

Interim Study:

Asset Pooling for Small Pension Systems

October 2018



PENSION REVIEW BOARD

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Executive Summary

Many public retirement systems across the country face ongoing challenges as unfunded liabilities continue to grow in an overall low interest rate environment. Smaller systems face additional challenges to meet or exceed their assumed rates of return over extended periods of time. Recognizing this, at its November 16, 2017 meeting, the PRB directed staff to study the possible benefits for smaller pension systems of pooling trust funds for investment purposes as part of the agency's mandate to include recommendations relating to public retirement systems that the board finds advisable through its Biennial Report to the Legislature and Governor.

To study the possible benefits of pooling assets, the PRB analyzed investment return and fee data reported by retirement plans for fiscal years 2007 to 2016. The data analyzed included all Texas actuarially funded defined benefit plans that reported to the PRB during that period, except for the 4 largest statewide plans. Staff also identified two primary structures of pooled pension trusts: an Investment Management only model (IM) and an Investment Management and Administration (IMA) model. Under both models, the participating systems transfer all or a portion of their assets into the group investment trust, while maintaining the existing governance structures, including contribution, benefit, actuarial and asset allocation decision-making.

To objectively analyze the benefits of the IM and IMA structures, the PRB modeled the potential impact on small plans. Modeling suggested asset pooling could have resulted in an additional 29% increase (\$32M) in total assets for small plans between 2007 and 2016.

This study constitutes a first step towards developing potential recommendations in this area. The evidence suggests smaller pension plans in Texas could benefit in several ways from pooling assets for investment purposes as well as pooling administrative functions. Further in-depth study of possible governance structures to provide asset pooling services including associated legal requirements is necessary and should include engaging small pension plans to provide input and explore viable options.

Background

The Pension Review Board (PRB) is mandated to oversee all Texas public retirement systems, both state and local, in regard to their actuarial soundness and compliance with state law. Its mission is to provide the state of Texas with the necessary information and recommendations to ensure that its public retirement systems, whose combined assets total in the multi-billions, are financially sound, benefits are equitable, the systems are properly managed, tax expenditures for employee benefits are kept to a minimum while still providing for those employees, and to expand the knowledge and education of administrators, trustees, and members of Texas public pension funds.

Texas is home to many public-sector pension funds sponsored by various political subdivisions with wide-ranging asset values. There are currently close to 350 public retirement systems registered with the PRB. This includes pre-funded defined benefit plans, defined contribution plans, and pay-as-you-go volunteer firefighter plans. The PRB's primary focus is overseeing the approximately 100 pre-funded defined benefit plans covering more than 2.5 million active and retired members; with asset values that range from as low as \$3 million to as large as \$150 billion.

At its November 16, 2017 meeting, the Board directed staff to study the possible benefits for smaller pension systems of pooling trust funds for investment purposes. The Board charged staff with conducting this interim study to develop potential legislative recommendations for inclusion in agency's 2018 Biennial Report to the Legislature and Governor.

This interim study is organized as follows. Section I discusses the potential benefits of pooling assets. Section II analyzes data to assess whether smaller Texas pension funds would likely be able to achieve these benefits. Section III reviews examples of asset pooling and models the potential impact of these on small plans, and Section IV provides recommendations. For the purposes of this study, "small plan" was defined as all plans that fell within the bottom quintile (i.e. smallest 20%) of all Texas plans, when sorted by asset size. For the 2016 Fiscal Year End, this includes all plans with less than \$12.5 million in assets.

I. Potential Benefits of Pooling Pension Assets

Pooling assets of smaller pension plans into a single, larger group investment trust may provide increased performance for participating pension plans for several reasons. Larger retirement systems are able to take advantage of economies of scale to reduce investment and administrative expenses and improve diversification through cost effective access to desired asset classes.¹

Economies of Scale

Higher investment management fees have been shown to be correlated with poorer investment performance, so much so that Morningstar has called expense ratios the "most proven predictor of future

¹ Dyck, Alexander, and Lukasz Pomorski. "Is Bigger Better? Size and Performance in Pension Plan Management." *SSRN Electronic Journal*, Feb. 2011, p. 3., doi:10.2139/ssrn.1690724

fund returns.”^{2,3} Larger investment funds typically have lower investment management fees because they have improved bargaining power or are able to hire internal investment managers at a lower cost than external investment managers.^{4,5} Further, many administrative costs are fixed and/or decrease on a per-participant basis as total participants increase.⁶ Therefore, pooling small pension plan assets for investment purposes, as well as pooling administrative tasks, could increase efficiency and reduce costs, resulting in an overall improvement in investment performance.

Diversification

Investment management costs for certain asset classes, including alternative investments, are usually much higher than traditional asset classes. Private equity and real estate, in particular, are directly affected by scale and negotiating power, and large plans have opportunities for co-investment that may require sophisticated contracts.⁷ Smaller pension plans pay comparatively high costs for a small allocation or may be unable to access these asset classes at all. Pooling assets allows small pension plans a cost-effective manner to invest in asset classes, and increase portfolio diversification, that frequently is not available to smaller plans.

II. Research and Analysis

Methodology

To study the possible benefits for smaller Texas pension systems of pooling trust funds for investment purposes, the PRB analyzed investment return and fee data submitted by public retirement systems for fiscal years 2007 to 2016.⁸ The data tested includes all actuarially funded defined benefit pension plans that reported to the PRB during that period, except for the 4 largest plans, Teacher Retirement System of Texas (TRS), Employees Retirement System of Texas (ERS), Texas Municipal Retirement System (TMRS), Texas County and District Retirement System (TCDRS).⁹ These large, statewide plans were excluded from the analysis because the smallest of these is 6 times larger than the next largest plan and instead were included as a separate group in the graphs and tables for comparison only. Data for individual pension plans that are managed as a single trust (e.g. El Paso Firemen’s Pension Fund, El Paso Police Pension Fund, and El Paso Firemen and Policemen’s Pension Staff Plan and Trust) were combined into a single entity.

² Aubry, Jean-Pierre, and Caroline V. Crawford, “How Do Fees Affect Plans’ Ability to Beat Their Benchmarks?” *State and Local Pension Plans*, vol. 61, Aug. 2018. p. 3.

³ Kinnel, Russel, “Predictive Power of Fees.” *Morningstar Manager Research*, May 2016. p. 1.

⁴ James, Estelle et al., “Administrative Costs and the Organization of Individual Retirement Account Systems: A Comparative Perspective.” *The World Bank Policy Research Dissemination Center*, Feb. 2001. p. 9.

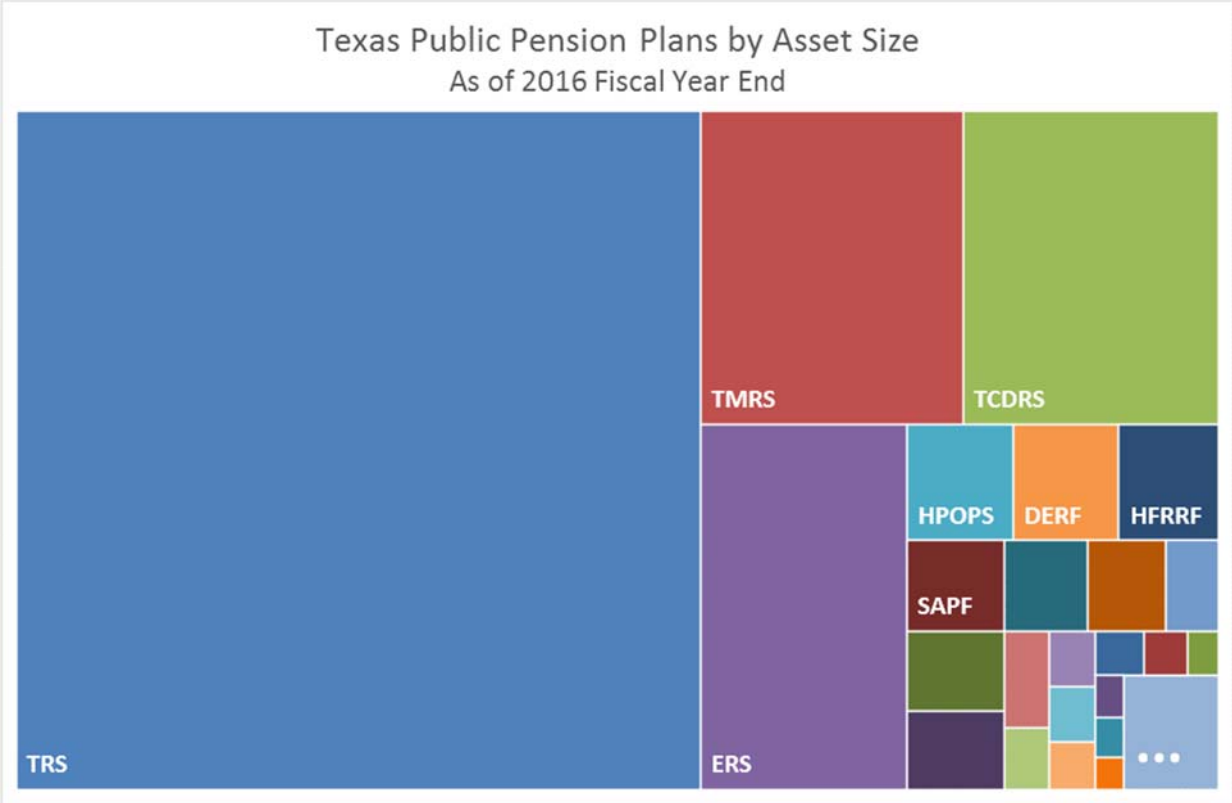
⁵ Dyck, “Is Bigger Better?” p. 4

⁶ Bikker, Jacob A., and Jan De Dreu, “Operating Costs of Pension Funds: the Impact of Scale, Governance, and Plan Design.” *Journal of Pension Economics and Finance*, vol. 8, no. 01, Feb. 2009, p. 68., doi:10.1017/s1474747207002995.

⁷ Dyck, “Is Bigger Better?” p. 4

⁸ Data collected by the PRB is as reported by the plans and may contain errors, omissions or misclassifications.

⁹ The Law Enforcement & Custodial Officer Supplemental Retirement Fund and the Judicial Retirement System of Texas Plan Two are included as part of ERS for this purpose.



The remaining data for each year was sorted by asset size and split into quintiles, with Quintile 1 containing the smallest plans, and Quintile 5 the largest (see the “Texas Public Pension Plans by Asset Size” table in the appendix for additional detail). The total assets of Quintile 1 plans (\$107.9M as of FYE 2016) generally fell near the bottom of the range for Quintile 4. Because Quintile 4 (as of FYE 2016) ranged from \$80M to \$400M, plans in Quintile 3 (\$32.5M to \$77M as of FYE 2016) were used to represent large plans in this study.

Investment return performance was evaluated on an absolute basis using annual returns net of investment fees; on a relative basis using excess annual net returns above the assumed rate of return; and on a risk-adjusted basis using 5-year and 10-year Sharpe ratios.^{10,11} In addition, differences in investment and administrative expense ratios were evaluated.

Results

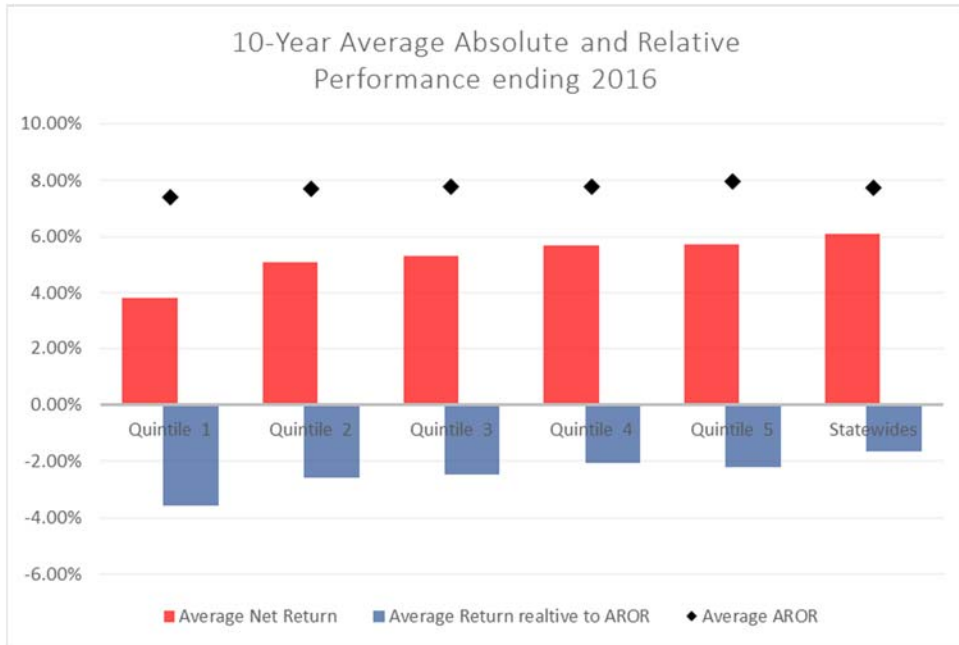
Overall, the data show that larger pension plans performed better than smaller plans on both an absolute basis and relative to their investment return targets.

Average annual net returns generally increased as asset size increased. Further, smaller plans not only had lower average assumed rates of return (AROR), but they also performed worse relative to their

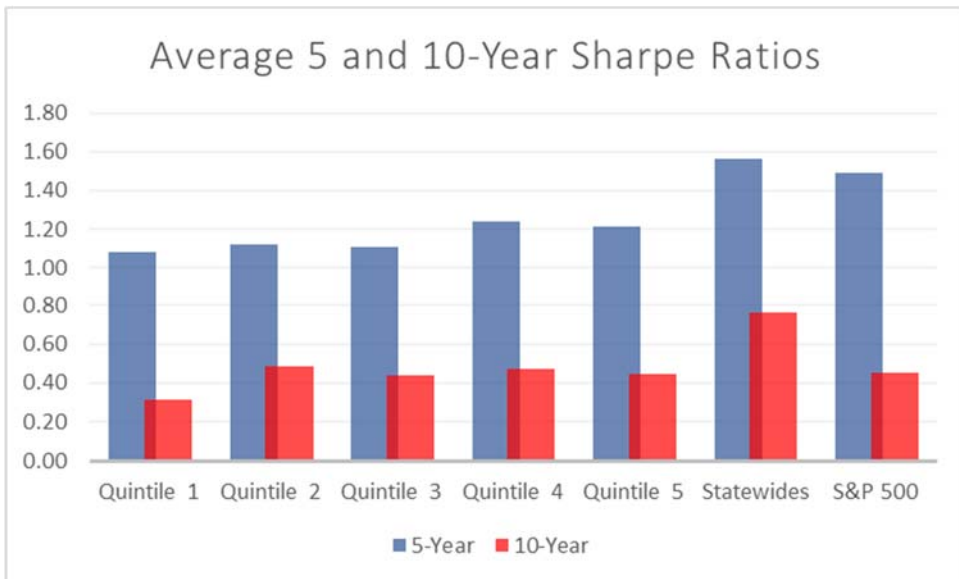
¹⁰ While assumed rate of return is not a common benchmark for evaluating relative performance, it provided a simple approach to measure a plan’s ability to achieve its broad investment goals.

¹¹ Sharpe ratios are a common and widely used measure of risk-adjusted return which attempts to capture the amount of excess return achieved above the risk-free rate per unit of total risk as measured by standard deviation.

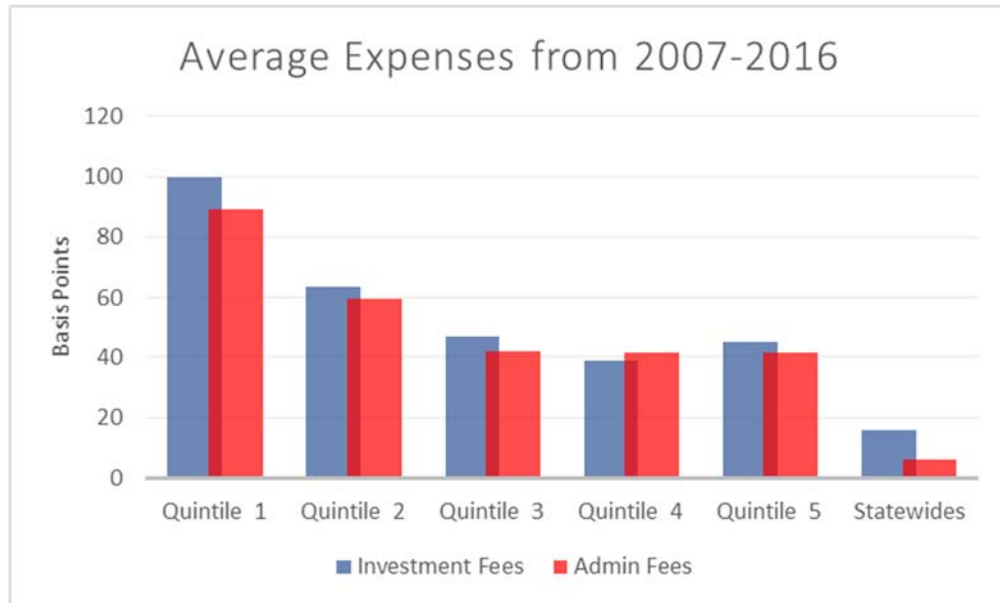
assumed rates of return (excess return). Over the period we considered, no quintile had average returns in excess of their assumed rates of return, so excess returns are negative for all quintiles.



The chart below shows that the 10-year and the 5-year Sharpe ratios were generally larger as plan size increased (indicating improved performance), although this result was clearer for 5-year ratios.



As illustrated in the chart below, the larger pension plans had significantly lower investment and administrative fees. Investment and administrative fees saw the largest decline from Quintile 1 to Quintile 2 as well as a significant decline from Quintiles 4 and 5 to the Statewide plans.



III. Possible Asset Pooling Models

Staff identified two primary models of pooled pension trusts: an Investment Management only model (IM) and an Investment Management and Administration (IMA) model. Under both models, the participating systems transfer all or a portion of their assets into the group investment trust, while maintaining the existing governance structures, including contribution, benefit, actuarial and asset allocation decision-making. An additional model, the Multiple-Employer Plan (MEP), also pools plan assets, but goes far beyond the scope of this study.

Investment Management Only

The investment management (IM) only model provides investment management services to member systems as a group trust. Some trusts require participating members to invest all assets with the trust, while others allow only a portion of the assets be invested. Some models manage members’ assets through model portfolios based on predetermined risk/return levels, while others replicate members’ asset allocations.

Massachusetts

The Massachusetts Pension Reserves Investment Management Board (PRIM) is charged with the general supervision of the Pension Reserves Investment Trust Fund (PRIT). The PRIT fund is a pooled investment trust fund established in 1983 to invest the assets of state and local retirement systems. The State Teachers’ Retirement System, the State Employees’ Retirement System, the State Boston/Teachers’ Retirement System, and the State Retiree Benefits Trust Fund are mandated by statute to invest all their assets in the PRIT. Local retirement systems may invest in the PRIT fund as participating members or

purchasing members. Participating members are required to transfer all assets to PRIM for a mandatory five-year period, while purchasing members can elect to invest just a portion of their assets with no minimum dollar amount or investment period.

Alberta and Ontario

The Alberta Investment Management Corporation (AIMCO) and the Investment Management Corporation of Ontario (IMCO) are Canadian Crown corporations (state-owned, nonprofit enterprises) of their respective provinces which provide investment management services to public sector clients. AIMCO provides services to endowment funds, pension plans, short-term government funds and special purpose government funds, while IMCO was created specifically to facilitate pooled asset management for Ontario public-sector institutions including public pension plans and other non-pension investment funds. The clients of both AIMCO and IMCO retain fiduciary duty and control over asset allocation decisions as well as full control of existing plans.

Investment Management and Administration

The Investment Management and Administration (IMA) model expands upon the IM model by adding various administrative functions to the list of services offered to the participating members. The services range from benefit administration to actuarial services.

Texas Hospital Association Master Trust

The Texas Hospital Association (THA) provides a variety of benefits and services to its members, including investment management, investment consulting, actuarial, audit, legal and benefit administration services to qualified defined benefit and defined contribution plans in the health care sector. Participating members include private, not-for-profit and public hospitals. For a defined benefit plan to be considered for inclusion in the program, it must meet minimum actuarial and legal requirements. Once accepted, plans are required to invest all assets with the trust as well as utilize THA's benefit administration services. Investing only a portion of a plan's assets or the use of alternative benefit administration services is generally not allowed. Defined benefit plans may select between four different pre-determined asset allocation models based on the employer's risk preferences. The models are a mix of equity and fixed income investments which are managed by the Trust's board of trustees with the assistance of independent investment advisors. Participating plans retain full control of existing benefit provisions.

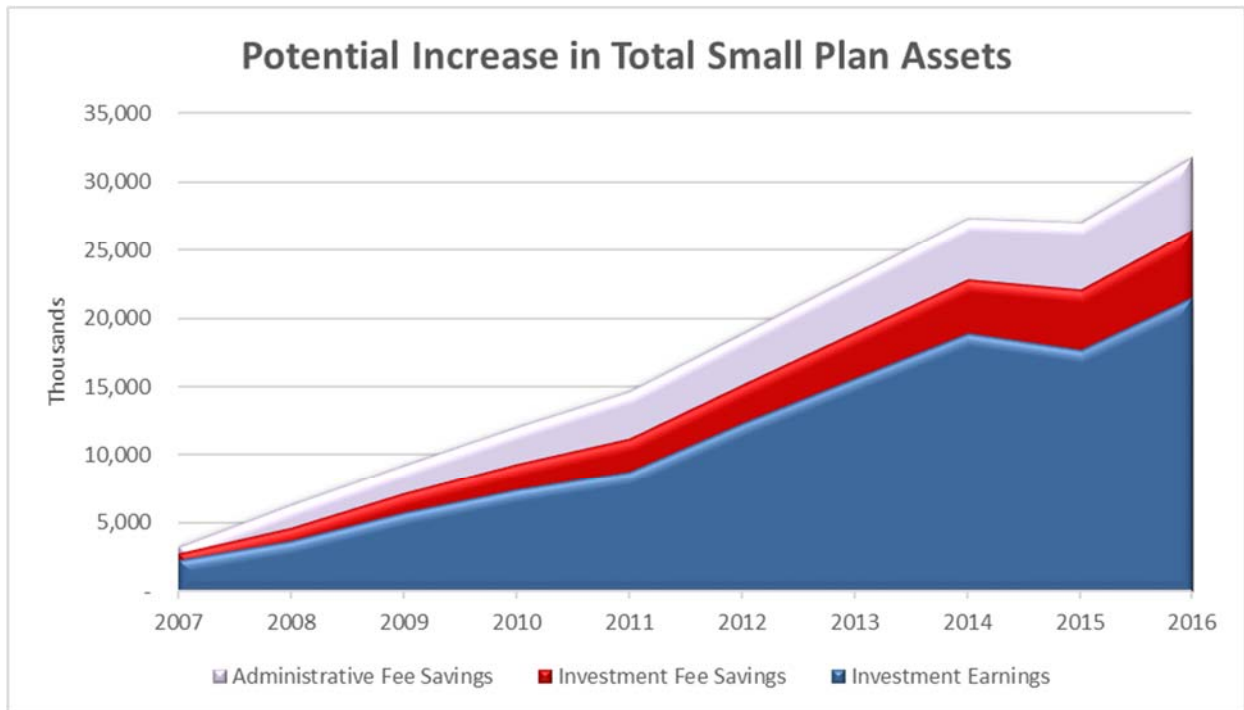
Agent Multiple-Employer Plans

An agent multiple-employer plan goes far beyond the IMA model, and therefore was not examined in this study. In this structure, the plan generally sets parameters for benefits and contributions and makes investment decisions on behalf of its participating employers.

Texas is home to two agent-multiple employer plans, the Texas Municipal Retirement System and the Texas County and District Retirement System, which pool assets of multiple municipalities and/or districts for investment purposes. member municipalities/districts may voluntarily join the systems, and those that participate have their own retirement plans within the general framework of their respective governing statutes. Plan provisions may vary depending upon the options selected by each individual employer.

Potential Impact

To objectively analyze the benefits of the IM and IMA structures, the PRB modeled the potential impact, by calculating the additional investment earnings systems in Quintile 1 could have earned if they achieved the same average returns as the systems in Quintile 3, as well as the potential savings in investment and administrative expenses if the average expenses paid by systems in Quintile 1 were the same as those paid by the systems in Quintile 3. It is estimated that the systems would have accrued an additional \$21.5 million in investment earnings plus saved approximately \$5 million in investment fees, totaling \$26.5 million in additional assets as of the end of the 2016 FY under the IM model. Under the IMA model, an additional \$5 million in administrative fees could have been saved, totaling \$32 million for the 10-year period ending in 2016. This represents an increase from \$108 million to \$140 million in aggregate assets, or a 29% increase.



IV. Recommendations

This study constitutes a first step towards developing potential recommendations in this area. The evidence suggests smaller pension plans in Texas could benefit in several ways from pooling assets for investment purposes as well as pooling administrative functions. Further in-depth study of possible governance structures to provide asset pooling services including associated legal requirements is necessary and should include engaging small pension plans to provide input and explore viable options.

Appendix

The appendix provides additional detail and explanation of the research performed and the data used.

Data and Methodology

Texas Public Pension Plans by Asset Size		
Plan Name	2016 FYE	
	Assets	Quintile
Teacher Retirement System of Texas	\$134,008,637,473	N/A
Texas County & District Retirement System	\$26,287,148,901	N/A
Employees Retirement System of Texas, LECOS & JRS II	\$25,706,748,855	N/A
Texas Municipal Retirement System	\$25,233,205,773	N/A
Houston Police Officers' Pension System	\$4,080,460,000	5
Houston Firefighters' Relief & Retirement Fund	\$3,729,670,009	5
Dallas Police & Fire Pension System-Combined Plan	\$3,378,593,785	5
Dallas Employees' Retirement Fund	\$3,352,043,000	5
San Antonio Fire & Police Pension Fund	\$2,834,548,000	5
Houston Municipal Employees Pension System	\$2,400,023,240	5
Austin Employees' Retirement System	\$2,299,708,386	5
Fort Worth Employees' Retirement Fund	\$2,097,716,741	5
CPS Energy Pension Plan	\$1,450,150,734	5
El Paso Police, Firemen's and Staff Pension Fund	\$1,295,716,967	5
Austin Fire Fighters Relief & Retirement Fund	\$829,610,196	5
Dallas County Hospital District Retirement Income Plan	\$828,755,000	5
El Paso City Employees' Pension Fund	\$723,103,443	5
Austin Police Retirement System	\$686,020,263	5
Harris County Hospital District Pension Plan	\$594,401,173	5
Dallas/Fort Worth Airport Board Retirement Plan	\$439,738,000	5
Lower Colorado River Authority Retirement Plan	\$403,120,000	4
University Health System Pension Plan	\$295,051,029	4
San Antonio Metropolitan Transit Retirement Plan	\$246,002,425	4
Houston MTA Workers Union Pension Plan	\$240,688,461	4

Texas Public Pension Plans by Asset Size		
Plan Name	2016 FYE	
	Assets	Quintile
Irving Firemen's Relief & Retirement Fund	\$186,556,007	4
Lubbock Fire Pension Fund	\$176,016,821	4
DART Employees' Defined Benefit Retirement Plan & Trust	\$168,334,000	4
Port of Houston Authority Retirement Plan	\$163,311,014	4
Dallas/Fort Worth Airport Board DPS Retirement Plan	\$160,945,000	4
Houston MTA Non-Union Pension Plan	\$153,103,411	4
Amarillo Firemen's Relief & Retirement Fund	\$152,996,702	4
Corpus Christi Fire Fighters' Retirement System	\$133,901,631	4
Plano Retirement Security Plan	\$126,698,362	4
Laredo Firefighters Retirement System	\$126,305,204	4
Beaumont Firemen's Relief & Retirement Fund	\$102,438,832	4
Texas Emergency Services Retirement System	\$93,964,008	4
Midland Firemen's Relief & Retirement Fund	\$82,664,948	4
Denton Firemen's Relief & Retirement Fund	\$75,304,750	3
Tyler Firemen's Relief & Retirement Fund	\$62,536,196	3
San Angelo Firemen's Relief & Retirement Fund	\$60,206,802	3
Abilene Firemen's Relief & Retirement Fund	\$55,018,029	3
Irving Supplemental Benefit Plan	\$52,258,122	3
Wichita Falls Firemen's Relief & Retirement Fund	\$46,950,042	3
Galveston Employees' Retirement Fund	\$45,640,194	3
McAllen Firemen's Relief & Retirement Fund	\$44,759,055	3
Odessa Firemen's Relief & Retirement Fund	\$44,257,040	3
Port Arthur Firemen's Relief & Retirement Fund	\$44,135,666	3
Nacogdoches County Hospital District Retirement Plan	\$43,662,691	3
Longview Firemen's Relief & Retirement Fund	\$41,056,538	3
Galveston Firefighter's Relief & Retirement Fund	\$40,155,474	3
Temple Firemen's Relief & Retirement Fund	\$39,862,402	3

Texas Public Pension Plans by Asset Size		
Plan Name	2016 FYE	
	Assets	Quintile
Killeen Firemen's Relief & Retirement Fund	\$35,342,830	3
Corpus Christi Regional Transportation Authority	\$32,583,077	3
Texarkana Firemen's Relief & Retirement Fund	\$31,777,180	2
Capital MTA Retirement Plan for Bargaining Unit Employees	\$29,535,196	2
Harlingen Firemen's Relief & Retirement Fund	\$28,747,083	2
Guadalupe-Blanco River Authority	\$26,632,375	2
The Woodlands Firefighters' Retirement System	\$26,188,804	2
Capital MTA Retirement Plan for Administrative Employees	\$23,811,865	2
Conroe Fire Fighters' Retirement Fund	\$22,529,049	2
Cleburne Firemen's Relief & Retirement Fund	\$21,323,149	2
Northwest Texas Healthcare System Retirement Plan	\$19,960,895	2
Galveston Employees' Retirement Plan for Police	\$19,784,817	2
Brazos River Authority Retirement Plan	\$18,726,771	2
Denison Firemen's Relief & Retirement Fund	\$15,721,368	2
Travis County ESD #6 Firefighter's Relief & Retirement Fund	\$15,043,500	2
Texas City Firemen's Relief & Retirement Fund	\$14,412,584	2
Lufkin Firemen's Relief & Retirement Fund	\$14,335,797	2
Waxahachie Firemen's Relief & Retirement Fund	\$14,201,159	2
Greenville Firemen's Relief & Retirement Fund	\$12,728,162	2
Galveston Wharves Pension Plan	\$11,895,228	1
Big Spring Firemen's Relief & Retirement Fund	\$10,387,399	1
Colorado River Municipal Water District Defined Benefit Retirement Plan & Trust	\$9,660,662	1
University Park Firemen's Relief & Retirement Fund	\$9,448,371	1
Weslaco Firemen's Relief & Retirement Fund	\$9,186,148	1
Corsicana Firemen's Relief & Retirement Fund	\$8,344,317	1
Orange Firemen's Relief & Retirement Fund	\$8,154,598	1
Sweetwater Firemen's Relief & Retirement Fund	\$7,826,879	1

Texas Public Pension Plans by Asset Size		
Plan Name	2016 FYE	
	Assets	Quintile
Marshall Firemen's Relief & Retirement Fund	\$7,712,228	1
Plainview Firemen's Relief & Retirement Fund	\$5,427,943	1
Paris Firefighters' Relief & Retirement Fund	\$4,764,272	1
Atlanta Firemen's Relief & Retirement Fund	\$3,744,867	1
Brownwood Firemen's Relief & Retirement Fund	\$3,617,575	1
San Benito Firemen Relief & Retirement Fund	\$2,987,515	1
Arlington Employees Deferred Income Plan	\$2,727,969	1
Refugio County Memorial Hospital District Retirement Plan	\$2,051,124	1

Total assets are all the assets available to a fund and may include, investments, cash, receivables, and capital assets. Investment return data was provided on a total fund level and is net of investment fees. Sharpe ratios were calculated based on annual data for investment returns, T-bill returns and standard deviation.

Expense data was calculated as a percentage of assets based on fees reported for investment and administrative expenses. Investment expenses primarily consist of investment management fees, investment consultant fees, and custodial and brokerage fees. Administrative expenses are fees related to operating the pension plan and may include professional consultants and benefits administration. The data is self-reported and, in some instances, contain inconsistencies in classification of fees across different pension plans with investment expenses, such as investment consultant fees, being reported as administrative expenses. Further, where pension funds utilize employees of the sponsoring entity to help perform administrative functions for the plan, administrative costs may not be fully recognized by the plan.¹²

For each year, the pension plans were grouped into quintiles by total assets and averages were calculated for each metric, excluding Sharpe ratios, which were calculated at the end of 2016 on a 5-year and 10-year basis. The metrics were then analyzed across quintiles for differences in performance based on asset size.

Summary statistics for each metric are included to provide information about the observations in each data set and include; mean, median, standard deviation and minimum and maximum values.

¹² Bikker, "Operating Costs of Pension Funds."

Results

Investment Returns

Investment return performance was evaluated on an absolute, relative, and risk-adjusted basis using net returns, excess returns over the assumed rate of return, and 5-year and 10-year Sharpe ratios respectively.

Absolute Returns. Pension plan returns were analyzed on an absolute basis using annual returns net of investment fees. 10-year geometric average annual net returns ranged from 3.30% for quintile 1 (the smallest plans) to 5.40% in quintile 5 (the largest plans). The statewide plans performed the best with an average return of 5.89%. Average annual net returns generally increased as asset size increased and demonstrate that larger plans have been outperforming smaller plans.

The mean average annual return for defined-benefit plans ranged from a minimum of -18.74% in 2008 to a maximum of 13.84% in 2013 while the median return ranged from -22.14% in 2008 to 18.50% in 2009. The standard deviation of returns for defined-benefit plans ranged from a minimum of 2.65% in 2015 to a maximum of 13.82% in 2009 with an average standard deviation during the period of 5.50%. The average annual range during the period was 26.16% suggesting that there is great variability between the returns of the best and worst performing funds.

Summary of Average Net Asset Returns												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Geometric Average	
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Year	5-Year
Quintile 1	7.36%	-21.81%	13.33%	10.35%	-0.12%	9.38%	12.55%	4.50%	-1.98%	4.61%	3.30%	5.69%
Quintile 2	8.06%	-20.46%	13.04%	12.58%	2.38%	11.07%	14.34%	6.36%	-2.02%	5.77%	4.60%	6.96%
Quintile 3	9.93%	-18.06%	14.62%	11.02%	1.26%	11.24%	13.16%	6.18%	-2.50%	6.46%	4.88%	6.77%
Quintile 4	9.22%	-20.54%	14.98%	11.86%	1.91%	11.53%	16.10%	6.62%	-1.04%	6.48%	5.17%	7.78%
Quintile 5	10.94%	-15.12%	5.71%	13.37%	5.11%	9.83%	13.76%	8.59%	-0.81%	5.95%	5.40%	7.35%
Statewide	10.98%	-9.80%	4.23%	9.70%	7.26%	9.54%	11.23%	11.05%	-0.10%	6.80%	5.89%	7.62%
Mean	9.19%	-18.74%	11.96%	11.75%	2.35%	10.56%	13.84%	6.66%	-1.61%	5.90%	N/A	N/A
Median	8.60%	-22.14%	18.50%	11.49%	-0.23%	11.02%	14.54%	5.80%	-1.77%	6.84%	N/A	N/A
Minimum	1.31%	-33.70%	-23.56%	3.79%	-4.80%	-0.75%	2.27%	0.11%	-12.60%	-10.84%	N/A	N/A
Maximum	18.35%	5.00%	31.13%	28.50%	22.03%	18.28%	24.34%	18.66%	5.80%	10.78%	N/A	N/A
St Dev	3.78%	9.73%	13.82%	3.43%	6.59%	3.94%	4.15%	3.96%	2.65%	3.53%	N/A	N/A

Relative Returns. The assumed rate of return for a pension plan is the expected return of its assets and is generally used to value its liabilities (i.e. discount expected future benefit payments) for funding/budgetary purposes. The return assumption is based on the plan's asset allocation and future capital market expectations. Comparing actual pension plan investment returns to assumed rates of return provides insight into the relative performance of the funds against the required fund return. While assumed rate of return is not a common benchmark for evaluating relative performance, we felt it provided a simple approach that illustrates a plan's ability to achieve its broad investment goals.

The assumed rate of return for Texas pension plans trended down during the 2007 through 2016 period. The average and median assumed rates of return decreased from 7.87% and 8.00% in 2007 to 7.48% and

7.50% in 2016 respectively. The standard deviation ranged from .42% to .50% indicating data was tightly clustered.

The average assumed rate of return was generally lower for pension plans with fewer assets and increased as asset size increased. The average assumed rate of return for pension plans in quintile 1 was 7.40% and increased to 7.96% for pension plans in quintile 5.

Average excess returns, defined as average net investment returns greater than the average assumed rates of return for pension plans, were negative for all quintiles. 10-year geometric average excess returns ranged from -4.15% for quintile 1 to -2.60% for quintile 5. Relative to all the systems, statewide plans performed the best averaging 1.87% below their assumed rate of return. Although pension plans in quintile 1 had the lowest average assumed rate of return, they had the lowest excess average return of all the quintile groups.

Summary of Average Excess Asset Returns												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Geometric Average	
											10-Year	5-Year
Quintile 1	-0.14%	-29.22%	5.89%	2.96%	-7.49%	2.05%	5.20%	-2.93%	-9.43%	-2.71%	-4.15%	-1.69%
Quintile 2	0.15%	-28.34%	5.24%	4.83%	-5.35%	3.39%	6.71%	-1.24%	-9.54%	-1.71%	-3.15%	-0.63%
Quintile 3	2.03%	-25.95%	6.81%	3.18%	-6.56%	3.40%	5.37%	-1.63%	-10.24%	-1.16%	-2.97%	-1.00%
Quintile 4	1.22%	-28.54%	6.99%	3.94%	-5.84%	3.78%	8.35%	-1.11%	-8.55%	-1.00%	-2.68%	0.13%
Quintile 5	2.80%	-23.26%	-2.45%	5.30%	-2.95%	1.81%	5.82%	0.73%	-8.52%	-1.58%	-2.60%	-0.46%
Statewide	3.23%	-17.55%	-3.52%	1.95%	-0.49%	1.79%	3.48%	3.30%	-7.78%	-0.89%	-1.87%	-0.11%
Mean	1.31%	-26.60%	4.13%	3.95%	-5.40%	2.84%	6.15%	-1.03%	-9.20%	-1.59%	N/A	N/A
Median	0.80%	-29.86%	10.36%	3.60%	-7.75%	3.18%	6.66%	-1.90%	-9.47%	-0.85%	N/A	N/A
Minimum	-6.28%	-41.45%	-31.06%	-3.96%	-12.06%	-9.01%	-5.73%	-7.54%	-19.85%	-17.84%	N/A	N/A
Maximum	9.85%	-3.00%	23.13%	21.00%	14.03%	10.28%	16.09%	11.16%	-1.69%	4.03%	N/A	N/A
St Dev	3.74%	9.75%	13.86%	3.39%	6.55%	3.95%	4.12%	3.99%	2.74%	3.47%	N/A	N/A

Risk-adjusted Returns. Sharpe ratios are a measure of risk-adjusted return and capture the amount of excess return achieved above the risk-free rate per unit of total risk as measured by standard deviation. As a reference the S&P 500 had 10-Year and 5-Year Sharpe ratios of .45 and 1.49 respectively.

The mean 10-Year Sharpe ratio for all defined-benefit plans was .45 while the median was .41. 10-Year Sharpe ratios ranged from a minimum of .08 to a maximum of 1.42 with a standard deviation of .22. The mean and median 5-Year Sharpe ratio for all defined-benefit plans was 1.15. 5-Year Sharpe ratios ranged from a minimum of .24 to a maximum of 1.80 with a standard deviation of .29.

Sharpe ratios generally increased as asset size increased suggesting larger pension plans had better risk-adjusted returns. The average 10-Year Sharpe ratio for quintile 1 was .32 and was .45 for quintile 5 while the 5-Year Sharpe ratio for quintile 1 was 1.08 and was 1.22 for quintile 5. Further, the statewide plans had 10- and 5-year Sharpe ratios of 0.76 and 1.57, respectively, showing better performance than the S&P 500 over the same period.

Expenses

Pension plans pay various expenses to operate a pension fund, including investment and administrative expenses. Investment and administrative expenses reduce pension plan returns as they are paid from investment earnings and plan assets. Higher expenses generally lead to a decrease in performance. The results of the study seem to indicate that pension plans exhibit economies of scale as average fees as a percent of assets appear to be inversely correlated with asset size.

The 10-year average investment fee for defined-benefit pension plans was 1.00% for pension plans in quintile 1 and .45% for pension plans in quintile 5. The average administrative fee was .81% for pension plans in quintile 1 and was .15% for pension plans in quintile 5. Average investment fees for quintile 1 were 1.5 to 2.5 times the size of the other quintile groups while average administrative fees were 2 to 5 times as large as the other quintile groups.

The average investment fee for defined-benefit plans ranged from a minimum of .48% in 2016 to a maximum of .69% in 2008 while the median investment fee ranged from .40% in 2016 to .62% in 2008. The standard deviation of investment fees for defined-benefit plans ranged from a minimum of .28% in 2014 to a maximum of .44% in 2008.

The average administrative fee for defined-benefit plans ranged from a minimum of .25% in 2014 to a maximum of .57% in 2008 while the median investment fee ranged from .17% in 2014 to .26% in 2011. The standard deviation of investment fees for defined-benefit plans ranged from a minimum of .24% in 2007 to a maximum of 1.83% in 2008.

Summary of Average Investment Fees												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Arithmetic Average	
											10-Year	5-Year
Quintile 1	1.12%	1.23%	1.04%	1.04%	1.09%	0.92%	0.92%	0.91%	0.90%	0.82%	1.00%	0.89%
Quintile 2	0.68%	0.78%	0.59%	0.69%	0.64%	0.72%	0.57%	0.59%	0.57%	0.54%	0.64%	0.60%
Quintile 3	0.50%	0.68%	0.45%	0.51%	0.46%	0.44%	0.42%	0.45%	0.46%	0.34%	0.47%	0.42%
Quintile 4	0.34%	0.43%	0.33%	0.32%	0.38%	0.39%	0.39%	0.44%	0.44%	0.41%	0.39%	0.41%
Quintile 5	0.48%	0.64%	0.41%	0.45%	0.44%	0.45%	0.41%	0.41%	0.42%	0.40%	0.45%	0.42%
Statewide	0.23%	0.16%	0.12%	0.14%	0.17%	0.15%	0.15%	0.12%	0.15%	0.17%	0.16%	0.15%
Mean	0.55%	0.69%	0.51%	0.51%	0.53%	0.52%	0.50%	0.51%	0.52%	0.48%	N/A	N/A
Median	0.50%	0.62%	0.43%	0.44%	0.47%	0.46%	0.41%	0.47%	0.48%	0.40%	N/A	N/A
Minimum	0.00%	0.01%	0.02%	0.02%	0.00%	0.03%	0.03%	0.03%	0.11%	0.10%	N/A	N/A
Maximum	1.66%	1.91%	2.35%	1.63%	1.63%	1.39%	1.37%	1.18%	1.21%	1.28%	N/A	N/A
St Dev	0.36%	0.44%	0.40%	0.34%	0.36%	0.30%	0.29%	0.28%	0.29%	0.28%	N/A	N/A

Summary of Average Administrative Fees												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Arithmetic Average	
											10-Year	5-Year
Quintile 1	0.53%	1.97%	0.68%	1.00%	1.09%	0.63%	0.45%	0.50%	0.64%	0.59%	0.81%	0.56%
Quintile 2	0.30%	0.46%	0.49%	0.37%	0.45%	0.32%	0.37%	0.32%	0.33%	0.32%	0.37%	0.33%
Quintile 3	0.24%	0.25%	0.21%	0.21%	0.26%	0.29%	0.27%	0.23%	0.21%	0.24%	0.24%	0.25%
Quintile 4	0.26%	0.38%	0.26%	0.27%	0.29%	0.18%	0.17%	0.13%	0.16%	0.17%	0.23%	0.16%
Quintile 5	0.14%	0.18%	0.16%	0.15%	0.15%	0.15%	0.14%	0.13%	0.15%	0.16%	0.15%	0.15%
Statewide	0.05%	0.06%	0.06%	0.06%	0.07%	0.06%	0.06%	0.06%	0.07%	0.06%	0.06%	0.06%
Mean	0.27%	0.57%	0.33%	0.37%	0.42%	0.30%	0.26%	0.25%	0.28%	0.28%	N/A	N/A
Median	0.19%	0.23%	0.24%	0.19%	0.26%	0.19%	0.18%	0.17%	0.19%	0.19%	N/A	N/A
Minimum	0.02%	0.01%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.03%	N/A	N/A
Maximum	1.17%	16.65%	2.44%	3.44%	6.42%	1.66%	1.90%	1.74%	2.80%	2.08%	N/A	N/A
St Dev	0.24%	1.83%	0.37%	0.52%	0.74%	0.31%	0.29%	0.25%	0.36%	0.29%	N/A	N/A

Statistical Analysis

Many statistical techniques and financial theories rely on the assumption that returns are normally distributed to simplify analysis. Studies have shown that asset returns do not follow a normal distribution as they have excess kurtosis, i.e. fatter tails or more results at the extreme ends of the distribution, therefore this study assumes that asset returns are log-normally distributed in order to address this concern.

The combined total assets for the plans in Quintile 1 fell within the lower end of the range of plans in Quintile 4. However, due to the large range of Quintile 4 (\$80mm to \$400mm), Quintile 3 was chosen as a more appropriate representation for comparing expected returns and expenses.

Except where specifically noted below, this study relies on the Welch t-Test for two samples assuming equal variances to test for statistical significance and the central limit theorem for samples of $n > 30$ to approximate a normal distribution. The null hypothesis is that the difference between the means of the underlying distribution equals zero while the alternative hypothesis is that the difference does not equal zero.

The t-Test for net investment returns failed to reject the null hypothesis at the 95% confidence level. However, sample size is likely driving this result. The sample size required to achieve 95% confidence, given the sample statistics cited above, is roughly 1,050 total observations (or 525 per sample), while our sample only includes 322 observations. So while the differences in average returns are arguably large in practical terms (i.e., greater than 100 basis points), we simply do not have a large enough sample for statistical significance.

Similarly, the t-Test for excess returns above the assumed rate of return failed to reject the null hypothesis at the 95% confidence level. Again, this could be caused by the small sample size. The sample size required for 95% confidence is roughly 2,100 total observations (or 1,050 per sample).

Average Annual Return 2007-2016			Average Excess Return 2007-2016		
	Q3	Q1		Q3	Q1
Mean	4.64%	3.30%	Mean	(3.16%)	(4.19%)
Variance	1.18%	1.28%	Variance	1.41%	1.52%
Observations	163	159	Observations	163	159
Pooled Variance	1.23%		Pooled Variance	1.46%	
df	320		df	320	
t Stat	1.09		t Stat	0.77	
P(T<=t) two-tail	0.28		P(T<=t) two-tail	0.44	

Numerous papers have shown that Sharpe ratios are not normally distributed,^{13,14} and have discussed several different approaches to performing hypothesis testing on the difference between two Sharpe ratios that produce robust results but are generally beyond the scope of this analysis. For simplicity, this study relies on the Mann–Whitney U test which is distribution free so does not rely on the assumption that the underlying values are normally distributed. The Mann-Whitney U test for the 5-Year Sharpe Ratio failed to reject the null hypothesis at the 95% confidence level, however, the 10-Year Sharpe Ratios are shown to be statistically different.

5-Year Sharpe Ratio			10-Year Sharpe Ratio		
	Q3	Q1		Q3	Q1
Median	1.05	1.11	Median	0.42	0.32
Observations	16	15	Observations	16	14
Sum of Ranks	248	248	Sum of Ranks	313	152
Mann-Whitney U	128	128	Mann-Whitney U	201	40
z	0.32		z	-2.99	
P(Z<=z) two-tail	0.75		P(Z<=z) two-tail	0.00	

The t-Tests for both investment and administrative fees indicates the differences in fees between Quintile 3 and Quintile 1 are statistically significant.

Average Investment Fees 2007-2016			Average Administrative Fees 2007-2016		
	Q3	Q1		Q3	Q1
Mean	0.47%	0.99%	Mean	0.24%	0.79%
Variance	0.00%	0.00%	Variance	0.00%	0.02%
Observations	152	102	Observations	162	142
Pooled Variance	0.00%		Pooled Variance	0.01%	
df	252		df	302	
t Stat	-14.04		t Stat	-4.51	
P(T<=t) two-tail	0.00		P(T<=t) two-tail	0.00	

¹³ Opdyke, John Douglas, “Comparing Sharpe Ratios: So Where Are the p-Values?” *Journal of Asset Management*, vol. 8, no. 5, Dec. 2007, pp. 308–336., doi:10.1057/palgrave.jam.2250084.

¹⁴ Riondato, Matteo, “Sharpe Ratio: Estimation, Confidence Intervals, and Hypothesis Testing.” *Two Sigma Technical Report 2018-001*, 14 June 2018.

The statistical analysis demonstrates that some of the metrics of pension performance examined as part of the study are not random and pooling assets could provide significant benefits to pension plans. Although net investment returns and excess returns over the assumed rate of return did not show any statistical significance, 10-Year Sharpe ratios suggest that larger pension plans had better risk-adjusted returns as compared to smaller pension plans during the period. Additionally, the differences between investment and administrative fees were significant.

Potential Impact Modeling

Average Investment Returns										
Quintiles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	7.36%	-21.81%	13.33%	10.35%	-0.12%	9.38%	12.55%	4.50%	-1.98%	4.61%
3	9.93%	-18.06%	14.62%	11.02%	1.26%	11.24%	13.16%	6.18%	-2.50%	6.46%
Additional Investment Returns	2.58%	3.75%	1.29%	0.67%	1.37%	1.86%	0.62%	1.68%	-0.52%	1.85%

Average Investment Fees										
Quintiles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	1.09%	1.28%	1.10%	1.04%	1.15%	0.92%	0.91%	0.92%	0.91%	0.84%
3	0.50%	0.70%	0.44%	0.50%	0.49%	0.42%	0.42%	0.45%	0.46%	0.34%
Savings	0.59%	0.58%	0.66%	0.54%	0.66%	0.50%	0.50%	0.47%	0.45%	0.50%

Average Administrative Fees										
Quintiles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.79%	2.34%	0.81%	1.00%	1.21%	0.63%	0.58%	0.54%	0.68%	0.63%
3	0.27%	0.32%	0.28%	0.28%	0.34%	0.34%	0.27%	0.23%	0.21%	0.24%
Savings	0.52%	2.02%	0.53%	0.72%	0.86%	0.29%	0.31%	0.31%	0.47%	0.39%