

Alexander D. Beath, PhD & Chris Flynn, CFA
CEM Benchmarking Inc.
372 Bay Street, Suite 1000
Toronto, ON, M5H 2W9
www.cembenchmarking.com

November 1 2017

ASSET ALLOCATION AND FUND PERFORMANCE OF DEFINED BENEFIT PENSION FUNDS IN THE UNITED STATES, 1998-2015 (UPDATED)

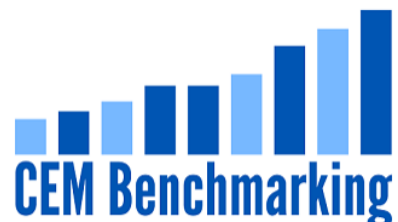


Table of Contents

Update of 2016 Report	2
Introduction	2
Asset returns	2
Asset Allocations	3
Total fund returns	3
Volatility and Risk Adjusted Returns	3
Correlations	4
Reporting lags for illiquid assets	4
Summary	5
References	6
Appendix A: Supplemental tables	7

This work was commissioned by Nareit®. The analysis and opinions contained herein are entirely those of CEM Benchmarking Inc., which is responsible for the contents. Copyright © (2017) by Nareit®. Reprinted with permission.

Asset Allocation and Fund Performance of Defined Benefit Pension Funds in the United States, 1998-2015

Alexander D. Beath¹, PhD & Chris Flynn, CFA
CEM Benchmarking Inc.
372 Bay Street, Suite 1000, Toronto, ON, M5H 2W9
www.cembenchmarking.com

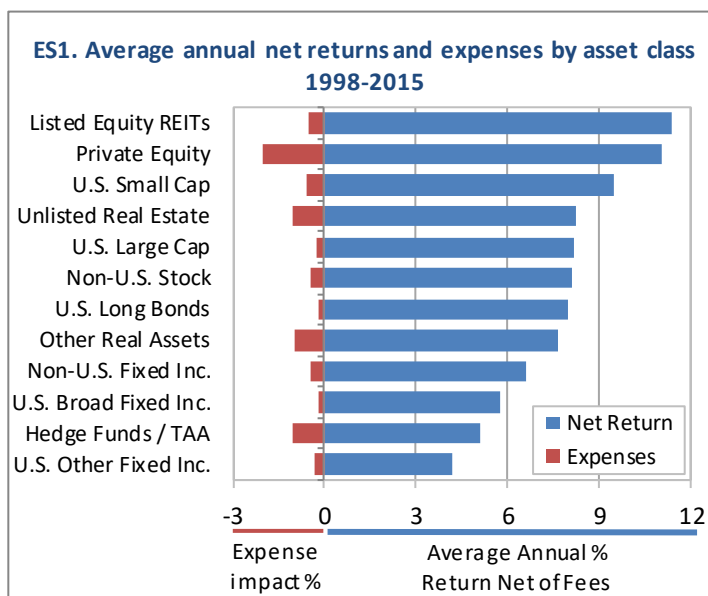
Update of 2016 Report

Introduction

- Of the \$24.0 trillion of retirement assets in the United States at the end of 2015, approximately \$5.1 trillion were held in public sector defined benefit (DB) funds and \$2.9 trillion were held in corporate sector DB funds (see Ref. 2). 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 an 18-year period, with nearly \$3.5 trillion in combined assets under management (AUM) at the end of 2015. 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 18-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.
- Listed equity REITs had the highest average net return over the period, averaging 11.4%. Private equity had the highest



¹ To contact the authors please send correspondence to: Alex@cembenchmarking.com

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

average gross return, estimated as 13.1%, but had the second highest average net return of 11.1% because the impact of expenses.

- 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 would have been the worst performing asset class with a 18-year arithmetic average annual net return of 5.1 percent.

Asset Allocations

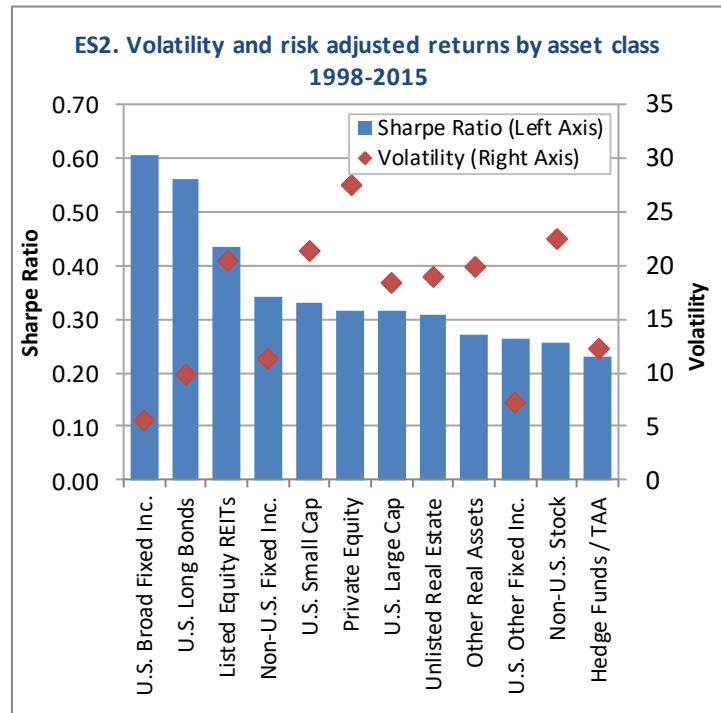
- The most material decrease in asset allocation was the decrease in allocation to U.S. large cap stock. In 1998 over 42 percent of the holdings of U.S. DB pension funds were dedicated to U.S. large cap stocks. By 2015 this had fallen to less than 19 percent.
- The most material increase in asset allocation 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 16 percent. This increase was confined to corporate sector pension funds.
- Although they had the highest arithmetic average annual net return of 11.4 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 3.5 percent allocation on average while having had an arithmetic average annual net return of 8.7 percent.

Total fund returns

- Large corporate-sector plans (> \$10 billion in AUM) outperformed (average compound net return of 8.30 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 7.38 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 27.4 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 20.4 percent is however comparable to U.S. small cap stocks at 19.8 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 20.3 percent and 18.8 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 0.80 to 0.93.
- 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 0.92, 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 are anti-correlated to stocks and private equity, but positively correlated to U.S. broad fixed income.

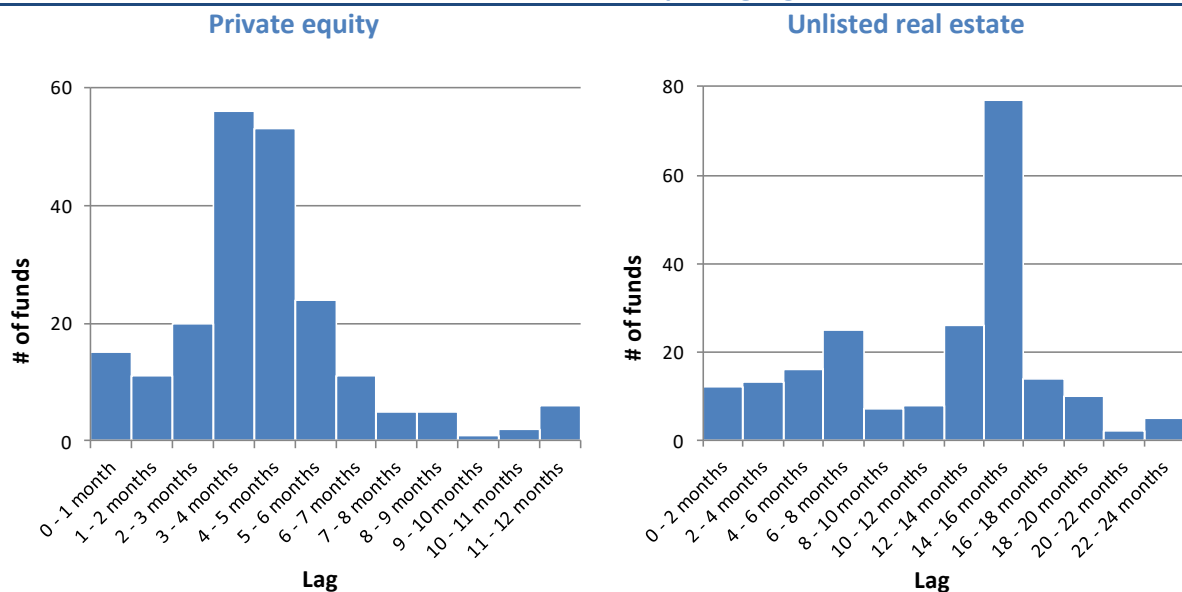
Reporting lags for illiquid assets

- 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 4A and 4B.
- 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

ES3. Correlations between aggregate asset classes: 1998-2015

	Stock: U.S. Large Cap	Stock: U.S. Small Cap	Stock: Non- U.S.	Hedge Funds /TAA	Private Equity	Fix. Inc.: U.S. Broad	Fix. Inc.: Long Duration	Fix. Inc.: U.S. Other	Fix. Inc.: Non- U.S.	Unlisted Real Estate	Listed Equity REITs	Other Real Assets
Stock: U.S. Large Cap	n/a	0.92	0.89	0.93	0.85	0.00	-0.43	0.65	0.50	0.49	0.55	0.28
Stock: U.S. Small Cap		n/a	0.89	0.80	0.88	-0.03	-0.52	0.66	0.51	0.58	0.64	0.41
Stock: Non-U.S.			n/a	0.86	0.91	-0.02	-0.54	0.72	0.60	0.55	0.58	0.53
Hedge Funds/TAA				n/a	0.80	0.14	-0.31	0.71	0.54	0.44	0.50	0.38
Private Equity					n/a	-0.11	-0.62	0.65	0.41	0.54	0.50	0.48
Fix. Inc.: U.S. Broad						n/a	0.66	0.62	0.65	0.37	0.43	0.18
Fix. Inc.: Long Duration							n/a	-0.06	0.11	-0.06	-0.02	-0.16
Fix. Inc.: U.S. Other								n/a	0.81	0.66	0.68	0.52
Fix. Inc.: Non-U.S.									n/a	0.50	0.63	0.38
Unlisted Real Estate										n/a	0.92	0.47
Listed Equity REITs											n/a	0.49
Other Real Assets												n/a

ES4 Distribution of reporting lag



distribution with peaks at 6-8 months and a stronger peak at 14-16 months.

Summary

- Aggregate asset class net returns, standardized to remove reporting lags in unlisted real estate and private equity, are summarized in Exhibit ES5.

ES5. 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
2015	0.67	-3.72	-3.25	-0.13	-3.51	-0.90	-3.35	1.56	1.74	-9.88	-1.05	5.58
2014	12.52	5.03	-1.78	6.91	19.39	1.79	2.85	26.28	20.19	2.37	4.75	2.62
2013	33.38	38.39	17.84	-2.09	-7.72	1.35	-0.39	-0.91	3.99	2.88	9.10	25.09
2012	16.27	16.00	17.72	7.14	10.51	5.41	11.54	15.18	20.55	3.84	7.54	16.50
2011	0.90	-3.08	-12.71	8.48	22.17	3.61	3.77	-4.08	2.05	-1.53	0.80	-7.58
2010	16.22	26.41	12.45	8.61	11.03	5.10	13.62	5.97	23.51	10.93	9.26	20.83
2009	29.52	33.41	39.57	11.88	4.18	13.13	20.38	32.71	29.89	5.65	14.84	40.72
2008	-38.10	-37.65	-44.44	0.07	13.96	-5.39	-8.67	-29.51	-38.20	-9.66	-17.84	-29.84
2007	5.81	2.24	14.30	6.51	7.66	4.89	7.88	-11.03	-10.75	14.40	8.07	2.89
2006	14.67	14.68	25.72	4.80	2.67	5.68	7.79	29.04	34.75	14.86	11.03	24.66
2005	6.75	7.21	16.72	3.15	5.99	3.32	1.93	10.74	14.16	19.19	7.44	5.74
2004	12.02	16.76	19.62	5.29	9.07	4.92	10.31	15.74	32.43	18.18	7.42	16.61
2003	30.80	43.17	37.56	6.11	6.87	8.12	18.10	26.55	33.09	9.56	15.61	27.92
2002	-21.45	-19.33	-14.12	9.38	15.21	2.35	14.11	-1.30	5.17	9.24	-12.17	-20.13
2001	-9.94	-1.27	-17.36	8.17	6.57	4.54	2.11	3.47	10.94	4.44	-5.02	-9.96
2000	-5.21	0.27	-12.45	11.42	16.14	6.33	4.65	31.55	26.58	18.95	1.50	6.13
1999	19.19	29.88	38.33	-0.63	-7.89	5.56	1.24	8.73	1.23	22.30	10.12	57.41
1998	23.59	2.94	11.80	8.50	11.90	6.19	10.64	-12.81	-6.39	1.75	21.09	14.23
Arit. Gross Ret.:	8.43	10.08	8.53	5.93	8.19	4.52	7.01	9.27	11.89	8.61	6.16	13.13
Avg. Invest. Cost:	0.23	0.56	0.44	0.17	0.18	0.30	0.42	1.06	0.51	0.98	1.03	2.05
Arit. Net Ret.:	8.20	9.52	8.08	5.75	8.01	4.22	6.58	8.22	11.39	7.64	5.14	11.08
Comp. Net Ret.:	6.48	7.56	5.59	5.68	7.70	4.16	6.33	6.86	9.65	7.24	4.69	9.15
Std. Dev.:	17.97	19.82	21.77	4.03	8.16	3.71	7.32	16.64	18.24	9.15	9.36	20.43
Volatility:	18.27	21.18	22.31	5.38	9.77	7.04	11.23	18.80	20.30	19.73	12.07	27.36
Sharpe Ratio:	0.31	0.33	0.26	0.60	0.56	0.26	0.34	0.31	0.44	0.27	0.23	0.32

References

[1] This update adds 2015 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 www.cembenchmarking.com.

[2] “2016 Investment Company Fact Book – A Review of Trends and Activities in the U.S. Investment Company Industry”, 56th edition, pp 136.

Appendix A: Supplemental tables

The following tables were included in the original version of this paper (i.e., Ref. 1) and are included here, updated with 2015 data, for reference purposes. Table numbering has been retained from Ref. 1.

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
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
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
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
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.:	8.43	10.08	8.53	5.93	8.19	4.52	7.01	9.95	11.89	8.61	6.16	12.39
Avg. Invest. Cost:	0.23	0.56	0.44	0.17	0.18	0.30	0.42	1.06	0.51	0.98	1.03	2.05
Arit. Net Ret.:	8.20	9.52	8.08	5.75	8.01	4.22	6.58	8.89	11.39	7.64	5.14	10.34
Comp. Net Ret.:	6.48	7.56	5.59	5.68	7.70	4.16	6.33	8.19	9.65	7.24	4.69	9.49
Std. Dev.:	17.97	19.82	21.77	4.03	8.16	3.71	7.32	11.23	18.24	9.15	9.36	13.31
Volatility:	18.27	21.18	22.31	5.38	9.77	7.04	11.23	14.23	20.30	19.73	12.07	22.55
Sharpe Ratio:	0.31	0.33	0.26	0.60	0.56	0.26	0.36	0.47	0.44	0.27	0.23	0.36

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., 2015 value - 1998 value), the absolute change per year, and the trend per year.

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
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:	37.39	6.10	15.39	27.19	1.37	2.42	2.01	3.32	0.55	0.08	1.43	2.74
Absolute change:	37.77	7.18	15.33	27.44	0.82	1.64	1.77	2.98	0.53	0.06	1.50	2.98
Change per year:	38.18	6.65	16.37	26.41	0.87	1.54	2.21	2.87	0.52	0.05	1.30	3.04

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 1998-2015. '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.
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.:		6.96	0.07	11.63	7.58	0.08	11.28	7.55	0.08	12.32
Compound Avg. Ret.:		6.25	0.07	n/a	6.93	0.08	n/a	6.77	0.08	n/a
Avg. Volatility:		11.92	n/a	n/a	11.61	n/a	n/a	12.62	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.
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.:		7.28	0.10	11.19	7.81	0.11	11.00	7.81	0.10	11.73
Compound Avg. Ret.:		6.63	0.11	n/a	7.20	0.11	n/a	7.12	0.11	n/a
Avg. Volatility:		12.05	n/a	n/a	11.87	n/a	n/a	12.53	n/a	n/a

