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Constructing a Systematic Asset Allocation Strategy:
The S&P Dynamic Tactical Allocation Index

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SUMMARY

A typical long-term investor may seek exposure to riskier asset classes in their portfolios with the hopes of higher returns and better outcomes. While the long-term historical returns for higher risk asset classes (such as equities, real estate, and commodities) have been higher relative to safer assets (like short-term U.S. Treasuries), losses can be substantial in downturns. In times of distress, market participants may tactically allocate to safe haven investments, such as cash or government bonds. Nevertheless, knowing when to be fully "risk on" and when to move to safety is not an easy undertaking.

The capital asset pricing model (CAPM) assumes that investors are rational and risk averse. However, in reality, behavior biases affect investor decision-making. In fact, research has shown that when investor performance lags the market, it is often attributable to these biases (Elan, 2010 and Feldman, 2011).

Behavioral biases, such as loss aversion, overconfidence, anchoring, or impulse, can lead to ill-timed or ill-advised investment decisions, resulting in less desirable outcomes (Kahneman and Ripe, 1998 and Pompian, 2018). Investors can be hardwired to want to take action in times of volatility, whether warranted or not. Although it can be challenging to overcome these behavioral tendencies, a systematic and dynamic allocation approach to control portfolio volatility can help prevent an unnecessary "anxious exit" from the market.

In this paper, we introduce the S&P Dynamic Tactical Allocation Index (DTAQ), which uses a systematic approach to asset allocation by incorporating dynamic and tactical investment strategies into the index design. We first review the portfolio construction methodology, providing empirically driven rationale for the asset class building blocks and overall ruleset. In part two of the paper, we review the historical index performance. We compare the strategy with hypothetical static allocation versions and the classic 60/40 equity/bond portfolio.

INTRODUCTION

The S&P DTAQ is a global, systematic, multi-asset allocation strategy that employs trend following, volatility, and economic activity signals to determine asset class allocations. The transparent, rules-driven strategy attempts to have exposure to riskier assets in up markets, while shifting to lower-risk assets in market downturns.

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As such, the index seeks to provide higher risk-adjusted returns than the broad market irrespective of the economic environment. To achieve the stated objective, the index uses several dynamic and tactical investment strategies.

As investments and markets fluctuate over time, dynamic asset allocation calls for periodic portfolio rebalancing, bringing holdings back to their target weights. In keeping with that theme, the S&P DTAQ is reviewed and rebalanced on a monthly basis. In an attempt to achieve higher risk-adjusted returns than the benchmark, tactical asset allocation, such as shifting weights from high-risk asset classes to low-risk asset classes, is also incorporated into the portfolio construction.

PORTFOLIO CONSTRUCTION

In this base case scenario, equities have a weight of 85%, divided into three regions: U.S., international, and emerging markets.

In this section, we cover the construction of the overall portfolio and its underlying strategies. The default index target weights are assigned to equities and alternative assets. This base scenario signifies a risk-on period, with the portfolio fully allocated among a diversified pool of risky assets.

In this base scenario, equities have a weight of 85%, divided into three regions: U.S., international, and emerging markets. To diversify away from equities, the remaining 15% is assigned to alternative assets—with real estate, commodities, and gold each assigned 5%.

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Even though fixed income is part of the eligible universe, it acts as a riskless asset, with a 0% weight in the base allocation. As detailed in the next section, a percentage of the portfolio may shift to fixed income based on allocation signals.

Exhibit 1: Asset Classes and Representative Indices		
ASSET CLASS	**ASSET**	**INDEX**
Equities	U.S. Equities	S&P DTAQ U.S. Equity Sub-Index
	Developed Ex-U.S. Equities	S&P Developed Ex-U.S. BMI
	Emerging Equities	S&P Emerging BMI
Alternative Assets	Real Estate	Dow Jones U.S. Real Estate Index
	Commodities	Dow Jones Commodity Index
	Gold	Dow Jones Commodity Index Gold
Fixed Income	U.S. Treasuries	S&P DTAQ Fixed Income Sub-Index

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

Exhibit 2: Target Asset Allocation

Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

The S&P DTAQ is reviewed on a monthly basis to determine whether the allocations remain at their target weights.
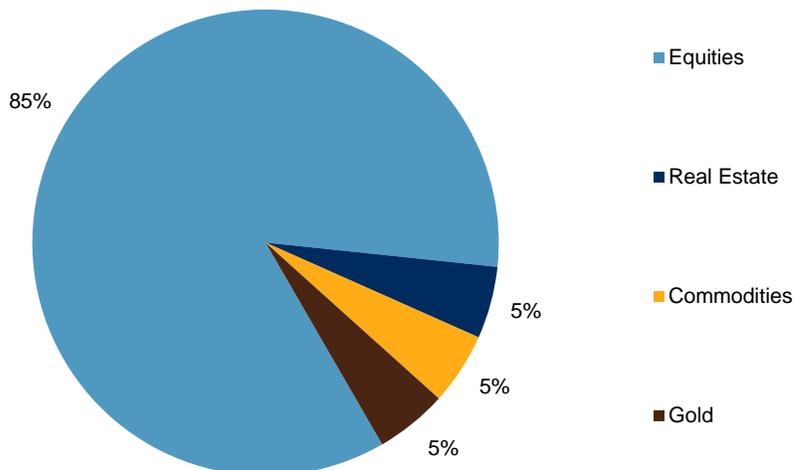
Allocation Signals

The S&P DTAQ is reviewed on a monthly basis to determine whether the allocations remain at their target weights. At the end of each month, each risky asset class is classified as risk on, mixed, or risk off, using two market signals: trend and volatility.[3] In periods of negative momentum or high volatility for an asset, allocation shifts to fixed income, categorized as the risk-off asset class. Since each is classified independently of the others, for a given month, one asset class may be marked as risk on, while another may be determined as risk off.

When an asset's price is trending upward (positive), its allocation remains at the full target weight, regardless of the volatility level.

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Exhibit 3: Allocation Matrix

TREND	VOLATILITY	ALLOCATION TO TARGET WEIGHT (%)
Positive	Normal	100
Positive	High	100
Negative	Normal	50
Negative	High	0

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

The trend signal is based on relative strength, which follows the notion that if an asset's price is above its historical moving average, it is a positive sign that the price may continue to rise. Conversely, if the current price is below the historical moving average, then the asset may continue to decline in value. The trend for each asset is based on the current price return index level compared with the prior six-month (125-day) average:

$$\text{Trend}_t = \begin{cases} \text{Positive when } P_t \geq \text{SMA}_t \\ \text{Negative when } P_t < \text{SMA}_t \end{cases}$$

where:

t	= Rebalance reference date
P_t	= Price return index value (Excess return for commodities)
SMA_t	= Prior 125-day simple moving average of P

The volatility signal is designed to capture periods of distress in a given asset.

The volatility signal is designed to capture periods of distress in a given asset. It compares short-term volatility (20 days) with long-term volatility (125 days). If the short-term volatility is materially higher than the long-term volatility, then the period is considered to be in a state of high volatility; otherwise, the period is classified as normal volatility. The threshold for a period to be high volatility is when the short-term volatility level is at least 150% of the long-term volatility level:

It compares short-term volatility (20 days) with long-term volatility (125 days).

$$\text{Volatility}_t = \begin{cases} \text{High when } \text{VOL}_{t,20D} \geq 150\% * \text{VOL}_{t,125D} \\ \text{Normal when } \text{VOL}_{t,20D} < 150\% * \text{VOL}_{t,125D} \end{cases}$$

where:

t	= Rebalance reference date
P_t	= Price return index value (Excess return for commodities)
$VOL_{t,20D}$	= Prior 20-day volatility of P
$VOL_{t,125D}$	= Prior 125-day volatility P

The level of 150% acts as the threshold based on an approximately statistically significant distance away from average volatility.

and:

This serves two purposes: 1) it reduces readings of false positives and short-term spikes, and 2) it is not overly conservative in labeling a period as high volatility.

$$VOL_{t,20D} = \sqrt{\frac{252 * \sum_{n=0}^{19} \left(\ln \left(\frac{P_{t-n}}{P_{t-n-1}} \right) \right)^2}{20}}$$

$$VOL_{t,125D} = \sqrt{\frac{252 * \sum_{n=0}^{124} \left(\ln \left(\frac{P_{t-n}}{P_{t-n-1}} \right) \right)^2}{125}}$$

The level of 150% acts as the threshold based on an approximately statistically significant distance away from average volatility. This serves two purposes: 1) it reduces readings of false positives and short-term spikes, and 2) it is not overly conservative in labeling a period as high volatility.

Additionally, while short- and long-term average volatilities are similar, short-term volatility tends to have higher variations in levels than long-term volatility. Based on historical figures, 150% of the 125-day volatility is a suitable approximation for 1 standard deviation above the historical mean of the 20-day volatility for the majority of the asset classes (see Appendix A). With this introduction to the allocation signals, we next review the construction of each asset class—equities, alternative assets, and fixed income.

Equities

The equities allocation covers three major regions: U.S., developed ex-U.S., and emerging markets.

The equities allocation covers three major regions: U.S., developed ex-U.S., and emerging markets. The base target weight for equities is 85%, allocated to each region based on its relative size in terms of market capitalization in the S&P Global BMI.[2] The target weight for each region is determined yearly at the end of December and is used for the upcoming calendar year.

On average, the respective weights have been 41.5% for the U.S., 36.8% for developed ex-U.S. markets, and 6.7% for emerging markets.

Relative weights between the three regions have changed over time due to differences in economic growth and market performance. On average, the respective weights have been 41.5% for the U.S., 36.8% for developed ex-U.S. markets, and 6.7% for emerging markets. Over the years, we observe an upward trend in emerging markets (see Appendix B for yearly weights).

Developed ex-U.S. and emerging markets use their representative indices for final allocation in the portfolio…

Developed ex-U.S. and emerging markets use their representative indices for final allocation in the portfolio, while the U.S. market comprises three tactical strategies—contrarian, momentum, and size. Contrarian and momentum are sector-rotation-based strategies, while size is represented by the S&P 500 Equal Weight Index (EWI). In total, two-thirds of the allocation goes to the sector rotation strategies, while the remaining one-third is assigned to size.

Exhibit 4: U.S. Equity Allocations
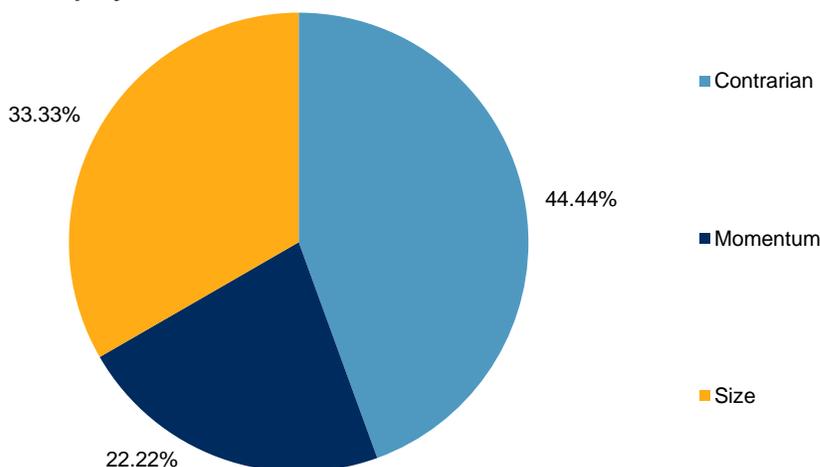
…while the U.S. market comprises three tactical strategies—contrarian, momentum, and size.

Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

The two sector rotation strategies are based on S&P 500® GICS® sectors, excluding Real Estate, as that sector has a separate allocation in the overall portfolio. The strategies are designed to take advantage of differences in performance of the individual sectors in different stages of market cycles (see Appendix C).

The contrarian strategy is based on the notion of mean reversion—the sectors that performed the worst in the recent past will perform better in the future.

The contrarian strategy is based on the notion of mean reversion—the sectors that performed the worst in the recent past will perform better in the future. The strategy rebalances once a year and allocates to the four worst-performing S&P 500 sectors of the prior year (see Appendix D1 for historical allocations). The selected sectors are equally weighted, with weights reset on a quarterly basis.

The momentum strategy is designed to capture the trend effect, which posits that the best-performing sectors will continue to outperform in the next period. On a quarterly basis, the strategy selects the two top-performing sectors of the prior six months, with each receiving 50% of the total momentum weight (see Appendix D2 for historical allocations).

The momentum strategy is designed to capture the trend effect, which posits that the best-performing sectors will continue to outperform in the next period.

The size strategy is designed to capture the size premium by equally weighting the companies in the S&P 500. Equal weighting effectively diversifies contribution to returns by reducing the concentration bias of the largest companies in the S&P 500 (Zeng and Luo, 2013).

To measure the effectiveness of each strategy and the resulting S&P DTAQ U.S. Equity Sub-Index relative to the benchmark S&P 500, we plot historical excess returns (see Exhibit 5). All three strategies individually outperformed the S&P 500 over the long term.

The size strategy is designed to capture the size premium by equally weighting the companies in the S&P 500.

Exhibit 5: Historical Excess Returns Versus S&P 500
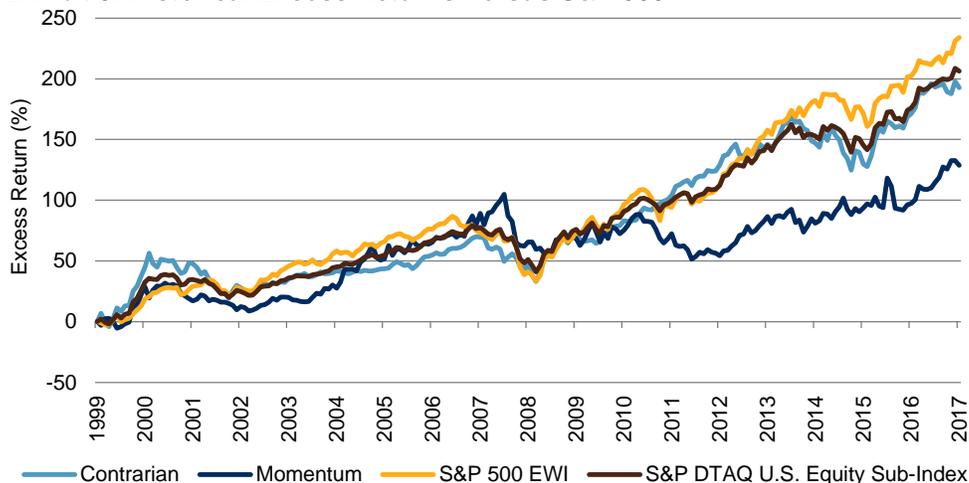
All three strategies individually outperformed the S&P 500 over the long term.

The contrarian and momentum portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Index performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 5 points to the rationale for using multiple tactical strategies combined into the aggregate S&P DTAQ U.S. Equity Sub-Index. While all three strategies outperformed the S&P 500, each showed periods of outperformance and underperformance.

While the S&P 500 EWI outperformed the combined U.S. equity portfolio on a cumulative basis…

Exhibit 6: Hit Rate and Average Excess Returns					
PERIOD TYPE	**NUMBER OF MONTHS**	**HIT RATE: MONTHS OUTPERFORMING THE S&P 500 (%)**			
		CONTRARIAN	**MOMENTUM**	**S&P 500 EWI**	**S&P DTAQ U.S. EQUITY SUB-INDEX**
All Months	216	52.78	53.24	54.63	58.33
Up Markets	138	50.72	53.62	62.32	59.42
Down Markets	78	56.41	52.56	41.03	56.41
PERIOD TYPE	**NUMBER OF MONTHS**	**AVERAGE MONTHLY EXCESS RETURN VERSUS THE S&P 500 (%)**			
		CONTRARIAN	**MOMENTUM**	**S&P 500 EWI**	**S&P DTAQ U.S. EQUITY SUB-INDEX**
All Months	216	0.28	0.21	0.33	0.28
Up Markets	138	0.13	0.05	0.50	0.24
Down Markets	78	0.56	0.48	0.02	0.36

…the S&P DTAQ U.S. Equity Sub-Index's monthly hit rate, measured as the percentage of months it outperformed the S&P 500, was higher than any of the individual strategies.

The contrarian and momentum portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Index performance based on monthly total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

While the S&P 500 EWI outperformed the combined U.S. equity portfolio on a cumulative basis, the S&P DTAQ U.S. Equity Sub-Index's monthly hit rate, measured as the percentage of months it outperformed the S&P 500, was higher than any of the individual strategies.

Additionally, the S&P DTAQ U.S. Equity Sub-Index had positive average excess returns in both up and down markets.

Additionally, the S&P DTAQ U.S. Equity Sub-Index had positive average excess returns in both up and down markets. In contrast, most of the outperformance for the individual strategies came in either up or down markets; contrarian and momentum mainly outperformed during down markets, while the S&P 500 EWI outperformed in up markets.

Alternative Assets

The inclusion of alternative assets—such as real estate, commodities, and gold—in a multi-asset portfolio can be advantageous for several reasons. First, they have historically exhibited low correlations to equities and fixed income, which may increase portfolio diversification and lead to higher risk-adjusted returns (Markowitz, 1952). Second, they may provide some level of inflation protection for the portfolios. These assets have performed better in the presence of unexpected inflation, a state that usually puts pressure on equity and fixed income prices (Bhardwaj et al., 2011). Prior to applying the trend and volatility signals, the base allocation for each asset is 5%.

Exhibits 7 and 8 show historical asset class correlations from 1999 to 2017; Exhibit 7 shows full-period cross correlations and Exhibit 8 shows rolling 36-month correlations.[3]

The inclusion of alternative assets— such as real estate, commodities, and gold—in a multi-asset portfolio can be advantageous for several reasons:

Exhibit 7: Asset Class Correlations

ASSET CLASS	U.S. EQUITIES	U.S. TREASURIES	REAL ESTATE	COMMODITIES	GOLD
U.S. EQUITIES	--	-0.30	0.63	0.39	0.02
U.S. TREASURIES	-0.30	--	-0.04	-0.11	0.29
REAL ESTATE	0.63	-0.04	--	0.28	0.13
COMMODITIES	0.39	-0.11	0.28	--	0.44
GOLD	0.02	0.29	0.13	0.44	--

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 8: Rolling 36-Month Asset Class Correlations
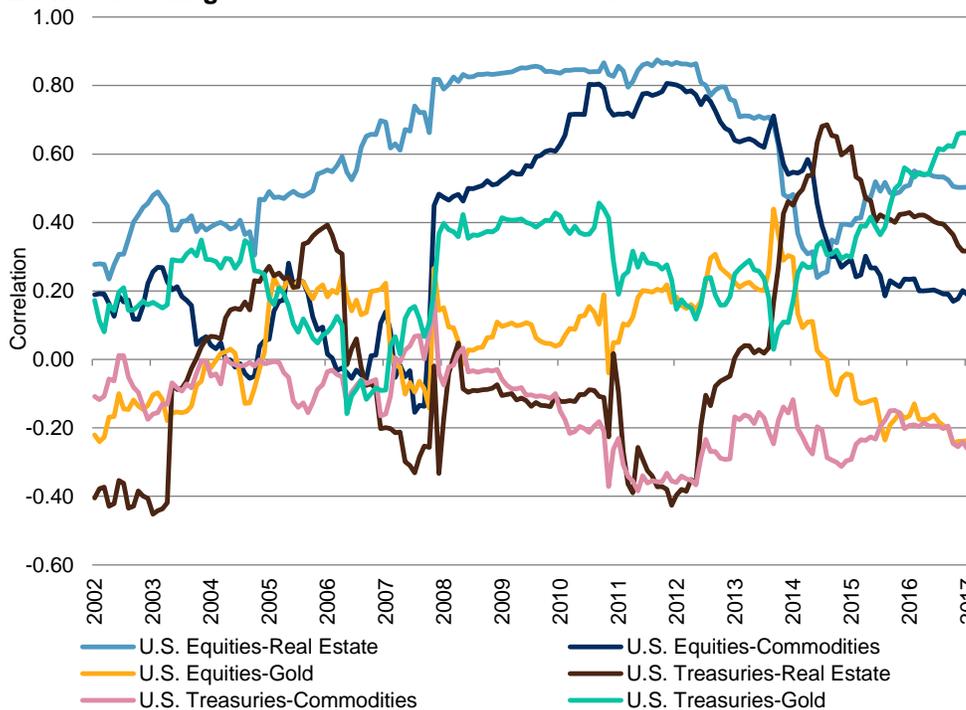
…they have historically exhibited low correlations to equities and fixed income, which may increase portfolio diversification and lead to higher risk-adjusted returns…

…they may provide some level of inflation protection for the portfolios…

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

…and they have performed better in the presence of unexpected inflation than equity and fixed income prices.

Inflation, as measured by the Consumer Price Index for All Urban Consumers (CPI-U), is often broken into two components—core and unexpected. Unexpected inflation is considerably less stable than core inflation (see Exhibit 9), which can make it more difficult to model and predict in the market.[4] Due to this, the inflation risk of a portfolio is generally concerned with changes in unexpected inflation, in particular positive surprises.

Exhibit 9: Year-Over-Year Monthly Inflation Changes

Inflation is often broken into two components— core and unexpected.

Unexpected inflation is considerably less stable than core inflation, which can make it more difficult to model and predict in the market.

Source: S&P Dow Jones Indices LLC, Federal Reserve Bank of St. Louis. Data from Dec. 31, 1999, to Dec. 29, 2017. Rolling year-over-year inflation change based on monthly, seasonally adjusted CPI-U. See Endnote 4 for more details on calculations. Chart is provided for illustrative purposes.

Exhibit 10 categorizes the year-over-year unexpected inflation changes into two regimes—positive change and negative change—and shows the hit rates and average excess returns relative to U.S. equities. In the presence of positive inflation shocks, real estate, commodities, and gold all typically outperformed U.S. equities and Treasuries (observed by a comparison of the respective columns in Exhibit 10).

In the presence of positive inflation shocks, real estate, commodities, and gold all typically outperformed U.S. equities and Treasuries.

Exhibit 10: Hit Rates and Excess Returns Versus U.S. Equities Based on Unexpected Inflation Direction				
PERIOD TYPE	**REAL ESTATE**	**COMMODITIES**	**GOLD**	**U.S. TREASURIES**
HIT RATE: MONTHS OUTPERFORMING U.S. EQUITIES (%)				
All Months	55.56	46.30	50.46	43.52
Positive Unexpected Inflation	58.73	53.17	54.76	46.03
Negative Unexpected Inflation	54.05	37.84	45.95	40.54
AVERAGE MONTHLY EXCESS RETURN VERSUS U.S. EQUITIES (%)				
All Months	0.51	-0.07	0.25	-0.03
Positive Unexpected Inflation	0.67	0.54	0.52	0.13
Negative Unexpected Inflation	0.27	-0.73	-0.08	-0.38

The low correlations to U.S. equities and fixed income, along with historical outperformance in inflationary periods, gives credence to the inclusion of these asset classes in the overall portfolio.

Source: S&P Dow Jones Indices LLC, Federal Reserve Bank of St. Louis. Data from Dec. 31, 1999, to Dec. 29, 2017. Inflation figures are the year-over-year change based on monthly, seasonally adjusted CPI-U. See Endnote 4 for more details on calculations of inflation figures. Due to the lag of publishing, inflation figures are lagged by one month where calculating relative performance of the asset classes. Non-material monthly changes in unexpected inflation, defined as a change of less than ±0.10%, are excluded from the analysis. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

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Constructing a Systematic Asset Allocation Strategy   November 2018

Fixed Income

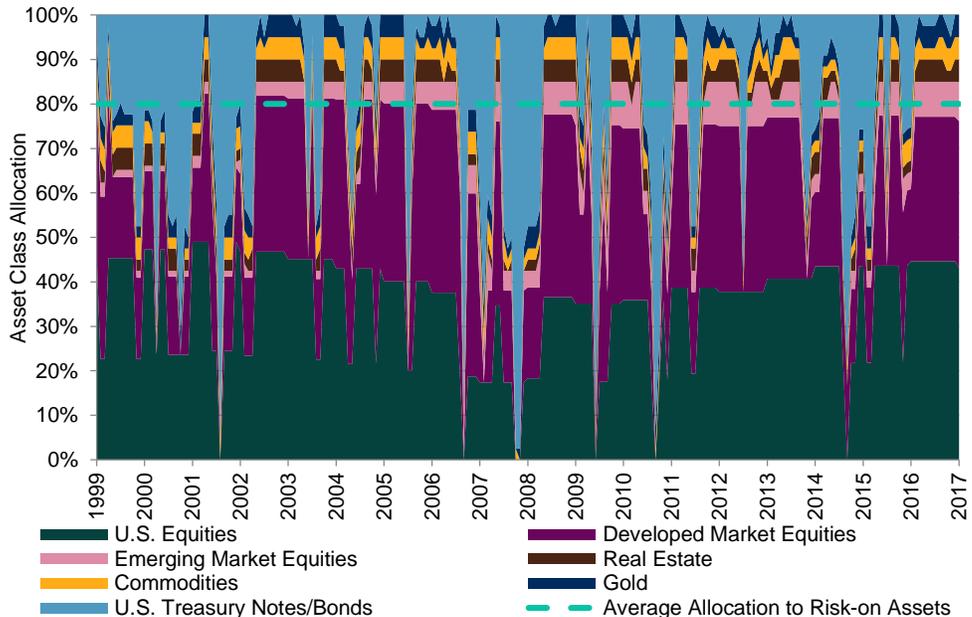The fixed income asset class is considered to be the reserve asset class, to which allocations shift when asset class trends and volatility signals point negative. As we'll demonstrate in Exhibit 19, while fixed income may underperform its riskier counterparts over the long term, it holds up better in economic downturns.

Since the asset class is the safety asset, the eligible universe is restricted to U.S. Treasuries, excluding riskier bonds such as corporates or international sovereign bonds. To allocate across the yield curve, four maturities (2, 5, 10, and 30 years), using the futures contracts, comprise the eligible U.S. Treasuries universe.

At each monthly rebalance, the initial allocation to fixed income is 0%, with the final allocation dependent on two factors. First, the total allocation is based on the allocation decision matrix for the risky asset classes (see Exhibit 3). If the determined exposure to any of the risky assets is less than 100% of their target weight, the excess weight is placed in fixed income. Second, in conjunction with the allocation to the asset class, the current economic conditions in the U.S., as measured by the Chicago Fed National Activity Index (CFNAI), determines how the weight is allocated across the yield curve.

The historical average allocation to the risk-on assets was 80% (see the dotted line in Exhibit 11), leaving 20% allocated to fixed income.

The fixed income asset class is considered to be the reserve asset class, to which allocations shift when asset class trends and volatility signals point negative…

…therefore, the eligible universe is restricted to U.S. Treasuries, excluding riskier bonds such as corporates or international sovereign bonds.

To allocate across the yield curve, four maturities (2, 5, 10, and 30 years), using the futures contracts, comprise the eligible U.S. Treasuries universe.

Exhibit 11: Historical Asset Class Allocations

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly allocations. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

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While 20% was the average allocation to fixed income, Exhibit 11 demonstrates the strategy's dynamic allocation rules. At any point in time, the fixed income allocation was rarely close to the average. The median fixed income allocation was 7.5%, which tells us that allocations in most months were lower than the average, and during times of expected market stress, the weight quickly surpassed the average.

At any point in time, the fixed income allocation was rarely close to the average of 20%.

We use the CFNAI to identify potential recessionary periods in the U.S. A composite of 85 economic indicators, the CFNAI is normalized such that the historical U.S. GDP growth rate equates to a value of zero, with a standard deviation of 1. Therefore, when the level is above zero, the economy is growing at a faster rate than the historical average, while a negative level indicates below trend growth, including economic decline.

The S&P DTAQ groups the CFNAI into three economic activity levels (EALs)…

The S&P DTAQ groups the CFNAI into three economic activity levels (EALs): EAL 1 indicates normal economic activity, EAL 2 indicates materially lower growth or a potential recession, and EAL 3 indicates the potential for a severe recessionary period. Each EAL, as measured by the CFNAI level EA_t at month t, is determined by the equations shown in Exhibit 12.

Exhibit 12: EAL Calculations

EAL	ECONOMIC ACTIVITY Z-SCORE
1	$EA_t > -1$
2	$-2 < EA_t \leq -1$
3	$EA_t \leq -2$

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

EAL 1 indicates normal economic activity, EAL 2 indicates materially lower growth or a potential recession, and EAL 3 indicates the potential for a severe recessionary period.

Along with the total amount allocated to fixed income, the EAL is important in determining where in the yield curve the allocation is placed. In normal economic conditions, when the EAL is 1, allocation is primarily placed in the S&P 2-Year U.S. Treasury Note Futures Index and S&P 5-Year U.S. Treasury Note Futures Index. In economic stress periods (EAL 2 and 3), the long end of the yield curve is prioritized in the allocation (see Appendix E for full allocation rules). Interest rates typically fall sharply during recessions (Romer 1994), and since long-term bonds have higher duration than short-term bonds, they could be expected to perform better when rates decrease.

Along with the total amount allocated to fixed income, the EAL is important in determining where in the yield curve the allocation is placed.

Exhibit 13 shows the historical CFNAI levels distribution, along with the EAL cutoffs.

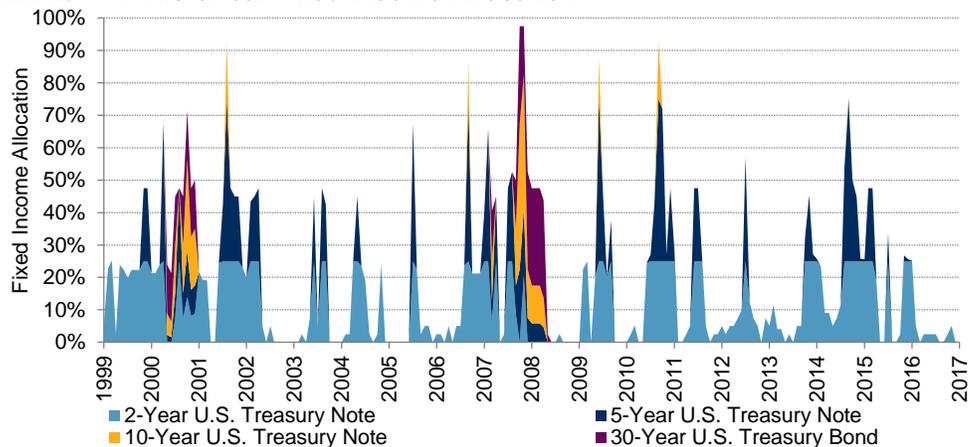**Exhibit 13: Historical CFNAI Distribution**
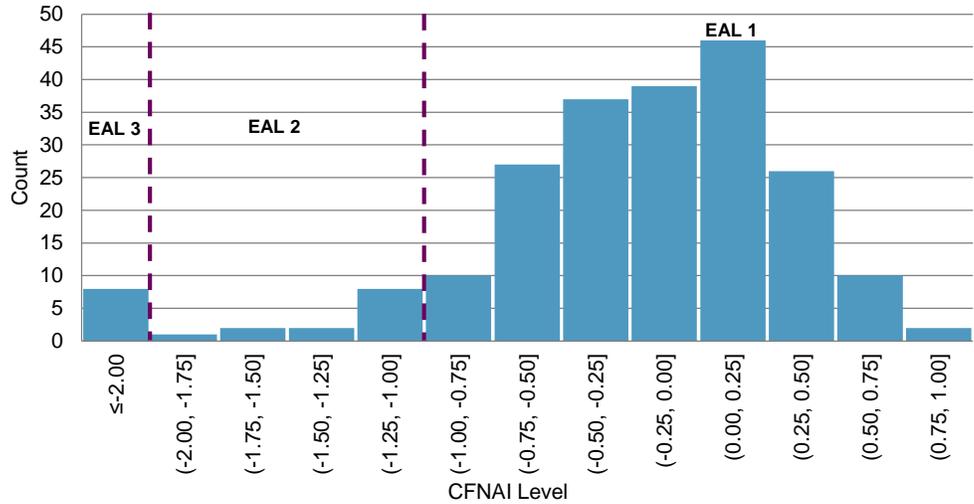
Source: S&P Dow Jones Indices LLC, Federal Reserve Bank of Chicago. Data from Dec. 31, 1999, to Dec. 29, 2017. Chart is provided for illustrative purposes and reflects hypothetical historical performance.

When the EAL is 1, allocation is primarily placed in the S&P 2-Year U.S. Treasury Note Futures Index and S&P 5-Year U.S. Treasury Note Futures Index.

In economic stress periods (EAL 2 and 3), the long end of the yield curve is prioritized in the allocation.

The CFNAI levels generally centered around zero, although it is also evident that the data contains a negative skew. The negative skewness is the primary rationale for separating CFNAI levels that are statistically far from the mean (1 or more standard deviations away) into multiple EALs. EAL 3 is meant to classify periods of significant distress in the economy, leading to further adjustments to the fixed income allocation beyond the adjustments made in EAL 2.

Combining the total allocation to fixed income and the EAL as classified by the CFNAI, Exhibit 14 shows the distribution of the fixed income allocation across the yield curve.

Combining the total allocation to fixed income and the EAL as classified by the CFNAI, Exhibit 14 shows the distribution of the fixed income allocation across the yield curve.

Exhibit 14: Historical Fixed Income Allocation

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly allocations. The 2-, 5-, and 10-year U.S. Treasury notes are represented by the S&P 2-Year U.S. Treasury Note Futures Index, S&P 5-Year U.S. Treasury Note Futures Index, and S&P 10-Year U.S. Treasury Note Futures Index, respectively. The 30-Year U.S. Treasury Bond is represented by the S&P U.S. Treasury Bond Futures Index. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

So far in this paper, we have reviewed the asset allocation process and rationale for the S&P DTAQ. In the final section, we will review the historical performance of the strategy.

HISTORICAL PERFORMANCE

In this section, we compare the S&P DTAQ to hypothetical portfolios with fixed weights: the classic 60/40 equity/bond mix, and the S&P Global BMI, which represents global equities.

To demonstrate the impact of changing allocations based on the allocation signals, we created two variants of the DTAQ strategy with fixed weights for the entire history.

To demonstrate the impact of changing allocations based on the allocation signals, we created two variants of the DTAQ strategy with fixed weights for the entire history (see Appendix F for allocation details). The first variant, "DTAQ-0%," is always in the risk-on regime, with 0% weight in fixed income. The allocation to the risky assets is based on the target weights of the DTAQ strategy, as seen in Exhibit 2, with the regional equity allocations based on the approximate historical average.

The first variant, "DTAQ-0%," is always in the risk-on regime, with 0% weight in fixed income.

The second fixed-weight variant, "DTAQ-40%," uses the same relative weights as the first variant, while incorporating a static 40% weight to fixed income. The fixed income portion is represented by the fixed income performance in the S&P DTAQ. The 60/40 equity/bond portfolio is a combination of the S&P Global BMI and S&P 5-Year U.S. Treasury Note Futures Index.[5] Exhibit 15 shows the cumulative performance of the S&P DTAQ compared with the other portfolios.

Exhibit 15: Cumulative Returns
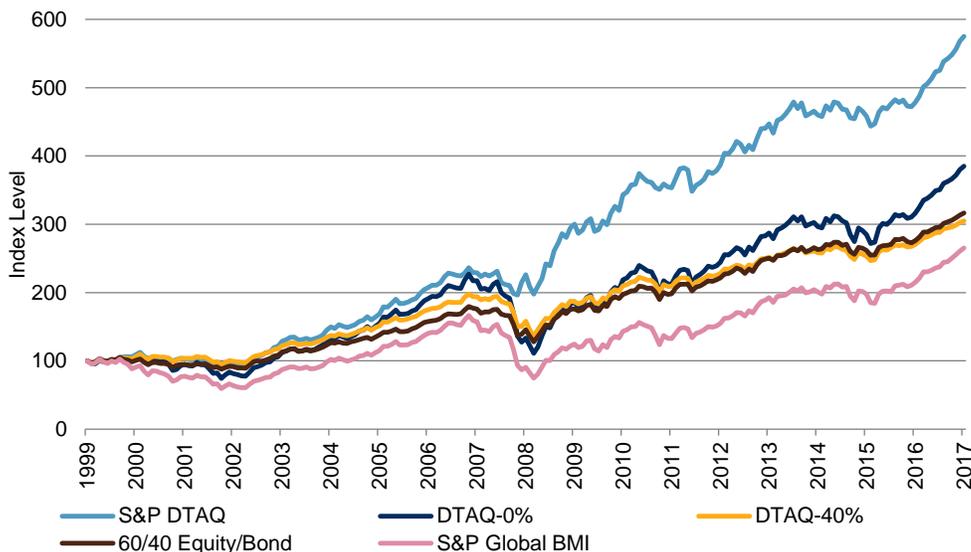
The second fixed-weight variant, "DTAQ-40%," uses the same relative weights as the first variant, while incorporating a static 40% weight to fixed income.
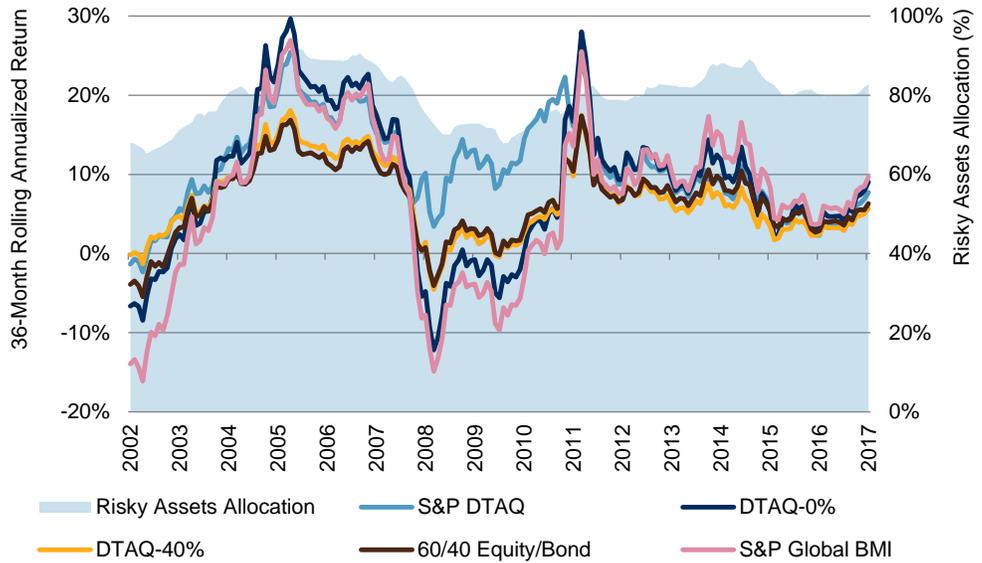

The DTAQ-0%, DTAQ-40%, and 60/40 equity/bond portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The analysis shows that the allocation rules set in place for the S&P DTAQ led to historical outperformance compared with the other portfolios by a wide margin. For the period studied, the S&P DTAQ returned 485%, compared with 285% for the DTAQ-0% portfolio, 205% for the DTAQ-40% portfolio, 186% for the 60/40 equity/bond portfolio, and 165% for the S&P Global BMI. Exhibit 16 shows the risk/return profile for the portfolios as of December 2017.

The analysis shows that the allocation rules set in place for the S&P DTAQ led to historical outperformance compared with the other portfolios by a wide margin.

Exhibit 16: Risk/Return Profile

PERIOD	S&P DTAQ	DTAQ-0%	DTAQ-40%	60/40 EQUITY/BOND	S&P GLOBAL BMI
ANNUALIZED RETURN (%)					
1-Year	20.25	21.70	12.75	14.26	23.22
3-Year	7.70	9.06	5.70	6.29	9.69
5-Year	8.25	9.52	5.96	7.20	11.32
10-Year	9.65	5.89	4.62	5.45	5.37
15-Year	12.67	10.91	7.75	8.12	9.98
18-Year	10.21	7.78	6.39	6.02	5.57
ANNUALIZED VOLATILITY (%)					
3-Year	5.97	9.58	5.66	5.93	10.56
5-Year	6.84	9.26	5.54	5.95	9.99
10-Year	10.88	16.01	9.73	9.61	17.13
15-Year	10.13	14.28	8.65	8.60	15.12
18-Year	9.97	14.52	8.64	8.73	15.68
RETURN/RISK					
3-Year	1.29	0.95	1.01	1.06	0.92
5-Year	1.21	1.03	1.08	1.21	1.13
10-Year	0.89	0.37	0.47	0.57	0.31
15-Year	1.25	0.76	0.90	0.94	0.66
18-Year	1.02	0.54	0.74	0.69	0.36

The S&P DTAQ returned 485%, compared with 285% for the DTAQ-0% portfolio, 205% for the DTAQ-40% portfolio, 186% for the 60/40 equity/bond portfolio, and 165% for the S&P Global BMI.

The DTAQ-0%, DTAQ-40%, and 60/40 equity/bond portfolios are hypothetical portfolios. Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The S&P DTAQ strategy produced higher volatility than the DTAQ-40% and 60/40 equity/bond portfolio for all of the periods. However, the additional risk paid off in terms of return per unit of risk; the long-term return-over-risk ratio for the S&P DTAQ (1.02 for 18-year) was materially higher than that of the comparison portfolios.

The S&P DTAQ strategy produced higher volatility than the DTAQ-40% and 60/40 equity/bond portfolio, however, the additional risk paid off in terms of return per unit of risk.

Since the strategy is dynamic in nature, it is useful to review rolling returns and risk data. Exhibit 17 shows the rolling 36-month annualized return and volatility for the portfolios. In addition, the average allocation to risky assets is shown in the background.

Exhibit 17: Rolling 36-Month Annualized Return and Volatility

Since the strategy is dynamic in nature, it is useful to review rolling returns and risk data.

The charts show that the S&P DTAQ consistently performed well on a relative basis…
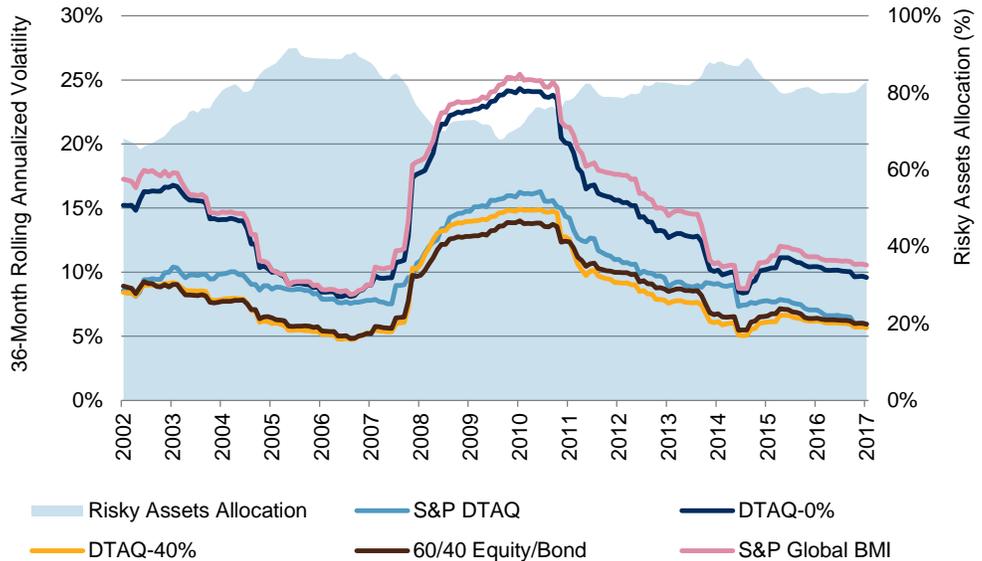
…while also reducing allocation to risky assets in stress periods, thereby reducing overall portfolio volatility.

The DTAQ-0%, DTAQ-40%, and 60/40 equity/bond portfolios are hypothetical portfolios. Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The charts show that the S&P DTAQ consistently performed well on a relative basis, while also reducing allocation to risky assets in stress periods, thereby reducing overall portfolio volatility. To study specific bear markets, the Exhibit 18 shows how each portfolio performed during the three worst equity market downturns since 1999, as determined by the S&P Global BMI.

Exhibit 18: The Three Worst Drawdowns of the S&P Global BMI
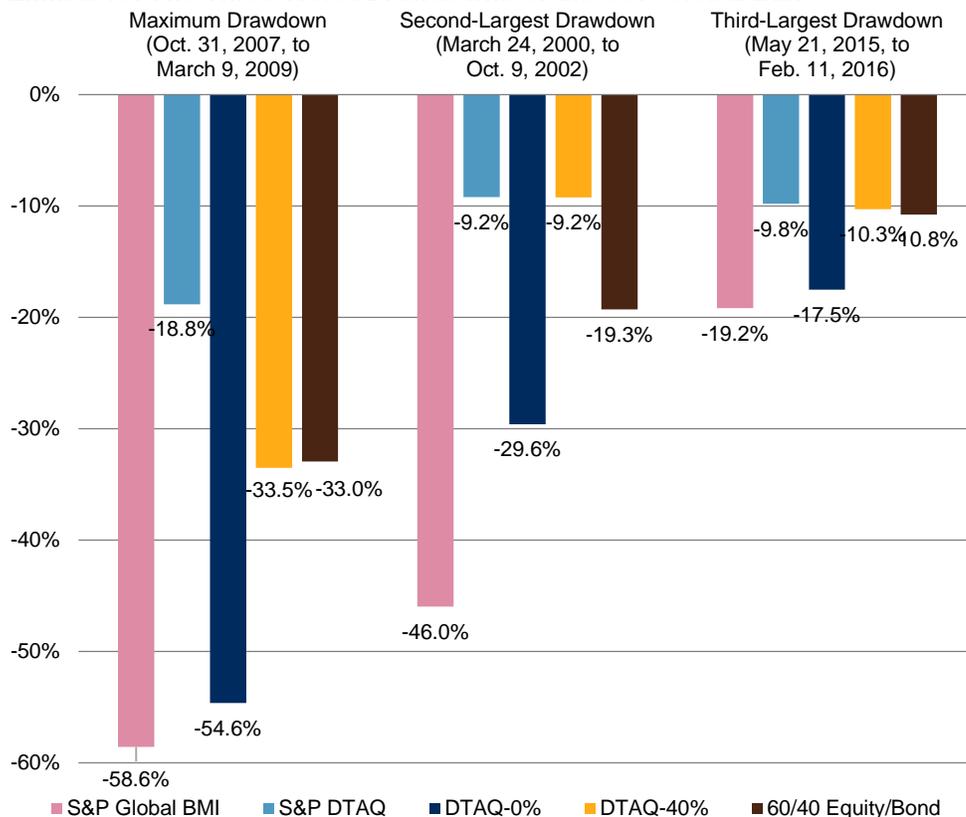
Exhibit 18 highlights that the S&P DTAQ outperformed the other portfolios in significant market downturns.

The ability for the strategy to shift all, or the majority, of its assets into fixed income gave it a leg up compared with the static fixed income portfolios.

The DTAQ-0%, DTAQ-40%, and 60/40 equity/bond portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 18 highlights that the S&P DTAQ outperformed the other portfolios in significant market downturns. The ability for the strategy to shift all, or the majority, of its assets into fixed income gave it a leg up compared with the static fixed income portfolios (the DTAQ-40% and 60/40 equity/bond portfolios; see Exhibit 11 for allocations over time). During the global financial crisis (in the maximum drawdown period), the S&P DTAQ had a drawdown of -18.8%, nearly 40% better than the S&P Global BMI. In addition, it outperformed the DTAQ-40% and 60/40 equity/bond portfolios by approximately 14% in the same period.

During the global financial crisis (in the maximum drawdown period), the S&P DTAQ had a drawdown of -18.8%, nearly 40% better than the S&P Global BMI.

We will next dissect average portfolio returns based on fixed income allocation percentages and the EALs indicated by the CFNAI. Exhibit 19 shows the one-month forward returns based on the allocation signals of the strategy.

Exhibit 19: Average Monthly Returns in Different Regimes

FIXED INCOME ALLOCATION	OCCURRENCE (%)	AVERAGE MONTHLY RETURNS (%)				
		S&P DTAQ	DTAQ-0%	DTAQ-40%	60/40 EQUITY/ BOND	S&P GLOBAL BMI
0%-25%	68.20	0.95	0.93	0.64	0.60	0.81
25%-50%	24.42	0.37	0.62	0.45	0.42	0.32
50%-100%	7.37	1.55	-0.91	0.06	0.08	-0.96

CFNAI LEVEL	OCCURRENCE (%)	AVERAGE MONTHLY RETURNS (%)				
		S&P DTAQ	DTAQ-0%	DTAQ-40%	60/40 EQUITY/ BOND	S&P GLOBAL BMI
1 (-1, ∞)	90.32	0.80	0.84	0.62	0.57	0.69
2 (-2, -1]	5.99	1.37	-0.53	0.17	0.06	-0.83
3 (-∞, -2]	3.69	1.34	-0.32	-0.50	-0.06	-0.44

The DTAQ-0%, DTAQ-40%, and 60/40 equity/bond portfolios are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Data based on monthly total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

In periods of EALs 2 and 3, the S&P DTAQ was able to produce relatively better average returns.

Returns were negative for all portfolios except the S&P DTAQ, which produced an average return of 1.34%.

The S&P DTAQ provides a transparent, rules-driven approach for an asset allocation portfolio.

Using simple yet effective tactical and dynamic strategies in a multi-asset portfolio context has historically produced higher risk-adjusted returns than a portfolio holding only U.S. equities or the classic 60/40 equity/bond portfolio.

In Exhibit 19, the most relevant moments are when the S&P DTAQ moves away from allocations in normal periods; specifically when fixed income allocation rises above 50% or when the EAL is at 2 or 3. When fixed income has a weight of 50% or more in the S&P DTAQ, the index significantly outperformed the other portfolios.

In fact, compared with the full risk-on DTAQ-0% portfolio, the S&P DTAQ outperformed by an average of 2.46% on a monthly basis. This highlights the potential effectiveness of the allocation signals in shifting away from risky assets into the reserve asset class.

Reviewing performance based on EALs, the S&P DTAQ was able to produce relatively better average returns in stressed periods (EALs 2 and 3). During periods of EAL 3, returns were negative for all portfolios except the S&P DTAQ, which produced an average return of 1.34%. These figures show the usefulness in taking into account the economic cycle when determining where to allocate across the yield curve.

CONCLUSION

The S&P DTAQ provides a transparent, rules-driven approach for an asset allocation portfolio. Using simple yet effective tactical and dynamic strategies in a multi-asset portfolio context has historically produced higher risk-adjusted returns than a portfolio holding only U.S. equities or the classic 60/40 equity/bond portfolio. This rules-driven approach removes the necessity for human judgment in allocations, thereby removing behavioral biases that may arise in allocation decision-making.

ENDNOTES

1   For U.S. equities, since the allocations change based on the underlying strategies, the S&P 500 EWI is used as the proxy for the trend and volatility signals.

2   For the U.S., the S&P United States BMI is used, while the representative indices in Exhibit 1 are used for the developed and emerging markets regions. This is done to make it an apples-to-apples comparison for measuring market size.

3   U.S. equities are represented by the S&P 500, U.S. Treasuries are represented by the S&P 10-Year U.S. Treasury Note Futures Total Return Index. Real estate, commodities, and gold are represented by the Dow Jones U.S. Real Estate Index, Dow Jones Commodity Index, and Dow Jones Commodity Index Gold, respectively, as used in the S&P DTAQ (see Exhibit 1).

4   Core inflation is the year-over-year change of the seasonally adjusted Consumer Price Index (CPI) for All Urban Consumers: All Items Less Food and Energy. Unexpected inflation is the Headline CPI for All Urban Consumers excluding core inflation.

5   The 60/40 equity/bond hypothetical portfolio is calculated in USD on a total return basis and is rebalanced annually at the end of the year to reset the asset class weights to 60% equity and 40% fixed income. The S&P 5-Year U.S. Treasury Note Futures Index was chosen to represent the fixed income portion, as it was the closest to the historical weighted average maturity of the S&P DTAQ fixed income allocation.

REFERENCES

Bhardwaj, G., D.J. Hamilton, and J. Ameriks. "Hedging inflations: The role of expectations." *Vanguard,* March 2011.

Elan, S. and M.K. Goodrich. "BEHAVIORAL PATTERNS AND PITFALLS OF U.S. INVESTORS." *Library of Congress – Federal Research Division*, August 2010.

Feldman, T. "Behavioral Biases and Investor Performance." *Algorithmic Finance*, 2011 (1): pp. 45-55.

Kahneman, D. and M.W. Riepe. "Aspects of Investor Psychology." *Journal of Portfolio Management*, Vol. 24, No. 4, Summer 1998: pp. 52-64.

Markowitz, H. "Portfolio Selection." *The Journal of Finance*, Vol. 7, No. 1. (March 1952), pp. 77-91.

Pompian, M. "The Behavioral Biases of Individuals." *CFA Institute,* 2018.

Romer, C. and D. Romer. "What Ends Recessions?." *NBER Macroeconomics Annual 1994,* Vol. 9, pp. 13-80.

Zeng, L. and Luo, F. "10 Years Later: Where in the World Is Equal Weight Indexing Now?" S&P Dow Jones Indices LLC, April 2013.

APPENDICES

Appendix A: Standard Deviation and 150% Thresholds of Short- and Long-Term Volatilities

MEASUREMENT	MEASUREMENT WINDOW	U.S. EQUITIES	DEVELOPED EX-U.S. EQUITIES	EMERGING EQUITIES	REAL ESTATE	COMMODITIES	GOLD
Average Volatility (%)	20-Day	17.4	15.1	16.3	20.7	14.9	16.7
	125-Day	18.2	15.8	17.1	21.6	15.3	17.3
Standard Deviation (σ) of Volatility (%)	20-Day	11.1	8.7	9.0	20.5	6.5	7.0
	125-Day	9.8	7.2	7.3	19.2	5.5	5.5
Average Volatility + 1 σ (%)	20-Day	28.4	23.8	25.3	41.3	21.4	23.7
	125-Day	28.0	23.0	24.5	40.9	20.8	22.8
150% * Average Volatility (%)	20-Day	26.0	22.6	24.5	31.1	22.4	25.0
	125-Day	27.3	23.7	25.7	32.4	22.9	26.0

Source: S&P Dow Jones Indices LLC. End-of-month calculations data from Dec. 31, 1999, to Dec. 29, 2017. Table is provided for illustrative purposes.

Appendix B: Historical Regional Equity Target Weights
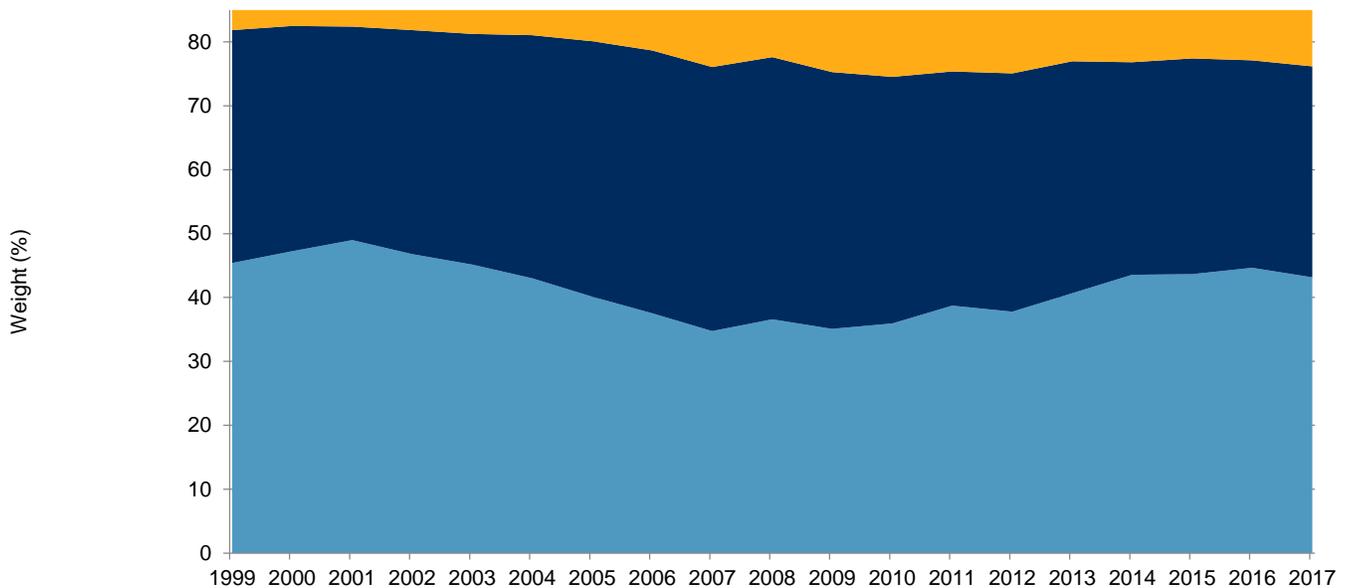
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
■ Emerging	3.1	2.5	2.6	3.2	3.8	3.9	4.9	6.3	8.9	7.4	9.7	10.5	9.6	9.9	8.0	8.2	7.6	7.9	8.8
■ Developed Ex-U.S.	36.5	35.2	33.4	35.0	36.1	38.1	40.0	41.2	41.4	41.1	40.2	38.6	36.7	37.3	36.3	33.3	33.8	32.5	33.0
■ U.S.	45.4	47.3	49.0	46.8	45.1	43.0	40.1	37.5	34.7	36.6	35.1	35.9	38.7	37.8	40.7	43.5	43.6	44.7	43.2

Source: S&P Dow Jones Indices LLC. End-of-year calculations from Dec. 31, 1999, to Dec. 29, 2017. Chart is provided for illustrative purposes.

Appendix C: S&P 500 Sectors Calendar Year Returns

YEAR	CONSUMER DISCRE- TIONARY	CONSUMER STAPLES	ENERGY	FINAN- CIALS	HEALTH CARE	INDUS- TRIALS	INFOR- MATION TECH- NOLOGY	MATERIALS	COMMUNI- CATION SERVICES	UTILITIES
2000	-20.0	16.8	15.7	25.7	37.1	5.9	-40.9	-15.7	-38.8	57.2
2001	2.8	-6.4	-10.4	-8.9	-12.0	-5.7	-25.9	3.5	-12.2	-30.4
2002	-23.8	-4.3	-11.1	-14.6	-18.8	-26.3	-37.4	-5.5	-34.1	-30.0
2003	37.4	11.6	25.6	31.0	15.1	32.2	47.2	38.2	7.1	26.3
2004	13.2	8.2	31.5	10.9	1.7	18.0	2.6	13.2	19.9	24.3
2005	-6.4	3.6	31.4	6.5	6.5	2.3	1.0	4.4	-5.6	16.8
2006	18.6	14.4	24.2	19.2	7.5	13.3	8.4	18.6	36.8	21.0
2007	-13.2	14.2	34.4	-18.6	7.2	12.0	16.3	22.5	11.9	19.4
2008	-33.5	-15.4	-34.9	-55.3	-22.8	-39.9	-43.1	-45.7	-30.5	-29.0
2009	41.3	14.9	13.8	17.2	19.7	20.9	61.7	48.6	8.9	11.9
2010	27.7	14.1	20.5	12.1	2.9	26.7	10.2	22.2	19.0	5.5
2011	6.1	14.0	4.7	-17.1	12.7	-0.6	2.4	-9.8	6.3	19.9
2012	23.9	10.8	4.6	28.8	17.9	15.3	14.8	15.0	18.3	1.3
2013	43.1	26.1	25.1	35.6	41.5	40.7	28.4	25.6	11.5	13.2
2014	9.7	16.0	-7.8	15.2	25.3	9.8	20.1	6.9	3.0	29.0
2015	10.1	6.6	-21.1	-1.5	6.9	-2.5	5.9	-8.4	3.4	-4.8
2016	6.0	5.4	27.4	22.8	-2.7	18.9	13.8	16.7	23.5	16.3
2017	23.0	13.5	-1.0	22.2	22.1	21.0	38.8	23.8	-1.3	12.1
Annual- ized	6.9	8.7	7.6	4.3	8.0	7.0	2.7	7.3	0.4	7.6

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Sector performance based on total return in USD. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Appendix D1: Contrarian Historical Allocations
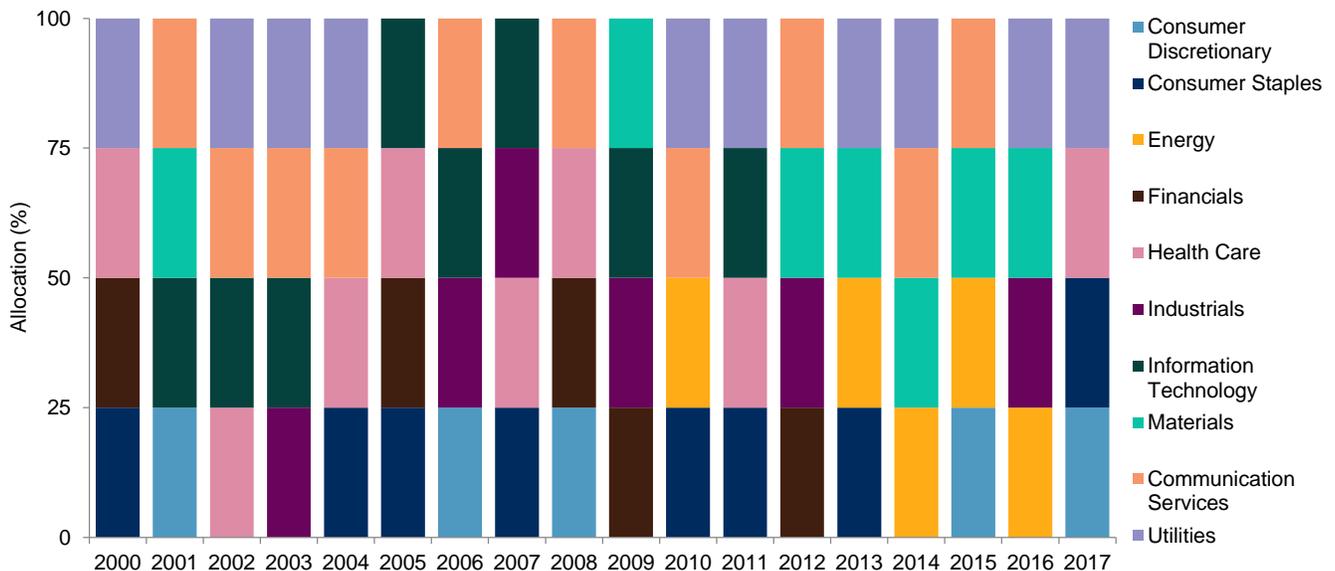
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999 to Dec. 29, 2017. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Appendix D2: Momentum Historical Allocations
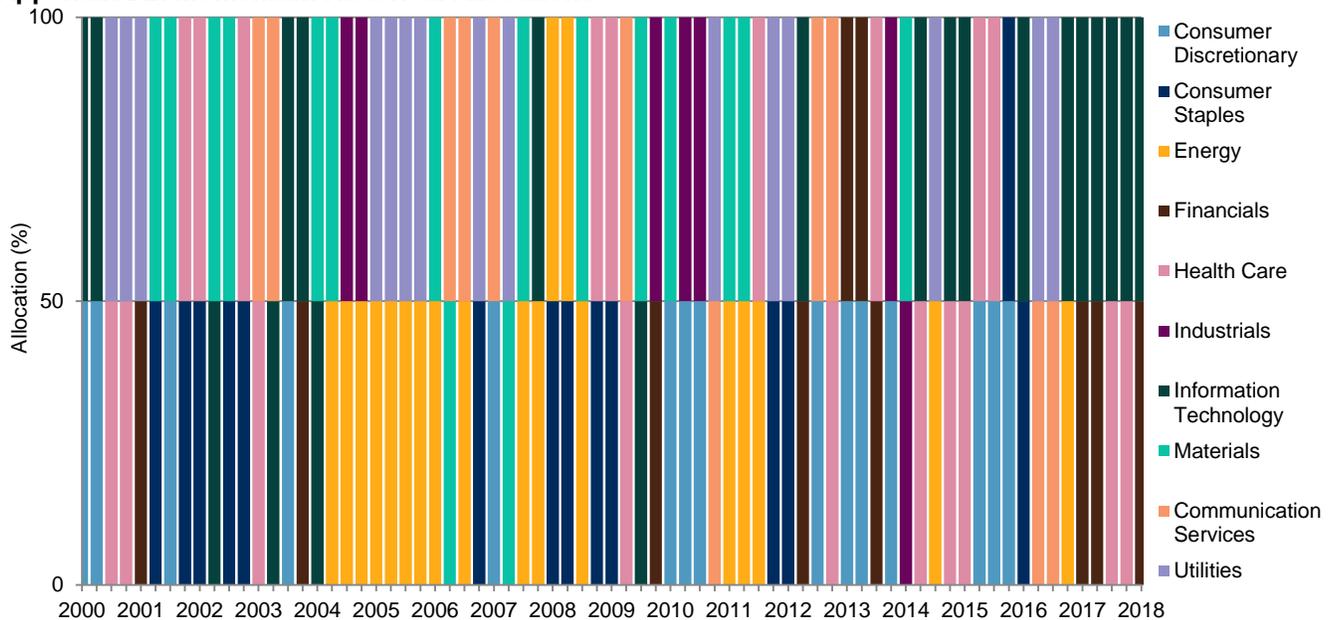
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1999, to Dec. 29, 2017. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Given the economic activity (EA_t) level and the pre-determined U.S. fixed income allocation (FI_t), the allocation along the yield curve is determined as outlined in Appendix E.

Appendix E: Allocations Within Each EAL

INDEX DESIGNATION	WEIGHT DESIGNATION	FIXED INCOME ALLOCATION (FI_T) CONDITION	WEIGHT
EAL 1			
2-Year	W_{2YR}	-	$\text{Min}(\text{FI}_t, 25\%)$
5-Year	W_{5YR}	$\text{FI}_t \leq 25\%$	0%
		$\text{FI}_t > 25\%$	$\text{Min}(\text{FI}_t - W_{2YR}, 50\%)$
10-Year	W_{10YR}	--	$\text{FI}_t - W_{2YR} - W_{5YR}$
30-Year	W_{30YR}	--	0%
EAL 2			
30-Year	W_{30YR}	$\text{FI}_t < 15\%$	$\dfrac{\text{FI}_t}{2}$
		$\text{FI}_t \geq 15\%$	15%
5-Year	W_{5YR}	--	$\dfrac{(\text{FI}_t - W_{30YR})}{4}$
2-Year	W_{2YR}	$\text{FI}_t < 25\%$	0%
		$\text{FI}_t \geq 25\%$	$\text{Min}\left(\dfrac{\text{FI}_t - W_{5YR} - W_{30YR}}{3}, 25\%\right)$
10-Year	W_{10YR}	--	$\text{FI}_t - W_{2YR} - W_{5YR} - W_{30YR}$
EAL 3			
30-Year	W_{30YR}	--	$\text{Min}(\text{FI}_t, 30\%)$
5-Year	W_{5YR}	--	$\dfrac{(\text{FI}_t - W_{30YR})}{3}$
10-Year	W_{10YR}	--	$\text{FI}_t - W_{5YR} - W_{30YR}$
2-Year	W_{2YR}	--	0%

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

Appendix F: S&P DTAQ Hypothetical Fixed-Weight Variants Asset Class Allocations

ASSET CLASS	FIXED WEIGHT IN DTAQ-0% (%)	FIXED WEIGHT IN DTAQ-40% (%)
U.S. Equities	45	27
Developed Ex-U.S. Equities	30	18
Emerging Equities	10	6
Real Estate	5	3
Commodities	5	3
Gold	5	3
U.S. Treasuries	0	40

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

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PERFORMANCE DISCLOSURE

The S&P Emerging BMI was launched December 31, 1997. The Dow Jones U.S. Real Estate Index was launched February 14, 2000. The Dow Jones Commodity Index was launched October 26, 2011. The Dow Jones Commodity Index Gold was launched July 1, 2014. The S&P 500 Consumer Discretionary, S&P 500 Consumer Staples, S&P 500 Energy, S&P 500 Financials, S&P 500 Health Care, S&P 500 Industrials, S&P 500 Information Technology, S&P 500 Materials, S&P 500 Telecommunication Services, and S&P 500 Utilities were launched June 28, 1996. The S&P 500 Equal Weight Index was launched January 8, 2003. The S&P Dynamic Tactical Allocation Index, S&P DTAQ U.S. Equity Sub-Index, and S&P DTAQ Fixed Income Sub-Index were launched June 14, 2017. The S&P 2-Year U.S. Treasury Note Futures Index, S&P 5-Year U.S. Treasury Note Futures Index, and S&P 10-Year U.S. Treasury Note Futures Index were launched March 28, 2011. The S&P U.S. Treasury Bond Futures Index was launched March 28, 2011. All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. Complete index methodology details are available at www.spdji.com. Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live: index values provided for any date or time period prior to the index's Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company's public website or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed "Date of introduction") is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index's public release date.

The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

The Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices LLC maintains the Index and calculates the Index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US $10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US $1,650), the net return would be 8.35% (or US $8,350) for the year. Over a three year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US $5,375, and a cumulative net return of 27.2% (or US $27,200).

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