Statewide Pension Funding and Exogenous Risk Factors

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Abstract

This analysis examines the funded status of pension systems in all fifty states to determine if there is a significant difference in state funding practice. Additionally, multiple regression is used to look at factors exogenous to statewide pension plans to determine what outside factors impact the funded status of a given retirement system. The analysis finds that significant differences in state pension funding exist, and the exogenous factor that significantly impacts pension funding is partisan, rather than demographic or economic.

Introduction

What, if any, differences exist in state pension funding, and what impacts do environmental factors have on the funded status of state public employee pension plans? Ongoing pension obligations strain state budgets. One way to manage the size of pension obligations is to fully fund plans, rather than defer fixed costs to a later date. This analysis will examine if significant differences exist between states in regards to the funded status of statewide pension plans, and then examine if any exogenous factors have a significant impact on plan funding within the state. The sample in this study is 110 retirement systems administered by fifty state governments. The exogenous factors included in the analysis are political, demographic, and economic:

- partisan control of a state's legislature and governorship,
- the size of state employment adjusted for the total population in the state,
- the number of public state employees represented by a union,
- the tax revenue of the state government, and
- the per capita GDP of the state.

Background

This study[1] looks at the funded status of state retirement systems and factors outside of the direct control of pension plan administrators to examine the relationships between several risk factors and the effect that those factors have on plan funded status. The data for this study was compiled from several sources. The primary data on statewide pension plans came from the Public Plans Database at the Center for Retirement Research. Data on statewide tax revenue was compiled from Pew Charitable Trust. Partisan composition of state legislatures and governorship was obtained from the National Conference of State Legislatures. State gross domestic product per capita was from the Bureau of Economic Analysis. State employment and union participation data was Governing and the Bureau of Labor Statistics. These factors were combined into a data set in R for purposes of this research exercise. If states are shown to have significantly better or worse statewide funding, then best practices can be identified that may be applicable to other states. If significant exogenous risk factors are detected, then pension plan administrators can identify the risk level of their retirement environment and respond proactively to manage funding challenges. The combined unfunded liability of all plans included in this data set is over twelve billion dollars. Any strategies that can help manage this increasing obligation will provide multiplicative economic benefits to cash-strapped state governments.

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[1]R Markdown and LaTeX are an amazing combination for report preparation. This analysis was written solely in RStudio

Data and Analysis

Data Sources

To begin, the data was loaded from the sources listed above and combined into a single data frame. All data is for fiscal year 2017, except for union participation which is year-end 2016[2].

```r
library(tidyverse)
library(reshape2)

# from Pew Charitable Trust
tax.data <- read_csv("../Data/TaxRevenue.csv")
#from the National Conference of State Legislatures
partisan.data <- read_csv("../Data/partisanComposition.csv")
# from The Center on Retirement Research
pension.data <- read_csv("../Data/PPD_PlanLevel.csv")
# from the Bureau of Economic Analysis
gdp.data <- read_csv("../Data/percapgdp.csv")
# from the Bureau of Labor Statistics
emp.data <- read_csv("../Data/emp.data.csv")
union.data <- read_csv("../Data/uniondata.csv")


tax.data <- tax.data %>%
  select(-c(X52, X53))
tax.data <- melt(tax.data) %>%
  filter(QtrRolAvg == "2017Q4") %>% #4QtrRolAvg dollars in thousands
  rename(BudgRev = value, GovtName = variable)

pension.data <- pension.data %>%
  filter(fy == 2017) %>%
  inner_join(partisan.data, by = "GovtName") %>% #removes local govts from data set
  left_join(tax.data, by = "GovtName") %>%
  left_join(gdp.data, by = "GovtName") %>%
  left_join(emp.data, by = "GovtName") %>%
  left_join(union.data, by = "GovtName") %>%
  select(fy, PlanFullName, GovtName, PerCapGDP, ActFundedRatio_GASB,
         BudgRev, LegControl, GovParty, state_emp_per_tenk_pop, UnionRep)

model.data <- pension.data %>%
  select(ActFundedRatio_GASB, PerCapGDP, BudgRev, state_emp_per_tenk_pop, UnionRep,
         LegControl, GovParty)

attach(model.data)
```

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[2]Tidyverse is a game-changing package for data manipulation and cleaning.

Analysis of Variance

In order to determine if significant differences in funding exist among states, an analysis of variance is used.

```
state.model <- aov(pension.data$ActFundedRatio_GASB ~ pension.data$GovtName)
summary(state.model)
```

```
##                       Df Sum Sq Mean Sq F value  Pr(>F)
## pension.data$GovtName 44 1.6435 0.03735   2.102 0.00553 **
## Residuals             51 0.9064 0.01777
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 14 observations deleted due to missingness
```

According to the analysis of variance, there is a 0.5% probability that there is no systematic, significant difference between plan funding in the fifty states. A Tukey HSD test can then be utilized to determine which states are the drivers of the significant difference.

```
library(agricolae)
state.tukey <- HSD.test(state.model, "pension.data$GovtName", group = TRUE)
state.tukey
```

From the Tukey HSD grouped output, it is clear that pension plans in Wisconsin, New York, and Washington are significantly more funded than those in the rest of the country, leading to the statistical significance of the model.

Multiple Regression

Once the differences in the states are shown to be significant, a multiple regression can be used to analyze what, if any, exogenous factors have a significant impact on pension funding. The factors analyzed are partisan control of a state's legislature and governorship, the size of state employment adjusted for the total population in the state, the number of public state employees represented by a union, the tax revenue of the state government, and the per capita GDP of the state. Below is a scatter plot matrix that examines the interactions present within the data.

```r
library(GGally)
ggpairs(model.data) +
        theme(axis.line=element_blank(),
        axis.text=element_blank(),
        axis.ticks=element_blank())
```
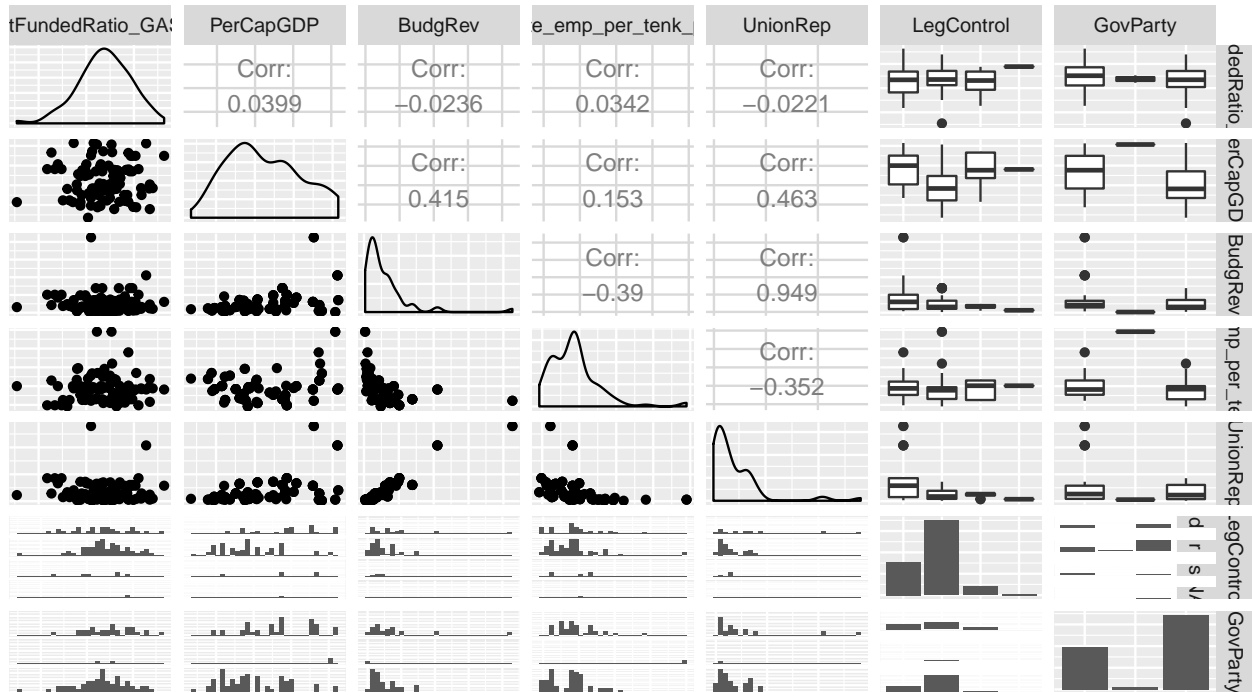

Some elements do not appear to be normally distributed. However, the response variable appears normal and meets the assumptions for linear regression. Transformations can be made to Budget Revenue, State Employment, and Union Representation to improve symmetry and reduce the impact of outliers.

```r
library(ggplot2)
ggplot(model.data, aes(x=log(BudgRev)))+
  geom_density() + theme_light()

ggplot(model.data, aes(x=log(state_emp_per_tenk_pop)))+
  geom_density() + theme_light()

ggplot(model.data, aes(x=log(UnionRep)))+
  geom_density() + theme_light()
```
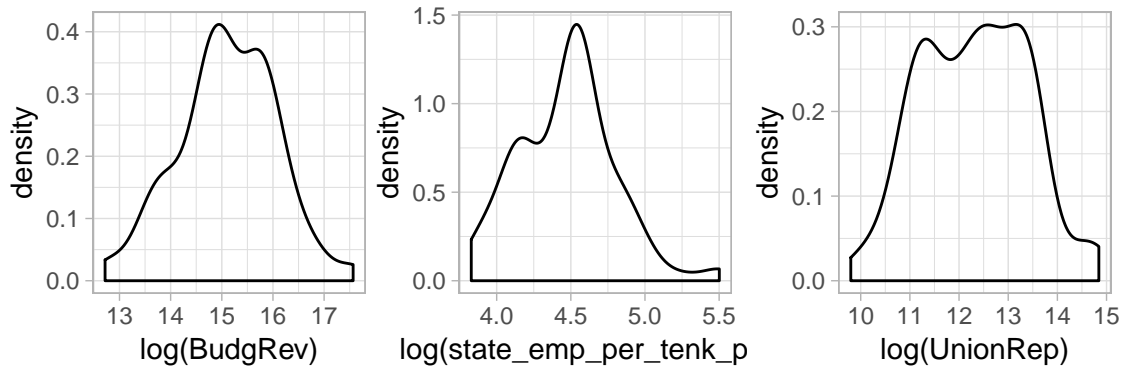
The LM regression model is created to include the plan's funded ratio as the response variable. Dummy variables will be used for the categorical indicators LegControl and GovParty, allowing them to be included in the regression. Interaction terms are specified for partisanship, economic, and demographic factors. A stepwise algorithm is used to determine the optimal model fit.

```
pension.model <- lm(ActFundedRatio_GASB ~ LegControl*GovParty+
                    log(state_emp_per_tenk_pop)*log(UnionRep)+log(BudgRev)*PerCapGDP)

summary(pension.model)
model1 <- step(pension.model)

summary(model1)
```

```
##
## Call:
## lm(formula = ActFundedRatio_GASB ~ LegControl + GovParty + LegControl:GovParty)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.55628 -0.09498 -0.01125  0.09912  0.30675
##
## Coefficients: (2 not defined because of singularities)
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)             0.80649    0.04742  17.008  < 2e-16 ***
## LegControlr            -0.06081    0.06160  -0.987  0.32626
## LegControls            -0.22024    0.09183  -2.398  0.01858 *
## GovPartyi              -0.03268    0.11795  -0.277  0.78240
## GovPartyr              -0.18424    0.06086  -3.027  0.00323 **
## LegControlr:GovPartyi        NA         NA      NA       NA
## LegControls:GovPartyi        NA         NA      NA       NA
## LegControlr:GovPartyr   0.15784    0.07632   2.068  0.04156 *
## LegControls:GovPartyr   0.43499    0.14918   2.916  0.00450 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1573 on 88 degrees of freedom
##   (15 observations deleted due to missingness)
## Multiple R-squared:  0.1385, Adjusted R-squared:  0.07977
## F-statistic: 2.358 on 6 and 88 DF,  p-value: 0.03694
```

The optimal model includes partisan control of the state legislature and partisan control of the governorship.

A split legislature is associated with a 22% decrease in funded status when compared to a Democratic legislature, with a p-value of 0.02. A Republican governor is associated with a 18% decrease in funded status over a Democratic governor, with a p-value of 0.003. However, the interaction of a Republican legislature and a Republican governor is associated with a 15% increase in funded status over a Democratic legislature. A split legislature with a Republican governor is also significant, but that is largely due to the small sample size of states that fall into that category.

Model Diagnostics

```
plot(model1)
```
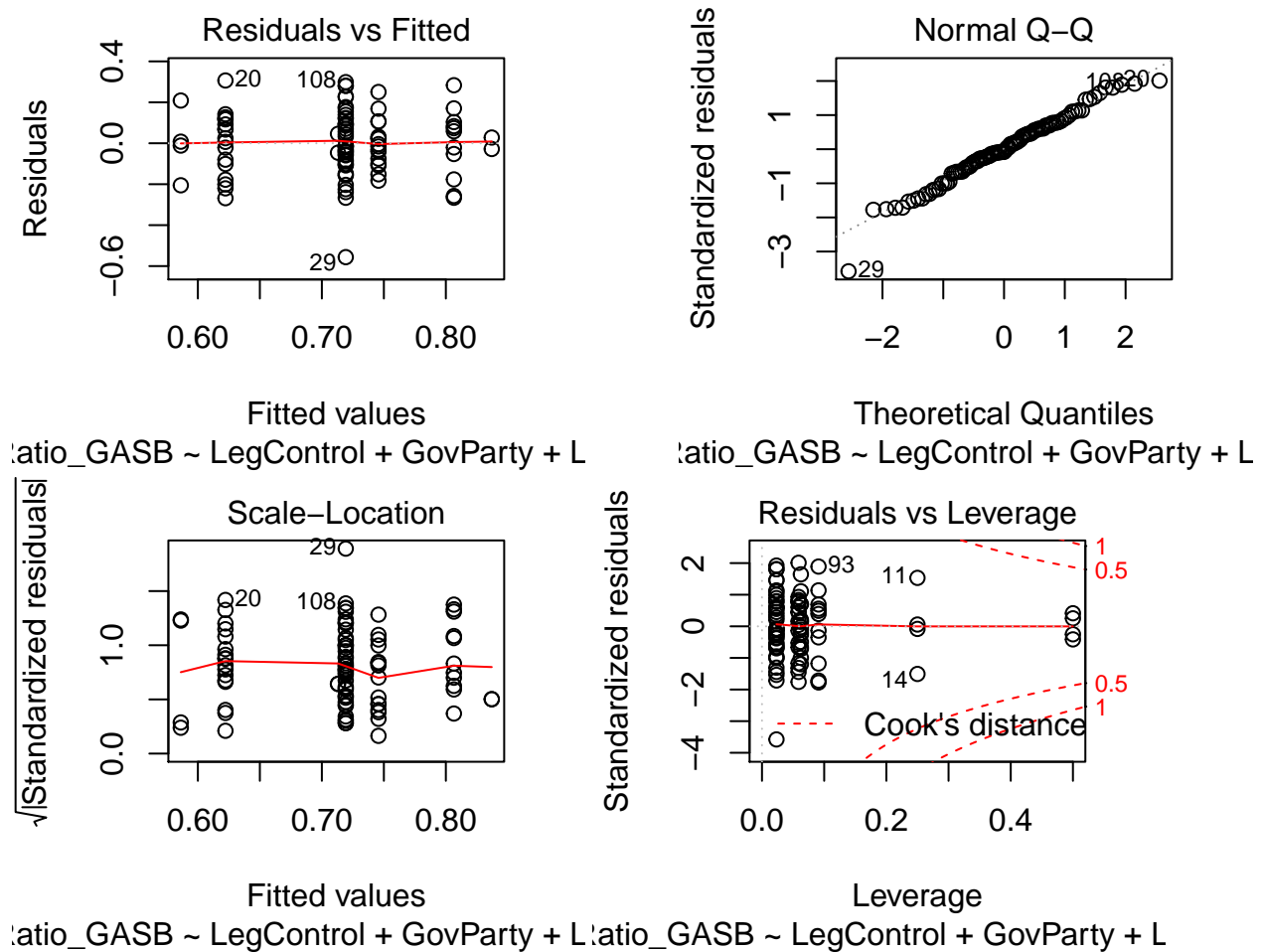

Diagnostic plots largely support the validity of the model. There is a slight s-shape to the QQ plot, but to a very minor degree and errors are dispersed appropriately.

Results and Key Findings

The analysis of statewide pension plan data indicates that a significant difference exists among the states in relation to plan funding status. Wisconsin, New York, and Washington stand apart from the rest of the states, and have significantly better plan funded status on average.

The only significant exogenous risk factors identified in the multiple regression are partisan control of state

legislatures and governorship. The size of state employment adjusted for the total population in the state, the number of public state employees represented by a union, the tax revenue of the state government, and the per capita GDP of the state did not have an impact on the funded status of a statewide retirement plan.

Conclusion

It is apparent from this analysis that there is a significant difference in plan funded status among states. Additionally, partisan factors are associated with changes in pension plan funding. Particularly, split legislatures and Republican governors are associated with a decrease in funded status. Generally, partisan unity across government control typically increases plan funded status in states. Also notable is the absence of significant statewide demographic and economic factors that play a roll in plan funded status. It appears the ability to under-fund a pension is not limited to states with low budgets and revenues. Additionally, union participation and the size of government employment does not appear to burden systems.

Washington is notable among the states identified as having significantly better funded systems in that it has a nonpartisan government actuarial service provider and select committee tasked with calculating and adopting contribution rates [3]. Additional research would be needed to show that nonpartisan pension processes improve plan funding, but it is feasible given the analysis conducted here.

If states are to manage pension debt effectively, one strategy may be to reduce the impact of partisanship where feasible, and implement non-partisan funding processes. Ultimately, states should not rely on economic or demographic trends to solve or excuse pension debt. Governments of all sizes are able to fund systems, and best practices may be able to be identified in those governments to support sustainable retirements for public employees.

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[3]It should be noted here that the author happens to work for said actuarial service provider and serve as staff to said select committee. I may be slightly biased.

Appendix

Data: Pension Plans, and Funded Status, and Exogenous Indicators

```
##        fy        PlanFullName        GovtName          PerCapGDP
##  Min.   :2017   Length:110         Length:110        Min.   :33558
##  1st Qu.:2017   Class :character   Class :character  1st Qu.:45321
##  Median :2017   Mode  :character   Mode  :character  Median :50556
##  Mean   :2017                                        Mean   :52602
##  3rd Qu.:2017                                        3rd Qu.:58217
##  Max.   :2017                                        Max.   :71456
##
##  ActFundedRatio_GASB   BudgRev           LegControl
##  Min.   :0.1630     Min.   :  333678   Length:110
##  1st Qu.:0.6175     1st Qu.: 2157176   Class :character
##  Median :0.7105     Median : 3476876   Mode  :character
##  Mean   :0.7148     Mean   : 5714135
##  3rd Qu.:0.8205     3rd Qu.: 7151410
##  Max.   :1.0900     Max.   :42588312
##  NA's   :14
##    GovParty        state_emp_per_tenk_pop    UnionRep
##  Length:110       Min.   : 46.00          Min.   :  18000
##  Class :character 1st Qu.: 65.00          1st Qu.:  88000
##  Mode  :character Median : 91.50          Median : 236000
##                   Mean   : 92.58          Mean   : 392746
##                   3rd Qu.:100.00          3rd Qu.: 577000
##                   Max.   :245.00          Max.   :2796000
##
```

PlanFullName	ActFundedRatio_GASB	LegControl	GovParty
Employees' Retirement System of Alabama	0.6780000	r	r
Teachers' Retirement System of Alabama	0.6890000	r	r
State of Alaska Public Employees' Retirement System	0.6670000	r	i
State of Alaska Teachers' Retirement System	0.7590000	r	i
Arizona Public Safety Personnel Retirement System	0.4530000	r	r
Arizona State Retirement System	0.7050000	r	r
Arkansas Public Employees Retirement System	0.7760000	r	r
Arkansas Teacher Retirement System	1.0000000	r	r
California Public Employees Retirement Fund	NA	d	d

California State Teachers' Retirement System	0.6300000	d	d
Colorado Public Employee Retirement Association-Local Division	0.7950000	s	d
Colorado Public Employee Retirement Association-School Division	0.5940000	s	d
Colorado Public Employee Retirement Association-State Division	0.5750000	s	d
Connecticut State Employees Retirement System	0.3810000	s	d
Connecticut State Teachers' Retirement System	NA	s	d
Delaware State Employees' Pension Plan	0.8650000	d	d
Florida Retirement System	0.8430000	r	r
Employees' Retirement System of the State of Hawaii	0.5490000	d	d
Public Employee Retirement System of Idaho	0.8960000	r	r
Illinois Municipal Retirement Fund	0.9290000	d	r
State Employees' Retirement System of Illinois	0.3540000	d	r
Teachers' Retirement System of The State of Illinois	0.4020000	d	r
State Universities Retirement System of Illinois	0.4443000	d	r
State of Indiana Public Employees' Retirement Fund	0.7900000	r	r
Indiana State Teachers' Retirement Fund	0.4805391	r	r
Iowa Public Employees' Retirement System	0.8139000	r	r
Kansas Public Employees Retirement System	0.6840000	r	r
County Employees Retirement System of Kentucky	0.5160000	r	r

Kentucky Employees Retirement System	0.1630000	r	r
Teachers' Retirement System of the State of Kentucky	0.5640000	r	r
Louisiana State Employees' Retirement System	0.6370000	r	d
Louisiana State Teachers Retirement System	0.6450000	r	d
Maine Public Employees Retirement System - Consolidated Plan for Participating Local Districts	0.8650000	s	r
Maine Public Employees Retirement System - State and Teacher Retirement Program	0.8090000	s	r
Maryland State Retirement and Pension System - Employees Combined System	0.6892000	d	r
Maryland State Retirement and Pension System - Teachers Combined System	0.7403000	d	r
Massachusetts State Retirement System	0.6470000	d	r
Massachusetts Teachers' Retirement System	0.5210000	d	r
Municipal Employees' Retirement System of Michigan	NA	r	r
Michigan Public School Employees' Retirement System	0.6160000	r	r
Michigan State Employees' Retirement System	0.6650000	r	r
Minnesota General Employees Retirement Plan	0.7775000	r	d
Minnesota State Employees Retirement Fund	0.8522000	r	d
Teachers Retirement Association of Minnesota	0.7679000	r	d
Public Employees' Retirement System of Mississippi	0.6110000	r	r

Missouri Department of Transportation and Highway Patrol Employees' Retirement System	0.5714000	r	r
Missouri Local Government Employees Retirement System	0.9480000	r	r
Public Education Employee Retirement System of Missouri	0.8580000	r	r
Missouri State Employees' Retirement System	0.6750000	r	r
Public School Retirement System of Missouri	0.8400000	r	r
Montana Public Employees' Retirement System	0.7300000	r	d
Teachers' Retirement System of Montana	0.7049000	r	d
Nebraska Public Employees Retirement System - School Employees Plan	0.8670000	NA	r
Public Employees' Retirement System of Nevada - Police and Firefighters Plan	0.7640000	d	r
Public Employees' Retirement System of Nevada - Regular Employees Plan	0.7390000	d	r
New Hampshire Retirement System	0.6180000	r	r
Public Employees' Retirement System of New Jersey	0.6008351	d	r
The Police and Firemen's Retirement System of New Jersey	0.6918594	d	r
Teachers' Pension and Annuity Fund of New Jersey	0.4212257	d	r
Public Employees Retirement Association of New Mexico	0.7490000	d	r
Educational Retirement Board of New Mexico	0.6290000	d	r
New York State Teachers' Retirement System	0.9770000	d	d

North Carolina Local Governmental Employees' Retirement System	NA	r	d
Teachers' and State Employees' Retirement System of North Carolina	NA	r	d
North Dakota Public Employees Retirement System	0.7070000	r	r
North Dakota Teachers' Fund for Retirement	0.6370000	r	r
New York State and Local Retirement System - Employees' Retirement System	NA	d	d
New York State and Local Retirement System - Police and Fire Retirement System	NA	d	d
Ohio Public Employees Retirement System	0.8113485	r	r
Ohio Police & Fire Pension Fund	NA	r	r
School Employees' Retirement System of Ohio	0.7070000	r	r
School Employees' Retirement System of Ohio	0.7510000	r	r
Oklahoma Public Employees Retirement System	0.9450000	r	r
Teachers' Retirement System of Oklahoma	0.7040000	r	r
Oregon Public Employees Retirement System	0.7540000	d	d
Public School Employees' Retirement System of Pennsylvania	0.5630000	r	d
Pennsylvania State Employees' Retirement System	0.5940000	r	d
Employees' Retirement System of Rhode Island	0.5403379	d	d
Rhode Island Municipal Employees' Retirement System	0.7860000	d	d
South Carolina Police Officers Retirement System	0.6300000	r	r
South Carolina Retirement System	0.5630000	r	r

Texas County & District Retirement System	0.8900000	r	r
Employees Retirement System of Texas	0.7010000	r	r
Texas Law Enforcement and Custodial Officer Supplemental Retirement Fund	0.6600000	r	r
Texas Municipal Retirement System	0.8740000	r	r
Teacher Retirement System of Texas	0.8050000	r	r
Tennessee Political Subdivisions Retirement Plan	NA	r	r
Tennesee State and Teachers' Retirement Plan	NA	r	r
Utah Public Employees Noncontributory Retirement System	NA	r	r
Vermont State Employees' Retirement System	0.7142687	d	r
State Teachers' Retirement System of Vermont	0.5422000	d	r
Virginia Retirement System	0.7703201	r	d
Washington Law Enforcement Officers and Firefighters Plan 2	1.0900000	d	d
Washington Public Employees' Retirement System	0.8900000	d	d
Washington School Employees Plan 2/3	0.8800000	d	d
Washington Teachers Plan 2/3	0.9100000	d	d
West Virginia Public Employees' Retirement System	0.9145117	r	d
West Virginia Teachers' Retirement System	0.6705445	r	d
Wisconsin Retirement System	1.0000000	r	r
State of Wyoming Retirement System	0.7628000	r	r
Arizona State Corrections Officers Retirement Plan	0.4950000	r	r
Connecticut Municipal Employees Retirement System	NA	s	d

Municipal Fire and Police Retirement System of Iowa	0.8140000	r	r
Louisiana Municipal Police Employees Retirement System	0.7139000	r	d
Louisiana School Employees' Retirement System	0.7416000	r	d
Louisiana State Parochial Employees Retirement System	0.9961500	r	d
Minnesota Public Employees Police & Fire Plan	0.8523000	r	d
Oklahoma Police Pension and Retirement System	1.0180000	r	r
Utah Public Safety and Firefighter Retirement Plan	NA	r	r
Pennsylvania Municipal Retirement System	NA	r	d