Q-Series
What times the bond market?

Equities

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The impact of interest rate changes on the profitability of systematic strategies
The recent 35-year bond rally has been driven **equally** by two components: falling yields (positive trend signals) and upward sloping yield curves (positive carry signals). It has therefore directly benefitted systematic fixed-income strategies, like trend-following or carry, but the implications of its underlying signals can be significant across asset classes, including credit and equities. This becomes more critical now that bond yields have started increasing, hence causing **signal disagreement**. How impactful is this?

The backward-looking view: 160 years of a backtest on bond trend and carry
Using data back to 1857, we conduct – possibly – the longest backtest of systematic bond strategies. Trend and carry long/short signals can significantly improve the performance of a long-only bond strategy. The performance is even stronger when the signals agree; this agreement occurs more often than possibly expected (two thirds of the time) and lasts on average for 8 months. Conversely, an investor should reduce the risk on bonds in periods of signal disagreement. At the time of writing, US bond trend and carry signals disagree. But fear not! It is probably a transient state, as disagreement only occurs roughly one third of the time, and lasts on average 3 to 4 months.

The forward-looking view: the relative strength of signals and the macro view
One way to tackle the signal disagreement is by looking more closely at their relative strength. Our **Macro Strategy team** argues that US bond term premia have once again turned positive and thus, US bonds may offer higher levels of carry. This suggests overweighting the carry signal at the current environment and taking a long position.

The implications of the current signal disagreement for credit and equities
Our **Credit Strategy team** believes the trend in Treasury yields is unlikely to persist in the medium term, as corporate leverage and interest coverage levels are nearing cycle peaks. The team prefers 7-10yr over 30yr US IG debt, higher quality and lower duration sectors, and senior-secured floating-rate bank loans over US HY. As for equities, our **Equity Strategy team** argues that while the Bull market is not likely to end in 2017, incremental caution is warranted. Since 1981, extended periods of signal disagreement have often been followed by higher market volatility, with Health Care, Financials and Technology sectors outperforming; a list of UBS's top picks in these sectors is included.

Executive Summary

The first few pages of this report provide a quick overview of the analysis. We present the facts, the research questions, the findings, and our forward-looking view. All that, backed with possibly the longest ever backtest: 160 years of data.

The core of the paper starts on page 7

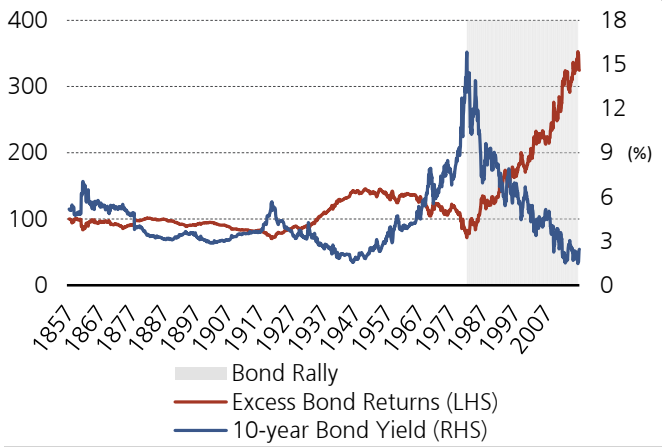
The facts

A. The 35-year Bond Rally

Yields fall, bond prices rally

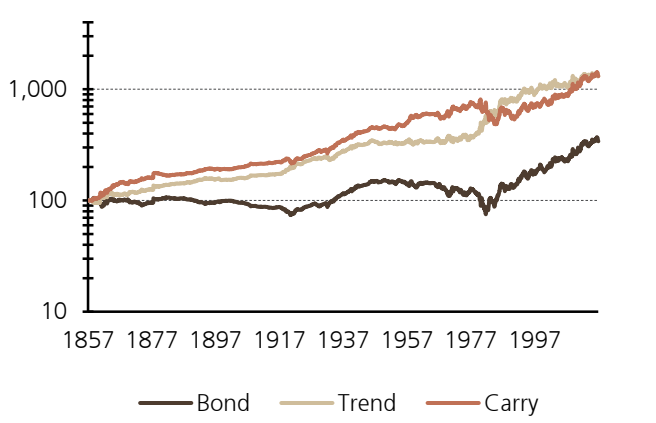
Since September 1981, the 10-year US Government bond yield has exhibited a strong long-term fall from the highs of 15.85% down to 1.46% at the end of July 2016. The mirror image of this fall has been the great bond rally (average excess return of 4.84% per annum and a Sharpe ratio of 0.59). Putting this in perspective, this recent 35-year bond rally has been the strongest in history over the last 160 years; see Figure 1 below.

Figure 1: 10-year Bond Yield and Bond Excess Returns



Source: UBS Quantitative Research, Global Financial Data. Data goes from January 1857 to December 2016.

Figure 2: Cumulative Returns for Systematic Strategies



Source: UBS Quantitative Research. The figure presents the cumulative returns of (i) a long-only bond strategy, (ii) a trend bond strategy, and (iii) a carry bond strategy. Sample period: January 1857 to December 2016.

B. There are two important systematic timing signals for bond markets

Pay attention to the bond price moves ("trend") and the steepness of the curve ("carry")

There are two important systematic signals that any investor should keep an eye on when looking at the bond markets, above and beyond any fundamental or macro view. First, the persistence in yield moves generates serial correlation in bond returns; hence, taking a long position when the bond price is trending upwards and a short position when the bond price is trending downwards generates a convex payoff that has been significantly profitable in the history. Second, as a bond naturally "rolls down" the curve, taking a long position when the yield curve (around the vicinity of the 10-year tenor) is upward sloping and a short position when the yield curve is downward sloping has been equally profitable in the history. As a proof of concept, Figure 2 presents 160 years of a backtest for these trend-following and carry bond strategies.

The observation and the research questions

A. Trend and Carry bond strategies have benefitted from the bond rally

The recent 35-year bond rally has been equally driven by two effects. First, the actual fall in the yields has caused the bond prices to go up (all else being equal).

Second, the upward sloping yield curve for most of this 35-year period has generated positive carry to a bond investor.

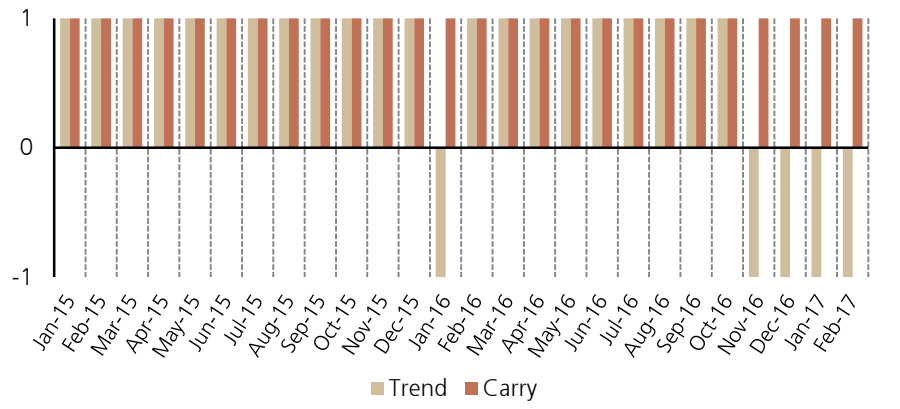
Reversing this observation, trend-following and carry bond strategies have been – for most of the time – on a long position over the 35-year bond rally and it is therefore not surprising that they have both benefitted from it.

B. The research questions

Trends have recently reversed

After July 2016, yields started increasing, eventually causing the bond price trends to turn negative (short trend signal) towards the end of 2016 and the start of 2017, while the yield curve has remained positive (long carry signal); see Figure 3.

Figure 3: Trend and Carry Signals over the recent years



Source: UBS Quantitative Research. The figure presents the trend signal and the carry signal for the 10-year US Government bond, as observed at the end of each month for the period January 2015 to February 2017.

This can potentially cause a challenge for systematic fixed-income strategies. As a result, a question that we, as a quant team, have been receiving more often in the recent months has been along the following lines:

"What would be the impact of a rising rate regime for the profitability of systematic strategies like trend-following and carry, which have been largely benefitted in the recent decades by the great bond rally?"

We can break this question down to two sub-questions:

1. *Are trend and carry genuine bond premia, or simply the lucky outcome of backtests during the 35-year bond rally?*
2. *How impactful is the trend-carry signal disagreement that we are currently observing? Is it here to stay or it is a transient state?*

The findings

A. Are trend and carry genuine bond premia?

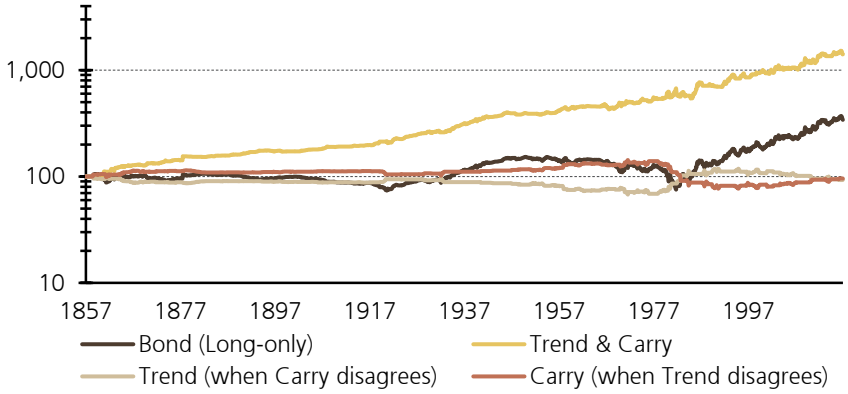
Yes, they are; backed with 160 years of backtest.

In short, absolutely yes. It is not just the past 35-bond rally that benefitted trend and carry strategies. Our 160-year long backtest, already presented in Figure 2 provides strong support in favour of our claim. The timing nature of trend and carry signals can improve significantly the risk-adjusted returns for a bond investor.

Most importantly, we find that, when the two signals agree (both long or both short), the performance of a combined trend & carry strategy is even stronger than each strategy in isolation. Conversely, paying attention to only one of the two

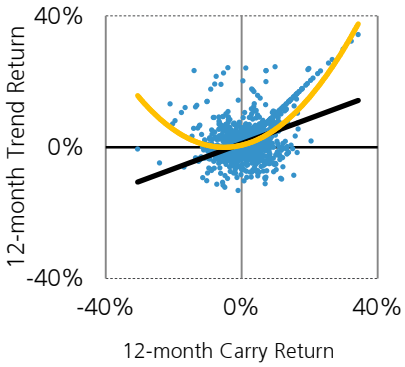
signals, and there is disagreement, generates statistically insignificant returns; see Figure 4. Figure 5 presents a scatterplot between the monthly observed 12-month rolling performance of a trend strategy and that of a carry strategy, and illustrates the diversifying nature of the convex payoff of the former.

Figure 4: Performance when signals agree and when they disagree



Source: UBS Quantitative Research. The figure presents the cumulative returns of (i) a long-only bond strategy, (ii) a trend and carry bond strategy, (iii) a trend bond strategy when the signals disagree, and (iv) a carry strategy when the signals disagree. Sample period: January 1857 to December 2016.

Figure 5: Trend versus Carry



Source: UBS Quantitative Research. The figure presents the scatterplot between the monthly time-series of 12-month rolling returns of the trend and carry strategies. January 1858 to December 2016.

B. How impactful is the trend-carry signal disagreement that we are currently observing? Is it here to stay or is it a transient state?

Clearly, Figure 4 above illustrates that signal disagreement (at least when using the binary long/short definition of the signals) does not lead to outperformance in the long run. However, it is important to know how frequently signal disagreement occurs, and most critically, once we enter a disagreement state, it is important to know how likely it is that we remain in such a state.

Figure 6 shows at the bottom right corner that the signals agree for about two thirds of the time (roughly 68%), whether we look at the entire 160-year sample period or during the 35-year bond rally. This is probably more often than what one would expect. Most importantly, as seen in Figure 7, the state of signal agreement is rather persistent, with the likelihood of remaining at such a state being 88% and the average duration of an agreement period being 8 months based on the past 160 years of backtests.

The trend and carry signals agree for about two thirds of the time

Figure 6: Trend and Carry Signal Agreement and Disagreement

Full Sample: 1857M01 – 2016M12 [Bond Rally: 1981M09 – 2016M07]		Carry		
		Long	Short	Sum
Trend	Long	42.6% [60.6%]	10.6% [7.6%]	53.2% [68.3%]
	Short	21.3% [24.6%]	25.5% [7.2%]	46.8% [31.7%]
	Sum	63.9% [85.2%]	36.1% [14.8%]	68.1% [67.8%]

Source: UBS Quantitative Research. The figure presents the proportion of months that each of the four different regimes (combination of long and short trend and carry signals) has occurred over the full sample, as well as over the 35-year bond rally period [in brackets]. **The bottom-right corner presents the sum across the diagonal**.

Figure 7: Disagreement Stats

Duration	Disagreement	Agreement
Average	3.87	8.33
Median	2	4
75th pct.	5	12
Trans. Matrix	**Disagreement**	**Agreement**
Disagreement	74%	26%
Agreement	12%	88%

Source: UBS Quantitative Research. The Table presents statistics for the duration of periods (in months) with signal agreement and disagreement and the transition matrix between the states.

Conversely, the states of signal disagreement have only occurred for one third of the time historically and are less persistent (74% probability of remaining at a disagreement state in the next month), lasting on average three to four months.

The view going forward for Bonds … and across other asset classes

There are three aspects to it: (a) the view based on our backtests, (b) the forward-looking view after incorporating the views of our Global Macro Strategy team and (c) the implications outside the bond market; views on credit and equity markets.

A. The view based on our backtests

Signal disagreement is not here to stay, at least based on historical norms

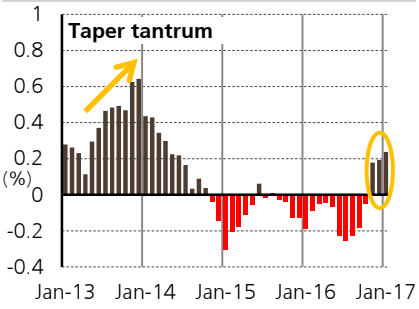
Any bond investor should pay attention to systematic signals like trend and carry. They both have significant market-timing ability and when they agree, they lead to outperformance. When they disagree though, it would be worth reducing the risk allocation to bonds. However, even when those disagreement phases arrive, they tend to be transient and to last only – on average – for a small number of months. So, in the current signal disagreement environment, fear not! Continue tracking the systematic signals and incorporate them in the investment decision process.

B. The view based on the opinions of our Global Macro Strategy team

During such periods of disagreement, as the one observed at the time of writing, it is worth incorporating (a) the relative strength of the signals (as opposed to just their binary long/short definition) and (b) some fundamentally-driven macro views.

Looking at the relative strength of the signals, it is true that the level of carry currently observed is relatively similar to the recent past. Conversely, the increase in the 10-year yield, albeit strong, has been primarily driven by the move during November 2016. Following November 2016, the yield moves have stabilised, gaining 8 basis points in December 2016, 2 basis points in January 2017 and falling, in fact, by 11 points in February 2017.

Figure 8: US Term Premium



Source: UBS Global Macro Strategy. The figure illustrates the level of term premium in the US. The sample period is from January 2013 to January 2017. See the appendix for a longer history and the Big Macro #3 for details on the estimation.

Besides, the recent work of our Global Macro Strategy team shows that with the conclusion of the QE programme in the US and the expectations of monetary tightening becoming more material following the recent rate hikes, the US term premium, which is the component of the yield that compensates an investor for bearing duration risk, has turned positive, since effectively late 2014 (Figure 8). Along these lines, the relatively higher levels of carry observed over the recent period might very well reflect this shift.

Term premia have recently turned positive, so it might be worth overweighting the carry signal

These points seem to argue in favour of overweighting the carry signal at the current environment; and given that the carry signal is long, the active view would be to take long positions on US government bonds (but always control the amount of risk assigned to these positions, given the documented signal disagreement).

C. Implications for credit and equities

Credit Strategy prefers floating-rate loans over US HY, 7-10 year (but not 30 year) US IG debt

Our Credit Strategy team also believes the trend higher in Treasury yields is unlikely to persist in the medium term, as corporate leverage and now interest coverage levels are nearing cycle peaks at a macro level. Given the short-run risk due to the signal disagreement, the team is less comfortable recommending 30 year debt than last year and would move down the duration curve to prefer 7-10 year debt. The team prefers higher quality and lower duration sectors, such as technology and financials. They also prefer senior-secured floating-rate bank loans as an attractive vehicle to capture yield with less duration and credit risk than US HY.

As for equity markets, our US Equity Strategy team argues that the current equity Bull market is not likely to end in 2017, but incremental caution is warranted. This is because, since 1981, extended periods of signal disagreement have exhibited on average positive returns on a 3 to 24 month forward basis, consistent with the

secular equity bull market which began in 1982. However during these periods, which include the Crash of 1987, the 1990 Recession/first Iraq War aftermath, the inflation of the Tech Bubble in 1996-7, and the Global "Recession That Wasn't" in 2010, market volatility rose, often significantly. Given that the S&P 500 is currently trading at 20x trailing 12 months earnings and 18.8x UBSe for 2017, levels typically associated with prior bull market peaks and the VIX remains near cycle lows, the team expresses preference for alpha over beta - companies which can improve their margin profiles or those which are levered to an economic acceleration which is potentially being foreshadowed by the rise in 10 year yields since the US Election.

The team finally identifies that since 1981, the sectors that have benefitted the most, following extended periods of bond signal disagreement (short trend, long carry), are Health Care, Financials and Technology, which happen to currently be UBS Equity and Derivatives Strategy overweight sectors. Additionally, this is consistent with the view of the Credit Strategy team, favouring higher credit quality and lower duration sectors. The table below presents the current top picks of UBS analysts for these three sectors.

Figure 9: UBS Sectors and Stocks that are Positively Impacted by this Theme

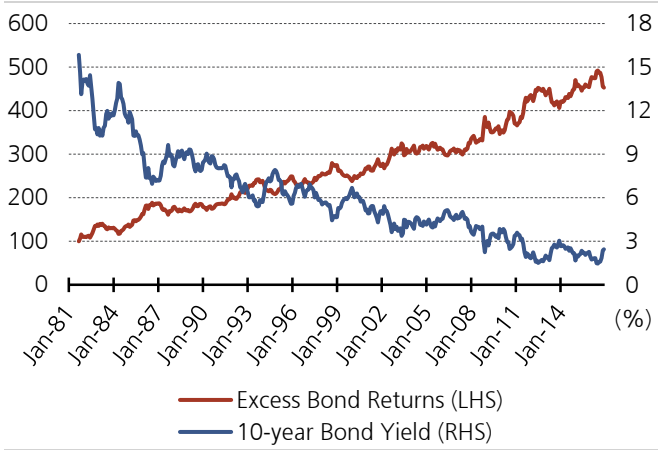
Company	Ticker	Analyst	Rating	Mkt Cap (M)	Price Target	Price*
Financials						
Progressive Corporation	PGR	Brian Meredith	Buy	$22,819.07	$44.00	$39.54
S&P Global	SPGI	Alex Kramm	Buy	$34,285.30	$140.00	$131.69
Goldman Sachs Group Inc.	GS	Brennan Hawken	Buy	$103,774.66	$285.00	$248.38
Healthcare						
Jazz Pharmaceuticals PLC	JAZZ	Marc Goodman	Buy	$8,119.83	$168.00	$134.83
Johnson & Johnson	JNJ	Matt Miksic	Buy	$348,188.78	$136.00	$126.21
UnitedHealth Group	UNH	A.J. Rice	Buy	$162,465.67	$193.00	$169.98
Walgreens Boots Alliance Inc	WBA	Michael Cherny	Buy	$92,028.16	$97.00	$85.63
Technology						
Alphabet Inc.	GOOG	Eric Sheridan	Buy	$587,261.36	$980.00	$843.25
Apple Inc.	AAPL	Steven Milunovich	Buy	$738,886.97	$151.00	$139.14
Applied Materials Inc.	AMAT	Stephen Chin	Buy	$40,295.64	$44.00	$38.12

Source: UBS Estimates, *Price as of close of 03/10/17.

Motivation – The 35-year Bond Rally

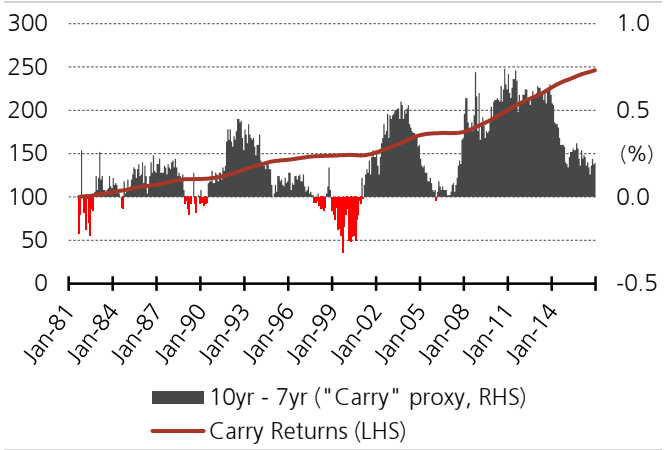
Starting in September 1981, the 10-year US Government bond yield has exhibited its strongest ever long-term fall from the highs of 15.85% down to 1.46% at the end of July 2016. The mirror image of this fall has been an unprecedented 35-year strong bond rally (see Figure 10) with an average excess return of 4.84% per annum and a Sharpe ratio of 0.59.[1] This bond rally has been one of the primary drivers of systematic strategies, like trend-following or carry, as well as for low-volatility equity systematic strategies.

Figure 10: US Bond Yields and Cumulative Excess Returns



Source: UBS Quantitative Research, Global Financial Data.

Figure 11: Slope of the Yield Curve and the Carry Return



Source: UBS Quantitative Research.

The bond rally has two components of returns.[2] The first is obviously **the actual fall in the yields**, which causes the price of the bond to go up (all else being equal). The second is slightly more subtle and is related to the fact that as time progresses **the bond "rolls down" the yield curve** as it approaches maturity and, as long as the long-end of the yield curve (around the 10-year point) is upward sloping, then the bond price increases (all else being equal). Figure 11 presents the slope of the long-end of the yield curve, as captured by the spread between the 10-year and the 7-year yields and the respective accumulation of the carry aspect of the bond return, for the entire 35-year bond rally period. It is visually easy to observe that when the long-end of the yield curve flattens (or reverses) the speed of accumulation for carry slows down. Conversely, at times when the slope at the long-end is steeper, carry accumulates faster. Importantly enough, when we visually compare Figures 10 and 11, we see that the two elements of the bond returns have equally contributed to the overall bond rally.

The two components of the rally:

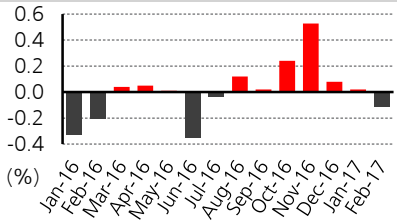
- **Fall in the yields**
- **Positive carry**

The accumulation of carry represents around 50% of the total return of a bond position over the 35-year bond rally.

However, since July 2016 and mainly following the US election, the 10-year yield has increased by 99 basis points up to 2.45% at the end of 2016 (see Figure 12), in its largest five-month positive move in approximately five years. Given the macro environment and following the outcome of the US election, this positive rally is likely to continue, potentially causing a challenge for systematic strategies.

In order to study the implications of such a shift, we collect data going back 160 years and conduct an analysis on the profitability of bond trend-following and carry strategies across different rate regimes.

Figure 12: MoM 10yr Yield Change



Source: Global Financial Data.

[1] Details on the estimation of bond returns are given later in the note.
[2] Strictly speaking, any asset return can be split between a carry component and a price return component; see Koijen, Moskowitz, Pedersen and Vrugt (2017).

Data

This section presents the dataset used for our analysis. Given that we have managed to extend our sample period 160 years back in time, we believe it is worth outlining all steps involved in this process, before looking at the actual empirical analysis on bond trend and carry premia, which starts on page 10.

Interest Rate Data

For the purpose of our empirical analysis we collect data from Global Financial Data (GFD) in order to go as far back in history as possible. Three rate variables are necessary for our analysis:

- **The 10-year US yield** (i^{10y}), which determines bond holding returns. The data for the 10-year constant maturity yield start in July 1786.
- **A yield with a tenor close to 10 years**, which allows for the generation of the carry signal as the local slope in the vicinity of 10-year tenor. Given the data availability in GFD, we use the 7-year yield (i^{7y}) for this purpose. The data for the 7-year constant maturity yield start in April 1941
- **A short-term rate**, which is used for the estimation of *excess* bond returns, as well as for the generation of the carry signal for the period before data for the 7-year yield become available. Given the data availability in GFD, we use the 3-month T-bill rate (i^{3m}) as our proxy for a short-term rate. The data for the 3-month rate start in January 1920.

Given the above setup, we cannot run our analysis before 1920, as we cannot estimate the carry signal or bond excess returns, due to the lack of data for the short-term rate prior to that data. However, there is a way to back-fill the 3-month rate using data for the Commercial Paper rate (i^{CP}) for New York City, following the methodology by Goyal and Welch (2008). GFD contains data for the Commercial Paper rate between January 1857 and December 1971. Running a regression of the 3-month rate on the Commercial Paper rate for the period of overlap of the two datasets (January 1920 to December 1971) yields (intercept and slope coefficients are statistically strong at 1% confidence level, denoted by **):

$$i_t^{3m} = -0.0041^{**} + 0.8815^{**} \cdot i_t^{CP} + \epsilon_t, \quad \text{with} \quad R^2 = 95.4\%$$

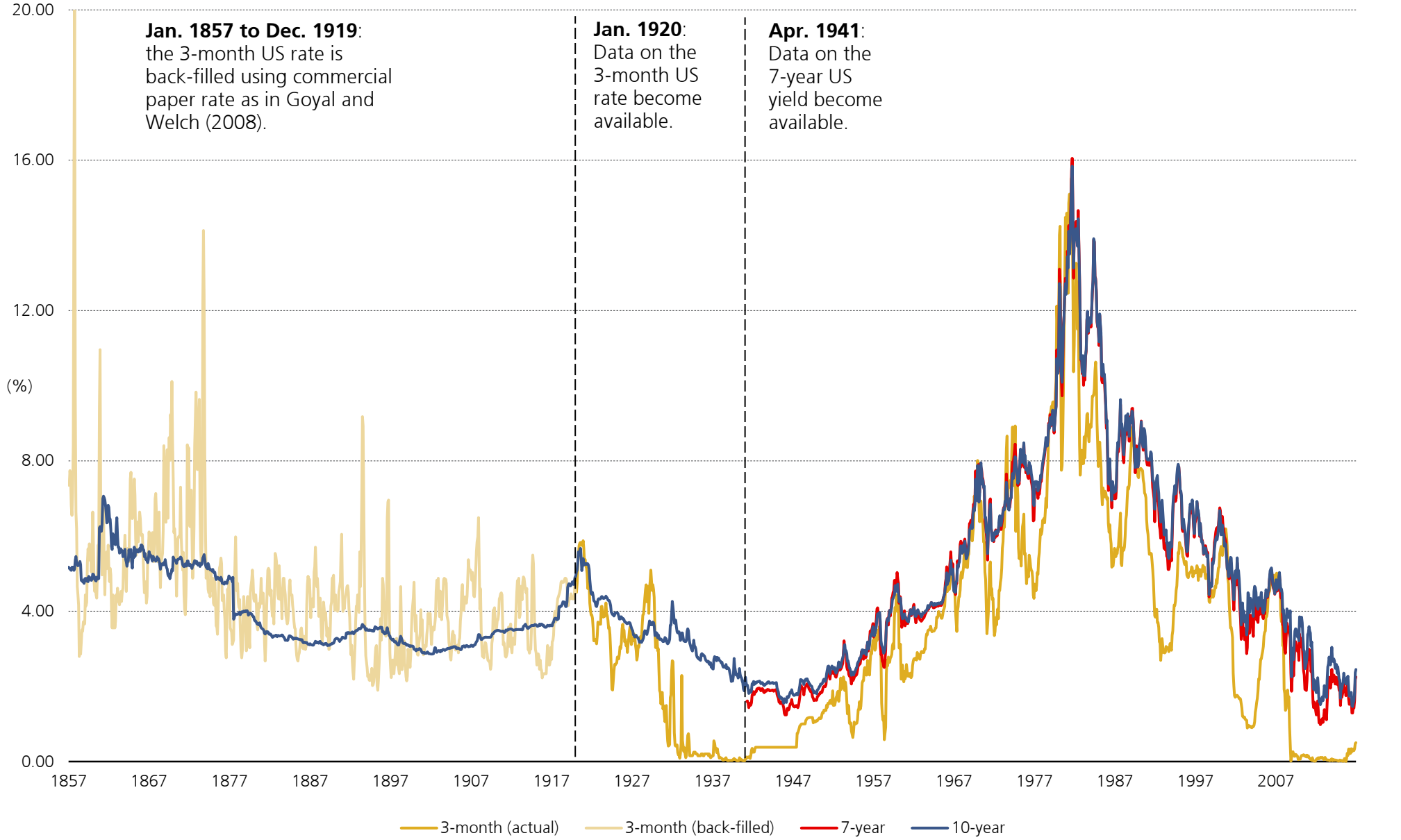
160 years of data

Using the above model we then generate estimates for the 3-month rate ($\hat{\imath}^{3m}$) for the period January 1857 to December 1919 and can therefore extend our analysis between January 1857 and December 2016; an impressive 160-year span!

Figure 13 presents these 160 years of data that are used in our analysis. Following the discussion in this section, we identify three sub-periods, which are clearly shown in the Figure:

- April 1941 to December 2016: all variables (i^{10y}, i^{7y}, i^{3m}) are available.
- January 1920 to March 1940: no data for i^{7y}; the carry signal is generated using the slope of the entire yield curve ($i^{10y} - i^{3m}$), as opposed to using the slope of the long-term end, around the 10-year tenor.
- January 1857 to December 1919: no data for i^{7y} and i^{3m}; the bond excess returns are estimated using the fitted $\hat{\imath}^{3m}$ values; the carry signal is generated using the slope of the entire yield curve from the fitted $\hat{\imath}^{3m}$ values ($i^{10y} - \hat{\imath}^{3m}$).

Figure 13: 160 years for US Bond Yields



Source: UBS Quantitative Research, Global Financial Data. The 3-month rate for the period between January 1857 and December 1919 is estimated using a regression against the Commercial Paper rate (fitted using data between January 1920 and December 1971).

Estimating Bond Excess Returns

Ideally, getting exposure to a 10-year government bond is achieved by rolling over a futures position on the bond as opposed to trading the actual bond. However, futures on US government bonds only became available to trade at a very late stage in our 160-year period. For this reason, our analysis is conducted using bond holding returns that are estimated from the constant-maturity yield data.

Assumptions for the calculation of monthly bond holding returns

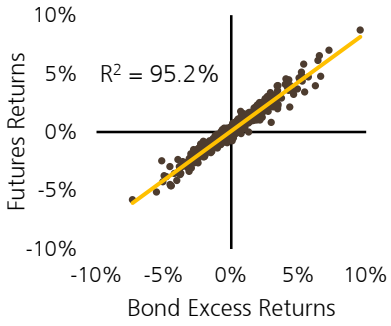
For the estimation of monthly bond returns, we follow the methodology proposed by Morningstar (2008) for the calculation of US Treasury constant maturity indices. In particular, we assume that:

- Each 10-year bond pays a coupon, and the payments occur semi-annually.
- A new 10-year bond is purchased at the beginning of the month and held for a month (when it has another 9 years and 11 months left before maturity).
- Each bond is trading at par (i.e. price is 100 units of currency) at the time of the purchase. This also implies that its coupon rate is identical to the yield.
- The yield curve is flat in the vicinity of the 10-year tenor. This is necessary, because after each holding month, the 10-year bond that was purchased at the start of the month has a remaining maturity of 9 years and 11 months. The assumption of a flat yield curve allows us to use the new value of the 10-year yield as the yield for a 9-year and 11-month bond (for which we have no data), which, in turn, allows for the estimation of the monthly bond return as a function of the change in the yield over the course of the month.

Based on the above assumptions, we can estimate monthly bond returns, and after subtracting the short-term rate, we generate monthly excess bond returns, which are used for our analysis throughout the paper. As a robustness check, Figure 14 compares the estimated bond excess returns to the futures returns of the 10-year Government bond for the period after April 1982 when futures data become available; the correlation between the two series is 0.98 and we can therefore safely assume that our estimates of bond returns are close to realisable returns.

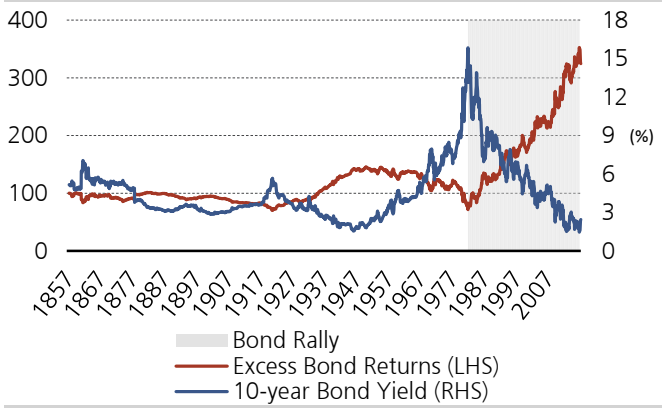
Figure 15 extends Figure 10 back to 1857 and presents the cumulative excess bond returns over the past 160 years; Figure 16 presents the 12-month rolling volatility. It is evident that the recent 35-year bond rally has been the longest in history. Additionally, the bond market has become progressively more volatile over the course of the 20th century.

Figure 14: Bond vs. Futures returns



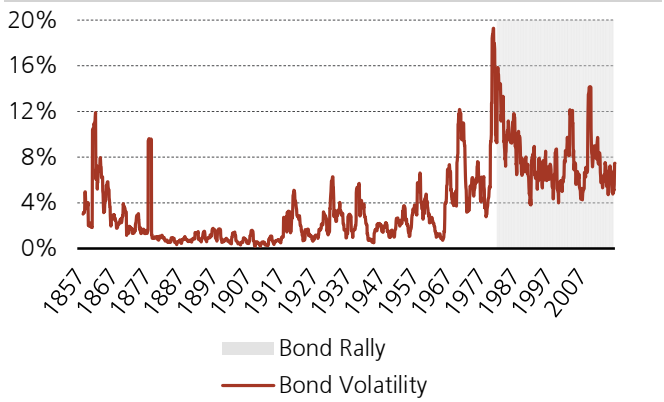
Source: UBS Quantitative Research, Bloomberg.

Figure 15: 10-year Bond Yield and Bond Excess Returns



Source: UBS Quantitative Research, Global Financial Data.

Figure 16: 12-month rolling volatility of the 10-year Bond



Source: UBS Quantitative Research.

Trend and Carry bond strategies

The univariate trend-following strategy on the 10-year Government bond is defined as a monthly rebalanced strategy that takes long or short positions on the bond based on the sign of its past 12-month excess return; long if the excess return has been positive and short if the excess return has been negative. The excess returns of the trend strategy are then given by:

Trend-following:
Go long (short) if the past 12-month bond excess return has been positive (negative).

$$r_{t,t+1}^{Trend} = sign\left(r_{t-12,t}^{Bond}\right) \cdot r_{t,t+1}^{Bond} \quad (1)$$

The univariate carry strategy on the 10-year Government bond is a monthly rebalanced strategy that takes long or short positions on the bond based on the sign of the slope of the yield curve around the 10-year tenor; long if the slope is positive and short if the slope is negative. Given the availability of data, we use the 7-year yield (from April 1941 onwards) as the tenor in closest vicinity to the 10-year tenor for the estimation of the slope. For the period before data on the 7-year yield becomes available, we have no alternative but to use the 3-month rate for the estimation of the slope. Clearly, the 3-month rate is not "close" to the 10-year tenor; however, given that we do not care about the actual magnitude of the slope, but only about its sign, any two points across the curve would give the same result as long as the shape of the entire yield curve is monotonic. The excess returns of the carry strategy are therefore given by:

Carry:
Go long (short) if the current slope of the yield curve around the 10-year tenor is positive (negative).

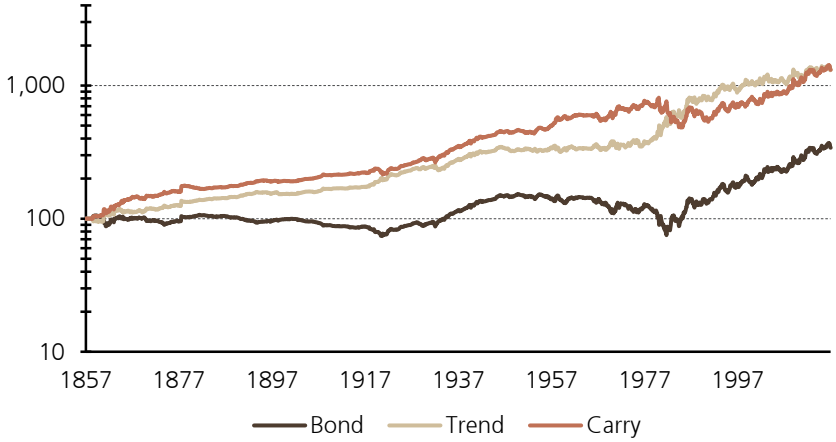
$$r_{t,t+1}^{Carry} = sign\left(i_t^{10y} - i_t^{7y}\right) \cdot r_{t,t+1}^{Bond} \quad (2)$$

Clearly both strategies aim to **time the exposure (long or short)** to the bond market. Their long term performance largely depends (a) for trend, on whether positive or negative price trends are – on average – persistent, and (b) for carry on whether the amount of carry, positive or negative, that is observed at the beginning of a period is enough to compensate – on average – an investor that accordingly takes long or short positions on the underlying bond.

The market timing nature of trend and carry signals

Figure 17 presents the performance of bond trend and carry strategies, as well as the performance of the underlying "long-only" 10-year US bond; Figure 18 reports various performance statistics.

Figure 17: Cumulative Returns of US Bond and its Trend and Carry strategies



Source: UBS Quantitative Research. The figure presents the cumulative returns of (i) a long-only bond strategy, (ii) a trend bond strategy, and (iii) a carry bond strategy. Sample period: January 1857 to December 2016.

Figure 18: Performance Statistics

1857 - 2016	Bond	Trend	Carry
Geometric Mean (%)	0.77	1.63	1.63
Arithmetic Mean (%)	0.91	1.75	1.75
NW T-statistic	2.03	4.77	4.20
Volatility (%)	5.19	5.18	5.16
Skewness	0.42	0.31	0.00
Kurtosis	11.86	11.95	12.18
Max Drawdown (%)	50.80	15.88	40.34
Sharpe Ratio	0.17	0.34	0.34
Sortino Ratio	0.26	0.53	0.51
Calmar Ratio	0.02	0.10	0.04

Source: UBS Quantitative Research. The figure presents various performance statistics for the three strategies shown in Figure 17.

Over the entire sample period, the trend and carry strategies significantly outperform the underlying bond. Over the past 160 years, these two systematic signals double the Sharpe ratio of the underlying bond (from 0.17 up to 0.34), which constitutes evidence that their market timing ability is strong. As expected, the trend-following strategy manages to significantly reduce the downside risk of the underlying bond (with the maximum drawdown falling from 50.80% to 15.88%); more analysis on the hedging behaviour of the trend-following strategy follows in the next pages.

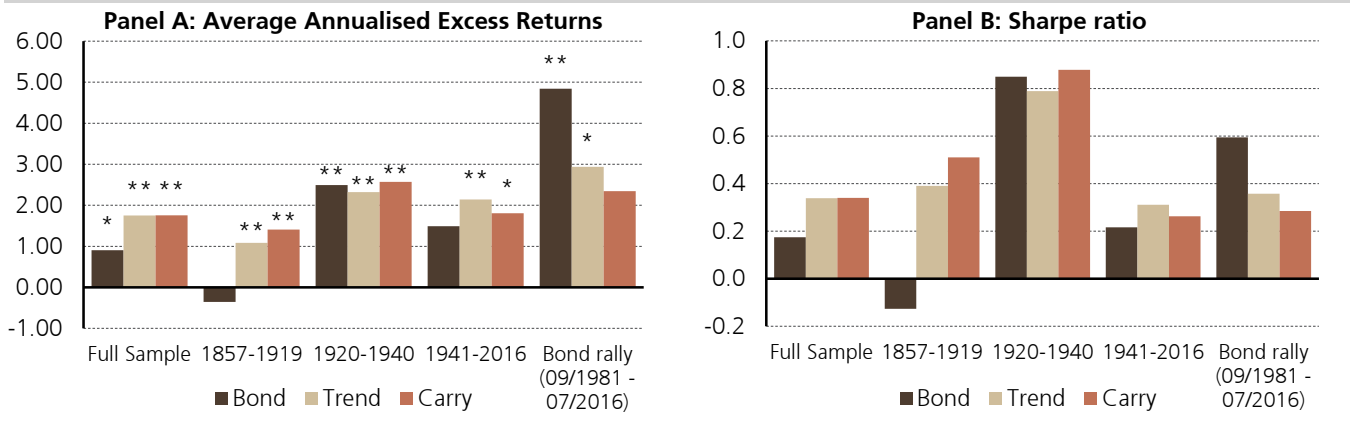
Trend-following and carry strategies generate strong excess returns over the last 160 years.

Eyeballing through the plot in Figure 17 across time, we can argue that this outperformance is not due to a particular period, but it is generally well distributed across historical periods. The bond rally over the last 35 years is visually clear to identify; during that period both trend and carry strategies performed well, by taking advantage of that rally, but as we will see shortly, not as greatly as the passive long-only bond strategy.

Is this strong outperformance due to a particular period?

Figure 19 presents the annualised excess returns and the Sharpe ratios of the three strategies across the entire sample period, across the three sub-periods that were identified in Figure 13 (based on data availability) and finally across the bond rally period, so to offer more insight to our performance evaluation exercise.

Figure 19: Performance Statistics: Full Sample vs. Sub-periods



Source: UBS Quantitative Research. Panel A presents annualised excess returns for a long-only bond position and for the trend and carry bond strategies. Statistical significance at 1% and 5% confidence levels is denoted by ** and * respectively based on Newey and West (1987) standard errors. Panel B presents Sharpe ratios.

The evidence shows that the trend and carry bond strategies outperform the underlying long-only strategy for almost all historical periods, except for the recent bond rally period. During this period a passive long-only exposure on the US 10-year bond generates more than twice as large average excess returns as any other historical period (albeit at a higher level of volatility, as deduced from the Sharpe ratio estimates). This should **not** be surprising. We explain next.

Trying to interpret the patterns during the most recent bond rally period, it is enough to argue that if an uninformed passive long-only position does so greatly, then any effort to actively "time" the exposure to the bond using either trend or carry signals would be by construction less successful. Most importantly, we must clarify once more our primary objective and avoid any confusion. The primary objective of this paper has **not** been to show that trend and carry bond strategies *always* outperform the underlying bond. Instead, we start from the fact that the recent bond rally might have largely benefitted these strategies (and it certainly has!) and our objective is to understand whether this was just a lucky period for trend and carry strategies or whether the timing nature of these signals is strong across different rate regimes. We then have to look more closely at their dynamics.

Our objective is to understand the impact of different rate regimes on the profitability of trend and carry systematic strategies. Is it their genuine timing ability or was their recent performance due to just going long bonds during the 35-year bond rally?

The dynamics of the trading signals

Following the documentation of the strong trend and carry bond premia, we now look more closely at the signal dynamics. How often do these signals agree? What are the performance implications when they agree and when they disagree?

Signal agreement and disagreement

The binary definition of the signals (long or short) leads to four different market regimes; two regimes when the signals agree and two regimes when they disagree.[3] Figure 20 illustrates these four regimes.

Figure 20: Favourable and Challenging Environments

		Yield Curve	
		Upward-sloping	Downward-sloping
Bond Price	Up-trend	Positive Trend Positive Carry	Positive Trend Negative Carry
	Down-trend	Negative Trend Positive Carry	Negative Trend Negative Carry

Source: UBS Quantitative Research. The figure presents the four different regimes defined by the combination of long and short trend and carry signals.

The 35-year bond rally:

- **Long Trend**
- **Long Carry**

When the two signals agree we have a *favourable* environment. When both are long, we are in an environment of an upward-sloping yield curve and falling rates (positive bond price trend) and a long bond position should benefit from both; **this has been primarily the case over the 35-year bond rally** as already explained earlier in this report. Equally, when both signals are short, we are in an environment of an inverted yield curve and increasing rates (negative bond price trend) and therefore a short position should benefit from both.

The potential challenge ahead:

- **Short Trend (increasing rates)**
- **Positive Carry (upward-sloping curve)**

In contrast to the above, when the two signals disagree we may have a *challenging* environment. A long bond position due to a positive bond trend can suffer when the yield curve is inverted (because of the negative carry). Equally, a long bond position when the yield curve is upward sloping can suffer when interest rates are increasing (because of falling bond prices); **this is the environment that we seem to have entered towards the end of 2016 and at the start of 2017**, when rates started increasing whilst the yield curve has remained upward sloping.

So, how frequently do we have signal agreement and disagreement? Figure 21 provides some guidance across the full sample and across the 35-year bond rally.

Figure 21: Trend and Carry Signal Agreement and Disagreement

Full Sample: 1857M01 – 2016M12 [Bond Rally: 1981M09 – 2016M07]		Carry		
		Long	Short	Sum
Trend	Long	42.6% [60.6%]	10.6% [7.6%]	53.2% [68.3%]
	Short	21.3% [24.6%]	25.5% [7.2%]	46.8% [31.7%]
	Sum	63.9% [85.2%]	36.1% [14.8%]	68.1% [67.8%]

Source: UBS Quantitative Research. The figure presents the proportion of months that each of the four different regimes (combination of long and short trend and carry signals) has occurred over the full sample, as well as over the 35-year bond rally period [in brackets]. **The bottom-right corner presents the sum across the diagonal**.

[3] In a more sophisticated analysis, one can additionally take into account the relative strength of the signals and therefore depart from signals with binary nature and introduce a continuum of values; this is out of the scope of this note, but certainly a topic worth exploring in the future.

On a univariate basis and over the entire sample period, the trend signal has been almost equally split between long and short (53.2% and 46.8% of the time respectively). Conversely, the carry signal has been mostly long (63.9% of the time). As expected, during the recent 35-year bond rally, both signals have been primarily long (68.3% of the time for trend and 85.2% of the time for carry), hence supporting our claim that the bond rally has benefitted both strategies.

Over the 35-year bond rally, both signals were mainly long (trend: 68.3% of the time; carry: 85.2% of the time)

What is even more interesting is to look at the proportion of time that the signals agree (both long, or both short; highlighted in green in Figure 21) versus the proportion of time that they disagree (highlighted in red in Figure 21). The evidence shows that for about two thirds of the time (either during the 160-year sample, or over the bond rally) the signals agree, leaving the rest one third of the time for signal disagreement. We therefore continue our analysis by asking the following two questions:

The two signals agree for about two thirds of the time!

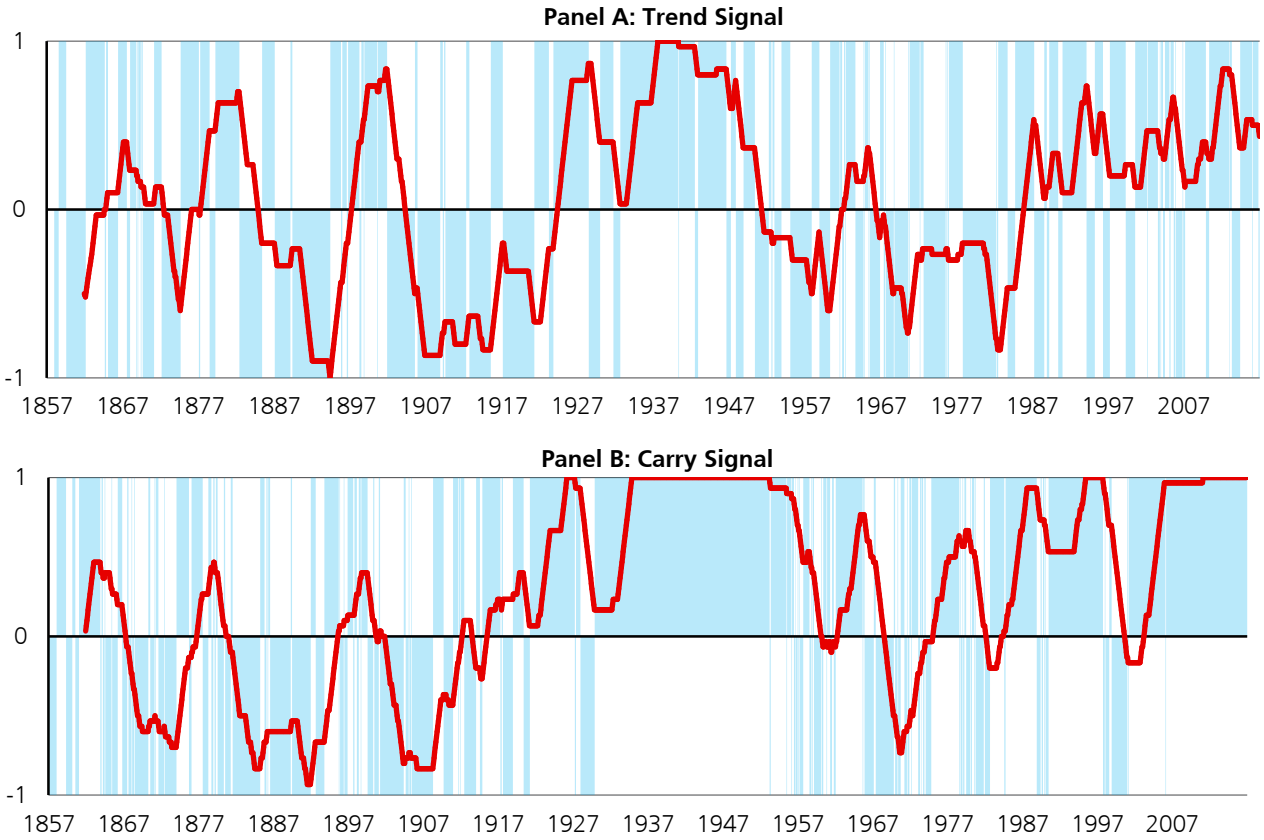
Instead, signal disagreement occurs one third of the time.

- First, we ask how persistent these states of agreement and disagreement are. Put differently, once we enter a month when the signals agree, how likely is it that we remain in such a state next month?
- Second, we ask whether there is any systematic relationship between signal agreement/disagreement and the actual profitability of the trend and carry strategies, and therefore whether these two states have historically been favourable and challenging respectively.

To answer the first question, Figure 22 presents the trend and carry signals over the entire sample period, including a 60-month rolling average for each of them.

How persistent is signal agreement/disagreement?

Figure 22: Trend and Carry Signals (including 60-month rolling averages)

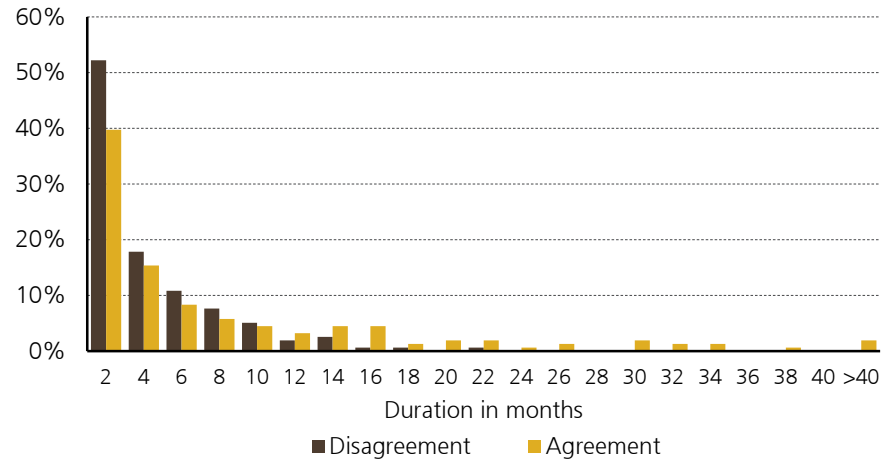


Source: UBS Quantitative Research. The figure presents the trend (Panel A), and carry (Panel B) signals for the 10-year US Bonds over the entire sample period, 1857 to 2016. Additionally, the figure presents 60-month rolling averages.

The historical evidence shows that there are long periods when one or both of the signals remain unchanged. This means that once we enter one state of positive/negative trend and/or positive/negative carry, we are highly likely to remain in that state one month later. Let us quantify this.

Figure 23 presents the histogram for the duration of periods (in months) of signal agreement and disagreement, whereas Figure 24 reports duration statistics in Panel A, and the transition matrix between the states (including a one-standard deviation confidence interval for the estimated probability) in Panel B.

Figure 23: Duration of periods of signal agreement and disagreement



Source: UBS Quantitative Research. The figure presents the histogram for the duration of periods (in months) with trend and carry signal agreement and disagreement. Sample period: January 1858 to December 2016.

The evidence is strong. The state of signal agreement is much more persistent than that of signal disagreement. Once we enter a month of signal agreement, there is an 88% probability to remain in that state next month, and the median (average) amount of time that we should spend in this state is four months (eight months). Conversely, a month of signal disagreement is 74% likely to be followed by a month of signal disagreement and the median (average) duration of this cycle is only two months (three to four months).

Figure 25 provides more granularity by extending Figure 24 and looking explicitly at the four underlying states; two for agreement (both long, both short), and two for disagreement (trend long, carry short and trend short, carry long).

The evidence is even stronger. The high levels of persistence in signal agreement is solely due to the fact that when both signals are long are highly likely to remain long next month (with probability 89.1% and median duration of four months) and when both of them are short, they are highly likely to remain short (with probability 84.8% and median duration of three months). In other words, it is highly unlikely to even document consecutive months of signal agreement with both of the signals changing sign at the same time (so move from both-long to both-short or vice versa; transition probabilities are 0.5% and 0.6% respectively).

Looking at signal disagreement, the evidence again shows less amount of persistence. Most importantly, once we are in any of the two states of disagreement, it is almost impossible to transition to the other state of disagreement. Put differently, in leaving any of the two states of disagreement, we are almost certain that we will end up to a state of signal agreement. This is again due to the fact that it is very unlikely for both signals to flip sign at the same time.

Figure 24: Duration Statistics

Panel A: Duration Statistics

	Disagreement	Agreement
Average	3.87	8.33
Median	2	4
75th pct.	5	12

Panel B: Transition Matrix

	Disagreement	Agreement
Disagreement	**74%** [71%, 78%]	26% [24%, 28%]
Agreement	12% [11%, 13%]	**88%** [85%,91%]

Source: UBS Quantitative Research. Panel A presents statistics for the duration of periods (in months) with signal agreement and disagreement. Panel B presents the transition matrix between the states, including a one-standard deviation confidence interval for the probability estimates. Sample period: January 1858 to December 2016.

The state of signal agreement is much more persistent

It is very unlikely for both (trend and carry) signals to flip sign at the same time

Figure 25: Signal States and Statistics: a more granular analysis

Panel A: Duration Statistics

	Agreement	Disagreement		Agreement
	Both Short	Trend Short / Carry Long	Trend Long / Carry Short	Both Long
Average Duration	6.57	4.10	3.31	9.13
Median Duration	3	2	3	4
75th percentile	9	6	4	12

Panel B: Transition Matrix

	Agreement	Disagreement		Agreement
	Both Short	Trend Short / Carry Long	Trend Long / Carry Short	Both Long
Agreement – Both Short	**84.8%** [80.6%, 89.0%]	10.5% [9.0%, 12.0%]	4.1% [3.2%, 5.0%]	**0.6%** [0.3%, 1.0%]
Trend Short / Carry Long	11.6% [9.9%, 13.3%]	**75.8%** [71.5%, 80.1%]	**0.0%** [0.0%, 0.0%]	12.6% [10.8%, 14.4%]
Trend Long / Carry Short	11.4% [9.0%, 13.8%]	**1.5%** [0.6%, 2.3%]	**69.8%** [63.9%, 75.7%]	17.3% [14.4%, 20.3%]
Agreement – Both Long	**0.5%** [0.2%, 0.7%]	5.4% [4.6%, 6.2%]	5.0% [4.3%, 5.8%]	**89.1%** [85.7%, 92.4%]

Source: UBS Quantitative Research. Panel A presents statistics for the duration of periods all possible combinations of trend and carry signals. Panel B presents the transition matrix between the states, including a one-standard deviation confidence interval for the probability estimates. Sample period: January 1858 to December 2016.

Figure 26 in the next page contains further details on these dependences. In particular, we present a scatterplot between the actual values of the 12-month bond return (whose sign determines the trend signal) and the contemporaneous (at the end of each 12-month period) yield differential between the 10-year and the 7-year tenors (whose sign determines the carry signal). The sample period is constrained to the period after data for the 7-year yield become available (April 1941). The respective average duration and probability of remaining in the same state are re-estimated for this sample period and are generally in lines with the values already reported in Figure 25.

Is signal agreement and disagreement related to future performance?

Are these statistics and results important? They would be important if there is any systematic relationship between the performance of trend and carry strategies across the different states of signal agreement and disagreement. In other words, having documented that both signals in isolation have significant market timing ability, can we say anything about their joint behaviour? This was the second question that we set to ourselves a few pages back; we look at it next.

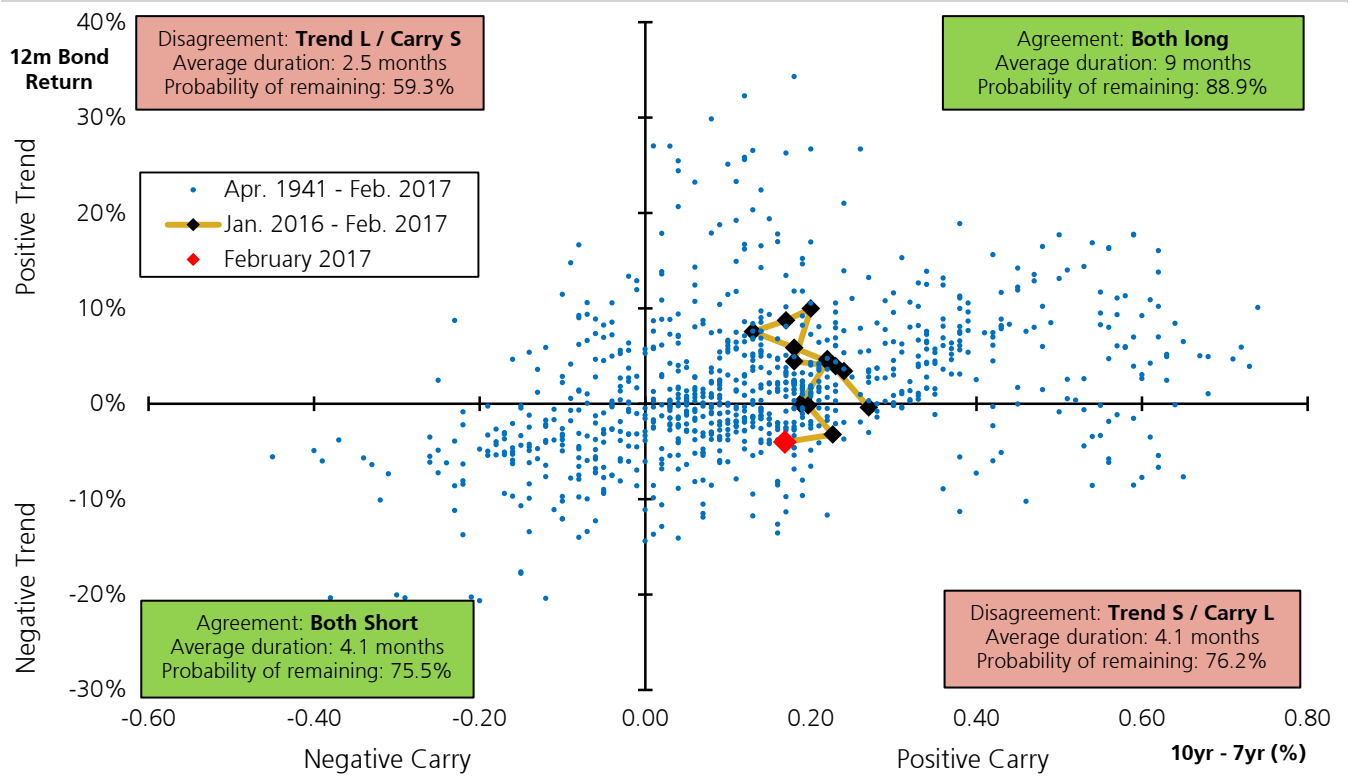
Agreement of signals is associated to outperformance

See the appendix for an overview of the academic literature on this topic.

Figure 27 presents the performance of a strategy that goes long or short the bond when both signals agree (this can also be interpreted as a combination of the two single-premium strategies on an equally weighted basis) and contrasts this against a trend strategy that is only active during signal disagreement and a carry strategy that is only active during signal disagreement; given the binomial nature of the two signals, the latter two strategies are effectively a mirror image of each other.[4]

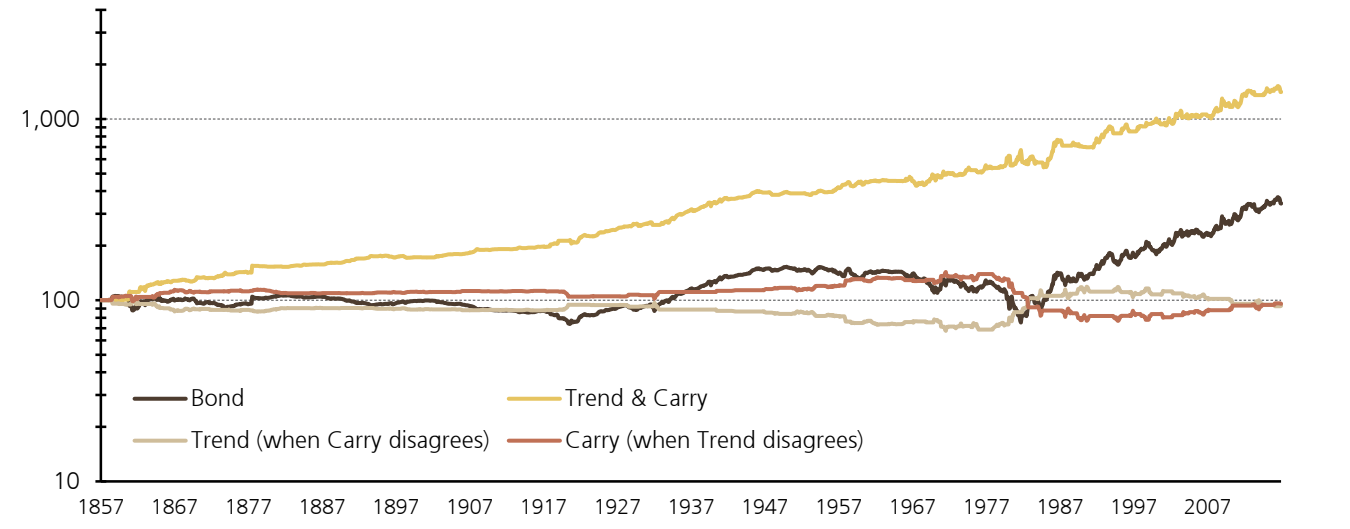
[4] Any numerical differences in the cumulative return plots are due to the compounding effect of arithmetic returns.

Figure 26: In-depth view of the four signal regimes [April 1941 – February 2017]



Source: UBS Quantitative Research. The figure presents a scatterplot between the 12-month bond returns (y-axis), whose sign determines the trend signal, and the contemporaneous yield differential between the 10-year and the 7-year tenors (x-axis), whose sign determines the carry signal. The sample period is constrained to the period after data for the 7-year yield become available (April 1941 – February 2017).

Figure 27: Performance when signals agree and when signals disagree



Source: UBS Quantitative Research. The figure presents the cumulative returns of (i) a long-only bond strategy, (ii) a trend and carry bond strategy, (iii) a trend bond strategy when the signals disagree, and (iv) a carry strategy when the signals disagree. Sample period: January 1857 to December 2016.

In short, Figure 27 illustrates a very strong pattern. Signal agreement (which, as already mentioned, occurs on average for about two thirds of the time) leads to strong performance. Conversely, when the signals disagree, neither of the two contains strong timing information; at least not in their binary definition and across the entire 160-year sample period. This finding can have important implications for a bond investor (if not more broadly); we attempt to offer some guidance for signal disagreement regimes at a later section of this note, in pages 23-25.

Keep an eye when the signals disagree; neither is profitable in the long run

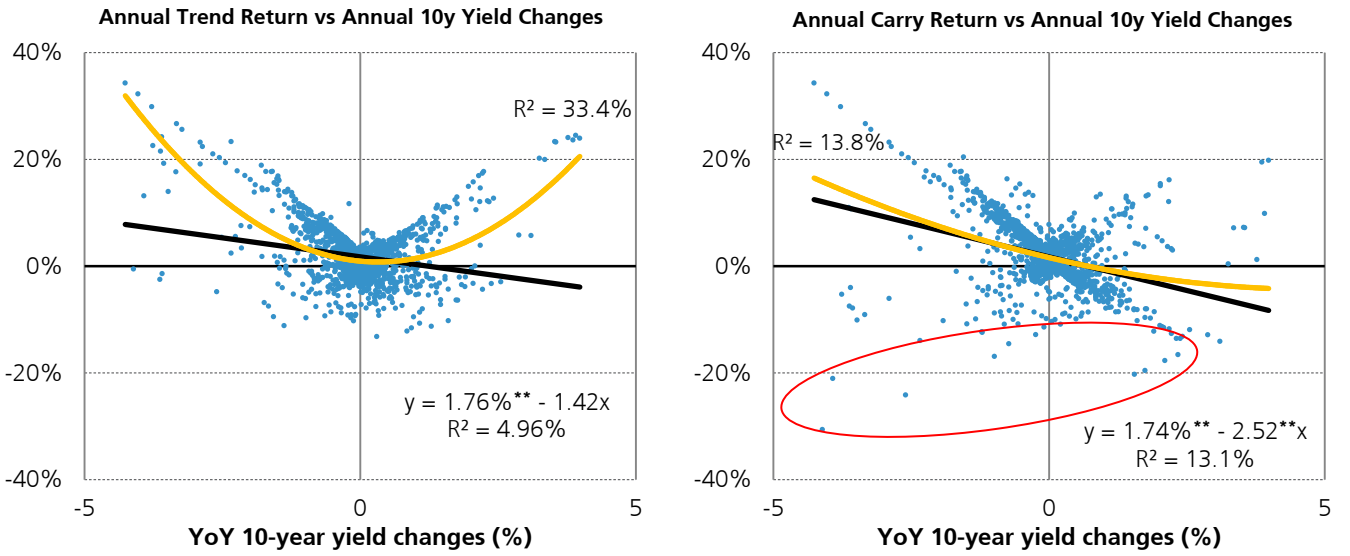
The premia and the interest rate dynamics

In the next pages, we look more closely at the performance of the two premia in relation to the dynamics of interest rates.

Versus changes in the 10y yield…

Figure 28 presents scatterplots for the annual performance of the two premia versus the contemporaneous changes in the 10-year yield.[5] The scatterplots contain a linear as well as a quadratic fit (polynomial of order 2) in order to identify potential non-linearities. The behaviour of the two premia is quite different.

Figure 28: Annual performance of Bond Trend and Carry strategies against contemporaneous 10-year yield changes



Source: UBS Quantitative Research. The figure presents the scatterplots for the annual performance of trend and carries strategies versus the contemporaneous changes in the 10-year US yield. The scatterplots contain a linear as well as a quadratic fit (polynomial of order 2). Statistical significant is denoted with * and ** for confidence levels of 5% and 1% respectively, based on Newey and West (1987) standard errors with 11 lags. Sample period: January 1858 to December 2016.

Convex relationship for Trend

- **Trend:** the trend strategy does not exhibit statistically significant linear dependence on contemporaneous changes in the 10-year yield (the slope coefficient is statistically insignificant; t-statistic of -1.60). Conversely, it has strong non-linear dependence, offering a convex payoff; it is worth noting the increase in the adjusted R^2 from 4.96% to 33%, when the quadratic term is included (t-statistic of 8.18). Strong yield moves, either positive or negative, are associated with strong bond price trends that are captured by the trend strategy, hence generating the respective profile. The trend payoff resembles the payoff of an option straddle and is therefore related to the return profile of CTA and managed futures funds (see Fung and Hsieh, 1997, 2001, Moskowitz, Ooi and Pedersen, 2012, and Baltas and Kosowski, 2013).

Negative linear dependence for Carry

- **Carry:** the carry strategy exhibits a completely different profile. It has a statistically strong negative exposure to the contemporaneous changes in the yield (the slope coefficient is statistically significant at the 1% level; t-statistic of -3.01), and insignificant non-linear dependence (the t-statistic of the quadratic term is 0.59). In other words, when the yield goes up, a carry strategy is more likely to underperform (unless the carry signal was short at the start of the period, which has not been the norm historically).

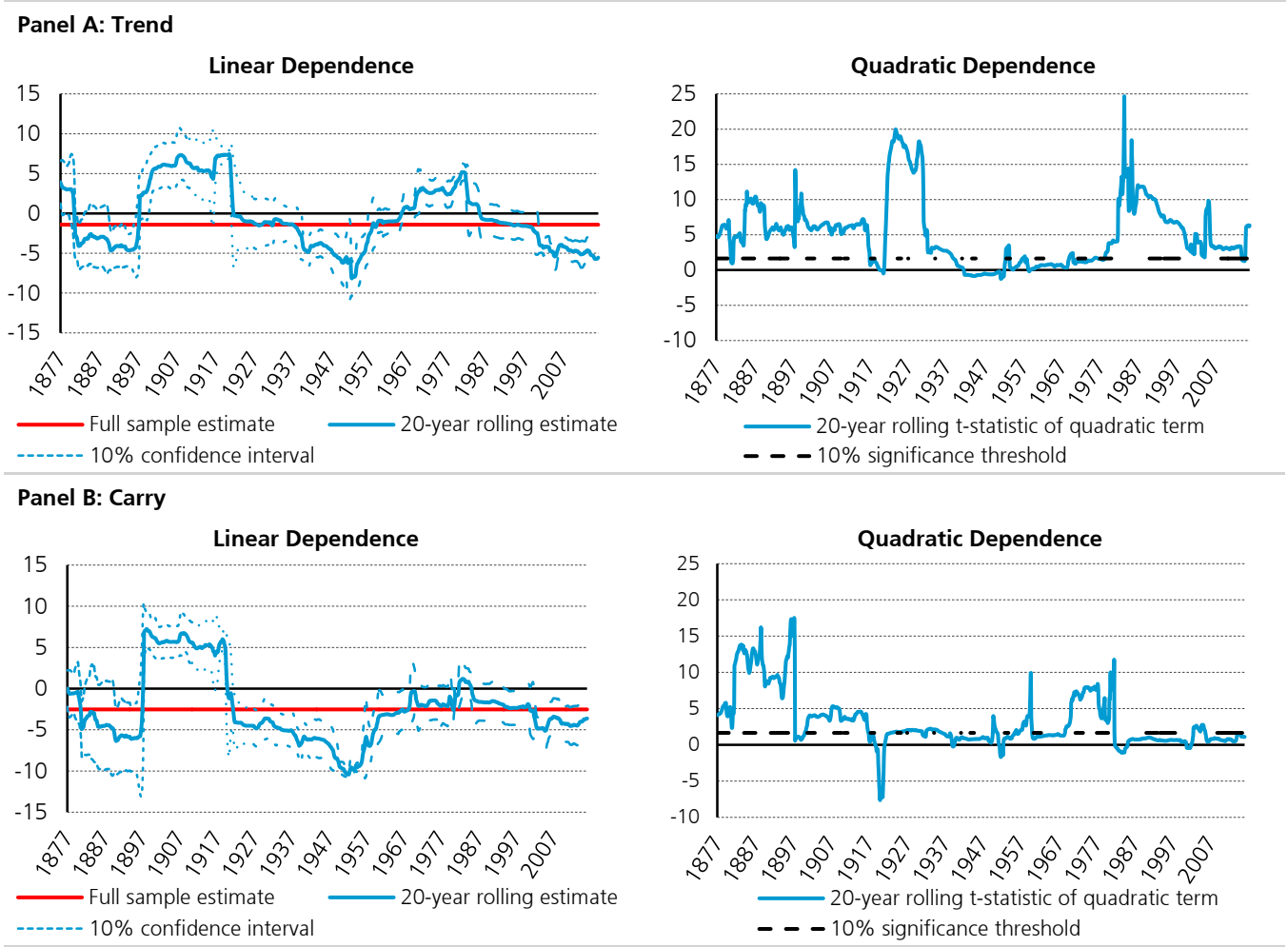
[5] Figure 28 contains monthly sampled data, so there is serial correlation in the variables, which is taken into account in the estimation of t-statistics using Newey and West (1987) standard errors that account both of serial correlation and heteroskedasticity. The use of non-overlapping data does not change qualitatively or quantitatively the results.

Irrespective of the different behaviour of the two premia, they both exhibit a positive "alpha" that has similar magnitude, 1.76% for trend and 1.74% for carry, both statistically strong at 1% level.

Conditional analysis

The full-sample analysis presented above covers a very long historical period. It is therefore important to additionally study the conditional dynamics. Figure 29 presents for both premia the 20-year rolling window estimate of the linear slope (left panes) and the 20-year t-statistic of the quadratic term (right panes).

Figure 29: Rolling Statistics



Source: UBS Quantitative Research. The figure presents results from linear and quadratic fits on the relationship between the annual performance of trend (Panel A) and carry (Panel B) on contemporaneous changes in the 10-year US yield. The left panes present the full sample estimate of the linear fit as reported in Figure 28 and the 20-year rolling estimates along with a 10% confidence interval. The right panes present the 20-year rolling t-statistic of the quadratic term. All t-statistics are estimated using Newey and West (1987) standard errors with 11 lags. Given the 20-year rolling window, the sample period is from January 18577 to December 2016.

The bulk of our full-sample findings carry over into our conditional analysis:

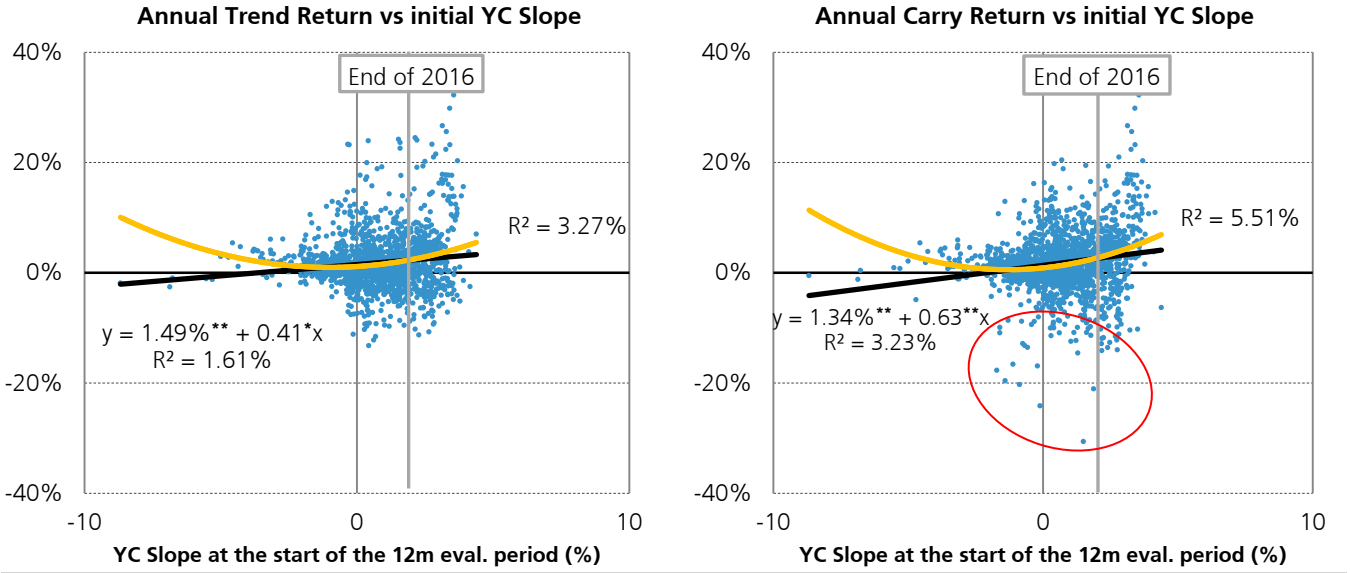
- **Trend:** the trend strategy exhibits time-varying dependence on the underlying changes in the yield, generally lacking statistical significance. Interestingly enough, excluding the period prior to 1920 (i.e. the period that the short-term rate is backfilled) leads to a statistically significant and negative slope (point estimate -1.79 with a t-statistic of -1.98). As far as the non-linearity of the trend payoff is concerned, this is generally statistically strong for the very large part of our long history; a trend strategy does exhibit convexity both on a conditional and on an unconditional basis.

- **Carry:** in line with the full sample analysis, the carry strategy has more explicit directional exposure to the underlying bond, mainly due to the fact that the slope of the yield curve switches from positive to negative relatively infrequently, especially after 1920 (see Panel B in Figure 22). In this post-1920 period the rolling window analysis shows a negative and for most of the time statistically significant exposure of the strategy on the contemporaneous changes in the yield. The post-1920 estimate of the slope is -2.72 with a t-statistic of -3.03, which is very close to the full sample estimate reported in Figure 28 (-2.52 with a t-statistic of -3.01). Conversely, the lack of any quadratic exposure that was documented in the full sample analysis is also confirmed in the rolling window analysis.

Versus the slope of the yield curve at the start of the period…

Next, we look at the dependence of annual profitability for the two premia on the slope of the yield curve at the start of the respective 12-month evaluation period, which is – in fact – a crude estimate of the level of carry that is available. Figure 30 presents the relevant scatterplots, which also include the value of the slope of the yield curve at the end of 2016 (equal to 1.95%).

Figure 30: Annual performance of Bond Trend and Carry strategies vs. the Yield Curve slope at the start of the period



Source: UBS Quantitative Research. The figure presents the scatterplots for the annual performance of trend and carries strategies versus the yield curve at the start of the respective 12-month evaluation period. The scatterplots contain a linear as well as a quadratic fit. Statistical significant is denoted with * and ** for confidence levels of 5% and 1% respectively, based on Newey and West (1987) standard errors with 11 lags. Sample period: **January 1858 to December 2016.**

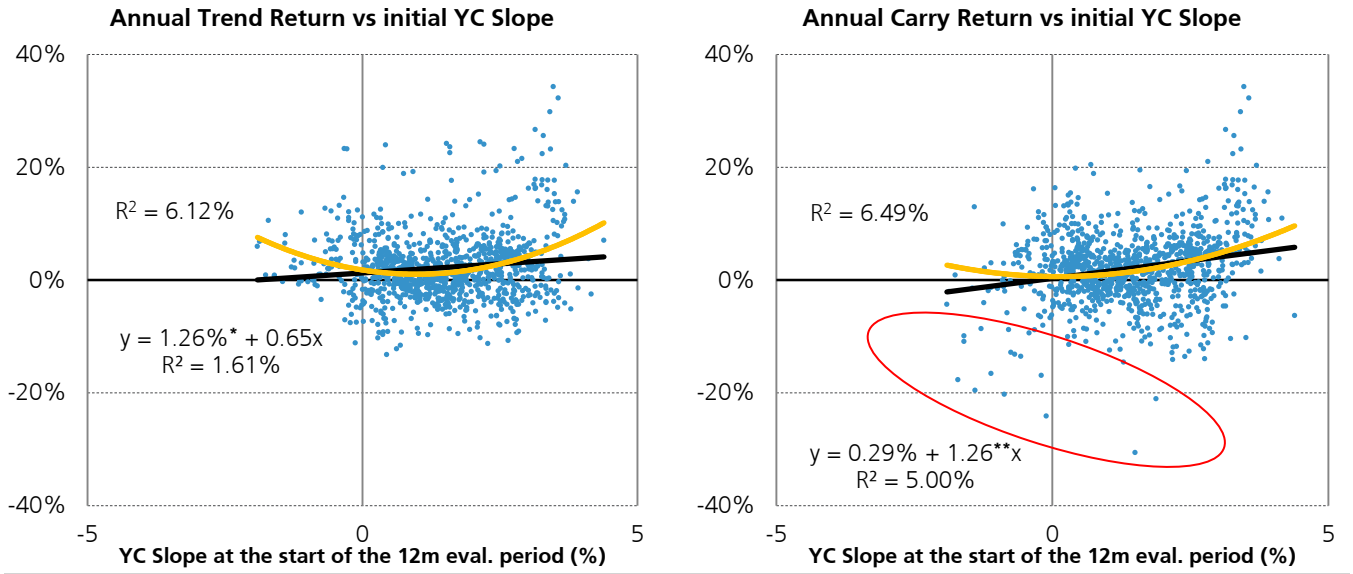
The behaviour of the two premia is rather similar, though as we shall see in the next page, this is primarily driven due to the noisy nature of the slope of the curve in the early years of our sample period and before 1920 (i.e. during the period that the short-term rate is proxied using a backfill). Over the entire sample period both premia are positively and statistically significantly exposed to the slope of the yield curve that is observed at the start of the 12-month period. However, the carry strategy is more strongly related to the initial slope of the curve, both in terms of magnitude as well as statistical significance.

Aside from the linear dependence, both premia exhibit mild convexity (the quadratic terms are both statistically strong at 5% for trend and at 1% for carry). This convexity is primarily driven by the behaviour of the premia following periods with steep curves.

Analysis in the post-1920 period

In the scatterplots of Figure 30 there exist several instances of extreme negative slopes for the yield curve. Eyeballing through the historical movement of the various rates used in our analysis in Figure 13 it is very clear that these extreme values are only witnessed in the pre-1920 period, when the short-term rate is backfilled using Commercial Paper data. Figure 31 below repeats the analysis of Figure 30 only for the period after 1920.

Figure 31: The dependence on the initial slope of the Yield Curve in the post-1920 period



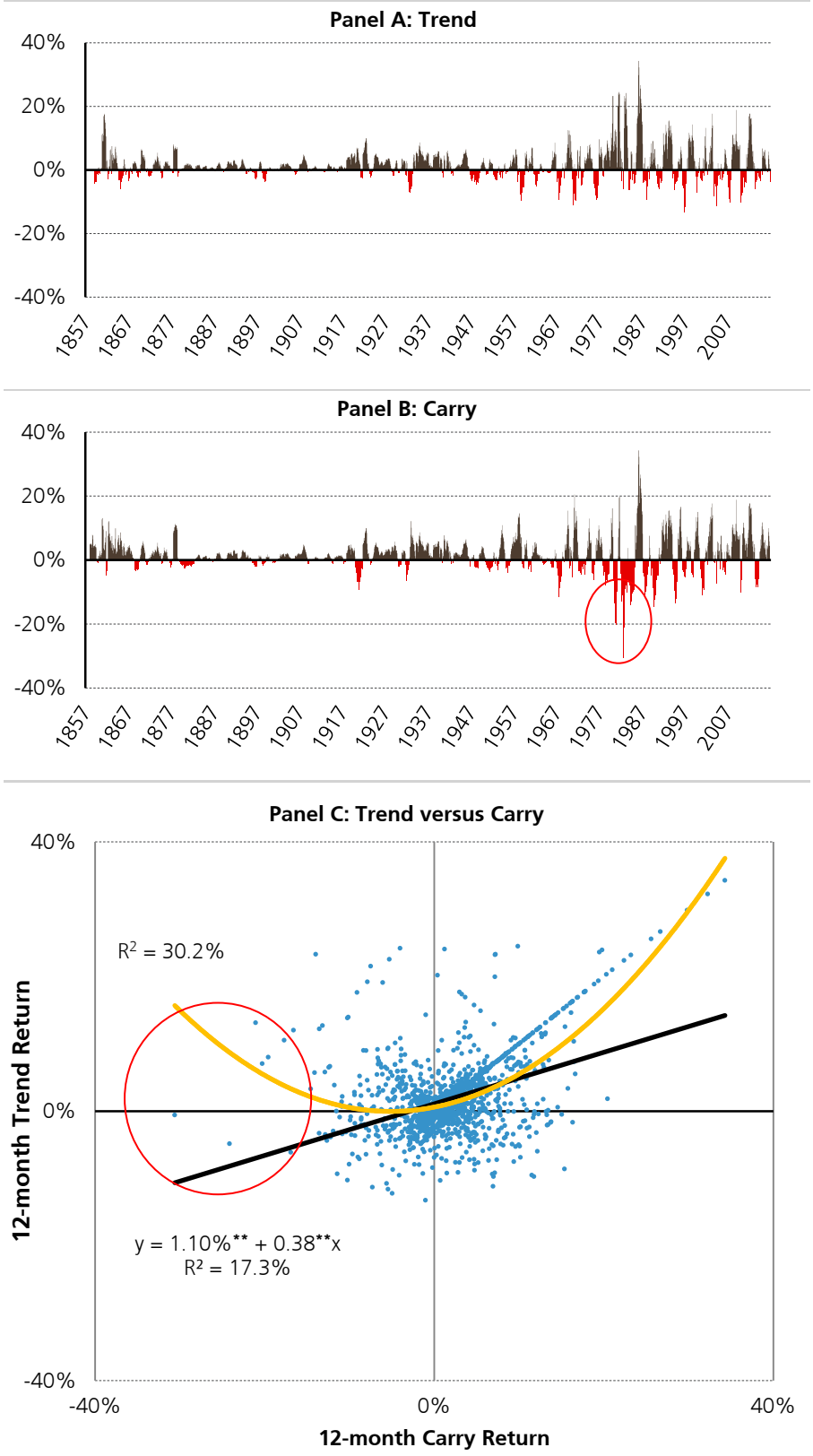
Source: UBS Quantitative Research. The figure presents the scatterplots for the annual performance of trend and carries strategies versus the yield curve at the start of the respective 12-month evaluation period. The scatterplots contain a linear as well as a quadratic fit. Statistical significant is denoted with * and ** for confidence levels of 5% and 1% respectively, based on Newey and West (1987) standard errors with 11 lags. Sample period: **January 1920 to December 2016.**

The results are now quite different. It is the carry strategy that exhibits much stronger linear dependence on the initial slope of the yield curve (the t-statistic of the linear slope estimate is 3.17 for the carry strategy, hence statistically strong at 1% level, and 1.69 for the trend strategy, hence marginally statistically strong at 10% level). Conversely, it is the trend strategy that exhibits much stronger quadratic dependence on the initial slope of the yield curve and – to a certain extent – mimicking its relationship against the contemporaneous changes in the 10-year yield, presented earlier in Figure 28 (the t-statistic of the quadratic term is 3.63 for the trend strategy, hence statistically strong at 1%, and 1.79 for the carry strategy, hence statistically strong at 10%).

The last part of our analysis in this section looks at some extreme negative returns for the carry strategy as indicated with ellipses in Figures 28, 30 and 31. Panels A and B in Figure 32 below present the monthly time-series of the 12-month rolling performance of the trend and carry strategies, where it is easy to visually identify those extreme negative carry returns; they all tend to occur at the same time[6] and in particular around the dramatic shift in the rates regime in September 1981. Interestingly, the trend strategy does not suffer from any significant drawdowns during that period, which constitutes empirical evidence of the diversifying nature of the carry-trend combination and supports our earlier findings in this report. The scatterplot in Panel C of Figure 32 nicely illustrates this.

[6] This is partly related to the overlapping nature of a 12-month window that is rolled over on a monthly basis.

Figure 32: Rolling 12-month performance



Source: UBS Quantitative Research. Panels A and B present the monthly time-series of a 12-month rolling returns for trend and carry strategy on the US 10-year bond. Panel C presents the scatterplot between the two, along with a linear and a quadratic fit. Statistical significant is denoted with * and ** for confidence levels of 5% and 1% respectively, based on Newey and West (1987) standard errors with 11 lags. Sample period: January 1858 to December 2016.

The relative importance of the signals and the macro view going forward

We have focused on binary definitions of systematic signals

So far, we have only focused on the sign of the trend and carry signals and one of our strongest findings is that an investor should go long or short the underlying bond when both signals agree (go long when the rates are falling and the yield curve is upward sloping; go short when rates are increasing and the yield curve is downward sloping). Conversely, when the signals disagree, the risk-reward is less appealing and statistically insignificant. This has been strongly supported by the longest backtest in the literature, as presented earlier in Figure 27.

What about the relative strength of the signals?

What our analysis has not (yet) focused on is whether the relative strength of the two signals has any information content on the positioning. Put differently, when the signals disagree, would it benefit an investor to "listen" to just one of the signals? If yes, is this decision regime-dependent? One can generate stylised examples when this would be the case:

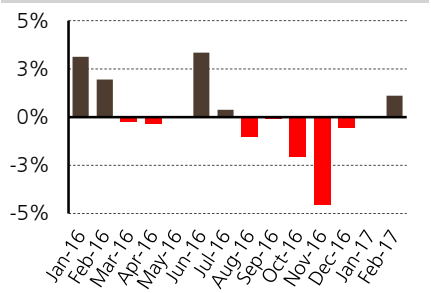
- **Overweighting Carry:** If the level of the yield, which determines the trend signal, changes smoothly in an environment of steep curves (either upward or downward sloping), the investor is probably more likely to benefit from taking a position in line with the carry signal, exactly because the steepness of the curve is more likely to compensate the investor from an adverse move in the level of the yields.
- **Overweighting Trend:** If the yield curve is not very steep (either positive or negative), but the entire yield curve experiences strong parallel shifts, then the investor is probably more likely to benefit from taking a position in line with those shifts, because if they are persistent, the trend signal is more likely to generate stronger returns than the "roll down" of the curve.

A closer look into the dependences of relative signal strength is beyond the scope of this report. However, we want to provide some guidance to a bond investor in the current market environment that we do indeed experience signal disagreement between trend and carry.

The current environment and the macro view going forward

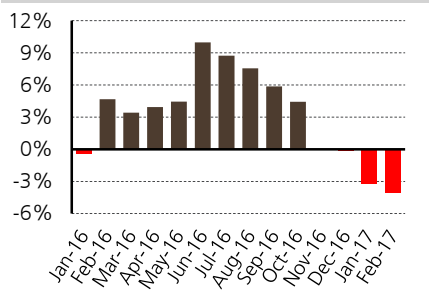
Figures 33-35 provide an overview of the current environment (last 14 months, up to the end of February 2017) by presenting (a) the monthly bond excess returns, (b) the annual rolling bond excess returns, which define the trend signal, and (c) the slope of the yield curve at the vicinity of the 10-year point, expressed as the spread between the 10-year and the 7-year yields, which defines the carry signal.

Figure 33: MoM Bond Excess Return



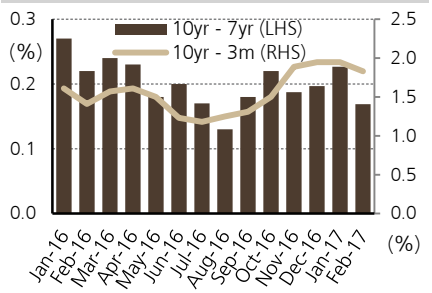
Source: UBS Quantitative Research. The figure presents the monthly excess returns of the 10-year US Government Bond from January 2016 to February 2017.

Figure 34: YoY Bond Excess Return



Source: UBS Quantitative Research. The figure presents the 12-month rolling excess returns of the 10-year US Government Bond from January 2016 to February 2017.

Figure 35: Slope of the Yield Curve



Source: UBS Quantitative Research. The slope of the yield curve is captured as the spread between the 10-year yield vs. either the 7-year yield or the 3-month rate. Sample period: January 2016 to February 2017.

The bond trend reversal is obvious in the monthly returns after July 2016, which is then reflected in the 12-month rolling bond performance following November 2016. Based on the 12-month definition of the trend signal, Figure 34 illustrates that the trend signal has been "short" for the last four months (end of November 2016, December 2016, January 2017 and February 2017). At the same time, the carry signal, defined in this paper as the sign of the slope of the yield curve in the vicinity of the 10-year tenor has been positive over the recent period.

Interestingly, the slope of the curve expressed as the yield differential between the 10-year and 7-year tenors is positive and remains at similar levels to those of the recent past. Even more so, the steepness of the entire yield curve, expressed as the differential between that 10-year yield and the 3-month rate (also presented in Figure 35) was at the end of January 2017 at its largest value since the beginning of 2016 at 195 basis points (down to 183 bps at the end of February 2017).

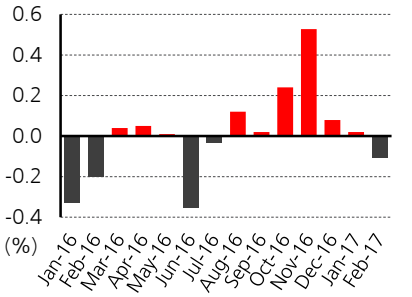
Clearly, the trend and carry signals currently disagree. The question then becomes: **is an investor better off overweighting one of the two signals in a way to resolve the current disagreement?**

Conflicting signals in 2H16:

- **Negative Trend**
- **Positive Carry**

The level of carry that is currently observed is at similar levels compared to the recent past as per Figure 35. Conversely, the increase in the 10-year yield, though strong, was primarily driven by the November 2016 move; the July 2016 to January 2017 change in the 10-year yield was 101 basis points, 53 of which occurred in November 2016 (see Figure 36 to the right). Following November 2016, the yield increase has stabilised, gaining 8 basis points in December 2016, just 2 basis points in January 2017 and, in fact, falling by 11 basis points in February 2017. Along these lines, in such a period of disagreement, it is worth considering the underlying macro dynamics that are expected to unravel in the coming months, in order to tactically over- and underweight the two conflicting signals. For this reason, we seek insight from the recent work of UBS's Global Macro Strategy team.

Figure 36: MoM 10yr Yield Change



Source: Global Financial Data.

As recently discussed by our Global Macro Strategy team (see Big Macro #3), the long-term Government bond yield can be decomposed into two components: (a) one relating to the (short-term) **interest rate expectations**, which is generally affected by the policy of central bank, and (b) the so called **"term premium"**, which captures the returns that an investor expects as compensation for being exposed to duration risk from holding a long-term bond.[7] These two components roughly align with the two principal components of the term structure of interest rates: the level and the slope of the yield curve.

The two components of long-term bond yields:

- **Interest rate expectations**
- **"Term premium" defined as the compensation for bearing duration risk**

It can be argued that the changes in interest rate expectations are generally picked up by a trend signal, whereas most of the observed level of carry (slope of the yield curve around the 10-year tenor) effectively represents compensation for bearing duration risk, hence it partly reflects the term premium.

In the period following the GFC, central banks across the globe introduced asset purchase programmes, known as Quantitative Easing (QE), as a way to address the zero bound constraint. The central banks started by purchasing long-term government bonds in exchange for newly printed cash, in order to boost investment spending and consumption. The impact of these asset purchasing mechanisms has been to largely reduce the amount of *excess* compensation

QE programmes can cause the term premia to squeeze, as central banks offer cash by taking on any duration risk

[7] Though similar in nature, this should not be confused with the TERM factor of Fama and French (1993), which is defined as the difference between long-term bond returns and the one-month T-Bill rate.

received by investors who hold longer-term bonds, as the respective "term premia" got largely squeezed to reflect the fact that the central bank removed duration risk in exchange of cash.

The impact of the QE programmes has been so extreme that the term premia globally have generally squeezed, in several cases, turned negative during or after the second half of 2014, as documented in the calculation of our Global Macro Strategy team (see Figure 37 as well as the Big Macro #3 note for details on the estimation of the term premia). The key take-away from that report was that the source of positive returns for a long position on the government bonds in the recent years has been primarily driven by the falling interest rate expectations.

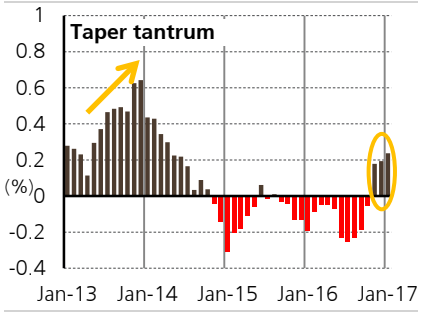
With the conclusion of the QE programmes in the US and expectations of monetary tightening becoming more material following the recent federal fund rate hikes, our Global Macro Strategy team recently documented the increase in the US term premium, which only just turned positive after a two-year period, as seen in Figure 37.[8] Put differently, with the central bank not planning any further government bond purchases, the compensation for duration risk is resurrected. Along these lines, the relatively higher levels of carry observed over the recent period (as per Figure 35) might very well reflect this shift.

In light of the above discussion, let us now try to put all pieces together:

- 12-month trend signals for government bonds have recently turned negative. However, the level of the 10-year yield has stabilised, relatively speaking, hence reducing the strength of the trend signal.
- The carry of US Government bonds, expressed as the slope of the curve in the vicinity of the 10-year tenor has been positive for several years and is currently at nine-month highs, most likely driven by the increase in the term premia, as explained in the next point.
- The "term premium" part of the 10-year yield has returned to positive territory after a couple of years and is likely to increase further if/when the Fed proceeds further with tightening.

Following the above, even if the bond trend and carry signals currently appear conflicting (when considered in their binary form) our view, combined with the view of our Global Macro Strategy team, is that the current market conditions would probably overweight the carry element, in which case the active view is to go long bonds. Clearly, keeping track of the trend signal is of utmost importance, as in the longer-run a systematic bond strategy maximises its potential when both trend and carry signals agree. One should therefore watch out for any strengthening of the recently initiated upward trend in the yields.

Figure 37: US Term Premium



Source: UBS Global Macro Strategy. The figure illustrates the level of term premium in the US. The sample period is from January 2013 to January 2017. See the appendix for a longer history and the Big Macro #3 for details on the estimation.

Term premia have been (globally) negative since 2014…

… but turned positive in the second half of 2016

Connecting the dots

Overweighting the carry signal…

…but watch out for any catalysts on trend

[8] At first glance, it might appear confusing that the level of carry in the vicinity of the 10-year tenor (proxied by the slope of the yield curve between the 10-year and the 7-year tenors) has been positive in the recent period (see Figure 35), whereas the "term premium" has only just turned positive (see Figure 37). The reason is that the slope of the curve partly reflects interest rate expectations and partly reflects compensation for bearing duration risk. Instead, the actual "term premium" presented in Figure 37 captures only the latter. See the Big Macro #3 note for further discussion on the distinction between the two.

Implications for Credit and Equity Markets

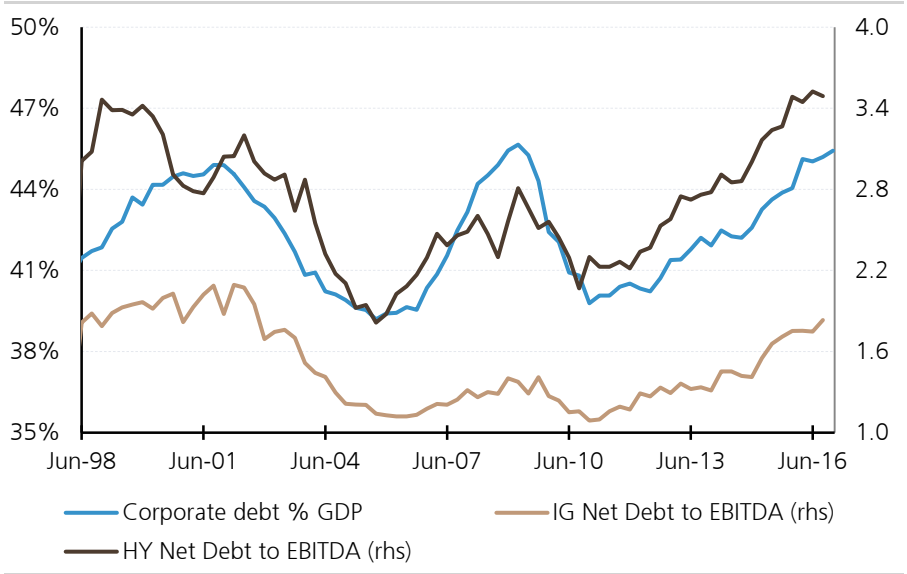
Stepping outside the government bond markets, it is reasonable to argue that systematic trend and carry bond signals can have important implications in corporate structure and therefore have implications for the credit and equity markets. We therefore invited our UBS Credit and Equity strategists to form an opinion on the potential repercussions of the current signal disagreement.

The views of the UBS US Credit Strategy team

Stephen Caprio, Credit Strategist

The corporate credit markets provide an additional reason why the trend higher in US Treasury yields is unlikely to persist over the medium run. It is likely not a surprise to many, after years of quantitative easing and low interest rates, that corporate leverage has ballooned to near record levels. US Corporate Debt to GDP is at all-time peaks while the median IG and HY firm Net Debt to EBITDA are also nearing cyclical highs (see Figure 38). The implications of this are notable for the trajectory of Treasury yields. First, these debt burdens may be having an impact on business spending decisions; 64% of CFOs in the December Duke CFO survey answered that high debt burdens would restrict future investment, despite post-election optimism about the US economic outlook. This is perhaps one reason (along with post-election legislative uncertainty) that bank corporate loan growth has stalled over the last 3 months, which puts a damper on stronger demand pushing US yields higher. High leverage has also empirically acted as a drag on corporate earnings.

Figure 38: Corporate Leverage is still climbing

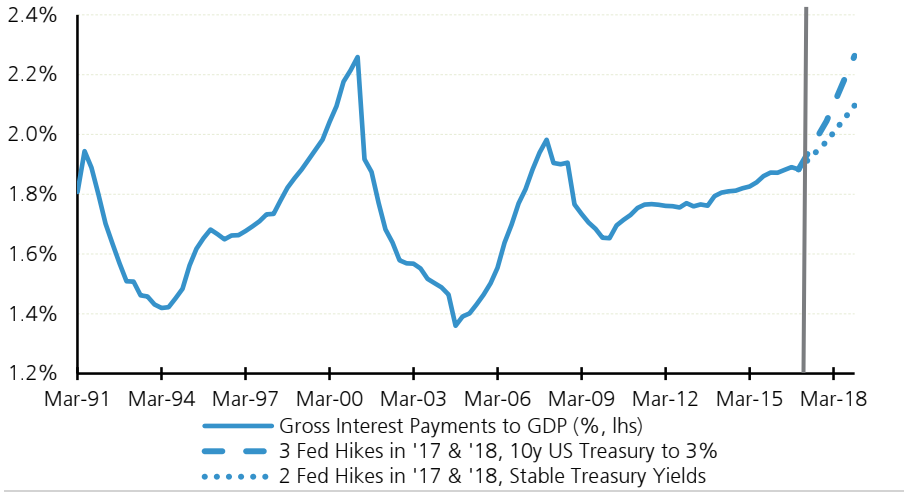


Source: UBS Credit Strategy, Bloomberg, Worldscope. Sample period: June 1993 to December 2016.

Second, nonfinancial corporate interest payments to GDP are also now near record highs, suggesting that material non-bank corporate issuance alongside weak growth has started to overwhelm the impact of low rates (Figure 39). To be fair, interest payments relative to earnings look healthier, but this is mainly a function of elevated profit margins (Figure 40). And our forward scenario analysis out to 2018 suggests high interest payments will remain a structural problem for markets. If the Fed hikes 3 times in 2017 and 2018, with 10-year yields rising to 3%, Y/Y corporate earnings would have to increase by 25% to keep interest payments stable relative to earnings. This is a growth rate more synonymous with aggressively expanding margins from a tough than current elevated margins today.

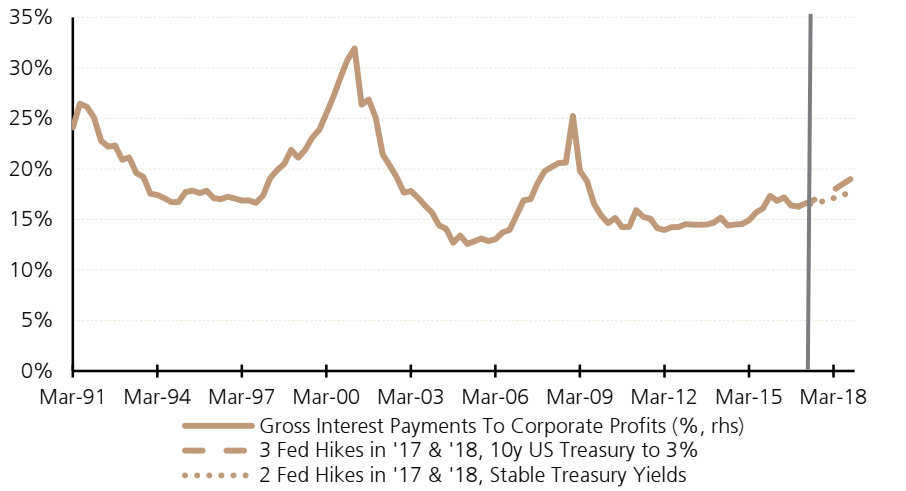
And while many expect tax policy to rescue US corporates, we believe the boost to operating cash flow will be more modest at 3-8%. Quite simply, corporate America will find it difficult to manage Fed rate hikes or higher back-end Treasury yields without a material change in capital structures to favour equity over debt. Here again, our recent work on US corporate leverage suggests that even US tax reform is unlikely to change firm capital structures meaningfully.

Figure 39: Corporate Interest Payments to GDP highlight an elevated and growing risk…



Source: UBS Credit Strategy, Bloomberg, Yieldbook, S&P LCD, Federal Reserve.

Figure 40: … stronger revenues/stable margins are essential to support this near-term



Source: UBS Credit Strategy, Bloomberg, Yieldbook, S&P LCD, Federal Reserve.

The team prefers…

… 7-10yr over 30yr US investment-grade debt

What then for investors? In a nod to our short trend signal, we are less comfortable taking 30 year investment-grade duration risk than we were in 2016. The risks here are too great, especially with credit spread curves having flattened in recent months. Our preference now is for 7-10 year maturity US investment-grade debt (the major IG ETF LQD fits this criteria), using much of the same logic as that formalized in our government bond signals. This part of the US investment-grade credit curve is quite steep at the moment, providing an attractive carry roll-down for investors. We do admit rate volatility in the short-run may drag on returns, but ultimately we think there is a limit on how far Treasury yields can rise with debt levels so elevated.

… senior-secured floating-rate bank loans over US high-yield

We also prefer senior-secured floating-rate bank loans (ETF: BKLN) as an attractive vehicle to capture 4-5% yield with less duration and credit risk than US high-yield. US loan demand is surging as LIBOR rates increase, in contrast to weak US high-yield demand.

… higher credit quality and lower duration sectors

For investment-grade sectors (see Figure 41) that fit our current rate signal disagreement and our cautious stance on credit risk, we prefer to move up in quality and to shorten duration. US bank credit fits this bill. In recent years, bank credit returns have exhibited lower mark-to-market sensitivity versus the broader market. And historically, financials tend to outperform in a spread-widening environment if asset quality does not deteriorate substantially, which we do not expect.

We also favor technology as its high average rating (AA-) and low beta to the index provide protection against spread widening. If tax reform that allows for offshore cash repatriation is passed, a potential decline in Technology supply could aid the sector.

We are more guarded on Telecoms. Concentration risk, concern over M&A re-leveraging, a higher than average duration, and lower than average credit quality make this sector a risky play.

We are also cautious on REITS, given our concerns over frothiness in commercial real estate lending and significant tightening of bank lending standards from the Fed Loan Officer Survey. While duration is low, the sensitivity of credit risk to higher rates is meaningful.

Figure 41: Sector duration and Credit Quality

Sector	Sector Duration	Average Credit Quality
Banking	5.14	A-
REITS	5.74	BBB+
Electronics	5.93	A
IG Index	7.25	A-
E&P	7.27	A-
Chemicals	7.40	BBB+
Bev & Bottling	7.67	A-
Gas Pipelines	7.70	BBB
Technology	7.94	AA-
Diversified Mfg	7.98	A
Pharmaceuticals	8.00	A
Metals & Mining	8.11	BBB
Ind. Finance	8.32	A
Retail Stores	8.33	A
Life Insurance	8.55	A
Telecom	8.65	BBB+
Transportation	9.41	A-
Electric Utilities	9.78	A-

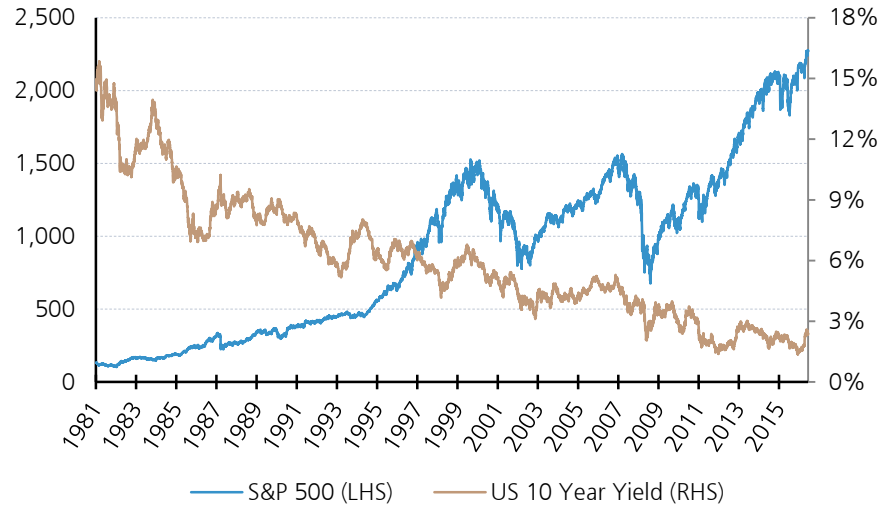
Source: UBS Credit Strategy.

The views of the UBS US Equity Strategy team

Julian Emanuel, Equity Strategist

The ascent of US Equities, up 2,200% since the early 1980s and up over 250% since the bottom of the last cyclical bear market in 2009, would seem to owe much to the secular fall in 10 year yields from near 16% in September 1981 to the most recent low at 1.36% on July 8, 2016 (see Figure 42).

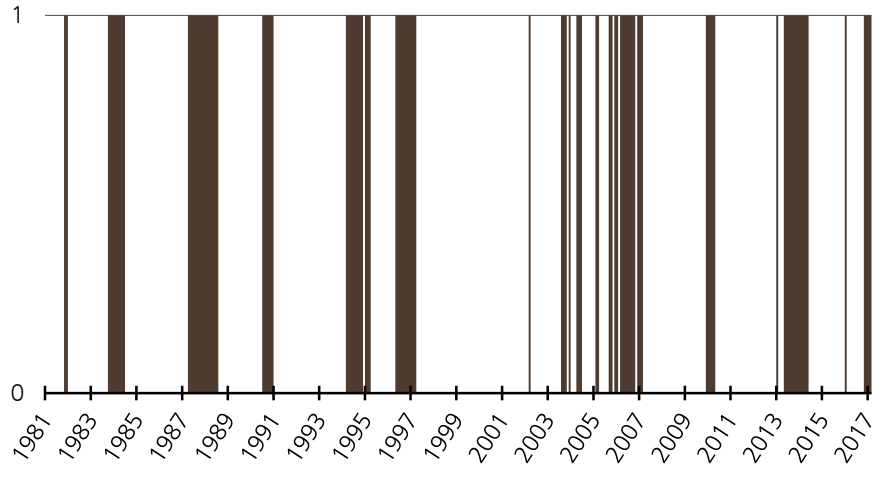
Figure 42: Stocks and Bonds – The (35 year) Wonder of It All



Source: UBS Equity Strategy, Bloomberg.

Throughout this historically extended 35-year cycle, there have been numerous episodes of both upside and downside equity market volatility, which have coincided with the present extended state of bond market signal disagreement where the trend signal is short and the carry signal is long (see Figure 43).

Figure 43: Periods of Short Trend signal and Long Carry signal



Source: UBS Quantitative Research.

Focusing solely on the periods in this 35-year cycle, where this type of signal disagreement (negative trend and positive carry) lasted for at least four months (as is currently the case (November 2016 to February 2017, see Figure 3), we present in Figure 44 the performance of the S&P 500 between one month and 24 months *after* the fourth consecutive month of such signal disagreement for each period.

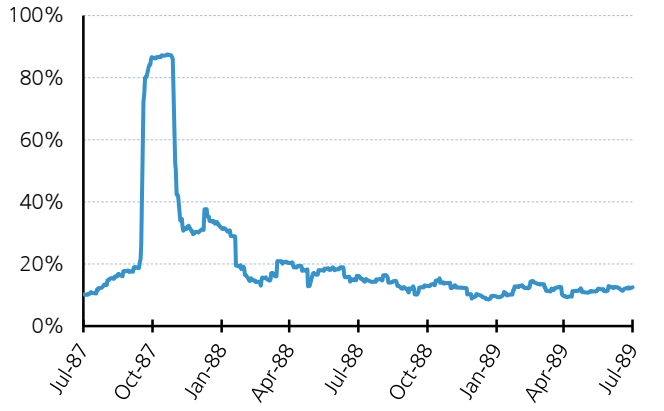
Figure 44: S&P 500 forward returns after the 4th month of Signal Disagreement

4th month of Disagreement	Duration (months)	1m	3m	6m	12m	18m	24m
Jan-84	9	-3.36%	-1.00%	-5.47%	15.34%	25.39%	42.16%
Jul-87	16	3.89%	-20.34%	-18.15%	-11.73%	-1.59%	16.47%
Oct-90	6	6.47%	14.38%	25.87%	33.84%	43.51%	47.06%
Jun-94	9	3.27%	4.95%	4.97%	26.32%	44.55%	59.33%
Aug-96	11	5.62%	16.82%	22.67%	40.98%	65.81%	52.69%
Jun-06	8	0.58%	5.76%	12.75%	20.63%	19.21%	5.21%
Mar-10	5	1.58%	-11.58%	-1.52%	15.37%	-0.42%	25.21%
Aug-13	13	3.14%	11.22%	15.09%	25.18%	32.92%	25.91%
Feb-17	≥4	?	?	?	?	?	?
Average	9.6	2.65%	2.52%	7.03%	20.74%	28.67%	34.26%
Maximum	16	6.47%	16.82%	25.87%	40.98%	65.81%	59.33%
Minimum	5	-3.36%	-20.34%	-18.15%	-11.73%	-1.59%	5.21%

Source: UBS Quantitative Research, UBS US Equity Strategy. The figure presents the performance of the S&P 500 for a number of different horizons, after the fourth consecutive month of signal disagreement (negative trend, positive carry) in the period between September 1981 and February 2017. The figure also reports the overall duration of signal disagreement in each case.

While in all cases stocks were higher 24 months after the realization of the extended signal disagreement entering into the 75th percentile observation of duration (see Figure 24) the path was frequently volatile both to the downside (1984, 1987, 2010) as well as to the upside (1996, 2013), particularly when taking the VIX into context, whose long-run average is around 19%, but currently rests at cycle lows near 11% (Figure 45 and Figure 46).

Figure 45: 1987-89 The "Crash" and More (SPX 30 Day Vol)



Source: UBS, Bloomberg.

Figure 46: 1996-98 Tech Bubble Inflation (SPX 30 Day Vol)

Source: UBS, Bloomberg.

Looking at the S&P 500 at a sector level (see Figure 47), on average, following periods of extended bond signal disagreement where trend is short and carry is long, Health Care, Financials and Technology – all UBS Equity and Derivatives Strategy overweights – have tended to outperform, while interest rate sensitive sectors such as Telecom and Utilities, Strategy underweights, have generally underperformed in the first 12 months following extended signal disagreement.

Following periods of extended bond signal disagreement (short trend, long carry), Health Care, Financials and Technology sectors have historically benefitted.

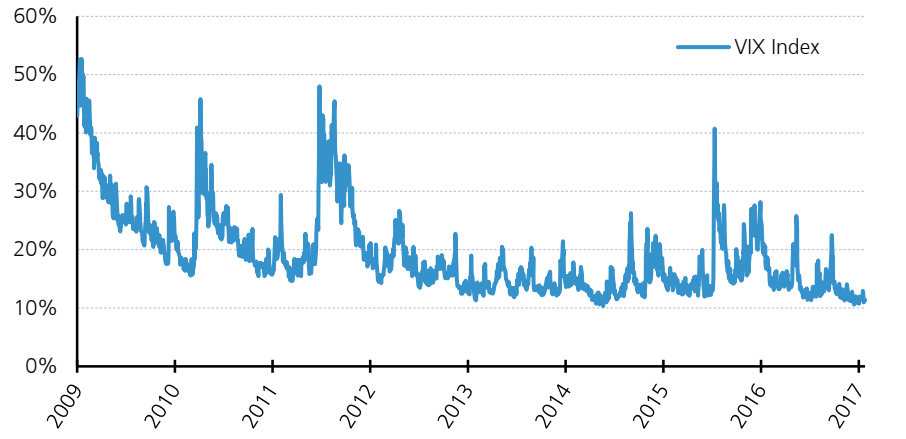
It seems reasonable to now ask whether an extended bond market signal disagreement in 2017 is likely to produce a ratcheting higher in equity market volatility (Figure 48) toward historical norms, eight years after the rally genesis and after gains of over 250%.

Figure 47: Average relative performance since 1981 after the 4th month of Signal Disagreement

	1m	3m	6m	12m	18m	24m
Energy	0.81%	-2.60%	-3.70%	0.48%	-8.26%	-10.30%
Materials	-0.62%	-1.68%	-2.38%	-0.19%	-6.93%	-11.81%
Industrials	-0.55%	-1.07%	-1.82%	-0.89%	-3.56%	-7.17%
Cons. Disc.	-0.04%	-1.34%	0.50%	-1.18%	-0.46%	5.05%
Cons. Stpls.	-0.65%	0.39%	2.02%	-1.64%	7.60%	13.71%
Health Care	0.15%	2.47%	3.07%	1.65%	8.77%	9.89%
Financials	1.57%	2.23%	2.67%	3.43%	2.22%	2.81%
Technology	0.99%	4.49%	3.32%	9.08%	6.24%	4.18%
Telecom	-1.58%	-0.11%	1.41%	-1.91%	3.89%	4.48%
Utilities	-0.45%	-1.47%	-0.49%	-3.78%	0.31%	2.45%

Source: UBS Equity Strategy.

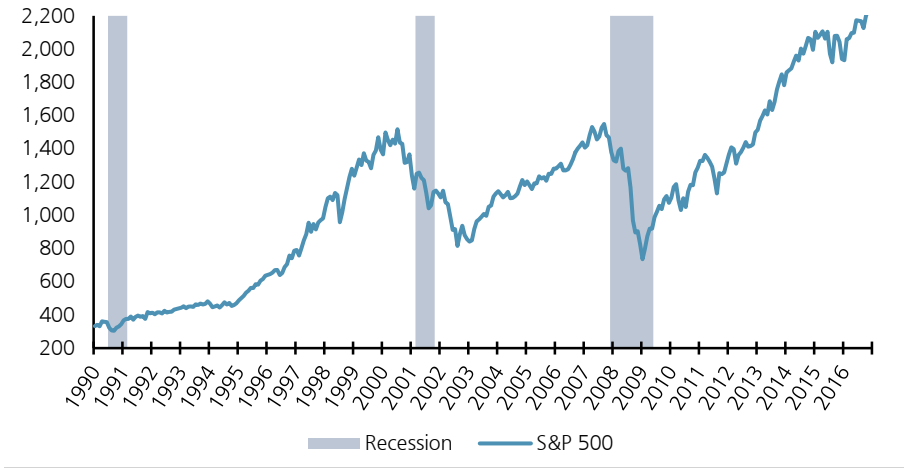
Figure 48: Mean (1987) or Pleasant (1996) Mean Reversion Ahead?



Source: UBS, Bloomberg. Sample period: February 13, 2009 to March 8, 2017.

We do not expect an end to the cyclical (post 2009) bull market within the secular (post 1982) bull market as was the case during the 1987's 33.5% drawdown. 1987 is notable as it was the last time that a cyclical bear market occurred without a recession following within 12 months of a major market top (Figure 49).

Figure 49: Since 1990, Only Recessions Kill the Bull



Source: UBS, Factset. Sample period: January 1990 to December 2016.

What we do believe is that, at 20x trailing 12 months' earnings and 18.8x UBSe for 2017, levels typically associated with prior bull market peaks (Figure 50), equities are at risk of a multi-month "risk reset" of around 10%, to the 200 Day Moving Average at 2,192 as the realization of higher interest rates and the complexity of passing economic and business friendly legislation in Washington begins to be realized by markets.

Figure 50: S&P 500 – Trailing PE (past bull markets)

Start Date	End Date	Max P/E Ratio
10/22/1957	12/12/1961	22.4x
06/26/1962	02/09/1966	20.0x
10/07/1966	11/29/1968	19.0x
05/26/1970	01/11/1973	20.2x
10/03/1974	09/21/1976	13.7x
03/06/1978	01/06/1981	9.9x
08/12/1982	08/25/1987	22.7x
12/04/1987	07/16/1990	16.6x
10/11/1990	03/24/2000	31.0x
10/09/2002	10/09/2007	21.7x
03/09/2009	?	
	Average:	19.7x

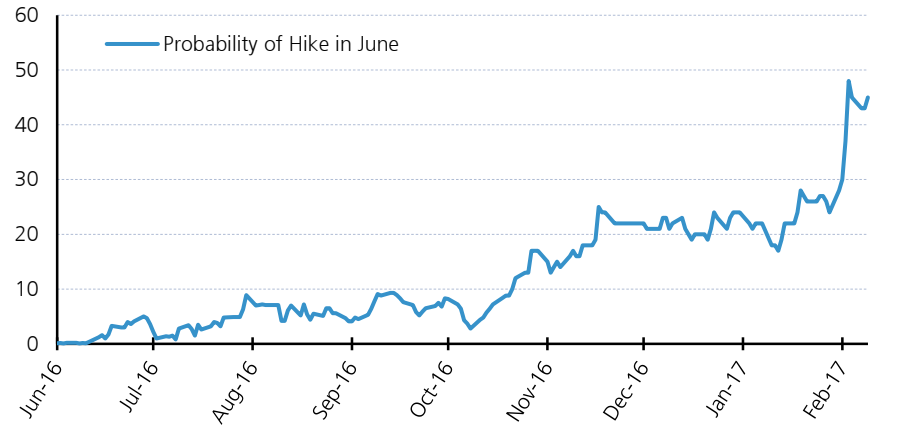
Source: UBS, Bloomberg.

Such a pullback, were it to materialize, would be consistent with the selloffs of 5 - 15% experienced intermittently throughout the eight years of the current cycle bull market phase.

With the clear message of the bond market during a signal disagreement phase – stay long but keep an eye on risk – we think maintaining equity market exposure is prudent but would take a more cautious stance by emphasizing alpha over beta. This leads us to prefer companies immune from the macro and political noise which are in a unique position to improve their margin profiles or those which are levered to an economic acceleration which is potentially being foreshadowed by the rise in 10-year yields since the US election.

After 9 years of Fed Chairmanship which emphasized erring on the side of dovishness seemingly sidelined by Chair Yellen's revising market hiking expectations quickly and significantly (Figure 51) in recent days, we adjust our view of near term equity market risks accordingly.

Figure 51: FOMC Hikes - March a "Done Deal"; June Now In Play?



Source: UBS, Bloomberg.

While the equity bull market has, in our view, further to run, we are reminded of the lessons from legendary Fed watcher Martin Zweig's most notable saying, "Don't Fight the Fed" and market analyst Edson Gould's phrase "Three Steps and a Stumble." As the bond market is in the midst of an extended signal disagreement, as the Fed gets ready to hike for the third time in the cycle that began in December 2015, we believe incremental equity market caution, consistent with our year end S&P 500 price target of 2,300, is warranted.

Stock ideas

Following the results on the historical sector performance in a similar environments of bond signal disagreement (see Figure 47), we present below the current top picks of UBS analysts within Health Care, Financials and Technology.

Figure 52: UBS Sectors and Stocks that are Positively Impacted by this Theme

Company	Ticker	Analyst	Rating	Mkt Cap (M)	Price Target	Price*
Financials						
Progressive Corporation	PGR	Brian Meredith	Buy	$22,819.07	$44.00	$39.54
S&P Global	SPGI	Alex Kramm	Buy	$34,285.30	$140.00	$131.69
Goldman Sachs Group Inc.	GS	Brennan Hawken	Buy	$103,774.66	$285.00	$248.38
Healthcare						
Jazz Pharmaceuticals PLC	JAZZ	Marc Goodman	Buy	$8,119.83	$168.00	$134.83
Johnson & Johnson	JNJ	Matt Miksic	Buy	$348,188.78	$136.00	$126.21
UnitedHealth Group	UNH	A.J. Rice	Buy	$162,465.67	$193.00	$169.98
Walgreens Boots Alliance Inc	WBA	Michael Cherny	Buy	$92,028.16	$97.00	$85.63
Technology						
Alphabet Inc.	GOOG	Eric Sheridan	Buy	$587,261.36	$980.00	$843.25
Apple Inc.	AAPL	Steven Milunovich	Buy	$738,886.97	$151.00	$139.14
Applied Materials Inc.	AMAT	Stephen Chin	Buy	$40,295.64	$44.00	$38.12

Source: UBS Estimates, *Price as of close of 03/10/17.

APPENDIX

A. A short note on the literature

On the impact of rate regimes on the performance of systematic strategies

The academic coverage on the relationship between systematic strategies and interest rate changes is relatively limited. The few papers that exist look solely at the profitability of multi-asset trend-following strategies across different market regimes, as opposed to looking explicitly at the bond market and the respective trend and carry premia. Most papers argue that multi-asset trend-following performs well across various rate regimes; see Hurst, Ooi and Pedersen (2012), Lemperiere *et al.* (2014), Hamill, Rattray and van Hemert (2016), as well as a report by Campbell & Company (2013). Conversely, Niederhoffer and Weddepohl (2014) claim that "*[multi-asset] trend following strategies are likely to have a more difficult time in a rising interest rate environment*". Out of these papers, those by Hurst, Ooi and Pedersen (2014) and Lemperiere *et al.* (2014) contain similarly long sample periods for the US government bond; see Figure 53.

Figure 53: Sample periods in the literature

Paper	Sample period used for the US Bond
Hurst, Ooi and Pedersen (2012)	1880 – 2013
Campbell & Company (2013)	1972 – 2012
Lemperiere *et al.* (2014)	1918 – 2014
Niederhoffer and Weddepohl (2014)	1990 – 2013
Hamill, Rattray and van Hemert (2016)	1960 – 2015

Source: UBS Quantitative Research.

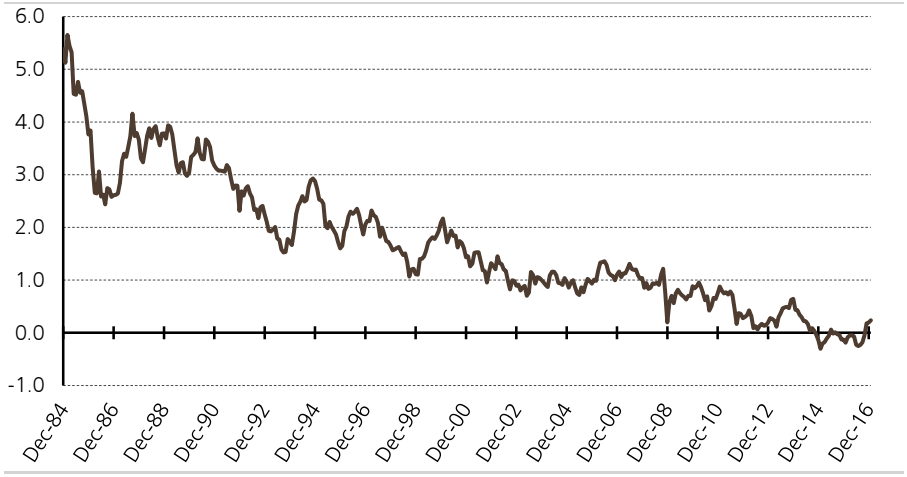
On the benefit of combining trend and carry signals

As for the benefit of combining trend and carry signals, there are a few papers recently written on the topic focusing solely on the FX markets (Mettler, Thony and Schmidt, 2010, Burnside, Eichenbaum and Rebelo, 2011, and Olszweski and Zhou 2013), or across asset classes (Ahmerkamp and Grant, 2013, and Bhansali, Davis, Dorsten and Rennison, 2015).

B. US Term Premium

Figure 54 presents the term premium for the 10-year US Government bond for the period between December 1984 and January 2017 as extracted by our UBS Global Macro Strategy team; for details in the estimation see Big Macro #3.

Figure 54: US Term Premium



Source: UBS Global Macro Strategy. The figure illustrates the level of the US term premium. See Big Macro #3 for details on the estimation.

References

Ahmerkamp, J. D., & Grant, J. (2013). The returns to carry and momentum strategies. *Available at SSRN: 2227387.*

Baltas, N., & Kosowski, R. (2013). Momentum strategies in futures markets and trend-following funds. *Available at SSRN: 1968996.*

Bhansali, V., Davis, J., Dorsten, M., & Rennison, G. (2015). Carry and Trend in Lots of Places. *Journal of Portfolio Management, 41*(4), 82-90.

Burnside, C., Eichenbaum, M., & Rebelo, S. (2011). Carry trade and momentum in currency markets. *Annual Review of Financial Economics, 3*(1), 511-535.

Campbell & Company (2013): Prospects for CTAs in a Rising Interest Rate Environment, *Campbell & Company white paper*.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3-56.

Fung, W., & Hsieh, D. A. (1997). Empirical characteristics of dynamic trading strategies: The case of hedge funds. *Review of Financial Studies, 10*(2), 275-302.

Fung, W., & Hsieh, D. A. (2001). The risk in hedge fund strategies: Theory and evidence from trend followers. *Review of Financial studies, 14*(2), 313-341.

Goyal, A., & Welch, I. (2008). A comprehensive look at the empirical performance of equity premium prediction. *Review of Financial Studies, 21*(4), 1455-1508.

Hamill, C., Rattray, S., & Van Hemert, O. (2016). Trend Following: Equity and Bond Crisis Alpha. *Available at SSRN: 2831926.*

Hurst, B., Ooi, Y. H., & Pedersen, L. H. (2012). A century of evidence on trend-following investing. *AQR white paper.*

Koijen, R. S., Moskowitz, T. J., Pedersen, L. H., & Vrugt, E. B. (2017). Carry. *Journal of Financial Economics, forthcoming.*

Lempérière, Y., Deremble, C., Seager, P., Potters, M., & Bouchaud, J. P. (2014). Two centuries of trend following. *Journal of Investment Strategies, 3*(3), 41-61.

Mettler, U., Thöny, M., & Schmidt, H. (2010). Carry and trend strategies in FX markets. *Journal of Asset Management, 11*(5), 321-331.

Morningstar (2008). Return Calculation of U.S. Treasury Constant Maturity Indices. *Morningstar Methodology Paper*.

Moskowitz, T. J., Ooi, Y. H., & Pedersen, L. H. (2012). Time series momentum. *Journal of Financial Economics, 104*(2), 228-250.

Newey, W. K., & West, K. D. (1987). A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica, 55*(3),703-708.

Niederhoffer, R. & Weddepohl, C. (2014). CTAs and Rising Interest Rates: Is the Party Over? *R. G. Niederhoffer Capital Management white paper*.

Olszweski, F., & Zhou, G. (2013). Strategy diversification: Combining momentum and carry strategies within a foreign exchange portfolio. *Journal of Derivatives & Hedge Funds, 19*(4), 311-320.

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Goldman Sachs Group Inc.[4, 5, 6a, 6b, 6c, 7, 16]	GS.N	Buy	N/A	US$248.38	10 Mar 2017
Jazz Pharmaceuticals PLC[16]	JAZZ.O	Buy	N/A	US$134.83	10 Mar 2017
Johnson & Johnson[2, 4, 5, 6a, 6b, 7, 16]	JNJ.N	Buy	N/A	US$126.21	10 Mar 2017
Progressive Corporation[6b, 7, 16]	PGR.N	Buy	N/A	US$39.54	10 Mar 2017
S&P Global[16]	SPGI.N	Buy	N/A	US$131.69	10 Mar 2017
UnitedHealth Group[4, 6a, 7, 16, 18a]	UNH.N	Buy	N/A	US$169.98	10 Mar 2017
Walgreens Boots Alliance Inc[2, 3, 4, 5, 6a, 7, 16, 18b]	WBA.O	Buy	N/A	US$85.63	10 Mar 2017

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