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ASSET ALLOCATION AND FUND PERFORMANCE OF DEFINED BENEFIT PENSION FUNDS IN THE UNITED STATES, 1998-2022



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Asset Allocation and Fund Performance of Defined Benefit Pension Funds in the United States, 1998-2022

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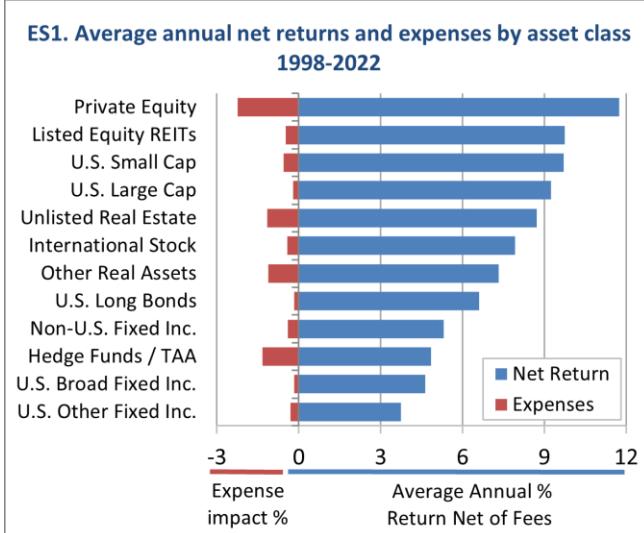
2024 Executive Summary

Introduction

- Of the \$33.6 trillion of retirement assets in the United States at the end of 2022, approximately \$7.6 trillion were held in public sector defined benefit (DB) funds and \$3.1 trillion were held in corporate sector DB funds (see Reference 1). Because millions of Americans rely on these pensions for their retirement security, the investment allocation decisions of these pension funds are of critical importance.
- This study provides a comprehensive look at investment allocations and realized investment performance across aggregate asset classes using a unique and proprietary dataset covering over 200 public and private sector pensions over a 25-year period, with nearly \$4.1 trillion in combined assets under management (AUM) at the end of 2022 (see Reference 2 for a detailed description of methodology). One of the unique benefits of the dataset is that it provides the actual realized performance net of investment costs of the assets chosen by plan managers and trustees.

Asset returns

- This study compares annual average returns net of all investment costs across 12 aggregate asset classes with appropriate adjustments for reporting lags associated with illiquid asset classes (e.g., unlisted real estate and private equity).
- Over the 25-year period covered by this study² there were striking differences in performance across aggregate asset classes. Exhibit ES1 summarizes arithmetic average annual net returns and average annual investment costs (both in percentage points) for the 12 asset classes covered in the study.
- Private equity had the highest average gross return over the period, averaging 14.0 percent.



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² The study commences in 1998 since this is the year hedge fund and listed REIT data were first collected by CEM Benchmarking.

Private equity had the highest average net return as well, estimated as 11.7 percent, much lower than the gross return because of the impact of expenses. Listed equity REITs and small cap. U.S. stock had the second and third highest net return over the period, both averaging around 9.7 percent.

- The two worst performing asset classes were U.S. other fixed income and U.S. broad fixed income. Excluding the two fixed income asset classes which include cash holdings, Hedge Funds/TAA was the next worst performing asset class with a 25-year arithmetic average annual net return of 4.8 percent.

Asset Allocations

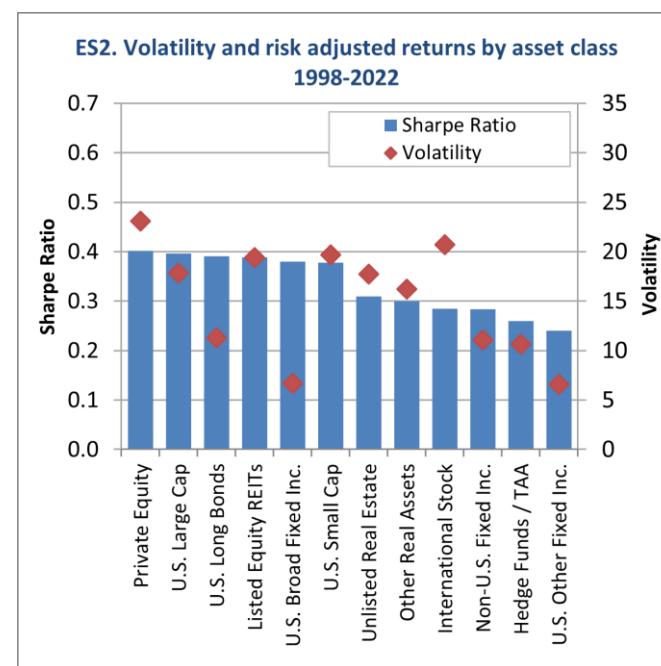
- The most material decrease in asset allocation was the decrease in allocation to U.S. large cap stocks. In 1998 over 42 percent of U.S. DB pension funds holdings were dedicated to U.S. large cap. stocks. By 2022 this had fallen to just over 11.6 percent, despite large cap. U.S. stock having the second highest net returns over the past decade 2013-2022 (see Appendix 1, Tables 4A and B).
- The most material increase in asset allocation was the increase in allocation to U.S. long bonds. In 1998, the allocation to U.S. long bonds was less than 1 percent whereas at the end of 2022 it was nearly 21.4 percent. This increase was primarily because of increased long bond allocations by corporate sector pension funds.
- Although they had the second highest arithmetic average annual net return of 9.7 percent and the second highest compound average annual net return of 8.2 percent as well, listed equity REITs were the least used asset class covered in the study. Allocations to listed equity REITs averaged just 0.6 percent of total assets. Unlisted real estate by contrast had a 4.0 percent allocation on average while having had an arithmetic average annual net return of 7.7 percent and a compound average annual net return of 6.6 percent.

Total fund returns

- Large corporate-sector plans (> \$10 billion in AUM) outperformed over the 25-year period (average compound net return of 7.1 percent) due to a timely increase in allocation to long duration fixed income just before the financial crisis of 2008.
- Public-sector DB plans (especially large plans) have had relatively strong performance post financial crisis, benefitting from higher allocations to both public and private equity.

Volatility and Risk Adjusted Returns

- The study also compared volatilities and risk adjusted returns using the Sharpe ratio across asset classes. The data are summarized in Exhibit ES2.
- Private equity and U.S. large cap stocks had the highest Sharpe ratios, indicating a strong balance between their elevated returns and substantial volatilities.
- U.S. Other Fixed Income had the lowest Sharpe ratio, reflecting its poor returns despite being paired with low volatility.
- After adjusting for reporting lags, private equity was the riskiest aggregate asset class, with an annualized volatility of 23.1 percent. The large volatility reflects both the large standard deviation of average returns across years (market risk) as well as the large dispersion of returns between funds within years (idiosyncratic risk). The study shows that market risk of private equity at 18.2 percent is similar to U.S. small cap stocks around 18.7 percent and lower than that of



international stocks (Formerly known as Non-U.S., see reference 4 for a revised description) at 20.3 percent.

- After adjusting for reporting lags, the study found that listed equity REITs and unlisted real estate had comparable volatilities. Listed equity REITs and unlisted real estate had the 4th and 6th most volatile net returns with volatilities of 19.4 percent and 17.7 percent respectively.

Correlations

- The study compared correlations of annual returns among the 12 asset classes, summarized in Exhibit ES3.
- The broadest group of highly correlated aggregate asset classes were equity asset classes together with hedge funds / TAA; this includes U.S. large cap stock, U.S. small cap stock, international stocks, hedge funds, TAA, and private equity. The high correlation of listed equities to private equity only emerged after accounting for reporting lags. Correlations in this group ranged from 0.76 to 0.93.
- Listed equity REITs and unlisted real estate were highly correlated once reporting lags in unlisted real estate were accounted for. The correlation between the two asset classes is 0.90, among the highest of all. The high correlation is not surprising given both asset classes invest in fundamentally the same assets, real estate.
- Both listed equity REITs and unlisted real estate are not highly correlated to any other aggregate asset classes.
- The long duration U.S. bonds were slightly negatively correlated to most equity asset classes (including hedge funds / TAA and private equity), but positively correlated to U.S. broad fixed income.

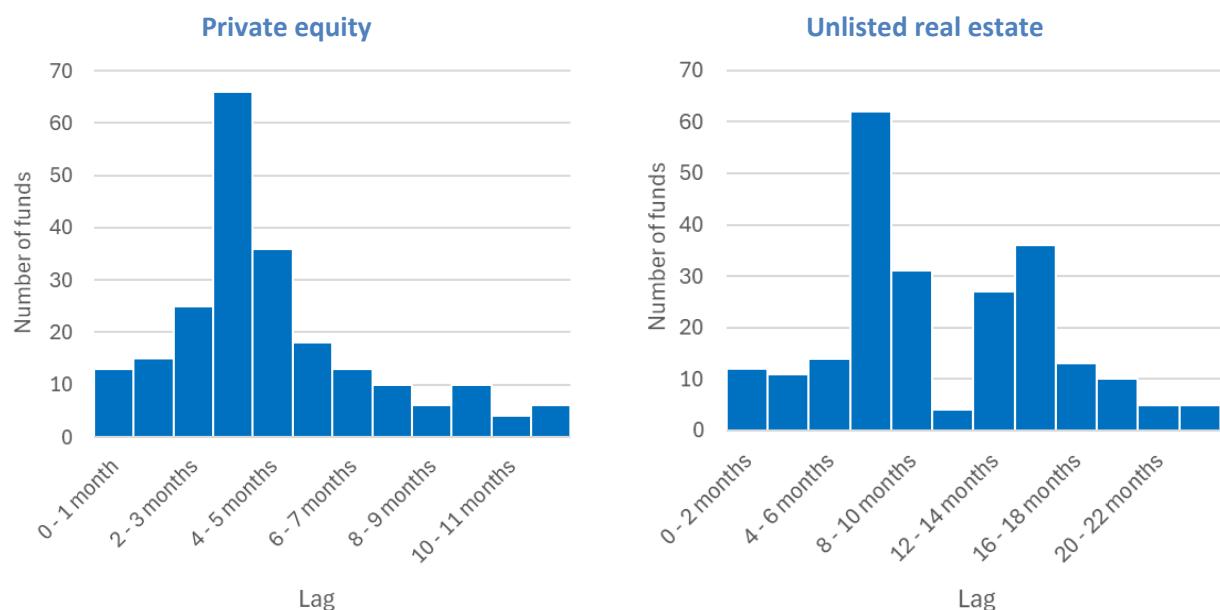
Reporting lags for illiquid assets

- Reporting lag is the delay between when an underlying asset changes value and when that change in value is reported by the pension fund or investor. Illiquid assets like unlisted real estate and private equity have reporting lags measured in months (private equity) to years (unlisted real estate).
- The unique CEM dataset allows adjustment for illiquid asset reporting lag at the individual pension fund level. Typically, this type of adjustment is made using a single assumption applied to all investment returns in an illiquid asset class.
- In addition to improving the accuracy of the returns, volatilities and correlations, adjusting for reporting lag at the fund portfolio level allows the observation of the distribution of reporting lags across funds. The distributions are shown in Exhibit ES4.
- The distribution of reporting lags associated with private equity is clustered around 3 to 4 months.
- The distribution of reporting lags associated with unlisted real estate is clustered in two groups, one at 6-8 months and another at 14 to 16 months. The long delay between unlisted real estate and listed assets is the cause of a common misperception that unlisted real estate is uncorrelated to other asset classes.

ES3. Correlations between aggregate asset classes: 1998-2022

	Stock: U.S. Large Cap	Stock: U.S. Small Cap	Stock: Int'l Cap	Hedge Funds / TAA	Private Equity	Fixed Income: U.S. Broad	Fixed Income: Long Duration	Fixed Income: Other	Unlisted U.S. Non U.S.	Real Estate	Listed Equity REITs	Other Real Assets
Stock: U.S. Large Cap	n/a	0.93	0.89	0.85	0.87	0.27	0.03	0.67	0.54	0.55	0.59	0.11
Stock: U.S. Small Cap	n/a	0.89	0.76	0.90	0.26	-0.02	0.70	0.57	0.59	0.65	0.65	0.02
Stock: Non U.S.	n/a		0.83	0.87	0.24	-0.06	0.72	0.61	0.56	0.59	0.59	-0.07
Hedge Funds / TAA		n/a	0.79	0.14	-0.13	0.67	0.44	0.43	0.49	0.49	0.49	-0.10
Private Equity			n/a	0.27	-0.01	0.72	0.54	0.61	0.58	0.58	0.58	0.03
Fixed Income: U.S. Broad				n/a	0.86	0.65	0.82	0.39	0.43	0.43	0.43	-0.38
Fixed Income: Long Duration					n/a	0.28	0.57	0.17	0.19	0.19	0.19	-0.23
Fixed Income: U.S. Other						n/a	0.82	0.67	0.71	0.71	0.71	-0.37
Fixed Income: Non U.S.							n/a	0.49	0.58	0.58	0.58	-0.34
Unlisted Real Estate								n/a	0.90	0.90	0.90	-0.07
Listed Equity REITs									n/a	n/a	n/a	-0.14
Other Real Assets										n/a	n/a	n/a

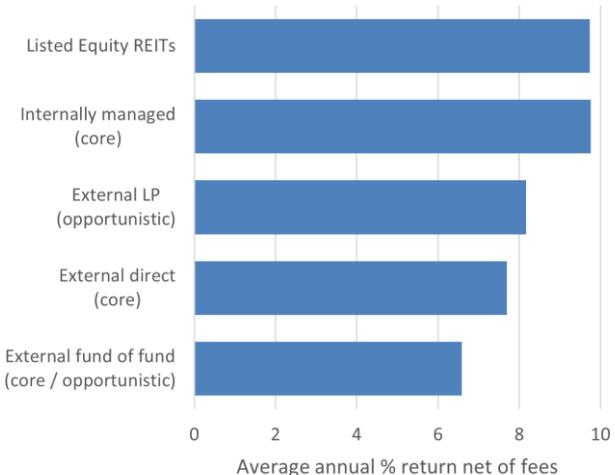
ES4 Distribution of reporting lag



Real estate performance by implementation style

- Unlisted real estate net returns by year and by implementation style are provided in Appendix B (see Reference 3 for a description of the methodology).
- As shown in ES5, real estate internally managed by funds performed better compared with more expensive external LP real estate (i.e., opportunistic real estate managed by a GP sometimes called private equity real estate). External direct real estate (i.e., core real estate) slightly underperformed external LP real estate but outperformed real estate managed through a fund-of-funds.
- Listed equity REITs outperformed external LP (opportunistic), external direct (core) and fund of fund real estate, and performed as well as internally managed real estate.
- External direct (core) real estate had the lowest volatility of all real estate implementation styles.
- Internally managed (core) provided higher Sharpe ratios than the most common style of unlisted real estate, namely external direct (core) funds.

**ES5. Real estate average net return by style
(1998-2022)**



Summary

- Aggregate asset class net returns, standardized to remove reporting lags in unlisted real estate and private equity, are summarized in Exhibit ES6.

ES6. Standardized aggregate asset class net returns for U.S. DB pension funds (in percent)

Year	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	International	U.S. Broad	U.S. Long Bonds	U.S. Other	Non- U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
2022	-17.74	-17.06	-17.14	-15.71	-26.28	-3.17	-17.74	-15.20	-18.20	9.31	3.49	-3.79
2021	25.93	19.28	11.68	-1.29	-2.35	4.11	-2.72	21.01	30.93	16.95	7.36	14.49
2020	17.73	19.54	15.27	10.32	16.22	3.22	8.11	1.97	-3.85	-2.28	5.47	28.72
2019	29.97	26.89	23.25	10.69	20.05	5.71	12.24	16.20	21.05	7.10	5.93	39.61
2018	-5.36	-10.74	-13.16	-0.52	-5.24	-0.36	-3.59	1.53	-4.20	-0.84	-1.98	-14.31
2017	21.45	16.24	27.77	4.66	11.20	2.98	9.46	7.97	7.96	6.20	5.90	12.69
2016	11.56	17.40	5.06	4.14	7.50	5.25	8.73	8.37	4.88	8.99	2.42	23.45
2015	0.67	-3.72	-3.25	-0.13	-3.51	-0.90	-3.35	4.70	1.74	-9.88	-1.05	4.67
2014	12.52	5.03	-1.78	6.91	19.39	1.79	2.85	24.87	20.19	2.37	4.75	2.78
2013	33.38	38.39	17.84	-2.09	-7.72	1.35	-0.39	0.24	3.99	2.88	9.10	25.91
2012	16.27	16.00	17.72	7.14	10.51	5.41	11.54	15.06	20.55	3.84	7.54	17.12
2011	0.90	-3.08	-12.71	8.48	22.17	3.61	3.77	-1.28	2.05	-1.53	0.80	-6.66
2010	16.22	26.41	12.45	8.61	11.03	5.10	13.62	-0.54	23.51	10.93	9.26	19.37
2009	29.52	33.41	39.57	11.88	4.18	13.13	20.38	31.41	29.89	5.65	14.84	41.61
2008	-38.10	-37.65	-44.44	0.07	13.96	-5.39	-8.67	-27.09	-38.20	-9.66	-17.84	-29.74
2007	5.81	2.24	14.30	6.51	7.66	4.89	7.88	-10.56	-10.75	14.40	8.07	3.30
2006	14.67	14.68	25.72	4.80	2.67	5.68	7.79	28.73	34.75	14.86	11.03	24.10
2005	6.75	7.21	16.72	3.15	5.99	3.32	1.93	9.46	14.16	19.19	7.44	6.72
2004	12.02	16.76	19.62	5.29	9.07	4.92	10.31	18.49	32.43	18.18	7.42	16.20
2003	30.80	43.17	37.56	6.11	6.87	8.12	18.10	25.38	33.09	9.56	15.61	31.49
2002	-21.45	-19.33	-14.12	9.38	15.21	2.35	14.11	-0.28	5.17	9.24	-12.17	-18.64
2001	-9.94	-1.27	-17.36	8.17	6.57	4.54	2.11	0.35	10.94	4.44	-5.02	-13.23
2000	-5.21	0.27	-12.45	11.42	16.14	6.33	4.65	31.56	26.58	18.95	1.50	17.95
1999	19.19	29.88	38.33	-0.63	-7.89	5.56	1.24	8.92	1.23	22.30	10.12	34.00
1998	23.59	2.94	11.80	8.50	11.90	6.19	10.64	-9.71	-6.39	1.75	21.09	16.94
Arit. Gross Ret.:	9.45	10.31	8.36	4.80	6.79	3.91	5.73	8.83	10.23	8.44	6.14	14.03
Avg. Invest. Cost:	0.21	0.60	0.43	0.17	0.17	0.16	0.41	1.17	0.49	1.12	1.30	2.20
Arit. Net Ret.:	9.25	9.71	7.93	4.63	6.61	3.75	5.32	7.66	9.74	7.32	4.84	11.83
Comp. Net Ret.:	7.63	7.96	5.78	4.46	6.03	3.69	4.97	6.57	8.16	6.98	4.51	10.23
Std. Dev.:	17.56	18.75	20.31	5.87	10.64	3.60	8.37	15.03	17.67	8.41	8.10	18.16
Volatility:	17.85	19.65	20.73	6.67	11.27	6.59	11.06	17.72	19.41	16.22	10.61	23.07
Sharpe Ratio:	0.40	0.38	0.28	0.38	0.39	0.24	0.28	0.31	0.39	0.30	0.26	0.40

References

[1] "2023 Investment Company Fact Book – A Review of Trends and Activities in the Investment Company Industry", 63rd edition, p 99.

[2] This update adds 2015 - 2022 statistics to the executive summary of the previously published report "Asset Allocation and Fund Performance of Defined Benefit Pension Funds in the United States, 1998-2014". In so-doing, historical unlisted real estate and private equity net returns, standardized to remove reporting lag, have been restated. Please see the full article for details at:

<https://www.cembenchmarking.com/insights.html>

[3] Alexander D. Beath and Chris Flynn, "Real Estate Performance by Investment Style", December 2018. Full article available at:

<https://www.cembenchmarking.com/insights.html>

[4] This category, formerly identified as 'Non-U.S. Stock', includes dedicated developed international and emerging portfolios, as well as global (including U.S.) stock portfolios. The latter, which used to represent a very small portion of the assets in the category have been growing in popularity. The category has been renamed to reflect this shift.

Appendix A: Supplemental tables

The following tables were included in the original version of this paper (i.e., Reference 2) and are included here, updated with 2015-2022 data. Table numbering has been retained from Reference 2.

Tables 1A and 1B. Assets under management (AUM) for U.S. public sector (top) and corporate sector (bottom) pension funds by year expressed in \$millions (USD) within the CEM database.

Table 1A. Assets Under Management: U.S. Public Sector DB Pension Funds (in \$millions USD)

Year	#	Avg.	Std. Dev.	Min.	Q1	Med.	Q3	Max.	Total
2022	44	\$67,721	\$92,968	\$1,098	\$9,908	\$32,166	\$92,915	\$479,314	\$2,979,709
2021	45	\$70,648	\$93,714	\$2,047	\$10,130	\$38,985	\$93,148	\$465,861	\$3,179,147
2020	50	\$55,020	\$78,654	\$1,820	\$8,547	\$20,596	\$73,161	\$415,823	\$2,751,001
2019	48	\$52,346	\$72,048	\$600	\$6,647	\$19,525	\$76,684	\$367,259	\$2,512,631
2018	57	\$50,198	\$67,628	\$598	\$6,399	\$23,186	\$73,245	\$354,843	\$2,811,109
2017	60	\$46,482	\$62,497	\$1,299	\$7,360	\$21,329	\$59,551	\$326,388	\$2,788,900
2016	60	\$40,987	\$56,787	\$595	\$5,667	\$16,863	\$48,490	\$296,294	\$2,459,212
2015	62	\$40,256	\$55,249	\$1,198	\$5,481	\$16,512	\$46,318	\$292,427	\$2,495,849
2014	62	\$38,600	\$54,629	\$837	\$5,390	\$16,075	\$42,904	\$287,947	\$2,393,191
2013	64	\$33,828	\$48,252	\$989	\$5,903	\$14,763	\$39,599	\$263,404	\$2,164,985
2012	68	\$31,244	\$43,229	\$927	\$5,295	\$13,667	\$36,827	\$235,389	\$2,124,617
2011	68	\$30,068	\$41,631	\$867	\$6,271	\$13,072	\$34,583	\$225,228	\$2,044,656
2010	73	\$23,804	\$36,400	\$813	\$3,080	\$9,871	\$23,795	\$215,814	\$1,737,684
2009	73	\$21,410	\$32,703	\$320	\$3,081	\$8,632	\$21,596	\$195,277	\$1,562,899
2008	72	\$25,508	\$40,166	\$710	\$3,306	\$8,858	\$24,107	\$222,213	\$1,836,579
2007	80	\$22,364	\$39,052	\$621	\$2,808	\$7,500	\$22,592	\$243,745	\$1,789,094
2006	69	\$23,801	\$37,362	\$422	\$3,293	\$7,842	\$22,175	\$216,422	\$1,642,253
2005	72	\$18,868	\$32,835	\$393	\$2,596	\$6,324	\$17,865	\$194,502	\$1,358,529
2004	76	\$17,827	\$30,330	\$369	\$2,350	\$5,678	\$16,034	\$175,296	\$1,354,833
2003	74	\$15,849	\$25,427	\$325	\$2,126	\$5,571	\$15,256	\$146,841	\$1,172,830
2002	74	\$15,205	\$25,304	\$314	\$2,061	\$5,016	\$13,684	\$142,563	\$1,125,203
2001	83	\$15,400	\$26,473	\$147	\$1,826	\$5,466	\$13,058	\$158,116	\$1,278,235
2000	80	\$17,134	\$30,773	\$502	\$2,284	\$5,449	\$12,713	\$167,867	\$1,370,738
1999	83	\$15,911	\$27,745	\$305	\$1,588	\$4,947	\$12,294	\$161,527	\$1,320,607
1998	69	\$15,124	\$25,913	\$292	\$1,552	\$4,963	\$11,671	\$139,930	\$1,043,527

Table 1B. Assets Under Management: U.S. Corporate Sector DB Pension Funds (in \$millions USD)

Year	#	Avg.	Std. Dev.	Min.	Q1	Med.	Q3	Max.	Total
2022	93	\$11,688	\$13,636	\$328	\$2,697	\$6,270	\$15,186	\$65,714	\$1,086,969
2021	91	\$13,351	\$15,682	\$416	\$2,919	\$6,606	\$17,491	\$66,991	\$1,214,897
2020	97	\$12,225	\$14,470	\$296	\$2,680	\$5,598	\$16,129	\$61,132	\$1,185,790
2019	93	\$11,640	\$13,401	\$251	\$2,514	\$6,218	\$14,320	\$57,928	\$1,082,522
2018	99	\$10,731	\$12,982	\$224	\$2,249	\$4,750	\$13,120	\$58,263	\$1,062,325
2017	97	\$9,987	\$12,382	\$223	\$2,008	\$4,552	\$12,688	\$57,599	\$968,694
2016	100	\$10,071	\$12,416	\$327	\$1,991	\$5,393	\$12,428	\$54,857	\$1,007,070
2015	101	\$9,771	\$11,979	\$474	\$2,221	\$5,074	\$12,099	\$56,534	\$986,860
2014	97	\$10,302	\$12,569	\$469	\$2,749	\$5,354	\$12,335	\$58,866	\$999,256
2013	112	\$9,073	\$12,184	\$152	\$2,187	\$3,994	\$11,660	\$59,191	\$1,016,147
2012	120	\$8,031	\$11,366	\$47	\$1,879	\$3,518	\$9,859	\$61,469	\$963,749
2011	124	\$7,579	\$12,512	\$37	\$1,573	\$3,153	\$8,282	\$93,529	\$939,748
2010	121	\$7,162	\$12,005	\$34	\$1,434	\$2,529	\$7,432	\$85,991	\$866,645
2009	122	\$6,475	\$11,381	\$160	\$1,258	\$2,494	\$6,437	\$86,296	\$789,957
2008	130	\$6,268	\$12,043	\$78	\$1,185	\$2,423	\$5,728	\$94,962	\$814,814
2007	121	\$7,093	\$12,703	\$90	\$1,630	\$3,141	\$7,355	\$102,587	\$858,221
2006	64	\$9,154	\$16,144	\$424	\$1,864	\$3,721	\$9,189	\$105,719	\$585,882
2005	69	\$8,988	\$14,764	\$375	\$1,972	\$3,588	\$8,950	\$92,692	\$620,189
2004	78	\$7,525	\$12,941	\$37	\$1,592	\$3,276	\$7,031	\$85,437	\$586,963
2003	71	\$7,089	\$11,992	\$55	\$1,362	\$2,678	\$6,277	\$73,289	\$503,314
2002	69	\$7,159	\$11,506	\$82	\$1,397	\$2,783	\$6,451	\$62,327	\$494,000
2001	81	\$6,750	\$11,741	\$26	\$1,270	\$2,664	\$6,103	\$71,398	\$546,710
2000	72	\$7,471	\$13,257	\$123	\$1,144	\$2,402	\$6,833	\$76,600	\$537,927

1999	85	\$5,835	\$10,932	\$128	\$1,080	\$1,908	\$4,749	\$74,550	\$495,979
1998	91	\$5,385	\$10,363	\$120	\$979	\$1,928	\$3,904	\$71,850	\$490,017

Table 2. Annual average net returns by aggregate asset class as reported to CEM (in percent). Summary statistics include the arithmetic average return, the compound average net return, the standard deviation of annual average net returns, the volatility (which includes the effects of in-year standard deviation of annual average net returns), and the sharp ratio (the risk-free rate of return used are 3-month T-bills).

Table 2. As reported aggregate asset class net returns for U.S. DB pension funds (in percent)

Year	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
2022	-17.74	-17.06	-17.14	-15.71	-26.28	-3.17	-17.74	11.67	-18.20	9.31	3.49	-0.44
2021	25.93	19.28	11.68	-1.29	-2.35	4.11	-2.72	19.02	30.93	16.95	7.36	44.39
2020	17.73	19.54	15.27	10.32	16.22	3.22	8.11	-0.05	-3.85	-2.28	5.47	14.86
2019	29.97	26.89	23.25	10.69	20.05	5.71	12.24	5.40	21.05	7.10	5.93	9.66
2018	-5.36	-10.74	-13.16	-0.52	-5.24	-0.36	-3.59	6.79	-4.20	-0.84	-1.98	14.49
2017	21.45	16.24	27.77	4.66	11.20	2.98	9.46	7.05	7.96	6.20	5.90	15.38
2016	11.56	17.40	5.06	4.14	7.50	5.25	8.73	8.00	4.88	8.99	2.42	8.87
2015	0.67	-3.72	-3.25	-0.13	-3.51	-0.90	-3.35	12.74	1.74	-9.88	-1.05	8.39
2014	12.52	5.03	-1.78	6.91	19.39	1.79	2.85	12.73	20.19	2.37	4.75	15.37
2013	33.38	38.39	17.84	-2.09	-7.72	1.35	-0.39	12.00	3.99	2.88	9.10	15.43
2012	16.27	16.00	17.72	7.14	10.51	5.41	11.54	9.74	20.55	3.84	7.54	11.91
2011	0.90	-3.08	-12.71	8.48	22.17	3.61	3.77	13.37	2.05	-1.53	0.80	10.53
2010	16.22	26.41	12.45	8.61	11.03	5.10	13.62	9.01	23.51	10.93	9.26	12.42
2009	29.52	33.41	39.57	11.88	4.18	13.13	20.38	-29.69	29.89	5.65	14.84	-3.97
2008	-38.10	-37.65	-44.44	0.07	13.96	-5.39	-8.67	-8.14	-38.20	-9.66	-17.84	-10.79
2007	5.81	2.24	14.30	6.51	7.66	4.89	7.88	15.42	-10.75	14.40	8.07	20.46
2006	14.67	14.68	25.72	4.80	2.67	5.68	7.79	19.08	34.75	14.86	11.03	16.99
2005	6.75	7.21	16.72	3.15	5.99	3.32	1.93	23.12	14.16	19.19	7.44	18.94
2004	12.02	16.76	19.62	5.29	9.07	4.92	10.31	13.51	32.43	18.18	7.42	15.64
2003	30.80	43.17	37.56	6.11	6.87	8.12	18.10	9.63	33.09	9.56	15.61	9.02
2002	-21.45	-19.33	-14.12	9.38	15.21	2.35	14.11	5.22	5.17	9.24	-12.17	-12.19
2001	-9.94	-1.27	-17.36	8.17	6.57	4.54	2.11	6.00	10.94	4.44	-5.02	-18.19
2000	-5.21	0.27	-12.45	11.42	16.14	6.33	4.65	12.63	26.58	18.95	1.50	28.98
1999	19.19	29.88	38.33	-0.63	-7.89	5.56	1.24	9.91	1.23	22.30	10.12	33.76
1998	23.59	2.94	11.80	8.50	11.90	6.19	10.64	13.81	-6.39	1.75	21.09	13.51
Arit. Gross Ret.:	9.45	10.31	8.36	4.80	6.79	3.91	5.73	9.89	10.23	8.44	6.14	13.94
Avg. Invest. Cost:	0.21	0.60	0.43	0.17	0.17	0.16	0.41	1.17	0.49	1.12	1.30	2.20
Arit. Net Ret.:	9.25	9.71	7.93	4.63	6.61	3.75	5.32	8.72	9.74	7.32	4.84	11.74
Comp. Net Ret.:	7.63	7.96	5.78	4.46	6.03	3.69	4.97	8.18	8.16	6.98	4.51	10.91
Std. Dev.:	17.56	18.75	20.31	5.87	10.64	3.60	8.37	9.96	17.67	8.41	8.10	13.39
Volatility:	17.85	19.65	20.73	6.67	11.27	6.59	11.06	12.48	19.41	16.22	10.61	18.96
Sharpe Ratio:	0.40	0.38	0.28	0.38	0.39	0.24	0.28	0.53	0.39	0.30	0.26	0.46

Table 4A. Arithmetic average annualized returns in percent by aggregate asset class for selected multi-year time spans. Unlisted real estate and private equity have been standardized for reporting lag. Maximum values within each time span are highlighted in green while lows are highlighted in red.

Table 4A. Annualized arithmetic average net return by time span (in percent)

Time Span	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
5-year												
2017 - 2022	10.10	7.58	3.98	0.70	0.48	1.90	-0.74	5.37	5.15	6.05	4.05	13.12
2017 - 2021	17.94	14.24	12.96	4.77	7.98	3.13	4.70	9.92	10.38	5.42	4.54	16.43
2016 - 2020	15.07	13.87	11.64	5.86	9.95	3.36	6.99	7.52	5.17	3.83	3.55	18.09
2015 - 2019	11.66	9.21	7.93	3.77	6.00	2.54	4.70	7.72	6.29	2.31	2.24	13.25
2014 - 2018	8.17	4.84	2.93	3.01	5.87	1.75	2.82	9.58	6.11	1.37	2.01	5.89
2013 - 2017	15.92	14.67	9.13	2.70	5.37	2.09	3.46	9.14	7.75	2.11	4.22	13.89
2012 - 2016	14.88	14.62	7.12	3.19	5.23	2.58	3.87	10.63	10.27	1.64	4.55	14.79
2011 - 2015	12.75	10.52	3.56	4.06	8.17	2.25	2.88	8.33	9.70	-0.46	4.23	8.74
2010 - 2014	15.86	16.55	6.71	5.81	11.08	3.45	6.28	7.66	14.06	3.70	6.29	11.67
2009 - 2013	19.26	22.22	14.98	6.81	8.03	5.72	9.78	8.81	16.00	4.36	8.31	19.40
2008 - 2012	4.96	7.02	2.52	7.24	12.37	4.37	8.13	3.48	7.56	1.85	2.92	8.29
2007 - 2011	2.87	4.27	1.84	7.11	11.80	4.27	7.40	-1.84	1.30	3.96	3.02	5.51
2006 - 2010	5.62	7.82	9.52	6.37	7.90	4.68	8.20	4.25	7.84	7.24	5.07	11.67
2005 - 2009	3.73	3.98	10.37	5.28	6.89	4.33	5.86	6.25	5.97	8.89	4.71	9.18
2004 - 2008	0.23	0.65	6.38	3.96	7.87	2.68	3.85	3.47	6.48	11.39	3.22	4.11
2003 - 2007	14.01	16.81	22.78	5.17	6.45	5.39	9.20	14.16	20.74	15.24	9.91	16.36
2002 - 2006	8.56	12.50	17.10	5.75	7.96	4.88	10.45	16.33	23.92	14.20	5.87	11.99
2001 - 2005	3.64	9.31	8.48	6.42	8.74	4.65	9.31	10.74	19.16	12.12	2.65	4.55
2000 - 2004	1.24	7.92	2.65	8.07	10.77	5.25	9.86	15.23	21.64	12.07	1.47	6.81
1999 - 2003	2.68	10.54	6.39	6.89	7.38	5.38	8.04	13.43	15.40	12.90	2.01	10.31
1998 - 2002	1.23	2.50	1.24	7.37	8.39	4.99	6.55	6.16	7.51	11.34	3.10	7.47
10-year												
2013 - 2022	13.01	11.12	6.55	1.70	2.93	2.00	1.36	7.26	6.45	4.08	4.14	13.51
2012 - 2021	16.41	14.43	10.04	3.98	6.61	2.86	4.29	10.27	10.32	3.53	4.54	15.61
2011 - 2020	13.91	12.19	7.60	4.96	9.06	2.81	4.94	7.92	7.44	1.69	3.89	13.42
2010 - 2019	13.76	12.88	7.32	4.79	8.54	2.99	5.49	7.69	10.17	3.01	4.27	12.46
2009 - 2018	13.71	13.53	8.95	4.91	6.95	3.74	6.30	9.19	11.06	2.86	5.16	12.65
2008 - 2017	10.44	10.84	5.82	4.97	8.87	3.23	5.79	6.31	7.66	1.98	3.57	11.09
2007 - 2016	8.88	9.44	4.48	5.15	8.52	3.42	5.64	4.40	5.79	2.80	3.79	10.15
2006 - 2015	9.19	9.17	6.54	5.22	8.04	3.47	5.54	6.29	8.77	3.39	4.65	10.21
2005 - 2014	9.79	10.26	8.54	5.55	8.99	3.89	6.07	6.96	10.01	6.29	5.50	10.42
2004 - 2013	9.74	11.44	10.68	5.38	7.95	4.20	6.82	6.14	11.24	7.87	5.76	11.76
2003 - 2012	9.49	11.91	12.65	6.20	9.41	4.88	8.66	8.82	14.15	8.54	6.42	12.32
2002 - 2011	5.71	8.38	9.47	6.43	9.88	4.57	8.92	7.24	12.61	9.08	4.44	8.75
2001 - 2010	4.63	8.56	9.00	6.40	8.32	4.67	8.76	7.50	13.50	9.68	3.86	8.11
2000 - 2009	2.49	5.95	6.51	6.68	8.83	4.79	7.86	10.74	13.81	10.48	3.09	7.99
1999 - 2008	1.45	5.60	6.39	5.43	7.63	4.03	5.94	8.45	10.94	12.14	2.61	7.21
1998 - 2007	7.62	9.65	12.01	6.27	7.42	5.19	7.88	10.16	14.12	13.29	6.51	11.91
15-year												
2008 - 2022	10.33	9.76	5.21	3.54	6.07	2.79	3.62	6.00	6.82	3.34	3.73	11.77
2007 - 2021	11.90	11.04	7.31	5.03	8.34	3.33	5.32	6.24	7.32	3.67	4.04	12.24
2006 - 2020	11.15	10.74	8.24	5.43	8.67	3.43	6.02	6.70	7.57	3.54	4.28	12.84
2005 - 2019	10.42	9.91	8.34	4.95	7.99	3.44	5.61	7.21	8.77	4.97	4.41	11.36
2004 - 2018	9.22	9.24	8.10	4.59	7.26	3.38	5.48	7.29	9.53	5.71	4.51	9.80
2003 - 2017	11.63	12.83	11.48	5.04	8.07	3.95	6.93	8.93	12.02	6.40	5.69	12.85
2002 - 2016	8.77	10.46	8.68	5.35	8.33	3.91	7.24	8.37	11.83	6.60	4.48	10.76
2001 - 2015	7.34	9.22	7.19	5.62	8.27	3.86	6.80	7.77	12.23	6.30	3.98	8.32
2000 - 2014	6.94	9.48	6.58	6.39	9.58	4.34	7.33	9.72	13.89	8.22	4.15	9.22
1999 - 2013	7.39	11.14	9.25	5.89	7.76	4.59	7.22	8.57	12.63	9.55	4.51	11.27
1998 - 2012	6.74	8.78	8.85	6.59	9.07	4.92	7.96	7.93	11.93	9.47	5.31	10.71
25-year												
1998 - 2022	9.25	9.71	7.93	4.63	6.61	3.75	5.32	7.66	9.74	7.32	4.84	11.83

Table 4B. Compound average annualized returns in percent by aggregate asset class for selected multi-year time spans.
 Unlisted real estate and private equity have been standardized for reporting lag. Maximum values within each time span are highlighted in green while lows are highlighted in red.

Table 4B. Annualized compound average net return by time span (in percent)

Time Span	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
5-year												
2018 - 2022	8.44	6.02	2.68	0.21	-0.98	1.85	-1.31	4.54	3.61	5.81	4.00	11.33
2017 - 2021	17.23	13.42	11.98	4.65	7.50	3.11	4.49	9.61	9.53	5.21	4.48	14.91
2016 - 2020	14.43	13.06	10.61	5.77	9.59	3.34	6.84	7.37	4.77	3.73	3.50	16.53
2015 - 2019	10.90	8.27	6.81	3.69	5.58	2.50	4.48	7.58	5.96	2.07	2.19	11.77
2014 - 2018	7.75	4.26	2.07	2.97	5.47	1.73	2.67	9.24	5.81	1.15	1.96	5.14
2013 - 2017	15.41	13.81	8.49	2.64	4.91	2.07	3.34	8.76	7.56	1.90	4.17	13.50
2012 - 2016	14.40	13.76	6.73	3.13	4.78	2.55	3.73	10.23	9.96	1.44	4.49	14.40
2011 - 2015	12.13	9.49	2.85	3.97	7.49	2.23	2.76	7.81	9.36	-0.60	4.16	8.14
2010 - 2014	15.40	15.61	5.99	5.73	10.55	3.44	6.14	7.10	13.69	3.62	6.24	11.01
2009 - 2013	18.69	21.28	13.71	6.70	7.58	5.65	9.54	8.06	15.47	4.28	8.21	18.33
2008 - 2012	1.80	3.40	-2.17	7.16	12.22	4.20	7.65	1.51	4.05	1.60	2.24	5.31
2007 - 2011	-0.10	0.83	-2.74	7.04	11.64	4.10	6.94	-3.68	-2.02	3.59	2.34	2.69
2006 - 2010	2.49	4.28	4.62	6.30	7.82	4.51	7.75	1.65	3.58	6.83	4.34	8.72
2005 - 2009	0.76	0.90	5.40	5.21	6.82	4.16	5.44	3.62	1.96	8.37	3.99	6.34
2004 - 2008	-2.13	-1.76	2.20	3.94	7.81	2.60	3.61	1.34	2.36	10.83	2.61	2.23
2003 - 2007	13.67	16.01	22.51	5.17	6.43	5.37	9.08	13.16	19.33	15.19	9.87	15.89
2002 - 2006	7.10	10.64	15.70	5.73	7.88	4.86	10.31	15.80	23.31	14.13	5.41	10.51
2001 - 2005	2.04	7.38	6.39	6.40	8.69	4.63	9.12	10.28	18.61	11.98	2.16	2.91
2000 - 2004	-0.35	5.95	0.45	8.05	10.70	5.23	9.70	14.47	21.09	11.93	1.01	5.00
1999 - 2003	0.89	8.23	3.41	6.81	7.02	5.36	7.83	12.66	14.75	12.70	1.51	7.98
1998 - 2002	-0.25	1.32	-0.79	7.28	8.01	4.98	6.43	5.26	6.95	11.05	2.46	5.55
10-year												
2013 - 2022	11.87	9.85	5.55	1.42	1.92	1.96	0.99	6.63	5.57	3.84	4.08	12.41
2012 - 2021	15.81	13.59	9.32	3.88	6.13	2.83	4.11	9.92	9.74	3.31	4.49	14.65
2011 - 2020	13.27	11.26	6.66	4.87	8.54	2.78	4.78	7.59	7.04	1.55	3.83	12.26
2010 - 2019	13.13	11.88	6.40	4.71	8.04	2.97	5.31	7.34	9.76	2.84	4.19	11.39
2009 - 2018	13.09	12.45	7.73	4.82	6.52	3.67	6.05	8.65	10.53	2.70	5.04	11.54
2008 - 2017	8.39	8.48	3.02	4.88	8.50	3.13	5.47	5.07	5.79	1.75	3.20	9.33
2007 - 2016	6.90	7.10	1.88	5.06	8.15	3.32	5.32	3.04	3.80	2.51	3.41	8.38
2006 - 2015	7.20	6.85	3.73	5.13	7.66	3.36	5.23	4.69	6.43	3.05	4.25	8.43
2005 - 2014	7.83	8.00	5.69	5.47	8.67	3.80	5.79	5.35	7.67	5.97	5.11	8.65
2004 - 2013	7.78	9.15	7.80	5.31	7.70	4.11	6.53	4.65	8.71	7.50	5.38	9.98
2003 - 2012	7.57	9.53	9.48	6.16	9.29	4.79	8.36	7.18	11.43	8.18	5.99	10.47
2002 - 2011	3.43	5.62	6.08	6.38	9.74	4.48	8.61	5.61	9.92	8.73	3.86	6.53
2001 - 2010	2.27	5.81	5.50	6.35	8.26	4.57	8.43	5.88	10.84	9.37	3.25	5.78
2000 - 2009	0.20	3.39	2.89	6.62	8.74	4.69	7.55	8.91	11.11	10.14	2.49	5.67
1999 - 2008	-0.63	3.11	2.80	5.36	7.41	3.97	5.70	6.85	8.38	11.76	2.06	5.07
1998 - 2007	6.49	8.42	10.24	6.22	7.22	5.18	7.75	9.14	12.97	13.10	6.10	10.60
15-year												
2008 - 2022	8.41	7.66	2.91	3.30	5.24	2.70	3.16	4.89	5.06	3.09	3.47	9.99
2007 - 2021	10.24	9.17	5.14	4.92	7.94	3.25	5.04	5.19	5.67	3.40	3.77	10.52
2006 - 2020	9.56	8.88	5.97	5.34	8.30	3.36	5.76	5.57	5.88	3.28	4.00	11.06
2005 - 2019	8.84	8.09	6.06	4.87	7.63	3.36	5.35	6.09	7.09	4.65	4.13	9.68
2004 - 2018	7.77	7.50	5.85	4.52	6.95	3.31	5.23	6.16	7.74	5.34	4.22	8.35
2003 - 2017	10.12	10.94	9.15	4.97	7.81	3.87	6.66	7.70	10.13	6.04	5.38	11.47
2002 - 2016	6.97	8.27	6.29	5.28	8.06	3.83	6.96	7.13	9.93	6.24	4.07	9.09
2001 - 2015	5.45	7.02	4.61	5.55	8.00	3.78	6.51	6.52	10.35	5.94	3.55	6.56
2000 - 2014	5.03	7.31	3.91	6.32	9.34	4.27	7.08	8.31	11.96	7.92	3.73	7.42
1999 - 2013	5.43	8.84	6.31	5.81	7.47	4.53	6.96	7.25	10.69	9.21	4.07	9.31
1998 - 2012	4.90	6.72	5.94	6.53	8.86	4.85	7.72	6.53	9.92	9.13	4.80	8.80
25-year												
1998 - 2022	7.63	7.96	5.78	4.46	6.03	3.69	4.97	6.57	8.16	6.98	4.51	10.23

Table 4C. Annualized volatility in percent by aggregate asset class for selected multi-year time spans. Unlisted real estate and private equity have been standardized for reporting lag. Maximum values within each time span are highlighted in green while lows are highlighted in red.

Table 4C. Annualized volatility by time span (in percent)

Time Span	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
5-year												
2018 - 2022	19.17	19.11	16.74	10.87	17.29	8.71	13.15	16.96	20.52	11.76	10.01	23.76
2017 - 2021	13.20	14.32	14.93	6.17	10.69	8.00	8.58	12.81	15.98	11.42	6.72	22.19
2016 - 2020	12.56	14.08	15.14	5.45	9.49	7.63	7.82	9.98	10.70	9.72	6.46	20.42
2015 - 2019	13.26	14.61	15.83	4.90	9.87	7.18	8.01	8.92	9.92	12.02	5.57	19.68
2014 - 2018	9.69	11.60	14.00	3.79	9.82	5.15	6.93	11.11	9.42	12.57	5.18	15.21
2013 - 2017	11.19	14.72	12.38	4.23	10.49	4.00	7.04	11.16	8.13	12.58	5.72	13.02
2012 - 2016	10.80	14.69	9.61	4.61	10.47	4.55	7.76	11.35	10.13	12.06	5.76	13.34
2011 - 2015	12.19	15.98	12.58	5.69	12.92	4.35	7.83	12.68	10.95	13.19	6.42	15.03
2010 - 2014	10.62	15.19	12.47	5.55	11.58	4.66	9.80	14.64	11.64	11.91	6.49	15.82
2009 - 2013	11.80	15.44	17.26	6.63	11.80	8.84	12.78	17.12	13.90	12.99	8.10	19.47
2008 - 2012	23.52	25.90	29.07	6.85	10.95	10.59	15.56	22.95	26.68	20.50	13.65	27.47
2007 - 2011	22.89	25.61	28.79	6.79	11.04	10.83	15.25	22.88	26.75	21.80	13.84	27.33
2006 - 2010	23.30	25.56	29.00	6.25	9.56	10.70	14.90	26.15	29.94	24.95	13.95	27.26
2005 - 2009	22.73	23.83	29.15	6.16	9.41	10.47	13.91	26.22	29.06	25.70	13.63	26.94
2004 - 2008	19.56	20.18	25.90	4.19	7.81	7.06	10.39	23.49	29.26	26.51	12.38	22.36
2003 - 2007	9.28	14.91	9.01	1.86	2.84	5.75	7.88	18.42	19.59	19.63	7.10	16.76
2002 - 2006	17.14	20.52	17.49	2.63	4.65	5.29	8.83	15.44	14.28	19.97	13.63	21.97
2001 - 2005	18.23	21.61	21.41	2.76	3.98	5.32	9.62	14.54	13.80	17.88	14.18	23.41
2000 - 2004	18.62	22.32	22.42	3.12	4.51	5.52	9.21	15.35	14.28	19.59	14.15	29.87
1999 - 2003	19.83	25.79	26.66	4.96	8.81	5.42	10.64	15.44	14.80	19.21	14.46	34.89
1998 - 2002	18.04	20.03	22.32	4.95	8.95	4.12	9.42	16.65	14.40	19.04	15.12	34.15
10-year												
2013 - 2022	15.96	17.42	14.94	8.31	14.51	6.78	10.76	14.48	15.66	12.33	8.15	19.16
2012 - 2021	12.16	14.50	12.89	5.51	10.67	6.51	8.19	12.11	13.38	11.90	6.26	18.33
2011 - 2020	12.43	15.15	14.49	5.64	11.37	6.23	8.09	11.42	11.06	11.78	6.45	18.53
2010 - 2019	12.19	15.35	14.26	5.33	11.05	6.07	8.98	12.13	11.49	11.99	6.38	17.87
2009 - 2018	12.14	16.18	16.83	5.72	10.91	7.50	10.85	14.44	12.86	12.87	7.49	18.73
2008 - 2017	19.21	21.41	22.59	6.13	11.28	8.09	12.30	18.27	19.72	17.01	10.48	21.68
2007 - 2016	18.88	21.51	21.62	6.13	11.25	8.35	12.22	19.11	20.72	17.65	10.63	22.00
2006 - 2015	18.94	21.36	22.55	6.08	11.36	8.25	12.19	20.65	22.56	20.32	10.86	22.06
2005 - 2014	18.75	20.95	22.50	5.87	10.75	8.12	12.03	21.25	22.50	20.20	10.70	22.13
2004 - 2013	18.75	20.95	22.42	5.72	10.01	8.14	12.02	20.72	23.40	21.17	10.77	22.32
2003 - 2012	18.44	21.69	23.79	5.12	8.53	8.54	12.35	21.49	24.31	21.16	11.43	23.11
2002 - 2011	20.42	23.57	25.01	5.19	8.69	8.53	12.55	21.53	24.24	21.52	13.81	25.01
2001 - 2010	20.95	23.68	25.49	4.83	7.33	8.45	12.55	21.41	23.99	21.84	14.12	25.66
2000 - 2009	20.81	23.17	26.29	5.08	7.63	8.38	11.96	21.95	24.20	22.90	13.98	28.47
1999 - 2008	19.73	23.68	26.29	4.82	8.33	6.44	10.72	20.49	23.62	23.16	13.48	29.47
1998 - 2007	15.70	19.05	20.14	3.89	6.71	5.00	8.78	18.01	18.42	19.44	12.29	27.27
15-year												
2008 - 2022	19.20	20.73	20.84	8.28	14.15	8.32	12.96	17.85	20.03	15.58	10.33	22.41
2007 - 2021	17.72	19.54	20.05	6.14	11.07	8.24	11.15	17.46	19.39	15.90	9.51	22.26
2006 - 2020	17.30	19.37	20.52	5.89	10.81	8.05	10.95	17.83	19.51	17.52	9.64	21.85
2005 - 2019	17.14	19.08	20.52	5.63	10.56	7.84	10.88	18.10	19.32	17.99	9.44	21.38
2004 - 2018	16.31	18.63	20.35	5.28	9.99	7.38	10.76	18.17	20.01	18.99	9.45	20.42
2003 - 2017	16.66	19.69	20.76	5.12	9.42	7.46	11.14	18.69	20.62	18.98	9.95	20.32
2002 - 2016	18.32	21.23	21.19	5.23	9.57	7.50	11.44	18.83	20.67	19.22	11.76	22.01
2001 - 2015	18.89	21.44	22.19	5.25	9.56	7.43	11.54	18.95	20.66	19.97	12.11	22.68
2000 - 2014	19.13	21.44	22.64	5.26	9.20	7.38	11.31	19.87	20.87	20.18	12.11	25.03
1999 - 2013	19.40	22.69	24.01	5.53	9.63	7.37	11.59	19.43	21.02	20.67	12.25	27.17
1998 - 2012	18.72	21.61	23.92	5.10	8.69	7.37	11.50	20.04	21.75	20.52	12.87	27.39
25-year												
1998 - 2022	17.85	19.65	20.73	6.67	11.27	6.59	11.06	17.72	19.41	16.22	10.61	23.07

Table 4D. Sharpe ratios by aggregate asset class for selected multi-year time spans. The risk-free rates used are the total returns from 3-month U.S. treasury bills. Unlisted real estate and private equity have been standardized for reporting lag. Maximum values within each time span are highlighted in green while lows are highlighted in red.

Table 4D. Sharpe ratios by time span

Time Span	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
5-year												
2018 - 2022	0.45	0.33	0.16	-0.05	-0.05	0.07	-0.15	0.24	0.19	0.40	0.27	0.50
2017 - 2021	1.25	0.90	0.78	0.60	0.65	0.25	0.42	0.68	0.57	0.37	0.48	0.69
2016 - 2020	1.10	0.89	0.68	0.85	0.92	0.28	0.73	0.64	0.38	0.27	0.36	0.82
2015 - 2019	0.81	0.56	0.44	0.58	0.51	0.20	0.46	0.76	0.54	0.10	0.21	0.62
2014 - 2018	0.75	0.35	0.16	0.58	0.51	0.21	0.31	0.78	0.56	0.06	0.25	0.34
2013 - 2017	1.40	0.98	0.73	0.58	0.49	0.46	0.46	0.79	0.91	0.15	0.69	1.05
2012 - 2016	1.36	0.99	0.73	0.67	0.49	0.54	0.48	0.92	1.00	0.13	0.77	1.10
2011 - 2015	1.04	0.65	0.28	0.70	0.63	0.50	0.36	0.65	0.88	-0.04	0.65	0.58
2010 - 2014	1.48	1.08	0.53	1.03	0.95	0.72	0.63	0.52	1.20	0.30	0.95	0.73
2009 - 2013	1.62	1.43	0.86	1.01	0.67	0.63	0.76	0.51	1.14	0.32	1.01	0.99
2008 - 2012	0.18	0.24	0.07	0.91	1.08	0.35	0.47	0.12	0.26	0.06	0.16	0.28
2007 - 2011	0.06	0.10	0.01	0.74	0.89	0.24	0.37	-0.14	-0.01	0.11	0.10	0.14
2006 - 2010	0.13	0.20	0.24	0.54	0.53	0.19	0.37	0.07	0.17	0.19	0.18	0.33
2005 - 2009	0.03	0.04	0.25	0.32	0.39	0.11	0.19	0.12	0.10	0.23	0.12	0.22
2004 - 2008	-0.16	-0.13	0.12	0.16	0.54	-0.09	0.05	0.01	0.11	0.31	-0.01	0.04
2003 - 2007	1.06	0.85	1.99	0.83	0.87	0.37	0.71	0.58	0.86	0.62	0.91	0.77
2002 - 2006	0.36	0.48	0.84	0.98	0.99	0.44	0.85	0.91	1.51	0.59	0.25	0.44
2001 - 2005	0.07	0.31	0.28	1.38	1.40	0.41	0.67	0.55	1.16	0.54	0.02	0.09
2000 - 2004	-0.09	0.21	-0.01	1.96	1.83	0.39	0.66	0.81	1.27	0.46	-0.10	0.13
1999 - 2003	-0.05	0.26	0.10	0.60	0.40	0.29	0.37	0.64	0.77	0.49	-0.12	0.19
1998 - 2002	-0.19	-0.10	-0.15	0.55	0.42	0.12	0.20	0.10	0.21	0.36	-0.10	0.09
10-year												
2013 - 2022	0.76	0.59	0.38	0.11	0.15	0.18	0.05	0.44	0.36	0.27	0.41	0.66
2012 - 2021	1.29	0.94	0.73	0.62	0.57	0.34	0.45	0.79	0.72	0.24	0.61	0.82
2011 - 2020	1.07	0.76	0.48	0.77	0.74	0.34	0.53	0.64	0.61	0.09	0.49	0.69
2010 - 2019	1.08	0.80	0.47	0.79	0.72	0.39	0.54	0.59	0.83	0.20	0.56	0.67
2009 - 2018	1.08	0.80	0.50	0.77	0.59	0.44	0.54	0.61	0.81	0.19	0.62	0.65
2008 - 2017	0.51	0.48	0.23	0.72	0.75	0.34	0.43	0.32	0.36	0.09	0.29	0.48
2007 - 2016	0.41	0.39	0.17	0.68	0.68	0.30	0.38	0.18	0.23	0.11	0.27	0.41
2006 - 2015	0.40	0.36	0.23	0.60	0.58	0.26	0.34	0.24	0.33	0.10	0.30	0.40
2005 - 2014	0.42	0.40	0.31	0.61	0.66	0.27	0.36	0.25	0.37	0.24	0.36	0.39
2004 - 2013	0.41	0.45	0.40	0.58	0.60	0.29	0.41	0.21	0.40	0.29	0.37	0.44
2003 - 2012	0.40	0.45	0.45	0.74	0.82	0.34	0.53	0.50	0.32	0.32	0.39	0.45
2002 - 2011	0.18	0.27	0.30	0.74	0.84	0.29	0.53	0.24	0.43	0.33	0.18	0.27
2001 - 2010	0.10	0.25	0.25	0.72	0.75	0.25	0.48	0.23	0.45	0.33	0.10	0.22
2000 - 2009	-0.03	0.12	0.13	0.68	0.75	0.20	0.38	0.35	0.44	0.33	0.00	0.17
1999 - 2008	-0.10	0.09	0.11	0.39	0.47	0.08	0.22	0.24	0.31	0.38	-0.07	0.13
1998 - 2007	0.24	0.30	0.40	0.60	0.51	0.26	0.42	0.35	0.54	0.49	0.22	0.30
15-year												
2008 - 2022	0.49	0.43	0.21	0.33	0.38	0.24	0.22	0.29	0.30	0.17	0.28	0.49
2007 - 2021	0.60	0.50	0.31	0.65	0.67	0.28	0.39	0.29	0.32	0.17	0.31	0.50
2006 - 2020	0.56	0.48	0.34	0.67	0.67	0.26	0.43	0.30	0.32	0.13	0.31	0.52
2005 - 2019	0.51	0.43	0.34	0.59	0.61	0.25	0.38	0.31	0.37	0.20	0.31	0.46
2004 - 2018	0.47	0.41	0.33	0.57	0.57	0.27	0.37	0.32	0.40	0.23	0.33	0.41
2003 - 2017	0.60	0.57	0.49	0.68	0.70	0.34	0.49	0.40	0.51	0.27	0.43	0.56
2002 - 2016	0.39	0.42	0.35	0.71	0.71	0.33	0.50	0.37	0.50	0.28	0.26	0.42
2001 - 2015	0.29	0.34	0.25	0.71	0.67	0.29	0.43	0.32	0.50	0.24	0.19	0.29
2000 - 2014	0.24	0.33	0.19	0.79	0.79	0.30	0.45	0.38	0.56	0.31	0.17	0.28
1999 - 2013	0.25	0.38	0.28	0.59	0.53	0.29	0.40	0.32	0.48	0.35	0.17	0.32
1998 - 2012	0.21	0.27	0.25	0.67	0.67	0.28	0.43	0.26	0.41	0.33	0.20	0.29
25-year												
1998 - 2022	0.40	0.38	0.28	0.38	0.39	0.24	0.28	0.31	0.39	0.30	0.26	0.40

Table 6. Average asset allocation for U.S. DB pension funds by year. Summary statistics include the average over all years, the absolute change (i.e., 2022 value - 1998 value), the absolute change per year, and the trend per year inferred from linear least-squares regression.

Table 6. Average asset allocation of U.S. DB pension funds by year (in percent)

Year	Stock			Fixed Income			Real Assets			Other		
	U.S. Large Cap	U.S. Small Cap	Internati onal	U.S. Broad	U.S. Long Bonds	U.S. Other	Non U.S.	Unlisted Real Estate	Listed Equity REITs	Other	Hedge Funds / TAA	Private Equity
2022	11.65	2.08	17.33	12.80	21.41	7.14	5.50	5.85	0.59	1.57	5.34	8.74
2021	13.21	2.12	20.08	12.65	20.77	6.51	3.97	4.78	0.74	1.41	5.86	7.91
2020	13.80	2.36	20.41	12.61	22.51	6.16	3.47	4.69	0.64	1.40	5.49	6.46
2019	13.72	2.24	18.82	12.58	23.52	6.26	2.68	5.26	0.57	1.48	6.13	6.74
2018	15.52	3.38	20.95	12.71	21.31	4.51	2.68	5.19	0.78	1.39	5.77	5.83
2017	16.96	3.59	21.76	11.07	19.36	5.01	2.60	4.95	0.74	1.74	6.62	5.61
2016	17.46	3.73	20.72	11.68	17.00	5.29	3.26	5.29	0.60	1.67	7.37	5.94
2015	18.18	3.07	20.46	12.74	16.94	4.88	2.77	4.91	0.73	1.36	8.26	5.70
2014	18.70	3.38	20.90	12.11	16.43	4.84	2.89	4.46	0.62	1.39	8.36	5.93
2013	20.94	4.03	20.92	13.13	14.63	4.89	2.58	4.20	0.56	1.37	7.13	5.63
2012	21.59	4.47	18.86	15.12	14.44	4.78	2.31	4.06	0.55	1.36	6.60	5.86
2011	22.62	4.80	18.92	14.88	13.17	5.07	2.82	3.72	0.62	1.30	6.40	5.67
2010	25.50	5.52	19.87	17.04	9.65	4.98	2.15	3.36	0.50	1.18	5.14	5.11
2009	25.83	5.19	18.25	20.44	7.83	5.65	1.90	3.89	0.48	0.94	4.57	5.03
2008	28.91	5.17	18.13	20.64	6.55	4.53	1.92	4.29	0.66	0.71	4.14	4.34
2007	32.76	6.10	20.07	19.24	4.12	4.03	1.69	3.82	0.73	0.57	3.48	3.39
2006	35.53	6.84	19.74	20.53	1.79	3.95	1.34	3.54	0.86	0.31	2.89	2.67
2005	37.40	6.81	18.60	21.14	1.35	4.09	1.53	3.03	0.88	0.22	2.43	2.52
2004	38.60	6.75	17.92	21.63	1.38	4.17	1.42	2.73	0.84	0.19	1.70	2.67
2003	38.12	6.26	16.79	23.73	1.60	3.56	1.80	2.87	0.75	0.23	1.39	2.88
2002	37.39	6.10	15.39	27.19	1.37	2.42	2.01	3.32	0.55	0.08	1.43	2.74
2001	37.77	7.18	15.33	27.44	0.82	1.64	1.77	2.98	0.53	0.06	1.50	2.98
2000	38.18	6.65	16.37	26.41	0.87	1.54	2.21	2.87	0.52	0.05	1.30	3.04
1999	41.24	6.57	15.63	25.42	1.09	1.61	2.12	2.55	0.46	0.03	1.09	2.19
1998	42.11	5.63	13.63	26.67	0.90	1.96	2.40	2.90	0.36	0.01	1.46	1.97
Average:	26.55	4.80	18.63	18.06	10.43	4.38	2.47	3.98	0.63	0.88	4.47	4.70
Absolute change:	-30.47	-3.55	3.70	-13.86	20.51	5.18	3.10	2.95	0.23	1.56	3.89	6.77
Change per year:	-1.22	-0.14	0.15	-0.55	0.82	0.21	0.12	0.12	0.01	0.06	0.16	0.27
Trend per year:	-1.39	-0.21	0.22	-0.73	1.12	0.19	0.09	0.12	0.00	0.08	0.27	0.24

Table 8A and 8B. Average annual total fund returns by year with population standard deviations (σ) and standard errors ($\sigma/\sqrt{#}$) for U.S. public sector (top) and corporate sector (bottom) pension funds spanning 1998-2022. (For details see section 3.4. of Ref. 1.)

Table 8A. Net returns by year: U.S. public sector DB pension funds (in percent)

Year	#	As-reported			Physical-asset-only			Standardized physical-asset-only		
		Avg.	Std. Err.	Std. Dev.	Avg.	Std. Err.	Std. Dev.	Avg.	Std. Err.	Std. Dev.
2022	44	-9.89	0.49	3.25	-8.35	0.54	3.57	-12.34	0.51	3.42
2021	45	15.92	0.57	3.85	16.43	0.58	3.88	13.58	0.54	3.59
2020	50	11.79	0.28	2.62	11.57	0.39	2.72	12.27	0.43	3.04
2019	48	17.05	0.29	2.04	16.82	0.37	2.58	20.77	0.38	2.65
2018	57	-3.01	0.26	1.96	-3.12	0.27	2.05	-6.01	0.17	1.30
2017	60	15.54	0.23	1.82	15.87	0.27	2.10	15.68	0.30	2.34
2016	60	7.83	0.13	0.97	7.59	0.11	0.82	8.88	0.18	1.41
2015	62	0.32	0.20	1.54	0.56	0.15	1.20	-0.60	0.16	1.25
2014	62	6.61	0.22	1.70	6.72	0.20	2.01	6.57	0.25	2.06
2013	64	15.40	0.40	3.21	16.13	0.47	3.73	15.98	0.44	3.59
2012	68	13.10	0.14	1.12	12.97	0.15	1.25	13.52	0.19	1.56
2011	68	0.99	0.19	1.60	1.27	0.20	1.65	-0.71	0.24	1.96
2010	73	13.34	0.19	1.59	13.10	0.18	1.50	13.23	0.20	1.73
2009	73	19.96	0.49	4.22	21.24	0.52	4.41	26.97	0.44	3.77
2008	72	-26.99	0.33	2.82	-24.11	0.44	3.76	-26.30	0.47	3.99
2007	80	8.43	0.19	1.70	8.39	0.20	1.79	6.40	0.18	1.61
2006	69	14.16	0.18	1.48	14.46	0.20	1.62	15.06	0.24	1.98
2005	72	8.42	0.20	1.71	8.62	0.23	1.95	7.79	0.18	1.54
2004	76	11.98	0.15	1.32	12.14	0.15	1.35	12.26	0.17	1.50
2003	74	22.95	0.34	2.89	23.70	0.31	2.69	24.75	0.32	2.74
2002	74	-8.76	0.31	2.63	-7.53	0.28	2.42	-7.87	0.29	2.52
2001	83	-4.30	0.26	2.41	-3.88	0.27	2.48	-3.93	0.27	2.48
2000	80	0.06	0.43	3.86	0.75	0.42	3.72	1.14	0.41	3.68
1999	83	14.56	0.45	4.14	16.33	0.52	4.71	16.32	0.52	4.77
1998	69	15.10	0.41	3.37	15.55	0.42	3.45	14.90	0.44	3.61
Arithmetic Avg. Ret.:		7.22	0.06	11.13	7.73	0.07	10.78	7.53	0.07	11.99
Compound Avg. Ret.:		6.58	0.06	n/a	7.14	0.07	n/a	6.80	0.07	n/a
Avg. Volatility:		11.42	n/a	n/a	11.13	n/a	n/a	12.30	n/a	n/a

Table 8B. Net returns by year: U.S. corporate sector DB pension funds (in percent)

Year	#	As-reported			Physical-asset-only			Standardized physical-asset-only		
		Avg.	Std. Err.	Std. Dev.	Avg.	Std. Err.	Std. Dev.	Avg.	Std. Err.	Std. Dev.
2022	93	-18.79	0.48	4.59	-16.46	0.58	5.55	-17.82	0.55	5.31
2021	91	8.26	0.49	4.59	8.64	0.49	4.60	6.89	0.45	4.12
2020	97	15.21	0.33	3.24	14.77	0.33	3.28	15.00	0.35	3.44
2019	93	19.81	0.33	3.16	19.27	0.36	3.47	21.30	0.35	3.35
2018	99	-4.36	0.22	2.16	-4.68	0.23	2.27	-6.21	0.21	2.12
2017	97	15.01	0.31	3.10	14.99	0.31	3.09	14.80	0.32	3.12
2016	100	7.61	0.23	2.28	7.65	0.18	1.81	8.54	0.19	1.89
2015	101	-1.22	0.15	1.48	-1.20	0.15	1.52	-1.73	0.13	1.30
2014	97	10.13	0.36	3.57	10.04	0.35	3.47	9.87	0.35	3.46
2013	112	10.52	0.65	6.85	11.63	0.62	6.61	11.86	0.63	6.66
2012	120	12.95	0.17	1.84	12.83	0.16	1.80	13.45	0.16	1.80
2011	124	5.55	0.55	6.15	5.24	0.53	5.91	3.72	0.55	6.12
2010	121	13.53	0.18	1.93	13.17	0.18	1.93	13.22	0.16	1.75
2009	122	18.24	0.60	6.65	19.96	0.55	6.12	24.32	0.53	5.83
2008	130	-23.77	0.76	8.70	-21.35	0.73	8.36	-22.85	0.73	8.29
2007	121	8.94	0.20	2.18	8.85	0.19	2.06	7.31	0.18	2.02
2006	64	13.79	0.20	1.62	14.26	0.21	1.67	14.78	0.22	1.79
2005	69	8.72	0.22	1.87	8.75	0.22	1.81	8.02	0.18	1.47
2004	78	12.23	0.18	1.56	12.33	0.19	1.66	12.41	0.20	1.76
2003	71	23.96	0.37	3.14	24.59	0.38	3.19	25.79	0.39	3.29
2002	69	-10.51	0.39	3.25	-9.59	0.36	2.98	-9.94	0.36	2.97
2001	81	-4.94	0.32	2.88	-4.87	0.28	2.54	-4.82	0.28	2.50
2000	72	1.02	0.67	5.66	1.88	0.85	7.21	1.86	0.81	6.87
1999	85	16.89	0.74	6.81	18.54	0.75	6.94	18.56	0.74	6.86
1998	91	14.94	0.34	3.28	15.57	0.37	3.55	14.88	0.38	3.66
Arithmetic Avg. Ret.:		6.95	0.08	11.57	7.39	0.09	11.23	7.33	0.08	12.00
Compound Avg. Ret.:		6.26	0.09	n/a	6.76	0.09	n/a	6.60	0.09	n/a
Avg. Volatility:		12.31	n/a	n/a	12.01	n/a	n/a	12.71	n/a	n/a

Tables 9A and 9B. Standardized physical-asset-only net returns by year for U.S. public sector pension funds (top) and corporate sector pension fund (bottom) by size cohort.

Tables 9A. Standardized physical-asset-only net returns by year for U.S. public sector pension funds by size (in percent)

Year	Less than \$2 billion AUM				\$2 billion to \$10 billion AUM				More than \$10 billion AUM			
	Avg.	Std. Err.	Std. Dev.	#	Avg.	Std. Err.	Std. Dev.	#	Avg.	Std. Err.	Std. Dev.	#
2022	-12.95	1.31	2.62	4	-12.27	1.98	5.25	7	-12.28	0.52	2.97	33
2021	n/a	n/a	n/a	0	13.27	0.69	2.29	11	13.68	0.67	3.92	34
2020	10.98	2.71	3.84	2	12.14	0.88	3.42	15	12.40	0.48	2.76	33
2019	20.79	0.74	1.48	4	19.74	0.92	3.20	12	21.16	0.43	2.43	32
2018	-6.35	0.50	1.13	5	-6.01	0.39	1.47	14	-5.97	0.20	1.25	38
2017	15.90	0.45	0.90	4	15.88	0.73	2.91	16	15.58	0.34	2.18	40
2016	8.64	0.24	0.54	5	8.62	0.29	1.21	17	9.04	0.26	1.55	38
2015	-1.13	0.51	1.25	5	-1.21	0.32	1.34	16	-0.28	0.17	1.08	41
2014	6.25	0.72	1.91	7	6.57	0.70	2.96	14	6.62	0.24	1.57	41
2013	18.23	1.19	3.58	9	15.03	1.13	4.68	16	15.88	0.43	2.80	39
2012	13.41	0.46	1.45	10	12.90	0.37	1.46	15	13.78	0.23	1.55	43
2011	-1.15	0.44	1.31	9	-0.59	0.37	1.64	20	-0.66	0.35	2.21	39
2010	13.34	0.55	2.14	15	13.50	0.28	1.29	21	13.03	0.29	1.73	37
2009	26.42	1.04	3.90	14	27.46	0.62	3.14	26	26.83	0.73	4.12	33
2008	-26.37	1.02	3.07	9	-26.41	0.58	3.11	30	-26.18	0.84	4.80	33
2007	6.05	0.43	1.61	14	6.55	0.31	1.75	31	6.41	0.25	1.44	35
2006	14.09	0.53	1.83	12	14.37	0.34	1.71	26	16.04	0.33	1.81	31
2005	7.15	0.37	1.42	15	7.88	0.24	1.33	31	8.07	0.35	1.74	26
2004	11.71	0.46	1.82	16	12.32	0.23	1.32	33	12.52	0.28	1.42	27
2003	24.53	0.40	1.67	17	25.35	0.53	3.02	32	24.10	0.57	2.77	25
2002	-7.23	0.58	2.46	18	-7.72	0.46	2.67	33	-8.57	0.45	2.14	23
2001	-2.99	0.61	2.80	21	-3.60	0.43	2.54	35	-5.07	0.30	1.55	27
2000	0.87	0.73	3.25	19	1.78	0.74	4.44	36	0.45	0.49	2.47	25
1999	15.38	0.86	4.20	24	16.44	0.87	4.90	32	17.00	0.95	4.94	27
1998	14.42	0.86	3.94	21	14.38	0.66	3.43	27	16.03	0.71	3.23	21
Arith. Avg. Ret.:	n/a	n/a	n/a	n/a	7.45	0.14	11.94	n/a	7.58	0.10	12.11	n/a
Comp. Avg. Ret.:	n/a	n/a	n/a	n/a	6.73	0.15	n/a	n/a	6.84	0.10	n/a	n/a
Avg. Volatility:	n/a	n/a	n/a	n/a	12.30	n/a	n/a	n/a	12.40	n/a	n/a	n/a

Tables 9B. Standardized physical-asset-only net returns by year for U.S. corporate sector pension funds by size (in percent)

Year	Less than \$2 billion AUM			\$2 billion to \$10 billion AUM			More than \$10 billion AUM					
	Avg.	Std. Err.	Std. Dev.	#	Avg.	Std. Err.	Std. Dev.	#	Avg.	Std. Err.	Std. Dev.	#
2022	-19.47	0.95	4.03	17	-18.53	0.87	5.44	40	-16.22	0.89	5.32	36
2021	5.37	1.38	4.68	15	7.18	0.66	3.96	38	7.21	0.63	3.88	38
2020	14.12	0.72	2.96	16	15.94	0.56	3.67	42	14.32	0.51	3.08	39
2019	18.72	1.08	4.30	16	22.48	0.30	1.87	37	21.16	0.56	3.45	38
2018	-4.62	0.81	3.45	18	-6.75	0.18	1.20	44	-6.35	0.28	1.69	36
2017	13.88	0.76	3.72	24	15.61	0.42	2.59	38	14.54	0.50	2.97	35
2016	7.89	0.39	1.96	25	8.84	0.33	2.07	39	8.67	0.25	1.49	36
2015	-2.06	0.31	1.42	21	-1.96	0.19	1.25	44	-1.24	0.19	1.14	36
2014	10.58	1.29	5.15	14	9.82	0.47	3.16	48	9.61	0.47	2.77	35
2013	11.55	1.48	7.82	27	12.35	0.90	6.33	52	11.40	1.04	5.98	33
2012	13.34	0.37	2.14	34	13.56	0.19	1.46	58	13.37	0.37	1.94	28
2011	4.20	1.01	6.45	41	3.52	0.83	6.33	59	3.38	0.98	4.82	24
2010	13.40	0.27	1.83	44	13.22	0.24	1.79	55	12.88	0.29	1.38	22
2009	24.22	0.87	6.31	52	24.73	0.81	5.82	53	23.43	0.95	4.02	17
2008	-22.84	1.12	8.62	59	-24.66	0.93	6.85	54	-17.19	2.12	8.74	17
2007	6.87	0.36	2.28	40	7.41	0.24	1.92	63	7.96	0.33	1.42	18
2006	14.04	0.37	1.55	18	14.76	0.30	1.76	35	16.10	0.44	1.45	11
2005	7.17	0.29	1.24	18	8.18	0.24	1.48	38	8.75	0.32	1.16	13
2004	11.96	0.28	1.31	22	12.47	0.28	1.89	44	13.06	0.52	1.80	12
2003	24.43	0.49	2.56	27	26.86	0.66	3.79	33	25.93	0.51	1.69	11
2002	-9.69	0.72	3.79	28	-10.22	0.42	2.30	30	-9.81	0.60	1.98	11
2001	-4.23	0.38	2.21	33	-5.06	0.44	2.63	35	-5.69	0.70	2.51	13
2000	2.09	1.14	6.33	31	1.25	1.52	8.05	28	2.62	1.38	4.97	13
1999	16.58	0.96	6.40	44	20.71	1.36	7.30	29	20.65	1.42	4.92	12
1998	14.54	0.58	4.01	48	15.67	0.54	3.10	27	13.91	0.97	3.08	10
Arith. Avg. Ret.:	6.88	0.16	11.70	n/a	7.50	0.13	12.62	n/a	7.70	0.16	11.38	n/a
Comp. Avg. Ret.:	6.18	0.17	n/a	n/a	6.69	0.14	n/a	n/a	7.06	0.18	n/a	n/a
Avg. Volatility:	12.49	n/a	n/a	n/a	13.27	n/a	n/a	n/a	11.93	n/a	n/a	n/a

Appendix B: Real estate performance by implementation style

The data appearing in Table 10 ‘Real estate net returns by implementation style, U.S. DB pension funds’ originally appeared in a separate publication, ‘Real estate performance by implementation style’ published in December 2018 by CEM Benchmarking. In this version we have added 2017-2022 data to the original 1998-2016 data, and the data for unlisted real estate for the entire period has been updated to reflect improvements to the estimates of reporting lag for each implementation style. For questions regarding the methodology, we invite the reader to read the original publication at: <https://www.cembenchmarking.com/insights.html>

Table 10. Real estate fund-weighted annual average net returns for U.S. public and corporate sector defined benefit plans in the CEM Benchmarking database 1998-2022 by style. For a description of styles see Reference 3. Net return data for unlisted real estate have been standardized to remove reporting lag on a fund-by-fund basis. For a detailed description of the methodology see Reference 2.

Real estate net returns by implementation style, U.S. DB pension funds (in percent)						
Year	Unlisted real estate styles				Listed equity	
	Internal (core)	External direct (core)	External LP (opportunistic)	External fund-of-fund (opportunistic)	Total (core & opportunistic)	REITs (primarily core)
2022	-13.82	-16.14	-17.54	-21.13	-15.20	-18.20
2021	19.05	20.61	19.34	13.78	21.80	30.93
2020	10.63	3.44	4.11	3.05	1.74	-3.85
2019	17.78	17.44	17.64	15.29	17.00	21.05
2018	0.01	1.85	2.32	3.92	1.53	-4.20
2017	8.66	7.84	9.13	9.59	7.50	7.96
2016	12.84	10.61	10.63	7.38	9.84	4.88
2015	2.34	1.43	1.56	-0.33	2.75	1.74
2014	27.43	26.65	26.61	23.15	26.27	20.19
2013	4.43	-0.60	0.40	-1.87	-0.67	3.99
2012	15.64	15.22	14.04	8.12	14.98	20.55
2011	0.35	-1.03	-2.91	-5.40	-1.70	2.05
2010	13.45	1.40	6.04	17.31	-0.58	23.51
2009	31.98	29.97	30.85	42.01	32.02	29.89
2008	-27.12	-26.48	-32.59	-28.96	-27.35	-38.20
2007	-8.49	-11.23	-4.19	-11.59	-11.58	-10.75
2006	33.08	27.61	34.01	21.07	28.73	34.75
2005	12.71	9.27	20.36	2.52	9.44	14.16
2004	23.80	17.25	19.70	18.43	18.10	32.43
2003	30.21	25.68	23.70	28.67	26.13	33.09
2002	-2.13	-0.56	-13.41	-2.41	-0.77	5.17
2001	6.38	2.64	-1.59	-2.14	0.82	10.94
2000	34.12	31.50	43.52	30.07	31.89	26.58
1999	7.06	8.55	6.68	9.29	9.07	1.23
1998	-16.30	-10.69	-14.34	-15.06	-10.22	-6.39
Net arit ¹ . avg.	9.76	7.69	8.16	6.59	7.66	9.74
Net geo ² . avg.	8.58	6.65	6.73	5.33	6.57	8.16
Stdev ³ .	15.66	14.65	17.18	16.08	15.03	17.67
Volatility ⁴	18.67	17.25	19.54	17.78	17.72	19.41
Sharpe ratio ⁵	0.40	0.32	0.31	0.24	0.31	0.39

1. Net arithmetic average return is the simple average of fund-weighted annual averages appearing in the table. The returns are net of all direct investment management expenses.

2. Net geometric average return is the compound average of fund-weighted averages appearing in the table. The returns are net of all direct investment management expenses.

3. Standard deviation is the population standard deviation of fund-weighted averages appearing in the table.

4. Volatility is the standard deviation that an individual fund can expect to experience. It is larger than the standard deviation because it includes the effects of idiosyncratic risk (i.e., in-year fund-to-fund dispersion of annual returns due to differences in investments).

5. Sharpe ratio is the excess return over the risk-free rate (taken here to be 3-month U.S. treasury bills) divided by the volatility.

Table 11. Fund-weighted average allocations to real estate for U.S. public and corporate sector defined benefit plans in the CEM Benchmarking database 1998-2022 by style. For a description of styles see Reference 3. Allocations are shown as a percent of total fund net asset value (NAV).

Average allocation to real estate by implementation style, U.S. DB pension funds						
Year	Unlisted real estate styles				Total (core & opportunistic)	Listed equity REITs (primarily core)
	Internal (core)	External direct (core)	External LP (opportunistic)	External fund-of-fund (opportunistic)		
2022	0.34	3.34	1.92	0.25	5.85	0.59
2021	0.25	2.78	1.53	0.21	4.78	0.74
2020	0.19	2.83	1.39	0.16	4.57	0.65
2019	0.22	2.94	1.91	0.18	5.26	0.57
2018	0.16	3.17	1.75	0.11	5.19	0.78
2017	0.15	2.90	1.78	0.12	4.95	0.74
2016	0.12	2.71	2.30	0.16	5.29	0.60
2015	0.09	2.58	2.10	0.14	4.91	0.73
2014	0.07	2.37	1.85	0.18	4.46	0.62
2013	0.09	2.29	1.67	0.16	4.20	0.56
2012	0.11	2.29	1.52	0.14	4.06	0.55
2011	0.10	2.18	1.24	0.20	3.72	0.62
2010	0.09	2.12	1.00	0.15	3.36	0.50
2009	0.13	2.49	0.99	0.28	3.89	0.48
2008	0.14	3.04	0.81	0.29	4.29	0.66
2007	0.11	2.94	0.52	0.24	3.82	0.73
2006	0.16	2.88	0.39	0.11	3.54	0.86
2005	0.15	2.51	0.28	0.09	3.03	0.88
2004	0.12	2.28	0.24	0.08	2.73	0.84
2003	0.20	2.40	0.16	0.10	2.87	0.75
2002	0.27	2.78	0.15	0.12	3.32	0.55
2001	0.19	2.61	0.09	0.09	2.98	0.53
2000	0.19	2.56	0.03	0.08	2.87	0.52
1999	0.16	2.24	0.08	0.07	2.55	0.46
1998	0.23	2.57	0.05	0.05	2.90	0.36
Average	0.17	2.62	1.04	0.15	3.98	0.63
Change per year ¹	0.00	0.03	0.08	0.01	0.12	0.01
Trend ²	0.00	0.02	0.10	0.00	0.12	0.00

1. Change per year is the absolute change in average allocation from 1998 to 2022 divided by the number of years. It represents the average change occurring in each year.

2. Trend is the change per year inferred from regression analysis. It differs from the trend because it adjusts for noise caused by un-even sampling of funds over the sample period.

Table 12. Correlations between annual average real estate net returns by implementation style (1998-2022). Unlisted asset class returns (i.e., internal, external direct, external LP, and fund of fund) have been standardized to remove lag in net returns [see Ref. 2 for details]. Also shown are correlations between real estate net returns by implementation style and the most common building blocks of U.S. DB pension fund portfolios, large cap. U.S. stocks and broad U.S. fixed income.

	Internal (core)	External direct (core)	External LP (opportunistic)	Fund of fund (opportunistic)	Listed equity REITs	Large cap. U.S. stocks	Broad U.S. fixed income
Internal (core)	n/a	0.98	0.96	0.95	0.93	0.55	0.42
External direct (core)	0.98	n/a	0.96	0.94	0.91	0.55	0.42
External LP (opportunistic)	0.96	0.96	n/a	0.91	0.88	0.54	0.39
Fund of fund (opportunistic)	0.95	0.94	0.91	n/a	0.89	0.47	0.47
Listed equity REITs	0.93	0.91	0.88	0.89	n/a	0.59	0.43
Average	0.95	0.95	0.93	0.93	0.90	0.54	0.43