Maryland State Retirement and Pension System

MARYLAND
STATE RETIREMENT
and PENSION SYSTEM

Maryland Pension Risk Mitigation Act

Risk Assessment

January 2019

Introduction

In accordance with HB 993, The Maryland Pension Risk Mitigation Act, the Board of Trustees is submitting an assessment of risk for the several Systems. The overarching risk to the System is a failure to meet pension obligations in full and on time. There are many potential causes for such a failure. This report will focus on risks associated with the investment program.

The Board of Trustees is charged with the responsibility of managing the assets of the Maryland State Retirement and Pension System. Investment policies are designed to support the fulfillment of the Board's mission to optimize risk-adjusted returns to ensure that sufficient assets are available to pay benefits to members and beneficiaries when due.

In pursuing this mission, the most powerful tool at the Board's disposal is its long-term strategic asset allocation policy. The strategic asset allocation policy establishes a mix of investment types (stocks, bonds, real estate, etc.) that collectively are modeled to produce the required return with the least risk over the horizon of the pension liabilities. The Board works with its independent investment consultant and staff to establish this long-term policy. Beyond this top-down approach, the Investment Division also contributes to the System's risk management process in its implementation of the strategic asset allocation.

A mix of techniques are utilized at both levels of the investment process. The Board of Trustees and the Investment Division regularly engage with other market participants, including public pension plan peers, financial institutions, and academia, to ensure the System's investment policies and procedures represent leading practices.

Collectively, the Board's strategic allocation and the implementation of that allocation by staff could lead to heightened risk of a funding shortfall if:

1. The collection of assets in the strategic asset allocation fail to achieve the expected returns
2. The collection of assets in the strategic asset allocation achieve the average return over long periods of time, but experience extreme negative returns in the near term, reducing the value of System assets
3. The implementation of the strategic asset allocation by Investment Division staff markedly underperforms the benchmark returns
4. The implementation of the strategic asset allocation does not maintain sufficient liquidity to make benefit payments

Assessment of the System's Investment Risk

<u>Strategic Asset Allocation</u>

Periodically, the System conducts an asset allocation review that evaluates long-term expected returns for the System as well as a variety of different measures of risk.

Regarding return objectives, the asset allocation review incorporates different considerations driving the System's long-term return requirements including factors such as its actuarial assumed rate of return, policy benchmark (i.e. market return of the strategic asset allocation assuming it could be invested passively), expected future inflation, projected cash flows, and liability status. This exercise analyzes the prospects for achieving the return objective using the System's existing asset classes, as well as any new opportunities that may increase return or reduce risk by investing in new or alternative asset classes. In addition, the review compares the System's asset allocation to peer retirement systems. The expected return over a twenty-year horizon of the System's strategic allocation is 7.7%, based on Meketa Investment Group's capital market expectations as published in their 2018 Annual Asset Study. This exceeds the System's 7.45% actuarial assumed rate of return and produces a probability of achieving 7.45% over time in excess of 50%.

The asset allocation review also analyzes numerous measures of risk including statistical and scenario-based approaches. These approaches help evaluate the risk that a period of underperformance could severely impact the existing pool of assets. These approaches include:

- Historical Scenarios Analysis: Assessing how the System would have performed in different historical scenarios with its current asset allocation. There are many different types of events that could result in sub-par returns for the System. In particular, extreme shocks such as the Global Financial Crisis and the Stagflation of the 1970s would have the most severe impact.

Historical Negative Scenario Analysis
Cumulative Return

Scenario:	Current Policy (%)
Taper Tantrum (May-Aug 2013)	-1.9
Global Financial Crisis (4Q07 thru 1Q09)	-22.1
Popping of the TMT bubble (Apr 2000 – Sep 2002)	-7.1
LTCM (Jul – Aug 1998)	-8.2
Interest Rate Spike (1994)	1.2
Crash of 1987 (September thru November 1987)	-9.4
Strong U.S. Dollar (1Q81 through 3Q82)	4.7
Volcker Recession (January thru March 1980)	-4.6
Stagflation (1Q73 thru 3Q74)	-20.4

Source: Meketa Investment Group

- Stress Testing: Estimating the possible risk of various changes in market conditions (e.g., interest rates, credit risk, currency fluctuations) by varying degrees. The largest market risk factors are equity market declines and widening credit spreads.

Stress Testing: Impact of Market Movements
Expected Return under Stressed Conditions

What happens if (over a 12-month period):	Current Policy (%)
10-Year T-Bond rates rise 100 bp	4.7
10-Year T-Bond rates rise 300 bp	-1.8
BBB Spreads widen by 50 bp, HY by 200 bp	-0.4
BBB Spreads widen by 300 bp, HY by 1000 bp	-19.2
Trade-weighted U.S.$ gains 10%	0.1
Trade-weighted U.S.$ gains 20%	-1.8
Equities decline 10%	-4.6
Equities decline 40%	-23.6

Source: Meketa Investment Group

- Value at Risk (VaR) and CVaR: Statistical measures of potential large drawdowns in the market value of investments. VaR is a measure of the risks to the System in the majority of potential outcomes, generally 67% to 99% of the time. The System's conditional value at risk (CVaR), evaluates the range of outcomes assuming the market is already outside the reasonably expected range. This is often described as a tail risk or black swan event. CVaR is a measure that indicates the policy allocation could lose 9.5% of market value in a single month. This potential loss of 9.5% is an average of the worst 1% of cases, so it possible for an extreme outlying event to produce a greater loss.

Conditional Value at Risk

Scenario	Current Policy
CVaR (%):	
One Month	-9.5
Three Months	-15.5

Source: Meketa Investment Group

- Economic Regime Management (ERM) Factor Sensitivity: A measure of the System's exposure to several economic risk factors (e.g., interest rate, growth, inflation). The largest risk exposure to the System is Systemic Risk, which was the main driver of the global financial crisis during the 2008-2009 period. Because most of the volatility of returns is a result of equity price risk, the System is also sensitive to changes in growth rates. Interest rate and inflation surprises have smaller impacts on the System.

ERM: Portfolio Sensitivity Comparison
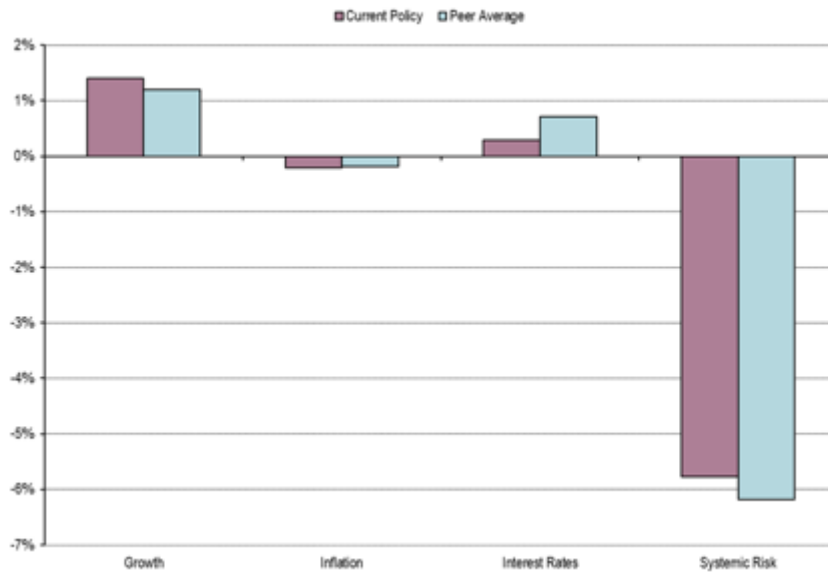
Source: Meketa Investment Group

- Funded Ratio Impacts: Evaluating changes to the System's funded ratio based on both historical scenarios and stress tests, as well as varying the sequence of investment returns over time. An equity market downturn has the most serious negative impact on funded status. Additionally, because the System currently pays more in benefits than it receives in contributions from the employees and employers, the sequence of returns is important. That is, the System could earn its actuarial rate of return, on average, over the next twenty years but still find itself well short of its anticipated funded status. For example, if the System has weak returns in years 1-10 offset by stronger returns in the future, the System's ending funded status would be projected to be lower than if it produced its assumed rate of return in each year.

Stress Testing: Impact of Market Movements
Funded Status under Stressed Conditions

| What happens if (over a 12-month period):	Current Policy (%)
10-Year T-Bond rates rise 100 bp	75.2
10-Year T-Bond rates rise 300 bp	70.5
BBB Spreads widen by 50 bp, HY by 200 bp	71.6
BBB Spreads widen by 300 bp, HY by 1000 bp	58.1
Trade-weighted U.S.$ gains 10%	71.9
Trade-weighted U.S.$ gains 20%	70.5
Equities decline 10%	68.5
Equities decline 40%	54.9

Source: Meketa Investment Group

- Tracking Error Attribution: Estimates the expected variation in performance versus peers over time. While not a direct risk to the System, it is important for Trustees to evaluate the asset allocation relative to the peer average. Tracking error is a metric that can be used to measure the variability of the System's returns versus the peer average. With the current asset allocation, the System can expect long-term variability of the difference between the System's return and the peer average return (tracking error) (i.e., over a 20-year period) to average 1.8% per annum due to differences in asset allocation. The vast majority of tracking error stems from the System's allocations to equities and rate sensitive fixed income differing from peers. Supplemental information in the report discusses the process of determining asset class expected returns and risk, as well as a comparison to peers' expected return forecasts. However, the System's expected return exceeds the expected peer return by 0.30% per annum and the variability of that return is lower. A good portion of the 1.8% tracking error is a result of the expected peer returns being lower and more volatile.

Sources of Tracking Error
System Policy versus Peers
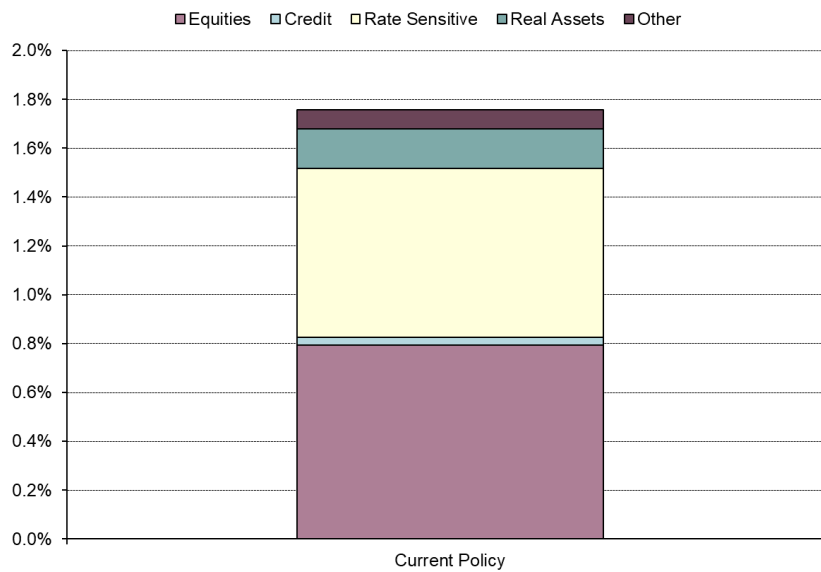
Source: Meketa Investment Group

Comparison of Asset Allocation versus Peers
## Current Allocation versus InvestorForce > $1 Billion Public DB Plan Universe
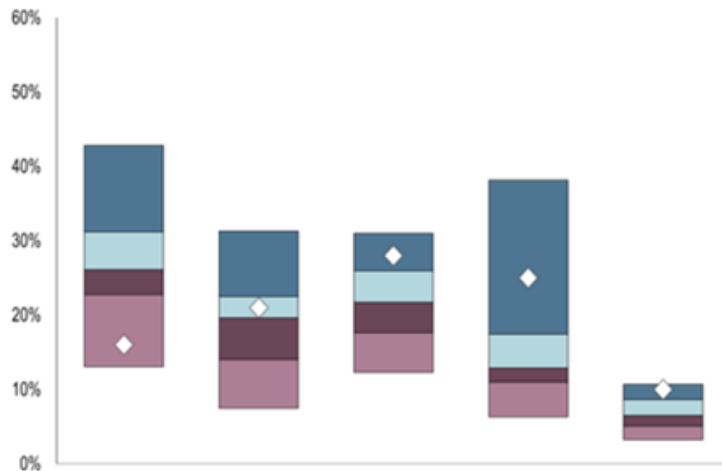
	U.S. Equity	Non-U.S. Equity	Fixed Income	Alternatives	Real estate
5th	42.8	31.3	40.0	38.2	10.7
25th	31.2	22.5	26.0	17.4	8.6
Median	26.1	19.6	21.7	12.9	6.5
75th	22.8	14.0	17.7	11.0	5.1
95th	13.1	7.5	12.3	6.3	3.2
Current Policy	16	21	28	25	10

Source: Meketa Investment Group

To complement Meketa's analysis above, the Investment Division is also able to utilize a risk budgeting tool provided by one of the System's investment managers, Bridgewater Associates, to perform an asset-liability management analysis of the strategic policy. The chart below presents a stress test of the System's funding ratio using 10-year time horizons, re-sampled every two years, since 1925. According to this analysis, using historical returns, there is a 45% chance of ending the prospective 10-year period at fully funded status, with only a 12% chance of ending at a lower funding ratio than the starting point. The table below the chart supplies additional summary information on the median, as well as the 20th and 80th percentile outcomes. It should be noted that while the median annualized total return is 9.2%, asset class returns are expected be lower over the next decade.

Historical Stress Test of Funding Ratio over 10-year Periods (1925-Present)
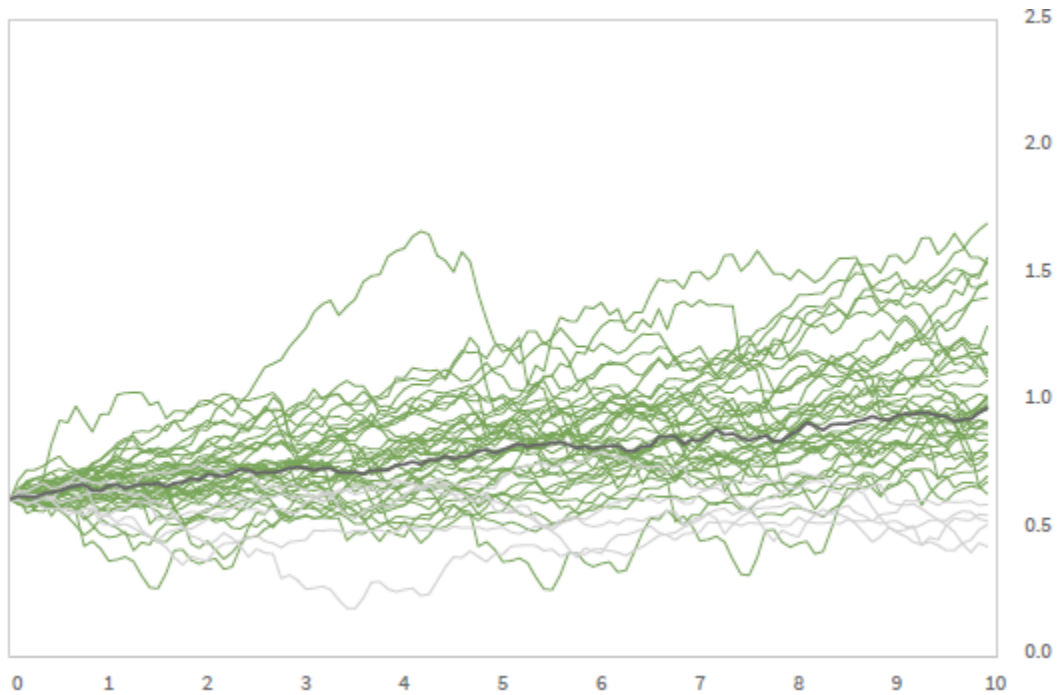
| Scenario Outcome	End Funding Ratio	Annualized Total Return
Median	1.0	9.2%
20th Percentile	0.8	6.4%
80th Percentile	1.2	11.7%

Source: Maryland State Retirement Agency, Bridgewater Associates

Climate Change Analysis

In addition to the traditional tools to evaluate the risk of not generating sufficient returns, the System has worked with Meketa to evaluate the risk that an externality such as climate change could impact the results. Meketa's supplemental climate change analysis examines the impact of a 2°C increase in global average temperature and a commensurate level of carbon dioxide emissions. The analysis estimates financial impacts across 35 risk factors in 44 asset classes that interact both directly and indirectly. The model runs more than 150 million simulations to generate a range of possible impacts of climate change on the System's portfolio over a ten-year horizon. The exhibit below shows the ten factors most impacted by rising temperatures. The impacts on the remaining factors are less pronounced.
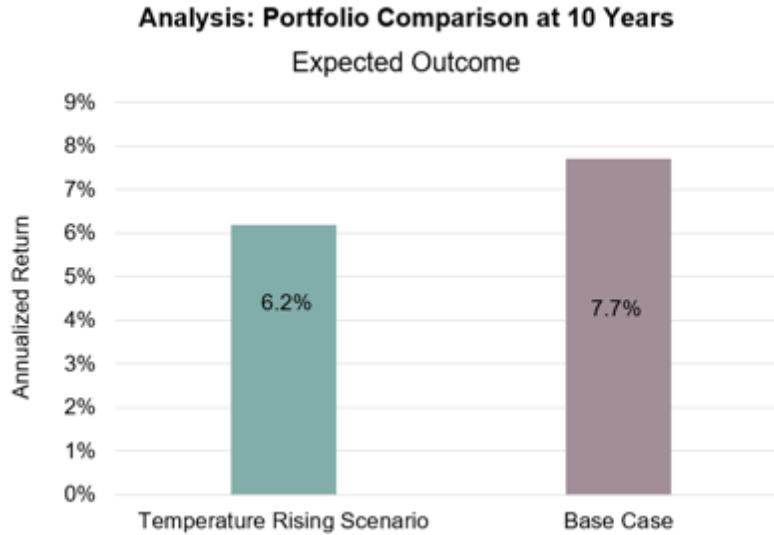
Factors Driven By Temperatures Rise By More Than 2C
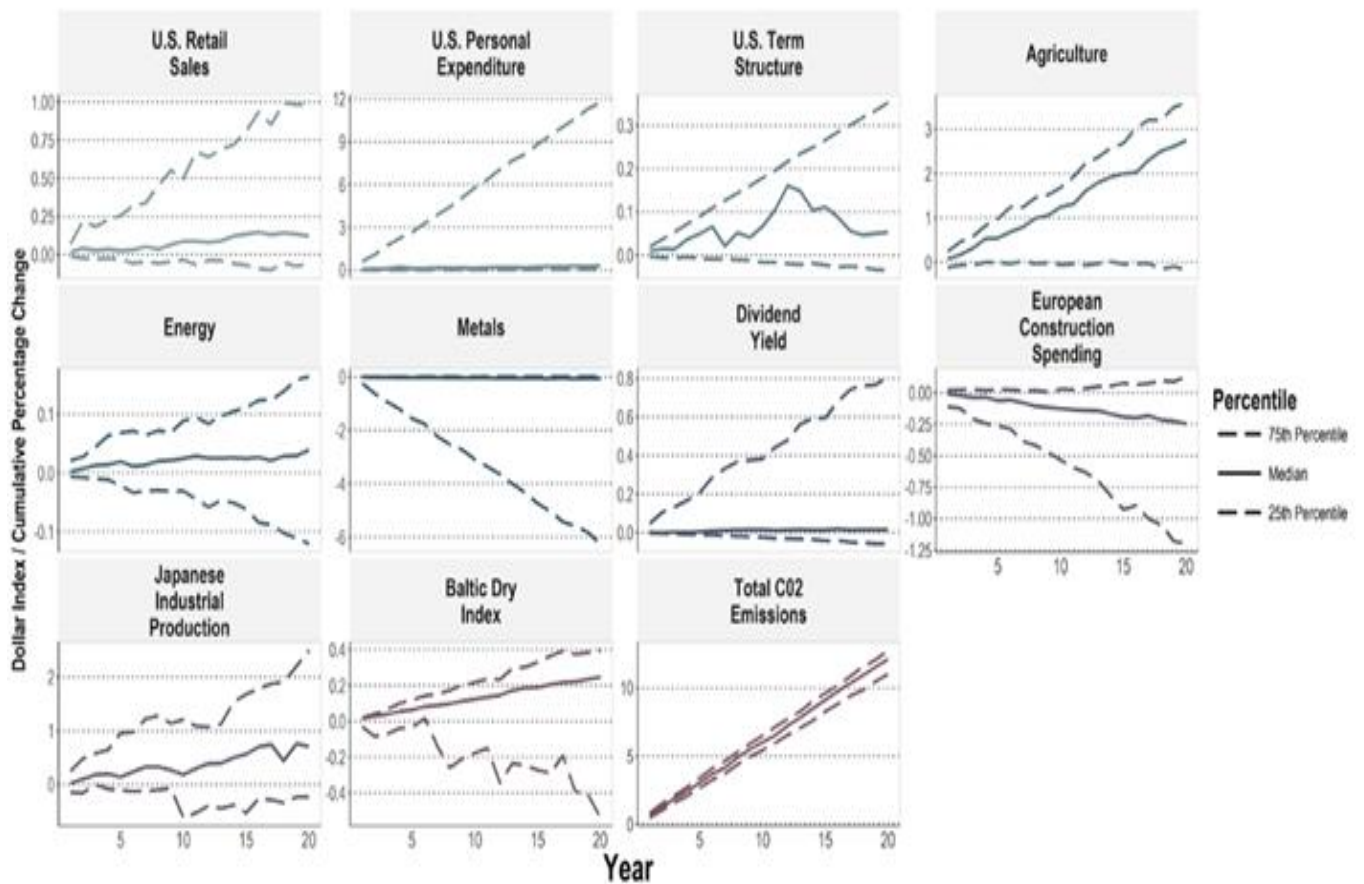
Source: Meketa Investment Group
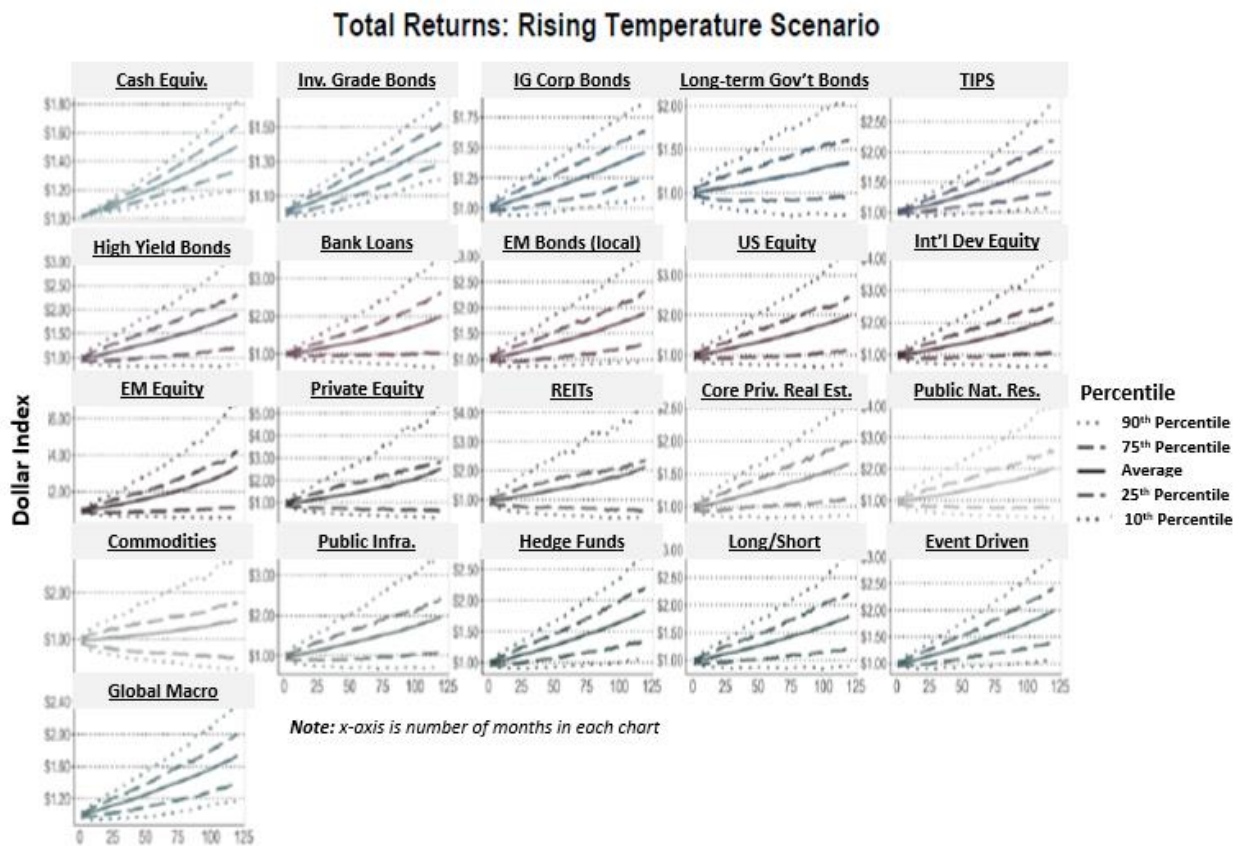
The results of the analysis imply that, although there is significant variation across asset classes and industries, the median expected return for the System is estimated to be lower than a "Base Case" scenario where global temperatures are more stable. Over the intermediate term (10-year time horizon), Meketa would expect the climate shocked portfolio to trail a base case portfolio by

approximately 1.5% per annum. However, there is a wide range of potential outcomes at the asset class level as shown below.

Analysis: Portfolio Comparison at 10 Years
Expected Outcome

Source: Meketa Investment Group

Total Returns: Rising Temperature Scenario


Note: *x-axis is number of months in each chart*

Source: Meketa Investment Group

Carbon Footprint of Public Equity Portfolio

Another tool to evaluate the risks associated with climate change is through the System's exposure to the emission of carbon. Through its risk analytics service, MSCI BarraOne, the Investment Division is able to gain insights on carbon exposure in financial markets, as well as the System's policy portfolios. MSCI ESG Carbon Metrics is a system that seeks to measure a company's carbon exposure along the dimensions of current emissions and fossil fuel reserves. The latter represents potential future emissions. MSCI and many other analytics firms continue to enhance their capabilities around measuring the carbon footprint of investment portfolios. However, the current state of the industry remains focused on public equity markets, and relies on self-reported data and extrapolations of information provided by reporting companies to non-reporting companies. As shown in the literature review section of this report, many organizations are working to broaden reporting across asset classes and improve measurement techniques.

As a function of the mix of emerging and developed economies in its strategic asset allocation, the System's public equity policy index has a greater carbon footprint than MCSI ACWI IMI, a generic global equity benchmark. The figure below displays the regional effects of the decision to adopt a public equity strategy that emphasizes emerging markets over developed economy equities. Specifically, the System's policy index is overweight Asia Pacific by 9.0% and underweight North America by 9.1% as compared to MSCI ACWI IMI. This disparity results in a carbon footprint of 176 metric tons per $1 million invested for the System's public equity policy index versus 144 metric tons per $1 million invested for MSCI ACWI IMI.

This analysis evaluates the exposure of the System's mix of equity assets relative to a public benchmark. The System's generally lower allocation to public equity may result in a lower carbon footprint than a peer plan with ACWI equity weights. Evaluating the risk of this larger footprint requires additional tools that do not yet exist, but measuring the difference is valuable in its own right.
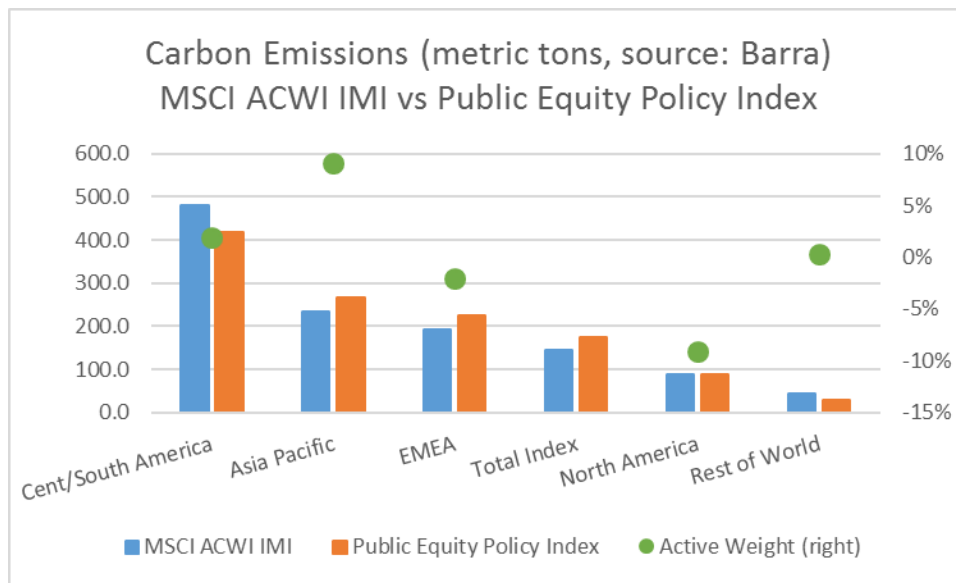
Source: Maryland State Retirement Agency, MSCI BarraOne

Implementation Risk Management

Once the Board of Trustees establishes the System's strategic asset allocation, the Chief Investment Officer, working with Investment Staff, specialty consultants and asset managers, is responsible for implementation. To capture the different types of risks associated with the implementation process, the Investment Division utilizes MSCI's x-sigma-rho methodology based on "Manager Risk Contribution: Attributing Risk in a Multi-Manager Portfolio" (Miller, Rao, 2014). The Investment Division utilizes this approach to calculate a forward-looking tracking error risk metric, which measures the variability in the difference between realized and benchmark returns, broken down according to three distinct phases of the investment process as follows:

1. Allocation risk – the risk that results from an over- or under-weight position in a particular asset class
2. Misfit risk – the risk that results from assigning a benchmark to a manager that is different from a particular asset class benchmark
3. Selection risk – the risk that results from a manager building a portfolio of securities that is different from the constitution of the assigned benchmark

The System's portfolio produces an expected tracking error, or "total active risk," of 1.06% versus the strategic policy index as of 6/30/2018, meaning that 67% of the time, the realized return will be within a range of +/- 1.06% around the benchmark return. At June 30, 2018, the vast majority – nearly 95% – of total active risk can be attributed to security selection decisions, a function of the Investment Division's belief that markets exhibit varying degrees of efficiency across asset classes and geographies, providing opportunities for skilled investors to add value. Selection risk within the Growth asset class, which includes public and private equity, constitutes the bulk of overall selection risk. Allocation risk represented slightly more than 7% of total active risk. An underweight position in Rates (Bonds) and an overweight allocation in Growth were among the primary contributors to allocation risk. Finally, misfit decisions serve to reduce total active risk largely due to the diversifying properties of benchmarks chosen for investments in the Absolute Return asset class.

Total Active Risk (basis points)

Asset class	Active weight	Allocation Risk	Selection Risk	Misfit Risk	Total Active Risk
Growth	0.09%	1	66	2	69
Rates	0.89%	3	7	2	11
Credit	-1.21%	-2	9	0	7
Real Assets	-2.03%	3	12	4	20
Absolute Return	-0.38%	-1	8	-9	-3
Multi Asset	1.66%	1	-2	0	-1
Cash	0.98%	3	0	0	3
Total	**0.00%**	**8**	**100**	**-2**	**106**

Source: Maryland State Retirement Agency, State Street, FactSet

Total Active Risk (Contribution to Risk)

Asset class	Active weight	Allocation Risk	Selection Risk	Misfit Risk	Total Active Risk
Growth	0.09%	0.60%	62.41%	1.78%	64.79%
Rates	0.89%	2.50%	6.25%	1.88%	10.63%
Credit	-1.21%	-1.45%	8.71%	-0.42%	6.85%
Real Assets	-2.03%	2.98%	11.75%	3.72%	18.45%
Absolute Return	-0.38%	-1.09%	7.18%	-8.84%	-2.75%
Multi Asset	1.66%	0.87%	-1.79%	0.00%	-0.92%
Cash	0.98%	2.94%	0.00%	0.00%	2.95%
Total	**0.00%**	**7.36%**	**94.53%**	**-1.89%**	**100.00%**

Source: Maryland State Retirement Agency, State Street, FactSet

To assess the effectiveness of this forward-looking, ex-ante tracking error, the following chart displays the tracking error forecast as of 6/30/2018 against historical realized tracking error. While actual realized tracking error generally has been below the current forecasted tracking error after the spike following the global financial crisis, the Investment Division believes the forecast is a reasonable long-term estimate supported by a bottom-up review of each manager in the System's current portfolio. Realized tracking error steadily decreased since the beginning of 2016 due in part to a market regime characterized by low volatility.

Source: Maryland State Retirement Agency, State Street, FactSet

- Liquidity Analysis: Another area where the combination of strategic asset allocation and implementation could create undo risk is liquidity. Meketa, the System's general investment consultant, evaluates the System's ability to continue to meet its cash needs amidst a weak equity market scenario. Even in an extremely negative scenario similar to the Global Financial Crisis, the System would still maintain ample liquidity to meet its near-term obligations.

Liquidity Stress Test

	Year 1	Year 2	Year 3	Year 4	Year 5
Ending Market Value ($ mm)	51,680	39,051	35,682	34,282	32,782
Net Outflows ($ mm)	1,100	1,200	1,300	1,400	1,500
Outflows as % of Market Value	2.1%	2.3%	3.3%	3.9%	4.4%
Remaining Liquid Market Value ($ mm)	40,142	30,403	27,443	26,043	24,543

Note: Remaining liquid market value includes all System assets that could be readily liquidated within 30 days. Returns in Years 1, 2 and 3 reflect asset class returns from the 4th Quarter 2007, Calendar Year 2008, and 1st Quarter 2009, respectively. Years 4 and 5 assume 0% returns in all asset classes.
Source: Meketa Investment Group

Review of Recent Studies and Actions

The State Retirement Agency staff, in conjunction with Meketa Investment Group, the Board's general consultant, conducted a review of recent studies and actions with respect to portfolio risks with the goal of identifying leading practices not currently employed that could be recommended for inclusion in the Investment Policy Manual.   As is the case with long-term returns, the primary determinant of portfolio risk is asset allocation. Academic and commercial finance professionals have been developing tools to analyze these risks for many decades. In the last decade, innovations have changed the analysis from a focus on asset class risks relating to stocks and bonds, to one of risk classes such as growth and inflation. These innovations have provided helpful insights into asset allocation but have not substantially changed the mix of assets employed. More recently, the advent of "Big Data" and artificial intelligence has offered the hope that traditional risk management tools may be used more effectively. For example, with the exception of the climate change analysis, the scenario analyses described above are only performed for a handful of potential scenarios. Enhanced computing techniques allow for a much more comprehensive set of scenarios, and artificial intelligence can improve the choice of scenarios to consider.

Much of the recent literature addressing investment risk has focused on Environmental, Social and Governance (ESG), including climate change, as investment risks that should be incorporated in the investment process. While the notion of ESG risk is not new, the measurement of ESG risk is still in its early stages. Most research focuses on risks to individual companies and industries, particularly companies with publicly traded stocks and bonds. The measurement of ESG risk at the company level is challenged by the lack of standardization in the types, level and forms of disclosure made by public companies, and the paucity of data available for private companies. Moreover, from a risk management perspective, individual company risks are best addressed at the portfolio implementation level. The industry is still developing portfolio construction tools focused on asset classes or risk classes that incorporate ESG and climate change.

Listed below are areas of research that were explored for the potential identification of leading practices, including samples of activities and research conducted by staff and Meketa Investment Group:

Risk Management and Asset Allocation

Manager Risk Contribution: Attributing Risk in a Multi-Manager Portfolio (Miller, Rao, 2014). The paper serves as the basis for the System's primary risk budgeting tool, an ex-ante estimate of tracking error decomposed into allocation, selection, and benchmark misfit risks.

Rethinking Alternative Data in Institutional Investment (Monk, Prins, Rook, 2018). The paper contemplates the opportunity for innovation in institutional investment management as new data sets emerge. The authors emphasize risk management and "organizational alpha" to improve returns through better investment and risk processes, instead of short-term alpha generation from security selection.

National Association of State Retirement Administrators Risk Survey (Meketa Investment Group, Investment Division, 2018). To assess peer institutions' risk management practices, System staff and Meketa collaborated with the National Association of State Retirement Administrators to distribute a survey to its members regarding how they analyze and mitigate risks to their investment portfolios. As

of 11/13/2018, 20 plans responded with asset levels ranging from $1.4 billion to $154.1 billion with a median of $29.0 billion (one plan declined to report its assets). As expected, risk management practices vary from one plan to another depending on asset size and staffing levels. However, all respondents placed greater emphasis on market-based risk factors versus environmental, social, and governance factors. Nearly all (19) peer plans responded that they place "significantly more" importance on market risks, while a single respondent placed "moderately more" importance on market risks.

Based on the results of the survey, the Investment Division is well positioned with respect to its risk management practices. The Chief Investment Officer and staff members spend a great deal of time reviewing the strategic asset allocation and structural risks, in conjunction with Meketa. With respect to the risks associated with tactical asset allocation and implementation, the Investment Division monitors and analyzes exposures with assistance from external risk analytics providers on a daily and monthly basis. The System is confident that its practices relating to climate risk are also competitive with peer institutions' efforts, particularly considering its small headcount relative to larger public plans.

Institutional Society of Risk Professionals (ISRP) Membership. ISRP was established in 2011 to encourage mutual cooperation with like-minded investment risk professionals. The purpose of this organization is to facilitate research and sharing of leading practices in the risk industry. The members are like-minded long-term investors with broad asset allocation mandates and similar risk management issues. The Investment Division participates on quarterly calls with other ISRP members and attends the annual conference.

State Retirement Agency contract with Cutter Associates and Funston Advisory Services to evaluate the current state of the investment process from a resource and operational perspective. The end work product of this engagement, conducted during the summer of 2017, is a strategic roadmap for cost optimization and best practices around staffing and resourcing to meet the System's evolving needs over the next ten years. This study supported the Board of Trustees' request for legislation in the 2018 session which was enacted.

When Diversification Fails (Page, Panariello, 2018). This article addresses the tendency of correlations to increase (i.e. asset prices all move in the same direction) during periods of market stress, and introduces a technique to improve the robustness of correlation estimates when returns are outside of the normal range.

MSCI US Institutional Investor Conference in Sacramento, CA – Disruptive Technologies in Finance (October 2018). The presentation offered perspectives on the potential impact of machine learning and Big Data in investment management, and sought to separate promise from hype.

The Role of Machine Readability in an AI World (SEC Keynote Address to FIMA Conference 2018). The speech outlines the challenges and misperceptions of advanced machine learning methods and stresses the importance having efficient methods to format and assimilate increasingly large amounts of data.

A Survey and Review of Asset Allocation & Best Practices (Frank Benham, Meketa Investment Group, Maryland Retirement and Pension System Board of Trustees Education Day, 2018). This presentation explained common approaches to asset allocation, including the process of setting capital markets expectations and addresses common critiques of traditional methodologies. Meketa and the

Investment Division also developed a survey to gauge how other plans conduct asset allocation with the results included in the presentation.

High Dimension Optimization: A New Framework for an Interconnected World (Meketa Investment Group, 2018). This memorandum introduces a technique that expands upon mean variance optimization, a widely used approach that seeks to identify an appropriate trade-off between return and the volatility of the return. Meketa believes that high dimension optimization is a more effective approach that allows investors to consider many different trade-offs simultaneously, rather than the traditional method of analyzing a small number of representative alternatives.

The Importance of System Risk Measurement: Stress Testing and Other Methods (Brad Armstrong, Brian Murphy, Jeffrey Tebeau, GRS Retirement Consulting, Maryland Retirement and Pension System Board of Trustees Education Day, 2018). This presentation provides an overview of risk measurement from an actuarial perspective and provides examples of maturity measures, scenario analysis, stress testing, stochastic modeling, and other techniques.

<u>Environmental, Social, and Governance</u>

MSRA Response to climate change Inquiry from the Joint Committee on Pensions. As part of the System's response to the Joint Committee on Pensions inquiry regarding climate change on 9/16/2016 (updated 10/17/2016), the Investment Division conducted a survey of US state public pension plans. The goal of the survey was to determine how other U.S. state public pension plans are addressing climate change risks.

Governance Engagement Activities. In addition to voting proxies, the System has the ability to contact (engage) the management of individual companies in support of initiatives consistent with proxy voting policies. During the 2018 fiscal year, the System participated in engagement activities in support of reduced carbon emissions by signing the Climate Action 100+ initiative. The objective of the initiative is to engage and encourage more than 100 companies to curb emissions, strengthen climate-related financial disclosures and improve governance on climate change risks. In addition, the System joined the 30% Coalition letter campaign with other pension plans to engage with companies that have less than two women on their board. The System also joined the Council of Institutional Investors and many other pension plans to discourage federal lawmakers from supporting the Financial Choice Act, which threatened shareholder rights such as shareholder proposals and voting on executive compensation.

Consultation with the Center for Global Sustainability at the University of Maryland School of Public Policy. The Agency has been in contact with the Center for Global Sustainability ("CGS") to stay abreast of the latest research and trends. According to its website, CGS "informs global, national, and local discussions on policy matters aimed to further a robust and sustainable global economy with a stable climate. The research of CGS is organized around four focus areas including climate policy, energy pathways, health & ecosystems, and adaption & resilience. CGS pointed to the Task Force on Climate-related Financial Disclosures' 2018 status report. Consistent with other studies reviewed by the Agency, this report offers "recommendations for disclosing clear, comparable and consistent information about the risks and opportunities presented by climate change." CGS also shared a data product recently released by Four Twenty Seven, a risk analytics provider, and real estate technology company, GeoPhy, which allows users to analyze the impact of climate change on real estate investment trusts.

Consultation with United Nations Principles for Responsible Investing. The System is a UNPRI Signatory, having joined in April 2018. As a signatory, the Investment Division is required to submit an annual report that highlights the System's activities and approach to assessing and managing ESG related risks. The System's ESG Risk Committee report details the Investment Division's activities and goals with respect to responsible investing and managing ESG related risks. The Investment Division, as needed, will reach out to UNPRI regarding best practices on certain issues.

To date, UNPRI has only been able to provide information and research on a portion of the System's total plan assets, primarily related to publicly traded securities. The Investment Division met with UNPRI representatives on November 8, 2018 to discuss the Agency's 2018 "PRI Assessment" report and disclosures. Investment Staff will continue to collaborate with UNPRI to ensure its activities and goals with respect to responsible investing and managing ESG related risks are transparent and properly reported.

CalPERS study. Professor Brad Barber of the University of California Davis made a presentation to CalPERS Investment Committee on 6/19/2017. He provided an overview of academic literature relating to ESG and noted there is industry consensus regarding theoretical framework and empirical evidence with respect to governance, but not the environmental and social factors. The Investment Division contacted CalPERS and requested information on their process to integrate ESG risk considerations into their total plan risk assessment/asset allocation. To date, they have used standard ESG data vendors' tools for certain asset classes. They have not yet developed a total fund risk assessment/asset allocation approach that incorporates ESG related risks.

Collaboration with the New Jersey Division of Investment. The Investment Division collaborated with the New Jersey Division of Investment in support of New Jersey's project to incorporate sustainable investment into their process. The Investment Division staff shared the System's process with respect to ESG risk management, and what it has accomplished to date, including the establishment of an ESG Risk Committee.

Sustainability Accounting Standards Board Membership (SASB). The System joined the SASB Alliance in 2018. This membership program is designed to develop and explore best practices to integrate material sustainability information into existing processes. Investment Division staff will attend the SASB Symposium 12/4/2018.

MIT Aggregate Confusion Project. As part of the MIT Sloan Sustainability Initiative, the project aims to improve the measurements of environmental impact, labor practices, social impact, product safety, and governance. The project's first paper had not been published at the time of this writing, but the Investment Division will review upon its release.

Intergovernmental Panel on Climate Change (IPCC). An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

The ESG Integration Paradox (Capucci, 2017). The paper addresses the question, "If the greatest benefits of ESG incorporation are achieved only through the full integration of ESG factors into the investment process, why have so few investment managers adopted the strategy?"

Environmental Risk Analysis by Financial Institutions – A Review of Global Practice, an input paper for the G20 Green Finance Study Group (University of Cambridge Institute for Sustainability Leadership, 2016). The Green Finance Study Group (GFSG) aims to identify institutional and market barriers to green finance and, based on country experiences and best practices, analyze options on how to enhance the ability of the financial system to mobilize private green investment, thereby facilitating the green transformation of the global economy. The GFSG asked the Cambridge Centre for Sustainable Finance for a global assessment of the tools and techniques that financial institutions are developing to analyze environmental risks. This paper is the output of the request.

Recommendation of Best Practices for the Investment Policy Manual

The Board of Trustees regularly reviews and updates the Investment Policy Manual in consultation with the Investment Division. Several recent revisions have been made to enhance the policies and procedures with respect to risk management, as well as corporate governance and proxy voting. The risk management section provides the purpose, asset allocation, analytical measures, non-market risks, liquidity risk, counterparty risk, and leverage risk.

In addition, the corporate governance and proxy voting section addresses the following topics:

1. Board of Directors
2. Shareholder Rights and Defenses
3. Capital/Restructuring
4. Compensation
5. Social/Environmental Issues
   a. Animal Rights
   b. Consumer Issues
   c. Climate Change and the Environment
   d. Diversity
   e. General Corporate Issues
   f. International Issues, Labor Issues, and Human Rights
   g. Sustainability
6. Routine/Miscellaneous

After reviewing the System's risk management processes in comparison with the leading practices of peers and new research from academic literature, it appears the System engages in leading practices concerning the evaluation and management of risks associated with the investment of System assets. While there are no recommendations of best practices to incorporate in the Investment Policy Manual at this time, the Board of Trustees and the Investment Division will continue to review studies and actions of other market participants to ensure the System's policies and procedures incorporate leading practices to the extent practicable.