

Investment Risk Reduction

MILLIMAN FINANCIAL RISK MANAGEMENT WHITE PAPER Q1 2020

SUMMARY

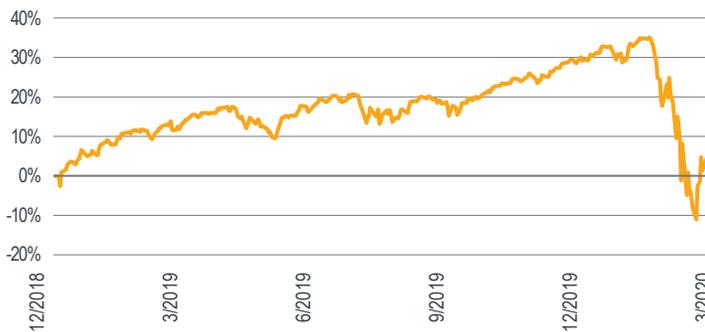
The market contraction at the onset of the coronavirus pandemic in Q1 2020 was the biggest test of risk-managed investment products since the 2008 financial crisis. This paper puts the downturn into historical context and examines how Milliman FRM's products performed.

MARKET CONTEXT

After posting one of its best calendar-year returns in recent decades, the S&P 500 continued to climb in early 2020, even amidst growing uncertainty about the spread and nature of COVID-19.

After reaching its all-time high on February 19, the S&P 500 embarked on a descent that lasted 23 trading days and left the index 34% lower, reducing its market cap by \$9.8 trillion and fully erasing the gain from 2019:

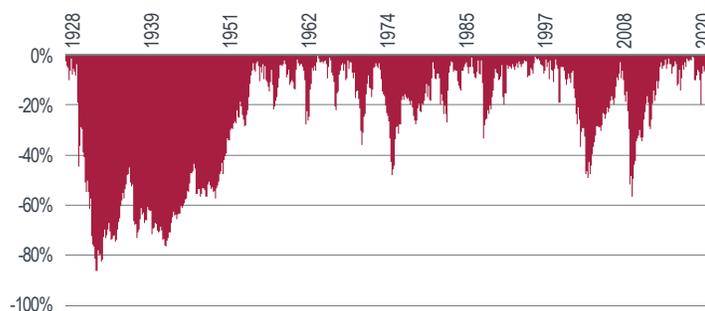
S&P 500 Cumulative Return



Source: Bloomberg

Over the past century, the stock market has experienced multiple drawdowns that exceeded 30%, but none was as swift as the drawdown during Q1 2020.

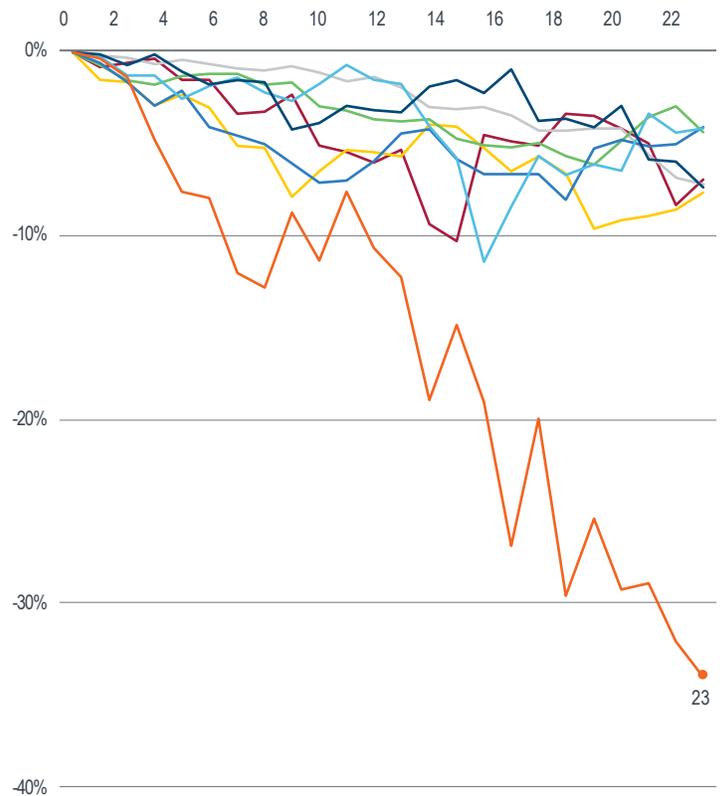
S&P 500 Historical Drawdowns



Source: Bloomberg

The severity of the Q1 2020 drawdown is illustrated by the fact that none of the other drawdowns that exceeded 30% were down more than 10% at their 23rd day:

Historic S&P 500 Drawdowns (23 days in)



■ September 1929 ■ March 1937 ■ November 1968 ■ January 1973
■ August 1987 ■ March 2000 ■ October 2007 ■ February 2020

Start Date	9/16/1929	3/10/1937	11/29/1968	1/11/1973	8/25/1987	3/24/2000	10/9/2007	2/19/2020
Full Drawdown	-86%	-60%	-36%	-48%	-34%	-49%	-57%	-34%

Source: Bloomberg

As is generally the case during severe drawdowns, volatility during the second half of Q1 2020 was exceptionally high, with daily returns as high as 9% and as low as -12%.

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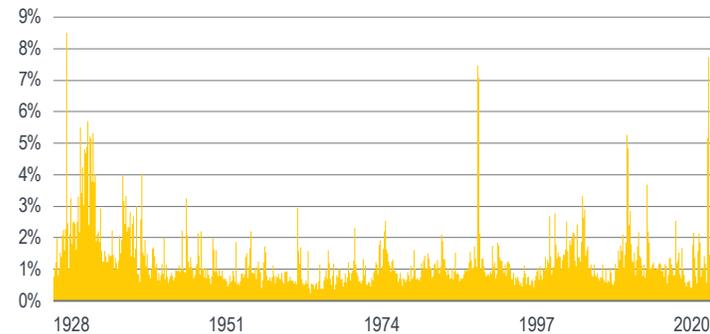
S&P 500 Daily Change (2019 - Q1 2020)



Source: Bloomberg

For the seven trading days ended on March 17, the S&P 500 experienced an average daily absolute change of 7.7%, a level exceeded only in 1929 at the onset of the great depression.

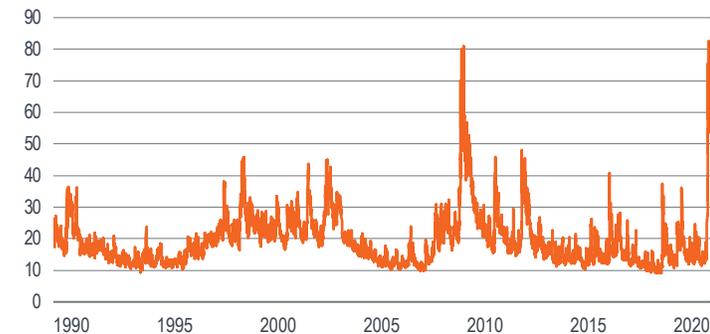
S&P 500 7-Day Average (Daily Absolute Change)



Source: Bloomberg

The options market was also pricing in record levels of volatility, pushing the Cboe Volatility Index (VIX) through its previous all-time high from 2008.

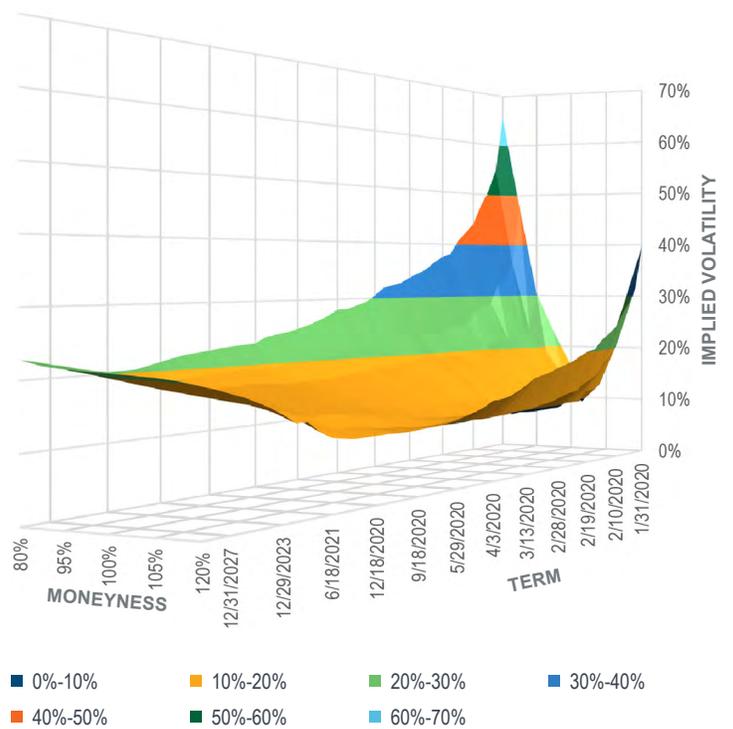
VIX Index



Source: Bloomberg

As late as the end of January, the near-term moneyness structure was exhibiting a smirkish smile that is often characteristic of option markets during periods of relative calm.

S&P 500 Volatility Surface on January 29

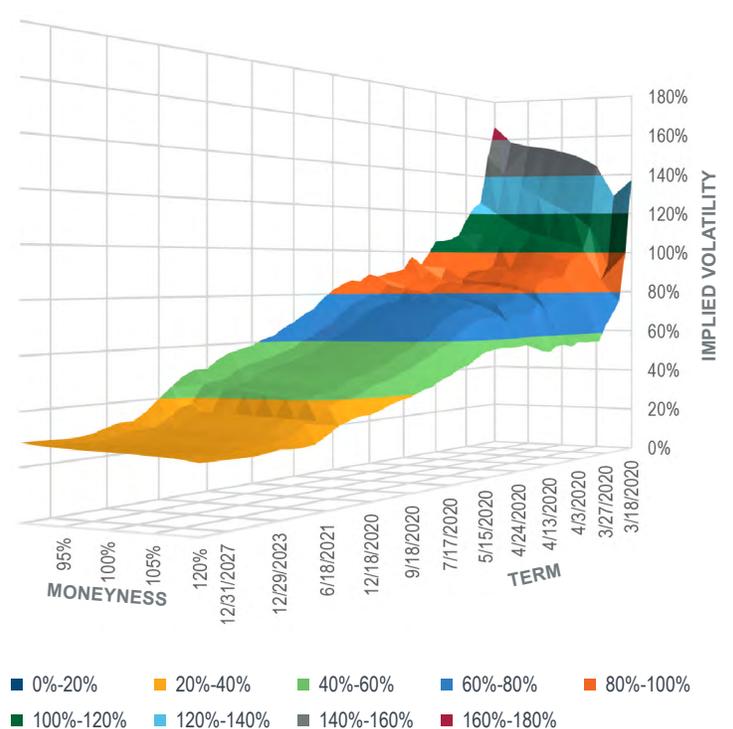


- 0%-10%
- 10%-20%
- 20%-30%
- 30%-40%
- 40%-50%
- 50%-60%
- 60%-70%

Source: Bloomberg

By mid-March, vol's term structure had shifted higher and steeper across the moneyness spectrum:

S&P 500 Volatility Surface on March 16



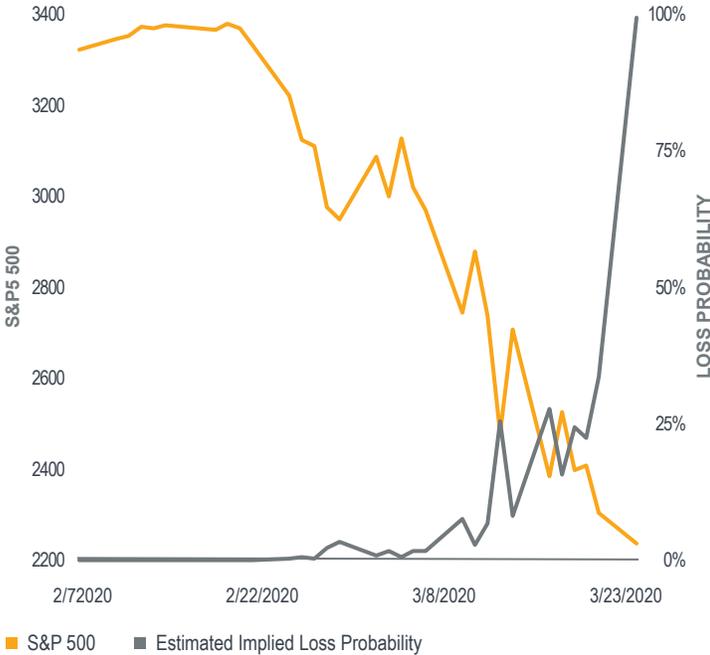
- 0%-20%
- 20%-40%
- 40%-60%
- 60%-80%
- 80%-100%
- 100%-120%
- 120%-140%
- 140%-160%
- 160%-180%

Source: Bloomberg

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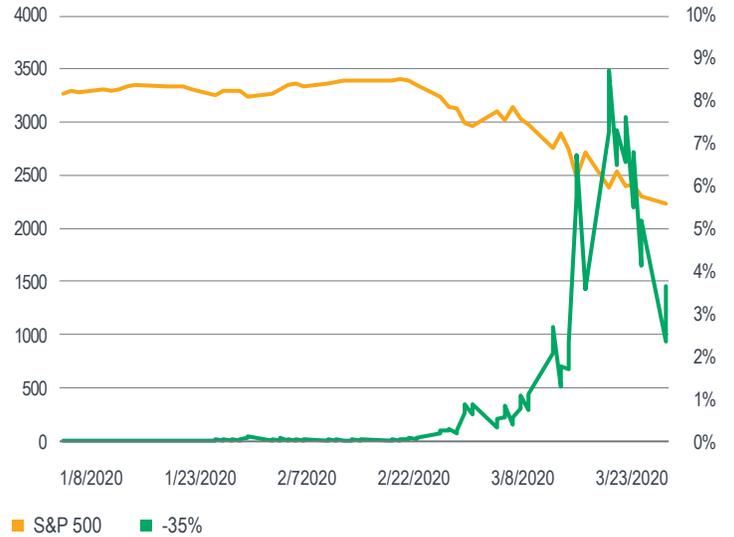
As part of our ongoing research and analysis of the option market, we estimate the option-implied probability of drawdowns of varying magnitude. Throughout January and most of February, our research of option prices indicated virtually no probability of a 30% drawdown occurring by the end of March. This indicates that even option markets, which can sometimes anticipate severe drawdown risk, didn't expect markets to go down by as much as they did.

Estimated Option-Implied Probability of S&P 500 Closing at 2337.40 (30% drawdown on the January 1 value) or Lower on 3/23/2020



Source: Bloomberg and calculations by Milliman FRM

Option-Implied Probability of 35% S&P 500 Drawdown at Evergreen 29-36 Day Horizon



Source: Bloomberg and calculations by Milliman FRM

This historically swift drawdown and high volatility put our risk management products to the test. What follows is a description of our various products and an overview of how they fared. Spoiler alert: they did what they were designed to do.

RESULTS BASED ON SIMULATED OR HYPOTHETICAL PERFORMANCE RESULTS HAVE CERTAIN INHERENT LIMITATIONS. UNLIKE THE RESULTS SHOWN IN AN ACTUAL PERFORMANCE RECORD, THESE RESULTS DO NOT REPRESENT ACTUAL TRADING. ALSO, BECAUSE THESE TRADES HAVE NOT ACTUALLY BEEN EXECUTED, THESE RESULTS MAY HAVE UNDER-OR OVER-COMPENSATED FOR THE IMPACT, IF ANY, OF CERTAIN MARKET FACTORS, SUCH AS LACK OF LIQUIDITY. SIMULATED OR HYPOTHETICAL TRADING PROGRAMS IN GENERAL ARE ALSO SUBJECT TO THE FACT THAT THEY ARE DESIGNED WITH THE BENEFIT OF HINDSIGHT. NO REPRESENTATION IS BEING MADE THAT ANY ACCOUNT WILL OR IS LIKELY TO ACHIEVE PROFITS OR LOSSES SIMILAR TO THESE BEING SHOWN. MILLIMAN DOES NOT MANAGED THE UNDERLYING FUND.

Milliman Financial Risk Management Products: Risk Reduction in Q1 2020

AGGREGATE DERIVATIVES AND EQUITY TRADES —NOTIONAL TRADED AND POSITIVE P&L GENERATED

In addition to creating investment risk management products, Milliman FRM also implements them through its global trading teams located in Chicago, London, and Sydney. As the market began to decline and volatility began to rise in late February, our traders executed hundreds of trades, totaling billions of dollars in notional amounts, across a variety of instruments and markets, including ETFs, options and futures.

Over the course of 23 trading days between February 19 through March 23, Milliman FRM traded futures contracts across 11 different markets, totaling \$21.5 billion in notional volume for our fund-based products. This activity contributed to a reduction in both volatility and in downside participation, resulting in a net positive P&L of \$3.5 billion for our clients.

Amongst the contracts traded, the S&P 500 e-mini represented the largest share, with \$12.8 billion in notional volume, and generating a positive P&L of \$2 billion. Other contracts traded included the EuroSTOXX 500, S&P Mid 400, e-mini Russell, FTSE 100, MSCI EM, MSCI EAFE, Topix and Nikkei 225. In spite of the challenging market conditions and extreme market turbulence, Milliman FRM continued to manage all products per client mandates. Milliman FRM traders remained focused on achieving best execution for hedging programs and products by monitoring market conditions, and maintaining close contact with all the top tier banks/brokers and FCMs with whom we work and carry out trading.

THE MILLIMAN MANAGED RISK STRATEGY® (MMRS)

is a customizable dynamic portfolio risk management strategy that seeks to:

- Prevent portfolio volatility from exceeding a designated threshold
- Capture long-term growth in up markets
- Defend against losses during sustained market declines

MMRS consists of two integrated and flexible components, volatility management and capital protection, that work in tandem to pursue the strategy objectives.

To examine MMRS' Q1 2020 performance, we look here at the S&P 500 Managed Risk 2.0 Index as a proxy. This index incorporates many of the same features used in MMRS and is used as a benchmark for investment products that integrate MMRS.

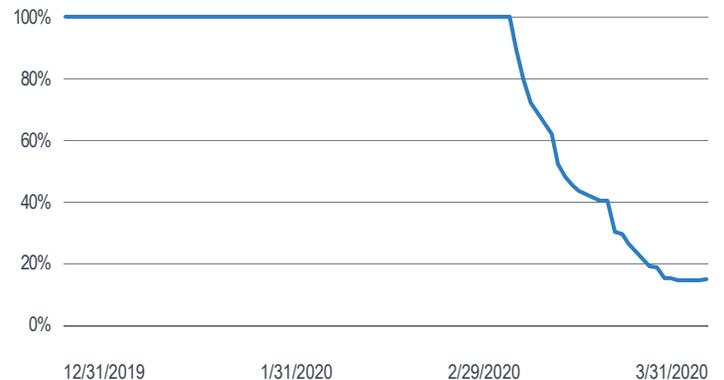
The **S&P 500 Managed Risk 2.0 Index (MR 2.0)** is composed of the S&P 500 Index, the S&P U.S. Treasury Bond Current 5-Year Index, and the S&P U.S. Treasury Bill 0-3 Month Index. The allocations to the underlying indexes are based on their

realized volatilities and are calculated to prevent the volatility of the MR 2.0 Index from exceeding its threshold of 22%.

The MR 2.0 Index also employs a capital protection strategy that produces an additional cushion against losses during significant and sustained market declines. This is achieved through tail hedging rooted in dynamic put option replication techniques.

Analysis: Year-to-date through the S&P 500 all-time high on February 19, MR 2.0 maintained a 100% allocation to equities and fully participated in the S&P 500's ascent. As equity market volatility began to increase above the MR 2.0 22% volatility threshold, the fund began to allocate out of the S&P 500 Index and into the S&P U.S. Treasury Bond Current 5-Year Index. Its first deallocation reduced its equity exposure on February 27 by its daily maximum of 10 percentage points and was followed up with an identical reduction the next day.

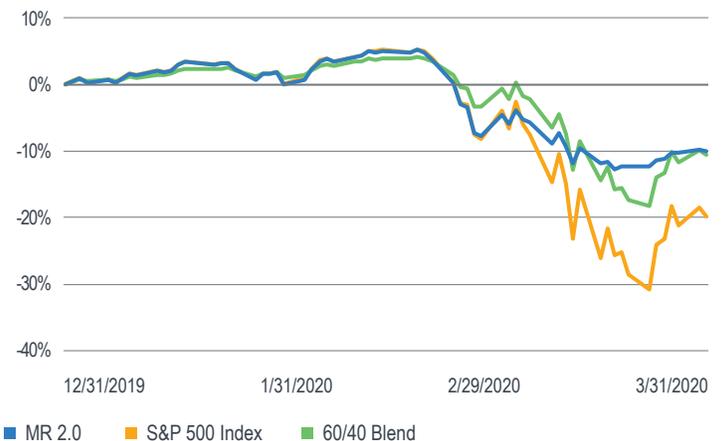
MR 2.0: Equity Allocation



Source: Bloomberg

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Cumulative Returns



Source: Bloomberg and calculations by Milliman FRM

By March 16, when the VIX hit its all-time high, MR 2.0 had reduced its equity allocation to 27%, which helped to significantly reduce its volatility and limit its drawdown.

Q1 2020	MR 2.0	S&P 500 Index	60/40 Blend
Return	-9.7%	-19.6%	-10.5%
Volatility	21.6%	57.0%	30.7%
Drawdown	-16.6%	-33.8%	-20.9%
Max Vol	32.2%	95.7%	51.4%

Source: Bloomberg and calculations by Milliman FRM

THE MILLIMAN MANAGED RISK PARITY GROWTH INDEX (MMRPG) is a benchmark for a risk parity product that Milliman FRM subadvises. It measures the results of the dynamic asset allocation approach of risk parity with the risk mitigating features of volatility management. MMRPG determines portfolio asset allocations based on the risk of each individual asset. Rather than passively letting risk be a byproduct of weights, MMRP dynamically assigns weights as a function of risk. Approaching it in this way limits the effect that any single asset class can have on portfolio performance.

In addition to its risk-based asset allocation, MMRPG uses ongoing volatility management to limit portfolio risk. To prevent portfolio volatility from rising above its designated threshold, the portfolio de-allocates into cash. This helps to stabilize portfolio risk and reduce portfolio drawdowns. MMRPG holds ETFs allocated across U.S. stocks, international stocks, long-term Treasuries, REITs, and gold.

The Milliman Managed Risk Growth Index has a 10% volatility threshold. Its implementation of volatility management is carried out by making pro rata allocations out of the respective ETFs and into cash.

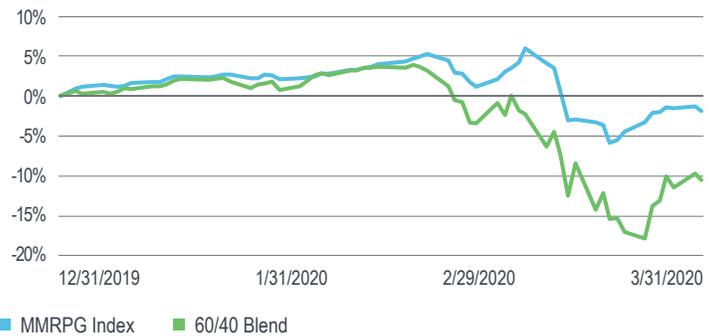
Analysis: MMRPG’s deallocation into cash during Q1 2020 was its highest level on record. As the volatility of both equities and long-term Treasuries increased, the volatility of the index began to test its 10% threshold, triggering a de-allocation to cash beginning on March 11 and peaking at 66% on March 26:

MMRPG Index: Cash Allocation



Source: Bloomberg

Cumulative Returns



Source: Bloomberg and calculations by Milliman FRM

This deallocation helped to reduce losses, volatility, and drawdown. In addition to achieving a higher YTD return through the beginning of the selloff, MMRPG generated an excess return of approximately 870 basis points over a 60/40 stock/bond blend¹, exhibited half the volatility, and experienced about half of the drawdown.

Q1 2020	MMRPG Index	60/40 Blend
Return	-1.8%	-10.5%
Volatility	13.9%	30.7%
Drawdown	-11.1%	-20.9%
Max Vol	22.6%	51.4%

Source: Bloomberg and calculations by Milliman FRM

60/40 RESULTS BASED ON SIMULATED OR HYPOTHETICAL PERFORMANCE RESULTS HAVE CERTAIN INHERENT LIMITATIONS. UNLIKE THE RESULTS SHOWN IN AN ACTUAL PERFORMANCE RECORD, THESE RESULTS DO NOT REPRESENT ACTUAL TRADING. ALSO, BECAUSE THESE TRADES HAVE NOT ACTUALLY BEEN EXECUTED, THESE RESULTS MAY HAVE UNDER-OR OVER-COMPENSATED FOR THE IMPACT, IF ANY, OF CERTAIN MARKET FACTORS, SUCH AS LACK OF LIQUIDITY. SIMULATED OR HYPOTHETICAL TRADING PROGRAMS IN GENERAL ARE ALSO SUBJECT TO THE FACT THAT THEY ARE DESIGNED WITH THE BENEFIT OF HINDSIGHT. NO REPRESENTATION IS BEING MADE THAT ANY ACCOUNT WILL OR IS LIKELY TO ACHIEVE PROFITS OR LOSSES SIMILAR TO THESE BEING SHOWN. MILLIMAN DOES NOT MANAGED THE UNDERLYING FUND.

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MILLIMAN DEFINED OUTCOME (D.O.) PRODUCTS

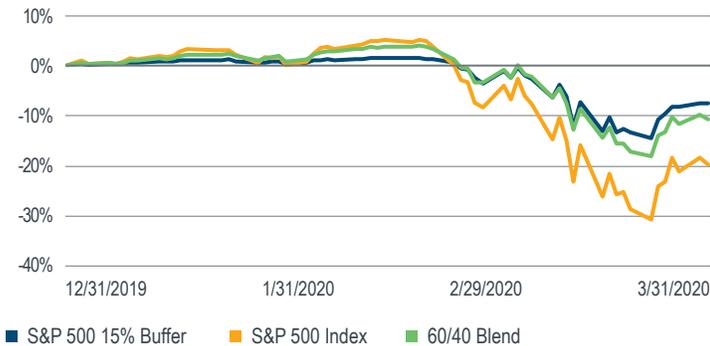
are designed to create clearly defined investment outcomes across broad asset classes and through a variety of product structures. A defined outcome investment is one that restructures an investment's upside and/or downside participation, over a specified outcome period.

The suite of **Cboe S&P 500 Buffer Protect Indexes** are designed to measure target outcome returns on the S&P 500 price index. Milliman sub-advises defined outcome investment products that pursue results similar to those being measured by the indexes. The Cboe S&P 500 15% Buffer Protect Index April Series had a cap of 11.42% with a buffer against the first 15% of losses, and an outcome period of one year.

Heading into 2020, the index cap had last reset on April 1, 2019. When the selloff began, the index was just six weeks away from the end of its outcome period and its 2020 reset. At the end of 2019 it was up 9.2% from its April 1 reset and had climbed another 1.5% through February 19, 2020.

When the market started to sell off and volatility began to rise, the index exhibited less sensitivity to market movements on account of its 15% buffer. The index buffer is created through a hypothetical put spread – the simultaneous purchase of an at-the-money put option and sale of a 15% out-of-the-money put option.

Cumulative Returns



Source: Bloomberg and calculations by Milliman FRM

Q1 2020	S&P 500 15% Buffer	S&P 500 Index	60/40 Blend
Return	-5.7%	-19.6%	-10.5%
Volatility	24.5%	57.0%	30.7%
Drawdown	-13.8%	-33.8%	-20.9%
Max Vol	42.0%	95.7%	51.4%

Source: Bloomberg and calculations by Milliman FRM

As the market sold off, the buffer helped to reduce the fund's participation in the downturn. In addition to generating significant excess return, the Buffer Protect Index exhibited less volatility than a 60/40 blend, and just half the volatility of the S&P 500. It also experienced about half the drawdown and maximum volatility of the S&P 500.

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Volatility	21.6%	13.9%	24.5%	57.0%	30.7%
Drawdown	-16.6%	-11.1%	-13.8%	-33.8%	-20.9%
Max Vol	32.2%	22.6%	42.0%	95.7%	51.4%

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Conclusion

Just as the coronavirus pandemic itself was largely unexpected, so too was the market turmoil that it caused. This downturn, much like the others that preceded it, has again shed light on the essence and nature of risk. It's not about what is happening currently; it's about what might happen or could happen. It is precisely because it exists in the future that we can't know exactly when, where or how it will manifest.

In the 21st century, notwithstanding massive advances made in our ability to manage risk, we still aren't able to eliminate it entirely. If Descartes could say in the 15th century, "I think, therefore I am," we might say today, "I'm at risk, therefore I am." Risk not only confirms existence, but is also intricately interwoven

into existence. No matter how proficient we might become at managing it, we will never be able to entirely rid the world of it.

Within the domains of asset management and financial planning, nowhere is risk management more important than for investors who rely on their assets to meet their liabilities and are exposed to sequence-of-returns risk. As a global pioneer in financial risk management, Milliman designs products to provide exposure to growth assets while dynamically managing against the risks of elevated volatility and extended drawdowns. The coronavirus contraction in 2020 has shown again the immense value of our risk-managed products and their ability to help investors mitigate investment risk.

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