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**ASSET ALLOCATION AND FUND
PERFORMANCE OF DEFINED BENEFIT
PENSION FUNDS IN THE UNITED
STATES, 1998-2017**



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Asset Allocation and Fund Performance of Defined Benefit Pension Funds in the United States, 1998-2017

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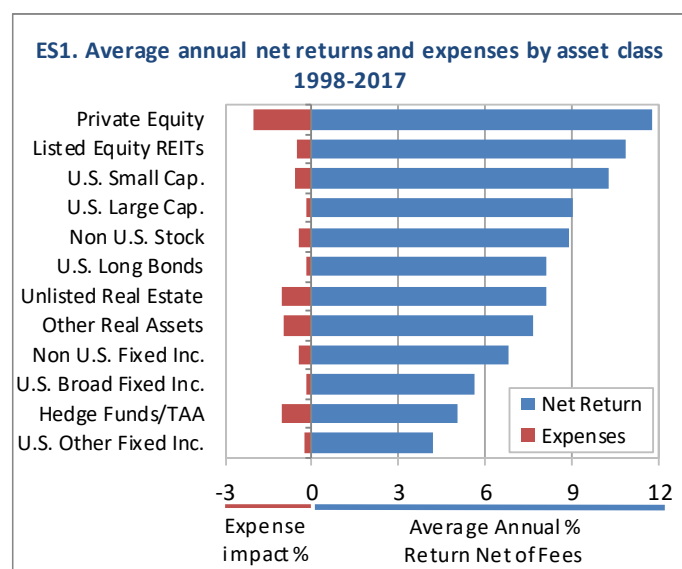
2019 Executive Summary

Introduction

- Of the \$27.1 trillion of retirement assets in the United States at the end of 2017, approximately \$5.7 trillion were held in public sector defined benefit (DB) funds and \$2.9 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 20-year period, with nearly \$3.8 trillion in combined assets under management (AUM) at the end of 2017 (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 20-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 13.8 percent. Private equity had the highest



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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.

average net return as well, estimated as 11.8 percent, much lower than the gross return because of the impact of expenses. Listed equity REITs had the second highest gross return over the period, averaging 11.4 percent and the second highest average net return of 10.9 percent as well.

- The two worst performing asset classes were hedge funds / tactical asset allocation (TAA) strategies and U.S. other fixed income. U.S. other fixed income however includes cash. If cash is excluded from U.S. other fixed income as an aggregate asset class, then hedge funds/TAA was the worst performing asset class with a 20-year arithmetic average annual net return of 5.0 percent.

Asset Allocations

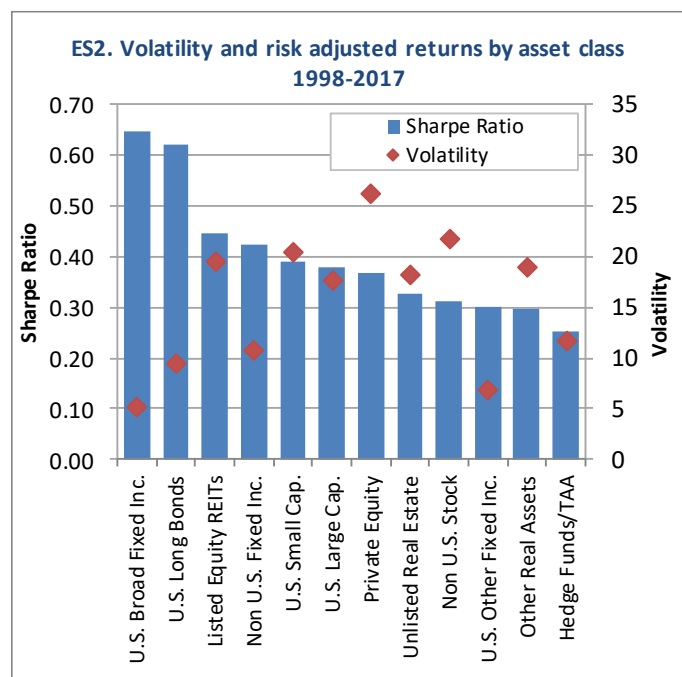
- The most material decrease in asset allocation was the decrease in allocation to U.S. large cap stocks. In 1998 over 42 percent of U.S. DB pension funds holdings were dedicated to U.S. large cap stocks. By 2017 this had fallen to less than 17 percent.
- The most material increase in asset allocation 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 today it is over 19 percent. This increase was largely confined to corporate sector pension funds.
- Although they had the second highest arithmetic average annual net return of 10.9 percent and the second highest compound average annual net return of 9.3 percent over the period, 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 3.7 percent allocation on average while having had an arithmetic average annual net return of 8.1 percent and a compound average annual net return of 6.9 percent.

Total fund returns

- Large corporate-sector plans (> \$10 billion in AUM) outperformed over the 20-year period (average compound net return of 8.1 percent) due to a timely increase in allocation to long duration fixed income just before the financial crisis of 2008.
- Small public-sector plans (< \$2 billion in AUM) underperformed (average compound net return of 7.2 percent) because of persistent underperformance in hedge funds, unlisted real estate, and private equity. The underperformance is due, in part, to the use of expensive fund-of-funds.

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.
- Two fixed income aggregate asset classes had the highest Sharpe ratios reflecting their extremely low volatilities, albeit with modest returns.
- Non-U.S. stocks and hedge funds / TAA had the lowest Sharpe ratios reflecting high volatility and poor returns respectively.
- After adjusting for reporting lags, private equity was the most volatile aggregate asset class by far at 26.1 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 19.4 percent is however



comparable to U.S. small cap stocks at 18.9 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 18.1 percent respectively.

Correlations

- The study also compared correlations of annual returns among the 12 asset classes as 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, non-U.S. 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 0.79 to 0.92.
- Listed equity REITs and unlisted real estate were highly correlated as well once reporting lags in unlisted real estate were accounted for. The correlation between the two asset classes is 0.91, among the highest of all. The high correlation is not surprising given both asset classes invest in fundamentally the same assets.
- Both listed equity REITs and unlisted real estate are not highly correlated to any other aggregate asset classes.
- Long duration U.S. bonds were anti-correlated to equity asset classes (including hedge funds / TAA and private equity), but positively correlated to U.S. broad fixed income.

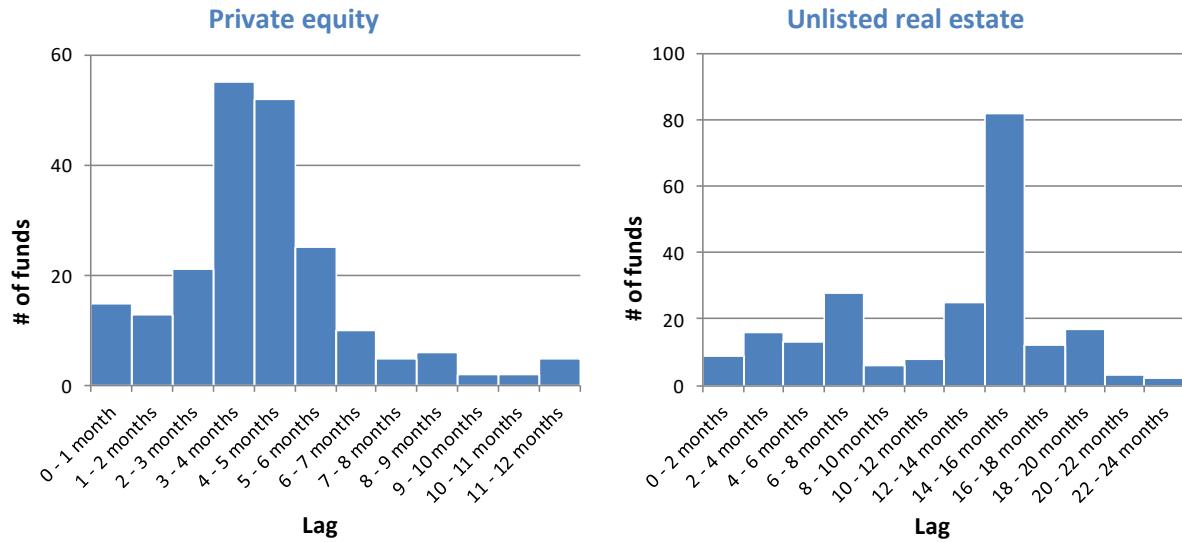
Reporting lags for illiquid assets

- Reporting lag is the time between when an underlying asset changes value and when that change in value is reported to the pension fund or investor. Illiquid assets like unlisted real estate and private equity have reporting lags.
- 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 5 months.
- The distribution of reporting lags for unlisted real estate shows no such clustering and has a bimodal distribution with peaks at 6-8 months and a stronger peak at 14-16 months.

ES3. Correlations between aggregate asset classes: 1998-2017

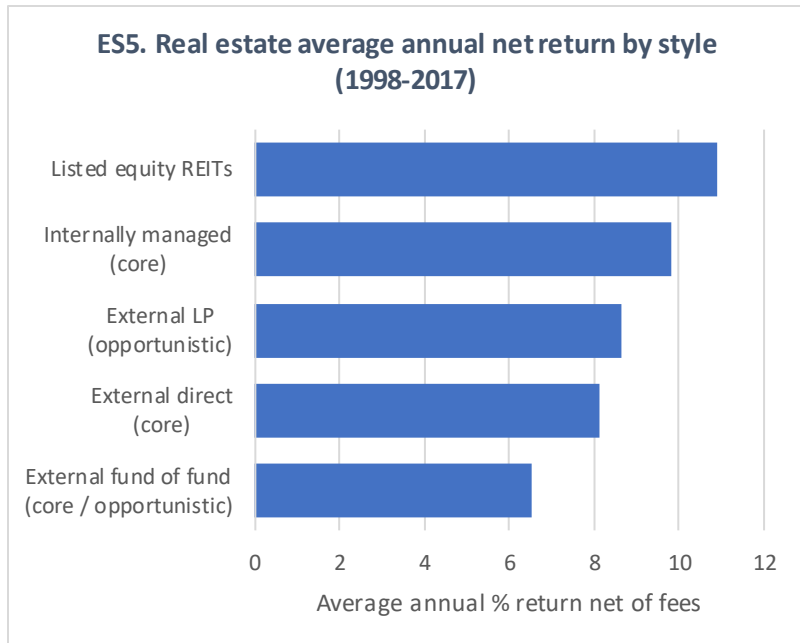
	Stock: U.S. Large Cap.	Stock: U.S. Small Cap.	Stock: Non- U.S.	Hedge Funds / TAA	Private Equity	Fixed Income: U.S. Broad	Fixed Income: Long Duratio	Fixed Income: U.S. Other	Fixed Income: Non- U.S.	Unlisted Real Estate	Listed Equity REITs	Other Real Assets
Stock: U.S. Large Cap.	n/a	0.92	0.89	0.92	0.85	-0.01	-0.41	0.63	0.50	0.47	0.53	0.27
Stock: U.S. Small Cap.		n/a	0.88	0.79	0.89	-0.04	-0.51	0.66	0.51	0.57	0.62	0.41
Stock: Non-U.S.			n/a	0.85	0.89	-0.03	-0.50	0.69	0.58	0.52	0.56	0.51
Hedge Funds / TAA				n/a	0.79	0.14	-0.30	0.71	0.53	0.43	0.50	0.38
Private Equity					n/a	-0.12	-0.61	0.66	0.41	0.53	0.49	0.47
Fixed Income: U.S. Broad						n/a	0.64	0.61	0.67	0.36	0.44	0.17
Fixed Income: Long Duration							n/a	-0.08	0.16	-0.06	-0.03	-0.16
Fixed Income: U.S. Other								n/a	0.81	0.65	0.67	0.52
Fixed Income: Non-U.S.									n/a	0.48	0.61	0.35
Unlisted Real Estate										n/a	0.91	0.48
Listed Equity REITs											n/a	0.50
Other Real Assets												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 outperformed 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 (core real estate) underperforms external LP opportunistic real estate but outperforms real estate held in a fund-of-fund.
- All styles of unlisted real estate underperform listed equity REITs by between 1-3 percent depending on style, primarily driven by differences in investment fees (see ES5).
- Core real estate had the lowest volatility of all real estate implementation styles.
- Listed equity REITs provided the highest Sharpe ratio of all real estate implementation styles.



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	Non-U.S.	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
2017	21.45	16.24	27.77	4.66	11.20	2.98	9.46	5.70	7.96	6.20	5.90	13.71
2016	11.56	17.40	5.06	4.14	7.50	5.25	8.73	11.06	4.88	8.99	2.42	21.84
2015	0.67	-3.72	-3.25	-0.13	-3.51	-0.90	-3.35	1.27	1.74	-9.88	-1.05	5.15
2014	12.52	5.03	-1.78	6.91	19.39	1.79	2.85	26.13	20.19	2.37	4.75	2.58
2013	33.38	38.39	17.84	-2.09	-7.72	1.35	-0.39	-0.99	3.99	2.88	9.10	25.69
2012	16.27	16.00	17.72	7.14	10.51	5.41	11.54	15.49	20.55	3.84	7.54	16.90
2011	0.90	-3.08	-12.71	8.48	22.17	3.61	3.77	-3.71	2.05	-1.53	0.80	-7.83
2010	16.22	26.41	12.45	8.61	11.03	5.10	13.62	5.39	23.51	10.93	9.26	20.65
2009	29.52	33.41	39.57	11.88	4.18	13.13	20.38	31.74	29.89	5.65	14.84	41.01
2008	-38.10	-37.65	-44.44	0.07	13.96	-5.39	-8.67	-29.44	-38.20	-9.66	-17.84	-29.79
2007	5.81	2.24	14.30	6.51	7.66	4.89	7.88	-12.06	-10.75	14.40	8.07	3.13
2006	14.67	14.68	25.72	4.80	2.67	5.68	7.79	29.26	34.75	14.86	11.03	24.75
2005	6.75	7.21	16.72	3.15	5.99	3.32	1.93	9.87	14.16	19.19	7.44	5.89
2004	12.02	16.76	19.62	5.29	9.07	4.92	10.31	15.51	32.43	18.18	7.42	16.71
2003	30.80	43.17	37.56	6.11	6.87	8.12	18.10	27.00	33.09	9.56	15.61	28.05
2002	-21.45	-19.33	-14.12	9.38	15.21	2.35	14.11	-1.15	5.17	9.24	-12.17	-20.12
2001	-9.94	-1.27	-17.36	8.17	6.57	4.54	2.11	2.66	10.94	4.44	-5.02	-9.78
2000	-5.21	0.27	-12.45	11.42	16.14	6.33	4.65	32.51	26.58	18.95	1.50	5.65
1999	19.19	29.88	38.33	-0.63	-7.89	5.56	1.24	9.36	1.23	22.30	10.12	55.74
1998	23.59	2.94	11.80	8.50	11.90	6.19	10.64	-13.72	-6.39	1.75	21.09	15.81
Arit. Gross Ret.:	9.25	10.81	9.36	5.79	8.33	4.45	7.26	9.16	11.39	8.64	6.10	13.81
Avg. Invest. Cost:	0.22	0.56	0.44	0.17	0.18	0.24	0.43	1.07	0.50	1.01	1.06	2.02
Arit. Net Ret.:	9.03	10.25	8.92	5.62	8.15	4.21	6.83	8.09	10.89	7.63	5.04	11.79
Comp. Net Ret.:	7.43	8.45	6.57	5.55	7.86	4.15	6.60	6.85	9.32	7.27	4.64	10.03
Std. Dev.:	17.30	18.93	21.11	3.85	7.78	3.54	6.98	15.96	17.38	8.69	8.90	19.41
Volatility:	17.61	20.27	21.63	5.17	9.34	6.76	10.75	18.05	19.36	18.89	11.54	26.06
Sharpe Ratio:	0.38	0.39	0.31	0.65	0.62	0.30	0.42	0.33	0.44	0.30	0.25	0.37

References

[1] “2018 Investment Company Fact Book – A Review of Trends and Activities in the U.S. Investment Company Industry”, 58th edition, p 160.

[2] This update adds 2015, 2016, and 2017 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>

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, 2016 and 2017 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. Statistics shown are the number of funds (#), annual average (avg.), population standard deviations (std. dev.), minimum (min.), 25th percentile (Q1), 50th percentile (med.), 75th percentile (Q3), maximum (max.) and the total of the in-year average AUM. Any differences from earlier versions of this manuscript are caused by either data revisions, data exclusions, or new data submissions. (The 2007 increase in corporate sector DB funds was a result of a partnership between CEM and an external organization.)

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
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
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	Non U.S.	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
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.:	9.25	10.87	9.36	5.79	8.33	4.27	7.26	9.83	11.39	8.64	6.10	12.54
Avg. Invest. Cost:	0.22	0.62	0.44	0.17	0.18	0.06	0.43	1.07	0.50	1.01	1.06	2.02
Arit. Net Ret.:	9.03	10.25	8.92	5.62	8.15	4.21	6.83	8.76	10.89	7.63	5.04	10.52
Comp. Net Ret.:	7.43	8.45	6.57	5.55	7.86	4.15	6.60	8.13	9.32	7.27	4.64	9.74
Std. Dev.:	17.30	18.93	21.11	3.85	7.78	3.54	6.98	10.66	17.38	8.69	8.90	12.68
Volatility:	17.61	20.27	21.63	5.17	9.34	6.76	10.75	13.59	19.36	18.89	11.54	21.52
Sharpe Ratio:	0.38	0.39	0.31	0.65	0.62	0.30	0.42	0.50	0.44	0.30	0.25	0.39

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.

Time Span	Table 4A. Annualized arithmetic average net return by time span (in percent)											
	Stock			Fixed Income				Real Assets			Other	
	U.S. Large Cap	U.S. Small Cap	Non U.S.	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
3-year												
2015 - 2017	11.23	9.97	9.86	2.89	5.06	2.44	4.94	6.01	4.86	1.77	2.42	13.57
2014 - 2016	8.25	6.24	0.01	3.64	7.80	2.04	2.74	12.82	8.94	0.49	2.04	9.86
2013 - 2015	15.53	13.23	4.27	1.56	2.72	0.74	-0.30	8.80	8.64	-1.54	4.27	11.14
2012 - 2014	20.72	19.80	11.26	3.99	7.39	2.85	4.67	13.54	14.91	3.03	7.13	15.06
2011 - 2013	16.85	17.10	7.62	4.51	8.32	3.46	4.97	3.60	8.86	1.73	5.81	11.59
2010 - 2012	11.13	13.11	5.82	8.08	14.57	4.71	9.64	5.72	15.37	4.42	5.87	9.91
2009 - 2011	15.55	18.91	13.11	9.66	12.46	7.28	12.59	11.14	18.48	5.02	8.30	17.95
2008 - 2010	2.55	7.39	2.53	6.85	9.73	4.28	8.44	2.56	5.07	2.31	2.08	10.63
2007 - 2009	-0.92	-0.67	3.14	6.15	8.60	4.21	6.53	-3.25	-6.36	3.46	1.69	4.79
2006 - 2008	-5.87	-6.91	-1.47	3.79	8.10	1.73	2.33	-4.08	-4.73	6.53	0.42	-0.64
2005 - 2007	9.08	8.04	18.91	4.82	5.44	4.63	5.87	9.02	12.72	16.15	8.85	11.25
2004 - 2006	11.15	12.88	20.69	4.41	5.91	4.64	6.68	18.21	27.11	17.41	8.63	15.78
2003 - 2005	16.52	22.38	24.63	4.85	7.31	5.45	10.11	17.46	26.56	15.64	10.16	16.88
2002 - 2004	7.12	13.53	14.35	6.93	10.39	5.13	14.17	13.79	23.56	12.32	3.62	8.21
2001 - 2003	-0.20	7.52	2.03	7.89	9.55	5.00	11.44	9.50	16.40	7.74	-0.53	-0.61
2000 - 2002	-12.20	-6.78	-14.64	9.66	12.64	4.41	6.96	11.34	14.23	10.87	-5.23	-8.08
1999 - 2001	1.34	9.63	2.84	6.32	4.94	5.47	2.67	14.84	12.92	15.23	2.20	17.20
1998 - 2000	12.52	11.03	12.56	6.43	6.72	6.03	5.51	9.38	7.14	14.33	10.90	25.73
5-year												
2013 - 2017	15.92	14.67	9.13	2.70	5.37	2.09	3.46	8.63	7.75	2.11	4.22	13.79
2012 - 2016	14.88	14.62	7.12	3.19	5.23	2.58	3.87	10.59	10.27	1.64	4.55	14.43
2011 - 2015	12.75	10.52	3.56	4.06	8.17	2.25	2.88	7.64	9.70	-0.46	4.23	8.50
2010 - 2014	15.86	16.55	6.71	5.81	11.08	3.45	6.28	8.46	14.06	3.70	6.29	11.60
2009 - 2013	19.26	22.22	14.98	6.81	8.03	5.72	9.78	9.58	16.00	4.36	8.31	19.29
2008 - 2012	4.96	7.02	2.52	7.24	12.37	4.37	8.13	3.89	7.56	1.85	2.92	8.19
2007 - 2011	2.87	4.27	1.84	7.11	11.80	4.27	7.40	-1.62	1.30	3.96	3.02	5.44
2006 - 2010	5.62	7.82	9.52	6.37	7.90	4.68	8.20	4.98	7.84	7.24	5.07	11.95
2005 - 2009	3.73	3.98	10.37	5.28	6.89	4.33	5.86	5.87	5.97	8.89	4.71	9.00
2004 - 2008	0.23	0.65	6.38	3.96	7.87	2.68	3.85	2.63	6.48	11.39	3.22	4.14
2003 - 2007	14.01	16.81	22.78	5.17	6.45	5.39	9.20	13.92	20.74	15.24	9.91	15.70
2002 - 2006	8.56	12.50	17.10	5.75	7.96	4.88	10.45	16.10	23.92	14.20	5.87	11.06
2001 - 2005	3.64	9.31	8.48	6.42	8.74	4.65	9.31	10.78	19.16	12.12	2.65	4.15
2000 - 2004	1.24	7.92	2.65	8.07	10.77	5.25	9.86	15.31	21.64	12.07	1.47	4.10
1999 - 2003	2.68	10.54	6.39	6.89	7.38	5.38	8.04	14.08	15.40	12.90	2.01	11.91
1998 - 2002	1.23	2.50	1.24	7.37	8.39	4.99	6.55	5.93	7.51	11.34	3.10	9.46
10-year												
2008 - 2017	10.44	10.84	5.82	4.97	8.87	3.23	5.79	6.26	7.66	1.98	3.57	10.99
2007 - 2016	8.88	9.44	4.48	5.15	8.52	3.42	5.64	4.49	5.79	2.80	3.79	9.93
2006 - 2015	9.19	9.17	6.54	5.22	8.04	3.47	5.54	6.31	8.77	3.39	4.65	10.22
2005 - 2014	9.79	10.26	8.54	5.55	8.99	3.89	6.07	7.17	10.01	6.29	5.50	10.30
2004 - 2013	9.74	11.44	10.68	5.38	7.95	4.20	6.82	6.11	11.24	7.87	5.76	11.71
2003 - 2012	9.49	11.91	12.65	6.20	9.41	4.88	8.66	8.91	14.15	8.54	6.42	11.95
2002 - 2011	5.71	8.38	9.47	6.43	9.88	4.57	8.92	7.24	12.61	9.08	4.44	8.25
2001 - 2010	4.63	8.56	9.00	6.40	8.32	4.67	8.76	7.88	13.50	9.68	3.86	8.05
2000 - 2009	2.49	5.95	6.51	6.68	8.83	4.79	7.86	10.59	13.81	10.48	3.09	6.55
1999 - 2008	1.45	5.60	6.39	5.43	7.63	4.03	5.94	8.35	10.94	12.14	2.61	8.02
1998 - 2007	7.62	9.65	12.01	6.27	7.42	5.19	7.88	9.92	14.12	13.29	6.51	12.58
15-year												
2003 - 2017	11.63	12.83	11.48	5.04	8.07	3.95	6.93	8.81	12.02	6.40	5.69	12.56
2002 - 2016	8.77	10.46	8.68	5.35	8.33	3.91	7.24	8.36	11.83	6.60	4.48	10.31
2001 - 2015	7.34	9.22	7.19	5.62	8.27	3.86	6.80	7.80	12.23	6.30	3.98	8.20
2000 - 2014	6.94	9.48	6.58	6.39	9.58	4.34	7.33	9.88	13.89	8.22	4.15	8.23
1999 - 2013	7.39	11.14	9.25	5.89	7.76	4.59	7.22	8.76	12.63	9.55	4.51	11.78
1998 - 2012	6.74	8.78	8.85	6.59	9.07	4.92	7.96	7.91	11.93	9.47	5.31	11.12
20-year												
1998 - 2017	9.03	10.25	8.92	5.62	8.15	4.21	6.83	8.09	10.89	7.63	5.04	11.79

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.

Time Span	Table 4B. Annualized compound average net return by time span (in percent)											
	Stock			Fixed Income				Real Assets			Other	
	U.S. Large Cap	U.S. Small Cap	Non U.S.	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
3-year												
2015 - 2017	10.90	9.53	9.10	2.87	4.87	2.41	4.78	5.93	4.83	1.42	2.39	13.36
2014 - 2016	8.12	5.88	-0.06	3.60	7.39	2.01	2.62	12.36	8.65	0.18	2.01	9.54
2013 - 2015	14.75	11.85	3.84	1.49	2.06	0.74	-0.33	8.14	8.34	-1.72	4.18	10.68
2012 - 2014	20.39	19.02	10.86	3.90	6.78	2.83	4.55	12.98	14.64	3.03	7.12	14.65
2011 - 2013	16.10	15.87	6.59	4.40	7.60	3.44	4.86	3.26	8.56	1.70	5.75	10.64
2010 - 2012	10.89	12.43	4.94	8.08	14.45	4.70	9.56	5.43	14.97	4.29	5.80	9.14
2009 - 2011	14.95	17.79	11.07	9.65	12.22	7.20	12.38	10.16	17.86	4.89	8.14	16.18
2008 - 2010	-2.33	1.69	-4.46	6.74	9.65	4.00	7.70	-0.68	-0.29	1.92	1.02	6.11
2007 - 2009	-5.33	-5.26	-3.94	6.04	8.53	3.93	5.85	-6.50	-10.52	2.97	0.65	0.70
2006 - 2008	-9.10	-9.91	-7.23	3.76	8.00	1.60	2.03	-7.09	-9.42	5.88	-0.47	-3.33
2005 - 2007	9.01	7.92	18.81	4.81	5.42	4.62	5.83	7.69	11.14	16.13	8.83	10.85
2004 - 2006	11.10	12.81	20.63	4.41	5.88	4.64	6.62	17.94	26.77	17.39	8.62	15.52
2003 - 2005	16.08	21.47	24.30	4.84	7.30	5.43	9.91	17.25	26.25	15.56	10.09	16.53
2002 - 2004	4.80	10.48	12.22	6.91	10.33	5.10	14.13	13.19	22.84	12.25	2.94	6.08
2001 - 2003	-2.55	4.47	-0.80	7.88	9.48	4.98	11.23	8.83	15.80	7.72	-1.20	-2.64
2000 - 2002	-12.47	-7.22	-14.67	9.65	12.56	4.39	6.83	10.38	13.88	10.71	-5.40	-8.68
1999 - 2001	0.58	8.74	0.03	6.19	4.46	5.47	2.66	14.16	12.44	14.96	2.01	14.08
1998 - 2000	11.77	10.26	10.63	6.30	6.18	6.03	5.44	7.73	6.25	13.97	10.61	23.97
5-year												
2013 - 2017	15.41	13.81	8.49	2.64	4.91	2.07	3.34	8.22	7.56	1.90	4.17	13.44
2012 - 2016	14.40	13.76	6.73	3.13	4.78	2.55	3.73	10.16	9.96	1.44	4.49	14.07
2011 - 2015	12.13	9.49	2.85	3.97	7.49	2.23	2.76	7.06	9.36	-0.60	4.16	7.87
2010 - 2014	15.40	15.61	5.99	5.73	10.55	3.44	6.14	7.92	13.69	3.62	6.24	10.88
2009 - 2013	18.69	21.28	13.71	6.70	7.58	5.65	9.54	8.86	15.47	4.28	8.21	18.17
2008 - 2012	1.80	3.40	-2.17	7.16	12.22	4.20	7.65	1.73	4.05	1.60	2.24	5.18
2007 - 2011	-0.10	0.83	-2.74	7.04	11.64	4.10	6.94	-3.67	-2.02	3.59	2.34	2.57
2006 - 2010	2.49	4.28	4.62	6.30	7.82	4.51	7.75	2.18	3.58	6.83	4.34	8.97
2005 - 2009	0.76	0.90	5.40	5.21	6.82	4.16	5.44	3.03	1.96	8.37	3.99	6.17
2004 - 2008	-2.13	-1.76	2.20	3.94	7.81	2.60	3.61	0.36	2.36	10.83	2.61	2.22
2003 - 2007	13.67	16.01	22.51	5.17	6.43	5.37	9.08	12.87	19.33	15.19	9.87	15.28
2002 - 2006	7.10	10.64	15.70	5.73	7.88	4.86	10.31	15.55	23.31	14.13	5.41	9.54
2001 - 2005	2.04	7.38	6.39	6.40	8.69	4.63	9.12	10.34	18.61	11.98	2.16	2.66
2000 - 2004	-0.35	5.95	0.45	8.05	10.70	5.23	9.70	14.55	21.09	11.93	1.01	2.62
1999 - 2003	0.89	8.23	3.41	6.81	7.02	5.36	7.83	13.31	14.75	12.70	1.51	8.71
1998 - 2002	-0.25	1.32	-0.79	7.28	8.01	4.98	6.43	4.88	6.95	11.05	2.46	6.55
10-year												
2008 - 2017	8.39	8.48	3.02	4.88	8.50	3.13	5.47	4.93	5.79	1.75	3.20	9.23
2007 - 2016	6.90	7.10	1.88	5.06	8.15	3.32	5.32	3.01	3.80	2.51	3.41	8.17
2006 - 2015	7.20	6.85	3.73	5.13	7.66	3.36	5.23	4.59	6.43	3.05	4.25	8.42
2005 - 2014	7.83	8.00	5.69	5.47	8.67	3.80	5.79	5.44	7.67	5.97	5.11	8.50
2004 - 2013	7.78	9.15	7.80	5.31	7.70	4.11	6.53	4.52	8.71	7.50	5.38	9.91
2003 - 2012	7.57	9.53	9.48	6.16	9.29	4.79	8.36	7.16	11.43	8.18	5.99	10.11
2002 - 2011	3.43	5.62	6.08	6.38	9.74	4.48	8.61	5.50	9.92	8.73	3.86	6.00
2001 - 2010	2.27	5.81	5.50	6.35	8.26	4.57	8.43	6.18	10.84	9.37	3.25	5.77
2000 - 2009	0.20	3.39	2.89	6.62	8.74	4.69	7.55	8.64	11.11	10.14	2.49	4.38
1999 - 2008	-0.63	3.11	2.80	5.36	7.41	3.97	5.70	6.64	8.38	11.76	2.06	5.42
1998 - 2007	6.49	8.42	10.24	6.22	7.22	5.18	7.75	8.80	12.97	13.10	6.10	10.83
15-year												
2003 - 2017	10.12	10.94	9.15	4.97	7.81	3.87	6.66	7.51	10.13	6.04	5.38	11.21
2002 - 2016	6.97	8.27	6.29	5.28	8.06	3.83	6.96	7.03	9.93	6.24	4.07	8.62
2001 - 2015	5.45	7.02	4.61	5.55	8.00	3.78	6.51	6.47	10.35	5.94	3.55	6.47
2000 - 2014	5.03	7.31	3.91	6.32	9.34	4.27	7.08	8.40	11.96	7.92	3.73	6.50
1999 - 2013	5.43	8.84	6.31	5.81	7.47	4.53	6.96	7.37	10.69	9.21	4.07	9.51
1998 - 2012	4.90	6.72	5.94	6.53	8.86	4.85	7.72	6.39	9.92	9.13	4.80	8.91
20-year												
1998 - 2017	7.43	8.45	6.57	5.55	7.86	4.15	6.60	6.85	9.32	7.27	4.64	10.03

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	Non U.S.	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
3-year												
2015 - 2017	8.84	10.48	13.41	2.86	6.70	3.84	7.58	6.08	4.31	13.05	4.74	9.44
2014 - 2016	5.73	9.48	4.43	3.93	10.28	3.48	6.96	11.11	9.88	13.81	4.55	11.84
2013 - 2015	13.71	18.46	10.23	4.81	12.63	3.39	6.59	13.06	10.17	13.70	6.51	13.33
2012 - 2014	9.34	14.29	9.81	5.32	12.16	4.53	7.94	12.13	10.78	10.32	5.46	12.49
2011 - 2013	13.47	17.29	14.75	6.27	13.26	5.04	8.47	9.82	10.91	11.84	6.88	15.52
2010 - 2012	7.51	12.66	13.53	4.11	7.24	5.08	10.27	10.23	12.39	12.02	6.98	14.26
2009 - 2011	12.08	16.65	21.96	5.80	11.07	10.39	13.94	17.77	15.30	15.25	9.60	22.57
2008 - 2010	29.42	32.42	35.41	7.93	11.87	13.07	18.96	27.39	32.73	24.35	16.87	32.52
2007 - 2009	28.20	29.64	35.62	7.74	11.77	13.40	17.07	28.02	30.49	25.54	16.60	32.36
2006 - 2008	23.19	22.68	30.91	5.23	9.85	8.68	11.83	26.73	31.90	29.14	14.96	25.77
2005 - 2007	4.44	6.34	5.98	1.79	2.73	4.64	5.44	21.43	20.23	19.36	4.85	15.22
2004 - 2006	3.70	4.99	4.77	1.43	3.28	2.90	6.09	15.14	11.90	21.68	4.70	15.53
2003 - 2005	10.57	15.99	9.91	2.06	2.43	5.90	9.77	13.78	12.34	16.27	8.06	17.72
2002 - 2004	21.73	26.18	21.69	2.60	4.14	6.53	8.34	13.12	15.60	16.96	16.93	26.17
2001 - 2003	22.60	27.37	25.52	2.37	4.49	6.41	10.49	14.20	14.31	16.82	17.27	25.79
2000 - 2002	7.93	12.37	5.28	2.79	4.66	4.12	8.63	17.03	11.32	20.59	12.70	29.82
1999 - 2001	13.85	20.75	26.43	5.94	9.98	3.29	7.70	15.11	13.11	22.05	8.85	44.30
1998 - 2000	14.03	19.78	22.29	6.03	10.54	3.89	9.39	20.52	17.65	18.57	9.85	41.37
5-year												
2013 - 2017	11.21	14.69	12.38	4.20	10.53	3.73	7.30	10.69	8.31	12.60	5.76	11.86
2012 - 2016	10.83	14.66	9.62	4.59	10.52	4.32	8.00	10.82	10.35	12.11	5.82	11.78
2011 - 2015	12.22	15.97	12.59	5.66	12.90	4.52	8.07	12.36	11.16	13.24	6.48	13.85
2010 - 2014	10.64	15.19	12.48	5.53	11.56	4.76	9.79	12.48	11.83	11.99	6.66	14.61
2009 - 2013	11.83	15.44	17.31	6.63	11.85	8.90	12.71	15.13	13.98	13.06	8.20	18.21
2008 - 2012	23.52	25.89	29.11	6.84	11.01	10.61	15.48	22.39	26.70	20.42	13.72	26.80
2007 - 2011	22.89	25.61	28.82	6.78	11.09	10.84	15.16	22.44	26.74	21.71	13.91	27.03
2006 - 2010	23.31	25.56	29.03	6.24	9.64	10.71	14.81	25.86	29.92	24.21	14.01	27.10
2005 - 2009	22.74	23.82	29.18	6.15	9.49	10.49	13.81	26.91	29.04	24.98	13.63	27.17
2004 - 2008	19.56	20.18	25.90	4.18	7.81	7.07	10.35	23.92	29.25	25.81	12.39	23.20
2003 - 2007	9.28	14.91	9.00	1.86	2.84	5.74	7.87	18.51	19.58	18.79	7.15	16.97
2002 - 2006	17.14	20.52	17.48	2.63	4.65	5.29	8.83	15.47	14.27	19.14	13.65	22.50
2001 - 2005	18.23	21.61	21.41	2.76	3.98	5.31	9.61	14.12	13.80	17.88	14.19	23.22
2000 - 2004	18.62	22.33	22.42	3.13	4.51	5.51	9.21	15.12	14.16	19.59	14.12	29.59
1999 - 2003	19.83	25.80	26.66	4.97	8.81	5.42	10.64	15.26	14.69	19.21	14.45	39.34
1998 - 2002	18.04	20.04	22.32	4.95	8.95	4.13	9.42	17.00	14.29	19.04	15.09	39.14
10-year												
2008 - 2017	19.22	21.40	22.61	6.11	11.32	8.03	12.33	17.70	19.77	16.97	10.54	20.91
2007 - 2016	18.89	21.49	21.64	6.11	11.30	8.29	12.25	18.65	20.76	17.61	10.69	21.33
2006 - 2015	18.95	21.35	22.57	6.07	11.39	8.31	12.22	20.31	22.60	19.89	10.92	21.59
2005 - 2014	18.76	20.94	22.52	5.85	10.78	8.16	11.97	21.01	22.54	19.77	10.76	21.85
2004 - 2013	18.75	20.95	22.44	5.72	10.03	8.18	11.96	20.31	23.41	20.75	10.81	22.19
2003 - 2012	18.44	21.69	23.81	5.12	8.57	8.54	12.29	21.14	24.32	20.73	11.49	22.74
2002 - 2011	20.42	23.57	25.03	5.18	8.72	8.54	12.50	21.21	24.23	21.10	13.85	25.03
2001 - 2010	20.95	23.68	25.51	4.82	7.39	8.45	12.50	21.03	23.98	21.42	14.15	25.53
2000 - 2009	20.82	23.17	26.30	5.08	7.68	8.39	11.91	22.33	24.15	22.50	13.97	28.51
1999 - 2008	19.73	23.68	26.29	4.82	8.33	6.44	10.70	20.86	23.57	22.76	13.47	32.53
1998 - 2007	15.70	19.05	20.14	3.90	6.71	5.00	8.78	18.21	18.37	19.02	12.29	30.32
15-year												
2003 - 2017	16.67	19.68	20.78	5.11	9.46	7.42	11.16	18.33	20.65	18.67	10.00	19.81
2002 - 2016	18.32	21.22	21.20	5.22	9.61	7.46	11.45	18.48	20.70	18.92	11.80	21.73
2001 - 2015	18.89	21.44	22.21	5.24	9.58	7.47	11.55	18.60	20.69	19.68	12.15	22.33
2000 - 2014	19.14	21.44	22.65	5.25	9.22	7.41	11.27	19.63	20.87	19.89	12.13	24.87
1999 - 2013	19.41	22.69	24.02	5.53	9.65	7.40	11.55	19.15	21.01	20.39	12.27	29.05
1998 - 2012	18.72	21.61	23.93	5.09	8.71	7.37	11.46	19.91	21.73	20.23	12.89	29.27
20-year												
1998 - 2016	17.61	20.27	21.63	5.17	9.34	6.76	10.75	18.05	19.36	18.89	11.54	26.06

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	Non U.S.	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
3-year												
2015 - 2017	1.22	0.91	0.70	0.86	0.69	0.52	0.60	0.92	1.03	0.10	0.42	1.39
2014 - 2016	1.51	0.70	-0.04	1.20	0.82	0.75	0.52	1.14	1.08	0.04	0.78	0.82
2013 - 2015	1.14	0.73	0.44	0.39	0.22	0.56	-0.14	0.67	1.04	-0.27	1.00	0.83
2012 - 2014	2.21	1.38	1.14	0.73	0.60	0.61	0.58	1.11	1.38	0.29	1.29	1.20
2011 - 2013	1.24	0.98	0.51	0.70	0.62	0.67	0.58	0.36	0.80	0.14	0.83	0.74
2010 - 2012	1.47	1.03	0.42	1.93	1.99	0.90	0.93	0.55	1.23	0.36	0.82	0.69
2009 - 2011	1.28	1.13	0.59	1.64	1.11	0.69	0.89	0.62	1.20	0.32	0.85	0.79
2008 - 2010	0.06	0.20	0.05	0.70	0.76	0.25	0.39	0.06	0.12	0.06	0.07	0.30
2007 - 2009	-0.12	-0.11	0.02	0.43	0.52	0.12	0.23	-0.21	-0.28	0.04	-0.05	0.07
2006 - 2008	-0.45	-0.51	-0.19	-0.06	0.39	-0.29	-0.16	-0.31	-0.28	0.09	-0.26	-0.18
2005 - 2007	1.10	0.58	2.47	0.36	0.37	0.06	0.30	0.22	0.41	0.61	0.94	0.45
2004 - 2006	2.27	1.80	4.20	0.61	0.63	0.50	0.55	1.00	2.02	0.66	1.25	0.82
2003 - 2005	1.31	1.24	2.18	1.13	1.91	0.58	0.80	1.13	1.91	0.86	1.00	0.85
2002 - 2004	0.26	0.46	0.59	2.26	2.29	0.56	1.53	0.94	1.40	0.64	0.13	0.26
2001 - 2003	-0.11	0.18	-0.02	2.14	1.38	0.38	0.78	0.50	0.93	0.31	-0.17	-0.12
2000 - 2002	-2.54	-0.97	-3.46	1.88	1.68	0.07	0.29	0.42	1.00	0.33	-0.78	-0.41
1999 - 2001	-0.28	0.21	-0.09	0.20	-0.03	0.09	-0.33	0.64	0.61	0.46	-0.34	0.27
1998 - 2000	0.49	0.28	0.31	0.17	0.12	0.14	0.00	0.19	0.10	0.48	0.54	0.49
5-year												
2013 - 2017	1.39	0.98	0.71	0.58	0.48	0.49	0.43	0.78	0.90	0.15	0.68	1.14
2012 - 2016	1.39	1.02	0.76	0.82	0.52	1.00	0.67	0.97	1.21	0.24	1.21	1.21
2011 - 2015	1.05	0.67	0.28	0.92	0.67	1.00	0.55	0.61	1.09	-0.11	1.06	0.61
2010 - 2014	1.48	1.08	0.53	1.03	0.95	0.70	0.63	0.67	1.18	0.30	0.93	0.79
2009 - 2013	1.62	1.43	0.86	1.01	0.67	0.63	0.76	0.62	1.14	0.32	1.00	1.05
2008 - 2012	0.18	0.24	0.07	0.91	1.07	0.35	0.47	0.15	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	0.10	0.18	0.20	0.18	0.35
2005 - 2009	0.03	0.04	0.25	0.32	0.39	0.11	0.19	0.10	0.10	0.23	0.12	0.22
2004 - 2008	-0.16	-0.13	0.12	0.16	0.54	-0.09	0.05	-0.03	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	0.64	0.90	0.74
2002 - 2006	0.36	0.48	0.84	0.98	0.99	0.44	0.85	0.88	1.51	0.62	0.25	0.38
2001 - 2005	0.07	0.31	0.28	1.38	1.40	0.41	0.67	0.60	1.16	0.54	0.02	0.08
2000 - 2004	-0.09	0.21	-0.01	1.96	1.83	0.39	0.66	0.82	1.28	0.46	-0.10	0.04
1999 - 2003	-0.05	0.26	0.10	0.60	0.40	0.29	0.37	0.68	0.78	0.49	-0.12	0.21
1998 - 2002	-0.19	-0.10	-0.15	0.54	0.42	0.12	0.20	0.08	0.21	0.36	-0.10	0.13
10-year												
2008 - 2017	0.52	0.49	0.24	0.74	0.75	0.35	0.44	0.33	0.37	0.09	0.30	0.51
2007 - 2016	0.43	0.41	0.17	1.00	0.87	0.56	0.58	0.19	0.26	0.25	0.35	0.43
2006 - 2015	0.42	0.38	0.24	0.91	0.75	0.47	0.52	0.25	0.36	0.24	0.38	0.41
2005 - 2014	0.42	0.40	0.31	0.61	0.65	0.27	0.36	0.26	0.37	0.24	0.36	0.40
2004 - 2013	0.41	0.45	0.40	0.58	0.60	0.29	0.41	0.22	0.40	0.30	0.37	0.45
2003 - 2012	0.40	0.45	0.45	0.74	0.82	0.34	0.53	0.33	0.50	0.33	0.39	0.44
2002 - 2011	0.18	0.27	0.30	0.75	0.84	0.29	0.53	0.25	0.43	0.34	0.18	0.25
2001 - 2010	0.10	0.25	0.25	0.72	0.75	0.25	0.48	0.26	0.45	0.34	0.10	0.22
2000 - 2009	-0.03	0.12	0.13	0.68	0.74	0.20	0.38	0.34	0.44	0.33	0.00	0.12
1999 - 2008	-0.10	0.09	0.11	0.39	0.47	0.08	0.22	0.23	0.31	0.38	-0.07	0.14
1998 - 2007	0.24	0.30	0.40	0.60	0.51	0.26	0.42	0.34	0.54	0.50	0.22	0.29
15-year												
2003 - 2017	0.63	0.60	0.50	1.04	0.91	0.66	0.74	0.46	0.57	0.57	0.57	0.68
2002 - 2016	0.41	0.44	0.35	1.07	0.91	0.63	0.75	0.43	0.55	0.57	0.35	0.49
2001 - 2015	0.30	0.36	0.25	1.05	0.87	0.55	0.65	0.38	0.56	0.50	0.25	0.35
2000 - 2014	0.24	0.33	0.19	0.79	0.79	0.30	0.45	0.45	0.56	0.31	0.17	0.33
1999 - 2013	0.25	0.38	0.28	0.59	0.53	0.29	0.40	0.38	0.48	0.36	0.17	0.42
1998 - 2012	0.21	0.27	0.25	0.67	0.67	0.28	0.43	0.29	0.41	0.34	0.20	0.38
20-year												
1998 - 2017	0.38	0.39	0.31	0.65	0.62	0.30	0.42	0.33	0.44	0.30	0.25	0.37

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., 2017 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	Non U.S.	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
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:	29.79	5.39	18.41	19.41	7.57	3.94	2.17	3.69	0.63	0.74	4.16	4.09
Absolute change:	-25.16	-2.05	8.14	-15.59	18.46	3.05	0.20	2.04	0.38	1.73	5.16	3.64
Change per year:	-1.26	-0.10	0.41	-0.78	0.92	0.15	0.01	0.10	0.02	0.09	0.26	0.18
Trend per year:	-1.48	-0.19	0.35	-0.93	1.11	0.20	0.05	0.12	0.01	0.10	0.42	0.23

Table 8A and 8B. Average annual total fund returns by year with population standard deviations (σ) and standard errors (σ/\sqrt{n}) for U.S. public sector (top) and corporate sector (bottom) pension funds spanning 1998-2016. 'As-reported' total fund net returns are calculated from total fund returns reported to CEM. 'As-reported' total fund net returns include returns produced from physical assets (i.e., stocks, bonds) and synthetic assets (derivatives and other overlays). 'Physical-asset-only' net returns are calculated by CEM from each funds' holdings weighted sum of physical asset net returns, stripping out in part the effects of derivatives and other overlays. 'Standardized physical-asset-only' net returns are calculated in the same fashion with the exception that returns for unlisted real estate and private equity have each been corrected for stale valuations (i.e., reporting lag). (See section 3.4. of Ref. 1.)

Summary statistics include the arithmetic average net return (6.96% 'as-reported' for public sector funds), the standard error on the arithmetic average net return (0.07% 'as-reported' for public sector funds), the standard deviation of the average annual net returns (11.63% 'as-reported' for public sector funds), the compound average of annual average net returns (6.25% 'as-reported' for public sector funds), the standard error on the compound average net return (0.07% 'as-reported' for public sector funds), and lastly the average volatility (11.92% 'as-reported' for public sector funds).

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.
2017	60	15.54	0.23	1.82	15.87	0.27	2.10	15.70	0.28	2.20
2016	60	7.83	0.13	0.97	7.59	0.11	0.82	8.88	0.15	1.19
2015	62	0.32	0.20	1.54	0.56	0.15	1.20	-0.51	0.15	1.21
2014	62	6.61	0.22	1.70	6.72	0.20	2.01	6.69	0.20	2.03
2013	64	15.40	0.40	3.21	16.13	0.47	3.73	16.03	0.45	3.59
2012	68	13.10	0.14	1.12	12.97	0.15	1.25	13.40	0.16	1.35
2011	68	0.99	0.19	1.60	1.27	0.20	1.65	-0.71	0.21	1.70
2010	73	13.34	0.19	1.59	13.10	0.18	1.50	13.29	0.23	1.95
2009	73	19.96	0.49	4.22	21.24	0.52	4.41	27.06	0.43	3.67
2008	72	-26.99	0.33	2.82	-24.11	0.44	3.76	-26.39	0.46	3.89
2007	80	8.43	0.19	1.70	8.39	0.20	1.79	6.50	0.17	1.56
2006	69	14.16	0.18	1.48	14.46	0.20	1.62	15.11	0.23	1.94
2005	72	8.42	0.20	1.71	8.62	0.23	1.95	7.82	0.18	1.53
2004	76	11.98	0.15	1.32	12.14	0.15	1.35	12.30	0.16	1.43
2003	74	22.95	0.34	2.89	23.70	0.31	2.69	24.67	0.33	2.81
2002	74	-8.76	0.31	2.63	-7.53	0.28	2.42	-7.92	0.29	2.51
2001	83	-4.30	0.26	2.41	-3.88	0.27	2.48	-3.85	0.26	2.41
2000	80	0.06	0.43	3.86	0.75	0.42	3.72	0.89	0.42	3.74
1999	83	14.56	0.45	4.14	16.33	0.52	4.71	16.65	0.54	4.91
1998	69	15.10	0.41	3.37	15.55	0.42	3.45	14.88	0.45	3.71
Arithmetic Avg. Ret.:		7.44	0.07	11.19	7.99	0.07	10.85	8.02	0.07	11.82
Compound Avg. Ret.:		6.78	0.07	n/a	7.39	0.07	n/a	7.31	0.07	n/a
Avg. Volatility:		11.47	n/a	n/a	11.18	n/a	n/a	12.12	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.
2017	97	15.01	0.31	3.10	14.99	0.31	3.09	14.87	0.32	3.14
2016	100	7.61	0.23	2.28	7.65	0.18	1.81	8.40	0.20	1.95
2015	101	-1.22	0.15	1.48	-1.20	0.15	1.52	-1.74	0.13	1.28
2014	97	10.13	0.36	3.57	10.04	0.35	3.47	9.82	0.35	3.42
2013	112	10.52	0.65	6.85	11.63	0.62	6.61	11.70	0.62	6.61
2012	120	12.95	0.17	1.84	12.83	0.16	1.80	13.30	0.17	1.85
2011	124	5.55	0.55	6.15	5.24	0.53	5.91	3.82	0.55	6.13
2010	121	13.53	0.18	1.93	13.17	0.18	1.93	13.35	0.15	1.69
2009	122	18.24	0.60	6.65	19.96	0.55	6.12	24.21	0.53	5.85
2008	130	-23.77	0.76	8.70	-21.35	0.73	8.36	-22.86	0.72	8.26
2007	121	8.94	0.20	2.18	8.85	0.19	2.06	7.33	0.18	1.98
2006	64	13.79	0.20	1.62	14.26	0.21	1.67	14.77	0.23	1.80
2005	69	8.72	0.22	1.87	8.75	0.22	1.81	8.05	0.18	1.48
2004	78	12.23	0.18	1.56	12.33	0.19	1.66	12.43	0.20	1.75
2003	71	23.96	0.37	3.14	24.59	0.38	3.19	25.66	0.39	3.28
2002	69	-10.51	0.39	3.25	-9.59	0.36	2.98	-10.00	0.36	2.97
2001	81	-4.94	0.32	2.88	-4.87	0.28	2.54	-4.64	0.27	2.47
2000	72	1.02	0.67	5.66	1.88	0.85	7.21	1.47	0.77	6.57
1999	85	16.89	0.74	6.81	18.54	0.75	6.94	19.12	0.76	7.03
1998	91	14.94	0.34	3.28	15.57	0.37	3.55	14.84	0.39	3.77
Arithmetic Avg. Ret.:		7.68	0.10	10.75	8.16	0.10	10.55	8.19	0.10	11.23
Compound Avg. Ret.:		7.08	0.10	n/a	7.60	0.10	n/a	7.56	0.10	n/a
Avg. Volatility:		11.59	n/a	n/a	11.40	n/a	n/a	12.01	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. For comparison, the averages of all six cohorts' average net returns are 7.76 percent (arithmetic) and 7.09 percent (compound).

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.	#
2016	8.68	0.23	0.52	5	8.66	0.23	0.93	17	9.00	0.22	1.33	38
2015	-0.67	0.46	1.03	5	-1.16	0.34	1.35	16	-0.23	0.17	1.06	41
2014	6.23	0.66	1.75	7	6.58	0.86	3.21	14	6.80	0.23	1.46	41
2013	18.29	1.14	3.41	9	14.90	1.22	4.87	16	15.97	0.43	2.66	39
2012	13.58	0.43	1.37	10	12.90	0.33	1.26	15	13.53	0.20	1.34	43
2011	-1.42	0.44	1.33	9	-0.72	0.34	1.54	20	-0.54	0.29	1.81	39
2010	12.73	0.80	3.09	15	13.46	0.28	1.26	21	13.41	0.26	1.59	37
2009	26.60	1.04	3.89	14	27.53	0.63	3.24	26	26.88	0.67	3.86	33
2008	-26.36	1.02	3.06	9	-26.44	0.56	3.08	30	-26.36	0.81	4.67	33
2007	6.09	0.42	1.59	14	6.63	0.32	1.78	31	6.55	0.22	1.30	35
2006	14.22	0.44	1.52	12	14.38	0.34	1.74	26	16.06	0.32	1.80	31
2005	7.16	0.37	1.42	15	7.93	0.24	1.33	31	8.06	0.33	1.70	26
2004	11.94	0.37	1.50	16	12.28	0.23	1.34	33	12.54	0.28	1.45	27
2003	24.13	0.53	2.18	17	25.38	0.54	3.05	32	24.14	0.54	2.68	25
2002	-7.22	0.57	2.43	18	-7.76	0.46	2.66	33	-8.71	0.44	2.13	23
2001	-3.14	0.58	2.67	21	-3.55	0.43	2.56	35	-4.80	0.30	1.56	27
2000	0.73	0.77	3.38	19	1.54	0.75	4.48	36	0.07	0.49	2.43	25
1999	15.65	0.86	4.24	24	16.62	0.86	4.88	32	17.56	1.02	5.31	27
1998	14.34	0.92	4.21	21	14.40	0.66	3.42	27	16.03	0.71	3.24	21
Arith. Avg. Ret.:	7.45	0.16	11.86	<i>n/a</i>	7.55	0.13	11.99	<i>n/a</i>	7.68	0.11	12.16	<i>n/a</i>
Comp. Avg. Ret.:	6.73	0.16	<i>n/a</i>	<i>n/a</i>	6.82	0.13	<i>n/a</i>	<i>n/a</i>	6.93	0.11	<i>n/a</i>	<i>n/a</i>
Avg. Volatility:	12.14	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	12.31	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	12.43	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>

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.	#
2016	7.50	0.51	2.54	25	8.71	0.29	1.84	39	8.68	0.22	1.31	36
2015	-2.08	0.31	1.42	21	-1.92	0.20	1.31	44	-1.33	0.17	1.03	36
2014	10.43	1.46	5.45	14	9.84	0.44	3.07	48	9.53	0.46	2.70	35
2013	11.68	1.53	7.97	27	11.98	0.88	6.33	52	11.28	1.00	5.74	33
2012	13.33	0.36	2.09	34	13.32	0.21	1.62	58	13.21	0.37	1.96	28
2011	4.18	1.01	6.46	41	3.77	0.83	6.38	59	3.33	0.97	4.74	24
2010	13.42	0.28	1.85	44	13.34	0.23	1.72	55	13.20	0.26	1.22	22
2009	24.24	0.88	6.38	52	24.39	0.79	5.77	53	23.58	1.01	4.16	17
2008	-22.81	1.11	8.56	59	-24.68	0.93	6.84	54	-17.28	2.13	8.79	17
2007	6.95	0.35	2.22	40	7.40	0.24	1.93	63	7.90	0.32	1.34	18
2006	14.03	0.36	1.53	18	14.73	0.30	1.75	35	16.12	0.48	1.60	11
2005	7.16	0.28	1.18	18	8.21	0.24	1.47	38	8.83	0.35	1.25	13
2004	11.98	0.29	1.34	22	12.50	0.28	1.85	44	13.01	0.52	1.82	12
2003	24.37	0.49	2.57	27	26.63	0.67	3.83	33	25.93	0.45	1.49	11
2002	-9.72	0.71	3.78	28	-10.24	0.43	2.33	30	-10.06	0.59	1.97	11
2001	-4.16	0.38	2.16	33	-4.87	0.45	2.66	35	-5.23	0.69	2.50	13
2000	1.96	1.10	6.15	31	0.90	1.44	7.64	28	1.52	1.30	4.67	13
1999	16.96	0.98	6.47	44	21.17	1.36	7.34	29	22.11	1.57	5.44	12
1998	14.55	0.60	4.14	48	15.60	0.55	3.18	27	13.72	1.00	3.17	10
Arith. Avg. Ret.:	7.58	0.18	11.11	<i>n/a</i>	7.94	0.16	11.97	<i>n/a</i>	8.32	0.20	10.87	<i>n/a</i>
Comp. Avg. Ret.:	6.95	0.19	<i>n/a</i>	<i>n/a</i>	7.21	0.16	<i>n/a</i>	<i>n/a</i>	7.74	0.22	<i>n/a</i>	<i>n/a</i>
Avg. Volatility:	12.02	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	12.70	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	11.45	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>

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 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:

http://www.cembenchmarking.com/Files/Documents/Research/Real_estate_by_implementation_style.pdf

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 1998-2017 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.

Year	Unlisted real estate styles					Listed equity REITs (primarily core)
	Internal (core)	External direct (core)	External LP (opportunistic)	External fund-of-fund (opportunistic)	Total (core & opportunistic)	
2017	5.81	5.97	5.49	7.14	5.70	7.96
2016	15.21	11.34	10.90	5.66	11.06	4.88
2015	2.55	0.49	0.86	1.16	1.27	1.74
2014	28.17	26.50	26.71	22.72	26.13	20.19
2013	-0.46	-0.96	-1.36	-1.50	-0.99	3.99
2012	19.21	15.49	15.87	9.39	15.49	20.55
2011	-4.72	-3.25	-4.47	-6.13	-3.71	2.05
2010	8.98	6.22	11.68	9.49	5.39	23.51
2009	32.35	31.13	29.73	34.98	31.74	29.89
2008	-25.19	-28.13	-35.07	-32.74	-29.44	-38.20
2007	-9.00	-12.46	-8.85	-11.85	-12.06	-10.75
2006	34.74	28.47	33.63	22.84	29.26	34.75
2005	12.11	8.84	20.30	3.16	9.87	14.16
2004	20.57	16.11	13.63	14.02	15.51	32.43
2003	31.98	25.99	26.80	30.03	27.00	33.09
2002	-3.53	-0.23	-12.15	-2.85	-1.15	5.17
2001	6.94	3.09	3.34	-0.21	2.66	10.94
2000	33.08	31.65	34.48	30.54	32.51	26.58
1999	8.59	8.58	17.19	10.08	9.36	1.23
1998	-21.07	-12.23	-15.82	-15.06	-13.72	-6.39
Net arit ¹ . avg.	9.82	8.13	8.64	6.54	8.09	10.89
Net geo ² . avg.	8.41	6.96	7.05	5.22	6.85	9.32
Stdev ³ .	17.09	15.51	17.76	16.27	15.96	17.38
Volatility ⁴	19.06	17.65	19.66	18.32	18.05	19.36
Sharpe ratio ⁵	0.40	0.34	0.33	0.24	0.33	0.44

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 1998-2017 by style. For a description of styles see Reference 3. Allocations are shown as a percent of total fund net asset value (NAV).

Year	Unlisted real estate styles					Listed equity REITs (primarily core)
	Internal (core)	External direct (core)	External LP (opportunistic)	External fund-of-fund (opportunistic)	Total (core & opportunistic)	
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	0.14	2.52	0.81	0.14	3.62	0.62
Change per year ¹	-0.01	0.01	0.12	0.01	0.13	0.01
Trend ²	-0.01	-0.01	0.13	0.01	0.12	0.00

1. Change per year is the absolute change in average allocation from 1998 to 2017 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 (1998-2017). 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	0.96	0.90	0.42	0.31
External direct (core)	0.98	n/a	0.96	0.98	0.91	0.47	0.38
External LP (opportunistic)	0.96	0.96	n/a	0.95	0.88	0.52	0.28
Fund of fund (opportunistic)	0.96	0.98	0.95	n/a	0.91	0.53	0.38
Listed equity REITs	0.90	0.91	0.88	0.91	n/a	0.53	0.44
Average	0.95	0.96	0.94	0.95	0.90	0.49	0.36