
To: Board of Trustees of Municipal Employees' Annuity & Benefit Fund of Chicago ("MEABF")
From: Marquette Associates Inc. ("Marquette")
Date: September 21, 2017
Re: Scenario Analysis

In September 2017, Marquette generated a Scenario Analysis for the MEABF Target Portfolio, per the Investment Policy Statement approved on February 23, 2017. The Scenario Analysis, also known as a stress test, is designed to evaluate portfolio performance during adverse market conditions. The Scenario Analysis incorporates estimated annual net cash flows for 2018-2022, based on the most recent actuarial report and newly projected city contributions.

In each historical and hypothetical scenario, the effected time period is supplemented with the baseline scenario in the following years. For example, the 2008 Financial Crisis scenario features 17 months of the historical market conditions (mimicking October 2007 through February 2009), followed by 43 months of the baseline scenario to complete the full five-year analysis.

All scenarios profiled, including the baseline, show a significant erosion of MEABF assets over the five-year period.

Key takeaways from the analysis:

- The largest risk is adverse equity markets as highlighted by the historical scenario of the 2008 Financial Crisis, or the flat market scenario.
- The Fund is less susceptible to significant rises in interest rates.
- Given the negative cash flow profile of the Fund, there is a risk of severe impairment. Most significantly, a repeat of the 2008 financial crisis could reduce the assets to less than \$1 billion over a five-year period.
- For the hypothetical scenarios, the most significant exposure to asset impairment is in negative equity markets, such as the equity decline and perfect storm scenarios, which can reduce assets to under \$1.5 billion over five years.

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About Marquette Associates

Marquette Associates is an independent investment consulting firm that helps institutions guide investment programs with a focused three-point approach and carefully researched advice. For more than 30 years, Marquette has served this mission in close collaboration with clients – enabling institutions to be more effective investment stewards. Marquette is a completely independent and 100% employee-owned consultancy founded with the sole purpose of advising institutions. For more information, please visit www.marquetteassociates.com.



Scenario Analysis

Chicago Municipal

Pension

September 20, 2017

Description of Scenario Analysis

This scenario analysis, also known as a stress test, is designed to evaluate portfolio performance during adverse market conditions.

This analysis examines portfolio performance under a variety of worst case scenarios to help our clients understand the downside risks in their portfolios. Unlike our asset allocation studies, which are stochastic and thus provide a range of potential outcomes, this stress test runs deterministic scenarios. As a result there is only a single outcome for each portfolio per scenario. Given that this analysis is designed to look at only stress scenarios instead of the full market cycle, this stress test examines the portfolios over a 3 year time frame, rather than the ten year investment horizon utilized in our asset allocation studies. The stress scenarios are described on the next page and are based on either actual historical events or hypothetical scenarios which further identify portfolio risks.

It is important to note some of the limitations of this analysis, particularly the hypothetical scenarios. While our model incorporates average correlations between asset classes, this can vary depending on what's happening in the market. This is especially true when financial markets are in flux. For example, while we expect international equities to decline in a similar matter to domestic equities, the possibility exists - though unlikely - for the next bear market to be concentrated in the U.S. Every market downturn has its own unique nuances, so while these scenarios demonstrate what might happen and how they could affect a portfolio, it is critical that the investor understands the unpredictable nature of financial markets and that any downturn will not exactly match our generic scenarios.

Description of Stress Scenarios

- **Baseline:** Normal market conditions. Note the results of this scenario may differ from the asset allocation study: the asset allocation study is a stochastic Monte Carlo simulation whereas the stress scenarios are deterministic.

Historical Scenarios

- **2008 Financial Crisis (October 2007 – Feb 2009):** The financial crisis of 2007–09 is considered by many economists to have been the worst financial crisis since the Great Depression of the 1930s. It threatened the collapse of large financial institutions, which was prevented by the bailout of banks by national governments, but stock markets still dropped worldwide. Equities around the world dropped 40% - 50% and the 10-year U.S. Treasury fell from 4.5% to 3.1%.
- **Black Monday (October 1987):** On Monday, October 19, 1987, stock markets around the world crashed. The crash began in Hong Kong and spread west to Europe, hitting the United States after other markets had already declined by a significant margin. The Dow Jones Industrial Average (DJIA) fell exactly 508 points to 1,738.74 (-22.6%) and the 10-year U.S. Treasury dropped from 9.6% to 8.9%.
- **2011 U.S. Debt Ceiling Crisis and Downgrade (June through September 2011):** The United States debt-ceiling crisis of 2011 was a stage in the ongoing political debate in the United States Congress about the appropriate level of government spending and its effect on the national debt and deficit. Ultimately, this led to the credit-rating agency Standard & Poor's downgrading the credit rating of the United States government for the first time in the country's history. The S&P 500 declined by almost 15%.
- **1994 Interest Rate Spike (December 1993 - December 1994):** Yields on 30-year Treasuries jumped some 200 basis points in the first nine months of the year, hammering investors and financial firms. The accepted story is that an over-eager Federal Reserve raised interest rates too soon. Equities fell slightly with the S&P 500 down 1.5%.
- **1981 Interest Rate Spike (July 1980 – July 1981):** The 1970's and early 80's featured stagnant growth coupled with high inflation (i.e. stagflation). In an effort to help contain the rampant inflation, the newly elected Fed Chairman, Paul Volcker, undertook a rapid series of rate hikes. While this process was ultimately successful - inflation dropped from 14.8% in March of 1980 all the way down to 3% by 1983 - the rapid rates decimated many fixed income investors, as the 10-year U.S. Treasury yield rose from 10.3% to 14.3%. However, equities were strong during this time, with the S&P 500 up over 7.5%.

Hypothetical Scenarios

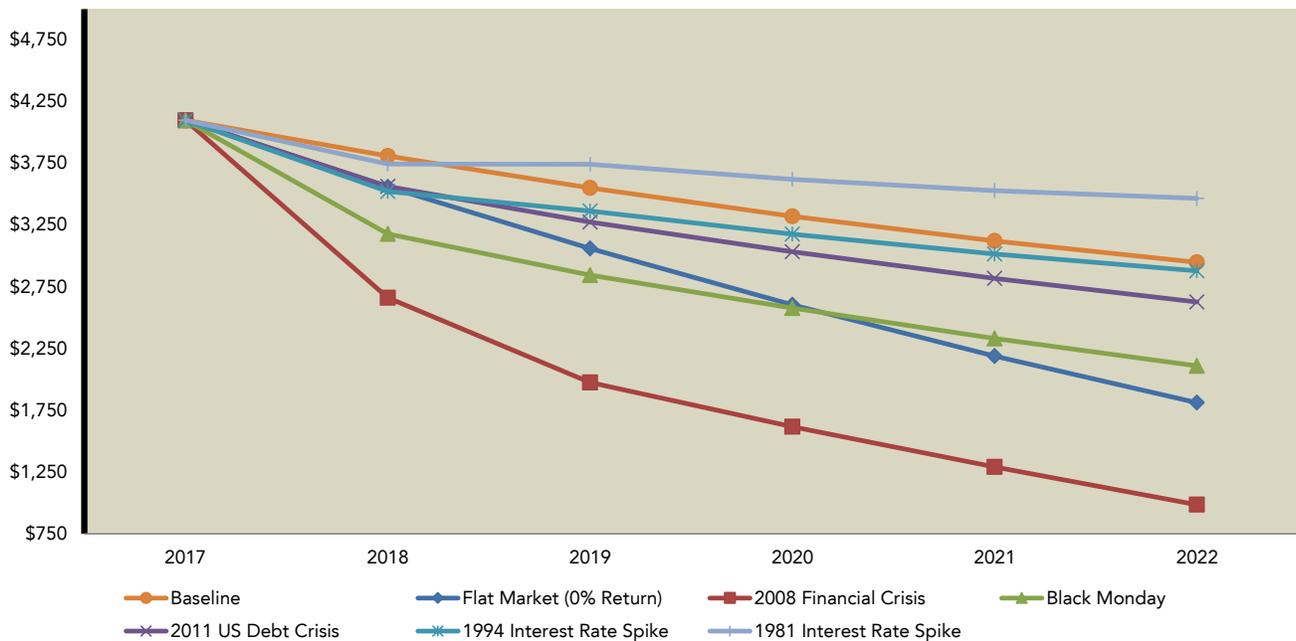
- **Interest Rates Rise 1% for 1 Year:** Treasuries up 1% in year 1 and flat in years 2 and 3.
- **Interest Rates Rise 1% Annually for 3 Years:** Treasuries up 1% for each of the 3 years.
- **Equities Decline 20% for 1 Year:** This is the definition of a bear market. Assumes that corporate spreads widen out by 1% as well, which is roughly the average spread change during equity downturns. Equities are as expected for years 2 and 3, while spreads remain unchanged.
- **Equities Decline 15% Annually for 3 Years:** Equities fall 15% in each of the 3 years with corporate spreads widening 1% each year. This is designed to model out a prolonged downturn in the market.
- **Perfect Storm for 1 Year:** Treasuries and spreads increase 1% in year 1, flat in years 2 and 3. Equities fall 20% in year 1 and as are expected for year 2 and 3.
- **Perfect Storm for 3 Years:** Treasury and spreads increase 1% in each of the 3 years. Equities fall 15% each year.

Portfolio Options

Asset Class	Policy Targets
Broad Fixed Income	17.0%
High Yield	5.0%
Bank Loans	5.0%
Total Fixed Income	27.0%
US Large-Cap Core	12.0%
US Large-Cap Value	2.0%
US Large-Cap Growth	2.0%
US Mid-Cap Growth	5.0%
US Small-Cap Value	5.0%
Total U.S. Equity	26.0%
Developed Large-Cap	12.0%
Non-US Small-Cap	5.0%
Emerging Market	5.0%
Total Non-U.S. Equity	22.0%
Defensive Equity	5.0%
Hedge Fund - FOF	5.0%
Total Hedge Funds	10.0%
Real Estate - Core	10.0%
Total Real Assets	10.0%
Private Equity - Fund of Funds	3.0%
Private Equity Mezzanine	2.0%
Total Illiquid Assets	5.0%

Historical Scenario Analysis: Policy Targets

Estimated Market Value Projections by Event (\$ Millions)



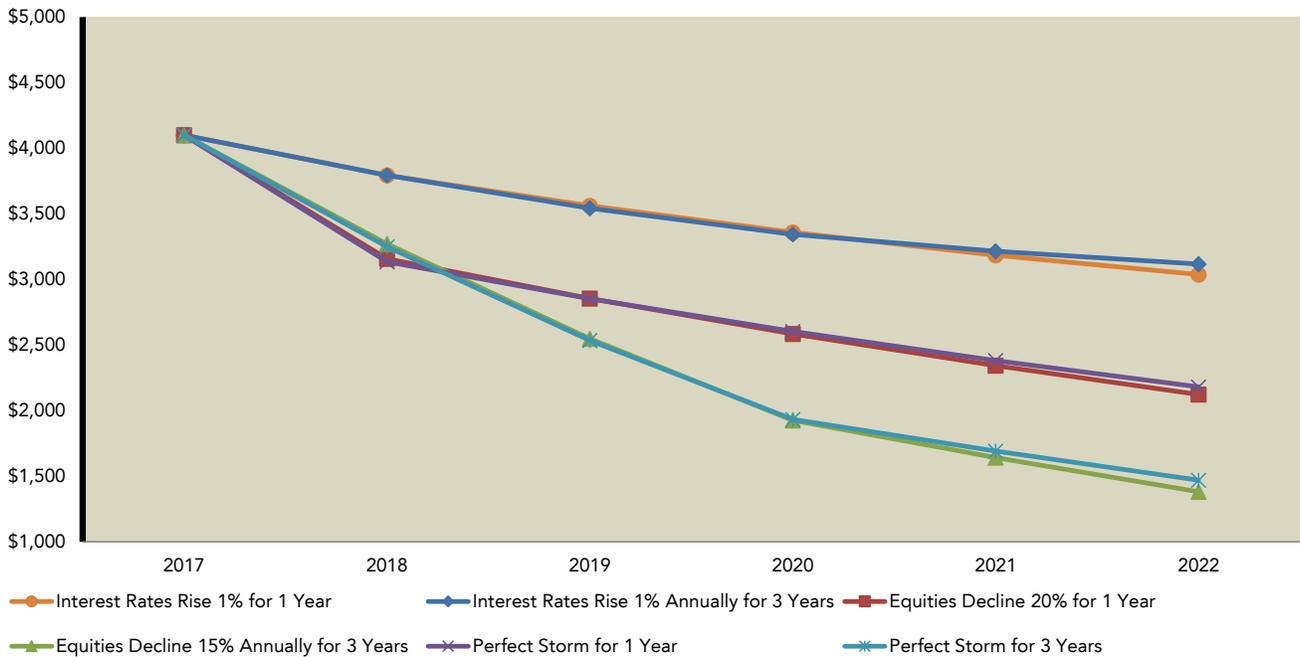
Forecasted Market Values (\$ Millions)

	2017	2018	2019	2020	2021	2022
Baseline	\$4,100.0	\$3,809.8	\$3,551.6	\$3,322.3	\$3,122.3	\$2,948.9
Flat Market (0% Return)	\$4,100.0	\$3,558.9	\$3,061.7	\$2,604.7	\$2,189.0	\$1,812.1
2008 Financial Crisis	\$4,100.0	\$2,662.3	\$1,975.4	\$1,618.6	\$1,291.3	\$985.5
Black Monday	\$4,100.0	\$3,180.0	\$2,845.1	\$2,577.6	\$2,332.9	\$2,110.4
2011 US Debt Crisis	\$4,100.0	\$3,563.3	\$3,275.6	\$3,035.3	\$2,819.6	\$2,627.8
1994 Interest Rate Spike	\$4,100.0	\$3,523.4	\$3,364.9	\$3,178.0	\$3,016.3	\$2,879.7
1981 Interest Rate Spike	\$4,100.0	\$3,745.0	\$3,742.6	\$3,621.4	\$3,529.2	\$3,467.0

Projected Portfolio Returns by Event

	Cummulative					Annualized 5 Year
	Year 1	Year 2	Year 3	Year 4	Year 5	
Baseline	6.1%	12.8%	20.0%	27.8%	36.1%	6.4%
2008 Financial Crisis	-21.9%	-27.4%	-23.8%	-19.6%	-15.2%	-3.2%
Black Monday	-9.2%	-4.6%	1.7%	8.5%	15.7%	3.0%
2011 US Debt Crisis	0.1%	6.0%	13.0%	20.4%	28.4%	5.1%
1994 Interest Rate Spike	-0.9%	8.7%	17.4%	26.8%	36.9%	6.5%
1981 Interest Rate Spike	4.5%	18.4%	29.0%	40.5%	53.0%	8.9%

Estimated Market Value Projections by Event (\$ Millions)



Forecasted Market Values (\$ Millions)

	2017	2018	2019	2020	2021	2022
Interest Rates Rise 1% for 1 Year	\$4,100.0	\$3,793.1	\$3,561.8	\$3,358.5	\$3,184.5	\$3,037.3
Interest Rates Rise 1% Annually for 3 Years	\$4,100.0	\$3,793.1	\$3,542.9	\$3,342.6	\$3,215.9	\$3,116.7
Equities Decline 20% for 1 Year	\$4,100.0	\$3,157.0	\$2,854.3	\$2,585.2	\$2,342.2	\$2,122.5
Equities Decline 15% Annually for 3 Years	\$4,100.0	\$3,269.7	\$2,548.9	\$1,926.3	\$1,642.0	\$1,381.4
Perfect Storm for 1 Year	\$4,100.0	\$3,134.3	\$2,853.4	\$2,604.5	\$2,381.2	\$2,180.8
Perfect Storm for 3 Years	\$4,100.0	\$3,248.6	\$2,534.4	\$1,932.6	\$1,690.7	\$1,469.7

Projected Portfolio Returns by Event

	Cumulative					Annualized 5 Year
	Year 1	Year 2	Year 3	Year 4	Year 5	
Interest Rates Rise 1% for 1 Year	5.7%	13.1%	21.2%	29.9%	39.3%	6.8%
Interest Rates Rise 1% Annually for 3 Years	5.7%	12.6%	20.8%	31.2%	42.5%	7.3%
Equities Decline 20% for 1 Year	-9.8%	-4.2%	2.1%	8.9%	16.2%	3.0%
Equities Decline 15% Annually for 3 Years	-7.1%	-13.4%	-19.0%	-13.5%	-7.4%	-1.5%
Perfect Storm for 1 Year	-10.4%	-4.2%	2.8%	10.4%	18.6%	3.5%
Perfect Storm for 3 Years	-7.6%	-13.7%	-18.7%	-11.4%	-3.2%	-0.6%