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 examine what factors impact the funded status of a given retirement system. The analysis finds that significant differences in state pension funding exist, and the exogenous factors that impact pension funding is the interaction of partisan control in state governments.

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 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 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 significant risk factors are detected, then pension plan administrators can identify the risk level of their retirement environment and respond proactively to manage funding challenges.

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.

```
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, UAAL_GASB,
         BudgRev, LegControl, GovParty, TotMembership, 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)
```

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.

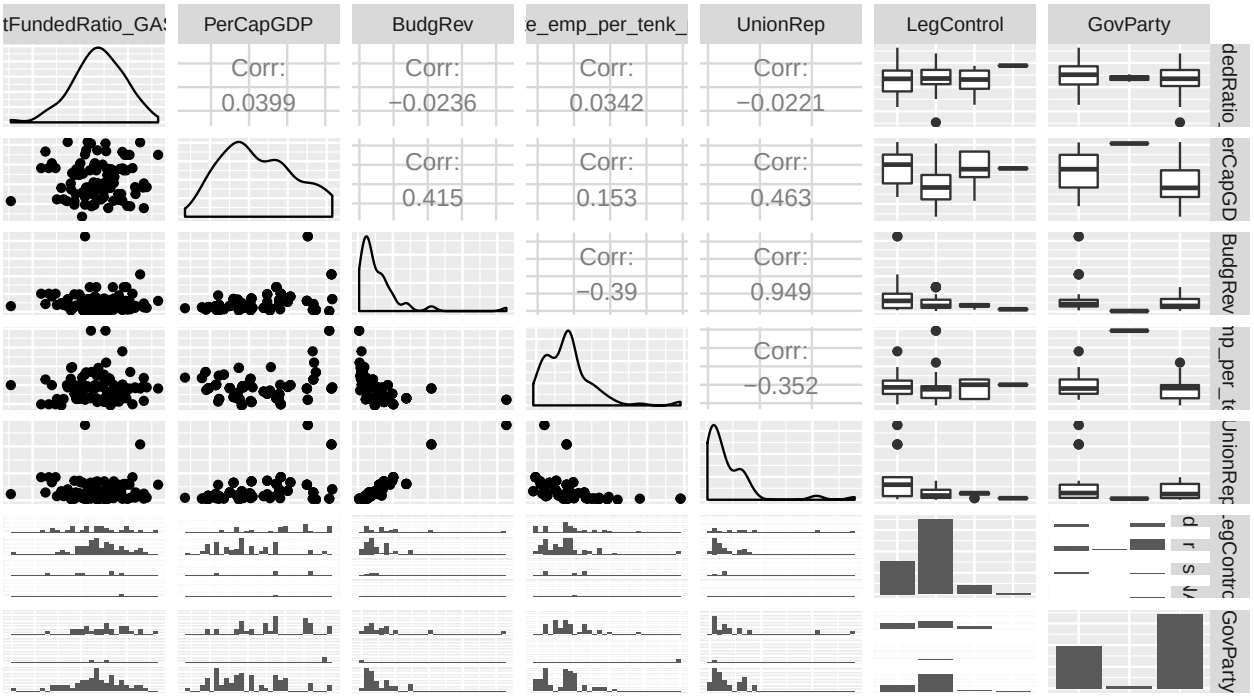
```
library(agricolae)
state.tukey <- HSD.test(state.model, "pension.data$GovtName", group = TRUE)
state.tukey
```

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 look at the interactions present within the data.

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

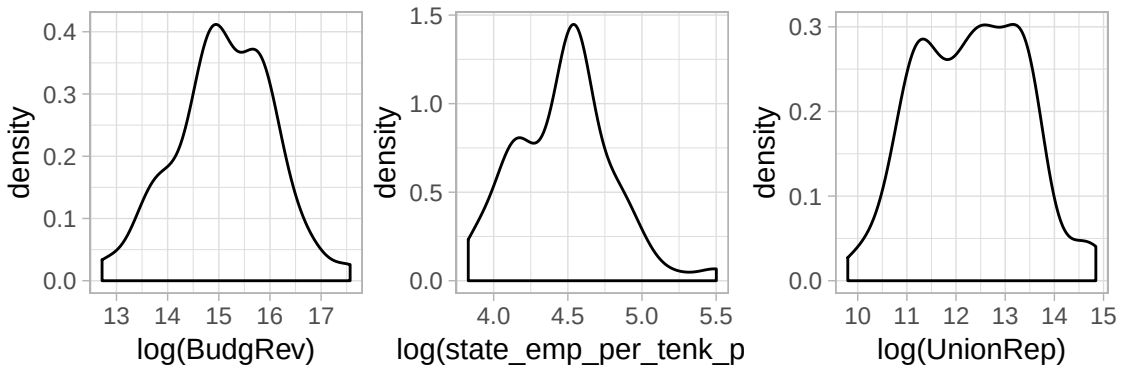


Some elements do not appear to be normally distributed. However, the response variable appears normal and meets the assumptions for linear regression. Transformations can be made to Budget Revenue, State Employment, and Union Representation to improve symmetry and reduce the impact of outliers.

```
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. 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)
```

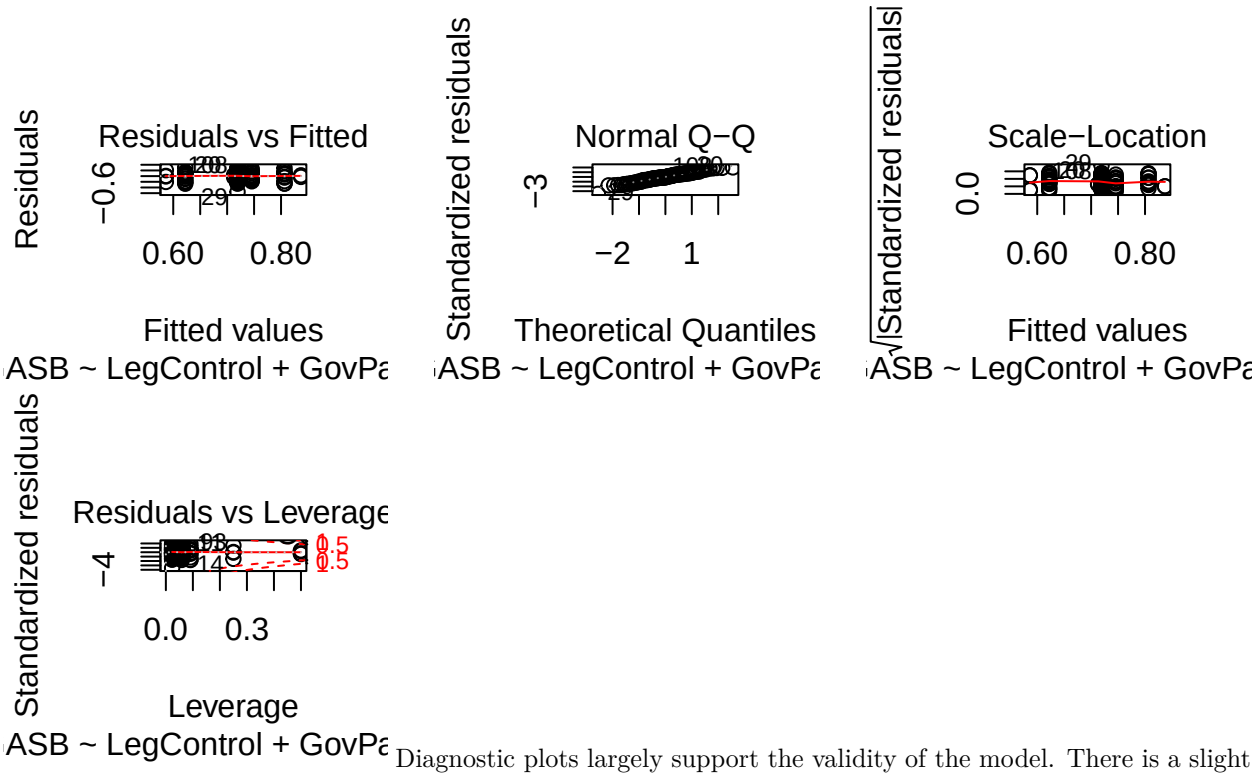
```
##
## Call:
## lm(formula = ActFundedRatio_GASB ~ LegControl + GovParty + LegControl:GovParty)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.55628 -0.09498 -0.01125  0.09912  0.30675
##
## Coefficients: (2 not defined because of singularities)
##                        Estimate 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. Additionally, 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 governess are associated with a decrease in funded status. Overall, partisan unity across government control typically increases plan funded status in those states. Also notable is the abscence of significant statewide demographic and economic factors. 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 employement 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 [1]. Additional research would be needed to show that nonpartisan pension processes improve plan funding, but it is feasible given the analysis conducted here.

Appendix

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

ActFundedRatio_GASB	PerCapGDP	BudgRev	state_emp_per_tenk_pop	UnionRep	LegControl	GovParty
0.6780000	39523	2539012	91	170000	r	r
0.6890000	39523	2539012	91	170000	r	r
0.6670000	70683	333678	245	59000	r	i
0.7590000	70683	333678	245	59000	r	i
0.4530000	42353	3754315	63	151000	r	r
0.7050000	42353	3754315	63	151000	r	r
0.7760000	37930	2426813	119	59000	r	r
1.0000000	37930	2426813	119	59000	r	r
NA	65160	42588312	61	2796000	d	d
0.6300000	65160	42588312	61	2796000	d	d
0.7950000	57654	3476876	63	263000	s	d
0.5940000	57654	3476876	63	263000	s	d
0.5750000	57654	3476876	63	263000	s	d
0.3810000	66592	4299789	115	288000	s	d
NA	66592	4299789	115	288000	s	d
0.8650000	66419	1019569	190	56000	d	d
0.8430000	42085	9218467	56	574000	r	r
0.5490000	55668	1833166	148	125000	d	d
0.8960000	39032	1158308	87	47000	r	r
0.9290000	58217	10132144	49	856000	d	r
0.3540000	58217	10132144	49	856000	d	r
0.4020000	58217	10132144	49	856000	d	r
0.4443000	58217	10132144	49	856000	d	r
0.7900000	48170	4825570	46	335000	r	r
0.4805391	48170	4825570	46	335000	r	r
0.8139000	53798	2115263	83	153000	r	r
0.6840000	50970	2151106	94	132000	r	r
0.5160000	41463	3124412	100	228000	r	r
0.1630000	41463	3124412	100	228000	r	r
0.5640000	41463	3124412	100	228000	r	r
0.6370000	48377	2958923	97	88000	r	d
0.6450000	48377	2958923	97	88000	r	d
0.8650000	41619	1084147	101	77000	s	r
0.8090000	41619	1084147	101	77000	s	r
0.6892000	59983	5514356	95	347000	d	r

[1] 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.

ActFundedRatio_GASB	PerCapGDP	BudgRev	state_emp_per_tenk_pop	UnionRep	LegControl	GovParty
0.7403000	59983	5514356	95	347000	d	r
0.6470000	71456	7093647	94	407000	d	r
0.5210000	71456	7093647	94	407000	d	r
NA	46055	7170665	68	651000	r	r
0.6160000	46055	7170665	68	651000	r	r
0.6650000	46055	7170665	68	651000	r	r
0.7775000	57809	6605676	76	388000	r	d
0.8522000	57809	6605676	76	388000	r	d
0.7679000	57809	6605676	76	388000	r	d
0.6110000	33558	1941618	120	90000	r	r
0.5714000	45076	3215960	92	290000	r	r
0.9480000	45076	3215960	92	290000	r	r
0.8580000	45076	3215960	92	290000	r	r
0.6750000	45076	3215960	92	290000	r	r
0.8400000	45076	3215960	92	290000	r	r
0.7300000	42276	708850	125	58000	r	d
0.7049000	42276	708850	125	58000	r	d
0.8670000	58053	1322267	101	74000	NA	r
0.7640000	47648	2239313	62	182000	d	r
0.7390000	47648	2239313	62	182000	d	r
0.6180000	55413	634396	86	74000	r	r
0.6008351	60684	8536928	100	666000	d	r
0.6918594	60684	8536928	100	666000	d	r
0.4212257	60684	8536928	100	666000	d	r
0.7490000	43566	1381192	128	64000	d	r
0.6290000	43566	1381192	128	64000	d	r
0.9770000	71252	21067688	91	2075000	d	d
NA	47142	6793576	80	174000	r	d
NA	47142	6793576	80	174000	r	d
0.7070000	67244	984879	134	25000	r	r
0.6370000	67244	984879	134	25000	r	r
NA	71252	21067688	91	2075000	d	d
NA	71252	21067688	91	2075000	d	d
0.8113485	50666	7438910	55	702000	r	r
NA	50666	7438910	55	702000	r	r
0.7070000	50666	7438910	55	702000	r	r
0.7510000	50666	7438910	55	702000	r	r
0.9450000	48569	2175386	94	97000	r	r
0.7040000	48569	2175386	94	97000	r	r
0.7540000	50138	2936204	107	267000	d	d
0.5630000	54725	9822353	77	724000	r	d
0.5940000	54725	9822353	77	724000	r	d
0.5403379	50446	853580	117	81000	d	d
0.7860000	50446	853580	117	81000	d	d
0.6300000	39673	2615933	92	52000	r	r
0.5630000	39673	2615933	92	52000	r	r
0.8900000	57077	13867786	65	606000	r	r
0.7010000	57077	13867786	65	606000	r	r
0.6600000	57077	13867786	65	606000	r	r
0.8740000	57077	13867786	65	606000	r	r
0.8050000	57077	13867786	65	606000	r	r
NA	46925	3878384	65	174000	r	r

ActFundedRatio_GASB	PerCapGDP	BudgRev	state_emp_per_tenk_pop	UnionRep	LegControl	GovParty
NA	46925	3878384	65	174000	r	r
NA	48376	1942144	95	79000	r	r
0.7142687	47408	794968	146	37000	d	r
0.5422000	47408	794968	146	37000	d	r
0.7703201	54730	5619885	82	226000	r	d
1.0900000	64937	6084081	91	577000	d	d
0.8900000	64937	6084081	91	577000	d	d
0.8800000	64937	6084081	91	577000	d	d
0.9100000	64937	6084081	91	577000	d	d
0.9145117	38860	1337095	135	88000	r	d
0.6705445	38860	1337095	135	88000	r	d
1.0000000	50431	4615147	58	244000	r	r
0.7628000	66776	461426	160	18000	r	r
0.4950000	42353	3754315	63	151000	r	r
NA	66592	4299789	115	288000	s	d
0.8140000	53798	2115263	83	153000	r	r
0.7139000	48377	2958923	97	88000	r	d
0.7416000	48377	2958923	97	88000	r	d
0.9961500	48377	2958923	97	88000	r	d
0.8523000	57809	6605676	76	388000	r	d
1.0180000	48569	2175386	94	97000	r	r
NA	48376	1942144	95	79000	r	r
NA	54725	9822353	77	724000	r	d