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PENSION SIMULATION PROJECT

Investment Return Volatility and the Michigan State Employees' Retirement System

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Introduction

Public pension funds invest in stocks, bonds, and other assets with the goal of accumulating sufficient funds, in combination with employer and employee contributions, to pay benefits when due. Investments can entail risk, and contributions may have to be adjusted to ensure that assets are sufficient to pay benefits. State and local governments generally backstop public pension funds, paying higher contributions when investment returns are below expectations or lower contributions when investment returns are above expectations. Thus, taxpayers and those who benefit from government services and investments bear the consequences of this investment risk. The Rockefeller Institute of Government's Pension Simulation Project is examining the potential consequences of investment-return risk for public pension plans, governments, and stakeholders in government.

In this report, we examine the potential implications of investment-return volatility for the Michigan State Employees' Retirement System (MISERS). We selected MISERS as one of five plans to analyze in detail in our Public Pension Simulation Project. The five plans have a broad range of characteristics: a deeply underfunded plan, a very well-funded plan, an average plan, a public safety plan, and a closed plan (MISERS). MISERS is highly unusual for public plans in that it is closed to new employees, has a large number of retirees relative to the number of active members, and has large net cash outflows before considering investment income (that is, benefit payments exceed contributions quite substantially). In addition, with a market-value funded ratio of 66.1 percent at the end of the 2015 fiscal year, MISERS is poorly funded by public pension plan standards. Our analysis is independent of MISERS.[1]

As a closed plan, MISERS uses a more aggressive approach to paying down ("amortizing") unfunded liabilities than that used by many public plans. Each year MISERS shortens the period over which unfunded liability will be repaid, so that the endpoint for full repayment is fixed. This is broadly consistent with the idea that closed plans should have their liabilities fully funded more quickly than open plans, as risks cannot be spread over the payroll of new entrants. Two recent reports have pointed out the importance of more aggressive funding of closed plans, and have suggested even more aggressive approaches than that used by MISERS.[2]

Our Analytic Approach

We constructed simulation scenarios to examine three questions about the finances of MISERS:

(1) How the finances of MISERS and the potential fiscal pressure it may impose on the state of Michigan may change over time if the return assumption is correct on average but investment returns can vary from year to year. We pay particular attention to the closed-plan nature of

MISERS and how that affects results; (2) how the finances of MISERS would be affected by a low investment-return environment or by higher volatility in investment returns; and (3) how the finances of MISERS would be affected by Governor Snyder's recommendation to lower the return assumption from 8 percent to 7.5 percent. We have constructed six simulation scenarios to examine these questions, described below:

Finances of MISERS when the investment return assumption is correct (over the long run):

1. *Assumption Achieved: Closed Plan:* We model a stochastic version of the plan's assumption, in which the expected long-term compound return is 8 percent — that is, the 8 percent return assumption is expected to be correct on average but varies from year to year and from simulation to simulation.[3] The standard deviation — a measure of how much returns vary — is 12 percent.[4,5] The plan is closed to new employees. This is our base-case stochastic scenario against which we compare other stochastic scenarios.

2. *Assumption Achieved: Open Plan:* This scenario is identical to *Scenario 1:* "*Assumption Achieved: Closed Plan*" except that MISERS is modeled as an open plan where new employees are hired annually to keep the number of active members constant from year to year. We compare the results from these two scenarios to demonstrate how the finances of a closed plan differ from those of an open plan. This is the only scenario in which we model MISERS as an open plan.

Impact of a period of low investment returns and impact of more-volatile investment returns:

3. *15 Years of Low Returns:* Expected investment returns fluctuate around an average that rises from 5 percent to 6.5 percent during the first fifteen years, then fluctuate around the plan's long-run assumption of 8 percent. This scenario recognizes that in the current low-inflation and low-interest-rate environment, it may be plausible for expected returns to be quite low for a long time, and then gradually rise, which makes it extremely difficult to achieve assumed returns in the short run, even if they may be achievable in later years.

4. *High Volatility:* The expected investment return is 8 percent, but investment return volatility is higher than in other scenarios, with a standard deviation of 18 percent rather than 12 percent, consistent with some current market forecasts.[6]

Impact of lowering assumed rate of return:

We examine two scenarios to see what would happen if the current 8 percent investment return assumption is too high and if the "true" long-run expected return over the next thirty years is 7.5 percent.

5. *Current Return Assumption:* The true expected investment return is 7.5 percent, but MISERS (in our model) does not know this, and keeps the current 8 percent assumption. Thus, contributions do not

change initially, but MISERS tends to have investment shortfalls that drive up future contributions.

6. *Lower Return Assumption:* The true expected investment return is 7.5 percent and MISERS lowers its assumed rate of return from 8 percent to 7.5 percent accordingly. This scenario requires higher contributions right away but creates less risk of future investment shortfalls.

Comparing *Current Return Assumption (Scenario 5)* and *Lower Return Assumption (Scenario 6)* can illustrate the extent to which lowering the earnings assumption can improve the sustainability of MISERS and how required government contributions would be affected.

We use two main measures of risk: (1) the probability that at some point in the next thirty years MISERS' market-value funded ratio will fall below a crisis level, which we define as 40 percent; and (2) the probability that the employer contribution will rise sharply in a short time period, increasing by more than 5 percent of Michigan's general fund revenue in any consecutive five-year period over the next thirty years.

Results

When modeled as a closed plan as it is in the real world, MISERS has very limited exposure to the risk of severe underfunding in the next thirty years if the return assumption of 8 percent is correct, even though it starts with a relatively low funded ratio of about 66 percent in 2016. This result is largely attributable to the amortization method used by MISERS, which has an amortization period that is shortened every year and can therefore ensure that unfunded liabilities are paid off in a timely manner. As a closed plan, MISERS will continue to decrease in size and will eventually stop being a potential source of fiscal stress for the state of Michigan in the very long run. However, that is far in the future: MISERS will remain a relatively large plan for most of the next thirty years, and could still create significant fiscal stress for the state government when financial crises hit, particularly given the current funding policy, which requires quick repayment of investment losses. The summary table below shows that under *Scenario 1: "Assumption Achieved: Closed Plan,"* there is about a one-in-four chance that the employer contribution will rise by more than 5 percent of the general fund revenue of Michigan in a five-year period sometime in the next thirty years.

MISERS faces substantially higher risk of severe underfunding and risk of large increases in employer contributions in a short time period under scenarios with a period of low expected returns (*Scenario 3: "15 Years of Low Returns"*) or high volatility in investment returns (*Scenario 4: "High Volatility"*).

Lowering the return assumption from 8 percent to 7.5 percent would increase the employer contribution in the short run (about a 10-percent increase in 2017 and 2018). In the long run lowering the return assumption will moderately reduce the risk of severe underfunding and the risk of sharp increases in employer contribution.

Probability of crisis-level funding or of significant employer contribution increases under different scenarios

All scenarios are stochastic

Risk Measures	Current return assumption of 8% is achieved		Impact of low expected return and Impact of high volatility		Impact of lowering return assumption (discount rate) from 8 percent to 7.5 percent	
	Scenarios		*Scenarios*		*Scenarios*	
	Scenario 1 (Assumption Achieved: Closed Plan)	Scenario 2 (Assumption Achieved: Open Plan)	Scenario 3 (15 Years of Low Returns)	Scenario 4 (High Volatility)	Scenario 5 (Current Return Assumption)	Scenario 6 (Lower Return Assumption)
*Probability of crisis-level funding sometime in the next 30 years (%)	7.2	30.2	24.5	24.1	9.1	4.1
**Probability of a significant employer contribution increase sometime in the next 30 years (%)	26.6	0.3	33.0	44.8	30.8	26.2

Notes on scenarios:
Scenario 1 (Assumption Achieved: Closed Plan): Constant expected return over 30 years. Expected compound return is 8%, consistent with actuarial assumption of 8%. The plan is closed to new members.
Scenario 2 (Assumption Achieved: Open Plan): Constant expected return over 30 years. Expected compound return is 8%, consistent with actuarial assumption of 8%. New members are allowed to join MISERS to keep the size of workforce constant.
S**cenario 3 (15 Years of Low Returns):** Expected returns are 5% in years 1-10, 6.5% in years 11-15, and 8% in years 16-30; 30-year compound return is about 6.6%. Closed Plan
Scenario 4 (High Volatility): Constant expected return over 30 years. Expected compound return is 8%, standard deviation is 18%. Closed Plan
Scenario 5 (Current Return Assumption): Constant expected return over 30 years. Expected compound return is 7.5%, standard deviation is 12%. Return assumption (discount rate) is 8%
Scenario 6 (Lower Return Assumption): Constant expected return over 30 years. Expected compound return is 7.5%, standard deviation is 12%. Return assumption (discount rate) starts with 8% but is lowered to 7.5% from 2017.

* Probability that funded ratio falls below 40% in at least 1 year out of the next 30 years.
** Probability that employer contribution rises by at least 5 percent of projected general fund revenue of the State of Michigan in any 5-year period in the next 30 years.

Conclusion

Our analysis suggests that if MISERS' investment-return assumption is approximately correct over the long run and it strictly follows its current funding policy that amortizes unfunded liability over an increasingly shortened time period, the plan has very little risk of becoming severely underfunded in the next thirty years. MISERS, as a closed plan, will shrink in size over time and in the very long run will stop being a potential source of fiscal stress for the state of Michigan. However, that is far in the future: MISERS will remain a relatively large plan for the next thirty years, and it could still create significant fiscal stress for the government when financial crises hit, particularly given the current funding policy, which requires quick repayments of investment shortfalls. Under plausible alternative investment-return assumptions, such as a long period of low expected returns or high volatility in investment returns, MISERS would face much greater risk of severe underfunding and the state of Michigan would face a much greater risk of sharp increases in required contribution.

If Governor Snyder's recommendation of lowering MISERS' assumed rate of return from 8 percent to 7.5 percent is implemented, our simulation results show that the required employer contribution will increase by about 10 percent in the short run. Lowering the return assumption would reduce the risk of severe underfunding and the risk of large increases in contributions, but the positive effect is likely to be relatively small, if the investment assumption is approximately correct.

Compared to open plans that accept new employees, funding security is more important for closed plans like MISERS. Because closed plans

usually have very large negative cash flows relative to their assets, they do not have the luxury of time to spread investment losses over longer periods, as open plans do. The broader lesson from our analysis of MISERS is that a very conservative contribution policy can protect a closed plan from becoming severely underfunded. However, for large closed plans like MISERS, the sponsoring government may face a risk of substantial contribution increases if the plan invests in risky assets and large shortfalls must be recouped in short periods of time.

Pension Simulation Project
Rockefeller Institute of Government

Introduction

Pension funds invest in stocks, bonds, and other assets with the goal of accumulating sufficient funds, in combination with employer and employee contributions, to pay benefits when due. Investments can entail risk, and contributions may be increased (or decreased) to ensure that assets are sufficient to pay benefits.

When a pension fund invests in a portfolio of assets that entail higher risk, expected investment returns generally will be higher and contributions lower than for a portfolio of lower-risk assets. The disadvantage is that expected returns are not guaranteed returns, neither over short time periods nor even over the long run.

Depending on how volatile investment returns are, a plan's funded ratio — the ratio of pension fund assets to pension fund liabilities — may rise or fall significantly, and required contributions may fall or rise considerably. The extent and timing of these changes will depend in part upon methods used to determine contributions. If adverse movements in investment returns are too large, funded ratios could become so low that they create political crises. In some states, this may lead to pressure to cut benefits. Adverse movements could cause requested contributions to increase so much that they create fiscal stress for employers, leading to pressure for substantial increases in taxes or other revenue, cuts in spending, or other undesirable outcomes. Alternatively, investment returns above expectations could lead to very high funded ratios and very low required contributions.

How much risk is too much risk? There is no magic rule, although academic research provides useful insights.[7] Plans, employers, and other stakeholders need to weigh the potential risks and rewards. The key to making these decisions is to understand risks, evaluate risks, and communicate that analysis to those affected.

In this report, we examine the potential implications of investment return volatility for the Michigan State Employees' Retirement System (MISERS). We selected MISERS as one of five plans to analyze in detail in our Public Pension Simulation Project. The five plans have a broad range of characteristics. MISERS is highly unusual for public plans in that it is closed to new employees and has a large number of retirees relative to the number of active members, and large net cash outflows before considering investment income (that is, benefit payments exceed contributions quite substantially). In addition, with a market-value funded ratio of 66.1 percent at the end of the 2015 fiscal year, MISERS is poorly funded by public pension plan standards. The other plans, which we examine in separate analyses, include a deeply underfunded plan, a very well-funded plan, an average plan, and a public safety plan. Our analysis is independent of MISERS.

Risks can be positive or negative, and we examine both in this report. However, we pay particular attention to the consequences of investment

return shortfalls because shortfalls can be extremely problematic for pension plans, beneficiaries, policymakers, and government stakeholders.

To evaluate risks, we focus primarily on whether the plan is adequately funded (the market-value funded ratio) and whether employer contributions are sufficient (employer contributions as a percentage of payroll), and the probability that either funding or contributions may change considerably over time or enter into dangerous territory. We examine MISERS finances under the current funding policy and practice and several alternatives, and we examine different investment return scenarios.

Our Pension Plan Simulation Model

We have developed a simulation model that can be used to evaluate the implications of investment risk. The model calculates the annual cash flows and fiscal position of a public pension plan for future years. Typically, we run a simulation for fifty years or more, but focus our analysis on the earlier years (the first thirty). Each year the model starts with beginning asset values and computes ending assets by subtracting benefits paid, adding employee and employer contributions (including any amortization), and calculating investment income.

The model keeps track of asset values, contributions, and income and other variables of interest, such as the funded ratio and employer contributions as a percentage of payroll. It saves all results so that they can be analyzed after a simulation run in any way desired.

The model is quite flexible:

- Benefits can be calculated within the model using rules of the plan (e.g., benefit factors and retirement ages), plan demographics, chosen mortality tables, and other actuarial assumptions. Multiple tiers can be modeled. Alternatively, the model can import projections of annual benefit payments that have been prepared by an actuary or the model user.

- Contributions can be determined actuarially under commonly used funding policies. The user can decide the length of the amortization period and whether it is open or closed, as well as whether the amortization payment is a level percentage of payroll or a level dollar amount. Asset smoothing can be allowed, or not. Actuarially determined contributions can be constrained by caps and floors, or overridden completely and set as a fixed percentage of payroll. We do not allow contributions to be negative (employers cannot withdraw assets from the fund).

- Accrued actuarial liabilities can be calculated under several common cost methods.

- The plan can be modeled as closed or new employees can be brought in each year to achieve a target for annual growth in the number of active members.

Investment returns are determined flexibly as well and can be:

- **Fixed (i.e., deterministic):** for example, 7.25 percent every year.

- **Stochastic:** for example, 7.25 percent expected return in every year, with a 12 percent standard deviation, drawn from a normal distribution. ("Stochastic" means that returns are random and follow a specific distribution.)

- **Time-varying:** returns can be set to a fixed value each year, but that value may vary from year to year — for example, 5 percent annually for the first five years, then 6 percent annually for the next five years, then 8 percent for the next forty years.

- **Time-varying and stochastic:** for example, expected return of 5 percent in the first five years with a standard deviation of 8 percent, followed by expected return of 6 percent for the next five years with a standard deviation of 10 percent, followed by expected return of 8 percent with a standard deviation of 12 percent for the next forty years.

When investment returns for a scenario have a stochastic component we run 2,000 simulations, each with a different set of annual investment returns (drawn from the same assumed probability distribution), so that we can examine the distribution of results. Each simulation results in different investment earnings, leading to different funded ratios and contribution requirements. By examining the 2,000 different sets of results we can gain insight into the probability of alternative outcomes. For example, we examine the probability that the funded ratio will fall below 40 percent anytime during the first thirty years — a level that has been associated with crisis in other states.

Table 1 illustrates possible investment returns for a scenario with a 7.25 percent expected return and a 12 percent standard deviation.[8] Returns vary randomly from year to year and from simulation to simulation, even though the expected return is the same in each year and simulation. Some simulations may produce much better outcomes for a pension plan than others. For example, simulation #3 clearly has much lower returns in the first two years than simulation #1; as a result, in our model assets and the funded ratio would be lower at the end of year two in simulation #3 than in #1.

Table 1. Investment Returns in the Model Can Vary Greatly From Year-to-Year and From Simulation-to-Simulation						
Illustration of investment returns used to calculate pension fund finances						
2,000 simulations of a given scenario, returns drawn from a normal distribution with mean 7.25%, standard deviation 12%						
	Simulation year					
Simulation number	1	2	3	…	49	50
1	24.7%	17.1%	2.7%	…	10.8%	36.0%
2	5.5%	15.1%	-1.8%	…	39.4%	-0.7%
3	-15.3%	-11.4%	-0.9%	…	2.1%	-4.2%
…	…	…	…	…	…	…
1,999	7.9%	8.5%	18.2%	…	-20.2%	17.0%
2,000	15.6%	-1.4%	-8.9%	…	23.5%	-6.5%
Source: Authors' generation of random investment returns						

About the Michigan State Employees' Retirement System[9]

Key Features of MISERS

The Michigan State Employees' Retirement System (MISERS) is a defined benefit public employee retirement plan governed by the state of Michigan. In addition to the pension plan, MISERS also includes an Other Post-Employment Benefit (OPEB) plan, which we exclude from our analysis — references to MISERS in this report pertain only to the pension plan.

As of September 30, 2016, MISERS had 12,381 active members, 4,225 vested terminated members, and 59,038 retirees and other beneficiaries. In 2015, MISERS had $10.7 billion in assets and paid $1.27 billion in benefits. Its market-value-of-assets funded ratio was 66.1 percent — about the 25th percentile among large plans.[10] Its unfunded liability was $5.8 billion.

Benefits generally are calculated based on the annual average of the highest three years of compensation. The normal retirement benefit equals 1.5 percent of the final average compensation multiplied by the member's years of employment. The overall MISERS normal cost — the cost attributed to each new year of service — was 7.38 percent of the total payroll in 2015.

In 1997, Michigan closed the MISERS defined benefit pension plan to new entrants, and all new employees became members of a defined contribution plan. This change was spearheaded by Governor John Engler in an effort to reduce state public pension costs and risks, after several unsuccessful efforts to reduce state defined benefit contributions.[11]

The MISERS pension plan also provides disability and death benefits for public employees who are participants of the defined contribution pension plan. Beginning with the 2010 actuarial valuation, the disability

and death benefits for defined contribution plan members are included in the calculation of liabilities and the employer contribution requirement for MISERS. In 2015, the normal cost of the benefits for defined contribution plan members accounts for about 1 percent of the total actuarially determined contribution.

Funding Approach

To fund the plan, the independent actuary determines a recommended employer contribution. This contribution is an actuarially determined amount calculated using the following method and funding policies:

- MISERS uses the Entry Age Normal actuarial cost method, a widely used method.
- Employees are generally required to contribute 4 percent of their salaries to the pension fund.
- According to MISERS actuarial valuation reports, unfunded liabilities "were amortized by level (principal and interest combined) dollar contributions over a reasonable period of future years." The amortization period is scheduled to decline with each new year: twenty-three years in 2013, twenty-two years in 2014, and twenty-one years in 2015, and so on, so that all unfunded liabilities are scheduled to be fully paid off by the end of 2035. Based on our understanding of the information provided in actuarial valuation reports, MISERS calculates annual amortization payments based on the total unfunded liability using the formula for an open amortization method, with the remaining amortization period reduced by one year from the previous year's value.
- Asset values are smoothed over five years. The actuarial value of assets is limited to be within 40 percent of the market value of assets.

This is a more aggressive amortization approach than that used by many public plans, because each year MISERS shortens the period over which unfunded liability will be repaid, so that the endpoint for full repayment is fixed. This is broadly consistent with the idea that closed plans should have their liabilities fully funded more quickly than open plans, as risks cannot be spread over the payroll of new entrants. Two recent reports have pointed out the importance of more-aggressive funding of closed plans, and have suggested even more-aggressive approaches than that used by MISERS.[12]

The actuarially determined contribution is a recommended amount and the contribution actually paid could differ from it. The state of Michigan has a mixed track record of paying the actuarially determined contributions. During the twelve years from 2004 through 2015, the state government paid less than 90 percent of the actuarially determined contribution in six years (only 51 percent was paid in 2004), and paid more than 110 percent of the actuarially determined contribution in three years.

Investment Return Assumption

MISERS currently uses an 8 percent earnings assumption. As of June 30, 2016, approximately 42 percent of assets were in equity, 13.2 percent in fixed income, and the remainder in other asset classes including real estate and private equity. Total investment return was 7.6 percent in the 2015-16 fiscal year, and the three-year, five-year, and ten-year annualized rate of returns are 8.4 percent, 10.2 percent, and 6.1 percent, respectively.

Governor Snyder's Proposal to Lower the Investment Return Assumption

Governor Rick Snyder's budget proposal for fiscal year 2018 recommended that the assumed rate of return be reduced from 8 percent to 7.5 percent for the state's defined benefit pension and retiree health care plans, including MISERS, based on the advice of the state's Bureau of Investments and the retirement systems' actuary. The goal is to be more consistent with current capital market expectations, in the hope that it will reduce the risk of future growth in the unfunded liability, make the retirement funds sustainable, and make contribution rates more stable. According to the budget proposal, lowering the return assumption to 7.5 percent will increase the required government contribution for MISERS, including both the pension plan and the OPEB plan, by about $83.7 million in fiscal year 2017-18.[13]

How We Modeled the Finances of MISERS

We use our pension simulation model to generate projections of actuarial liabilities and annual benefit payments of MISERS. We also generate a projection of payroll that is consistent with the demographics of the covered workforce. Actuarial liabilities, annual benefits, and payroll vary from year to year, but do not vary across simulations in a single scenario. These projections are made based on the demographic data, decrement tables, benefit provisions, and actuarial assumptions provided in the MISERS actuarial valuation report of 2015. The modeling process involves simplifications of some minor aspects of MISERS, and approximations when accurate and detailed plan data are not publicly available. (Please see the Appendix, "Modeling MISERS: Simplifications and Approximations," for a more detailed description.)

Simulation Scenarios

We constructed simulation scenarios to examine three questions about the finances of MISERS:

1. How might the finances of MISERS and the potential fiscal pressure it may impose on the state of Michigan change over time if the return assumption is correct on average but investment returns can vary from year to year? We pay particular attention to the closed-plan nature of MISERS and how that affects results.

2. How would the finances of MISERS be affected by a low investment-return environment or by higher volatility in investment returns?

3. How would the finances of MISERS be affected by Governor Snyder's recommendation to lower the return assumption from 8 percent to 7.5 percent? We have constructed six simulation scenarios to examine these questions, described below.

Finances of MISERS when the investment return assumption is correct (over the long run):

1. *Assumption Achieved: Closed Plan:* We model a stochastic version of the plan's assumption, in which the expected long-term compound return is 8 percent — that is, the 8 percent return assumption is expected to be correct on average but varies from year to year and from simulation to simulation.[14] The standard deviation — a measure of how much returns vary — is 12 percent.[15,16] The plan is closed to new employees. This is our base-case stochastic scenario against which we compare other stochastic scenarios

2. *Assumption Achieved: Open Plan:* This scenario is identical to *Scenario 1:* "*Assumption Achieved: Closed Plan*" except that MISERS is modeled as an open plan where new employees are hired annually to keep the number of active members constant from year to year. We compare the results from these two scenarios to demonstrate how the finances of a closed plan differ from those of an open plan. This is the only scenario in which we model MISERS as an open plan.

Impact of a period of low investment returns and impact of more-volatile investment returns:

3. *15 Years of Low Returns:* Expected investment returns fluctuate around an average that rises from 5 percent to 6.5 percent during the first fifteen years, then fluctuate around the plan's long-run assumption of 8 percent. This scenario recognizes that in the current low-inflation and low-interest-rate environment, it may be plausible for expected returns to be quite low for a long time, and then gradually rise, which makes it extremely difficult to achieve assumed returns in the short run, even if they may be achievable in later years.

4. *High Volatility:* The expected investment return is 8 percent, but investment-return volatility is higher than in other scenarios, with a standard deviation of 18 percent rather than 12 percent, consistent with some current market forecasts.[17]

Impact of lowering assumed rate of return:

We also examine what would happen if the current 8 percent investment return assumption is too high and if the "true" long-run expected return over the next thirty years is 7.5 percent.

5. *Current Return Assumption:* The true expected investment return is 7.5 percent, but MISERS (in our model) does not know this, and retains the current 8 percent assumption. Thus, contributions do not change initially, but MISERS tends to have investment shortfalls that drive up future contributions.
6. *Lower Return Assumption:* The true expected investment return is 7.5 percent and MISERS lowers its assumed rate of return from 8 percent to 7.5 percent accordingly. This requires higher contributions right away but creates less risk of future investment shortfalls.

Comparing *Scenario 5: "Current Return Assumption"* and *Scenario 6: "Lower Return Assumption"* illustrates the extent to which lowering the earnings assumption can improve the sustainability of MISERS and how required government contributions would be affected.

Table 2 shows these six simulation scenarios. The first two columns label and describe the simulation. Columns three and four show the expected compound return during subperiods of the first thirty years. The fifth column shows the expected compound return over the full thirty years and the sixth column shows the standard deviation. The final column shows the assumed rate of investment return by MISERS, which is equal to the discount rate used in the calculation of liabilities and government contributions.

Table 2. Investment Return Scenarios						
Scenario	Description	Year	Expected compound annual return for the period in question	Expected compound annual return over entire simulation period	Standard Deviation	MISERS assumed return (discount rate)
1 **Assumption Achieved: Closed plan**	Constant expected return over 30 years that meets the actuarial assumption; Closed plan	1-30	8%	8%	12%	8%
2 **Assumption Achieved: Open plan**	Constant expected return over 30 years that meets the actuarial assumption; Open plan	1-30	8%	8%	12%	8%
3 **15 Years of Low Returns**	A relatively long period of low expected returns (years 1-15), followed by expected returns of 8%.	1-10 11-15 16-30	5% 6.5% 8%	about 6.8%	12%	8%
4 **High Volatilty**	Higher volatility reflecting capital market assumptions from some private consulting firms	1-30	8%	8%	18%	8%
5 **Current Return Assumption**	Expected return of 7.5% over 30 years; return assumtion kept at 8%	1-30	7.5%	7.5%	12%	8%
6 **Lower Return Assumption**	Expected return of 7.5% over 30 years; return assumption lowered from 8% to 7.5%	1-30	7.5%	7.5%	12%	7.5%

Notes:
1. In Scenarios 3-6, MISERS is modeled as a closed plan just as in Scenario 1. Only Scenario 2 is modeled as an open plan.
2. We also run a deterministic simulation for each scenario, in which the annual investment returns are fixed and given by the column "Expected compound annual return for the period in question".
3. The 30-year simulation period shown in this table is 2017-2046. In the actual model runs, the simulations start from year 2015, which is the latest year in which the actuarial valuation report is available. Deterministic returns are used in year 2015 (7.6% according to 2016 CAFR of MISERS) and 2016 (8% assuming earnings assumption is achieved). For scenario 6 "Lower Return Assumption", assumed return (discount rate) of 8% is used in year 2015 and 2016.
4. When expected returns are not constant over the entire simulation period (Scenario 3), the approximate formula for calculating expected compound annual return is not readily available and the expected compound annual return is obtained by simulation approach (close to the mean of 50,000 simulations).

How We Modeled MISERS Funding Policy

We model the funding policy of MISERS as follows:

- ◼ *Employee* contributions are fixed at 4 percent of payroll.
- ◼ *Employer* contributions are determined as follows:
  - • In scenarios in which the plan is closed (all scenarios except for Scenario 2), the model calculates the actuarially determined contribution using the current MISERS policy: Unfunded liabilities are amortized using level dollar repayment method, with the initial amortization period being 20 years in 2016. The amortization period is shortened by one year each year after 2016 until the amortization period becomes one year in 2035. Asset values are smoothed over five years, but the actuarial value of assets cannot deviate from the market value of assets by more than 30 percent.
  - • In Scenario 2, in which the plan is open, actuarially determined contributions are calculated using the current MISERS policy except that unfunded liabilities are amortized using open-ended level dollar repayment method with an amortization period of twenty years.
  - • When the total actuarially determined contribution is greater than the employee contribution, the employer contribution is equal to the difference between them.
  - • When the total actuarially determined contribution is smaller than the employee contribution, the employer contribution is zero. No negative employer contribution (withdrawal from the fund) is allowed.

Measures We Use to Evaluate Results

We are primarily concerned about two kinds of risks:

- ◼ Extremely low funded ratios, which create a risk to pension plans and their beneficiaries, and create political risks that could lead to benefit cuts in states in which cuts are legally permissible; and
- ◼ Extremely high contributions, or large increases in contributions in short periods of time, which pose direct risks to plan sponsors and their stakeholders, and, in turn, could pose risks to pension plans and their beneficiaries.

There usually are trade-offs between these two kinds of risks, and how the trade-offs operate is a function of a plan's contribution policy. If a pension plan has a contribution policy designed to pay down unfunded liabilities very quickly, it is unlikely to have low funded ratios but it may have high contributions. If a pension plan has a contribution policy designed to keep contributions stable and low, there is greater risk that funded ratios may become very low because contributions may not increase rapidly in response to adverse experience.[18]

Probability That the Funded Ratio Will Fall Below 40 Percent During the First Thirty Years

When returns are stochastic, many outcomes are possible, including very extreme outcomes, so it does not make sense to focus on the worst outcomes or the best outcomes. We are particularly concerned about the risk of bad outcomes, and one useful measure is the probability that the funded ratio, using the market value of assets, will fall below 40 percent in a given time period, which we consider a crisis level.

We choose 40 percent because it is a good indicator of a deeply troubled pension fund. In 2013, only four plans out of 150 in the Public Plans Database[19] had a funded ratio below 40 percent — the Chicago Municipal Employees and Chicago Police plans, the Illinois State Employees Retirement System, and the Kentucky Employees Retirement System. Each plan is widely recognized as being in deep trouble, with the likelihood of either substantial tax increases, service cuts, or benefit cuts yet to come.

Given MISERS' current level of funding, falling to 40 percent funded would require an investment shortfall of about 40 percent, which is not likely in a single year. But as the time period extends, there is a chance of an extended period of low returns, leading to severe underfunding. This measure evaluates the likelihood of this occurring.

Probability That Employer Contributions Will Rise by More Than 5 Percent of the State General Fund Revenue in a Five-Year Period

Making contributions stable and predictable is one of the most important goals of funding policies from the perspective of the employer. Sharp increases in employer contributions, even if not large enough to threaten affordability, can cause trouble in budget planning. We use the probability that the employer contribution will rise by more than 5 percentage points of the projected state general fund revenue in a five-year period to measure this possibility. Extremely low returns in a very short time period as may occur in a severe financial crisis may push up the required contribution considerably even after being dampened by asset smoothing and amortization policies.

We constructed a projection of the state of Michigan general fund revenue up to 2046 as follows:

- For fiscal years 2016 to 2019, we used projections from the 2017 Consensus Revenue Agreement of the state of Michigan.[20]
- For fiscal year 2020 to 2046, we projected revenue using an annual growth rate of 3 percent.[21]

(Please see the Appendix, "Projected General Fund of the State of Michigan" for the projected values.)

In the analysis below, the employer contribution in the first year is about 4.8 percent of the projected general fund revenue. Thus, the fiscal

burden of MISERS will be doubled if the employer contribution as a percentage of the general fund rises by 5 percentage points.

Results

Although we extend our model for fifty years, we generally focus on the first thirty years, in the belief that this is a meaningful period for policymakers.[22] We organize our discussion of results as follows:

- We begin by discussing how the finances of MISERS and its fiscal pressure on the state of Michigan will change over time if the return assumption of 8 percent is achieved (*Scenario 1: "Assumption Achieved: Closed Plan"* and *Scenario 2: "Assumption Achieved: Open Plan").*
- Next we examine the finances of MISERS under two alternative return scenarios: fifteen years of low expected returns, and high volatility in investment returns (*Scenario 3: "15 Years of Low Returns"* and *Scenario 4: "High Volatility"*);
- Finally, we discuss how the finances of MISERS would be affected by the governor's recommendation to lower the investment return assumption from 8 percent to 7.5 percent (*Scenario 5: "Current Return Assumption"* and *Scenario 6: "Lower Return Assumption"*).
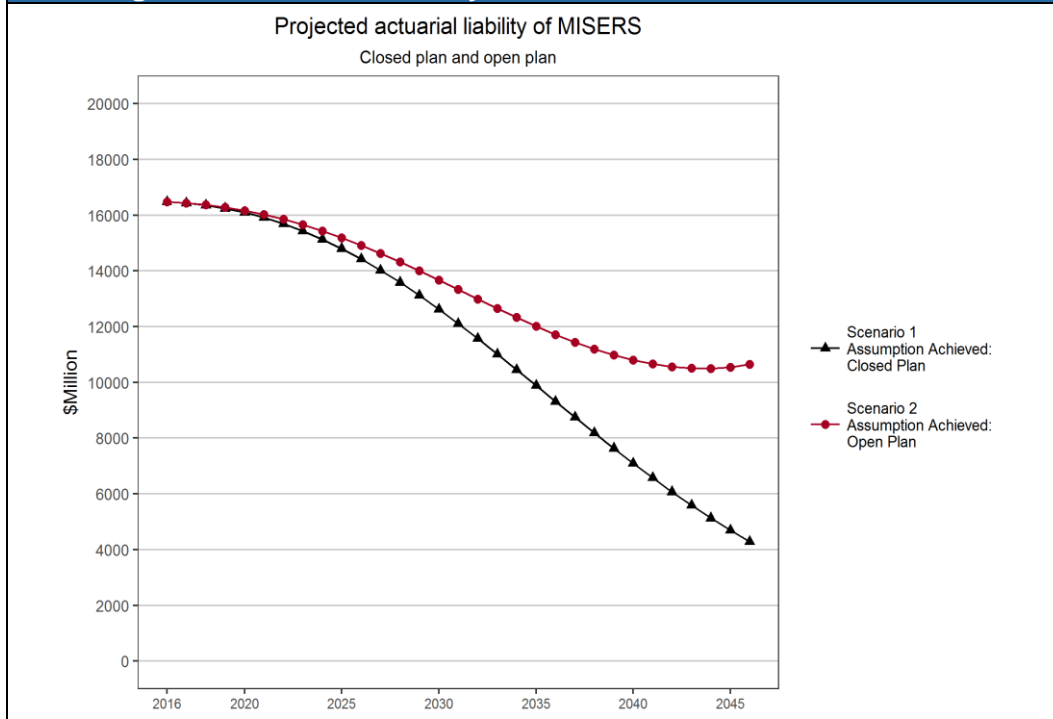
Results for Scenarios With the Investment Return Assumption Achieved (Scenario 1 and Scenario 2)

In *Scenario 1: "Assumption Achieved: Closed Plan"* and *Scenario 2: "Assumption Achieved: Open Plan,"* the expected long-run compound return is 8 percent, and returns vary from year to year with a standard deviation of 12 percent.

Impact on Plan Funding

The actuarial liability and benefit payments of MISERS, which is closed to new members, will decline over time as the accrued benefits are paid out and the number of beneficiaries decreases. Figure 1 shows the projected actuarial liability of MISERS in *Scenario 1: "Assumption Achieved: Closed Plan"* (black line) and *Scenario 2: "Assumption Achieved: Open Plan"* (red line). Our simulation model projects that the liability of MISERS will drop from $16.5 billion in 2016 to about $4 billion in 2046. By contrast, if new members are allowed to join MISERS, the actuarial liability in 2046 would be about $10.6 billion.

Figure 1. The Total Liability of MISERS Will Decline Over Time

Projected actuarial liability of MISERS
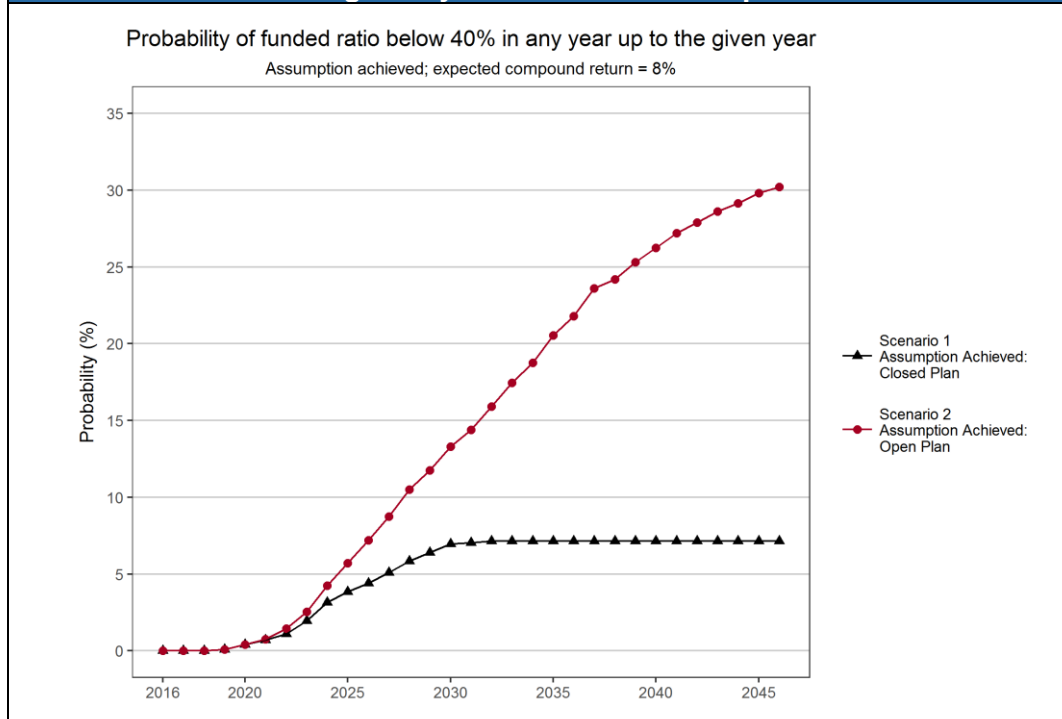
Closed plan and open plan

We next examine the risk of MISERS becoming severely underfunded under these two scenarios (closed plan and open plan, with assumptions achieved). The results show that if the 8 percent investment return assumption is achieved, the current amortization method (reducing the amortization period by one year every year) protects MISERS from the risk of severe underfunding in the next thirty years under the base-case *Scenario 1: "Assumption Achieved: Closed Plan."*

Figure 2 shows the probability of funded ratio falling below crisis level — 40 percent — under the two scenarios. At each year, the graph shows the probability that the funded ratio, based on the market value of assets, will have fallen below 40 percent in any year up to that point. In the base-case *Scenario 1: "Assumption Achieved: Closed Plan"* (black line), thirty years into the simulation, there is only about a 7.2 percent chance that the funded ratio will have fallen below 40 percent at some point in the period. Note that the probability of severe underfunding does not increase anymore after year 2030. This is because under the current MISERS funding policy, the amortization period will become very short after 2030 (six years in 2030 and one year after 2035), so that investment losses will be repaid very quickly and the funded status will not be severely affected. Actually, when the amortization period reduces to one year after 2035, any newly incurred unfunded liabilities will be paid immediately, and as a result the fund will be always fully funded.

Under *Scenario 2: "Assumption Achieved: Open Plan"*, the risk of severe underfunding is much higher than in *Scenario 1: "Assumption Achieved: Closed Plan"*: There is a 30 percent chance that the funded ratio will fall below 40 percent sometime in the next thirty years. This result is primarily attributable to (1) the open-ended amortization method we

assume the open plan uses, so that investment losses are repaid slowly; and (2) MISERS' relatively low funded ratio (66 percent) in the initial simulation year, which makes the funded ratio more likely to fall into crisis territory after a series of bad returns if the losses are not repaid in a timely manner.

Figure 2. MISERS Has Very Little Risk of Severe Underfunding Under the Current Funding Policy If the Return Assumption Is Correct

Impact on Employer Contributions

The simulation results show that, despite its shrinking liability, MISERS faces substantial contribution risks under its current funding policy.

Figure 3 shows the median employer contribution under *Scenario 1: "Assumption Achieved: Closed Plan"* (left panel) and *Scenario 2: "Assumption Achieved: Open Plan"* (right panel), along with the 25th percentile and 75th percentile.[23] Figure 4, which is similar to Figure 3, presents employer contributions as a percentage of projected general fund revenue in the state of Michigan. Under *Scenario 1*, there is substantial uncertainty in employer contributions before the unfunded liabilities are paid off in 2035. For instance, in a quarter of the simulations with relatively bad investment returns, represented by the 75th percentile line, employer contributions are higher than $870 million (5.9 percent of general fund) in 2035, while in another quarter of the simulations with good investment returns, represented by the 25th percentile, the employer contribution can drop to zero. The rapidly increasing range of employer contributions under *Scenario 1* is largely caused by the decreasing amortization period. For a fixed amount of unfunded liability, the annual amortization payment increases as the amortization period shortens. Year 2035, when the amortization period becomes one year, is the extreme case: The entire

unfunded actuarial liability must be repaid in a single year no matter how large it is.

After 2035, all three percentile lines of employer contribution drop toward zero because the unfunded liability is paid off and the normal costs are close to zero since there are almost no active members in MISERS by then. However, the risk of sharp increases in employer contributions, which can create fiscal stress for the state of Michigan, do not disappear right away when the legacy unfunded actuarial liability is paid off. To illustrate the contribution risk, consider a 15 percent loss in asset value in 2040, which is not unlikely in a severe financial crisis. The projected actuarial liability of MISERS is about $7 billion in 2040, which is 35 percent of projected general fund revenue. If MISERS were 100 percent funded in 2040, the immediate repayment of a 15 percent drop in asset value would require a sharp increase in employer contribution amounting to about 5 percent of general fund revenue. The contribution risk would fall over time as the size of MISERS continues to shrink.

The analysis of contribution risk above is based on the premise that MISERS would stick strictly to its current funding policy that incrementally moves toward immediate repayment of unfunded liabilities no matter how much contribution volatility it may create. In reality, however, MISERS is likely to adopt policy changes, such as stop shortening the amortization period or resetting the amortization period to a greater length, when it faces the threat of significant increases in contributions. To examine this possibility, we ran a simple variant of *Scenario 1* in which the amortization period never becomes shorter than five years.[24] Such an alternative policy would significantly reduce the contribution risk without increasing the risk of funded ratio falling below 40 percent. However, this alternative policy would still have a negative impact on funding security: The probability of reaching full funding after thirty years is only 64 percent under this alternative policy, while the probability is 86 percent if MISERS sticks strictly to the current policy. Please see the Appendix, "Alternative Funding Policy With Minimum Amortization Period of Five Years," for more details.

Under *Scenario 2*, where MISERS is modeled as an open plan with a twenty-year open amortization method, the fluctuation in employer contributions is much smaller than under *Scenario 1: "Assumption Achieved: Closed Plan"* (see right panels of Figure 3 and Figure 4).

Figure 3. There Is Substantial Uncertainty in Employer Contributions Before 2035
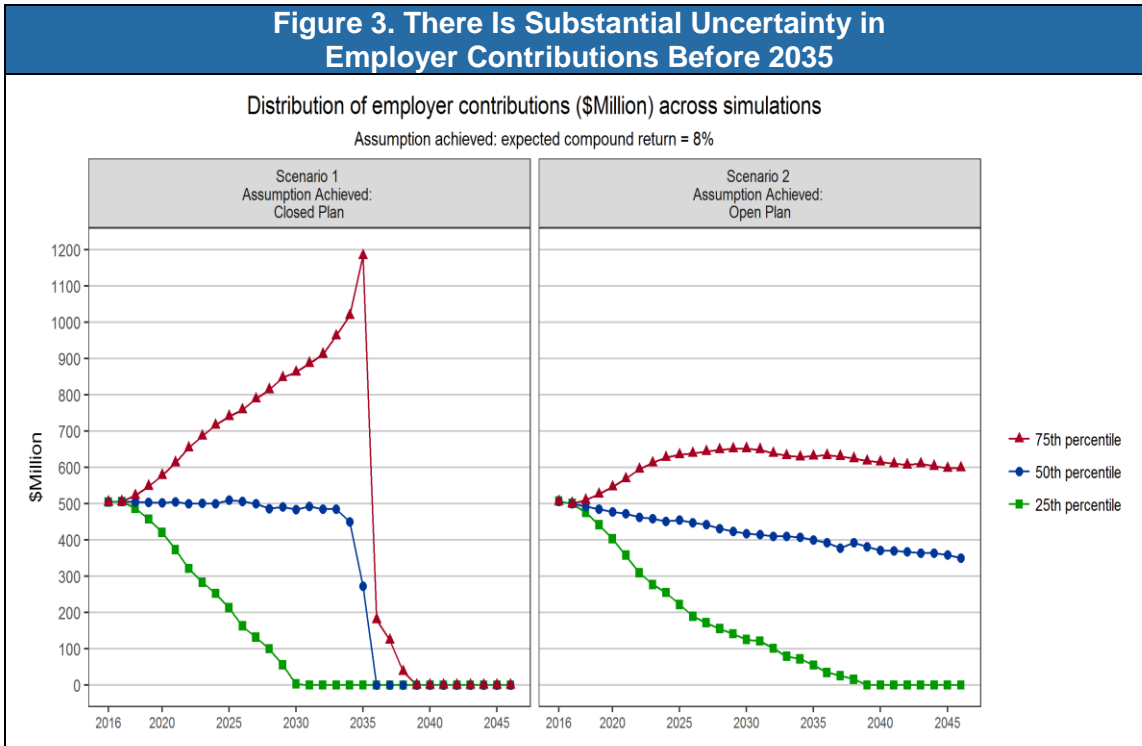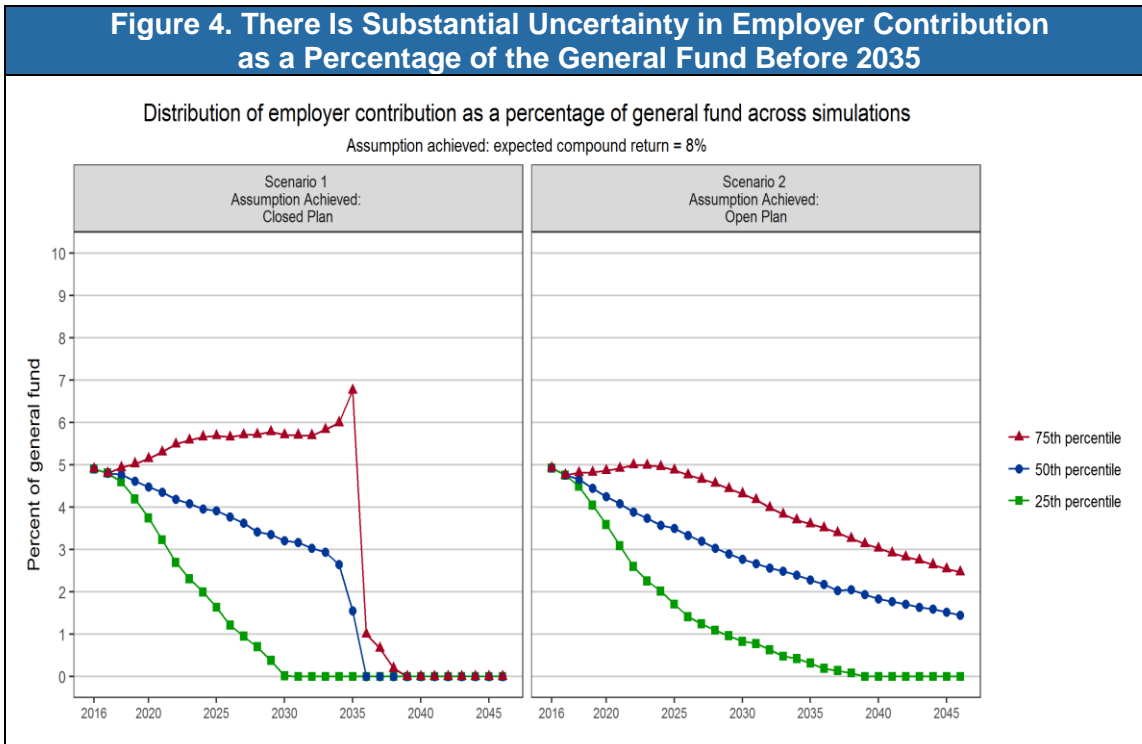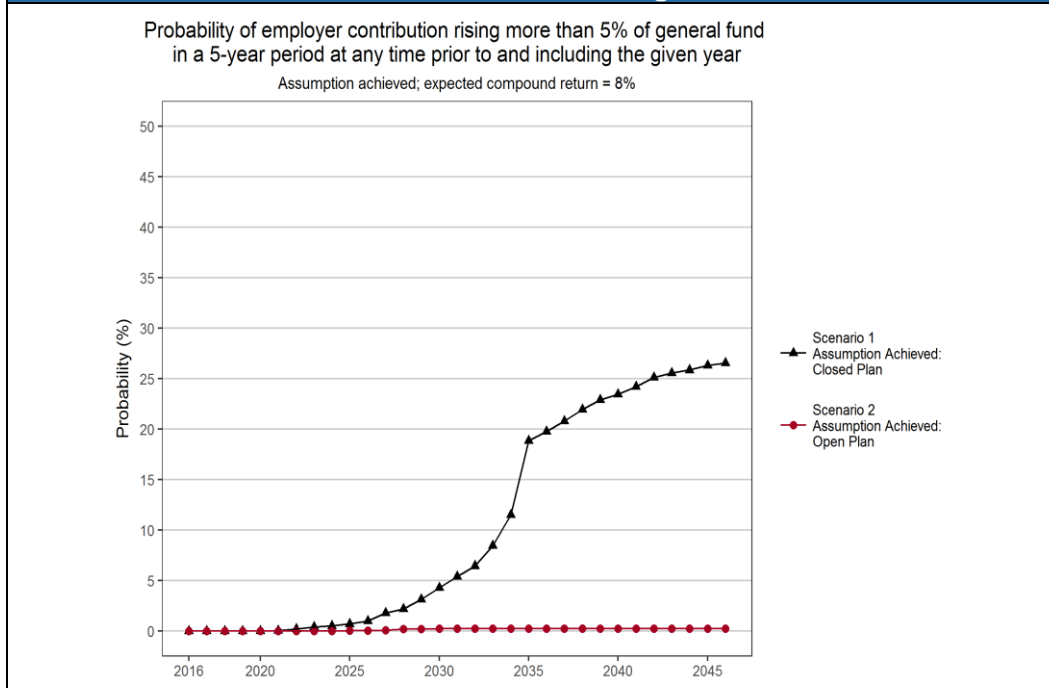

Distribution of employer contributions ($Million) across simulations
Assumption achieved: expected compound return = 8%

Figure 4. There Is Substantial Uncertainty in Employer Contribution as a Percentage of the General Fund Before 2035

Distribution of employer contribution as a percentage of general fund across simulations
Assumption achieved: expected compound return = 8%

The uncertainty in the employer contribution is demonstrated more clearly in Figure 5, which shows the risk of large increases of employer contributions in a short time under *Scenario 1: "Assumption Achieved: Closed Plan"* and *Scenario 2: "Assumption Achieved: Open Plan."* Each point shows the probability that the employer contribution rose by more than 5 percent of general fund revenue in any previous consecutive five-year period. For example, the probability at 2030 is about 4 percent. This

means that there is about a 4 percent chance that employer contributions will have increased by more than 5 percent of the general fund in any previous five consecutive years, such as periods from 2020 to 2025, 2021 to 2026, and so on, through 2025 to 2030. By the end of the thirty-year period, under *Scenario 1* there is about a 27 percent chance that contributions will have increased by more than 5 percent of the general fund revenue in at least one of those five-year periods. Under *Scenario 2*, there is no risk of a sharp increase in employer contributions because the contributions are smoothed using twenty-year open amortization.

Figure 5. There Is Substantial Risk of Sharp Increases in Employer Contributions Relative to the Michigan General Fund

Results for a Period of Low Returns and for Higher Investment-Return Volatility (Scenario 3 and Scenario 4)
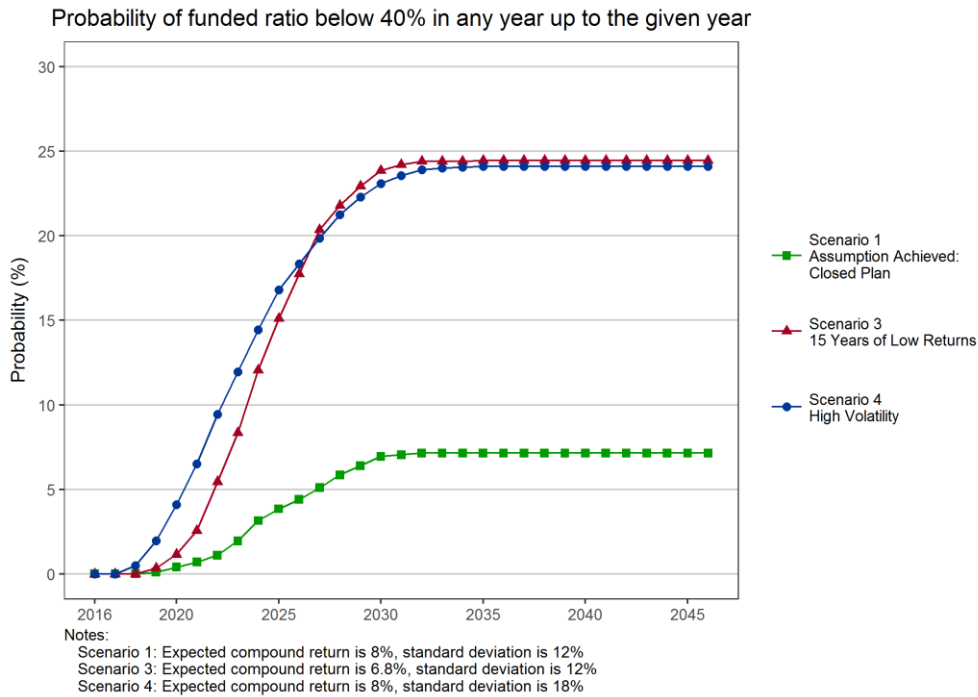
In this section we compare *Scenario 3: "15 Years of Low Returns"* and *Scenario 4: "High Volatility"* to our base-case *Scenario 1: "Assumption Achieved: Closed Plan,"* in which the expected return is 8 percent and the standard deviation is 12 percent. Refer back to Table 2 for details of investment return scenarios.

Impact on Plan Funding

The simulation results show that if the true expected compound return is lower than the assumed return of 8 percent in early years, or if investment-return volatility is higher than in the base case, the risk of severe underfunding will be much higher for MISERS than in the base-case scenario. Figure 6 shows the probability of the funded ratio falling below 40 percent under the three return scenarios. Under both *Scenario 3: "15 Years of Low Returns"* and *Scenario 4: "High Volatility,"* there will be a one-in-four chance that the funded ratio will fall below crisis level — 40

percent — sometime during the next thirty years; the probability is only 7.2 percent under the base-case *Scenario 1: "Assumption Achieved: Closed Plan."*
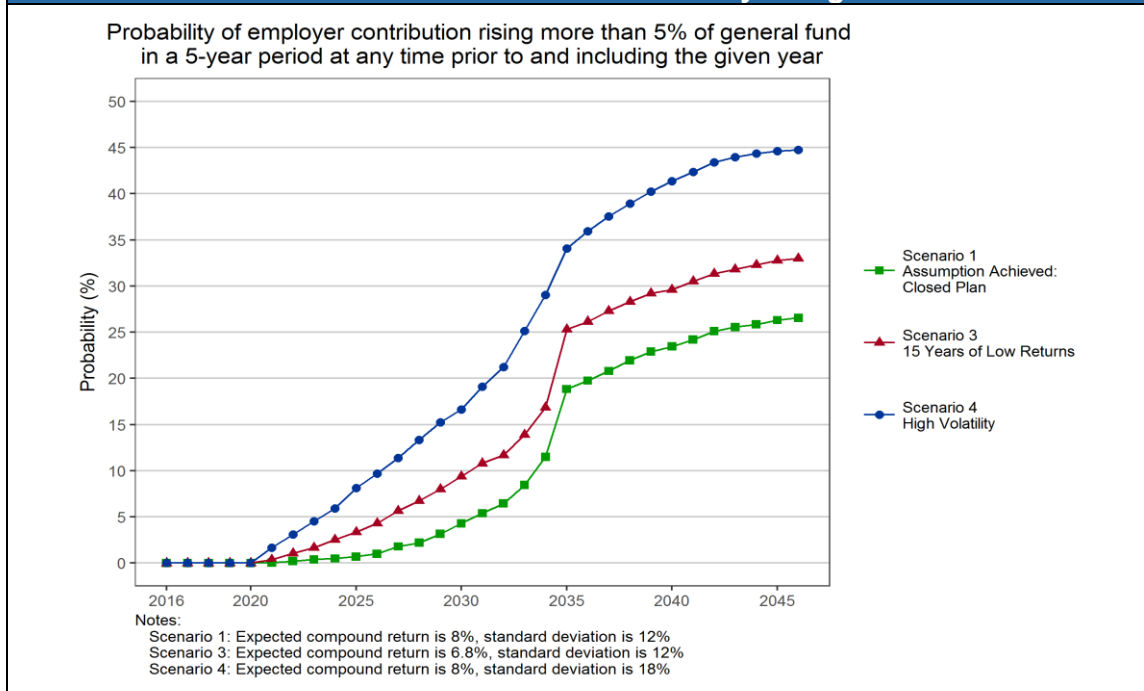

Figure 6. The Risk of Severe Underfunding Is Considerably Higher If There Are Fifteen Years of Low Expected Returns or If Investment Return Volatility Is High

Probability of funded ratio below 40% in any year up to the given year

Scenario 1
Assumption Achieved:
Closed Plan

Scenario 3
15 Years of Low Returns

Scenario 4
High Volatility

Notes:
Scenario 1: Expected compound return is 8%, standard deviation is 12%
Scenario 3: Expected compound return is 6.8%, standard deviation is 12%
Scenario 4: Expected compound return is 8%, standard deviation is 18%

Impact on Employer Contributions

Low expected returns in early years and higher investment-return volatility both create much higher risk of sharp increases in employer contributions. Figure 7 shows the probability of employer contribution rising by more than 5 percent of general fund revenue in a five-year period during thirty years. This probability increases from about 26.6 percent in the base-case *Scenario 1*, to 33 percent in the scenario with fifteen years of low returns, and to 44.8 percent in the scenario with high return volatility.

Figure 7. The Risk of Sharp Increases in Employer Contributions Is Considerably Higher If There Are Fifteen Years of Low Expected Returns or If Investment-Return Volatility Is High

Probability of employer contribution rising more than 5% of general fund in a 5-year period at any time prior to and including the given year

Scenario 1
Assumption Achieved:
Closed Plan

Scenario 3
15 Years of Low Returns

Scenario 4
High Volatility

Notes:
Scenario 1: Expected compound return is 8%, standard deviation is 12%
Scenario 3: Expected compound return is 6.8%, standard deviation is 12%
Scenario 4: Expected compound return is 8%, standard deviation is 18%

Impact of Lowering the Investment Return Assumption (Scenario 5 and Scenario 6)

In this section, we examine the impact of the governor's recommendation of lowering the investment return assumption from 8 percent to 7.5 percent by comparing *Scenario 5: "Current Return Assumption"* and *Scenario 6: "Lower Return Assumption."* In both scenarios, the true long-run expected compound return is 7.5 percent throughout the entire simulation period. In *Scenario 5*, MISERS continues to use the current return assumption of 8 percent, while in *Scenario 6* MISERS recognizes the low-return environment and lowers the investment return assumption to 7.5 percent in 2017. (In 2016 a return assumption of 8 percent is used in both scenarios).

The results show that lowering the return assumption from 8 percent to 7.5 percent would lead to an increase in the employer contribution of about 10 percent in 2017 and 2018; but in the long-run the employer contribution will become lower than the contribution with an 8 percent assumed return.

The risk of severe underfunding is relatively low in both scenarios, even in *Scenario 5* when the overly optimistic return assumption of 8 percent is used. The risk of a large increase in the employer contribution in a short time period will become slightly higher if the return assumption is lowered.

Figure 8 shows employer contributions as a percentage of projected general fund revenue under *Scenario 5* and *Scenario 6*. To make the

comparison more straightforward, the results presented in Figure 8 are from the deterministic runs of *Scenario 5* and *Scenario 6*, where the annual investment returns are equal to the long-run expected return of 7.5 percent each year. In 2017 and 2018, the employer contributions are about 4.8 percent of the general fund if the return assumption is kept at 8 percent, while the employer contribution would be about 5.3 percent of the general fund if the return assumption is lowered to 7.5 percent, an increase of about 10 percent. However, about ten years after the change in return assumption, the employer contribution with 7.5 percent return assumption becomes lower than that with 8 percent return assumption. This is because in *Scenario 5,* the difference between the assumed return of 8 percent and the actual return of 7.5 percent generates new unfunded liabilities that need to be repaid afterwards.

Figure 8. Lowering the Investment-Return Assumption Will Lead to Increases in Employer Contributions in the Short Run But Will Make Contributions Lower in the Long Run
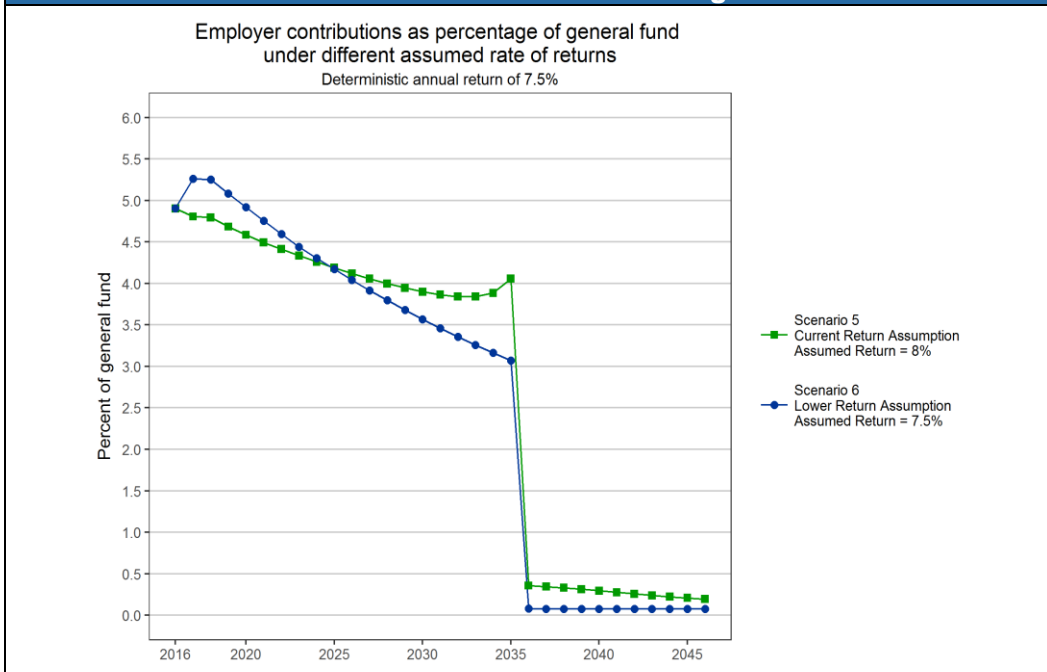
Figure 9 shows that the probabilities of the funded ratio falling below 40 percent are quite low under both *Scenario 5* and *Scenario 6*. By the end of 2046, there is only a 4 percent chance that the funded ratio will fall into crisis territory under *Scenario 6: "Lower return assumption"*; the risk more than doubles for *Scenario 5: "Current Return Assumption,"* but the probability of severe underfunding is still a relatively low 9 percent.

Figure 9. The Risk of Severe Underfunding Is Low Regardless of Whether the Return Assumption Is Lowered; But Lowering the Return Assumption Cuts the Risk in Half
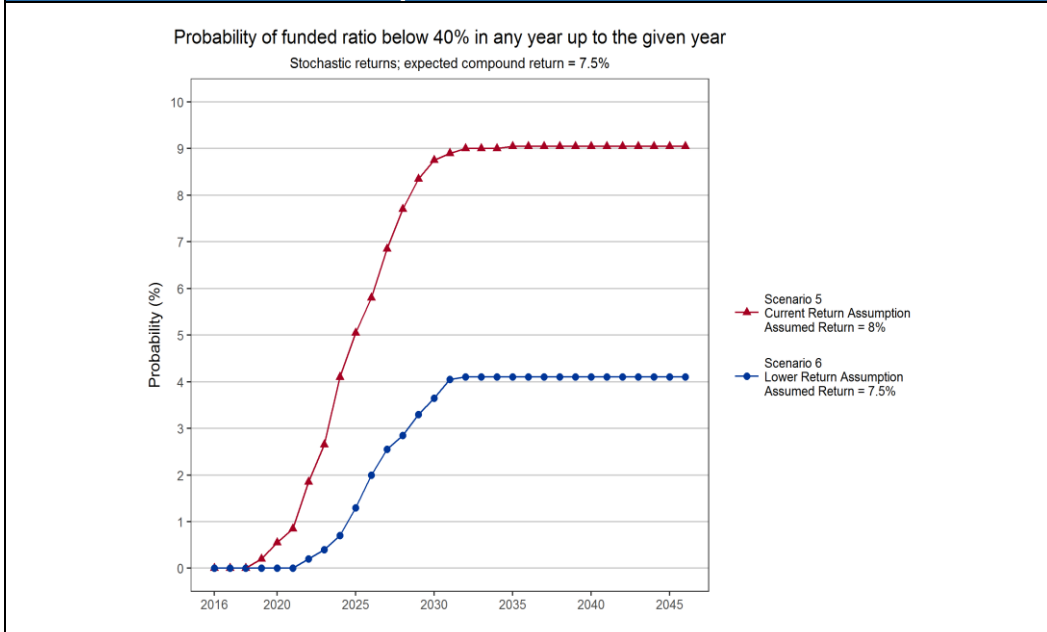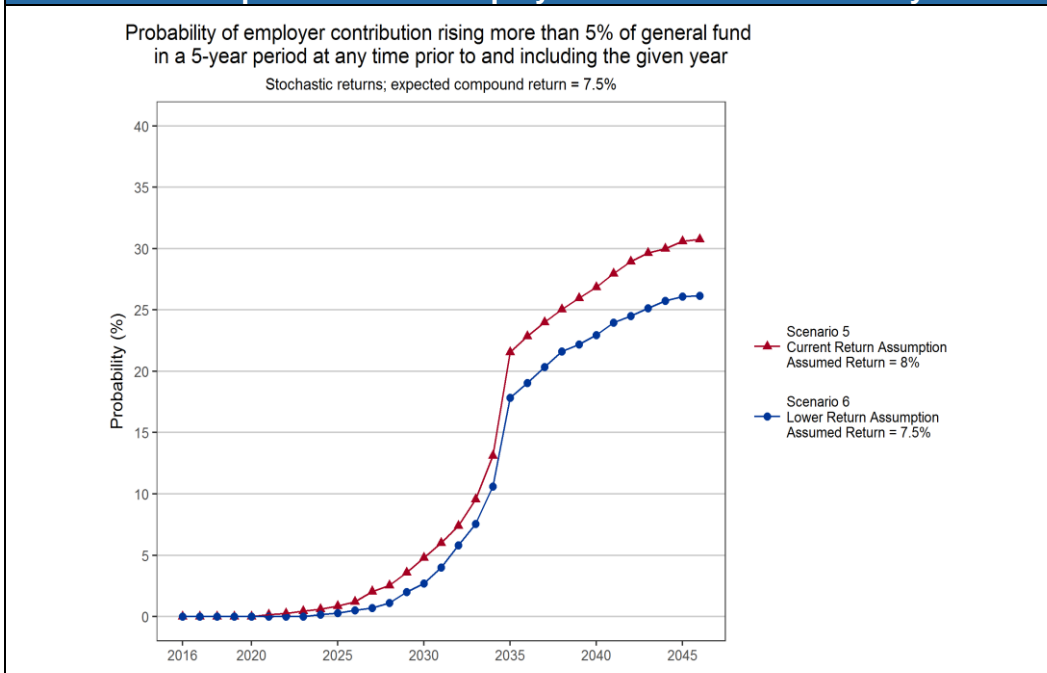
Probability of funded ratio below 40% in any year up to the given year

Stochastic returns; expected compound return = 7.5%

Scenario 5
Current Return Assumption
Assumed Return = 8%

Scenario 6
Lower Return Assumption
Assumed Return = 7.5%

Figure 10 shows the probability of the employer contribution rising by more than 5 percent of the projected general fund revenue in a five-year period during thirty years. Under *Scenario 6: "Lower Return Assumption,"* there is about a 26 percent chance that MISERS will experience such a sharp increase in employer contribution sometime in the next thirty years; under *Scenario 5: "Current Return Assumption,"* the probability is about 5 percentage points higher.

Figure 10. Lowering the Return Assumption Will Reduce the Risk of Sharp Increases in Employer Contribution Moderately

Probability of employer contribution rising more than 5% of general fund in a 5-year period at any time prior to and including the given year

Stochastic returns; expected compound return = 7.5%

Scenario 5
Current Return Assumption
Assumed Return = 8%

Scenario 6
Lower Return Assumption
Assumed Return = 7.5%

Summary of Results

Table 3 summarizes the results of the six simulation scenarios over the thirty-year period. The first column describes the measure that appears in each row, the next six columns show the risk measures under the six scenarios.

MISERS, when modeled as a closed plan, as it is in the real world, has very limited exposure to the risk of severe underfunding in the next thirty years if the return assumption of 8 percent is correct, even though it starts with a relatively low funded ratio of about 66 percent in 2016. This result is largely attributable to the amortization method used by MISERS, which has an amortization period that is shortened every year and can therefore ensure that unfunded liabilities are paid off in a timely manner. Because MISERS is a closed plan, it will keep decreasing in size and will eventually stop being a potential source of fiscal stress for the state of Michigan. However, that is far in the future: MISERS will remain a relatively large plan for most of the next thirty years, and could still create significant fiscal stress for the state government when future financial crises hit, given the current funding policy, which requires quick repayment of investment shortfalls. The table shows that under *Scenario 1: "Assumption Achieved: Closed Plan,"* there is more than a one-in-four chance that the employer contribution will rise by more than 5 percent of the general fund revenue of Michigan in a five-year period sometime in the next thirty years.

MISERS faces substantially higher risk of severe underfunding and risk of large increases in employer contributions in a short time period under scenarios with a period of low expected returns (*Scenario 3: "15 Years of Low Returns"*) or high volatility in investment returns (*Scenario 4: "High Volatility"*).

Lowering the return assumption from 8 percent to 7.5 percent would increase the employer contribution in the short run (about a 10-percent increase in 2017 and 2018). In the long run, lowering the return assumption will moderately reduce the risk of severe underfunding and the risk of sharp increases in employer contribution.

Table 3. Summary of Results

Probability of crisis-level funding or of significant employer contribution increases under different scenarios

All scenarios are stochastic

Risk Measures	Current return assumption of 8% is achieved		Impact of low expected return and Impact of high volatility		Impact of lowering return assumption (discount rate) from 8 percent to 7.5 percent	
	Scenarios		*Scenarios*		*Scenarios*	
	Scenario 1 (Assumption Achieved: Closed Plan)	Scenario 2 (Assumption Achieved: Open Plan)	Scenario 3 (15 Years of Low Returns)	Scenario 4 (High Volatility)	Scenario 5 (Current Return Assumption)	Scenario 6 (Lower Return Assumption)
*Probability of crisis-level funding sometime in the next 30 years (%)	7.2	30.2	24.5	24.1	9.1	4.1
**Probability of a significant employer contribution increase sometime in the next 30 years (%)	26.6	0.3	33.0	44.8	30.8	26.2

Notes on scenarios:
Scenario 1 (Assumption Achieved: Closed Plan): Constant expected return over 30 years. Expected compound return is 8%, consistent with actuarial assumption of 8%. The plan is closed to new members.
Scenario 2 (Assumption Achieved: Open Plan): Constant expected return over 30 years. Expected compound return is 8%, consistent with actuarial assumption of 8%. New members are allowed to join MISERS to keep the size of workforce constant.
Scenario 3 (15 Years of Low Returns): Expected returns are 5% in years 1-10, 6.5% in years 11-15, and 8% in years 16-30; 30-year compound return is about 6.6%. Closed Plan
Scenario 4 (High Volatility): Constant expected return over 30 years. Expected compound return is 8%, standard deviation is 18%. Closed Plan
Scenario 5 (Current Return Assumption): Constant expected return over 30 years. Expected compound return is 7.5%, standard deviation is 12%. Return assumption (discount rate) is 8%
Scenario 6 (Lower Return Assumption): Constant expected return over 30 years. Expected compound return is 7.5%, standard deviation is 12%. Return assumption (discount rate) starts with 8% but is lowered to 7.5% from 2017.

* Probability that funded ratio falls below 40% in at least 1 year out of the next 30 years.
** Probability that employer contribution rises by at least 5 percent of projected general fund revenue of the State of Michigan in any 5-year period in the next 30 years.
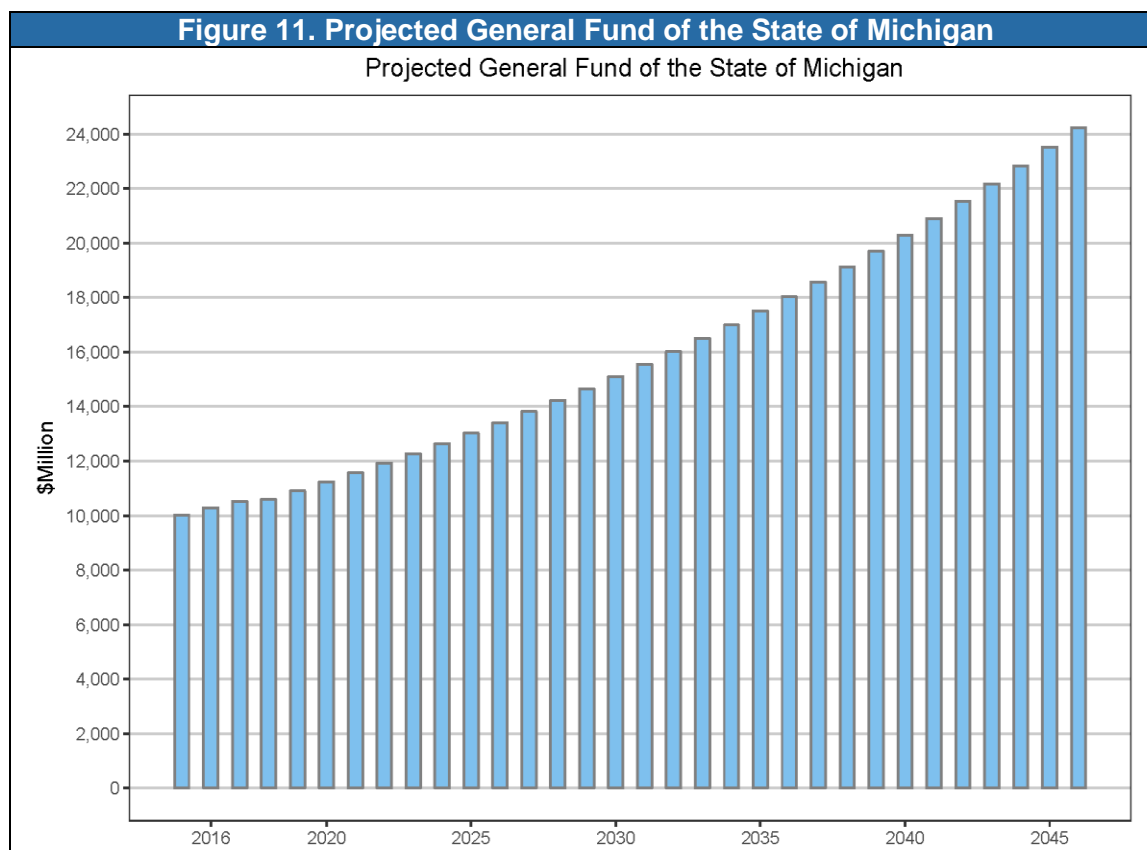
Conclusion

Our analysis suggests that if MISERS' investment-return assumption is approximately correct over the long run and it strictly follows its current funding policy that amortizes unfunded liability over an increasingly shortened time period, the plan has relatively little risk of becoming severely underfunded in the next thirty years. MISERS, as a closed plan, is shrinking in size over time and will eventually stop being a potential source of fiscal stress for the state of Michigan. However, that is far in the future: MISERS will remain a relatively large plan for the next thirty years, and could still create significant fiscal stress for the government when future financial crises hit, particularly under the current funding policy, which requires quick repayments of investment losses. Under plausible alternative investment-return assumptions, such as a long period of low expected returns or high volatility in investment returns, MISERS would face much greater risk of severe underfunding and the state of Michigan would face a much greater risk of sharp increases in required contributions.

If Governor Snyder's recommendation of lowering MISERS' assumed rate of return from 8 percent to 7.5 percent is implemented, our simulation results show that the required employer contribution will increase by about 10 percent in the short run. Lowering the return assumption would reduce the risk of severe underfunding and the risk of large increases in contributions, but the positive effect is likely to be relatively small, if the investment assumption is approximately correct.

Compared to open plans that accept new employees, funding security is more important for closed plans like MISERS, which do not have the luxury of time that open plans have. Closed plans usually have very large negative cash flows relative to their assets, and they cannot spread investment losses over long time periods and count on cash infusion from new entrants. The broader lesson from our analysis of MISERS is that a very conservative contribution policy can protect a closed plan from becoming severely underfunded. However, for large closed plans like MISERS, the sponsoring governments may face a risk of substantial contribution increases if the plan invests in risky assets and large shortfalls must be recouped in short periods of time.

Appendices

Projected General Fund Revenue of the State of Michigan

Figure 11. Projected General Fund of the State of Michigan

Projected General Fund of the State of Michigan

Modeling MISERS: Simplifications and Approximations

Our modeling process involves simplifications of some minor aspects of MISERS, and approximations when accurate and detailed plan data are not publicly available. The major simplifications and approximations are described below.

■ *Liabilities and cash flows for disability and death benefits for defined contribution plan members.* MISERS provides disability and death benefits for participants of the defined contribution plan for Michigan's public employees, which are included in the calculation of the total liability and employer contribution of MISERS beginning with the 2010 actuarial valuation. Modeling the liabilities and cash flows of the benefits for the defined contribution plan members requires detailed demographic data and actuarial assumptions for the defined contribution plan, which, however, we do not have access to. The only publicly available data we found about the MISERS' benefits for defined contribution plan members is the normal cost for these benefits in the 2015 actuarial valuation report, which is about $6.9 million and accounts for about 1.07 percent of

the total employer contribution. With the 2015 normal cost data, we constructed projections of the liabilities, normal cost, and benefit payments for the MISERS' disability and death benefits for defined contribution plan members based on the following assumptions: 1) the ratio of normal cost to actuarial accrued liability is about 0.02 in 2015, 2) the ratio of normal cost to benefit payment is 0.3 in 2015, and 3) normal cost and benefit payment grow at MISERS' assumed inflation rate of 3.5 percent. The assumptions are made based on our studies of other public pension plans that have very mature populations and have detailed demographic data that are publicly available. The total liability of MISERS in 2015 generated by our model, which consists of the liabilities for regular MISERS members and the liabilities for the defined contribution plan members, is about 1.5 percent higher than the value given in the actuarial valuation report, which is acceptable based on our knowledge about the standards of the pension actuary profession. We have conducted sensitivity tests by using alternative assumptions in the projection, which show that our conclusions in this report are not affected by the choice of assumptions.

■ *Demographics of beneficiaries.* Detailed demographic data of beneficiaries are not provided in the actuarial valuation reports of MISERS. Instead, we used demographic data of beneficiaries of MISERS collected by the Center for Retirement Research (CRR) at Boston College for the Public Plans Data. However, the data of MISERS beneficiaries from CRR have an extremely young average age and the liability calculated based on these data is far higher than the liability given in the actuarial valuation. In our simulation model, we calibrated the age distribution of beneficiaries of MISERS based on the CRR data such that it generally matches a typical mature public plan and the resulting liability is close to the value in the actuarial valuation.

■ *Age distribution of new entrants in Scenario 2.* When constructing *Scenario 2: "Assumption Achieved: Open Plan,"* an assumption on the age distribution of new entrants to MISERS is needed. However, it is difficult to infer the age distribution of new entrants based on the current active members of MISERS since the plan has been closed to new members for nearly twenty years. Therefore, in *Scenario 2: "Assumption Achieved: Open Plan"* we used an age distribution constructed based on a prototypical plan that has an average demographic structure among large public pension plans.

Alternative Funding Policy With Minimum Amortization Period of Five Years

To examine the possibility that MISERS will change its funding policy when it faces potential large increases in employer contributions, we ran a variant of *Scenario 1: "Assumption Achieved: Open Plan"* in which the amortization period is not shortened below five years. This alternative policy could significantly reduce contribution risk without increasing the risk of the funded ratio falling below 40 percent. However, this alternative policy still has a negative impact on the funding security of MISERS.

Figure 12 shows that the probability of the funded ratio falling below 40 percent sometime in the next thirty years increases by less than 0.5 percent under the alternative funding policy compared to the probability under the current policy.

Figure 12. The Alternative Funding Policy With a Minimum Amortization Period of Five Years Barely Increases the Risk of Severe Underfunding
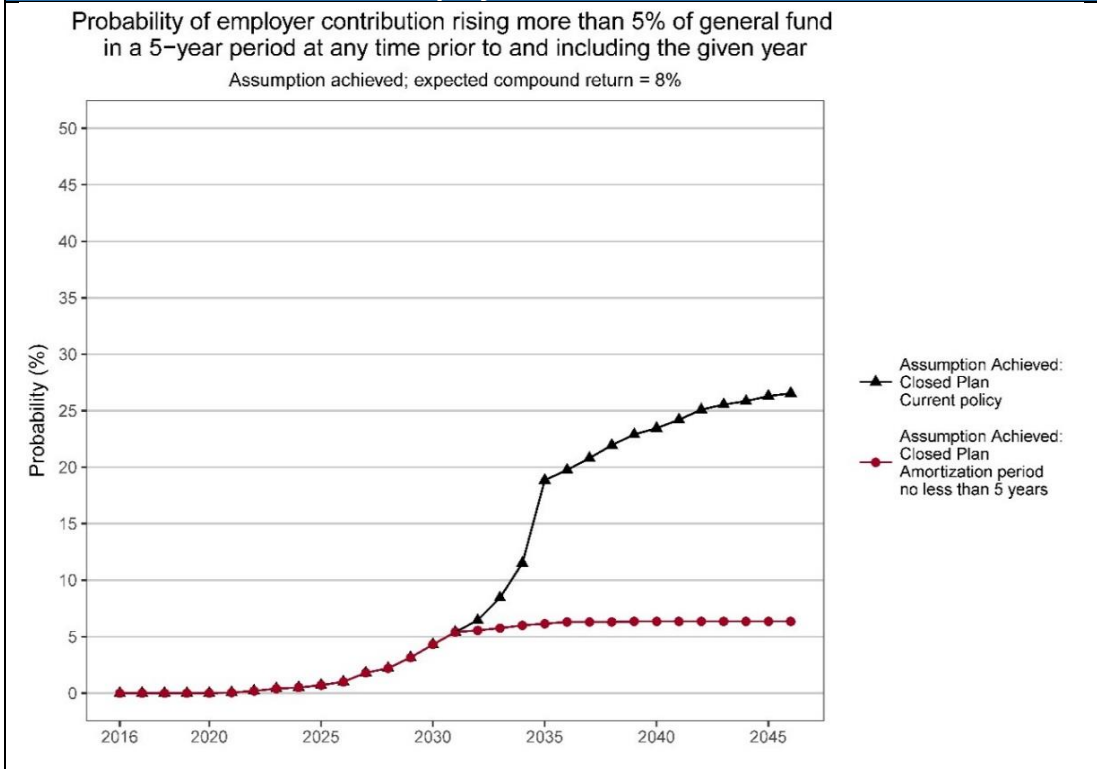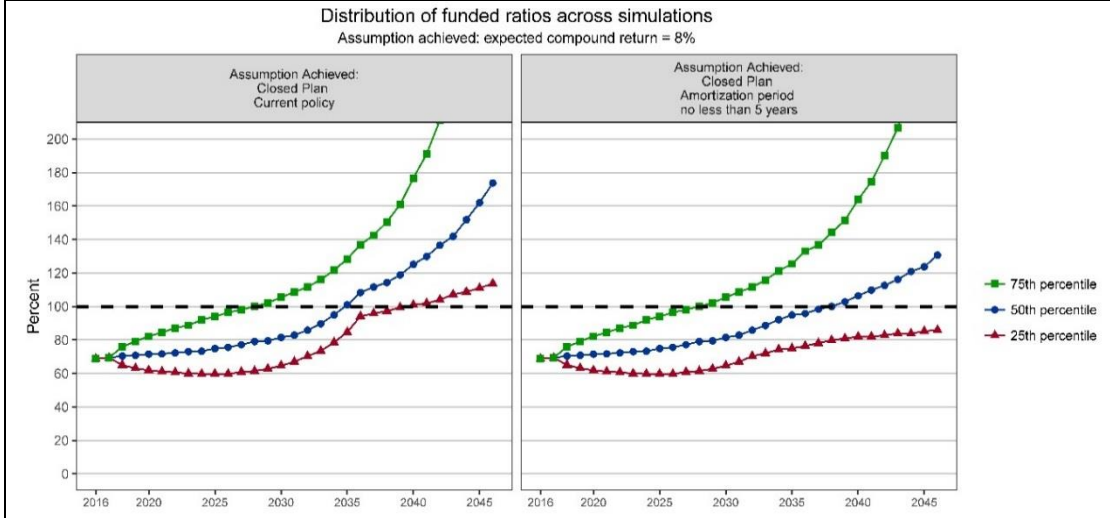
Figure 13 shows that under the alternative funding policy there is only about a 6 percent chance that the employer contribution will rise by more than 5 percent of the general fund of Michigan sometime during the next thirty years, while the chance is 27 percent under the current policy.

Probability of employer contribution rising more than 5% of general fund in a 5−year period at any time prior to and including the given year

Assumption achieved; expected compound return = 8%

However, MISERS is less likely to reach full funding under the alternative funding policy with a five-year minimum amortization period. Figure 14 shows the median funded ratio, along with the 75th percentile and 25th percentile, under the current policy and the alternative policy. The 25th percentile funded ratio, which represents results from simulations with relatively bad investment returns, is still well above 100 percent under the current funding policy, while the 25th percentile funded ratio is only about 86 percent under the alternative funding policy. The probability of reaching full funding after thirty years (based on a separate calculation that is not shown in the figure) is only 64 percent under this alternative policy, while the probability is 86 percent if MISERS strictly sticks to the current policy.

Figure 14. The Alternative Funding Policy With a Minimum Amortization Period of Five Years Has a Negative Impact on Funding Security

Distribution of funded ratios across simulations
Assumption achieved: expected compound return = 8%

Endnotes

1. Our analysis is based upon publicly available data, from actuarial valuations, and other technical documents. We did request some data directly from MISERS that were not in public documents, and that other plans often include in their public documents, but MISERS staff and leadership told us it would be too burdensome to provide the data. Rather than make a Freedom of Information request and increase burdens on MISERS, we worked with publicly available data, making a few simplifications discussed in the appendix that do not affect our conclusions in a meaningful way. We have not asked MISERS staff to review a draft of this report, given the other demands on their time.

2. See Delia Lugo et al., *Comprehensive Annual Financial Report* (Yorba Linda: Yorba Linda Water District, September 30, 2016), http://ylwd.com/images/about/district-departments/finance/2016-FS-CAFR.pdf. Also, "Core Elements of a Funding Policy, Type: Best Practice," Government Finance Officers Association, March 2013, http://gfoa.org/core-elements-funding-policy.

3. When we use the term "expected long-term compound return," we mean it in a statistical sense, where investment return is a "random variable" — we do not know what the return will be in any given year or even over a long period of time, but we know what it is likely to be. We are not referring to what a pension plan actuary expects or assumes. In fact, the statistical or true "expected return" could be different from what the actuary expects, and we model such a scenario later in this report. It is important to understand that the "expectation" is taken across simulations, meaning in any single simulation the realized compound return can be higher or lower than the "expected long-term compound return," but the mean compound return of a large number of simulations will be close to the "expected long-term compound return." That is one of the reasons we typically run at least 1,000 simulations of any particular analysis.

4. When investment returns are variable, the long-run compound return will be lower than the expected annual return. Thus, we use an annual expected return that is greater than 8 percent but is designed to achieve a long-run compound return of 8 percent in the average simulation. We calculate the annual expected return via a widely used approximation formula under which the long-run compound return equals the annual expected return minus one half of the annual variance.

5. This is broadly consistent with other estimates of risk associated with public pension plan portfolios. CalPERS has used a 12.96 percent standard deviation, Biggs assumed a 14 percent standard deviation, and Bonafede et al. estimated a 12.5 percent standard deviation. See: *Annual Review of Funding Levels and Risks as of June 30, 2012* (Sacramento: California Public Employees' Retirement System, March 2013), https://www.calpers.ca.gov/docs/forms-publications/annual-review-funding-2012.pdf; Andrew G. Biggs, "The Public Pension Quadrilemma: The Intersection of Investment Risk and Contribution Risk," *Journal of Retirement* 2, 1 (2014): 115-27; Julia K. Bonafede, Steven J. Foresti, and Russell J. Walker, *2015 Report on State Retirement Systems: Funding Levels and Asset Allocation* (Santa Monica: Wilshire Consulting, February 25, 2015), https://www.wilshire.com/media/38890/wilshire_2015_state_funding_report.pdf.

6. It is quite consistent with assumptions of Callan Associates reported in Timothy W. Martin, "Pension Funds Pile on Risk Just to Get a Reasonable Return," *Wall Street Journal*, May 31, 2016, Markets section, http://www.wsj.com/articles/pension-funds-pile-on-the-risk-just-to-get-a-reasonable-return-1464713013. Callan Associates has noted that it sympathizes with public pension funds given the challenges that professionals face in achieving assumed returns in the current interest rate environment.

7. Donald J. Boyd and Yimeng Yin, *Appropriateness of Risk-Taking by Public Pension Plans* (Albany: The Nelson A. Rockefeller Institute of Government, February 2017),

http://www.rockinst.org/pdf/government_finance/2017-02-01-Risk_Taking_Appropriateness.pdf.

8   This scenario is only used to illustrate the variability of investment returns, and is different from the scenarios that are used in our analysis in the following sections.

9   Except where noted, data in this section are from either *Michigan State Employees' Retirement System Annual Actuarial Valuation Report: September 30, 2015* (Fort Lauderdale: Gabriel Roeder Smith & Company, 2016) or from *Michigan State Employees' Retirement System: Comprehensive Annual Financial Report for the Fiscal Year Ended September 30, 2016* (Lansing: Michigan State Employees' Retirement System, January 18, 2017), https://audgen.michigan.gov/wp-content/uploads/2017/02/SERS_CAFR_2016_FINAL.pdf.

10 According to the Public Plans Database (PPD), the 25th percentile for the 2015 actuarial-value-of-assets funded ratio of 160 large plans was 62 percent. (The market-assets funded ratio is not reported in the PPD.) MISERS' actuarial funded ratio in 2015 was 64.2 percent, according to the 2015 actuarial valuation.

11 Michael Dennis Thorn, "Pension Politics: Partisan Influences on Public Sector Pensions" (Ph.D. diss., Michigan State University, 2012), https://etd.lib.msu.edu/islandora/object/etd%3A742/datastream/OBJ/download/Pension_politics__partisan_influences_on_public_sector_pensions.

12 See Delia Lugo et al., *Comprehensive Annual Financial Report.* Also, "Core Elements of a Funding Policy, Type: Best Practice."

13 *Fiscal Year 2018 Executive Recommendation Issue Papers* (Lansing: State Budget Office, State of Michigan, February 8, 2017), http://www.michigan.gov/documents/budget/FY18_Executive_Budget_Issue_Papers_550972_7.pdf.

14 When we use the term "expected long-term compound return," we mean it in a statistical sense, where investment return is a "random variable" — we do not know what the return will be in any given year or even over a long period of time, but we know what it is likely to be. We are not referring to what a pension plan actuary expects or assumes. In fact, the statistical or true "expected return" could be different from what the actuary expects, and we model such a scenario later in this report. It is important to understand that the "expectation" is taken across simulations, meaning in any single simulation the realized compound return can be higher or lower than the "expected long-term compound return," but the mean compound return of a large number of simulations will be close to the "expected long-term compound return." That is one of the reasons we typically run at least 1,000 simulations of any particular analysis.

15 When investment returns are variable, the long-run compound return will be lower than the expected annual return. Thus, we use an annual expected return that is greater than 8 percent but is designed to achieve a long-run compound return of 8 percent in the average simulation. We calculate the annual expected return via a widely used approximation formula under which the long-run compound return equals the annual expected return minus one half of the annual variance.

16 This is broadly consistent with other estimates of risk associated with public pension plan portfolios. CalPERS has used a 12.96 percent standard deviation, Biggs assumed a 14 percent standard deviation, and Bonafede et al. estimated a 12.5 percent standard deviation. See: Annual Review of Funding Levels and Risks as of June 30; Biggs, "The Public Pension Quadrilemma"; Bonafede, Foresti, and Walker, 2015 Report on State Retirement Systems.

17 It is quite consistent with assumptions of Callan Associates reported in Martin, "Pension Funds Pile on Risk Just to Get a Reasonable Return." Callan Associates has noted that it sympathizes with public pension funds given the challenges that professionals face in achieving assumed returns in the current interest rate environment.

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18 For a more detailed discussion of the trade-off between these two kinds of risk, see Donald Boyd and Yimeng Yin, *Public Pension Funding Practices: How These Practices Can Lead to Significant Underfunding or Significant Contribution Increases When Plans Invest in Risky Assets* (Albany: The Nelson A. Rockefeller Institute of Government, State University of New York, June 2016), http://www.rockinst.org/pdf/government_finance/2016-06-02-Pension_Funding_Practices.pdf.

19 The Public Plans Data (PPD) website is developed and maintained through a collaboration of the Center for Retirement Research at Boston College, the Center for State and Local Government Excellence, and the National Association of State Retirement Administrators, at http://publicplansdata.org/

20 See "Consensus Revenue Agreement" (House Fiscal Agency, the State of Michigan, January 12, 2017), http://www.house.mi.gov/hfa/Consensus.asp.

21 A caveat about using deterministic revenue growth rates, rather than allowing them to vary as investment returns vary, is that it ignores the potential correlation between tax revenues and the employer contributions. If investment returns and taxes both are correlated with economic growth, then investment returns and taxes will be higher when the economy grows rapidly, and lower when the economy does poorly. Contribution increases resulting from investment-income shortfalls might be required in an already fiscally stressed period. Therefore, ignoring the correlation between tax revenues and contributions may lead to an underestimate of fiscal pressure. We leave to future research a modeling approach that takes into account the correlation between taxes and contributions.

22 A note on nomenclature: In the tables and graphs that follow, we label each plan fiscal year by the year in which it begins. For example, 2016 is the year beginning July 1, 2016, also called the 2016-17 fiscal year. The year labeled 2045 is the 2045-46 fiscal year.

23 If we run the simulation 2,000 times, the values represented by the points on 25th/50th(median)/75th percentile lines are higher than the values in 25%/50%/75% of the 2,000 simulations. Half of the outcomes fall between the 75th and 25th percentile lines.

24 This scenario is constructed based on suggestions from advisory board members of our Pension Simulation Project. Some advisory board members also suggested that as the amortization period becomes shorter and assets shrink, the asset allocation should be modified to match the duration of anticipated benefit payment streams more closely. The actuaries would then be likely to reduce the investment earnings assumption and the discount rate, leading to increases in reported actuarial liability. We do not examine the impact of a dynamically adjusted asset allocation in this report.

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