	16.7
Sharpe ratio:																								
2017-2021	1.00	0.83	0.55	1.34	0.55	1.78	0.20	1.13	0.62	1.07	0.52	0.60	0.40	0.94	0.37	0.81	1.09	1.11	0.68	0.58	0.50	1.58	0.61	0.66
2008-2021	0.51	0.60	0.79	1.41	0.43	0.50	0.13	0.42	0.57	0.75	0.59	0.61	0.43	0.35	0.21	0.43	0.54	0.79	1.02	0.56	0.38	0.93	0.45	0.52
2005-2021	0.59	0.64	0.75	1.37	0.45	0.63	0.21	0.19	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.64	0.92	1.01	0.50	0.51	0.97	0.54	0.53

† Net investment returns for 8 of the 384 asset class/region/years are unavailable. To extend the analysis, a default calculated from the most recent years benchmark description are used instead. Asset classes/regions/years for which defaults have been applied are: Dutch infrastructure (2005), U.K. private fixed income (2008,2009,2011), U.K. listed real estate (2008,2009), other Europe private fixed income (2005, 2012), and other Europe infrastructure (2005).

‡ Asset-class returns for a most U.K. investors are provided with a March year end. Where year-end is reported in December for U.K. investors, they have been converted into March year-end to preserve comparability.

# Exhibit 6. 'Market-based 'standardized' return estimates for illiquid assets'

Returns of illiquid assets (i.e., private equity, private real estate, infrastructure) reported by institutional investors are nearly always based on appraisals. ***Appraisal-based returns*** cannot be (but often are) directly compared to ***market-based returns*** reported for liquid assets since appraisals both lag public markets and are smoother than public markets. The effect of lag reduces the observed correlation between listed and private market assets, while smoothing reduces the observed volatility of private market assets.

Market-based 'standardized returns' of 'as-reported' illiquid asset returns can be estimated by benchmarking each investors reported returns to a highly correlated, smoothed, lagged, and leverage adjusted public market proxy. ***Standardized returns are estimated by removing the smoothing (i.e., de-smoothing) and the lag (de-lagging)*** from the benchmark proxy, maintaining the annual outperformance / underperformance (i.e., net value added) relative to the benchmark. The process for private equity and private real estate in the Netherlands is illustrate below.

Private Equity: 'As-reported' appraised returns (left) and 'standardized' market returns (right)
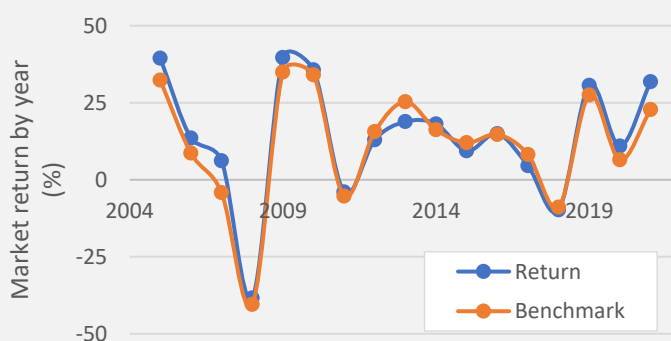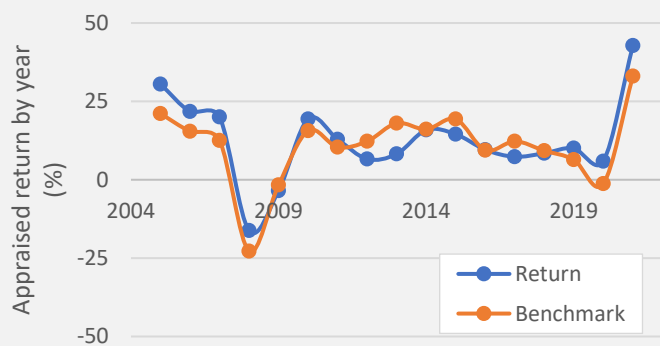
Private Real Estate: 'As-reported' appraised returns (left) and 'standardized' market returns (right)
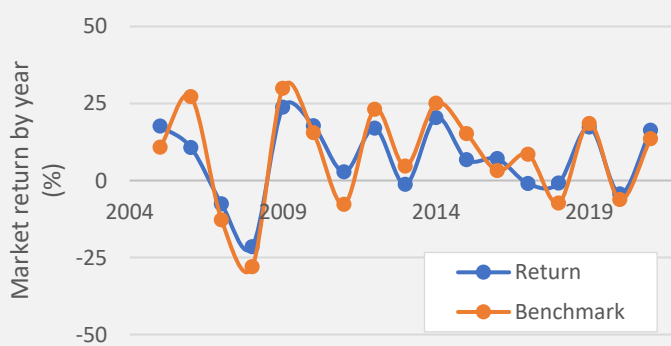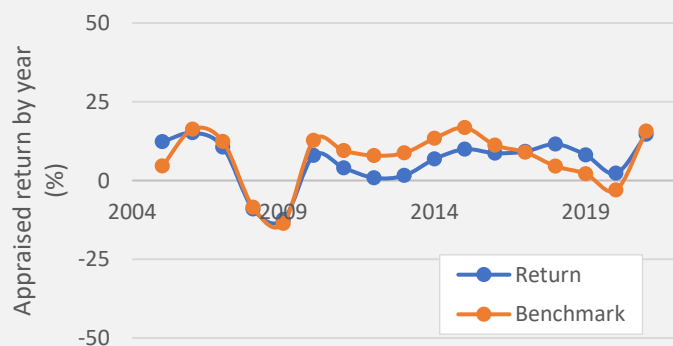
Methods: (for a complete academic description of the methodology please refer to Beath et al. 2022)

Appraised returns in illiquid markets are often **smoothed** to various degrees, most notably in private equity, private real estate, and infrastructure. Smoothing refers to the fact that appraised returns in one period is correlated with the returns in prior periods. Smoothing of market based returns can be simulated by:

$$Return\ (smoothed,\ year) = a \times Return\ (year) + (1-a) \times Return\ (smoothed,\ year - 1)$$

Smoothed appraisal based returns can be **de-smoothed** by recursion. That is:

$$Return\ (desmoothed,\ year) = (1/a) \times Return\ (smoothed,\ year) - (1/a) \times (1-a)\ Return\ (smoothed,\ year - 1)$$

Appraised returns nearly always **lag** public markets. That is, the appraised return reported on day X in year Y is in fact the return appraised on day X - L in year Y, with a lag of L days. In real estate markets, the lag can often be a year or more. An appraised **de-lagged** return can by first finding a smoothed, lagged benchmark R_{BM}(smoothed, lagged) and re-expressing the return without lag and smoothed. That is:

$$Return\ (lagged,\ smoothed) = Return\ _{BM}\ (lagged,\ smoothed) + Alpha$$

$$Return\ (de\text{-}smoothed,\ de\text{-}lagged) = Return\ _{BM}\ (de\text{-}smoothed,\ de\text{-}lagged) + Alpha$$

Leverage in illiquid markets is often substantially different than in the listed markets used to compute the smoothed, lagged benchmark return. Benchmark returns are **levered** and/or **de-levered** according to:

$$Return\ _{BM}\ (smoothed,\ lagged) = (1-b) \times Return\ _{equity}\ + b \times Return\ _{debt}$$

where $Return\ _{equity}$ and $Return\ _{debt}$ are liquid market equity and debt proxies for the illiquid asset class. The weigh of debt used b is calculated by enforcing the condition that the market beta between the asset class being benchmarked and the benchmark itself is one exactly.

Sharpe ratio of the asset class measuring the return per unit of risk is comparable to other asset classes. However, as discussed already, one should be extremely cautious in comparing the data across public and private asset classes or across regions. For example, the 'as-reported' volatility of private real estate is approximately half that of listed real estate which, as we will show, is due to smoothing of private market returns. On a like-to-like basis however where the effects of lag and appraisal smoothing are removed, listed and private real estate show very similar risk-return characteristics[7].

'Standardizing' performance to enable cross asset class comparisons (Exhibit 6)

Several adjustments to the return data need to be made to enable comparisons across asset classes, regions, and periods. The first adjustment is to restate returns from the group of U.K. investors that report returns with a March 31st year end to have a December 31st year end, like Dutch and other European investors. The second adjustment is to remove the lag from the unlisted asset classes private equity, private real estate, and infrastructure. The third adjustment is to remove the appraisal smoothing from the same three asset classes. We note that CEM Benchmarking does not have a model that standardizes returns for private fixed income, and so standardized returns are set to as-reported returns. A discussion of the calculation is provided in Exhibit 6, and the mathematics of lag / smoothing removal is reserved for Appendix B.

'Standardized' net returns (Exhibit 7, 8 and 9)

Histograms displaying the inferred lag, smoothing, relative leverage, and correlation (excluding investors with 3 or fewer years of data) are shown in Exhibit 7. Investors with 2 or fewer years of data are excluded as our method does not allow us to infer an optimal benchmark.

Standardized returns by year and in summary are provided in Exhibit 8. Data for listed market assets in the United Kingdom have been adjusted to reflect a December year end in order to enable comparison with Dutch and other European investors.

Summary statistics displaying average gross returns, average investment costs, average net returns (repeated from summaries in Exhibit 8), net value added, benchmark returns, volatilities, Sharpe ratios are shown in Exhibit 9. Median lag in trading days, smoothing parameter, leverage, and correlation are shown in Exhibit 9 as well. A graphic displaying gross vs. net return and the impact of costs is provided in the Executive Summary.

Private equity
The median inferred private equity lag in the Netherlands (88 trading days, or about 4 months) and in other Europe (99 trading days, or about 4.5 months) are in good agreement with our findings in other parts of the world, and are consistent with the idea that private equity valuations for any particular December year end are struck by GPs in August/September during the third quarter. In

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[7] There is one exception to this finding; in Sweden private real estate investments have readily outperformed their listed counterparts.

Exhibit 7. Distributions of lag, smoothing, leverage, and correlation.

Histograms of **lag** (in trading days), **smoothing** (in percent), **relative leverage** (bond fraction), and **correlation** inferred from optimal public-market based benchmarks as described in Exhibit 6 - 'Standardized Returns' for each of the three illiquid-market asset classes private equity, private real estate and infrastructure. Median lag, smoothing, relative leverage and correlation are provided in Exhibit 9 - 'Summary Statistics'. Correlations have been excluded for investors with only 3 years of data as the correlations tend to be artificially high.

Lag - the inferred difference in timing between as-reported returns and listed-market benchmark returns.
Smoothing - the inferred amount of appraisal smoothing affecting 'as-reported' returns. A smoothing parameter of 0.8 means that the optimal listed-market benchmark is comprised of 80% of this years' lagged, (de-) levered return and 20% of last years' lagged, (de-levered) and smoothed return.
Leverage - the fraction of bonds used in the benchmark to (de-) lever the listed-market equity proxy returns. Negative 0.5 leverage implies the returns are levered 150% equity / -50% bonds.
Correlation - the maximum correlation between 'as-reported' portfolio returns and lagged, smoothed, (de-) levered, listed-market benchmark returns found for investor portfolios with 4+ years of data.
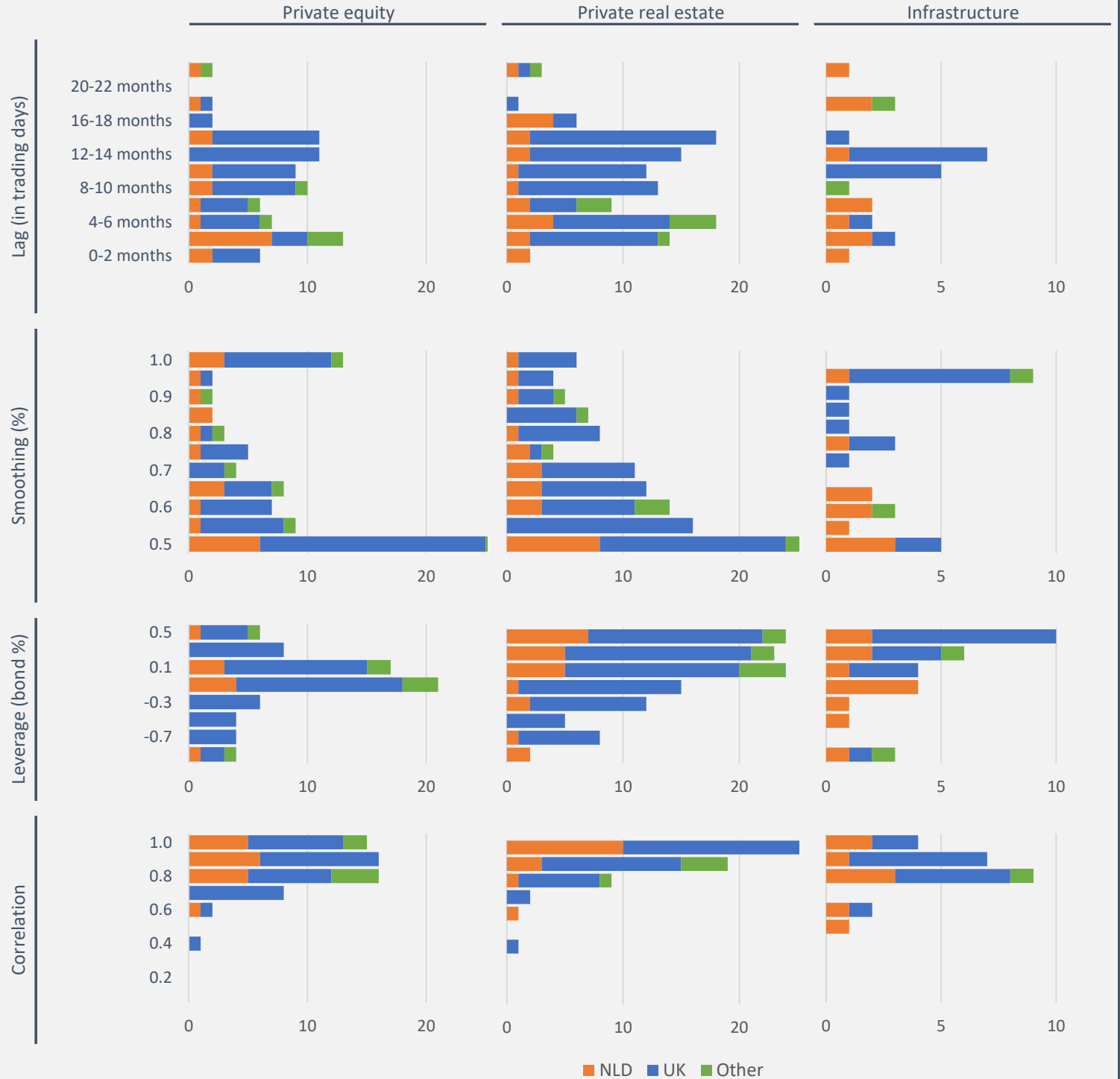
Exhibit 8. 'Standardized' average asset class returns net of all investment expenses in percent, 2005 - 2021.

Standardized' asset class returns net of all investment expenses by year for private equity, private real estate and infrastructure have been estimated from 'as-reported' returns (see Exhibit 6) to remove the effects of lag and smoothing. Upon standardization, the primary effects are: (i) a decrease in compound average geometric return because compounded returns are short volatility, (ii) an increase in volatility on account of synchronization of market cycles, (iii) a decrease in Sharpe ratios due to the above (compare private equity, private real estate and infrastructure 'as-reported' data in Exhibit 5 to 'standardized' data reported here in Exhibit 8).

Summary statistics are shown for the compound average net return, the volatility, and the Sharpe ratio for each of the by-year statistic categories (excluding standard deviation) for two periods, the full period on display (2005-2021) and the longest sub-period for which U.K. data is available. Volatility measures include contributions from in-year standard deviation (see text), while Sharpe ratios are measured using 1-month Euribor rates.

'Standardized' Asset Class Average Returns† (%)

	Netherlands								United Kingdom								Other Europe							
	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-
Year	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
2021	23.4	31.8	-3.0	4.8	29.7	26.7	16.4	22.5	14.5	27.3	0.0	11.6	18.9	14.5	8.0	12.0	26.6	42.9	0.3	12.4	21.4	29.0	14.9	11.3
2020	7.2	10.9	5.9	2.2	-9.7	-13.3	-2.2	-8.7	12.1	17.2	15.3	-7.8	-27.7	-6.0	2.1	-2.4	8.5	17.4	2.9	2.9	-9.5	-1.4	1.3	-19.9
2019	26.3	30.6	9.5	6.7	24.9	29.0	0.9	29.3	20.5	19.0	2.3	17.2	36.9	18.7	8.5	18.1	26.5	37.4	6.9	1.8	28.9	32.0	7.3	17.9
2018	-7.7	-9.8	1.0	1.8	-4.7	1.0	1.9	-4.3	-5.5	-7.4	-0.5	1.8	-1.2	-8.0	-7.0	-5.2	-6.3	-5.2	1.2	12.8	-5.7	8.1	2.9	12.0
2017	13.5	4.6	0.0	3.1	6.4	5.7	-7.7	12.2	15.1	10.0	2.9	6.8	11.5	12.6	6.9	3.7	14.9	8.2	0.9	0.0	8.2	13.6	1.3	-15.6
2016	10.6	14.9	8.1	5.0	3.1	14.0	-3.5	17.1	24.6	37.6	16.8	10.0	-3.6	0.6	9.3	26.0	10.2	18.8	5.0	6.1	10.7	17.5	5.2	16.8
2015	5.4	9.4	0.0	4.9	7.7	-2.4	1.0	-4.7	2.2	7.4	-1.3	5.5	24.6	8.5	0.4	2.2	7.1	6.4	1.2	-1.0	5.1	13.3	2.8	14.4
2014	12.9	18.1	17.1	5.5	25.3	25.6	6.1	25.0	7.1	6.8	12.1	5.3	13.6	15.3	5.2	18.3	15.2	20.1	9.0	13.8	28.8	30.3	9.8	36.2
2013	18.4	18.9	-2.6	4.1	3.1	2.2	1.0	2.9	21.0	26.0	0.4	5.4	7.8	11.7	6.7	4.4	20.9	20.7	0.1	4.8	1.9	5.4	6.9	8.0
2012	15.8	13.0	11.4	6.3	25.6	3.1	1.2	2.2	13.2	10.6	6.5	10.1	4.1	22.0	3.2	7.7	16.5	11.9	7.6	0.5	13.3	17.9	3.6	8.0
2011	-7.1	-4.0	8.2	4.6	-0.9	-1.0	-2.7	-4.1	-5.9	-2.6	18.1	3.0	4.4	-8.6	-0.3	1.6	-14.5	-3.8	4.9	5.4	-6.1	-3.6	-0.4	-5.8
2010	16.7	35.7	8.3	5.1	18.1	7.9	9.7	5.3	15.4	29.3	7.3	5.0	19.6	16.3	6.4	8.2	21.6	28.8	4.5	6.5	3.4	15.8	7.4	7.7
2009	35.3	39.7	11.6	3.3	34.4	21.3	12.6	22.8	29.7	19.4	5.5	3.0	23.1	25.0	-3.1	3.6	35.4	39.6	8.5	7.0	-8.0	23.5	23.7	19.4
2008	-41.3	-38.4	0.4	8.0	-42.1	-45.0	-14.2	-57.8	-23.2	3.5	4.0	4.1	-27.6	-40.4	-17.1	1.1	-37.6	-31.8	7.6	7.3	-7.7	-21.0	-18.0	-40.4
2007	2.9	6.2	0.5	1.7	-18.2	7.3	2.0	11.8	-	-	-	-	-	-	-	-	6.1	6.7	2.7	1.4	12.5	-10.5	10.3	17.1
2006	13.8	13.5	-0.3	3.3	34.9	25.3	2.8	25.9	-	-	-	-	-	-	-	-	17.3	18.2	0.3	1.7	12.2	49.5	5.3	31.1
2005	27.9	39.4	6.8	5.4	27.5	32.1	14.7	32.6	-	-	-	-	-	-	-	-	30.1	38.9	5.0	2.8	31.1	42.5	9.3	44.6
Net Returns:																								
2017-2021	11.8	12.5	2.6	3.7	8.2	8.6	1.6	9.2	11.0	12.6	3.8	5.6	5.3	5.8	3.6	4.9	13.3	18.8	2.4	5.8	7.6	15.6	5.4	-0.1
2008-2021	7.4	10.5	5.3	4.7	6.6	3.4	1.2	1.3	9.1	13.9	6.2	5.6	5.8	4.3	1.8	6.8	8.5	13.3	4.3	5.6	5.3	11.9	4.5	3.0
2005-2021	8.6	11.9	4.7	4.4	7.5	6.3	2.1	4.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10.0	14.5	4.0	5.0	7.5	14.0	5.2	7.4
Volatility:																								
2017-2021	12.6	18.6	4.9	2.8	17.1	17.8	9.6	16.8	9.8	13.6	7.5	10.8	24.6	12.6	8.8	10.6	12.9	19.1	3.6	10.2	17.4	13.8	9.0	27.7
2008-2021	18.2	21.4	6.8	3.3	20.3	20.1	11.0	22.5	14.1	14.1	9.2	8.4	19.8	18.2	8.7	10.9	19.1	20.5	4.2	10.2	16.0	15.9	10.9	23.2
2005-2021	17.3	20.9	6.5	3.2	21.3	20.3	10.9	22.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18.2	20.2	4.0	10.1	16.3	19.0	10.2	24.4
Sharpe ratio:																								
2017-2021	1.00	0.73	0.55	1.34	0.55	0.55	0.20	0.61	1.16	0.97	0.53	0.55	0.31	0.50	0.42	0.49	1.09	1.06	0.68	0.58	0.50	1.18	0.61	0.04
2008-2021	0.51	0.60	0.79	1.41	0.43	0.27	0.13	0.19	0.71	1.04	0.69	0.68	0.38	0.32	0.24	0.65	0.54	0.74	1.02	0.56	0.38	0.81	0.45	0.22
2005-2021	0.59	0.66	0.75	1.37	0.45	0.40	0.21	0.34	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.64	0.80	1.01	0.50	0.51	0.81	0.54	0.39

† Net investment returns for 8 of the 384 asset class/region/years are unavailable. To extend the analysis, a default calculated from the most recent years benchmark description are used instead. Asset classes/regions/years for which defaults have been applied are: Dutch infrastructure (2005), U.K. private fixed income (2008,2009,2011), U.K. listed real estate (2008,2009), other Europe private fixed income (2005, 2012), and other Europe infrastructure

Exhibit 9. Asset class summary statistics.

Gross return summary statistics for each period are estimated by adding average investment costs and 'standardized' net return summary statistics from the same period. *Investment costs* include for external mandates manager base fees, performance fees and/or carried interest, underlying fees paid by fund-of-fund managers to GPs, oversight costs and other internal expenses directly attributable to the asset class. Investment costs for internal mandates include all internal expenses directly attributable to the asset class such as salaries and benefits of internal teams and third party expenses. Cost expressed in basis points of in-year average assets (for private markets assets are measured in terms of net asset value rather than amount fees based on such as committed capital or unreturned invested capital) as that is the basis for which returns are grossed up. Costs exclude explicit and implicit transaction costs such as trading costs or bid-ask spreads. *Benchmark returns* for liquid asset classes are 'as-reported' while for private equity, private real estate and infrastructure they are estimated fund-by-fund as described in Exhibit 6. *Net value added* is the difference between net return and benchmark return. Median *lag, smoothing, leverage and correlation* as described in text.

Summary statistics by period (in percent except where noted)

	Netherlands								United Kingdom								Other Europe							
	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-
Statistic	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
Gross Returns:																								
2017-2021	12.0	17.8	2.7	4.2	8.5	9.5	4.1	11.0	11.2	16.6	4.0	6.9	6.0	6.7	5.2	6.9	13.5	21.9	2.5	6.8	7.8	16.2	7.6	1.5
2008-2021	7.6	14.5	5.4	5.1	6.9	4.4	3.8	3.2	9.4	17.2	6.3	6.8	6.5	5.3	3.8	8.6	8.7	16.1	4.4	6.2	5.6	12.6	7.1	4.8
2005-2021	8.9	15.7	4.9	4.8	7.8	7.3	4.7	6.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10.2	17.3	4.1	5.5	7.8	14.6	8.0	9.3
Investment cost (in basis points):																								
2017-2021	16	528	14	48	27	87	252	181	24	403	17	136	73	89	161	200	16	315	10	100	13	60	217	159
2008-2021	24	404	16	45	30	102	259	188	24	329	16	120	71	106	199	182	18	285	10	61	26	66	262	172
2005-2021	25	384	16	41	29	104	263	198	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18	281	9	53	32	64	288	183
Net Returns:																								
2017-2021	11.8	12.5	2.6	3.7	8.2	8.6	1.6	9.2	11.0	12.6	3.8	5.6	5.3	5.8	3.6	4.9	13.3	18.8	2.4	5.8	7.6	15.6	5.4	-0.1
2008-2021	7.4	10.5	5.3	4.7	6.6	3.4	1.2	1.3	9.1	13.9	6.2	5.6	5.8	4.3	1.8	6.8	8.5	13.3	4.3	5.6	5.3	11.9	4.5	3.0
2005-2021	8.6	11.9	4.7	4.4	7.5	6.3	2.1	4.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10.0	14.5	4.0	5.0	7.5	14.0	5.2	7.4
Net Value Added:																								
2017-2021	0.1	2.4	0.2	1.3	0.5	2.6	0.1	2.1	0.3	1.5	0	1.6	0.1	-1.3	0.6	-0.2	0.2	9.4	0.5	2.5	-2.5	7.5	0.8	-4.9
2008-2021	0.3	0.9	0.0	0.8	0.2	-1.7	-0.9	-2.1	0.8	1.4	0.3	2.3	-1.0	-1.9	-1.4	0.1	0.7	4.1	0.5	0.4	-1.2	4.0	-1.1	-1.4
2005-2021	0.4	2.0	0.0	0.9	0.8	-2.2	-0.7	-1.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.7	4.8	0.4	0.4	-0.5	5.1	-0.9	-1.1
Benchmark Return:																								
2017-2021	11.7	10.1	2.4	2.4	7.7	6.1	1.4	7.1	10.7	11.1	3.7	4.0	5.2	7.1	3.0	5.0	13.1	9.4	1.9	3.3	10.1	8.1	4.6	4.8
2008-2021	7.1	9.6	5.2	3.8	6.3	5.0	2.1	3.4	8.4	12.5	5.9	3.3	6.9	6.1	3.3	6.6	7.8	9.2	3.8	5.2	6.5	8.0	5.6	4.4
2005-2021	8.2	9.9	4.7	3.6	6.8	8.4	2.8	6.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9.4	9.8	3.6	4.6	8.0	8.9	6.0	8.6
Volatility:																								
2017-2021	12.6	18.6	4.9	2.8	17.1	17.8	9.6	16.8	9.8	13.6	7.5	10.8	24.6	12.6	8.8	10.6	12.9	19.1	3.6	10.2	17.4	13.8	9.0	27.7
2008-2021	18.2	21.4	6.8	3.3	20.3	20.1	11.0	22.5	14.1	14.1	9.2	8.4	19.8	18.2	8.7	10.9	19.1	20.5	4.2	10.2	16.0	15.9	10.9	23.2
2005-2021	17.3	20.9	6.5	3.2	21.3	20.3	10.9	22.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18.2	20.2	4.0	10.1	16.3	19.0	10.2	24.4
Sharpe ratio:																								
2017-2021	1.00	0.73	0.55	1.34	0.55	0.55	0.20	0.61	1.16	0.97	0.53	0.55	0.31	0.50	0.42	0.49	1.09	1.06	0.68	0.58	0.50	1.18	0.61	0.04
2008-2021	0.51	0.60	0.79	1.41	0.43	0.27	0.13	0.19	0.71	1.04	0.69	0.68	0.38	0.32	0.24	0.65	0.54	0.74	1.02	0.56	0.38	0.81	0.45	0.22
2005-39	0.59	0.66	0.75	1.37	0.45	0.40	0.21	0.34	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.64	0.80	1.01	0.50	0.51	0.81	0.54	0.39
Private market benchmarking statistics (medians, investors with 4+ years of data):																								
Lag (days):	n/a	82	n/a	n/a	n/a	151	n/a	133	n/a	183	n/a	n/a	n/a	209	n/a	243	n/a	99	n/a	n/a	n/a	128	n/a	206
Smoothing:	n/a	0.65	n/a	n/a	n/a	0.68	n/a	0.60	n/a	0.55	n/a	n/a	n/a	0.60	n/a	0.98	n/a	0.75	n/a	n/a	n/a	0.55	n/a	1.00
Leverage:	n/a	-0.04	n/a	n/a	n/a	0.37	n/a	-0.12	n/a	-0.04	n/a	n/a	n/a	0.32	n/a	0.41	n/a	0.03	n/a	n/a	n/a	0.20	n/a	0.31
Correlation:	n/a	0.88	n/a	n/a	n/a	0.95	n/a	0.80	n/a	0.81	n/a	n/a	n/a	0.91	n/a	0.88	n/a	0.83	n/a	n/a	n/a	0.92	n/a	0.81

the U.K. the median lag[8] (183 trading days, or about 8.5 months) is substantially longer, as found in the initial version of this research. Part of the reason for the longer lag is a higher usage of private equity fund of funds by smaller investors.

The median inferred private equity smoothing ratios of 0.65, 0.55, and 0.75 for the Dutch, U.K. and other Europe respectively suggests private equity returns are substantially smoothed (a smoothing ratio of one implies no smoothing, a ratio of 0.5 implies appraised returns are equal parts this years lagged actual return and last years lagged appraised return).

The median leverage ratios of -0.04, -0.04, and 0.03 for the Dutch, U.K. and other Europe respectively suggest private equity has comparable leverage to the public market benchmark proxy, S&P global small cap. As the components equities of small cap equity indices tend to have substantial financial leverage in comparison to the components of large cap equity indices, our results imply that private equity is substantially levered relative to large cap equities.

The median correlations between private equity and the benchmark model of 0.88, 0.81, and 0.83 for the Dutch, U.K. and other Europe respectively are higher than what we observe in the United States (see Beath 2022b). The improvement in correlation is because the benchmark model used here is more sophisticated than that used in the United States which only takes into account differences in lag.

After standardization, private equity returns remain uniformly high, being the highest observed in all three regions over nearly all time spans. However, private equity volatilities are high as well, 20% larger than listed equity in the Netherlands, equal in the U.K., and 10% larger in other Europe. Ultimately, in terms of return per unit of risk as measured by the Sharpe ratio, private equity performed better than listed equity, but only marginally so.

Private equity investment costs continue to be very high relative to other asset classes. In terms of net asset value, investment costs for a private equity portfolio range from a little under 300 basis points to over 500 basis points, depending on the region and the period in question.

Private real estate

The changes seen in the returns of unlisted real estate returns post-standardization are often dramatic. The reason is that the typical lag – median lag of 151, 209, and 128 trading days for the Netherlands, U.K., and other Europe respectively – tend to be long, meaning that the reported returns base little overlap with the reporting period.

Inferred smoothing ratios for private real estate, like private equity, are indicative of an asset class where the reported returns suffer from substantial appraisal smoothing. Median smoothing ratios are 0.68, 0.60, and 0.55 for the Netherlands, U.K. and other Europe respectively. Indeed, the 'as-reported' volatility of the typical real estate portfolio almost doubles once lag and smoothing are removed from the return series in each region, increasing from 9.5 to 20.3 percent in the Netherlands, from 11.7 to 18.2 percent in the U.K., and 11.0 to 19.0 percent in other Europe.

The median inferred leverage ratios for unlisted real estate of 0.37, 0.32, and 0.20 (Netherlands, U.K. and other Europe respectively) suggest that the amount of leverage in private real estate portfolios is substantially less than that of the benchmark equity series, which most often is the

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[8] Lag for U.K. funds is expressed relative to a December 31st year end.

FTSE EPRA / Nareit Developed Europe series. Despite having less leverage, unlisted real estate tends to have more volatility than listed real estate, not less.

Given the differences in leverage, it is instructive to compare the performance of listed and unlisted real estate on a leverage adjusted basis. The best way to do so is to compare net value added, the incremental return above a benchmark that in our case is leverage adjusted to match the volatility of the asset class. Listed real estate produces a higher net value added than private real estate over long periods of time in both the Netherlands and in the United Kingdom. Indeed, the average net value added in the Netherlands for listed real estate was 0.8 percent vs. -2.2 percent (2005-2021), compared to -1.0 percent vs. -1.9 percent in the United Kingdom (2008-2021).

Similar to our findings elsewhere (Beath 2022a), very large investors such as those found in the sample of other European investors have produced high net value added within unlisted real estate portfolios, easily outperforming its listed counterpart. We remark that the outperformance is, however, entirely due to the sub-sample of investors in Sweden who outperformed their optimal benchmarks by between 2 and 10 percent. The systematic outperformance of investors from a particular country raises the very real question of whether the effect is due to a currency effect that we have not properly taken into account, or perhaps a difference in geographic exposure between listed and unlisted real estate. Indeed, when we look at correlations in the next sub-section, there is strong evidence that unlisted real estate in the U.K. and in other Europe is concentrated domestically whereas listed real estate is more foreign.

Sharpe ratios for private real estate in the Netherlands and the United Kingdom are lower than for listed real estate over nearly all periods. By contrast, in other Europe Sharpe ratios for private real estate are higher than for listed real estate, driven primarily by superior returns. The higher Sharpe ratios (and net value added) achieved in listed real estate by Dutch investors in comparison to U.K. or other European investors is suggestive that investors with more mature listed real estate investment programs outperform.

Infrastructure

Inferred lag for infrastructure portfolios range from a median of 133 trading days (6 months) in the Netherlands, 243 trading days in the U.K. (1 year), to 206 trading days in other Europe (about 9 months). The range suggests that standardized returns should be substantially different from 'as-reported' returns.

In terms of smoothing it is interesting to note one surprising difference across regions; while infrastructure returns appear smoothed with high leverage in the Netherlands (median smoothing of 0.60; median relative leverage of -0.12 percent), they appear to have almost no smoothing and low leverage in the U.K. (median smoothing of 0.98; median leverage of 0.41) and other Europe (median smoothing of 1.0; median leverage of 0.31). In other words, infrastructure portfolios of Dutch investors are being benchmarked here with a tougher-to-beat levered public infrastructure proxy, with a median equity : bond ratio of 112 : -12 in comparison to the infrastructure portfolios of U.K. or other Europe investors

While the difference in benchmarks might be expected to have a negative consequence for the net value added of Dutch investors, we find that both Dutch and other European infrastructure portfolios produced similar, slightly negative net value added at -1.6 percent and -1.1 percent respectively (2005-2021). U.K. infrastructure portfolios produced essentially zero net value added.

Correlations across asset classes (Exhibit 10)

Correlations 'as-reported' and on a standardized basis are shown in Exhibit 10. Any differences observed between the two sets of data for each of the Netherlands and other Europe is due to standardization of private equity, private real estate, and infrastructure returns. In the case of the U.K., differences appear both because of standardization of illiquid asset returns, but also because of restatement of liquid market returns and private fixed income to reflect a December to December fiscal year end. In addition to the cross-asset class correlation data, Exhibit 10 also shows asset class correlations to the average defined benefit liability return[9] and the average total-fund return.

Netherlands
'As-reported' asset class returns are not highly correlated for any pair of asset classes in the Netherlands except for listed equity returns and listed real estate returns where the correlation is 0.86. The high correlation between listed equity and listed real estate is unique to the Netherlands and shows that geographic exposure in both asset classes is broadly similar. Together with the much higher allocation to listed real estate we suggest that the high correlation observed in the Netherlands is because listed real estate is invested in as part of the broad investment strategy, whereas outside of the Netherlands listed real estate has mostly been used to access niche markets as a completion strategy for the larger private real estate portfolio.

'Standardized' asset class returns show that correlation between listed and unlisted asset classes are far higher than commonly recognized. Pre-standardization, the correlation between listed and private equity is only 0.49. Post-standardization it rises to 0.95. Higher correlations between listed and private real estate emerge as well, with correlations jumping from 0.27 to 0.86. Infrastructure investments appear highly correlated to both listed and private real estate as well.

The pattern of correlations in the Netherlands suggests that, generally, three correlated asset classes: (i) equity investments, (ii) real estate and infrastructure investments, and (ii) fixed income. (While private fixed income is not correlated to any particular asset class, we emphasize that CEM does not have a model to standardize the returns from the asset class leaving open the question of how correlated private fixed income returns actually are.)

United Kingdom
Correlations across asset classes pre- and post-standardization in the U.K. are low in comparison to the Netherlands. That said, correlations between listed and private equity are somewhat high at 0.75 and do not change much on standardization. Listed and private real estate correlations increase slightly, from 0.67 to 0.78 on standardization, but not to the degree seen in the Netherlands. As previously remarked, it is likely that listed real estate is used in the U.K. to gain access to niche markets (geographic or sector) and is not part of a broad, domestic-market real estate allocation. This conclusion is bolstered by the observations that private real estate is substantially more correlated to listed equity (0.82) than listed real estate is to listed equity (0.51).

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[9] The liability proxy returns are calculated from a blend of real and nominal duration bonds, with the mix defined by inflation protection offered by each defined benefit pension plan in the sample, and with the duration chosen from actuarial tables based on the ratio of pensioners to active contributing members.

Exhibit 10. Correlations of 'as-reported' (left) and 'standardized' (right) returns.

Correlations between annual 'as-reported' (left-hand panes) and 'standardized' (right-hand panes) asset class net returns for the three regions in this study, Netherlands, the United Kingdom and other Europe. For visual aid, correlations above 0.85 have been grouped within dark black borders.

Pre-standardization , all 'as-reported' asset class net returns have correlations less than 0.85 with the exception of listed equity and listed real estate in the Netherlands, and listed equity and hedge funds in 'other Europe'.

Post-standardization , correlations increase for private equity, unlisted real estate and infrastructure as the effect of removing lag serve to synchronize the returns between listed and private assets. Note the change in listed market correlation in the U.K. is due to restatement of March 31st returns ('as-reported') to December 31st ('standardized').

Also shown are (i) correlations to the marked-to-market *liability* return of the average investor that is a DB pension fund, and (ii) the **average total-fund net return** from Exhibit 2. Correlations to liabilities are the maximum correlations found to a lagged liability model (see Appendix 3 and 4).

Netherlands

As-reported

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.49	0.28	-0.16	0.86	0.22	0.73	0.42
Private Equity	0.49	1.00	-0.17	-0.17	0.52	0.81	0.70	0.38
Listed Fixed Income	0.28	-0.17	1.00	0.29	0.37	-0.30	0.19	0.21
Private Fixed Income	-0.16	-0.17	0.29	1.00	0.05	-0.26	-0.13	-0.05
Listed Real Estate	0.86	0.52	0.37	0.05	1.00	0.27	0.74	0.37
Private Real Estate	0.22	0.81	-0.30	-0.26	0.27	1.00	0.27	0.35
Hedge Funds	0.73	0.70	0.19	-0.13	0.74	0.27	1.00	0.34
Infrastructure	0.42	0.38	0.21	-0.05	0.37	0.35	0.34	1.00
Liabilities	0.63	0.27	0.85	0.56	0.61	0.17	0.44	0.36
Total-fund net ret.	0.78	0.37	0.73	-0.04	0.77	0.20	0.54	0.40

Standardized

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.95	0.28	-0.16	0.86	0.85	0.73	0.88
Private Equity	0.95	1.00	0.33	-0.06	0.82	0.82	0.83	0.83
Listed Fixed Income	0.28	0.33	1.00	0.29	0.37	0.29	0.19	0.29
Private Fixed Income	-0.16	-0.06	0.29	1.00	0.05	-0.13	-0.13	-0.23
Listed Real Estate	0.86	0.82	0.37	0.05	1.00	0.86	0.74	0.83
Private Real Estate	0.85	0.82	0.29	-0.13	0.86	1.00	0.75	0.98
Hedge Funds	0.73	0.83	0.19	-0.13	0.74	0.75	1.00	0.69
Infrastructure	0.88	0.83	0.29	-0.23	0.83	0.98	0.69	1.00
Liabilities	0.63	0.65	0.85	0.56	0.61	0.47	0.44	0.46
Total-fund net ret.	0.78	0.77	0.73	-0.04	0.77	0.78	0.54	0.81

United Kingdom

As-reported

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.79	0.55	0.36	0.56	0.08	0.83	0.62
Private Equity	0.79	1.00	0.21	0.17	0.69	0.23	0.64	0.68
Listed Fixed Income	0.55	0.21	1.00	0.12	0.31	0.12	0.61	0.43
Private Fixed Income	0.36	0.17	0.12	1.00	0.32	0.25	0.30	0.17
Listed Real Estate	0.56	0.69	0.31	0.32	1.00	0.67	0.65	0.49
Private Real Estate	0.08	0.23	0.12	0.25	0.67	1.00	0.49	0.47
Hedge Funds	0.83	0.64	0.61	0.30	0.65	0.49	1.00	0.80
Infrastructure	0.62	0.68	0.43	0.17	0.49	0.47	0.80	1.00
Liabilities	0.51	0.42	0.80	0.34	0.34	0.23	0.38	0.48
Total-fund net ret.	0.55	0.55	0.35	0.18	0.52	0.62	0.68	0.66

Standardized

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.75	0.04	0.29	0.51	0.82	0.76	0.48
Private Equity	0.75	1.00	0.10	0.31	0.21	0.42	0.64	0.61
Listed Fixed Income	0.04	0.10	1.00	-0.33	-0.39	-0.18	0.14	0.27
Private Fixed Income	0.29	0.31	-0.33	1.00	0.63	0.40	0.43	0.69
Listed Real Estate	0.51	0.21	-0.39	0.63	1.00	0.78	0.52	0.37
Private Real Estate	0.82	0.42	-0.18	0.40	0.78	1.00	0.73	0.38
Hedge Funds	0.76	0.64	0.14	0.43	0.52	0.73	1.00	0.62
Infrastructure	0.48	0.61	0.27	0.69	0.37	0.38	0.62	1.00
Liabilities	0.45	0.36	0.91	0.56	0.40	0.25	0.28	0.67
Total-fund net ret.	0.91	0.72	0.26	0.26	0.44	0.76	0.93	0.56

Other Europe

As-reported

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.40	-0.04	-0.12	0.52	0.33	0.85	0.28
Private Equity	0.40	1.00	-0.54	0.20	0.54	0.71	0.41	0.30
Listed Fixed Income	-0.04	-0.54	1.00	0.17	0.13	-0.56	0.01	-0.50
Private Fixed Income	-0.12	0.20	0.17	1.00	-0.02	-0.18	0.15	-0.25
Listed Real Estate	0.52	0.54	0.13	-0.02	1.00	0.64	0.34	0.26
Private Real Estate	0.33	0.71	-0.56	-0.18	0.64	1.00	0.13	0.47
Hedge Funds	0.85	0.41	0.01	0.15	0.34	0.13	1.00	0.11
Infrastructure	0.28	0.30	-0.50	-0.25	0.26	0.47	0.11	1.00
Liabilities	0.73	0.21	0.70	0.51	0.52	0.28	0.69	0.16
Total-fund net ret.	0.98	0.47	0.01	-0.07	0.59	0.34	0.85	0.31

Standardized

	Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure
Listed Equity	1.00	0.95	-0.04	-0.12	0.52	0.75	0.85	0.66
Private Equity	0.95	1.00	0.02	0.03	0.54	0.73	0.84	0.64
Listed Fixed Income	-0.04	0.02	1.00	0.17	0.13	0.00	0.01	0.05
Private Fixed Income	-0.12	0.03	0.17	1.00	-0.02	0.02	0.15	0.09
Listed Real Estate	0.52	0.54	0.13	-0.02	1.00	0.67	0.34	0.67
Private Real Estate	0.75	0.73	0.00	0.02	0.67	1.00	0.56	0.78
Hedge Funds	0.85	0.84	0.01	0.15	0.34	0.56	1.00	0.70
Infrastructure	0.66	0.64	0.05	0.09	0.67	0.78	0.70	1.00
Liabilities	0.73	0.68	0.70	0.51	0.52	0.47	0.69	0.44
Total-fund net ret.	0.98	0.96	0.01	-0.07	0.59	0.76	0.85	0.66

Asset class correlations to total-fund returns in the U.K. are substantially different than in the Netherlands, and the reasons are clear. In the U.K., allocations to listed equity are much higher than in the Netherlands, and so it is not surprising that the correlation between total-fund returns and listed equity returns are high as well (0.91 in the U.K. compared to 0.78 in the Netherlands). Private equity and private real estate also show substantial correlations to total funds returns at 0.72 and 0.76 respectively, very similar to what is seen in the Netherlands. Listed fixed income and listed real estate however show low correlations to total fund returns in the U.K. The former is due to a much lower allocation to listed fixed income by U.K. investors while the latter speaks again to the fact that listed real estate investments in the U.K. appear to have different geographic and sector exposures than the rest of the average portfolio.

Other Europe

Like in the Netherlands, the most striking change in correlation upon standardization is the emergence of high correlation between listed and unlisted equity (0.40 'as-reported' vs. 0.95 'standardized'). In this respect, U.K. is an outlier.

As in the U.K., listed and unlisted real estate are not highly correlated either pre- or post-standardization (0.64 'as-reported' vs. 0.67 'standardized'), and once again private real estate shows a higher correlation to listed equity than does listed real estate. Together with the low allocation, listed real estate is most likely used only as part of a completion strategy within real estate where, for example, the ability to invest privately is onerous and easier to access via listed channels than via private vehicles.

Correlations to total-fund returns are very high for listed and private equity, and hedge funds as well. High listed equity correlations to total-fund returns can be expected on account of the outsized allocation to listed equities by other European investors, while high correlations to total-fund returns by private equity results from the fact that listed and private equity are correlated themselves, and likewise with hedge funds.

It would be curious that listed real estate is less correlated to total-fund returns if it weren't for the fact that we have already pointed out exhaustively that listed real estate is less correlated to listed equity than private real estate.

Correlations to liabilities (Exhibit 10 and Appendix A3)

Also shown in Exhibit 10 are correlations between 'as-reported' and 'standardized' asset class returns and marked-to-market liability returns of those investors with DB liabilities. Here, liability returns are modeled as a portfolio of real and nominal bonds, with the ratio of real to nominal bonds determined by the degree of inflation protection offered to active and retired members, and the durations of the real and nominal bonds determined by the ratio of active to retired members. The durations and fractions of real to nominal bonds used for each region are the average for that region[10], and one "average" liability return series is then constructed for each of the regions.

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[10] Real bond fractions are 53%, 88%, and 72% for the Netherlands, the U.K., and other Europe respectively with the remaining fraction comprising nominal bonds. Real durations are 10.1, 16.3, and 14.3 years while nominal durations are 21.8, 10.3, and 13.1 for the same three regions.

Since the CEM liability model is based on a proxy, it produces liability return series with data more frequently than annually. This allows for an interesting analysis the results of which are beyond the scope of the present paper, namely lagged liability correlations to annual asset class returns, 'as-reported' and 'standardized'. The results of this analysis on a bi-monthly basis are shown in Appendix A3. The data clearly shows that correlations for most asset classes are maximized on a lagged basis, particularly for the Dutch cohort where the asset class returns data is cleanest (i.e., is reported December through December, is of a single currency etc.).

For example, looking at the 'standardized' Dutch data in Appendix A3 it is clear that the maximum correlation is found for liabilities lagged two months; that is liability returns with October 31 year end correlate best with December 31 year end asset class returns. The only exceptions are (i) listed fixed income, which for all regions shows maximum correlations with no lag, and (ii) private fixed income which correlates best with liabilities lagged four to six months, depending on region. The longer lag for private fixed income is of course related to the fact that CEM lacks a model to standardize returns for this asset class.

The effect of lag in private equity, private real estate, and to a lesser extent infrastructure are also clear in the data. On an 'as-reported' basis in the Netherlands and other Europe, private equity and private real estate returns correlate best to liabilities lagged by 8 to 12 months. Standardizing those returns pulls the data forward and shows that the maximum correlation to liabilities like for listed versions thereof are in the range of two months. This behavior is less clear in the U.K. data, but on account of the multiple layers of corrections applied to the data (i.e., restatement of listed asset classes to December year end, restatement of total fund returns to December year end, standardization of private asset class returns) this should be unsurprising.

The data in Appendix 3 is summarized in Exhibit 10, where for each asset class we show the maximum correlation found on a bi-monthly basis (slightly higher correlations are found where the maximum correlations occur in odd-months, but this doesn't change any of our conclusions).

Equity
Listed and private equity correlations to liabilities tend to be very similar, ranging from 0.65 or so in the Netherlands, to 0.4 in the U.K., to 0.7 in other Europe. Differences between listed and private equity correlations are small, and while it might appear that listed equity has a higher correlation to liabilities than private equity outside of the Netherlands, this conclusion is likely to fine for the data at hand. However, given the data in Appendix A3, it is abundantly clear that equities were correlated to liability returns with a lag of around two months, and that correlations without any liability lag tend to be low.

Fixed income
Fixed income correlations to liabilities are high universally. Listed fixed income correlations are maximized without any liability lag, and range from 0.85 in the Netherlands, 0.91 in the United Kingdom, down to 0.70 in other Europe. The lower correlations in other Europe likely reflects a different regional mix of bonds in investor portfolios relative to the European bonds used in the liability proxy. As discussed, private fixed income returns all correlate better to lagged liabilities demonstrating that private fixed income returns possess lag themselves, like other private market assets (see for example the 'as-reported' correlation spectrum in Appendix A3). Of all asset classes,

fixed income has the highest correlation to liabilities which should not surprise given that liability returns are proxied by us with a portfolio of real and nominal bonds.

Real estate

Real estate correlation to liabilities in the Netherlands are similar to listed equity, at least for listed real estate, while private real estate are somewhat lower. Correlations in both cases are much higher with two month lagged liabilities. The higher correlation for listed real estate to liabilities than for private real estate is consistent across regions, but the differences are small enough that result may be due to a failure to perfectly synchronize returns of private markets to public markets.

In the U.K., real estate correlations appear to be maximized not with two month lagged liabilities, but instead two month leading liabilities, offering the possibility that real estate returns have some predictive power on bond markets in the U.K. However, the correlations for two month leading liability returns are not vastly different that for two month lagged liability returns, and are in fact smaller than for one month lagged liability returns (not shown). Indeed, given the multiple layers of data correction and standardization required to standardize U.K. data, the differences in the lagged / leading liability correlation data in comparison to the Netherlands and other Europe is not strong enough to suggest that real estate in the U.K. behaves differently than elsewhere.

Infrastructure and hedge funds

Infrastructure and hedged fund returns behave similarly to equities and real estate in that returns are most highly correlated to liabilities lagged two (or more) months. The maximum correlations however tend to be smaller than for simple equity, and are the same of smaller for real estate. This observation is interesting in part because, at least for infrastructure, the asset class is invested in because of the potential for inflation linked returns that should offer a good liability hedge.

Concluding remarks

European institutional investors are broadly diversified investors, with 99 percent of their allocations made to equity, fixed income, real estate, infrastructure, and hedge funds. Within the core asset classes of equity, fixed income, and real estate they invest both through listed channels and private (unlisted) channels. Listed asset classes provide liquidity, daily market pricing, and for the most part less risk than private channels.

Private equity in particular is both riskier than public equity but over the course of this study has compensated institutional investors with superior returns and higher Sharpe ratios over long periods of time, and likewise for private credit[11]. The situation for real estate is less clear; where listed real estate investing is well established – in the Netherlands – it has historically performed better than private real estate, with higher returns and larger Sharpe ratios although it is more volatile in part because it has more leverage. On a leverage adjusted basis, listed real estate in the Netherlands has done even better, outperforming benchmarks by 0.8 percent versus a loss of 2.2 percent for private real estate.

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[11] The higher Sharpe ratios of private credit are less well established as CEM does not have a model that standardizes the returns to remove lag an smoothing which otherwise supress the volatility of private market assets.

Because of this history, the implementation into listed and private channels of allocations to equity, fixed income and real estate by European institutional investors appears odd. Universally, we see allocation to listed equity between 12 and 14 times that of private equity, allocations to listed fixed income between 16 and 34 times that of private fixed income, but allocations to listed real estate are one third to one half that of private real estate.

Another reason to invest in listed markets beyond the added liquidity and transparency of valuations are differences in investment costs. Over the longest periods of time included in this study, investment costs for listed equity are on average between 18 and 25 basis points (0.18 percent to 0.25 percent). In comparison, private equity fees are enormous, at between 281 basis points and 384 basis points depending on the region. Similar patterns hold for fixed income and real estate, where listed implementations are universally less costly than private channels. Given the often slight and idiosyncratic differences in performance across channels, investors face difficult decisions on how best to manage their portfolios.

Some of the most important insights in this white paper concern the correlations between listed and unlisted assets. In the Netherlands and other European regions, listed and private equity appear highly correlated after removing the lag and smoothing inherent in private market valuations. In the United Kingdom listed and private equity display high (if somewhat lower) correlation.

Real estate however shows some of the most fascinating correlations. It is usual to hear the refrain that listed real estate is highly correlated to listed equities, and that appears to be true in the Netherlands. However, once lag and smoothing are removed form private real estate returns, the correlations to listed equity for private real estate are at least as high. In the United Kingdom and other European regions the inverse appears to be true; *private real estate is more correlated to listed equity than listed real estate*. The reason for the situation is most likely one of geographic exposure; where private real estate portfolios share similar geographic diversity as listed equity portfolios, dedicated listed real estate portfolios are used only rarely for niche investments as part of a real estate completion strategies.

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'As-Reported' Asset Class Idiosyncratic Risk (%)

Year	Netherlands Equity Listed	Netherlands Equity Private	Netherlands Fixed Income Listed	Netherlands Fixed Income Private	Netherlands Real Estate Listed	Netherlands Real Estate Private	Netherlands Hedge Funds	Netherlands Infrastructure	UK Equity Listed	UK Equity Private	UK Fixed Income Listed	UK Fixed Income Private	UK Real Estate Listed	UK Real Estate Private	UK Hedge Funds	UK Infrastructure	Other Europe Equity Listed	Other Europe Equity Private	Other Europe Fixed Income Listed	Other Europe Fixed Income Private	Other Europe Real Estate Listed	Other Europe Real Estate Private	Other Europe Hedge Funds	Other Europe Infrastructure
2021	3.5	16.4	2.3	5.2	16.7	2.8	1.3	5.2	3.3	17.1	2.7	3.6	7.3	5.6	4.3	7.1	5.6	31.0	3.0	9.2	7.2	8.0	14.9	7.7
2020	4.2	14.3	3.3	0.9	5.6	3.1	2.3	6.1	7.1	15.8	10.4	9.3	13.3	3.7	7.0	9.9	4.3	4.0	3.0	8.5	11.7	3.9	6.7	9.8
2019	2.1	9.1	2.1	1.4	2.9	3.0	7.0	4.8	4.8	14.5	6.2	9.8	24.6	3.0	6.0	7.8	3.9	4.5	2.6	6.0	7.4	6.7	4.9	6.4
2018	1.9	9.3	1.3	1.4	3.0	3.7	4.3	4.7	3.2	10.5	2.1	4.9	8.5	2.7	5.4	6.8	2.7	3.9	2.7	12.6	7.5	6.5	4.8	3.7
2017	2.7	7.3	1.3	1.5	5.5	3.1	11.7	6.2	2.5	4.4	1.6	5.8	5.8	3.2	4.3	6.7	3.4	4.3	2.2	7.0	10.8	6.2	5.8	86.1
2016	1.4	6.5	1.9	2.3	2.9	4.0	16.1	4.0	3.6	9.6	7.3	8.1	5.3	3.9	4.7	14.4	2.7	5.3	2.3	6.5	5.1	11.6	5.8	8.4
2015	4.3	11.0	1.3	2.9	7.2	4.5	18.4	9.9	2.2	9.3	1.5	5.6	0.0	3.5	4.0	12.4	4.1	3.9	1.7	14.7	4.7	9.8	4.1	21.1
2014	2.9	12.4	6.1	3.1	7.6	6.6	8.0	7.3	2.8	8.9	8.0	4.5	4.3	5.5	4.2	14.6	6.3	6.7	4.0	14.8	10.0	3.4	9.9	3.2
2013	3.4	12.0	1.8	4.1	4.0	5.0	5.2	6.0	4.3	5.3	3.4	5.0	2.0	3.7	5.3	8.1	4.6	5.0	1.3	2.9	4.2	8.9	3.6	7.1
2012	1.5	6.7	2.2	4.9	3.3	6.0	10.3	6.2	2.9	6.8	3.8	8.1	6.6	5.7	4.0	11.6	2.7	2.2	2.6	-	18.6	5.4	4.5	0.7
2011	3.0	11.3	5.4	4.0	5.2	4.6	5.0	5.0	3.6	4.1	12.3	-	0.0	5.0	2.8	10.1	5.4	3.4	2.1	0.0	12.1	7.4	5.3	7.2
2010	5.1	15.7	2.9	1.7	9.0	9.0	4.5	5.0	4.1	10.0	2.6	0.0	0.0	7.4	5.6	8.0	8.7	7.9	3.2	0.0	4.8	4.7	5.4	3.9
2009	4.1	14.6	6.6	2.7	5.5	6.9	11.4	5.6	0.0	0.0	12.3	-	-	13.9	2.5	0.0	14.9	9.2	3.9	0.0	21.5	10.0	13.5	10.8
2008	3.8	15.7	9.5	4.0	4.2	16.2	5.9	31.6	0.0	0.0	28.6	-	-	5.6	0.0	0.0	7.1	6.8	5.8	0.0	0.0	5.9	1.2	4.7
2007	2.7	12.5	1.8	1.9	7.1	10.7	7.3	18.4	-	-	-	-	-	-	-	-	3.4	13.8	1.0	0.0	0.0	5.3	6.2	7.9
2006	3.3	53.3	1.6	4.0	12.8	7.4	6.4	0.0	-	-	-	-	-	-	-	-	6.4	22.7	1.9	0.0	-	13.9	2.3	0.0
2005	3.8	31.9	2.9	0.9	9.1	5.2	8.1	-	-	-	-	-	-	-	-	-	6.3	18.3	1.5	-	-	23.1	6.3	-
Idiosyncratic Risk																								
2017-2021	2.9	11.3	2.0	2.1	6.8	3.1	5.3	5.4	4.2	12.5	4.6	6.7	11.9	3.6	5.4	7.7	4.0	9.5	2.7	8.7	8.9	6.3	7.4	22.7
2008-2021	3.1	11.6	3.4	2.9	5.9	5.6	8.0	7.7	3.7	9.7	7.3	6.5	8.6	5.2	4.6	9.8	5.5	7.0	2.9	9.1	9.7	7.0	6.5	12.9
2005-2021	3.1	15.3	3.2	2.8	6.6	6.0	7.8	8.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.4	9.0	2.6	9.1	9.7	8.3	6.2	12.6

Appendix A2. 'Standardized' idiosyncratic risk by year, 2005 - 2021.

Idiosyncratic risk is the in-year standard deviation of annual net investment returns across the sample of institutional investors in the CEM database. Where only one investor reported a return, the idiosyncratic risk is displayed as '0.0'. Where no investor reported a return (they may report an allocation but not a return) the idiosyncratic risk is displayed as '-'.

Standardized idiosyncratic risk for listed asset classe s in the Netherlands and other Europe are unchanged from that appearing in Appendix A1. Standardized idiosyncratic risk for listed assets in the U.K. have been calculated using net investment returns on a December year end basis.

Standardized idiosyncratic risk for private equity, private real estate, and infrastructure are calculated from the standard deviation of inferred market-based net investment returns as described in Exhibit 6.

'Standardized' asset class idiosyncratic Risk (%)

	Netherlands								United Kingdom								Other Europe							
	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-	Equity		Fixed Income		Real Estate		Hedge	Infra-
Year	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure	Listed	Private	Listed	Private	Listed	Private	Funds	structure
2021	3.5	12.6	2.3	5.2	16.7	12.5	1.3	11.0	3.6	8.6	2.6	4.2	7.3	7.8	4.4	4.8	5.6	10.3	3.0	9.2	7.2	3.2	14.9	0.0
2020	4.2	9.3	3.3	0.9	5.6	6.7	2.3	8.7	7.4	7.7	10.1	8.4	13.3	6.5	7.7	7.8	4.3	3.7	3.0	8.5	11.7	5.6	6.7	22.9
2019	2.1	8.8	2.1	1.4	2.9	3.8	7.0	6.8	4.2	6.5	7.8	9.8	24.6	4.9	8.4	6.1	3.9	8.5	2.6	6.0	7.4	5.8	4.9	0.0
2018	1.9	11.8	1.3	1.4	3.0	8.7	4.3	5.8	3.2	8.5	1.9	4.9	8.5	5.5	7.1	8.3	2.7	8.3	2.7	12.6	7.5	1.9	4.8	0.0
2017	2.7	6.6	1.3	1.5	5.5	7.6	11.7	8.4	2.5	3.5	1.7	5.8	5.8	5.4	5.6	3.0	3.4	1.3	2.2	7.0	10.8	11.0	5.8	0.0
2016	1.4	6.0	1.9	2.3	2.9	3.5	16.1	5.2	3.7	10.5	7.3	8.1	5.3	6.2	4.9	8.4	2.7	3.9	2.3	6.5	5.1	7.0	5.8	0.0
2015	4.3	7.1	1.3	2.9	7.2	4.9	18.4	8.1	2.4	5.0	1.9	5.6	0.0	2.8	4.1	12.1	4.1	1.7	1.7	14.7	4.7	7.8	4.1	0.0
2014	2.9	6.2	6.1	3.1	7.6	6.3	8.0	6.8	2.7	6.3	7.9	4.5	4.3	3.9	4.4	6.2	6.3	6.5	4.0	14.8	10.0	5.0	9.9	4.5
2013	3.4	6.6	1.8	4.1	4.0	6.2	5.2	4.3	4.4	9.7	2.8	5.0	2.0	7.1	5.1	5.6	4.6	8.4	1.3	2.9	4.2	9.8	3.6	0.0
2012	1.5	4.9	2.2	4.9	3.3	10.6	10.3	5.3	2.8	3.6	3.4	8.1	6.6	5.8	4.3	-	2.7	7.3	2.6	-	18.6	7.4	4.5	-
2011	3.0	7.5	5.4	4.0	5.2	9.6	5.0	5.8	3.9	5.1	12.3	-	0.0	4.4	2.8	-	5.4	8.6	2.1	0.0	12.1	6.6	5.3	0.0
2010	5.1	6.3	2.9	1.7	9.0	2.4	4.5	4.3	3.7	5.9	2.7	0.0	0.0	10.4	5.6	-	8.7	11.9	3.2	0.0	4.8	4.1	5.4	-
2009	4.1	7.0	6.6	2.7	5.5	13.7	11.4	3.0	0.0	0.0	7.8	-	-	10.2	2.5	-	14.9	8.6	3.9	0.0	21.5	11.5	13.5	-
2008	3.8	11.0	9.5	4.0	4.2	14.3	5.9	25.7	0.0	0.0	21.4	-	-	22.2	0.0	-	7.1	4.4	5.8	0.0	0.0	14.3	1.2	-
2007	2.7	14.8	1.8	1.9	7.1	13.9	7.3	0.0	-	-	-	-	-	-	-	-	3.4	11.8	1.0	0.0	0.0	1.9	6.2	-
2006	3.3	8.9	1.6	4.0	12.8	11.9	6.4	-	-	-	-	-	-	-	-	-	6.4	13.3	1.9	0.0	-	5.7	2.3	-
2005	3.8	7.1	2.9	0.9	9.1	0.0	8.1	-	-	-	-	-	-	-	-	-	6.3	18.6	1.5	-	-	1.4	6.3	-
Idiosyncratic Risk																								
2017-2021	2.9	9.8	2.0	2.1	6.8	7.8	5.3	8.1	4.2	7.0	4.8	6.6	11.9	6.0	6.6	6.0	4.0	6.4	2.7	8.7	8.9	5.5	7.4	22.9
2008-2021	3.1	8.0	3.4	2.9	5.9	7.9	8.0	7.8	3.7	6.7	6.5	6.4	8.6	7.4	5.1	6.9	5.5	6.7	2.9	9.1	9.7	7.2	6.5	13.7
2005-2021	3.1	8.4	3.2	2.8	6.6	8.5	7.8	7.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.4	8.1	2.6	9.1	9.7	6.5	6.2	13.7

Appendix A3. Correlations to lagged liabilities

Correlations between lagged (> 0 months) and leading (< 0 month) liability proxy returns and asset class returns on an 'as-reported' and 'standardized' basis. Liability proxy returns are calculated from a blend of real and nominal bonds duration matched to the average investor liability per region as described in the text.

Generally, upon standardization of private asset class returns (except private fixed income for which no standardization is made), correlations between asset classes and liabilities are maximized when liabilities are lagged by around 2 months, indicating that asset class returns lag liability returns.

Netherlands

Liability Lag	As-reported Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average	Standardized Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average
12 months	0.31	0.27	-0.39	-0.12	0.22	0.17	0.22	0.19	0.11	0.31	0.31	-0.39	-0.12	0.22	0.05	0.22	0.08	0.09
10 months	0.05	0.10	-0.07	0.01	0.06	0.11	0.08	0.17	0.06	0.05	0.11	-0.07	0.01	0.06	-0.17	0.08	-0.15	-0.01
8 months	0.22	0.16	-0.17	0.04	0.12	0.01	0.35	0.32	0.13	0.22	0.29	-0.17	0.04	0.12	-0.02	0.35	-0.03	0.10
6 months	0.33	0.07	0.47	0.37	0.25	-0.09	0.40	0.34	0.27	0.33	0.46	0.47	0.37	0.25	0.28	0.40	0.23	0.35
4 months	0.45	0.09	0.64	0.56	0.46	-0.05	0.41	0.32	0.36	0.45	0.55	0.64	0.56	0.46	0.47	0.41	0.40	0.49
2 months	0.63	-0.02	0.71	0.34	0.61	-0.19	0.44	0.36	0.36	0.63	0.65	0.71	0.34	0.61	0.47	0.44	0.46	0.54
0 months	0.18	-0.21	0.85	0.49	0.23	-0.29	0.05	0.23	0.19	0.18	0.20	0.85	0.49	0.23	0.14	0.05	0.13	0.29
-2 months	0.31	-0.08	0.77	0.33	0.37	-0.20	0.19	0.28	0.25	0.31	0.30	0.77	0.33	0.37	0.40	0.19	0.37	0.38
-4 months	-0.03	-0.43	0.70	0.26	0.10	-0.44	-0.19	0.02	0.00	-0.03	-0.11	0.70	0.26	0.10	-0.03	-0.19	-0.03	0.08
-6 months	-0.29	-0.69	0.11	0.01	-0.30	-0.52	-0.44	-0.04	-0.27	-0.29	-0.38	0.11	0.01	-0.30	-0.46	-0.44	-0.43	-0.27
-8 months	-0.37	-0.65	-0.05	-0.19	-0.41	-0.49	-0.39	-0.09	-0.33	-0.37	-0.45	-0.05	-0.19	-0.41	-0.49	-0.39	-0.47	-0.35
-10 months	-0.43	-0.74	0.20	0.10	-0.39	-0.53	-0.49	-0.20	-0.31	-0.43	-0.49	0.20	0.10	-0.39	-0.45	-0.49	-0.45	-0.30
-12 months	-0.32	-0.59	0.08	-0.05	-0.39	-0.33	-0.48	-0.16	-0.28	-0.32	-0.37	0.08	-0.05	-0.39	-0.35	-0.48	-0.32	-0.28

United Kingdom

Liability Lag	As-reported Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average	Standardized Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average
12 months	-0.22	-0.24	-0.17	-0.46	-0.25	-0.07	-0.07	-0.14	-0.20	-0.19	-0.30	-0.26	0.04	0.02	0.08	-0.08	-0.40	-0.14
10 months	-0.21	-0.43	-0.06	-0.31	-0.36	-0.19	-0.16	-0.31	-0.25	-0.15	-0.14	0.07	-0.13	-0.25	-0.10	-0.03	-0.32	-0.13
8 months	-0.30	-0.39	-0.26	-0.44	-0.35	-0.19	-0.32	-0.43	-0.33	-0.08	-0.07	-0.13	-0.01	-0.10	-0.03	-0.01	-0.33	-0.09
6 months	-0.22	-0.45	0.17	-0.20	-0.60	-0.54	-0.32	-0.24	-0.30	-0.28	-0.07	0.36	0.04	-0.35	-0.33	-0.23	0.08	-0.10
4 months	-0.33	-0.32	0.23	-0.13	-0.51	-0.26	-0.33	-0.02	-0.21	-0.10	0.21	0.37	0.56	0.03	-0.15	0.08	0.67	0.21
2 months	0.51	0.42	0.76	0.13	0.24	0.01	0.38	0.48	0.37	0.45	0.36	0.62	0.13	0.20	0.25	0.25	0.48	0.34
0 months	0.21	-0.03	0.80	0.34	0.16	0.12	0.24	0.13	0.25	0.01	0.09	0.91	-0.08	-0.14	-0.12	0.18	0.44	0.16
-2 months	0.10	0.18	0.71	-0.07	0.20	0.23	0.24	0.40	0.25	0.15	0.09	0.51	0.39	0.40	0.25	0.28	0.57	0.33
-4 months	0.23	0.14	0.80	-0.01	0.07	-0.05	0.25	0.39	0.23	0.09	0.00	0.62	0.23	0.14	0.11	0.08	0.48	0.22
-6 months	-0.09	-0.07	0.42	-0.29	0.18	-0.03	-0.13	0.03	0.00	-0.15	-0.38	0.21	-0.04	0.30	0.01	-0.18	-0.04	-0.03
-8 months	0.05	0.01	0.20	-0.07	0.34	-0.01	-0.02	-0.01	0.06	-0.22	-0.43	0.01	-0.45	0.06	-0.08	-0.32	-0.45	-0.24
-10 months	-0.21	-0.27	-0.01	-0.28	-0.11	-0.41	-0.40	-0.34	-0.25	-0.34	-0.40	-0.01	-0.31	-0.10	-0.26	-0.47	-0.36	-0.28
-12 months	-0.07	-0.01	-0.09	-0.18	0.12	-0.17	-0.29	-0.20	-0.11	0.01	-0.03	-0.07	-0.22	0.10	-0.02	-0.17	-0.24	-0.08

Other Europe

Liability Lag	As-reported Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average	Standardized Equity Listed	Equity Private	Fixed Income Listed	Fixed Income Private	Real Estate Listed	Real Estate Private	Hedge Funds	Infra-structure	Average
12 months	0.25	0.12	-0.53	-0.12	-0.17	0.28	0.04	0.16	0.00	0.25	0.23	-0.53	-0.12	-0.17	0.09	0.04	0.00	-0.03
10 months	-0.03	0.02	-0.31	-0.18	-0.14	0.23	-0.27	0.09	-0.07	-0.03	-0.06	-0.31	-0.18	-0.14	-0.02	-0.27	-0.12	-0.14
8 months	0.25	0.21	-0.28	0.16	0.03	0.21	0.23	-0.01	0.10	0.25	0.26	-0.28	0.16	0.03	0.07	0.23	0.18	0.11
6 months	0.33	-0.02	0.32	0.51	0.24	-0.02	0.33	-0.26	0.18	0.33	0.41	0.32	0.51	0.24	0.24	0.33	0.35	0.34
4 months	0.53	-0.01	0.58	0.34	0.52	-0.03	0.44	-0.18	0.27	0.53	0.60	0.58	0.34	0.52	0.47	0.44	0.43	0.49
2 months	0.73	-0.11	0.50	0.02	0.31	-0.20	0.69	-0.03	0.24	0.73	0.68	0.50	0.02	0.31	0.47	0.69	0.44	0.48
0 months	0.41	-0.24	0.70	-0.03	0.32	-0.32	0.33	-0.15	0.13	0.41	0.38	0.70	-0.03	0.32	0.25	0.33	0.19	0.32
-2 months	0.52	-0.04	0.64	0.22	0.42	-0.30	0.61	-0.07	0.25	0.52	0.54	0.64	0.22	0.42	0.28	0.61	0.39	0.45
-4 months	0.01	-0.30	0.48	0.14	-0.11	-0.59	0.04	-0.15	-0.06	0.01	-0.06	0.48	0.14	-0.11	-0.16	0.04	-0.23	0.01
-6 months	-0.31	-0.73	0.22	-0.23	-0.49	-0.63	-0.30	-0.18	-0.33	-0.31	-0.47	0.22	-0.23	-0.49	-0.58	-0.30	-0.44	-0.33
-8 months	-0.51	-0.73	0.10	-0.10	-0.69	-0.58	-0.37	-0.31	-0.40	-0.51	-0.60	0.10	-0.10	-0.69	-0.64	-0.37	-0.41	-0.40
-10 months	-0.65	-0.82	0.37	0.03	-0.54	-0.58	-0.58	-0.42	-0.40	-0.65	-0.67	0.37	0.03	-0.54	-0.51	-0.58	-0.42	-0.37
-12 months	-0.59	-0.71	0.22	-0.13	-0.48	-0.40	-0.50	-0.30	-0.36	-0.59	-0.63	0.22	-0.13	-0.48	-0.50	-0.50	-0.28	-0.36

Appendix D: Standardization of illiquid asset class returns

To make standardize as-reported returns we rely on the fact that clients supply asset-class benchmark descriptions to CEM. Noting that the return from any asset class can be decomposed into a passive market return plus (or minus) the net value added from active management, we express the return in year *y* with year end in March, R_y^{Mar}, as:

$$R_y^{Mar} = \alpha_y^{Mar} + \beta_y^{Mar}$$

where α_y^{Mar} is net value added (sometimes referred to as 'alpha') and β_y^{Mar} is the benchmark return, both calculated over the year with March 31st year end.

Transforming the return to a December year end is accomplished by switching the beta to that of a December year end, preserving the reported March year end net value added[12]. This is equivalent to:

$$R_{y,listed}^{Dec} = R_{y,listed}^{Mar} - \left(\beta_y^{Mar} - \beta_y^{Dec}\right)$$

showing that the effect of switching the market return from March to December is the same as subtracting the return differential of the benchmark. In practice, CEM has a library of 'most common' benchmarks for each asset class and region and applies the same transformation across funds / regions to preserve the relative performance across investors.

A more complex adjustment is required to standardize the returns of illiquid asset classes. To do so, we recognize that the primary differences between market-based returns of listed public market assets and the appraised returns of unlisted private market assets are lag, leverage and smoothing.

The method, described in Exhibit 6, has been previously used by CEM to study net value added in unlisted (private market) real estate portfolios (see Beath 2022a). In brief, we find portfolio-by-portfolio, the optimal lagged, smoothed and (de-)levered public market benchmark for private equity, private real estate, and (private) infrastructure. The optimal benchmark is that which has: (i) the highest correlation, and (ii) an equity / bond mix that ensures that the regression slope of asset return to benchmark return is one exactly. The de-smoothed, de-lagged return is then equal to

$$R_{y,private}^{Dec} = R_{y,private}^{Provided} - \left(\beta_y^{lagged,smoothed} - \beta_y^{de-lagged,de-smoothed}\right)$$

where $\beta_y^{lagged,smoothed}$ is the optimal lagged and smoothed benchmark and $\beta_y^{de-lagged,de-smoothed}$ is the same benchmark with no lag and no smoothing. Note that the leverage is preserved in the above, and so differences in return can arise due to differences in leverage.

Private equity
For private equity, optimal lagged, smoothed and (de-) levered benchmarks are constructed using the S&P global small cap index for the equity component and the Bloomberg global corporate aggregate bond index for the bond component used to lever or de-lever the equity to ensure that the regression slope (or beta) between reported returns and benchmark returns is one exactly.

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[12] The data provided to CEM is annual which does not allow for the net value added to be ascribed to any particular sub-period within the year.

Private real estate

For private real estate we have tested the method using several different listed equity indices provided by EPRA including FTSE EPRA / Nareit (i) Global, (ii) Developed Europe, (iii) Developed Europe ex-United Kingdom, (iv) United Kingdom, and (v) Netherlands. Bond series used to (de-) lever the returns use the Bloomberg global corporate aggregate bond index. In terms of regions, we limit the use of the Netherlands real estate equity series to investors in the Netherlands, and the United Kingdom Series to investors in the United Kingdom. Most of solutions found use FTSE EPRA / Nareit Developed Europe.

Infrastructure

For infrastructure, like private equity, optimal lagged, smoothed and (de-) levered benchmarks are constructed using the S&P global infrastructure index for the equity component and the Bloomberg global corporate aggregate bond index for the bond component used to (de-) lever the equity component.