Credit Benchmark®

Consensus Sovereign Credit Data and Tradeable Anomalies in Government Bond Prices

David Carruthers
Barbora Makova
Sheliza Siddiqui

August 2019

Executive Summary

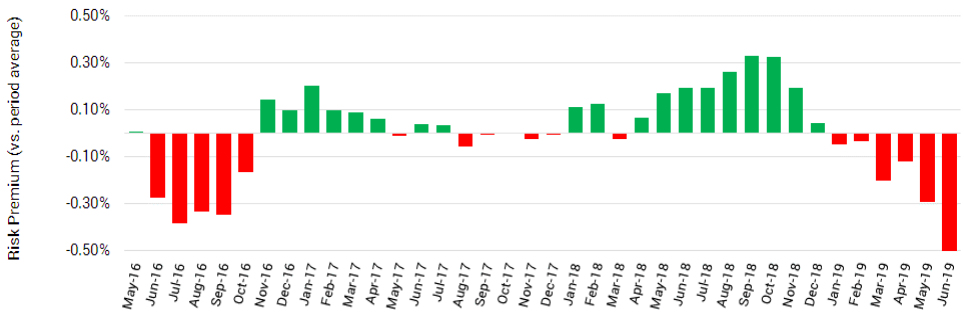
- This report uses data for 31 Government bond markets, each with a full consensus credit estimate history for the past 38 months. Government bonds are usually liquid, but more volatile than pure credit risk estimates.

- Consensus credit risk estimates:

  - May provide valuation benchmarks for Government bonds.
  - Are correlated with Government bonds, but are less volatile.
  - Provide positive but volatile out-of-sample performance in specific markets and time periods vs. traditional trading strategies.

- **Bond – Credit correlations follow the credit cycle**: Bonds and credit have positive but variable cross-sectional correlations across 31 diverse countries with very different credit profiles. Bond market correlations show some dramatic shifts over this period.

Average Risk Premium May 2016 - June 2019



Credit Risk Premium is currently low; bond yields vs. credit risk is a proxy for the market price of credit risk. Recent bond yield drops mean reduced compensation for Sovereign credit risk. Individual markets appear to show mean reversion, implying scope for risk premium-based trading signals.

- **Credit data can provide trading signals**. Active, credit consensus-based strategies are most frequently successful in Austria, Canada, China, Germany, Poland, Singapore, Spain and Sweden. Trend-based strategies are most successful in the Czech Republic, Mexico, Netherlands and Thailand (after correcting for global trend). There are no clear winners in the UK and Taiwan.

- The "Naïve" strategy (i.e. assume no price change) is often successful, especially after adjusting for trends, but bond price phases can be approximated by a quadratic time trend. Active trading signals based on credit consensus estimates may be a source of excess returns when used to trade the different phases of the bond cycle, with scope to improve on the Naïve strategy.

- **The Active strategy may be a high beta alternative to the other strategies**. When Trend or Naïve strategy returns are positive, the Active strategy returns are often significantly higher; but when the Trend or Naïve strategy returns are negative, the Active strategy returns are significantly more negative.

Overview

Government bonds are the largest, most liquid asset class in the world. Traditionally, developed economy yields and prices were driven by inflation expectations; but Central Bank QE policies now dominate. A growing proportion of Government bonds (currently $15trn) now trade at negative yields (despite positive inflation), and this total is expected to increase.

Within this "Bonds Through the Looking Glass" world, Sovereign credit risk remains a constant feature. In less developed or distressed economies it has always been present – Argentina in the late 19th Century, various European nations in the 1930s, Argentina (again) in the 1980s, Russia in the 90s, Greece and Argentina (yet again) in the early 21st century. A long list of smaller countries – Bermuda, Mozambique, Venezuela, Philippines – have been in various degrees of default over the past 100 years.

But for developed countries, Sovereign risk has historically been very low. It is true that bond yields have, at times (e.g. the 1970s), been very responsive to fiscal deterioration – an element in Sovereign risk. But the growth of Central Bank balance sheets in the wake of the 2008/09 financial crisis has put developed economy Sovereign risk under scrutiny.

Brexit has highlighted broader tensions within the EU; even within the Eurozone there is a significant range of funding costs for individual Governments. Before President Trump was elected he raised the specter of a US debt default as a bargaining chip in trade negotiations with China (one of the largest international holders of US Government debt). This may have been an idle threat, but it is worth noting that even Greek Government bonds yields have recently traded below US 10-year Treasuries.

The larger, developed economy Government bond markets are very liquid. This, together with historically low price volatility, has made them the first choice as collateral for most financing trades. It also means that they can provide a benchmark for the market price of credit risk, without distortions due to the liquidity risk premium and other technical sources of pricing noise.

But the market price of credit risk is itself subject to short-term variations and noise. French Government bond yields and CDS prices rose dramatically in the run up to the last Presidential election, with fears of a Le Pen victory. Italian bonds have been a rollercoaster for political and financial reasons, and – as noted above – even US bonds are not immune to shifts in credit sentiment.

The relatively new consensus credit data set provides medium-term estimates of credit risk that are typically more stable than market implied estimates but also updated more frequently than ratings from Credit Ratings Agencies (CRAs). This paper presents promising evidence that, in some markets and under certain assumptions, simple trading rules applied to the differences between the two metrics may offer scope for excess trading profits. This suggests that consensus credit risk data can be used in some markets to identify tradeable short-to medium-term anomalies in Government bond prices.

1 Consensus Credit Ratings for Sovereigns

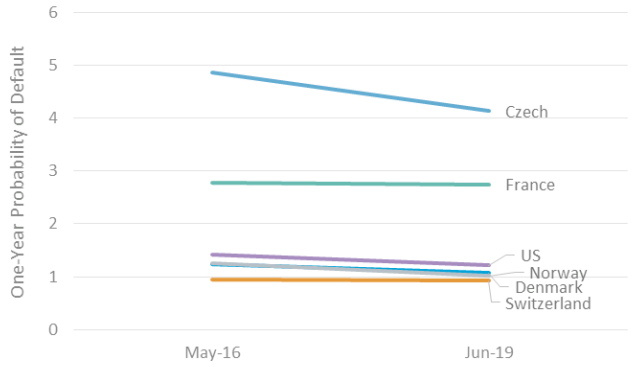
Consensus Credit Ratings are derived from monthly data contributed by more than 40 major financial institutions globally. These ratings reflect the expert views of more than 30,000 credit analysts in contributing organizations.[1] The data is one-year, Hybrid Through-the-Cycle estimates of Probability of Default ("PD") used in Risk Weighted Asset (RWA) calculations. The data provides more than 500 industry/geography trend tracking aggregates and 50,000 single legal entities, more than 100 Sovereigns, including otherwise unrated countries such as Algeria and Libya. This report uses 38 month-end estimates for 31 Sovereigns for the period May 2016 to June 2019.

2 Recent trends in Sovereign credit risk and Government bond yields.

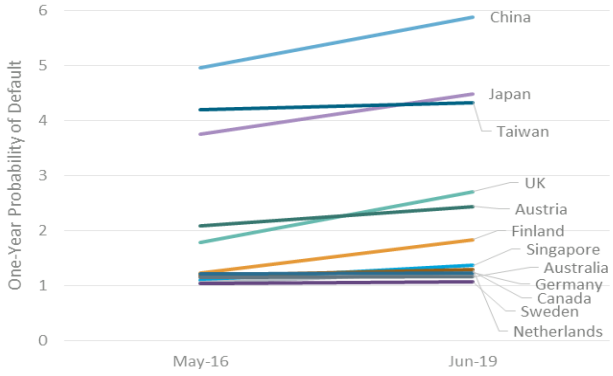
Figure 2.1 shows rends in Sovereign credit risk for 31 countries between May 2016 and June 2019.

Figure 2.1: Recent Trends in Sovereign Credit Risk

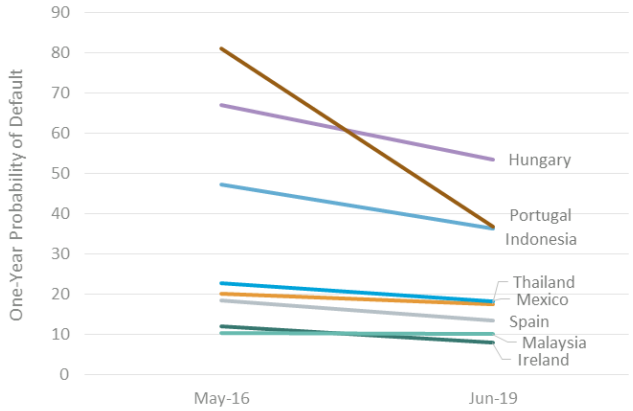
Improving (PD =< 10 Bps)



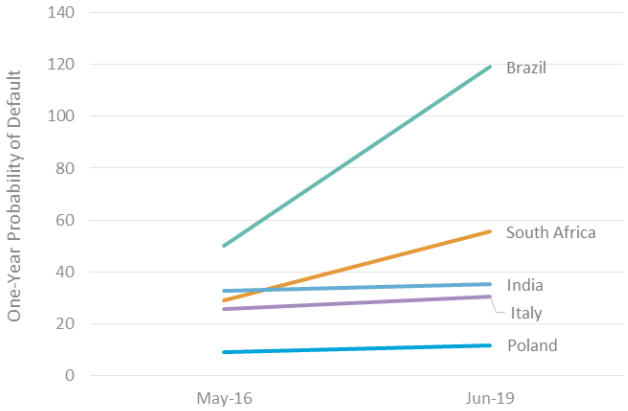
Deteriorating (PD =< 10 Bps)



Improving (PD > 10 Bps)



Deteriorating (PD > 10 Bps)



Overall, 17 Sovereigns show a deterioration and 14 show an improvement. Some of these moves towards deterioration are dramatic: The PDs for Brazil and South Africa have roughly doubled; China has risen 20% from 5 Bps to 6 Bps; and the UK has increased from less than 2 Bps and is now close to 3 Bps – an increase of 50%. Even some low risk markets like Canada and Japan have seen increases of around 20%. In terms of noteworthy improvements, the PD for Portugal has halved, and the Czech Republic has dropped by 20%.

[1] The Diversity Prediction Theorem – better known as the "Wisdom of Crowds" – implies that the collective view of a group of independent experts provides an unbiased, minimum variance estimate of the population mean. The corollary for credit is that the collective view will converge on the population mean faster and more accurately than a typical expert analyst. In this context, the NRSRO opinion-based ratings can be viewed as part of the broader group of expert views.

3 Correlations between Government Bond Yields

Government bond yields have been dropping in many countries, and the implication is that bond markets are becoming more strongly correlated. Figures 3.1 and 3.2 explore this by showing correlations between Government bond yield levels for the periods May 2016 to Dec 2017 and Jan 2018 to June 2019 respectively. (Green = positive, Red = negative)

Figure 3.1 Yield level correlation May 2016 to Dec 2017

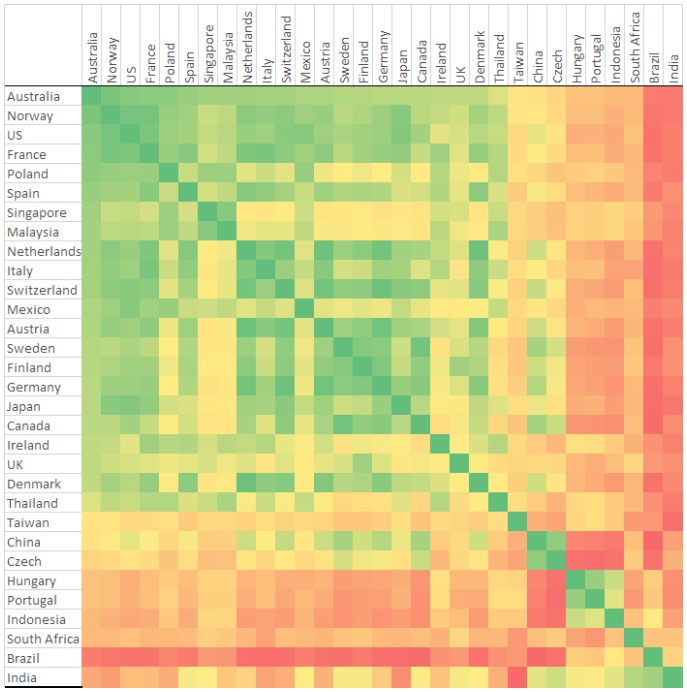
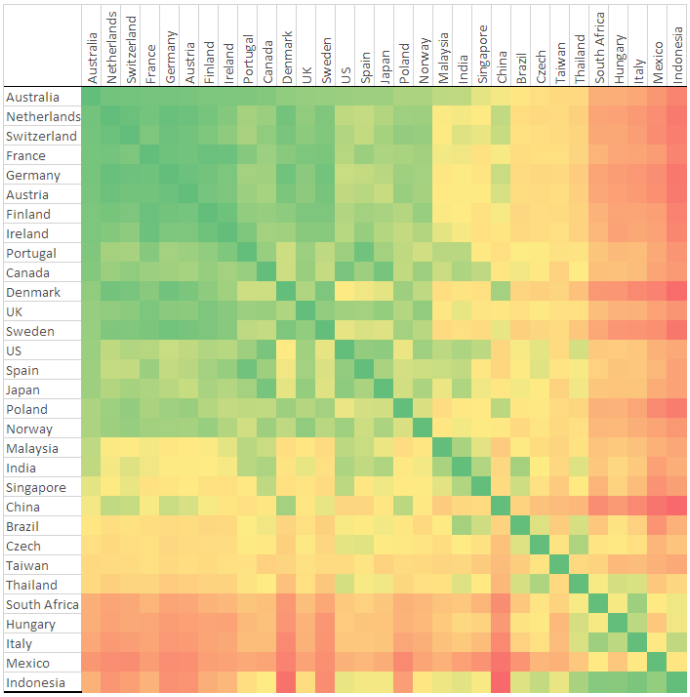


Figure 3.2 Yield level correlation Jan 2018 to June 2019



Sweden and Japan occupy similar positions in both matrices. Most of the core Eurozone markets are in similar groups in both time periods, although Germany was closer to the middle of the set in the first period, during which Germany acted as a pivot for the matrix overall. The US has this role in the second period. Czech Republic, Hungary, Indonesia and South Africa form a block. Austria, Finland, Germany and Switzerland also form a loose block. There are some notable differences: Italy Mexico, Norway, Ireland, India and Portugal all show significant changes in their overall position in the matrix. The more recent matrix appears to be more coherent – there is an obvious block of markets showing a strongly positive correlation. This is confirmed by the average correlations: 0.45 for the earlier period, 0.58 for the later period.

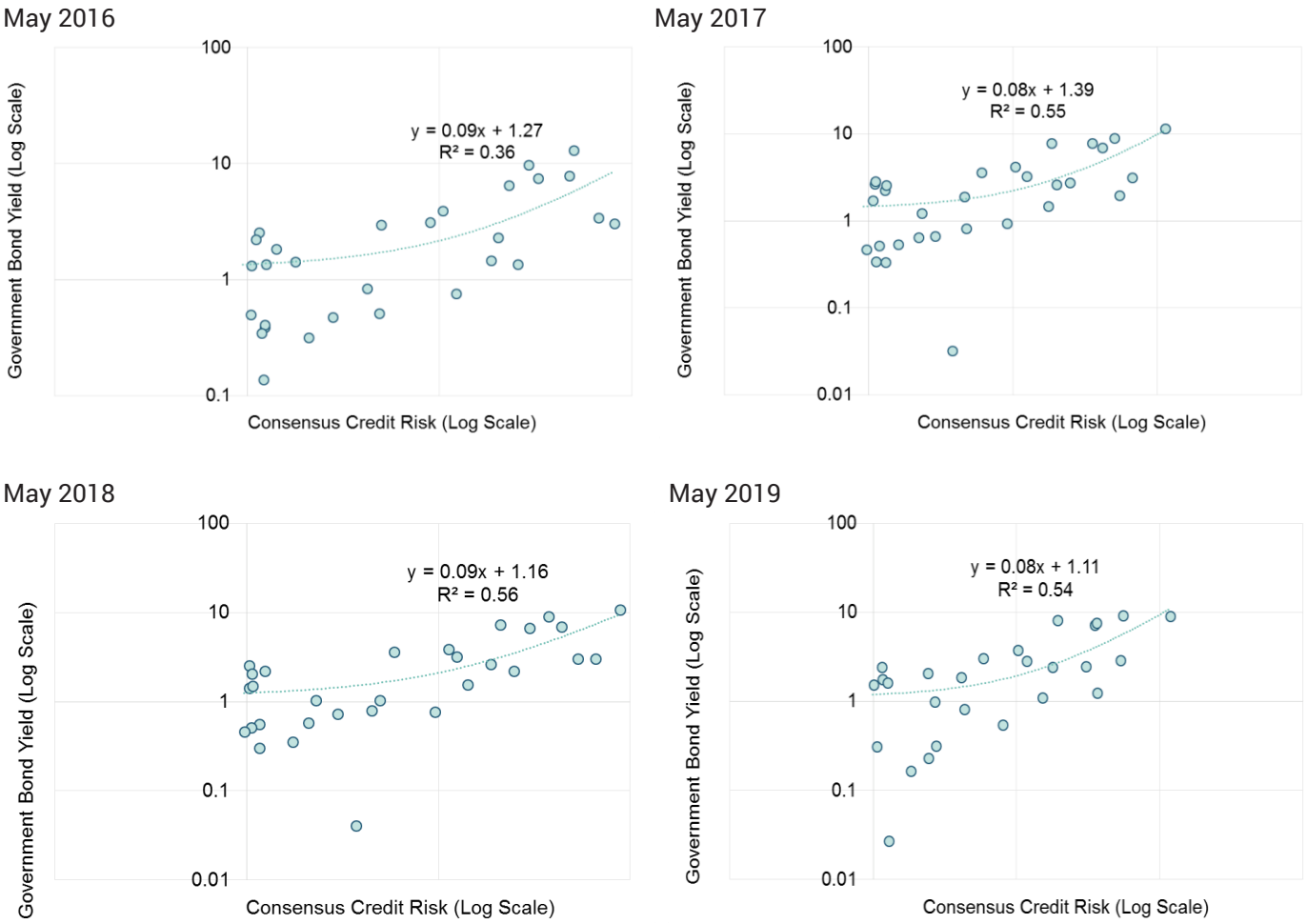
The normalized[2] volatilities one-year bond proxies have an interquartile range of 10% to 41%. Normalized volatilities of PDs are in the range of 7% to 11%.

2 Normalized = Coefficient of Variation i.e. Standard Deviation ÷ Average

4 Correlations between Government Bond Yields and Sovereign Credit Risk

Figure 4.1 plots Government Bond Yields against Real World Probabilities of Default, on log scales, for the 31 countries in this report.

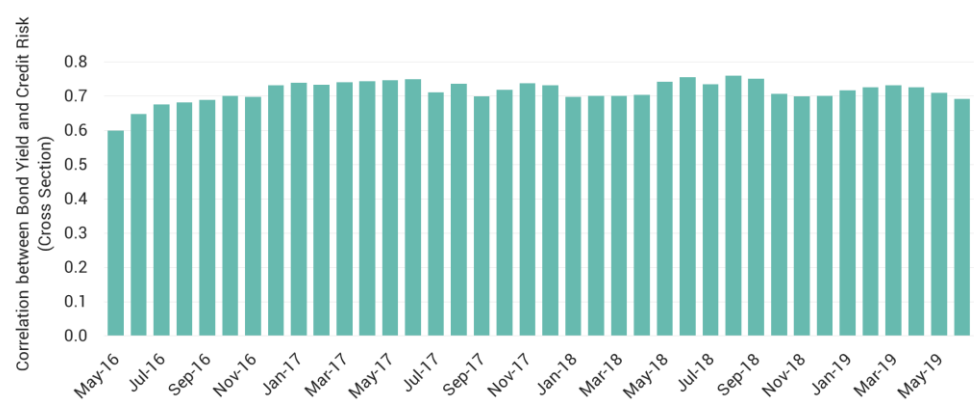
Figure 4.1: Government Bond Yields vs. Real World Consensus Credit Risk, Log Scale, Annual Snapshots



The R-squared measure of fit ranges from 36% to 55%. The intercepts, representing the base level of global nominal yields, are in a narrow range from 1.11 to 1.39 basis points, and the slope varies between 0.08 and 0.09, representing movements in the short-term credit risk premium.

Figure 4.2 shows the correlation between monthly yields and credit risks over the whole sample period.

Figure 4.2 Cross Sectional Linear Correlation: monthly Government bond yields vs. consensus credit risk



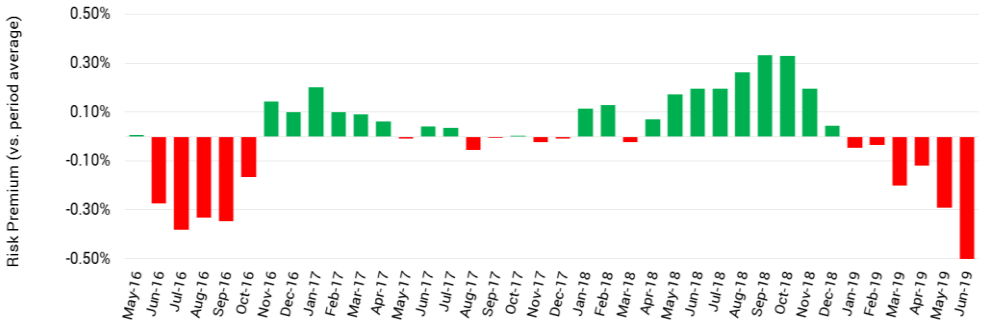
In early 2016, the correlation was in around 0.60. It rose steadily until late 2016 and then stabilized for about 18 months. It has been trending lower for the past 9 months.

This correlation shows modest (possibly cyclical) changes over time, with high persistence (positive autocorrelation) over shorter time periods. This may reflect changes in the risk premium; at times yields will be mainly driven by credit, but there will be phases where other factors – such as changing expectations around monetary or fiscal policies – will dominate.

The drop in correlation suggests that the influence of credit is waning in recent months as Government bond yields around the world have dropped to record low levels. Observed divergences between bond yields and credit risk will persist until credit again becomes a significant factor[3].

Figure 4.3 illustrates this with the time series of the average risk premium.[4]

Figure 4.3 Average Risk Premium May 2016 - June 2019



The average risk premium (across all 31 countries) is clearly cyclical. The below-average phase in mid-2016 was followed by two phases when the risk premium was modestly (early 2017) and strongly (mid 2018) above average.

Since late 2018 it has moved increasingly below average. The one-month autocorrelation is +0.82, confirming the obvious cyclical and trending behavior plotted here.

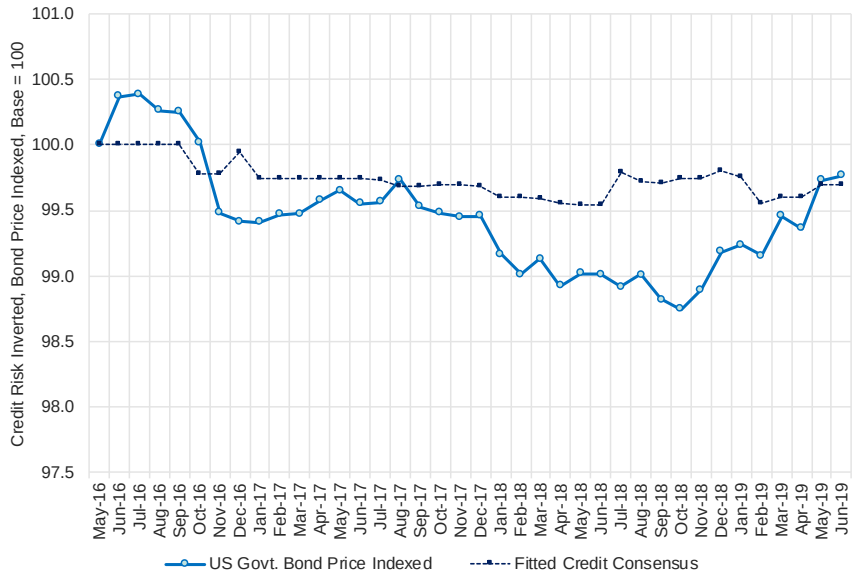
This suggests that the risk premium has some cyclical and mean reverting characteristics that could provide a basis for an active trading strategy.

3 *Inflation rates – current and expected – have traditionally been a major component for some individual country yields. But in cross section, this current dataset only shows a modest correlation between inflation and credit risk and it tends to be driven by a few outliers. Interest rate policy and fiscal changes will also exert a major influence, although these three drivers are somewhat interdependent.*

4 *Risk Premium = Bond Yield – Consensus Yield Equivalent. The latter is estimated as Probability of Default x 50%), where 50% is the estimated Loss Given Default.*

5 Charts: Government Bond Yields vs. Consensus Credit Risk, May 2016 - June 2019

Figure 5.1 plots the US Government bond price index[5] against the real-world credit equivalent over a 38-month period[6]. The latter is based on the consensus PD, converted to a bond price equivalent. Both series are rebased to a base value of 100 in May 2016. This is how the bond price would behave if real-world consensus credit risk was the only driver of price changes. The difference can be viewed as a "price premium", the reciprocal of the yield-based risk premium.



The US Government Bond price proxy series has a range of about 0.43%, whereas the real-world credit equivalent is about 0.13%. The monthly correlation between the two series is 0.69. The Government bond chart has an approximately cyclical appearance over this period, dropping from its highest to its lowest point over about 20 months, followed by a sustained recovery. The real-world equivalent shows a modest drop until early 2018 and a slight net increase into 2019. The Government index has crossed the credit equivalent index three times over this period.

To what extent can the more stable real-world credit estimates provide a valuation benchmark for the more volatile Government bonds?

Government Bond yields reflect expectations about inflation, currency movements, yield term structures, supply (i.e. Government debt issuance), and liquidity as well as credit. Markets view some Government bond markets as "safe havens", reflecting a benign environment for some or all of these factors. Credit risk estimates will mainly reflect debt levels and changes. A depreciating currency can undermine debt servicing capacity, so the two may be related. Credit analysts at banks may make some reference to market prices in their assessments; in this way they collective group of 30,000 analysts that underpin the consensus data set may act as a filter, potentially extracting the signal from the market noise.

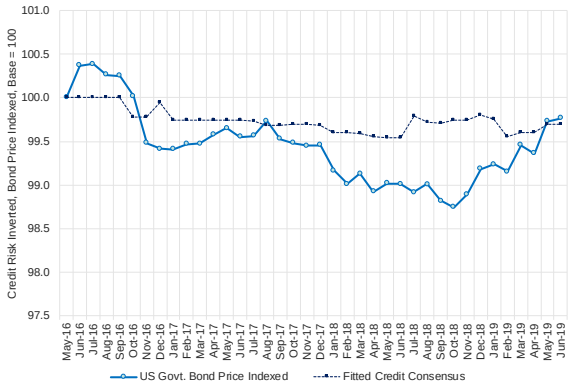
Traders and investors will have their own perspective on which factors are driving short-term movements in bond yields, but the chart suggests that, in the US, if bond yields appear to have passed a turning point, the fitted line can provide an estimate of their medium-term expected value – a point of navigation for possible mean reversion.

5 *The 10-year annual bond yield has been converted to a one-year equivalent bond to eliminate duration effects. The real-world credit price equivalent is based on annual PD estimates.*
6 *Based on a regression of the bond index on the real-world credit estimates. The dotted line is a "stretched" version of the original credit estimate, rescaled to the same base value of 100 in May 2016.*

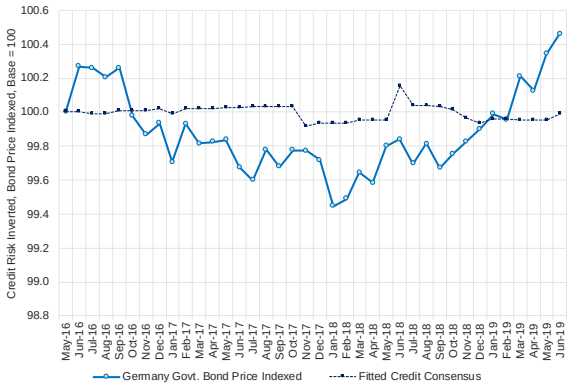
Figures 5.2 and 5.3 show these plots for two groups of six countries ("G6" and Selected Eurozone) out of the 31 countries. These plots reveal the typical scale and frequency of divergences between yields and credit risk, and provide some insight into the dynamics between the two.

Figure 5.2 G6 Sovereigns

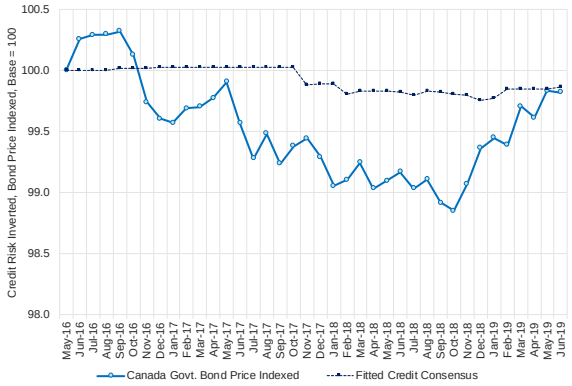
US



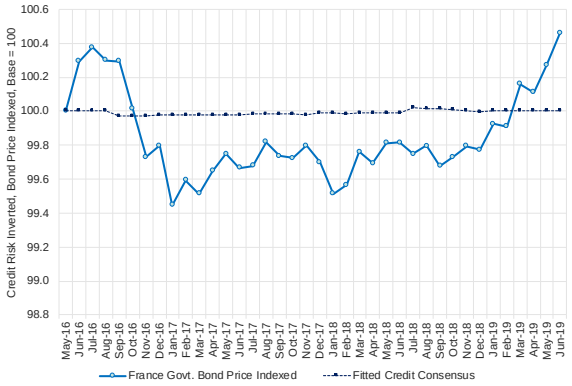
Germany



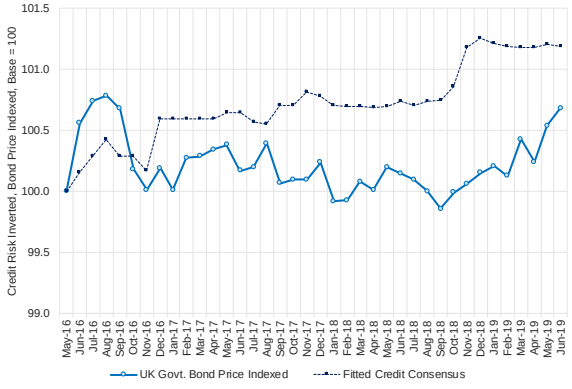
Canada



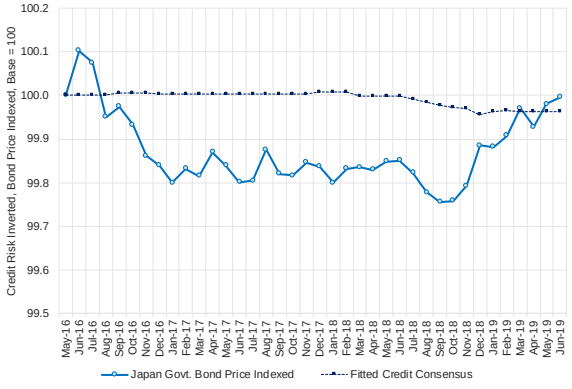
France



UK



Japan

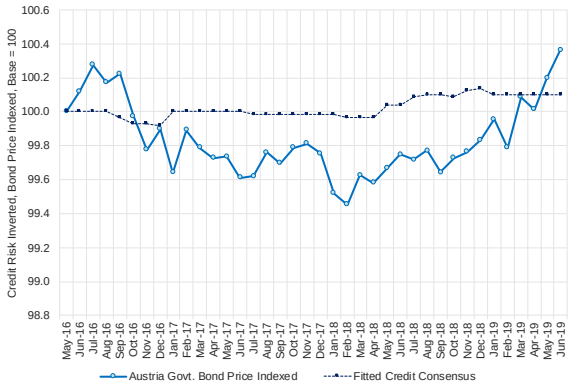


In some cases, the fitted line is close to horizontal; some show more significant variation and/or trending[7]. Compared with the fitted (black dotted) lines, two (France and Germany) of the G6 bond markets are currently significantly above the implied credit quality line. The US and Japan are slightly above, and Canada is slightly below. The UK is significantly below.

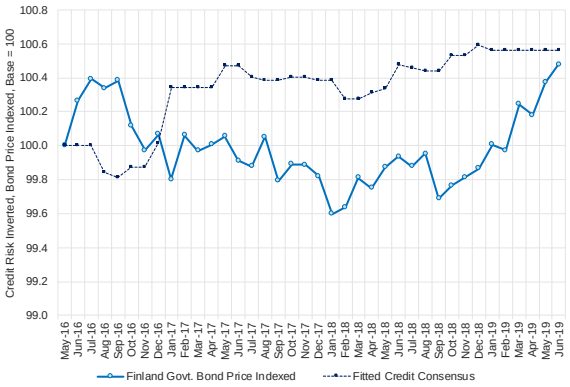
7 Note that the slope of the fitted line is determined by the slope of the bond price line. If the bond and credit time series are correlated, but with opposite sign, that will not be reflected in the fit. In some markets, the bond price can be increasing despite a trend deterioration in credit, because other factors are dominating. Results like these can be filtered out based on the overall fit (R-squared) and the slope coefficient.

Figure 5.3 Selected Eurozone (excluding France and Germany) Sovereigns

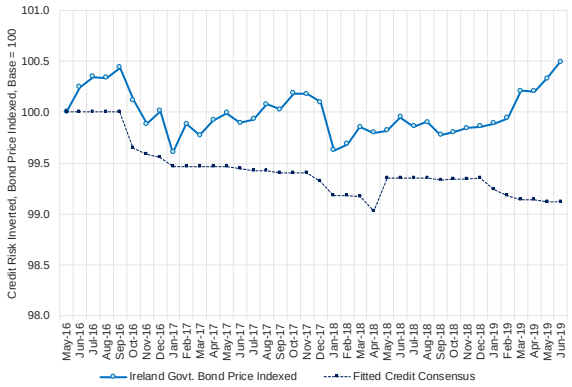
Austria



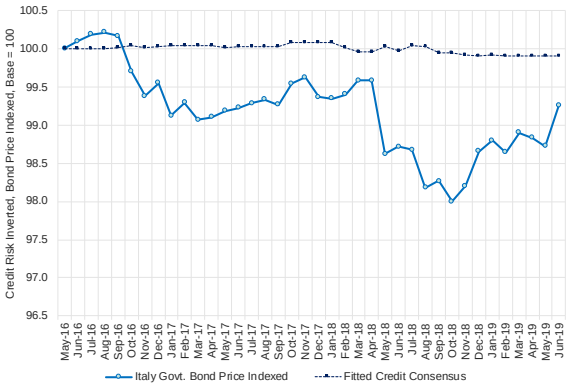
Finland



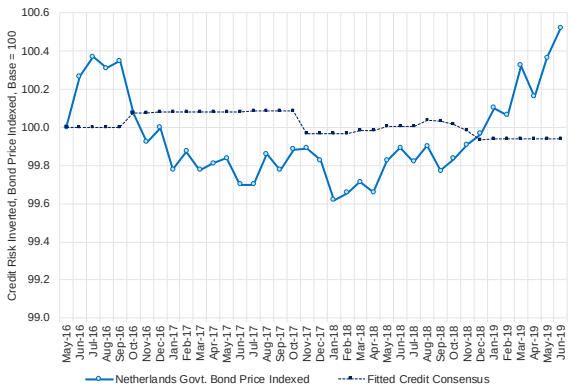
Ireland



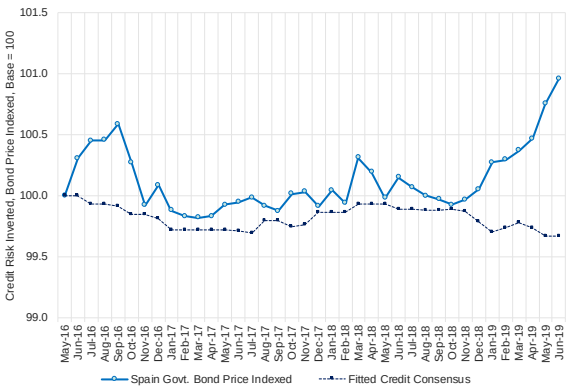
Italy



Netherlands



Spain



Four of these selected Eurozone members are above the fitted real world credit equivalent. Finland is slightly below and Italy is significantly below.

Where bonds are above the credit line, markets are paying a premium for these bonds. The reasons can vary from scope for further QE and lower short rates, fiscal expectations, or an appetite for liquidity.

6 Testing Price Premium Anomalies for Trading Signals

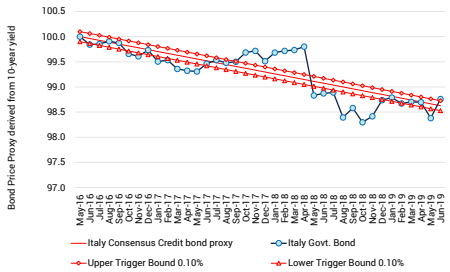
Some charts in section 5 suggest an element of mean reversion between bond prices and credit consensus, but most are dominated by a sustained increase in the proxy bond price that begins in the latter half of 2018.

This section quantifies the utility of the credit consensus as a valuation and trading benchmark for this asset class. The focus here is on relative prices and relative credit risk; each country is compared with an equally weighted benchmark of all the Governments in the group of 31.

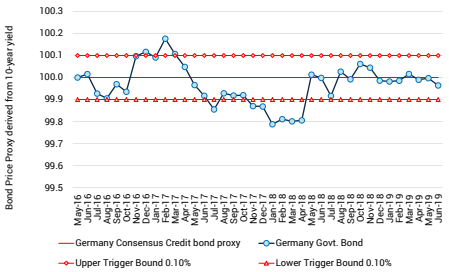
When comparing bond prices with valuation benchmarks, there are three broad patterns: (1) trending with no significant turning points (2) cyclical but stable (effectively a stationary series) (3) "turbulent" which shows mini-cycles, short lived trends, and multiple turning points. Figure 6.1 illustrates these:

Figure 6.1 Typical Dynamics of Bond Prices and Valuation Benchmarks (May 2016 - June 2019)

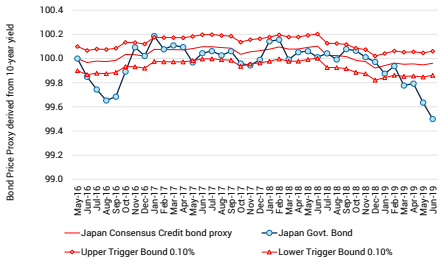
Trending (Italy)



Cyclical but Stable (Germany)



Turbulent (Japan)



For all of these patterns, the test results reported here use a simple trading rule that assumes long or short trades (overweight / underweight positions) triggered when the relative bond price premium moves below/above a relative Buy/Sell boundary. The trigger boundary is X% below or above the relative fitted credit price line, and results are collated for increments of X, from 0.05% to 0.40%. The examples in Figure 6.1 use a trigger of 0.1%.

Corresponding to these patterns, four types of valuation benchmark are tested:

Trend ("T"): time trend fitted to the Government bond proxy – relevant for strongly trending markets
Naïve ("N"): fixed value of 100 – relevant for cyclical but stable markets
Active ("A"): regression fit between the bond proxy and Consensus credit – relevant when markets are turbulent and major turning points are difficult to identify. The consensus can provide a stable axis to navigate the noisy bond price data.
Buy & Hold ("BH"): Equivalent to a very wide trigger band, where no interim trades are initiated and the portfolio holds a long position throughout.

Key points on the test outputs:

(1) In a relative dataset, an equally-weighted portfolio produces a zero "Buy & Hold" ("BH") return. Individual countries may have positive or negative BH return for the sample period.

(2) Reported results are based on one-year duration zero-coupon bond proxies. For longer duration bonds, absolute (and relative) returns and risks will be larger; but the essential results will be the same.

(3) The credit price line is fitted to a subset of the data; results are recorded like-for-like for all three strategies, for a variety of out-of-sample periods and range of trigger boundaries. Results are compared only for the out-of-sample performance.

Figure 6.2.1 shows a typical set of out-of-sample results for all three strategies using the first 20 observations for the regression fit and then projecting for the remaining 18 months using the fitted coefficients. Buy & Hold returns for the same period are also shown (at the top of the table) – equivalent to any of these strategies where the trigger band is sufficiently wide that no interim trades are initiated. The first column is the average[8] return across all countries, the second is the standard deviation of those returns across all countries, and the third column is the proportion of positive returns ("Hit Rate").

Figure 6.2.1 Example results (Fit = 20 observations, out of sample = 18), various trigger bands.

Active	1	20 Buy&Hold:		+0.89%	+0.24%	+1.12%	+0.17%	+0.06%	-0.12%	+0.36%	+0.28%	+0.34%	+0.41%	-0.90%	+0.00%	-1.70%	+0.26%	-0.69%	-0.41%	-0.36%	-0.74%	+0.30%	-0.28%	+0.47%	+0.74%	-0.42%	+0.00%	+0.30%	+0.33%	+0.10%	-0.54%	-0.37%	+0.16%	+0.00%
Average	Cross-Section Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.21%	0.88%	55%	0.05%	-0.31%	+0.78%	+2.67%	+0.17%	+0.53%	-0.12%	-0.36%	+0.38%	+0.43%	+0.88%	+0.90%	-0.38%	+3.26%	-0.26%	-0.69%	-0.41%	+0.11%	+0.74%	-0.44%	+0.03%	+0.46%	-0.98%	-0.32%	+0.01%	+0.30%	-0.66%	-0.04%	-0.08%	-0.35%	+0.16%	+0.02%
+0.19%	0.88%	58%	0.10%	-0.72%	+0.82%	+2.67%	+0.17%	+0.52%	-0.12%	-0.36%	+0.38%	+0.43%	+0.52%	+0.90%	+0.14%	+3.26%	-0.26%	-0.69%	-0.41%	-0.16%	+0.74%	-0.55%	+0.03%	+0.46%	-0.98%	+0.06%	+0.01%	+0.30%	-0.66%	-0.04%	-0.26%	-0.35%	+0.16%	+0.02%
+0.18%	0.88%	55%	0.15%	-0.72%	+0.24%	+2.67%	+0.17%	+0.82%	-0.12%	-0.36%	-0.28%	+0.43%	+0.41%	+0.90%	+0.14%	+3.26%	-0.26%	-0.69%	-0.41%	+0.03%	+0.74%	-0.55%	-0.16%	+0.46%	-0.74%	+0.42%	+0.01%	+0.30%	-0.79%	-0.04%	-0.26%	-0.45%	+0.16%	+0.30%
+0.16%	0.78%	58%	0.20%	-0.72%	+0.24%	+2.67%	+0.17%	+1.10%	-0.12%	-0.36%	-0.28%	+0.34%	+0.41%	+0.90%	+0.34%	+2.25%	-0.26%	-0.69%	-0.41%	+0.36%	+0.74%	-0.55%	+0.06%	+0.46%	-0.74%	+0.06%	+0.01%	+0.30%	-0.79%	-0.24%	-0.54%	-0.37%	+0.16%	+0.34%
+0.13%	0.73%	58%	0.25%	-0.72%	+0.24%	+2.67%	+0.17%	+1.10%	-0.12%	-0.36%	-0.28%	+0.34%	+0.41%	+0.90%	+0.34%	+1.71%	-0.26%	-0.69%	-0.41%	-0.36%	+0.74%	-0.55%	+0.06%	+0.08%	-0.74%	+0.06%	+0.01%	+0.30%	-0.69%	-0.23%	-0.54%	+0.37%	+0.16%	+0.34%
+0.15%	0.71%	58%	0.30%	-0.72%	+0.24%	+2.67%	+0.17%	+1.10%	-0.12%	-0.24%	+0.14%	+0.34%	+0.41%	+0.90%	-0.00%	+1.71%	-0.26%	-0.69%	-0.41%	-	+0.74%	-0.29%	+0.12%	+0.08%	-0.74%	+0.06%	+0.01%	+0.30%	-0.33%	-0.42%	-0.56%	+0.37%	+0.16%	+0.00%
+0.14%	0.67%	55%	0.35%	+0.02%	+0.24%	+2.67%	+0.17%	+0.06%	-0.12%	+0.08%	+0.14%	-	+0.41%	+0.90%	-0.00%	+1.71%	-0.26%	-0.69%	-0.41%	-	+0.74%	-0.29%	-	+0.24%	-0.74%	+0.31%	+0.01%	+0.30%	-0.33%	-0.42%	-0.60%	-	+0.16%	+0.00%
+0.15%	0.66%	58%	0.40%	+0.27%	+0.24%	+2.67%	+0.17%	+0.06%	-0.12%	+0.08%	+0.22%	-	+0.41%	+0.90%	-0.00%	+1.71%	+0.14%	-0.69%	-0.42%	-	+0.74%	-0.29%	-	+0.07%	-0.74%	+0.31%	+0.01%	+0.30%	-0.33%	-0.42%	-0.62%	-	+0.16%	+0.00%
+0.16%	0.75%	58%		-0.46%	+0.38%	+2.67%	+0.17%	+0.66%	-0.12%	-0.23%	+0.05%	+0.29%	+0.49%	+0.90%	+0.07%	+2.36%	-0.21%	-0.69%	-0.41%	-0.00%	+0.74%	-0.44%	+0.02%	+0.29%	-0.80%	+0.12%	+0.01%	+0.30%	-0.57%	-0.23%	-0.43%	-0.10%	+0.16%	+0.13%
Naive	1	20																																
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.24%	0.75%	65%	0.05%	-0.33%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.51%	+0.82%	+0.80%	+0.82%	+0.90%	+1.68%	+2.67%	+0.89%	-0.69%	-0.11%	+0.38%	+0.74%	-0.41%	+0.28%	-0.33%	+0.74%	-0.56%	+0.01%	+0.30%	-0.98%	-0.10%	-0.08%	+0.02%	+0.16%	+0.00%
+0.22%	0.74%	68%	0.10%	+0.02%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.51%	+0.55%	+0.34%	+0.41%	+0.90%	+1.36%	+2.87%	+0.86%	-0.69%	-0.41%	+0.71%	+0.74%	-0.55%	+0.28%	-0.33%	+0.74%	-0.82%	+0.01%	+0.30%	-0.66%	-0.10%	-0.08%	+0.37%	+0.16%	+0.00%
+0.17%	0.76%	68%	0.15%	+0.02%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.51%	+0.71%	+0.34%	+0.41%	+0.90%	+0.92%	+2.87%	+0.89%	-0.69%	-0.41%	+0.29%	+0.74%	-0.55%	+0.28%	-0.49%	+0.74%	-1.31%	+0.01%	+0.30%	-0.66%	-0.10%	-0.11%	+0.37%	+0.16%	+0.00%
+0.17%	0.80%	68%	0.20%	+0.02%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.51%	+0.71%	+0.34%	+0.41%	+0.90%	+0.98%	+3.26%	+0.26%	-0.69%	-0.41%	+0.56%	+0.74%	-0.29%	+0.28%	-0.52%	+0.74%	-1.31%	+0.01%	+0.30%	-0.66%	-0.10%	-0.41%	+0.37%	+0.16%	+0.00%
+0.07%	0.59%	61%	0.25%	+0.02%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.12%	+0.28%	+0.34%	+0.41%	+0.90%	-0.00%	+2.09%	+0.26%	-0.69%	-0.41%	-0.36%	+0.74%	-0.29%	+0.28%	-0.64%	+0.74%	-	+0.01%	+0.17%	-0.79%	-0.10%	-0.54%	+0.37%	+0.16%	+0.00%
+0.08%	0.61%	55%	0.30%	+0.27%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.21%	-	+0.34%	+0.41%	+0.90%	-0.00%	+2.25%	-	-0.69%	-0.41%	-	+0.74%	-0.33%	+0.28%	-0.78%	+0.74%	-	+0.01%	+0.12%	-0.33%	-0.10%	-0.96%	+0.37%	+0.16%	+0.00%
+0.13%	0.57%	55%	0.35%	+0.27%	+0.24%	-1.14%	+0.17%	+0.06%	-0.12%	+0.21%	-	+0.34%	+0.41%	+0.90%	-0.00%	+2.25%	-	-0.69%	-0.41%	-	+0.74%	-	+0.17%	-0.46%	+0.74%	-	+0.01%	+0.11%	-0.33%	-0.15%	+0.54%	-	+0.16%	+0.00%
+0.10%	0.49%	45%	0.40%	-0.15%	+0.30%	-1.14%	+0.17%	+0.06%	-0.12%	-	-	-	+0.41%	+0.90%	-0.00%	+1.71%	-	-0.69%	-	-	+0.74%	-	+0.17%	-0.46%	+0.74%	-	+0.01%	+0.00%	-0.33%	-	+0.54%	-	+0.16%	+0.00%
+0.15%	0.63%	68%		+0.01%	+0.25%	-1.14%	+0.17%	+0.06%	-0.12%	+0.32%	+0.38%	+0.36%	+0.46%	+0.90%	+0.62%	+2.30%	+0.40%	-0.69%	-0.32%	+0.20%	+0.74%	-0.30%	+0.26%	-0.50%	+0.74%	-0.50%	+0.01%	+0.20%	-0.59%	-0.10%	-0.14%	+0.24%	+0.16%	+0.00%
Trend	1	20																																
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
-0.02%	0.96%	45%	0.05%	-0.88%	+0.17%	+4.15%	-0.17%	-0.06%	+0.12%	-0.36%	-0.28%	-0.11%	-0.22%	-0.39%	+0.00%	-1.08%	+0.73%	+0.87%	-0.41%	+0.04%	-1.39%	+0.29%	-0.30%	-0.33%	-0.74%	-0.32%	-1.60%	+0.30%	+0.33%	-0.36%	+0.54%	+0.37%	+0.16%	+0.32%
+0.00%	0.94%	45%	0.10%	-0.88%	+0.17%	+4.15%	-0.17%	-0.06%	+0.12%	-0.36%	-0.28%	-0.06%	+0.41%	-0.39%	+0.00%	-1.08%	+0.73%	+1.04%	-0.41%	-0.36%	-1.39%	+0.29%	-0.53%	-0.33%	-0.74%	+0.06%	-1.07%	+0.30%	+0.33%	-0.36%	+0.54%	+0.37%	+0.16%	-0.10%
+0.11%	0.90%	52%	0.15%	-0.88%	+0.37%	+4.15%	-0.17%	-0.06%	+0.12%	-0.36%	-0.28%	+0.37%	-0.41%	-0.39%	+0.52%	-1.08%	+0.26%	+1.04%	-0.41%	-0.36%	+0.74%	+0.29%	-0.81%	-0.33%	-0.74%	+0.42%	+0.01%	+0.30%	+0.33%	-0.36%	+0.54%	+0.37%	+0.16%	-0.10%
+0.03%	0.91%	48%	0.20%	-0.45%	+0.06%	+4.15%	-0.17%	-0.06%	+0.12%	-0.36%	-0.28%	+0.37%	-0.00%	-0.39%	+0.52%	-1.71%	+0.26%	-0.69%	-0.41%	-0.36%	+0.74%	+0.03%	-0.86%	-0.33%	-0.74%	+0.06%	+0.01%	+0.30%	+0.33%	-0.13%	+0.54%	+0.37%	+0.16%	-0.04%
+0.04%	0.89%	48%	0.25%	-0.67%	+0.15%	+4.15%	-0.17%	-0.06%	+0.12%	-0.36%	-0.28%	+0.02%	-0.00%	-0.39%	+0.52%	-1.71%	+0.26%	-0.69%	-0.41%	-0.36%	+0.74%	+0.03%	-	-0.40%	-0.74%	+0.06%	+0.01%	+0.30%	+0.33%	-0.16%	+0.54%	+0.37%	+0.16%	-0.04%
+0.05%	0.90%	55%	0.30%	-0.67%	+0.15%	+4.15%	-0.17%	-0.06%	+0.12%	+0.08%	+0.05%	+0.02%	-0.00%	-0.90%	+0.52%	-1.71%	-	-0.69%	-0.41%	-0.09%	+0.74%	+0.03%	-	-0.52%	-0.74%	+0.06%	+0.01%	+0.30%	+0.33%	-0.24%	+0.54%	+0.37%	+0.16%	+0.21%
+0.04%	0.90%	48%	0.35%	-0.67%	+0.17%	+4.15%	-0.17%	-0.06%	+0.12%	+0.08%	+0.05%	+0.02%	-0.00%	-0.90%	+0.52%	-1.71%	-	-0.69%	-0.41%	-	+0.74%	-0.06%	-	-0.64%	-0.74%	-	+0.01%	+0.17%	+0.16%	-0.24%	+0.54%	+0.37%	+0.16%	+0.16%
+0.04%	0.90%	45%	0.40%	-0.61%	-	+4.15%	-0.17%	-0.06%	+0.12%	+0.08%	+0.14%	+0.04%	+0.06%	-0.90%	+0.68%	-1.71%	-	-0.69%	-0.18%	-	+0.74%	-0.06%	-	-0.78%	-0.74%	-	+0.01%	+0.17%	-0.17%	-	+0.54%	+0.37%	+0.16%	+0.16%
+0.04%	0.86%	48%		-0.71%	+0.15%	+4.15%	-0.17%	-0.06%	+0.12%	-0.19%	-0.14%	+0.08%	-0.02%	-0.58%	+0.41%	-1.47%	+0.28%	-0.06%	-0.38%	-0.19%	+0.21%	+0.11%	-0.31%	-0.46%	-0.74%	+0.04%	-0.33%	+0.27%	+0.25%	-0.23%	+0.54%	+0.37%	+0.16%	+0.07%

In this sample, the Hit Rate is usually highest for the Naïve strategy, but drops sharply for wider trigger bands and is below 50% for the 0.4% band. It is usually below 50% for the Trend strategy. The Active strategy is consistently above 50% and is the most stable strategy for all trigger bands.

Active also shows the highest average return across all trigger bands, although Naïve is higher in some cases, especially the narrower bands. The Trend strategy is the most volatile.

Compared with Buy & Hold, the Active strategy is the same or better in 21countries, the Naïve in 22 countries, and the Trend in 15 countries.

This particular set of Active returns is strong in Austria, China, Germany, Poland, Singapore, Spain and the US. Trend returns are much higher in Brazil, Sweden, Taiwan and Thailand.

8 *Arithmetic average is used. Geometric and Harmonic means produce very similar results. Median is not used due to the non-monotonic nature of the returns by sample.*

Figure 6.2.2 shows the results with the price trends removed ("Zero-trend"). To remove the trend, the original price series is deflated by a linear fitted time trend, calibrated to the entire time series sample. This introduces an element of hindsight bias, but it shows the results that can be expected during phases when bond markets have no strong trend.

Figure 6.2.2 Example results (Fit = 20 observations, out of sample = 18), various trigger bands (Zero-trend)

Active	1	20 Buy&Hold:		+0.76%	+0.24%	+0.15%	+0.67%	+0.28%	+0.87%	+0.22%	+0.31%	+0.32%	+0.42%	-1.14%	+0.34%	-1.76%	+0.23%	-0.04%	-0.53%	-0.42%	+0.08%	+0.27%	-0.14%	+0.21%	-0.64%	-0.40%	-0.27%	+0.18%	+0.27%	+0.11%	-0.87%	-0.39%	+0.18%	+0.53%
Average	Cross-Section Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.13%	0.90%	65%	0.05%	+0.29%	+0.78%	+0.81%	+0.38%	+0.85%	-0.86%	-0.22%	+0.36%	+0.40%	+0.52%	+2.72%	+0.02%	+2.16%	+0.02%	+0.60%	-0.53%	+0.28%	-2.09%	-0.43%	-0.67%	-0.45%	+0.64%	+0.04%	-1.31%	+0.18%	-0.89%	-0.04%	+0.54%	+0.03%	+0.18%	-0.25%
+0.12%	0.85%	55%	0.10%	+0.65%	+0.82%	+0.81%	+0.47%	+0.85%	-0.86%	-0.22%	+0.36%	+0.40%	+0.52%	+2.62%	-0.34%	+1.57%	-0.23%	+0.60%	-0.53%	-0.05%	-2.09%	-0.57%	-0.75%	-0.81%	+0.64%	+0.04%	-0.27%	+0.18%	-0.89%	-0.24%	+0.88%	+0.00%	+0.18%	-0.08%
+0.18%	0.74%	55%	0.15%	+0.65%	+0.24%	+0.81%	+0.47%	+0.85%	-0.86%	+0.58%	-0.31%	+0.31%	+0.52%	+2.62%	-0.34%	+1.57%	-0.23%	+0.60%	-0.53%	-0.42%	-0.08%	-0.56%	-0.14%	-0.81%	+0.64%	+0.04%	-0.27%	+0.18%	-0.80%	-0.23%	+0.88%	+0.39%	+0.18%	-0.53%
+0.17%	0.75%	48%	0.20%	+0.04%	+0.24%	+0.81%	+0.47%	+0.85%	-0.86%	-0.22%	-0.31%	+0.31%	+0.42%	+2.62%	-0.34%	+2.09%	-0.23%	+0.79%	-0.53%	-0.42%	-0.08%	-0.56%	-0.14%	-0.50%	+0.64%	-0.06%	-0.27%	+0.18%	-0.27%	-0.42%	+0.88%	+0.39%	+0.18%	-0.53%
+0.32%	0.96%	58%	0.25%	+0.51%	+0.24%	+3.64%	+0.51%	+0.87%	-0.86%	+0.18%	+0.12%	+0.31%	+0.42%	+2.62%	-0.34%	+2.09%	-0.23%	+0.79%	-0.53%	-0.42%	-0.08%	-0.27%	-0.14%	-0.48%	+0.64%	+0.04%	-0.27%	+0.18%	-0.27%	-0.42%	+0.88%	+0.39%	+0.18%	-0.53%
+0.36%	0.96%	65%	0.30%	+0.51%	+0.24%	+3.64%	+0.84%	+1.11%	-0.86%	+0.18%	+0.20%	+0.31%	+0.42%	+2.62%	-0.34%	+2.09%	+0.17%	+1.10%	-0.53%	-0.42%	-0.08%	-0.27%	-0.40%	-0.53%	+0.64%	+0.04%	-0.27%	+0.18%	-0.27%	-0.42%	+0.59%	+0.39%	+0.18%	+0.06%
+0.32%	0.90%	55%	0.35%	+0.51%	+0.24%	+3.64%	+0.09%	+1.11%	-0.86%	+0.18%	+0.20%	-	+0.42%	+1.35%	-0.34%	+2.09%	-	+1.86%	-0.53%	-	-0.08%	-0.27%	-0.40%	-0.20%	+0.64%	+0.04%	-0.27%	+0.20%	-0.27%	-0.24%	+0.59%	+0.39%	+0.18%	-0.24%
+0.35%	0.88%	48%	0.40%	+0.92%	+0.29%	+3.64%	+0.09%	+1.11%	-0.86%	+0.22%	-	-	+0.42%	+1.15%	-0.34%	+2.09%	-	+1.86%	-0.47%	-	-0.08%	-	-	-	+0.64%	+0.31%	-0.27%	+0.20%	-0.27%	-0.24%	+0.48%	-	+0.18%	-0.11%
+0.24%	0.79%	58%		+0.51%	+0.39%	+2.23%	+0.41%	+0.95%	-0.86%	+0.08%	+0.08%	+0.26%	+0.46%	+2.29%	-0.30%	+1.97%	-0.09%	+1.03%	-0.53%	-0.18%	-0.58%	-0.36%	-0.33%	-0.47%	+0.64%	+0.06%	-0.40%	+0.19%	-0.49%	-0.28%	+0.71%	+0.25%	+0.18%	-0.28%

Naive	1	20																															
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.24%	1.11%	55%	0.05%	+0.49%	+0.57%	+4.10%	+0.01%	+0.55%	-0.18%	+0.50%	+0.36%	+0.31%	+0.87%	+1.74%	-0.34%	+2.16%	+0.72%	+1.48%	-0.53%	-0.10%	-1.58%	-0.42%	-0.24%	-0.20%	+0.64%	-0.81%	-1.79%	-0.49%	-0.89%	-0.40%	+0.88%	+0.03%	+0.18%	-0.12%
+0.23%	0.96%	61%	0.10%	+0.20%	+0.24%	+3.32%	+0.14%	+0.85%	-0.18%	+0.80%	+0.54%	+0.31%	+0.42%	+1.97%	-0.34%	+1.57%	+0.75%	+1.00%	-0.53%	+0.19%	-1.58%	-0.56%	-0.30%	-0.20%	+0.64%	-1.06%	-1.15%	-0.49%	-0.89%	-0.11%	+0.88%	+0.39%	+0.18%	+0.06%
+0.28%	1.03%	61%	0.15%	+0.20%	+0.24%	+3.32%	+0.47%	+1.11%	-0.18%	+0.82%	+0.54%	+0.31%	+0.42%	+2.62%	-0.34%	+2.09%	+0.23%	+1.00%	-0.53%	-0.42%	-1.58%	-0.27%	+0.14%	-0.20%	+0.64%	-1.06%	-1.15%	-0.11%	-0.99%	-0.11%	+0.88%	+0.39%	+0.18%	+0.06%
+0.26%	0.94%	61%	0.20%	+0.51%	+0.24%	+3.32%	+0.47%	+1.19%	-0.86%	+0.22%	+0.71%	+0.31%	+0.42%	+1.35%	-0.34%	+2.09%	+0.23%	+1.00%	-0.53%	-0.42%	-1.58%	-0.27%	+0.04%	-0.20%	+0.64%	-0.40%	-1.31%	-0.20%	-0.27%	-0.11%	+0.88%	+0.39%	+0.18%	+0.30%
+0.23%	0.89%	61%	0.25%	+0.51%	+0.24%	+3.32%	+0.47%	+0.27%	-0.86%	+0.22%	+0.20%	+0.31%	+0.42%	+1.35%	-0.34%	+2.09%	+0.23%	+1.00%	-0.53%	-0.42%	-1.15%	-0.27%	+0.04%	-0.20%	+0.64%	-0.50%	-1.31%	-	-0.27%	-0.11%	+0.88%	+0.39%	+0.18%	+0.30%
+0.28%	0.87%	48%	0.30%	+0.51%	+0.24%	+3.32%	+0.47%	+0.27%	-0.86%	+0.22%	-	+0.31%	+0.42%	+1.35%	-0.34%	+2.09%	-	+1.70%	-0.53%	-	-1.15%	-0.30%	-0.01%	-0.20%	+0.64%	-	-0.27%	-	-0.27%	-0.11%	+0.88%	+0.39%	+0.18%	-0.11%
+0.32%	0.83%	48%	0.35%	+0.62%	+0.24%	+3.32%	+0.09%	+0.27%	-0.86%	+0.22%	-	+0.31%	+0.42%	+1.35%	-0.34%	+2.09%	-	+1.86%	-0.53%	-	-0.08%	-	-	-0.20%	+0.64%	-	-0.27%	-	-0.27%	-	+0.88%	-0.02%	+0.18%	+0.13%
+0.34%	0.84%	45%	0.40%	+0.92%	+0.29%	+3.32%	+0.09%	+0.27%	-0.86%	-	-	+0.31%	+0.42%	+1.58%	-0.34%	+2.09%	-	+1.86%	-0.29%	-	-0.08%	-	-	-0.20%	+0.64%	-	-0.27%	-	-0.27%	-	+0.88%	-	+0.18%	+0.13%
+0.27%	0.90%	58%		+0.50%	+0.29%	+3.42%	+0.27%	+0.60%	-0.60%	+0.38%	+0.29%	+0.31%	+0.47%	+1.66%	-0.34%	+2.04%	+0.27%	+1.36%	-0.50%	-0.15%	-1.10%	-0.26%	-0.04%	-0.20%	+0.64%	-0.48%	-0.94%	-0.16%	-0.52%	-0.12%	+0.88%	+0.25%	+0.18%	+0.09%

Trend	1	20																															
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.00%	0.92%	42%	0.05%	-0.76%	+0.17%	+3.64%	-0.67%	-0.27%	-0.86%	-0.22%	-0.31%	-0.09%	-0.23%	-0.61%	+0.34%	-1.14%	+0.72%	+1.37%	-0.53%	-0.01%	-0.34%	+0.27%	-0.26%	-0.50%	+0.64%	-0.34%	-1.81%	+0.18%	+0.27%	-0.36%	+0.88%	+0.39%	+0.18%	+0.35%
+0.04%	0.91%	48%	0.10%	-0.76%	+0.17%	+3.64%	-0.67%	-0.27%	-0.86%	-0.22%	-0.31%	-0.04%	+0.41%	-0.61%	+0.34%	-1.14%	+0.72%	+1.62%	-0.53%	-0.42%	-0.08%	+0.27%	-0.47%	-0.50%	+0.64%	+0.04%	-1.31%	+0.18%	+0.27%	-0.36%	+0.88%	+0.39%	+0.18%	+0.06%
+0.07%	0.89%	48%	0.15%	-0.76%	+0.37%	+3.64%	-0.67%	-0.27%	-0.86%	-0.22%	-0.31%	+0.39%	-0.42%	-0.61%	+0.82%	-1.14%	+0.23%	+1.62%	-0.53%	-0.42%	-0.08%	+0.27%	-0.77%	-0.50%	+0.64%	+0.40%	-0.27%	+0.18%	+0.27%	-0.36%	+0.88%	+0.39%	+0.18%	+0.06%
+0.01%	0.86%	45%	0.20%	-0.39%	+0.06%	+3.64%	-0.67%	-0.27%	-0.86%	-0.22%	-0.31%	+0.39%	-0.01%	-0.61%	+0.82%	-1.77%	+0.23%	-0.03%	-0.53%	-0.42%	-0.08%	+0.01%	-0.81%	-0.50%	+0.64%	+0.04%	-0.27%	+0.18%	+0.27%	-0.12%	+0.88%	+0.39%	+0.18%	+0.30%
+0.01%	0.85%	45%	0.25%	-0.57%	+0.15%	+3.64%	-0.67%	-0.27%	-0.86%	-0.22%	-0.31%	+0.04%	-0.01%	-0.61%	+0.82%	-1.77%	+0.23%	-0.03%	-0.53%	-0.42%	-0.08%	+0.01%	-	-0.53%	+0.64%	+0.04%	-0.27%	+0.18%	+0.27%	-0.16%	+0.88%	+0.39%	+0.18%	+0.30%
+0.03%	0.87%	48%	0.30%	-0.57%	+0.15%	+3.64%	-0.67%	-0.27%	-0.86%	+0.18%	+0.03%	+0.04%	-0.01%	-1.15%	+0.82%	-1.77%	-	-0.03%	-0.53%	-0.11%	-0.08%	+0.01%	-	-0.54%	+0.64%	+0.04%	-0.27%	+0.18%	+0.27%	-0.24%	+0.88%	+0.39%	+0.18%	+0.52%
+0.01%	0.86%	42%	0.35%	-0.57%	+0.17%	+3.64%	-0.67%	-0.27%	-0.86%	+0.18%	+0.03%	+0.04%	-0.01%	-1.15%	+0.82%	-1.77%	-	-0.03%	-0.53%	-	-0.08%	-0.08%	-	-0.59%	+0.64%	-	-0.27%	+0.06%	+0.12%	-0.24%	+0.88%	+0.39%	+0.18%	+0.13%
+0.01%	0.86%	39%	0.40%	-0.52%	-	+3.64%	-0.67%	-0.27%	-0.86%	+0.18%	+0.12%	+0.06%	+0.05%	-1.15%	+0.90%	-1.77%	-	-0.03%	-0.29%	-	-0.08%	-0.08%	-	-0.71%	+0.64%	-	-0.27%	+0.06%	-0.21%	-	+0.88%	+0.39%	+0.18%	+0.13%
+0.02%	0.84%	48%		-0.61%	+0.16%	+3.64%	-0.67%	-0.27%	-0.86%	-0.07%	-0.17%	+0.10%	-0.03%	-0.81%	+0.71%	-1.53%	+0.27%	+0.56%	-0.50%	-0.23%	-0.11%	+0.08%	-0.29%	-0.55%	+0.64%	+0.03%	-0.59%	+0.15%	+0.19%	-0.23%	+0.88%	+0.39%	+0.18%	+0.23%

The Active and Naïve strategies have the same overall Hit Rate but the Naïve strategy has fewer samples where the Hit Rate is above 50%. Despite this, the Naïve strategy has a slightly higher average return, but it also shows higher volatility.

For the US, de-trending the bond prices actually improves the Trend strategy results, because the zero-trend series forms a wave pattern around a horizontal line; for this reason the Naïve results for the US are similar to the Trend results, for specific trigger bands.

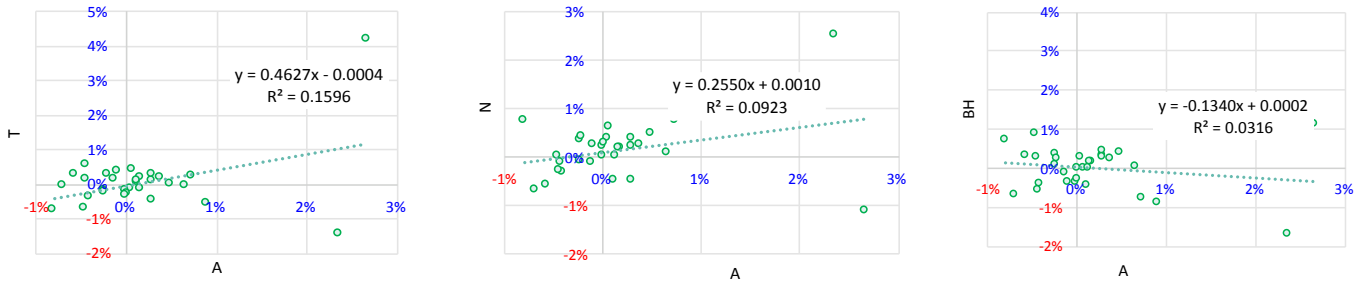
For the UK, de-trending has a very marginal impact and the strategy / sample choices make no difference. Unlike the UK, the US Active strategy returns are higher than Buy & Hold in the original dataset but lower in the zero trend dataset.

In a trended market like Brazil, the Trend strategy provides very high returns; these are reduced in the zero-trend results.

In some countries, the relationship with trigger band size is not strongly monotonic. For example, Active returns show strong results for the 0.05% and 0.10% bands in Austria but these are followed by weaker returns in the other bands.

Figures 6.3 and 6.4 show the relative value of the different strategies as pairwise plots, and a comparison of the Active with the Buy & Hold strategy for each country. Figure 6.3 and 6.4 are plotted for the same fitted sample of 20 observations shown in Figure 6.2.1 Note that the influence of outliers is likely to be significant in all of these charts.

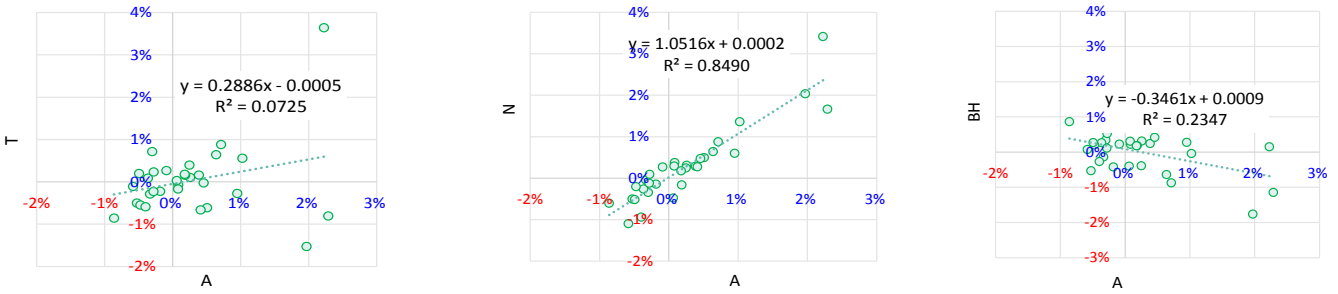
Figure 6.3 Country returns by Strategy (Fit = 20 observations, out of sample = 18), Average for all triggers Trend = Not Removed, A = Active, T=Trend, N=Naïve, and BH = Buy & Hold.



The intercept is negative for the Trend strategy, but positive for the Naïve and Buy & Hold. The slope coefficients are all less than one; implying that, for some estimation periods, the Active strategy could provide a high beta (return-focused) alternative to the other strategies. (In other words, when the Trend or Naïve strategy returns are positive, the Active strategy returns are significantly higher; but when the Trend or Naïve strategy returns are negative, the Active strategy returns are significantly more negative.) For specific groups of countries, the opposite may apply – in which case the Active strategy provides a low beta (risk-focused) alternative.

Figure 6.4 shows the same charts for the same sample, but the bond price series trend has been removed.

Figure 6.4 Country returns by Strategy (Fit = 20 observations, out of sample = 18), Average for all triggers Trend = Removed, A = Active, T=Trend, N=Naïve, and BH = Buy & Hold.



Removing the trend results in a dramatic jump in the Naïve fit (R-squared = 85%), and the slope coefficient is now above 1. The intercept for the Trend strategy becomes more negative, and the Naïve intercept becomes less positive. The Buy & Hold intercept becomes more positive and the slope coefficient becomes more negative; the fit is also better.

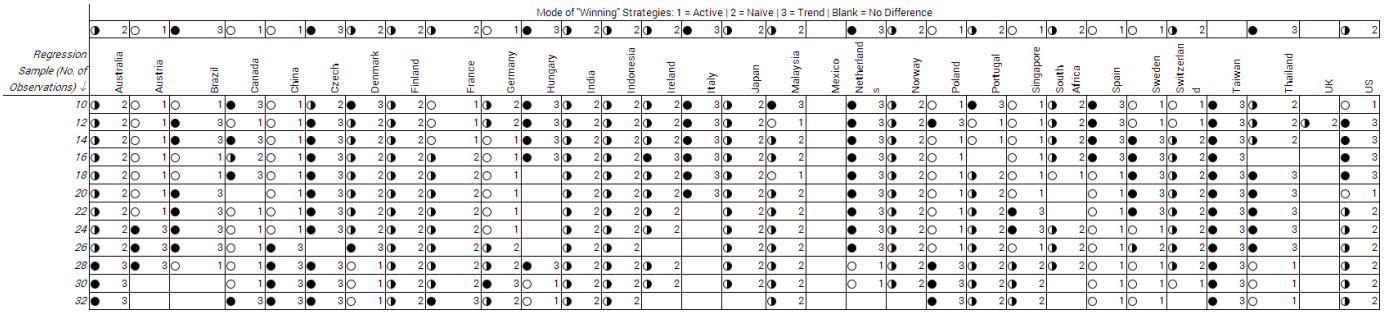
Repeating this exercise for other samples results in some dramatic changes in coefficients, fits and signs; but in most of the trended data samples the Active strategy functions as a high beta alternative to Trend, Naïve, and Buy & Hold.

The negative coefficient for Buy & Hold suggests that the Active strategy has potential to introduce a highly diversifying element into an actively managed portfolio, but this is likely to be sensitive to the different groups of countries that could be selected for the regression.

Alternative time series samples can show considerable variation in results. To assess the overall value of each strategy, the tables in Figures 6.2.1 to 6.2.3 have been re-calculated multiple times for regression fit samples that vary from 10 monthly observations to 32 monthly observations, rising in increments of 2 observations.

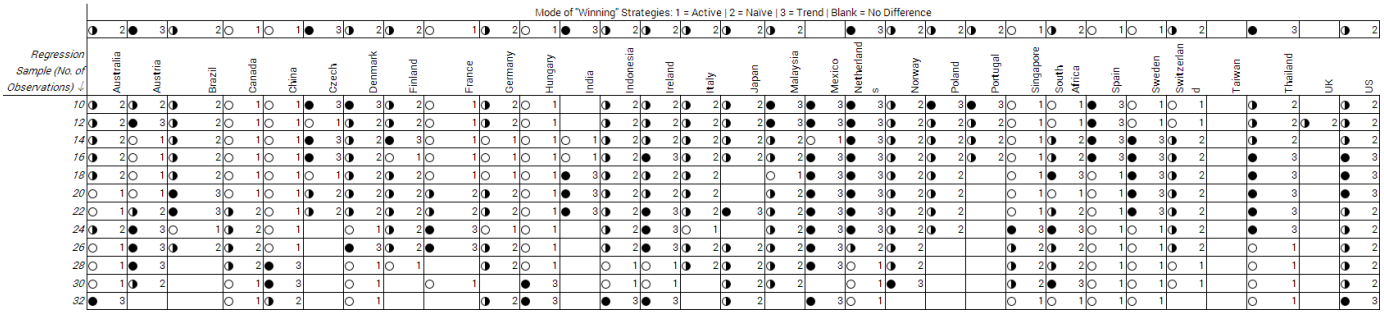
Figures 6.5.1 and 6.5.2 summarize the results for each country, showing the "winning" strategy (based on the average out of sample return across all trigger boundaries) for the chosen regression fit samples. The numbers and Harvey balls in the row above the table show the mode for each country. (They show the strategy with the highest returns for that country across all trigger bands).

Figure 6.5.1 Distribution of winning strategies by fitted sample size and country.



Frequency count: (Across countries) Active = 8, Naïve = 14, Trend = 6, No difference = 3
Frequency count: (Across countries and regression samples) Active = 83, Naïve = 144, Trend = 93, No Difference = 52

Figure 6.5.2 Distribution of winning strategies by fitted sample size and country. (Prices Zero-trend)

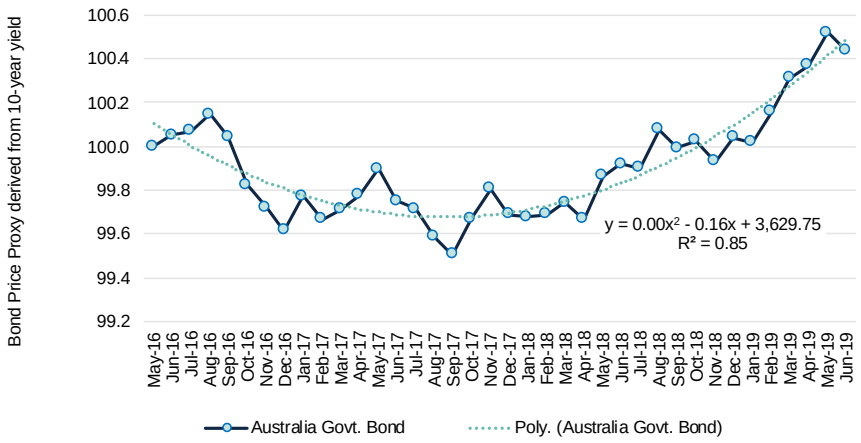


Frequency count: (Across countries) Active = 7, Naïve = 16, Trend = 5, No difference = 3
Frequency count: (Across countries and regression samples) Active = 102, Naïve = 131, Trend = 74, No Difference = 65

The countries where the Active strategy is most consistently successful are Austria, Canada, China, Germany, Poland, Singapore, Spain and Sweden. Even after de-trending (which uses the full sample), the Trend strategy is most successful in the Czech Republic, Netherlands and Thailand. There are no clear winners in Mexico, UK and Taiwan. In the remaining countries, the Naïve strategy is best, with 14 winners in the original sample and 16 winners in the zero-trend sample. In most cases, the winning strategy in the original sample is the same as the winner in the zero-trend sample.

This suggests that – over this period – the Naïve approach appears to dominate. But this is somewhat misleading; counting the number of winning strategies (where there is a difference) across countries and regression samples shows that the Naïve strategy wins over the Active strategy in a ratio of about 3:2 or more in the original dataset; whereas removing the trend shifts the balance towards the Active or No Difference. However, Naïve remains the single largest winning category. In some countries, including the US, all three strategies may perform best depending on the sample chosen for the fit.

To explore the success of the Naïve strategy in more detail, it is worth noting that, for the full sample period, most of the zero-trend bond price series have a semi-cyclical appearance, and a quadratic time trend provides the best fit in the majority of cases. Figure 6.6 shows Australia as an example with a quadratic fit (R-squared) of 85%. (The linear fit is 22%).



The price cycle troughs in late 2017, and the same pattern is repeated for many of the bond markets in this report. This suggests that in some cases, two separately calibrated Active strategies may provide additional returns when applied to the negatively or positively sloped mini-trends in each half of the quadratic. The challenge here is that major turning points are only obvious with hindsight; so results are only reported for the post-turning point section of each time series.

Figure 6.7 shows the results of testing this for the period that typically contains most of the positively sloped 2nd half of the quadratic, ignoring the first 20 months of data and using the next 10 observations to calibrate the trading for the remaining eight data points in that latter period.

Figure 6.7 Results for positively sloped mini-trend (fitted sample = 10 observations, start date in middle of period)

Active	20	10 Buy&Hold:		+0.41%	-0.17%	+0.91%	+0.40%	-0.42%	+0.31%	-0.30%	-0.08%	-0.09%	-0.10%	+0.04%	+0.55%	+0.16%	-0.14%	+0.78%	-0.63%	-0.46%	+0.61%	-0.14%	-0.30%	-0.17%	-0.20%	-0.30%	+0.44%	+0.16%	-0.20%	-0.22%	-0.90%	-0.11%	-0.11%	+0.47%
Average	Cross Section Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.16%	0.88%	58%	0.05%	+0.44%	+0.30%	+2.85%	+1.59%	+0.41%	-0.18%	-0.19%	+0.73%	+0.60%	+0.18%	+2.10%	+0.14%	+1.05%	-0.09%	+0.35%	-0.60%	+0.45%	-1.92%	-0.37%	-0.76%	+0.03%	-0.74%	+0.36%	+0.21%	-0.38%	-0.40%	+0.35%	+0.13%	-0.01%	-0.78%	-0.55%
+0.20%	0.86%	65%	0.10%	+0.44%	+0.34%	+2.85%	+1.05%	+0.46%	+0.24%	-0.07%	+0.55%	+0.47%	+0.18%	+1.77%	+0.14%	+1.05%	-0.09%	+1.02%	-0.60%	+1.00%	-1.92%	-0.67%	-0.45%	+0.03%	-0.74%	+0.36%	+0.21%	-0.38%	-0.37%	+0.38%	+0.13%	+0.06%	-0.83%	-0.34%
+0.16%	0.79%	68%	0.15%	+0.04%	+0.07%	+2.85%	+0.61%	+0.66%	+0.24%	+0.02%	+0.04%	+0.38%	+0.18%	+1.82%	+0.14%	+1.05%	-0.09%	+1.02%	-0.60%	+0.26%	-1.36%	-0.67%	-0.39%	+0.03%	-0.88%	+0.36%	+0.12%	+0.37%	-0.40%	+0.19%	+0.13%	-0.33%	-0.72%	-0.34%
+0.13%	0.84%	58%	0.20%	+0.04%	-0.00%	+2.97%	+0.68%	+0.66%	+0.34%	-0.05%	+0.04%	+0.32%	+0.18%	+1.62%	+0.14%	+1.05%	-0.09%	+0.64%	-0.60%	-0.25%	-1.82%	-0.42%	-0.39%	+0.03%	-1.41%	+0.36%	+0.12%	+0.37%	-0.48%	+0.13%	+0.80%	-0.33%	-0.17%	-0.34%
+0.18%	0.91%	58%	0.25%	-0.18%	-0.00%	+2.97%	+0.77%	+0.66%	+0.46%	-0.05%	+0.04%	+0.32%	+0.18%	+2.05%	+0.14%	+1.05%	+0.07%	+1.73%	-0.60%	-0.25%	-1.82%	-0.41%	-0.40%	+0.03%	-1.41%	+0.36%	+0.17%	+0.04%	-0.58%	+0.11%	+0.80%	-0.36%	-0.15%	-0.26%
+0.21%	0.82%	55%	0.30%	-0.30%	-0.00%	+2.94%	+0.77%	+0.66%	+0.46%	-0.05%	+0.12%	+0.32%	+0.18%	+1.85%	+0.14%	+1.05%	+0.07%	+1.73%	-0.60%	-0.25%	-0.17%	-0.41%	-0.40%	-0.21%	-1.41%	+0.27%	+0.17%	+0.10%	-0.58%	+0.11%	+0.80%	-0.36%	-0.15%	-0.26%
+0.21%	0.69%	58%	0.35%	-0.54%	-0.00%	+1.63%	+0.77%	+0.93%	+0.46%	+0.18%	+0.12%	+0.31%	+0.18%	+1.85%	+0.14%	+1.05%	+0.22%	+1.73%	-0.60%	-0.25%	-0.17%	-0.13%	-0.21%	-0.09%	-1.41%	+0.29%	-0.01%	+0.16%	-0.47%	+0.11%	+0.68%	-0.24%	-0.15%	+0.01%
+0.14%	0.63%	52%	0.40%	-0.54%	+0.09%	+1.63%	+0.47%	+0.93%	-0.41%	+0.18%	+0.20%	+0.31%	+0.34%	+1.85%	+0.14%	+1.05%	+0.19%	+0.66%	-0.60%	-	-0.17%	-0.18%	-0.21%	-0.09%	-1.41%	+0.26%	-0.01%	+0.32%	-0.06%	-0.27%	+0.29%	-0.24%	-	-0.27%
+0.18%	0.76%	61%		-0.07%	+0.10%	+2.59%	+0.81%	+0.67%	+0.20%	-0.01%	+0.23%	+0.38%	+0.20%	+1.86%	+0.14%	+1.05%	+0.02%	+1.11%	-0.60%	+0.09%	-1.17%	-0.41%	-0.40%	-0.03%	-1.17%	+0.33%	+0.12%	+0.07%	-0.42%	+0.14%	+0.47%	-0.22%	-0.37%	-0.29%
Naive	20	10																																
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.17%	1.22%	58%	0.05%	+0.46%	+0.33%	+4.33%	+0.39%	+0.10%	+0.24%	+0.32%	+0.31%	+0.32%	+0.53%	+0.97%	+0.14%	+1.45%	+1.48%	+2.11%	-0.60%	+0.08%	-2.76%	-0.27%	-0.17%	-0.03%	-0.51%	-0.73%	-2.35%	-0.68%	-0.57%	-0.23%	+0.80%	-0.31%	-0.15%	+0.42%
+0.16%	1.08%	61%	0.10%	+0.17%	-0.00%	+3.54%	+0.52%	+0.40%	+0.24%	+0.62%	+0.73%	+0.32%	+0.08%	+1.20%	+0.14%	+0.86%	+1.51%	+1.63%	-0.60%	+0.37%	-2.76%	-0.41%	-0.23%	-0.03%	-0.51%	-0.97%	-1.72%	-0.68%	-0.68%	+0.06%	+0.80%	+0.05%	-0.15%	+0.59%
+0.20%	1.14%	61%	0.15%	+0.17%	-0.00%	+3.54%	+0.92%	+1.05%	+0.32%	+0.64%	+0.73%	+0.32%	+0.08%	+1.85%	+0.14%	+1.57%	+0.98%	+1.63%	-0.60%	-0.25%	-2.76%	-0.16%	+0.21%	-0.03%	-0.51%	-0.97%	-2.16%	-0.29%	-0.86%	+0.06%	+0.80%	+0.05%	-0.15%	+0.08%
+0.14%	1.09%	58%	0.20%	+0.48%	+0.09%	+3.54%	+1.01%	+1.12%	-0.41%	+0.08%	+0.71%	+0.32%	+0.26%	+0.57%	+0.14%	+1.37%	+0.09%	+1.81%	-0.60%	-0.25%	-2.76%	-0.25%	+0.04%	-0.03%	-0.51%	-0.42%	-2.32%	-0.53%	-0.14%	-0.06%	+0.80%	+0.05%	-0.15%	+0.32%
+0.10%	1.04%	58%	0.25%	+0.48%	+0.15%	+3.54%	+0.49%	+0.01%	-0.41%	+0.13%	+0.20%	+0.32%	+0.26%	+0.57%	+0.14%	+1.37%	+0.23%	+1.81%	-0.60%	-0.25%	-1.88%	-0.25%	+0.04%	-0.03%	-0.51%	-0.50%	-2.90%	-	-0.30%	-0.12%	+0.80%	+0.05%	-0.15%	+0.32%
+0.17%	1.00%	42%	0.30%	+0.48%	+0.22%	+3.54%	+0.51%	+0.23%	-0.41%	+0.18%	-	+0.32%	+0.34%	+1.01%	+0.14%	+1.37%	-	+2.39%	-0.60%	-	-1.88%	-0.30%	-0.01%	-0.03%	-0.51%	-	-1.86%	-	-0.30%	-0.12%	+0.80%	-0.01%	-0.15%	-0.11%
+0.30%	0.85%	45%	0.35%	+0.59%	+0.24%	+3.54%	+0.09%	+0.23%	-0.41%	+0.22%	-	+0.32%	+0.34%	+1.01%	+0.14%	+1.37%	-	+2.55%	-0.60%	-	-0.17%	-	-	-0.03%	-0.51%	-	-0.12%	-	-0.30%	-	+0.80%	-0.02%	-0.15%	+0.15%
+0.32%	0.86%	42%	0.40%	+1.01%	+0.29%	+3.54%	+0.09%	+0.23%	-0.41%	-	-	+0.32%	+0.42%	+1.24%	+0.14%	+1.37%	-	+2.55%	-0.29%	-	-0.17%	-	-	-0.03%	-0.51%	-	-0.12%	-	-0.37%	-	+0.80%	-	-0.15%	+0.18%
+0.20%	0.98%	52%		+0.48%	+0.16%	+3.64%	+0.50%	+0.42%	-0.16%	+0.28%	+0.33%	+0.32%	+0.29%	+1.05%	+0.14%	+1.32%	+0.54%	+2.06%	-0.56%	-0.04%	-1.89%	-0.20%	-0.02%	-0.03%	-0.51%	-0.45%	-1.70%	-0.27%	-0.44%	-0.05%	+0.80%	-0.02%	-0.15%	+0.24%
Trend	20	10																																
Average	Std. Dev.	Hit Rate	Trigger Band	Australia	Austria	Brazil	Canada	China	Czech	Denmark	Finland	France	Germany	Hungary	India	Indonesia	Ireland	Italy	Japan	Malaysia	Mexico	Netherlands	Norway	Poland	Portugal	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Thailand	UK	US
+0.00%	0.48%	52%	0.05%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.41%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-0.69%	-0.12%	+0.21%	-0.03%	-1.41%	-0.25%	-0.12%	-0.37%	+0.05%	+0.06%	+0.80%	-0.36%	-0.17%	+0.55%
-0.02%	0.56%	52%	0.10%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.41%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-1.80%	-0.12%	+0.21%	-0.03%	-1.41%	-0.05%	-0.12%	-0.37%	+0.05%	+0.06%	+0.80%	-0.05%	-0.17%	+0.55%
-0.01%	0.57%	55%	0.15%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.41%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-1.80%	-0.12%	+0.21%	-0.03%	-1.41%	+0.31%	-0.12%	-0.37%	+0.05%	+0.06%	+0.80%	-0.05%	-0.17%	+0.55%
-0.03%	0.56%	55%	0.20%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.23%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-1.80%	-0.12%	+0.21%	-0.03%	-1.41%	+0.04%	-0.12%	-0.37%	+0.05%	+0.06%	+0.80%	-0.20%	-0.46%	+0.55%
-0.06%	0.67%	55%	0.25%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.54%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-2.38%	-0.12%	+0.21%	-0.03%	-1.85%	+0.04%	-0.12%	-0.44%	+0.05%	+0.06%	+0.80%	-0.20%	-0.46%	+0.55%
-0.06%	0.67%	55%	0.30%	+0.73%	-0.00%	+0.05%	+0.33%	-0.18%	+0.54%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-2.38%	-0.12%	+0.21%	-0.03%	-1.85%	+0.04%	-0.12%	-0.44%	+0.05%	+0.06%	+0.80%	-0.24%	-0.46%	+0.55%
-0.05%	0.67%	52%	0.35%	+0.73%	-0.00%	+0.05%	+0.43%	-0.18%	+0.54%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-2.38%	-0.12%	+0.21%	-0.03%	-1.85%	-	-0.12%	-	+0.05%	+0.06%	+0.80%	-0.26%	-0.46%	+0.55%
+0.01%	0.52%	52%	0.40%	+0.73%	-0.00%	+0.05%	+0.43%	-0.18%	+0.48%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.29%	-0.68%	-0.12%	+0.21%	-0.03%	-1.85%	-	-0.12%	-	+0.05%	+0.06%	+0.80%	-0.33%	-0.14%	+0.55%
-0.03%	0.58%	55%		+0.73%	-0.00%	+0.05%	+0.35%	-0.18%	+0.45%	+0.04%	-0.02%	+0.32%	+0.08%	+0.37%	+0.14%	+1.05%	+0.09%	-0.66%	-0.60%	-0.25%	-1.73%	-0.12%	+0.21%	-0.03%	-1.63%	+0.02%	-0.12%	-0.29%	+0.05%	+0.06%	+0.80%	-0.21%	-0.31%	+0.55%

The Hit Rate is highest for the Active strategy. The results show that the Active and Naïve strategies provide similar overall returns, with the Naïve return slightly above the Active despite its lower Hit Rate; the Trend strategy shows a higher and more stable Hit Rate than Naïve but poor returns. The Trend strategy has the lowest standard deviation while the Naïve has the highest.

7 Conclusions

- Consensus credit risk estimates:
    - Can be used as valuation benchmarks for Government bonds.
    - Are correlated with Government bonds, but are less volatile.
    - Provide positive but volatile out-of-sample performance in specific markets and time periods vs. traditional trading strategies.

- Bond market correlations show dramatic changes over the period analyzed here. Correlations between bonds and consensus data show moderate to high cross-sectional correlations across 31 diverse countries with very different credit profiles. These correlations change over time, probably due to the different credit cycles across the sample of countries.

- Consensus credit estimates are less volatile than government bond prices, but that the two series often show stable medium- to longer-term relationships, implying an element of mean reversion. This suggests that relative risk premiums may provide valuation and trading signals.

- Trading signals:
    - The countries where the Active strategy is most frequently successful are Austria, Canada, China, Germany, Poland, Singapore, Spain and Sweden. Even after de-trending (which uses the full sample), the Trend strategy is most successful in the Czech Republic, Netherlands and Thailand. There are no clear winners in Mexico, UK and Taiwan. In the remaining countries, the Naïve strategy is best. The Naïve strategy has slightly more winners in the zero-trend samples.

    - After de-trending, the proportion of winning Active sample/trigger combinations increases, suggesting that the Active strategy is more suitable for trendless markets. The Naïve strategy is best suited to markets with a clear turning point that can be fitted closely to a quadratic time trend.

    - Suitably calibrated Active strategies may offer enhanced return when applied to the two halves (negative and positively sloped) on either side of the turning point in the time series. Since the turning point is much easier to spot and confirm with hindsight, this has only been tested for post turning point samples.

    - For some estimation periods, the Active strategy may provide a low / high beta alternative to the other strategies. In other words, when the Trend or Naïve strategy returns are positive, the Active strategy returns are significantly lower/higher; but when the Trend or Naïve strategy returns are negative, the Active strategy returns are significantly less/more negative. Compared with Buy & Hold, the Active strategy appears to be a diversifier.

- This research suggests that there is value in identifying the prevailing regime in each Government bond market with the aim of determining the optimal strategy to implement at that point.

*Credit Benchmark publish consensus credit ratings on 50,000 individual borrowers. There are 21 separate rating categories **(aaa,aa+…cc,c),** and 7 summary categories **(aaa,aa…c).** The 50,000 published consensus ratings are based on a broader database of 800,000+ monthly credit updates contributed by 40+ major global banks. This broader database supports the calculation of aggregates such as credit risk time series, as well as the credit transition matrices. The current history spans more than 4 years.*