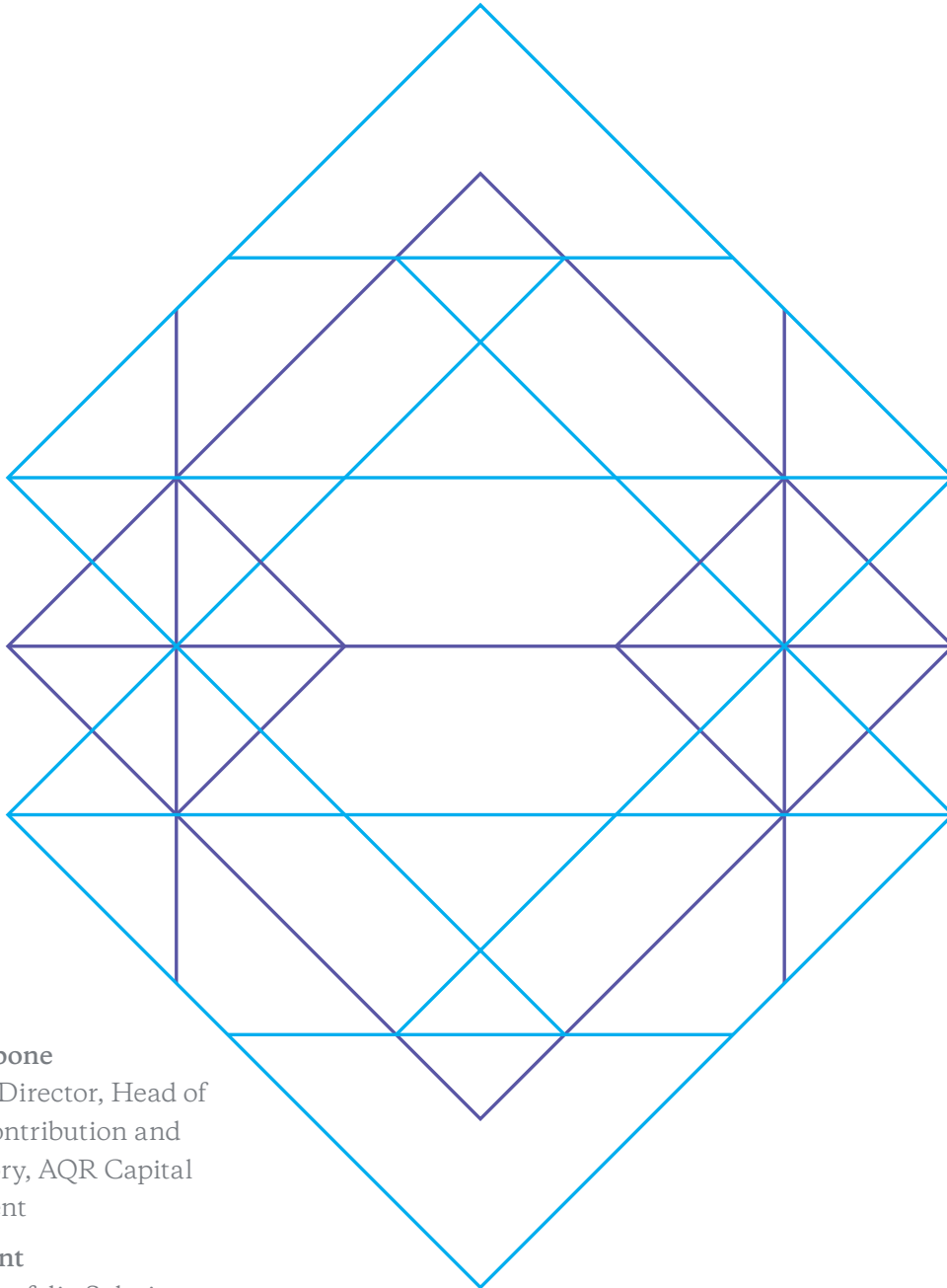




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Trend Following Strategies in Target-Date Funds



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Contents

Introduction	03
Problems with Target-Date Funds: Equity Risk Concentration and Lack of Diversification	04
Part of the Solution: Incorporating Trend Following	07
Trend Following as a Component within a TDF	12
Conclusion	16
Appendix 1	17
Appendix 2	18
Disclosures	20

Introduction

What Is Trend Following?

Trend following is a diversified alternative strategy investing across multiple liquid asset classes.

Trend Following's Role Within a Target-Date Fund (TDF):

- Tendency to offer downside protection during prolonged equity market drawdowns.
- Diversifies return sources and may enhance long-term risk-adjusted returns.

Over a 40-year work life cycle, plan participants investing within Defined Contribution (DC) plans try to maximize their respective retirement outcomes. These outcomes can be summarized in two major areas: 1. wealth accumulation and 2. wealth preservation.

To help achieve these outcomes, plan sponsors have flocked to the target-date fund (TDF) as a solution for participants to save for retirement. Regulatory direction has anointed the TDF as a Qualified Default Investment Alternative (QDIA), which has prompted substantial and ongoing inflows to these types of savings vehicles across the DC plan universe. Callan Associates' DC Index supports the notion of both the increasing prevalence and utilization of TDFs. As of the third quarter of 2015, Callan estimated that 88% of U.S. DC plans tracked included TDFs, with an average allocation to TDFs of 30%. Also in the third quarter of 2015, an estimated 61% of new cash flows to DC plans were allocated to TDFs.¹ Though TDFs have become the most popular DC investing vehicle, we believe that several shortcomings should be addressed to more reliably maximize retirement outcomes.

In this edition of *DC Solutions*, we will focus specifically on the need for TDFs to protect against large equity drawdowns, as well as enhance long-run risk-adjusted returns. We suggest incorporating trend following as a potential solution to these issues and discuss the benefits this may have for participants.

¹ Callan Associates, The Callan DC Index, Q3 2015.

Problems with Target-Date Funds: Equity Risk Concentration and Lack of Diversification

Traditional TDFs enable participants to make a simple, ready-mixed asset allocation choice — selecting the vintage (generally at five-year increments) that most closely approximates their retirement year.

As participants age, their risk tolerance decreases. To reflect this change in risk preference, most traditional TDFs glide from a concentrated equity portfolio — say 90/10 stocks/bonds — to a more capital balanced portfolio, such as 60/40 or even a 50/50 allocation. Yet, even these near-retirement portfolios are not truly balanced: because equities can have approximately three to four times the volatility of bonds, these “moderate” allocations lead to portfolios that are roughly 90% dominated by equity risk.² **Exhibit 1** looks at an average TDF glide path over a 40-year period, from 1975-2014, the typical period for savers during their working career. The top panel shows the glide-path in terms of capital allocations, while the bottom panel shows the risk allocation at retirement at the end of 2014. Even though the portfolio de-risks over time (by reducing its equity allocation), it still suffers from the dominating effects of concentrated equity risk at retirement.

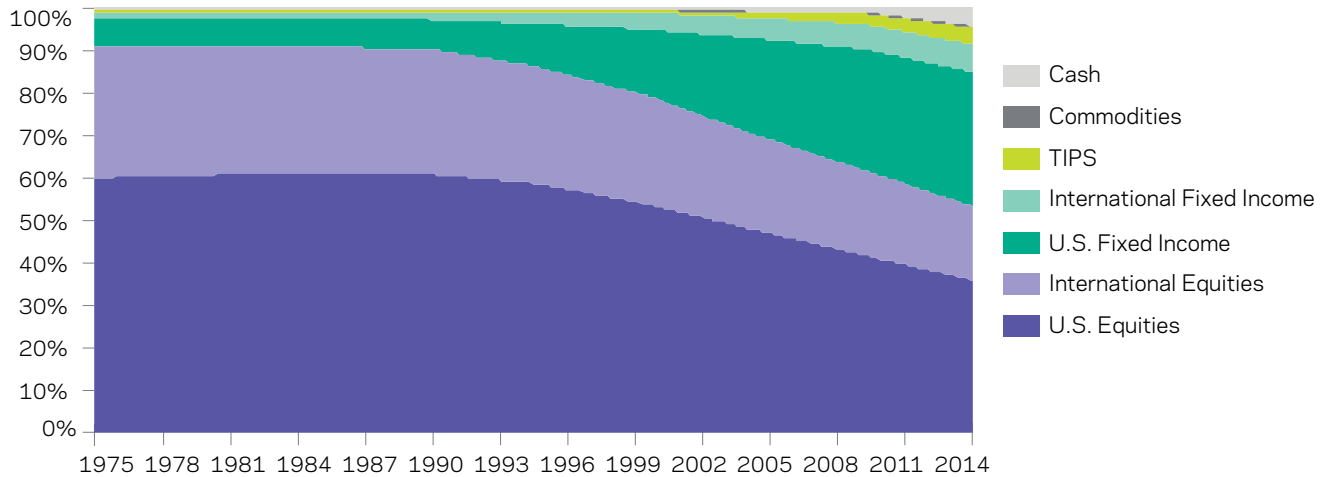
Such concentrated equity risk can leave a portfolio susceptible to equity market drawdowns — events that can have a particularly large impact on participants near retirement, when they have the most money saved and the least amount of time to recoup losses.

Exhibit 2 shows the hypothetical gross performance of the final 10 years of the 40 year glide path from **Exhibit 1** for a participant retiring in February 2009, at the end of the Global Financial Crisis (GFC). The Exhibit shows that a participant would have lost over a quarter of his or her wealth just before retirement. In other words, a hypothetical nest egg of \$162,497, built up over decades of work, would have been reduced to about \$116,987 in just the final 16 months of working life. This sudden loss would have occurred despite the fact that the TDF would have been most concentrated in bonds during this period (at least when concentration is measured by dollars), and therefore would be at its lowest overall risk level. **Exhibit 3** shows the amount of time it would have taken for a participant to recoup this loss and get back to his or her peak level of savings seen just before the GFC, given different assumed annual rates of return. Unfortunately, those near retirement are exposed to the greatest dollar losses, and also have the fewest working years to recoup them.

² Volatility is just one important measure in determining the risk of an asset. Throughout this paper, “risk” is measured as the volatility (standard deviation) of returns. However, the concepts presented extend to other measures of risk such as marginal risk contribution, value-at-risk (VaR), stress test based loss estimates, and other measures of risk. These risk exposures are based on AQR volatility and correlation estimates and are for illustrative purposes only.

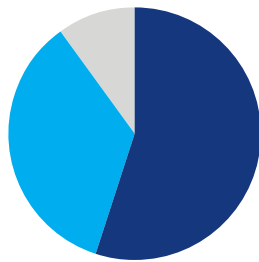
Exhibit 1

Capital Allocation of a Traditional TDF Glide Path
(Average across Three Largest TDF Providers)

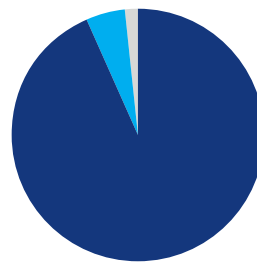


Even at Retirement, TDFs May Seem Diversified...

...But in Practice, Their Risk is Still Driven by Equities



How Dollars are Allocated



How Risk is Allocated

- Equities
- Fixed Income
- Other (Inflation and Cash)

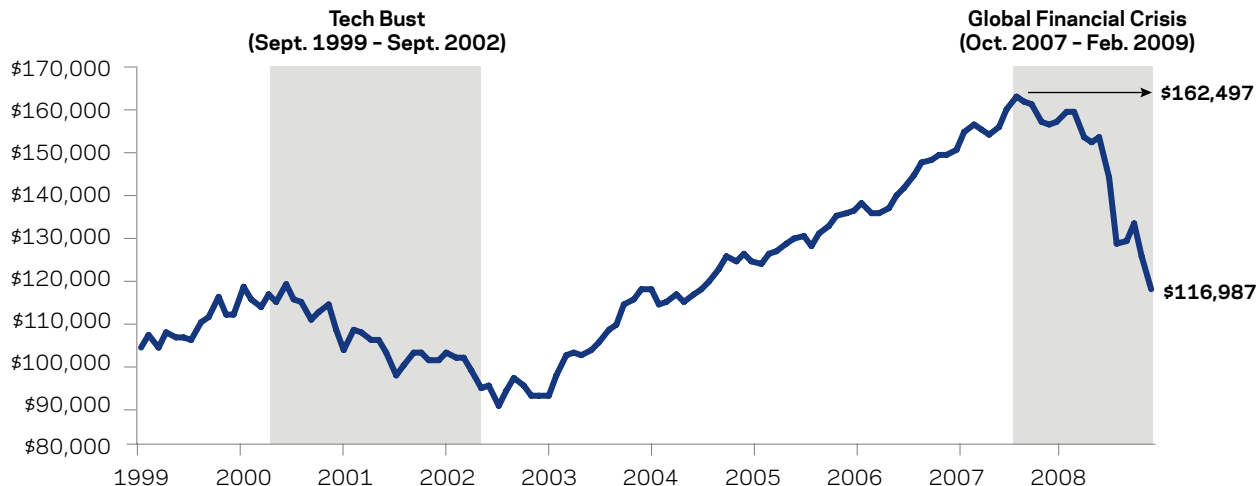
Source: AQR. For illustrative purposes only and not representative of any AQR product or investment. The traditional TDF glide path uses the average recommended asset allocation from the three largest providers based on AUM: Fidelity, Vanguard and T. Rowe Price as of June 2015. Risk allocation is based on AQR’s asset class volatility and correlation assumptions.

We believe that reducing equity risk concentration by adding diversifying risk premia may help both preserve wealth during these equity drawdown periods and enhance long-term TDF returns. Together, this means potentially improved final

wealth balances for participants. **Exhibit 4** provides a brief summary of, and the potential ways to address, some of the shortcomings we see in traditional TDFs.

Exhibit 2

Hypothetical Growth of \$100,000 for a Traditional TDF, March 1999 - February 2009



Source: AQR, Bloomberg. Returns are gross of fees and transaction costs. The traditional TDF glide path uses the last 10 years of the average recommended asset allocation from the three largest providers by AUM as of June 2015. Cash is U.S. 3-Month Treasury Bills. Commodities is an equal-weighted composite of 24 commodities. TIPS are simulated using U.S. 10 year yields from Bloomberg and consensus inflation forecasts from Consensus Economics prior to 1998, and are live U.S. TIPS returns thereafter. International Fixed Income is a GDP-weighted composite of Australian, German, Canadian, Japanese, U.K. and U.S. 10-year government bonds, while U.S. Fixed Income is 10 Year Treasuries. International Equities is the MSCI EAFE (net) Index and U.S. Equities is the S&P 500 TR. Hypothetical performance results have inherent limitations, some of which are disclosed at the end of this document. Past performance is not a guarantee of future performance.

Exhibit 3

Time to Recoup Losses

Annual Rate of Return	Years to Recoup Loss
2.0%	16.6
5.0%	6.7
7.0%	4.9
10.0%	3.4

For illustrative purposes only.

Exhibit 4

Shortcomings of Traditional Target-Date Funds

Shortcomings of TDF's	Proposed Improvement
Losses during equity drawdowns	Include assets which can offset equity risk concentration
Poorly diversified asset allocation	Provide exposure to new sources of return
Insufficient final retirement wealth	Enhance returns with alternative strategies

Source: AQR. This list is not all encompassing. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not indicative of future results.

Part of the Solution: Incorporating Trend Following

A well-constructed trend following strategy may help address these shortcomings. Trend following is a long and short alternative strategy which invests in a diversified set of liquid forwards and futures contracts across global equities, global fixed income, and currencies. The strategy primarily goes long assets with recent positive returns and short assets with recent negative returns.

Trend following has historically been one of the most diversifying strategies to the assets in a traditional TDF, and the strategy also has a valuable tendency to perform well during prolonged drawdown periods for traditional assets. The strategy has also generated attractive risk-adjusted returns over time (see Exhibit 6). These benefits mean that allocating to a trend following strategy within a traditional TDF may allow DC plan participants to better preserve wealth during drawdowns without sacrificing long-run returns, thus accumulating more wealth over their working lives.

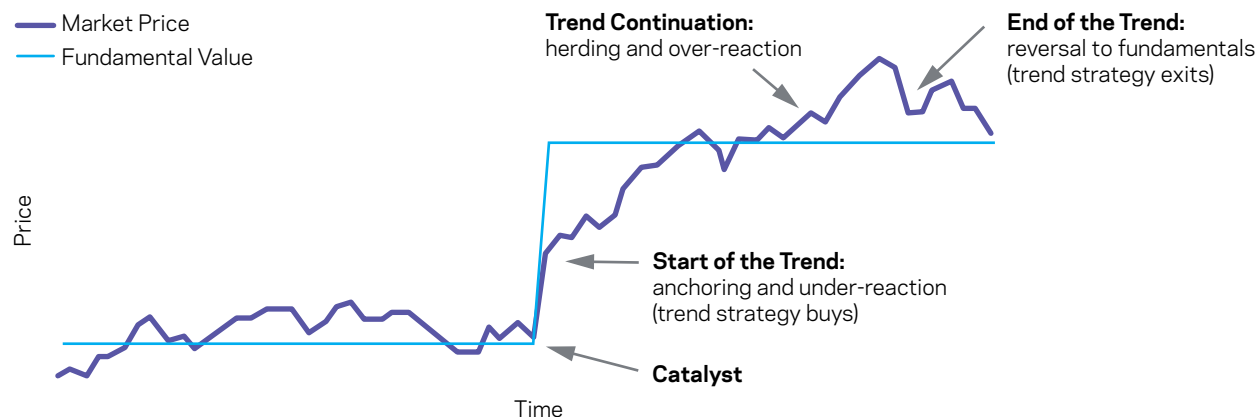
What Is Trend Following?

A trend following investment strategy seeks to profit from the tendency of markets to exhibit price trends. We believe that these trends exist because of both behavioral biases and non-profit-seeking market participants (such as central banks and hedgers). **Exhibit 5** diagrams the hypothetical life cycle of a trend. As the diagram shows, investors may initially under-react to new information, such as updated earnings or a change in interest rates due to documented behavioral biases such

as “anchoring” and the “disposition effect” (see Appendix for a more detailed explanation of these). This initial under-reaction means that new information can create trends that last beyond the initial positive or negative price performance. Price movements thereafter are often impacted by additional behavioral biases, such as investor herding, which may create an over-reaction which prolongs trends and causes them to persist past an asset’s fundamental value. Finally, we see evidence of trends reversing after this period of over-reaction, which is one of the main risks to a trend following strategy. This aspect is important to the AQR portfolio construction and risk management processes, which we will discuss later.

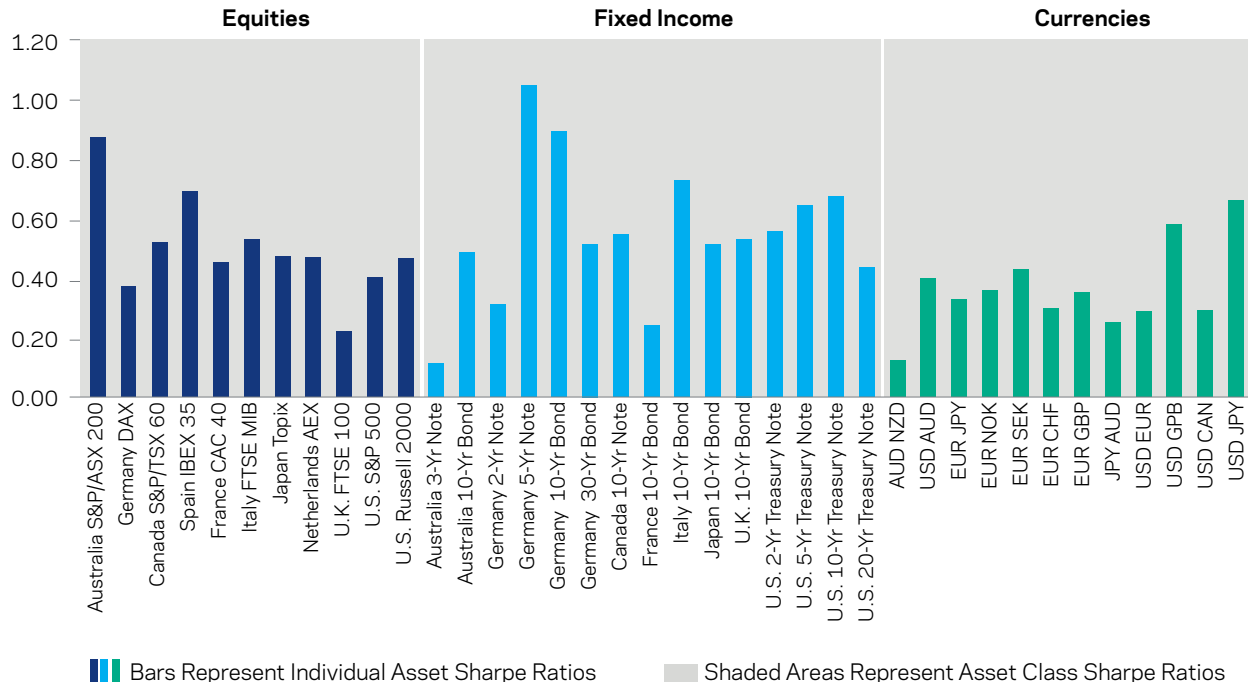
We find strong evidence of trends across asset classes throughout the 135 years of history for which we have financial market data. **Exhibit 6** shows the long-run Sharpe ratios of trend following strategies in 38 markets across three broad asset classes — equity indices, government bonds and currencies. It’s noteworthy that for every asset we test, we see a positive long-run expected return for trend following in that asset. Additionally, the shaded regions represent the long-run Sharpe ratios from combining trend following in all individual assets within an asset class. Because of the benefits of diversification, the Sharpe ratios for broad asset classes are generally higher than they are for individual assets. Hence, there is also strong evidence in favor of implementing a trend following strategy across a broadly diversified portfolio of assets.

Exhibit 5 Hypothetical Life Cycle of a Trend



Source: AQR. The chart above is a hypothetical illustration and not representative of an actual investment. Please read important disclosures at the end of this presentation.

Exhibit 6 Trend Following Sharpe Ratios for Individual Assets and Asset Classes, January 1880 - June 2015



Source: AQR. The Sharpe ratios are based on the Hypothetical Trend Following Strategy backtest, gross of fees and estimated transaction costs. This analysis is provided for illustrative purposes only and is not based on an actual portfolio AQR manages. Markets considered only where data existed during the time period. Please read performance disclosures in the Appendix for a description of the investment universe and the allocation methodology used to construct the Trend Following Strategy. Hypothetical data has inherent limitations, some of which are disclosed at the end of this paper. Sharpe ratios use 3-month U.S. Treasury Bills as the risk-free rate and are based on the average annual return and volatility for the full period that asset class data is available. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not indicative of future results.

Such a diversified trend following portfolio has also demonstrated a valuable ability to deliver positive returns during prolonged drawdowns for traditional portfolios. In other words, historically trend following strategies have often been positioned short during drawdown periods for traditional portfolios (which, due to equity risk concentration, are typically the same as equity drawdown periods).

Exhibit 7 shows the hypothetical performance of a trend following strategy across equity indices, government bonds and currencies during the 10 worst drawdowns for a traditional 60/40 portfolio since 1880. Trend following delivered positive performance in eight of the ten worst drawdowns. The two exceptions, the recession of 1937-1938 and the crash of 1987, provide two examples of when trend following did not perform well. One is during a series of quick sharp reversals over a very short period of time, such as during the crash of 1987. Another is during a series of reversals which

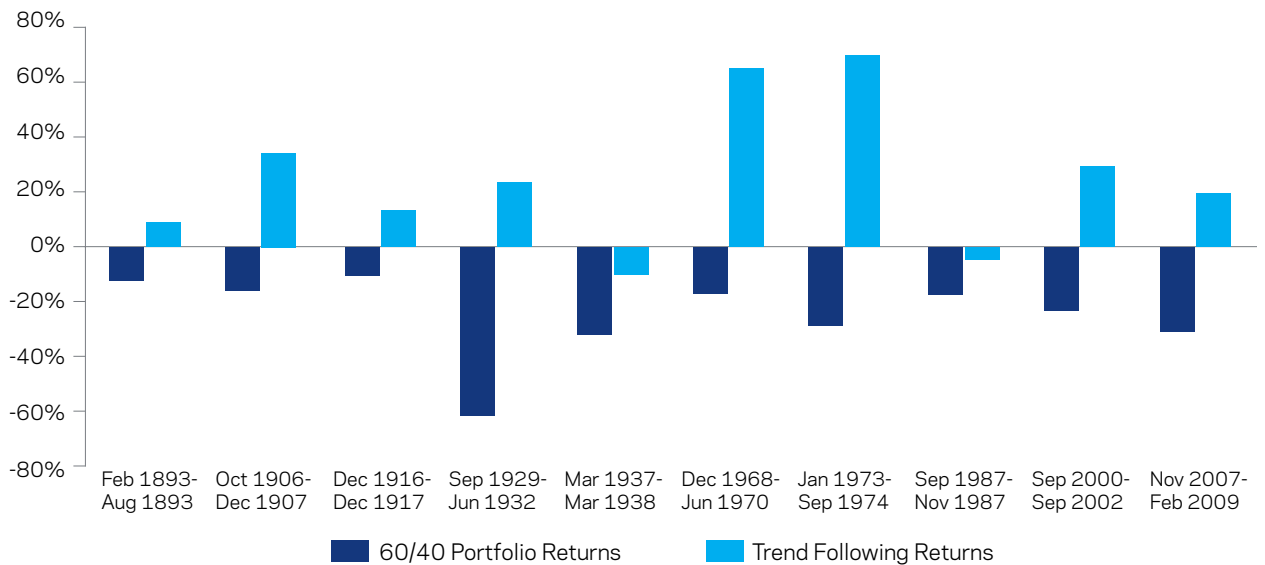
happen over a longer term period, such that by the end, markets haven't exhibited a clear direction. Both are environments in which trend following might not perform well.

Constructing a Trend Following Strategy — The AQR Approach

At AQR, we believe a trend following strategy should focus on two major objectives: providing protection during prolonged equity drawdowns and delivering attractive risk-adjusted returns over time. In order to achieve these objectives, we believe it's critical for the strategy to be diversified across both asset classes and trend horizons. As mentioned previously (see Exhibit 6), trend following has historically worked well across a wide variety of assets, and trend following strategies may achieve better risk-adjusted returns when they are diversified across asset classes. Therefore, our

Exhibit 7

Hypothetical Performance during the 10 Largest Drawdowns for a U.S. 60/40 Portfolio, January 1880 - December 2015



Source: AQR. The Hypothetical Trend Following Strategy performance is a discounted backtest, gross fees and net of estimated transaction costs (as described in Appendix 2). The 60/40 portfolio has 60% of the portfolio invested in S&P 500 and 40% invested in U.S. 10-year bonds. The portfolio is rebalanced to the 60/40 weights at the end of each month, and no fees or transaction costs are subtracted from the portfolio returns. Please read performance disclosures in the Appendix for a description of the investment universe and the allocation methodology used to construct the Trend Following Strategy. Markets considered only where data existed during the time period. Chart is provided for illustrative purposes only and is not based on an actual portfolio AQR manages. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix hereto. Past performance is not a guarantee of future performance.

Exhibit 8

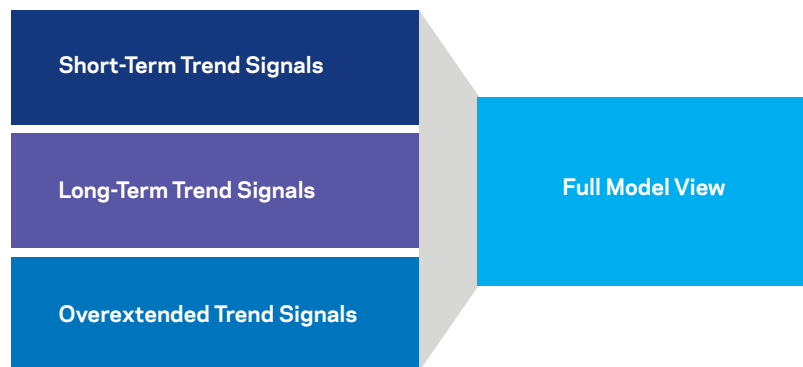
Assets Included in AQR's Trend Following Strategy

Currencies	Equities	Fixed Income
Developed Countries	Developed Country Indices	Government Bond Futures
Australia	Australia (ASX SPI 200)	3-Yr (AUS)
Canada	Canada (S&P/TSX 60)	10-Yr (AUS)
Euro	Europe (EuroStoxx 50)	2-Yr (Euro)
United Kingdom	France (CAC 40)	5-Yr (Euro)
United States	Hong Kong (Hang Seng)	10-Yr (Euro)
New Zealand	Germany (DAX)	30-Yr (Euro)
Norway	Italy (FTSE/MIB)	10-Yr (U.K.)
Sweden	Japan (TOPIX, Nikkei)	10-Yr CGB
Japan	MSCI EAFE	10-Yr (France)
Emerging Countries	Netherlands (AEX)	10-Yr JGB
Brazil	Spain (IBEX 35)	10-Yr (Italy)
Chile	Sweden (OMX30)	2-Yr Note (U.S.)
Colombia	United Kingdom (FTSE 100)	5-Yr Note (U.S.)
Czech Republic	United States (S&P 500, S&P 400, NASDAQ 100, Russell 2000, DJIA)	10-Yr Note (U.S.)
Indonesia	Emerging Country Indices	20-Yr Bond (U.S.)
Israel	Brazil (Bovespa)	Ultra Long Bond (U.S.)
Korea	China (HSCEI, FTSE China A Share)	Short-Term Interest Rate Futures
Malaysia	India (Nifty)	Euro (7 contracts)
Mexico	MSCI Emerging	Switzerland (3 contracts)
Philippines	Singapore (MSCI)	United Kingdom (7 contracts)
Poland	Taiwan (MSCI)	United States (7 contracts)
Singapore	South Africa (All Share)	Canada (2 contracts)
South Africa	South Korea (KOSPI200)	Australia (2 contracts)
Taiwan		
Turkey		

Source: AQR. Specific exposures and asset classes are subject to change. Diversification does not eliminate the risk of experiencing investment losses.

Exhibit 9

Signal Types within AQR's Trend Following Strategy



Source: AQR. For illustrative purposes only. These signals are elements of the strategy and will not always lead to successful investing.

trend following strategy includes all the assets shown in **Exhibit 8**. This means the strategy is not reliant on trends in any single market at any time, but rather exposed to a wide variety of trends across asset classes.

Along with diversification across asset classes, we strongly believe in diversification across trend horizons. As shown in **Exhibit 9**, AQR's trend following strategy includes three signal types: short-term trend signals, long-term trend signals, and overextended trend signals. Short- and long-term trend signals analyze price movements over various horizons within the past year and aim to take advantage of continuation in these price movements. Overextended trend signals try to determine if a trend has extended too far past fundamentals and might be more likely to reverse. The overextended trend signals can therefore help

protect the strategy from sudden trend reversals — the types discussed earlier which can negatively affect the performance of trend following strategies. The strategy takes input from all three signal types in order to form an aggregate position in each asset.

When combining the full model views for each asset (see Exhibit 8), we use the foundational elements of AQR's portfolio construction: risk balancing and volatility targeting. Risk balancing means that each asset's position is based on our short-term volatility forecast, which helps ensure that each asset class contributes meaningfully to the strategy. Risk targeting helps keep the strategy's aggregate risk level more consistent over time. Additional layers of risk management are embedded in every aspect of our portfolio construction process, which includes a number of risk limits at the position, asset class, and the overall portfolio levels.

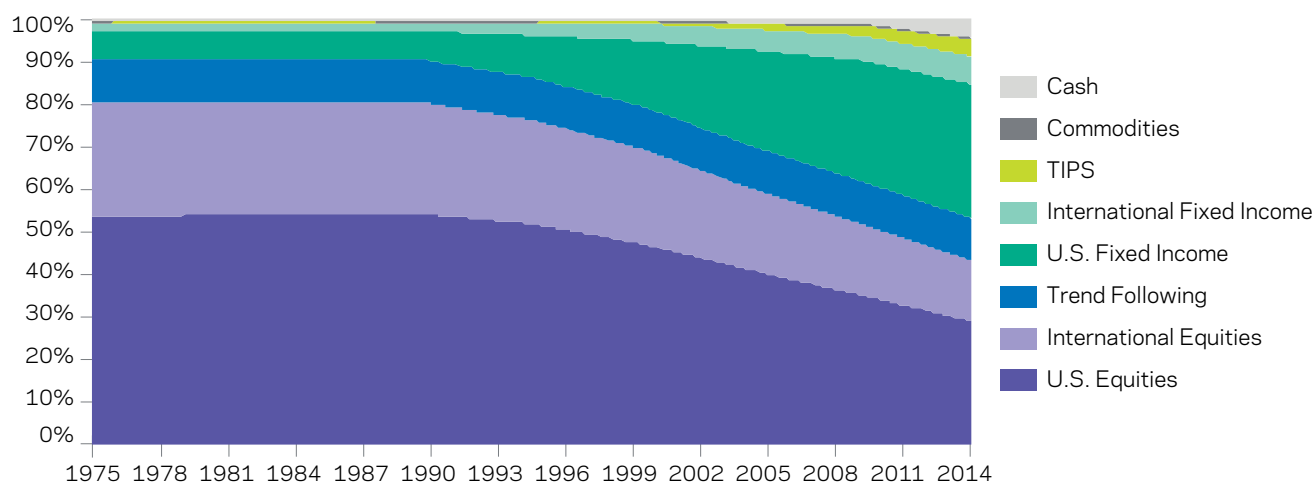
Trend Following as a Component within a TDF

Up to this point, we have described trend following, discussed why investors should care about this strategy in the context of retirement plan investing, and outlined our approach to constructing a trend following strategy. Now we want to focus on the best way to implement it within the framework of a TDF.

An important decision in implementing a trend following strategy within a TDF is deciding where to fund an allocation from. As discussed earlier, equities contribute most of the risk to traditional TDFs, and this risk concentration leaves traditional TDFs susceptible to large losses during equity drawdowns. Therefore, the case for diversification

points toward funding from equities. However, this presents a different problem in that equity allocations glide down near retirement, which is precisely when having drawdown protection becomes most critical. For that reason, we believe the best approach is to fund the trend following allocation from equities and to keep it consistent over time. In other words, as capital moves from the equity sleeve to the fixed income sleeve, the allocation to trend following remains constant. This way, the ratio of trend following to equities increases slightly over time, as the trend following allocation remains constant while the equity allocation declines.

Exhibit 10
Glide Path with 10% from Stocks Re-allocated to a Trend Following Strategy



Source: AQR. For illustrative purposes only and not representative of any AQR product or investment. Trend Following is a discounted backtest that is gross of fees and net of transaction costs (as described in Appendix 2). Cash is U.S. 3-Month Treasury Bills. Commodities are an equal-weighted composite of 24 commodities. TIPS are simulated using U.S. 10 year yields from Bloomberg and consensus inflation forecasts from Consensus Economics prior to 1998, and are live U.S. TIPS returns thereafter. International Fixed Income is a GDP-weighted composite of Australian, German, Canadian, Japanese, U.K. and U.S. 10-year government bonds, while U.S. Fixed Income is 10 Year Treasuries. International Equities is the MSCI EAFE (net) Index and U.S. Equities is the S&P 500 TR.

Selecting a volatility target for a trend following strategy is a bit more difficult, and to some extent relies on whether participants are more interested in lower risk or greater returns. In this paper, we suggest a trend following strategy with a 10% volatility target, which is close to the volatility of a traditional TDF.³ The resulting TDF glide path, with a 10% static allocation to trend following, is illustrated in **Exhibit 10**.

These implementation choices may not be a “one size fits all” solution. Plan sponsors may prefer to allocate pro-rata from all assets in the TDF, or to a trend following strategy with a higher or lower risk target. Regardless of these implementation choices, the broader benefits of a trend following strategy in a TDF will still hold.

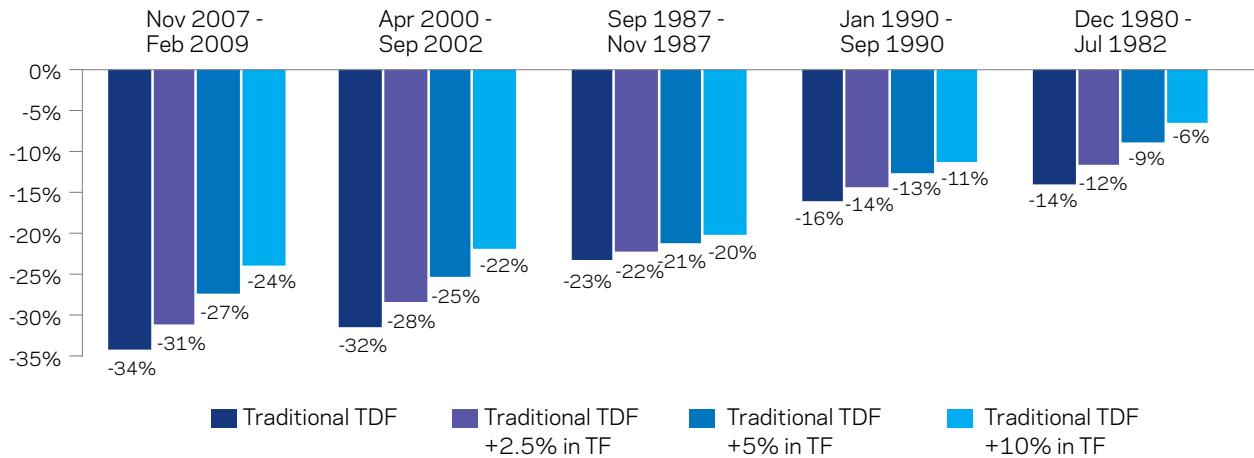
Benefit #1: Trend Following May Help Preserve Wealth during Equity Drawdowns

As previously discussed, equity drawdowns can lead to significant loss of retirement wealth, especially when they occur towards the end of participants’ working life cycles, when they have the most to lose. Historically, trend following has often been positioned short during prolonged equity drawdowns, meaning that the strategy’s incorporation in a traditional TDF can help make drawdowns during these periods less severe.

Exhibit 11 shows the five worst drawdowns for the cohort retiring at the end of 2014. In each case, an allocation to trend following would have made the drawdown less severe. The analysis assumes that

Exhibit 11

Returns during the Five Worst Drawdowns for a Traditional TDF, January 1975 - December 2014



Sources: AQR, Bloomberg. Returns are calculated gross of fees; if fees were included, the results would be lower. The analysis assumes that the participant worked for 40 years and stayed invested throughout the period (1975-2014) prior to their retirement year. The traditional TDF glide path uses the average recommended asset allocation from the three largest providers by AUM as of June 2015. The glide path with Trend Following re-allocates 5 / 10 / 15% of global and U.S. equities towards trend following. Hypothetical performance results have inherent limitations, some of which are disclosed at the end of this document. The Trend Following Strategy performance is a discounted backtest, gross of fees and net of transaction costs (as described in Appendix 2). This analysis is provided for illustrative purposes only and is not based on an actual portfolio AQR manages. Please read performance disclosures in the Appendix for a description of the investment universe and the allocation methodology used to construct the Trend Following Strategy and for details on the construction of the U.S. Equity series. Markets considered only where data existed during the time period. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix. There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not indicative of future results.

3 There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected.

the participant worked for 40 years and remained invested throughout the period. Less severe drawdowns during these periods can help preserve retirement wealth, allowing participants to protect more of their savings during these tough times for their portfolios. They can also help partially offset a significant drop in real ending wealth for participants who are unlucky enough to retire just after drawdown periods.

Benefit #2: Trend Following May Enhance Long-run Risk-Adjusted Returns

In addition to helping preserve wealth during drawdown periods, a diversified trend following strategy may also help lower TDF volatility and enhance long-run returns. It's important to note that the balance between risk reduction and return enhancement will be largely determined by the specific volatility target of the trend following strategy added.

Exhibit 12 shows how the inclusion of a diversified 10% volatility trend following strategy may benefit a traditional TDF in terms of risk, return, risk-adjusted returns (Sharpe ratios), and real ending wealth.⁴ It focuses on the cohort retiring at the end of 2014 and assumes that participants worked over 40 years and stayed invested throughout the period. It looks at the traditional TDF as well as three additional glide paths, each with a static trend following allocation funded from equities.

Even in small increments, including a trend following strategy could have potentially reduced risk while also earning slightly better returns. As discussed earlier, the trend following strategy is itself diversified across both asset classes and trend horizons, allowing it to add attractive returns over time when included in a traditional TDF. The strategy is also *diversifying* to both stocks and bonds, which means it can help reduce risk when incorporated in the framework of a traditional TDF. These two features contribute to the outcomes shown in Exhibit 12, which include better Sharpe ratios and greater real ending wealth.⁵

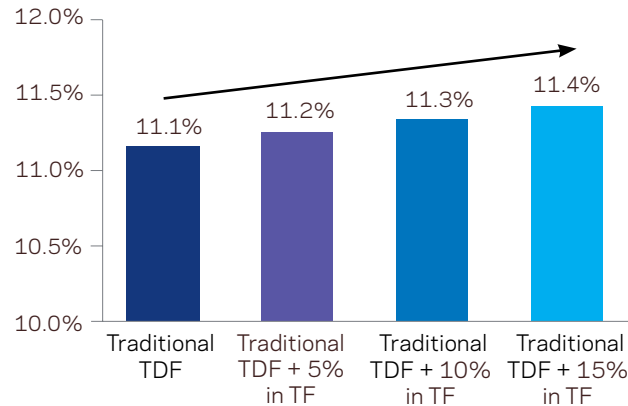
⁴ Mathematically, the Sharpe ratio is the annualized return in excess of cash (total return – risk-free return) divided by the annualized standard deviation (or volatility) of returns.

⁵ There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not indicative of future results.

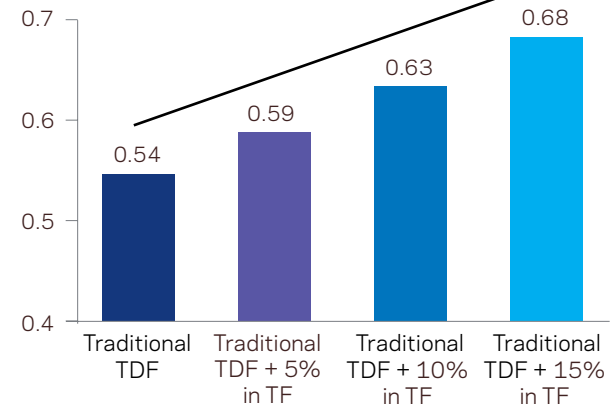
Exhibit 12

Key Portfolio Statistics for Cohort Retiring December 2014,
January 1975 - December 2014

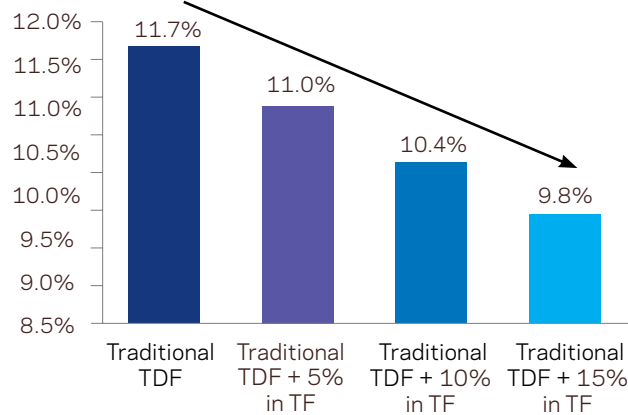
Annual Total Returns, 1975-2014



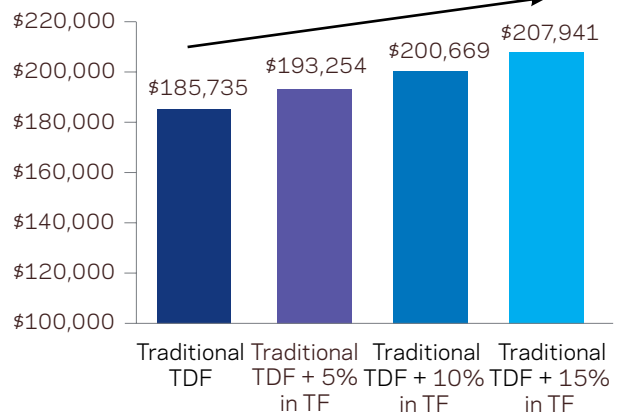
Sharpe Ratios, 1975-2014



Annual Volatility, 1975-2014



Annual Volatility, 1975-2014



Sources: AQR, Bloomberg. Returns are calculated gross of fees; if fees were included, the results would be lower. The analysis assumes that the participant worked for 40 years, contributed \$1000 at the start of each year, and stayed invested throughout the period (1975-2014) prior to their retirement year. The traditional TDF glide path uses the average recommended asset allocation from the three largest providers by AUM as of June 2015. The glide path with Trend Following re-allocates 5 / 10 / 15% of global and U.S. equities towards Trend Following, which is based on a discounted backtest that is gross of fees and net of estimated transaction costs (as described in Appendix 2). Hypothetical performance results have inherent limitations, some of which are disclosed at the end of this document. Past performance is not a guarantee of future performance.

Conclusion

We believe that implementing a trend following strategy within a TDF can help to better preserve wealth during equity drawdowns and improve long-run risk-adjusted returns. The strategy is able to do this by introducing a new source of returns that is uncorrelated to traditional asset classes and has a valuable ability to go short during drawdowns.

To achieve these results, it is important to select a trend following strategy that is diversified across both asset classes and trend horizons. Broad diversification within the strategy means that results are not contingent on any one asset trending over a particular horizon, but that the strategy can

instead capture the historical tendency of a broad range of assets to exhibit price trends.

With TDF prevalence and usage rates higher than ever, it is increasingly important to address both exposure to equity drawdowns and under-diversification. Incorporating a trend following strategy can both help mitigate potentially catastrophic drawdowns, as well as enhance long-run diversification to allow participants to achieve greater real ending wealth.

Why AQR for Defined Contribution?

AQR is a custom retirement investment solutions provider. We focus on both nontraditional investment solutions and innovative long-only, style-based investment capabilities to address retirement savings risks.

Our approach to investing — meaningfully diversified, long-term and disciplined — seeks to help investors retire comfortably and soundly.

Appendix 1

Additional Details on Behavioral Biases

As shown in Exhibit 5 and discussed previously, we believe that several behavioral biases may account for the long-run returns of trend following strategies. Three of the most important biases are described in detail below:

Anchoring

Anchoring is when investors rely too heavily on initial information, thereby failing to adapt to new information quickly. In other words, investors may be “anchored” to the information they already have and slow to acknowledge the importance of newer information in determining an asset’s value. For example, they may be slow to adjust to a new earnings report, thereby initially failing to fully incorporate this news into a company’s stock price.

Disposition Effect

The disposition effect refers to the tendency of investors to sell “winners” too quickly and hold onto “losers” for too long. In the case of “winners”, investors may be immediately eager to realize profits, thereby selling before the asset has fully realized its fundamental value. In the case of “losers”, investors may be initially hesitant to take losses, thereby holding an asset for longer than they ordinarily would in the hopes that it will turn around. In both cases, the disposition effect may lead to an initial under-reaction to a change in fundamental value, as investors who sell too quickly on positive news prevent an asset from realizing its full value, just as investors who hold an asset too long after negative news prevent the asset from falling all the way to its new fair value price.

Herding

Herding (or the bandwagon effect) refers to the increasing rate at which investors adopt the views of other investors as those views become more prevalent. Therefore, as a position in a particular asset becomes more widely held, investors may become more likely to themselves establish a similar position. This phenomenon can prolong trends, causing them to persist past an asset’s fundamental value.

Appendix 2

Trend Following Backtest

The Trend Following Strategy was constructed with an equal-weighted combination of 1-month, 3-month, and 12-month Trend Following strategies for 38 markets across 3 major asset classes — 11 equity indices, 15 bond markets, and 12 currency pairs — from January 1880 to June 2015. Since not all markets have return data going back to 1880, we construct the strategies using the largest number of assets for which return data exist at each point in time. We use futures returns when they are available. Prior to the availability of futures data, we rely on cash index returns financed at local short rates for each country.

In order to more accurately reflect expectations for the strategy going forward, we discount the backtest. The average return from 1880 to 2015 is discounted by approximately 26%. This discount factor was chosen because it yields a similar Sharpe ratio as applying a 2% management fee and 20% performance fee. The backtest is also net of estimated transaction costs. The transaction costs used in the strategy are based on AQR's 2012 estimates of average transaction costs for each of the four asset classes, including market impact and commissions. The transaction costs are assumed to be twice as high from 1993 to 2002 and six times as high from 1880-1992, based on Jones (2002). The transaction costs used are as follows:

Asset Class	Time period	One-Way Transaction Costs (as a % of notional traded)
Equities	1880-1992	0.34%
	1993-2002	0.11%
	2003-2015	0.06%
Bonds	1880-1992	0.06%
	1992-2002	0.02%
	2003-2015	0.01%
Currencies	1880-1992	0.18%
	1993-2002	0.06%
	2003-2015	0.03%

The 2014 estimate of assets under management in the BarclayHedge Systematic Traders index is \$280 billion. We looked at the average monthly holdings in each asset class (calculated by summing up the absolute values of holdings in each market within an asset class) for our time series momentum strategy since 2000, run at a NAV of \$280 billion, and compared them to the size of the underlying cash or derivative markets. For equities, we use the total global equity market capitalization estimate from the October 2014 World Federation of Exchanges (WFE) monthly statistics tables. For bonds, we add up the total government debt for the 15 developed countries with the largest debt using Bloomberg data. For currencies, we use the total notional outstanding amount of foreign exchange derivatives, excluding options, which are U.S. dollar denominated in the first half of 2014 from the Bank for International Settlements (BIS) November 2014 report.

	Average Position Size in \$280B Time Series Momentum Portfolio (bn)	Total Market Size (bn)	Percentage of Total Market
Equities	99	63,000	0.2%
Bonds	758	33,000	2.3%
Currencies	226	62,000	0.4%

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