

October 2020

# BOND-EQUITY CORRELATIONS

## Are the times a-changin'?

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### Executive summary

Questioning the persistence of the negative correlation between equity and investment grade fixed income price returns has become relevant and timely because of the intersection of a few topics. First, co-movement of the equity and sovereign bond markets during the March 2020 market sell-off (despite this having occurred for various idiosyncratic reasons) reignited the debate and concern about the hedging potential offered by fixed income assets. This led to (a)an (re)investigation of the – perhaps taken for granted – sovereign bond-equity correlation relationship, a relationship that has been negative over the past two decades. And, since many argue that much of this negative correlation can be attributed to the lowering and persistently low levels of inflation over this same period, the recently (re)ignited debate about the outlook for inflation has brought this bond-equity relationship discussion back to the forefront of popular macroeconomic debate.

We investigate the importance (or not) of correlation risk.

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# Introduction

The correlation of asset returns as an input to portfolio theory dates back to the 1950s. Markowitz employed this to form the basis for the construction of diversified portfolios.

Effective diversification (or even better, hedging) by managers is reliant on the returns of 'broad' asset classes, primarily equities and bonds, moving independently (or even better, in opposing directions). The recent property of negative correlation between equities and bonds, see figure 1, has allowed managers to use fixed income assets, in addition to delivering a predictable income stream, as protection in periods of high market stress.<sup>1</sup> It has largely been the mainstay of asset managers' playbooks for decades.



Source: Bloomberg, CFM

**Figure 1:** The trailing 100-day exponential moving average (EMA) equity-bond correlation, using daily returns.<sup>2</sup> This correlation, while having brutally turned negative in Q4 1997,<sup>3</sup> has, in fact, been mostly positive over the past more than sixty years. The clearly observed and quite dramatic 'flip' in the correlation observed at the end of the 90s coincided with the end of a near two decade period of inflation taming. One can just about discern two conspicuous and similarly dramatic drops in the positive correlation at the end of the 80s, i.e. the October 1987 market crash, when the US equity market lost 12.2% in a week (and famously 20.5% on Black Monday, October 19, 1987), and again in October 1999 – the so-called 'Friday the 13<sup>th</sup> mini-crash'.

The crucial nature of this correlation for building portfolios in the asset management industry makes explaining the

source of the correlation, be it positive or negative, all the more important.

Moreover, if we understand the correlation maybe we can forecast its sign in the future.

And while the source of the negative correlation has had rather limited coverage in the academic literature, the consensus, nevertheless, appears to be that the correlation is related to *inflation* and the market's perception of whether it is under control, i.e. *inflation expectations*.<sup>4</sup>

Historically, and, at least anecdotally, this rhymes.

A look back at financial history reveals that under a gold standard, inflation (or monetary supply) is limited by the convertibility to gold – a commodity that has a finite world inventory and limited new supply. This system naturally limits inflation fluctuations. With the move towards fiat currencies and a fractional reserve system post Bretton Woods at the start of the 1970s, inflation was initially difficult to tame. It is only towards the late 1980s and 1990s that central banks began to successfully keep inflation levels under control.

It was then, around the turn of the century, that the correlation structure flipped quite brutally, coinciding with the Asian crisis that unfolded in October 1997 and inflation expectations that sunk to below 3% (from above 5% less than a decade earlier). With a belief that the central bank had successfully brought future-return-eroding inflation under control, investors now deemed sovereign paper a legitimate store of value – especially in those times of severe equity market distress.

This was akin to a behavioural shift on the parts of investors, with inflation expectations anchored, sovereign paper could now be sought as a defensive, ('flight-to-quality' or 'safe-haven') investment if and when concerns about future equity returns flooded the market, with investors confident that monetary policy could be loosened safely, if need be, without stoking inflation.

Already in much earlier work at CFM,<sup>5</sup> did we posit that changes in 'conventions', e.g. the overall sentiment in the market, could spontaneously appear or disappear and even "invert the purported correlation" – as was the case in 1997 when a new flight-to-quality convention set in.

And, despite 10 years of ultra-loose developed market central bank policy, inflation levels have crept ever lower

<sup>1</sup> Throughout this note, when referring to equity and bond returns, we employ the S&P 500 and US 10-year treasuries.

<sup>2</sup> We deliberately use an EMA for the correlation input so as to overweight the more recent price returns.

<sup>3</sup> The exact moment of the flip into negative territory naturally depends on the size of the correlation window and the frequency of the data. Nevertheless, various lags and data frequencies exhibit a similar pattern of a shift to negative correlation between bonds and equity around the end of the 90s.

<sup>4</sup> Research arguing convincingly that inflation and inflation expectations are a key driver of the bond-equity correlation structure includes Andersson et al, "Why does the correlation between stock and

bond returns vary over time?" and Yang et al. "The stock-bond correlation and macroeconomic conditions: One and a half centuries of evidence". It is worth noting that many other references exist, with similar conclusions. However, many of these have been published before, or only shortly after the correlation became strongly negative.

<sup>5</sup> Wyart and Bouchaud, "Self-referential behaviour, overreaction and conventions in financial markets", Journal of Economic Behavior & Organization, Vol. 63 (2007) 1-24

to reach a situation that seems similar to those seen through Japan's lost decades of deflation. But, under the weight of these extreme policies and heading into the Covid-induced crisis of 2020, central bank balance sheets look ever more bloated and inflation seems likely to surface...(or not?), procrastinating a move back towards a less negative correlation structure (or not?).

The rest of the paper is set out as follows: we first introduce simple bond and equity pricing models to explain the relationship with inflation, before pausing to consider how important the negative correlation is for the asset management industry. We then show how this negative correlation has been the historical anomaly, rather than the norm over the past nearly 150 years and then associate the relatively recent flip in the correlation to inflation by running a linear regression model. We finally conclude by speculating on what the future might hold. In the appendix we present a more extensive data analysis of the correlation measured through time, across countries, across tenors and using corporate debt and investigate whether the negative correlation is a bulk effect, or whether it comes from the tails of return distributions.

## Back to basics: bond and equity pricing.

In order to qualitatively explain the relationship between the bond-equity correlation and inflation levels, let us consider a simple setup for the pricing of bonds and equities.

A bond is classically priced as the present value of the future cash flows:

$$p_{bond} = \sum_{n=1}^N \frac{C}{(1+y)^n} + \frac{FV}{(1+y)^N}$$

Where:

$C$ s are the  $N$  coupon payments,

$y$  is the bond yield,

and  $FV$  is the face value at maturity  $N$ .

Inflation does not factor into this equation at all. In practice, however, if the money printers are primed and monetary supply is expanded then an IOU must decrease in value as all future cash flow has its value eroded. The yield of a bond represents the premium paid to a lender to cover the risk of a spike in inflation (assuming no threat of default). So, as inflation rises so too does the yield. The sensitivity of bond pricing to inflation is therefore

unambiguous: as inflation increases so too does yield, thus making the price of the bond drop.

The situation for equities is not quite so unambiguous and relates to whether or not the market believes that equities (like commodities) are an inflation hedge or not. Let's try to price a stock in the same way using discounted future cash flows:

$$p_{equity} = \left( Assets - Liabilities + \sum_{n=1}^{\infty} \frac{CF_n}{(1+y)^n} \right) \times \frac{1}{RP}$$

Where:

$CF$ s are the future cash flows coming from earnings or from dividends.

We use the bond yield for discounting (for the sake of simplicity) and we introduce a Risk Premium term,  $RP$ , to represent the premium required to hold the stock.

As market or idiosyncratic risk increases, the premium to hold the stock increases making the price decrease and the future effective yield increase. The Assets and (especially) the Liabilities may have term dependence which we are neglecting here for the sake of simplicity.

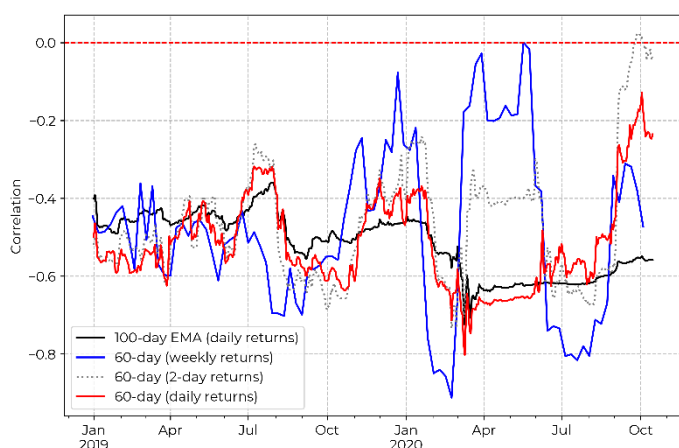
We now have two terms: one that represents the current state of the firm and one that represents discounted future cash flow. The future cash flow term has the same dependence on inflation as is the case for bonds. The growth of future cash flow, however, depends, along with the book value of the firm, on whether one believes that a firm will hedge inflation (rise under rising inflation same as a commodity) or whether inflation is detrimental to the business cycle, making a future economic environment less of a sure-thing and worsening the prospects for capital appreciation of cash flow or book value. The effect of increasing inflation on the price of stocks therefore depends on the market's perception of how detrimental to the economy such a level of inflation is.

Quantitative easing has become, to a large extent, the norm, but stubbornly persistent low levels of inflation and the moral hazard free nature of the most recent Covid-related fiscal stimulus measures might lead one to question whether the tipping point into an inflationary environment is just around the corner.

One could be forgiven for mistaking the March 2020 "dash-for-cash" period (of approximately two weeks) when bonds and equities looked to be moving in lockstep as the first signs of such an effect.

And, in fact, when looking at the correlation dynamics 2019 to date,<sup>6</sup> there seems to be a significant uptick towards a greater level of positive correlation in 2020 – see figure 2. However, this uptick is, as is evident in figure 2, dependent on the timescale. On longer timescales, the change in the correlation seems more muted, with any uptick in this subsample on shorter timescales not statistically significant.

It is worthwhile, however, to question the stability and persistence of such a regime.



Source: Bloomberg, CFM

**Figure 2:** The correlation between bonds and equities from January 2019 to October 2020. The black line represents the 100-day exponential moving average (as in figure 1), and is plotted alongside the 60-day flat average of returns calculated over various time periods. On shorter timescales, the 'breakdown' of co-movement between bonds and equities seem ominous, however, it is statistically insignificant.

## Just how important is this for the asset management business?

The classic 60/40 mix of equities and bonds provides a benchmark widely used by the industry. Over the past 30 years or so bonds have risen dramatically as central banks steadily reigned in inflation and dropped interest rates. Over the past 10 years, at least since the Great Financial Crisis (GFC) of 2008, developed market equities have also exhibited stellar performance.<sup>7</sup> This combined with the anti-correlation between bonds and equities has led to non-traditional assets and strategies struggling to outperform the benchmark 60/40 over recent history. Table 1 illustrates the power of the negative correlation

with a Sharpe ratio pick up post-98 when the correlation dramatically flipped.

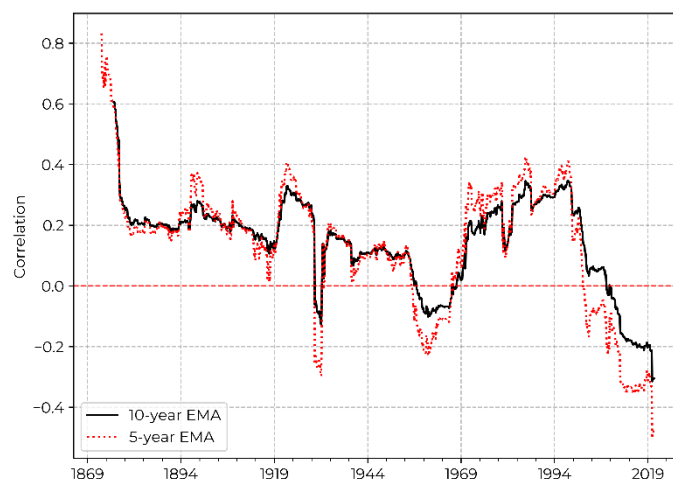
	Negative Correlation (-0.4)	Positive Correlation (+0.4)	Realised
1980 - today	0.74	0.54	0.58
Pre-1998	1.14	0.78	0.78
Post-1998	0.51	0.40	0.47

Source: Bloomberg, CFM

**Table 1:** Sharpe ratios of a 60/40 portfolio in three different time periods 1980-today, 1980-1998 and 1998-today. The latter two periods are characterized by the flip in correlation that occurred in 1997. In the first column of table 1 we assume an arbitrary -0.4 correlation between equities and bonds and recalculate the Sharpe ratios. We repeat for the second column with an arbitrary +0.4 correlation. The last column corresponds to Sharpe ratios with the actual correlations. What is striking is the increase in pre-1998 Sharpe ratio from 0.78 to 1.14 by flipping the correlation, and from 0.40 to 0.51 following the same flip in sign for the period post-1998. The level of 60/40 risk adjusted returns are very sensitive to the level of correlation between equities and bonds!

## How does the correlation change over 150 years in the US?

While stock and government bond prices have been moving in opposite directions since the beginning of the new millennium, the correlation prior to around 1997 in the US, as seen in figure 3, was broadly positive for more than a century. Using data going back to the mid-19<sup>th</sup> century, it is clear that the correlation between equities and bonds has been mostly positive, making the recent, and consistent stretch of negative correlation the anomaly, rather than the rule.



<sup>6</sup> As of writing, October, 2020.

<sup>7</sup> For a more detailed look into just how stellar the performance of equities over the last decade was, see our whitepaper "Lucking Up" - until beta fails" available on our website.

Source: Global Financial Data, CFM

**Figure 3:** The trailing 10-year and 5-year equity-bond correlation of monthly price returns of US large-cap equities and US Treasuries. The correlation has been mostly positive over the past more than a century, with the exception of the period during the Great Depression, and mid-1950 to 1960 as the US treasury struggled to stop Europeans converting their dollars into gold.

So, is there a reason for this stubbornly positive correlation over this extended period?

Prior to the early 1970s the developed economies of the world mostly managed monetary policy according to a gold standard. This system equates to a world trade system effectively backed by a finite, relatively unchanging quantity of a valuable hard asset. Gold has the advantage over most commodities for this purpose in that supply is always small compared to the outstanding world inventory. It follows therefore that one cannot inflate away its value by flooding the market with fresh supply, unlike many other commodities.

The historical difficulty of transactions being conducted directly in gold made its convertibility into currencies practical and necessary. This convertibility limits money supply expansion and currencies hold their value. The Bretton Woods system set up following the end of the Second World War ensured convertibility of all currencies into the dollar and the dollar into gold. The gold standard itself is a self-adjusting mechanism – as countries export more they accumulate gold reserves, experience an increase in money supply, an increase in the domestic price level, and finally a drop in international competitiveness and subsequently a correction to the balance of payments.

The process itself can be accelerated using a drop in interest rates to reduce the cost of borrowing which in turn further increases domestic demand. A reduction in interest rates also leads to capital flight which again adjusts the balance of payments. Usage of such a system and sticking to the ‘rules of the game’<sup>8</sup> means that a positive correlation between bonds and equities is most plausible.

A simplified scenario would be: if a country underperforms economically, then downward pressure on equities is accompanied by a balance of payments deficit and a central bank needing to increase interest rates, thus depressing the price of bonds.

The system was abandoned in 1971 as the US ended the convertibility of the dollar into gold. The US at the time

was struggling with inflation due to higher spending on the Vietnam War, while the Federal Reserve was being increasingly influenced by Keynesian economics. The inflationary environment of the key currency of the Bretton Woods system was unsustainable and led to its demise from 1971-73. The period that followed saw the adoption of a floating currency system still in use today.

## Is this correlation behaviour similar for other countries?

For most other developed economies, yes. In section A of the Appendix we illustrate the bond-equity correlation using similarly long term data sets for France, Germany, Japan, the UK and Australia.

Moreover, the general pattern also holds across emerging countries, with the exception that the pattern is decidedly more volatile and that the correlation has remained positive, not following developed markets into negative territory – see section B in the Appendix. The suggestion is therefore that the market does not readily see emerging debt as being a store of value in quite the same way as for developed markets.

This naturally also then begs the question about the correlation structure between equity and different tenors of sovereign debt, as well as for corporate debt. The pattern holds, with some intuitive variations – see sections C and D in the appendix.

## Bulk or tail correlation – which is the most important?

We subscribe to the possible explanation of negative bond-equity correlation over the past 20 years being qualitatively explained through inflation expectations and the behavioral effect induced that bonds be used as a store of value in times of crisis. High quality government paper is often considered the best form of protection in the most extreme of market scenarios. The GFC illustrated that, in a banking crisis, unsecured cash deposits at a commercial bank become risky while T-bills held at a custodian bank are more likely to be returned to the holder in the (less likely) case of default of the custodian.

<sup>8</sup> The ‘Rules of the Game’ is a phrase attributed to Keynes, alluding to the fact that governments and central banks were bound to manoeuvre within the constraints as imposed by the classic Gold Standard.



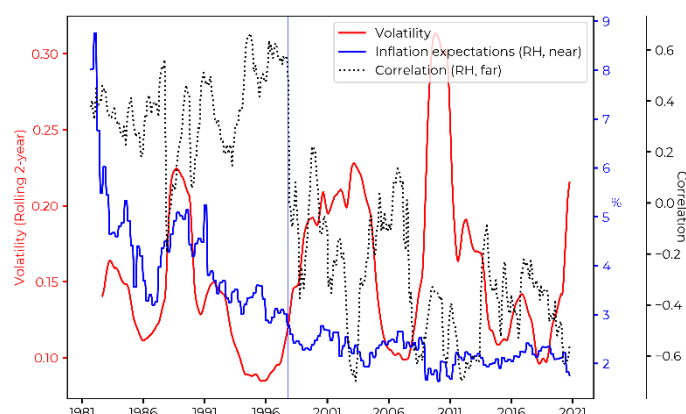
For these reasons, in the most extreme crisis situations the best quality paper has become the haven of choice. Even at low levels of interest paid (and recently negative interest rates!) high quality government bonds, at such crisis times, can demand a premium to be paid as investors become more concerned about return of capital rather than return on capital.

In sections E of the appendix we investigate the difference between the correlation in the 'bulk' and the 'tails', and in sections F and G we consider how bonds have historically performed as a flight to quality during the periods of deepest drawdown and most extreme negative equity returns, pre-and-post the correlation flip. On the whole the bulk and tail correlations follow the same pattern.

## Inflation (and volatility) as the drivers of the correlation structure

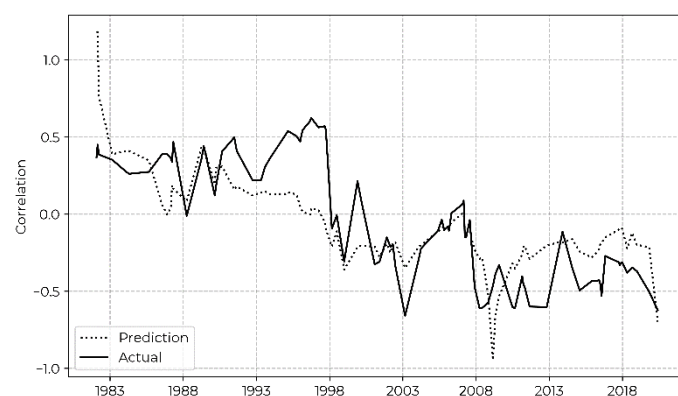
As alluded to above, strong arguments exist for the relationship between inflation (inflation expectations) and bond-equity correlations. Anecdotally, we saw especially during the 1970s and 80s – a period characterised by high oil prices and rising inflation – a positive and increasingly positive correlation between equities and bonds (refer again to figure 1). Persistently (very) high inflation from the mid-70s to mid-80s (above 5%), to high and above-target inflation (2-5%) from the mid-80s to near-end of the 90s was accompanied – as the Federal Reserve mandate for providing price stability would dictate – by tighter monetary policy, higher rates, and higher bond yields. Remember, although it might seem very foreign given our current paradigm, that the US Fed Funds rate reached a record 20% in late 1980 under the stewardship of then Chairman Volcker.

In figure 4(i) we plot the correlation of returns between US large cap stocks (our equity proxy) and US Treasuries (our bond proxy), along with inflation expectations. The realised volatility of equity markets is also plotted and used in a linear regression as an explanatory variable along with inflation expectations. In figure 4(ii) we plot the results of a linear regression model with bond-equity correlation as the dependent variable, and inflation expectations and the volatility of US large cap stock as the two independent variables.



Source: Bloomberg, Federal Reserve Bank of Philadelphia, CFM

**Figure 4(i):** Inflation expectations, along with the 100-day average realised volatility of the S&P 500 from Q3 1981 and the 100-day EMA bond-equity correlation. The bond-equity correlation seems to turn sharply more negative in those periods of high market volatility, which is consistent with the argument that bonds are sought after in periods of high market stress. The vertical blue line indicates the brutal shift in the correlation structure (October 1997), shortly after inflation expectations sunk below 3% for the first time.



Source: CFM

**Figure 4(ii):** We plot the actual (realised) bond-equity correlation from 1980 and the predicted output from a simple two variable linear regression model. We find a statistically significant and positive coefficient for inflation expectations (coef = 0.63), and a negative and statistically significant coefficient for equity volatility (coef = -0.30) with a decent fit ( $R^2 = 0.54$ ). The magnitude of the coefficients is indicative of the relative contribution of each variable since we first normalise the variables by their standard deviation, suggesting that inflation expectation is more significant in explaining the change in correlation. We limited ourselves to this time period as the inflation expectations data we used are only available from Q3 1981. This data, the Survey of Professional Forecasters, comes courtesy of the Federal Reserve Bank of Philadelphia, and includes survey-based inflation expectations over various forward-looking periods.<sup>9</sup>

<sup>9</sup> In this instance, we used the annual average inflation expectation for the following year as updated each quarter when a new survey is conducted.

## Conclusion

While one may be forgiven for taking the negative bond-equity relationship as scripture, the market is often reminded, typically following an idiosyncratic event (e.g. the March 2020 co-movement), of the benefits of this negative correlation. Moreover, it is worth bearing in mind that this negative correlation, as one look backs through history, is more the anomaly than the rule.

Our research suggests that this negative correlation is, at the moment, still very much in place, notwithstanding a recently observed reduction in the level of negative correlation in 2020. Of course, managers have reasons to fret about the hedging potential of bonds, given their low yields and the broad consensus that rates are set to stay lower-for-longer. Given this setting, both the return and hedging potential of bonds are reduced. If the hedging ability of rates becomes less effective as a portfolio hedge, investors will be left with few options..., or, be well-advised to look at alternatives for diversification purposes.

Investors are moreover increasingly debating the likelihood of an inflation uptick, with those voices arguing for, seemingly outnumbering those against. The recent rally in the gold price, often used as a safe-haven asset and hedge against inflation, is another topical market feature that investors summon to point to market unanimity about the likelihood of rising inflation.

Our regression analysis points to a shift in the correlation structure if inflation picks up along with volatility. We are of course cognisant of the inherent limitations of regressions although both quantities have a certain intuitive logic to their explanatory power of the correlation between bonds and equities.

It is of course important for hedge funds and asset managers alike to question the consequences of a shift in correlation for various aspects of the business. Certainly, a 60/40 benchmark loses its appeal in terms of risk adjusted returns and perhaps exposure to market shocks. Risk Parity programs equally employ the same source of return but employ leverage through futures markets. CTAs are predominantly directional in nature and therefore have to also be concerned about a regime shift in any of the correlations between instruments.

Our own research on the subject at CFM has led to various tests of correlation structure, erring on the side of limiting exposure to positions leveraging the negative correlation and all the while trying to not adversely affect risk adjusted returns. We also employ other efforts, such as shocking

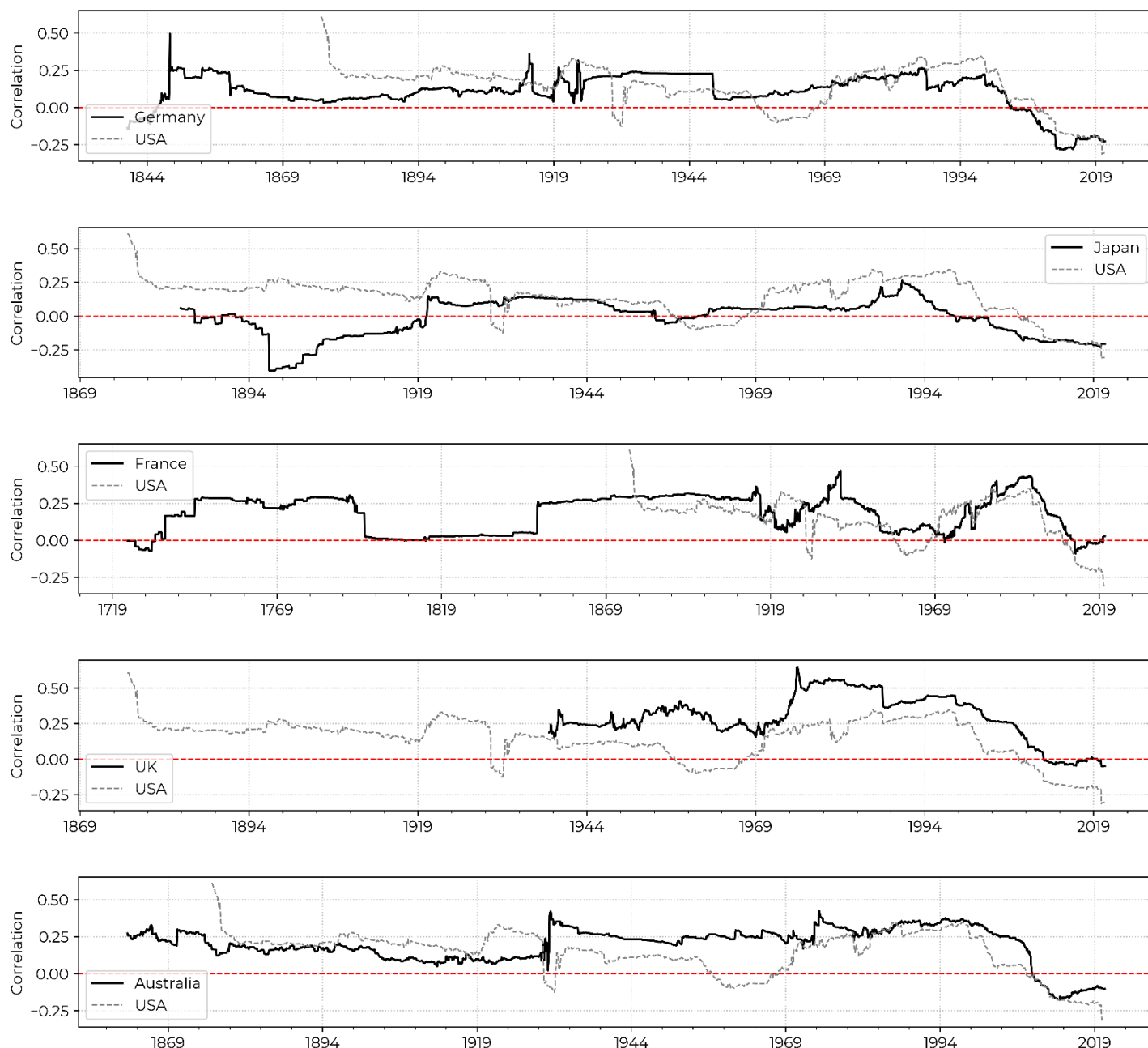
portfolios using scenario analyses and testing our portfolios against these types of regime shifts. This, after all, is an issue for the whole market and not just for us.

The recent “dash-for-cash” episode earlier in 2020 set alarm bells ringing in financial markets. For the moment, the correlation between equities and bonds remains negative but we, along with doubtless many others, are watching this space, ready to act!

## Appendix

### Does the same correlation structure exist for other developed countries?

Extending the study to other developed countries, the correlation pattern compared to that of the US seems decidedly similar – see figure A. However, a couple of things to note: first, there appears to be a series of decoupling's of the correlation between the US and other developed markets from approximately 2013. This aligns, at first, with the 'Taper Tantrum' in the US when then Fed Chairman Ben Bernanke threatened to reign in the ultra-loose monetary policy employed by the US central bank and, later, a divergence of monetary policy with other developed market central banks. Also of note are the dissimilarities with Japan, where the correlation turns negative earlier compared to its G-7 partners. Deflation has been a persistent problem in Japan since the latter half of the 90s due to a negative output gap, a higher exchange rate and many unique structural features. Japan's central bank experimented with Quantitative Easing (QE) many years ahead of the post-GFC experience of the European Central Bank (ECB) and the Fed.



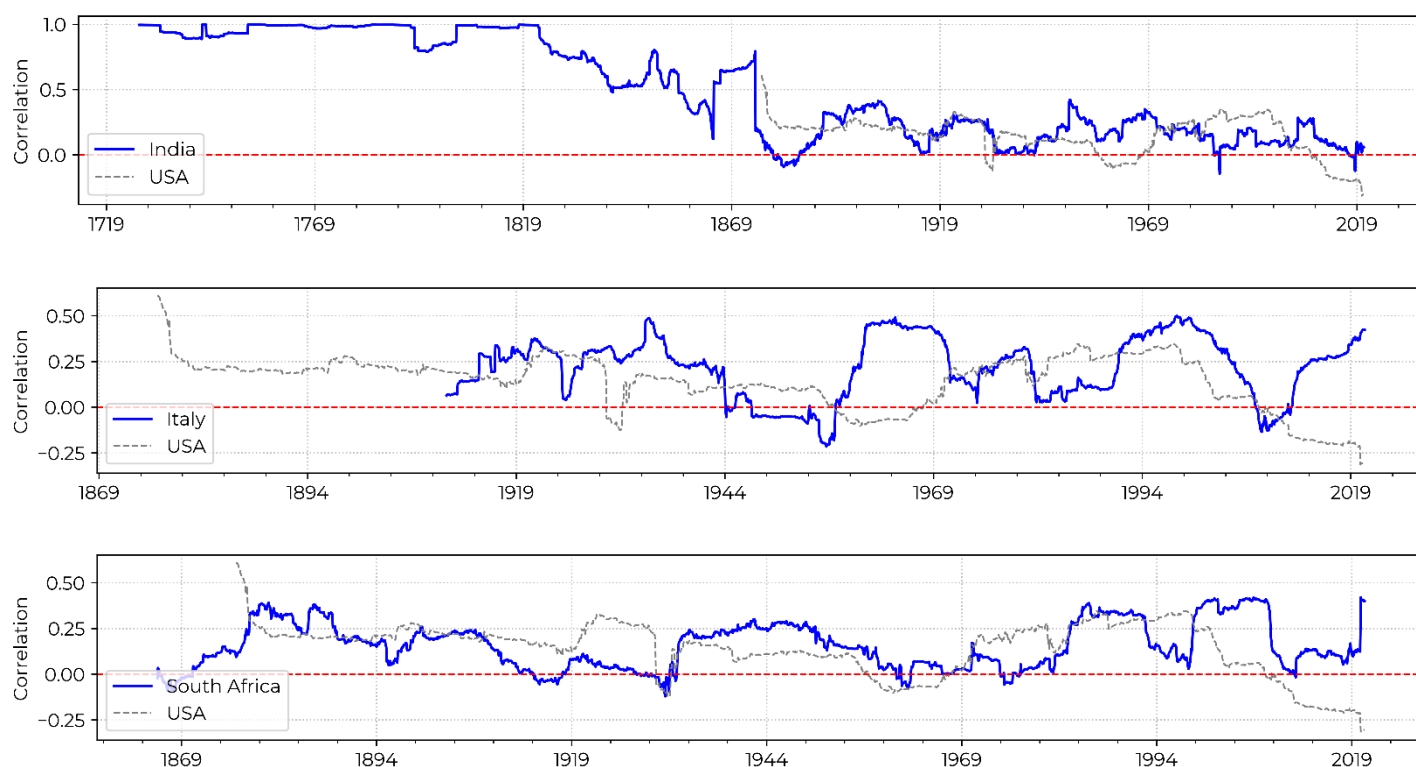


Source: Global Financial Data, CFM

**Figure A:** The trailing 10-year EMA correlation of bonds and equities of major global economies, using monthly data of each country's benchmark 10-year yield and the price returns of that country's main composite equity index (with historical data for each country as far back as is available). The correlation pattern, notwithstanding distinctive events and patterns across countries, is fairly consistently positive across these markets prior to 1998, where after the correlation structure flips to become negative. Astute readers will notice a recent decoupling of the correlation pattern between Europe and the United States (and the rest of the world) after the 2016 US presidential election. The separation concurs with the divergence of monetary policies between the Fed and the ECB following the inauguration of President Trump. Substantial fiscal stimulus in the form of a generous tax break sent the US stock market on a 40% Bull Run up until October 2018, while the 10-year Treasury yield surged 130 basis points. The correlation structure of Japan, especially at the turn of the 20<sup>th</sup> century, is an outlier compared to the other nations, as it turned less positive and ultimately turned negative before all other G-7 nations.

### Does the same correlation structure exist for developing/emerging countries?

The correlation pattern across developing markets is similar. Italy, however, is an interesting case. Prior to the European crisis of 2011, all European government paper was converging towards the highest quality paper – that issued by the German government – as was the correlation between bonds and equities. The change in direction of the correlation for Italy occurs approximately at the time of the crisis when investors began to realise that not all government debt was of the same quality!

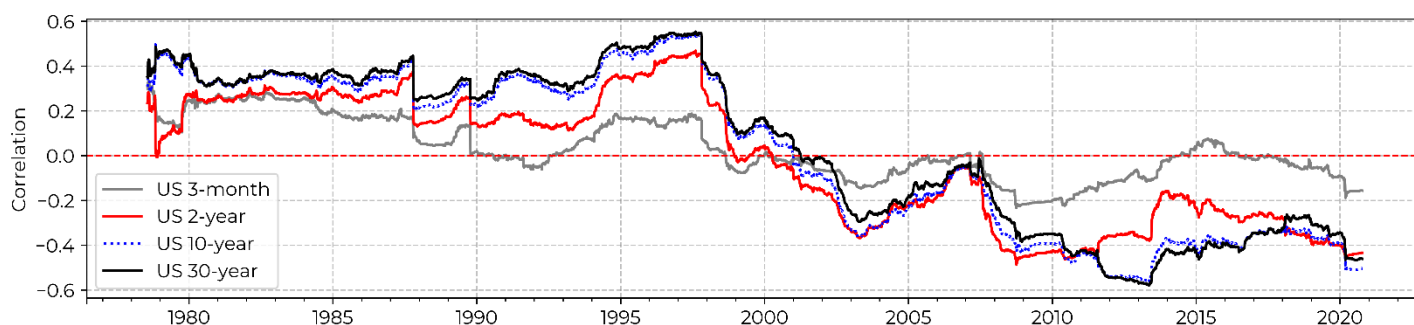


Source: Global Financial Data, CFM

**Figure B:** The trailing 10-year EMA correlation of bonds and equities of emerging market economies (South Africa and India chosen for having the most complete and deepest historical depth of data), along with the correlation of Italy. The pattern, albeit noisy, is consistent between developed and emerging markets bar the distinct slip into a negative correlation regime that is absent in emerging markets, as well as, illustrated here, Italy. While the Italian bond-equity correlation followed suit in the late 90s – briefly turning negative along with its European partners – it soon returned to positive territory where it has remained since. Emerging market (and lower credit-worthy developed market debt) behaves much more like equities, and is not considered by the market as a viable hedge.

### Does the same correlation structure exist for other tenors?

We repeat the correlation computation as we did for figure 1 but adding the other main tenors of the US yield curve. In figure C we observe that the correlation structure presents very similarly for all durations of tenors. However, for the most part, shorter dated debt have been less positive than longer dated debt when the overall correlation was positive, and less negatively correlated than longer dated debt when the overall correlation has been negative.



Source: Bloomberg, CFM

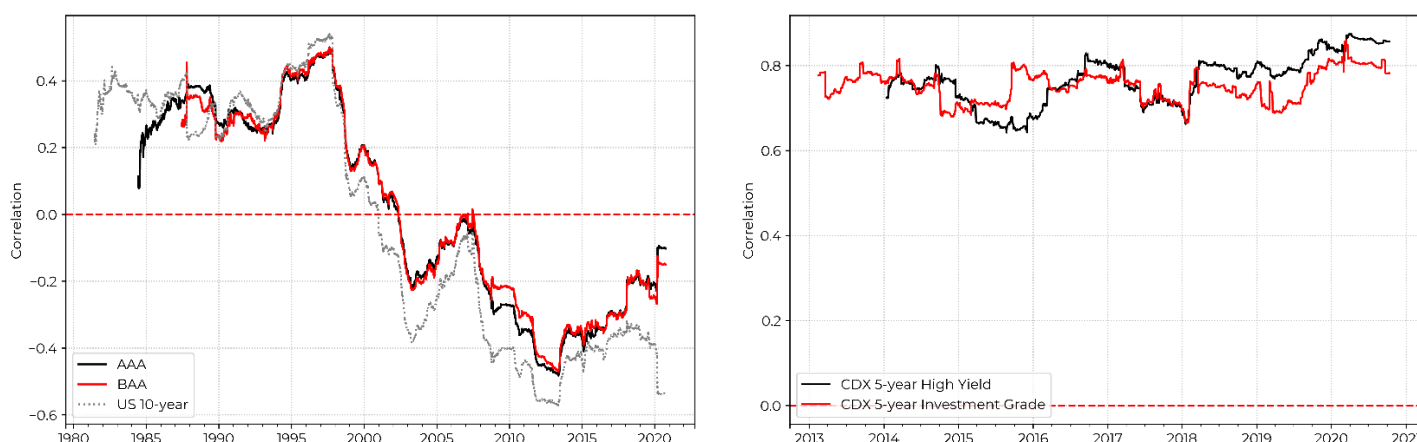
**Figure C:** The trailing 2-year equity-bond correlation of daily price returns of US large-cap equities and various tenors on the US Treasury curve. While the pattern is largely consistent across the yield curve, the shorter tenors (3-month and 2-year) are less negatively correlated with equities, this pattern becoming especially distinct after the GFC.

### Does the same correlation structure exist for corporate debt?

Companies also need to finance their activities and corporate bond markets are a good laboratory to test our understanding of correlation with equities. The interest rate at which a firm is able to borrow can be decomposed into a spread over the risk free rate of the lowest credit risk bonds (generally) issued by the government and the premium required to cover the bond buyer against the risk of default and that associated to idiosyncratic and/or market risk. One would therefore expect corporate bonds to correlate more positively with equities similar to emerging market debt.

To test this proposition, we compute the correlation of various tranches of corporate credit with equities, which shows a continuum of higher (lower) correlation with equities as the credit rating decreases (increases) as seen in figure D(i). Many funds have moved into credit as a way of getting extra pick up in yield following post-GFC monetary policies. The recent, dramatic shift in correlation (as is clearly evident in the divergence post-2020 in figure D(ii)) illustrates how shaky that diversification now is.

In figure D(ii) we also plot the correlation between equities and two aggregated corporate bond indices of different credit quality.



Source: Bloomberg, CFM

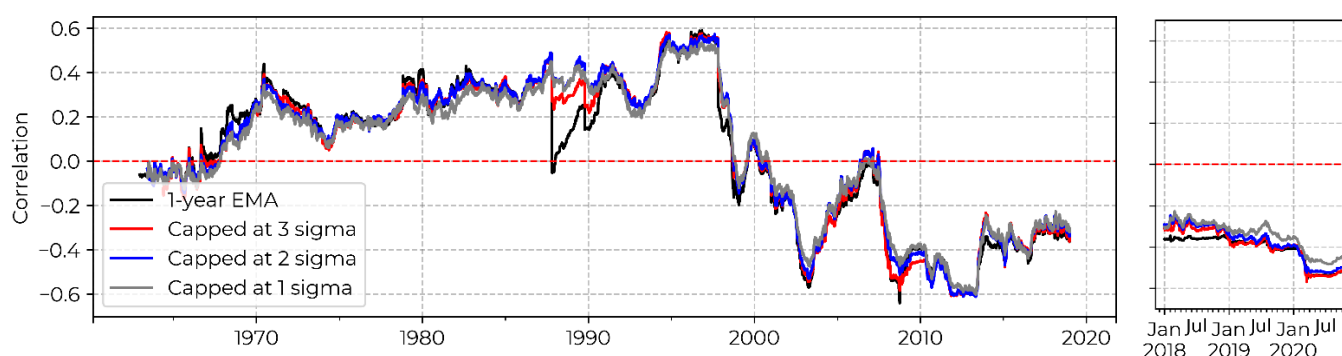
**Figures D(i) and D(ii):** The trailing 2-year correlation of daily price returns of US large-cap equities and corporate credit risk. Two key observations to be made here: One, the correlation structure between equities and corporate debt shows a similar pattern as with sovereign debt. Two, lower rated credit (as indicated here by using the average returns of bonds rated BAA) behave more like equities in periods of higher market stress – see for example the period during and directly following the GFC. The correlation with higher rated credit (here using the average daily returns of a large basket of AAA-rated corporate bonds) tracks much closer to the correlation of equities and government debt. Figure D(ii) shows the correlation with two Credit Default Swap Indices (CDXs)<sup>10</sup> – the US 5-year High Yield and Investment Grade respectively. These have limited historical depth, but it is clear that both of these are very highly correlated with equities – the reason being that a CDS is composed of equity and default risk, and does not contain the exposure to the risk free interest rate, the component that drives the negative correlation with equities.

## Distinction between bulk or tail correlation?

There is a subtle difference between an anti-correlation in the most extreme cases, with the potential to avoid the most extreme of losses, and ‘normal’ times when equities deliver a risk premium and bonds deliver a rate of interest consistent with the monetary policy of the day.

The optimal mix between two strategies can be found using a Mean Variance Optimisation technique that takes as input the correlation matrix, the returns and the volatilities of the strategies, and yields, as output, the weighting scheme that maximises risk adjusted returns (Sharpe ratio). These correlations are assumed to be stable over the time window used for the optimisation. Correlations can, however, be different between the heart of return distributions i.e. the ‘normal’ times and the tails of the return distributions i.e. the biggest up or down days for a market. In building portfolios one needs to consider what exactly an investor would like to maximise – in the case of Sharpe ratios over long histories – then the correlation from the heart of the distribution is important, whereas in the case of a hedge in tumultuous times – then, perhaps the tail correlation is more important. The tail and bulk correlations may, of course, be of the same sign and size but it is worth investigating.

Our first test is to consider reducing the weight of large returns in the calculation of correlation. Figure E shows the correlation considering returns capped at varying levels of standard deviation. In order to cap the time series at varying levels of “sigma”, we need to first translate the daily percentage returns into units of risk – for this study, we use a rolling 2-year standard deviation.



Source: Bloomberg, CFM

**Figure E:** The returns of both the S&P 500 and US 10-year Treasury is standardised by a rolling volatility before ‘capping’ the time series of the S&P 500 by various tranches of standard deviation and then recalculating the correlation between the two by the new time series.<sup>11</sup> On the larger, left-hand plot we render the correlation time series until 2018, while zooming in on the last two years on the right-hand plot. If anything, it seems the correlation structure is remarkably stable, and the negative correlation, at least over the past two years, has increased (before flattening out in 2020). The lackluster bond returns during the most recent period of high market volatility (and a few events of co-movement of bonds and equities) accompany the correlation that has flattened since March. However this recent period is not of any statistical significance when looking over a much longer time period.

<sup>10</sup> A CDS is a derivative contract that offers protection against a credit event, such as the default or bankruptcy of an issuer. The CDX is an index of single name CDSs.

<sup>11</sup> We progressively cap the time series at higher levels of standard deviation, i.e. capping all returns greater than one sigma (one standard deviation) at one sigma, then two, and then finally three sigma. That is to say, if the returns of either equities or bonds are higher or lower than 1 sigma the return is limited (or capped) at the one sigma level, and similarly for the other levels of sigma.

## How well do bonds hedge the worst equity drawdowns?

Asset managers have become accustomed to being able to rush into the safest and most liquid of assets, typically US treasuries, as a hedge when equity markets sell-off. The 'protective' property of so-called 'safe-haven' assets such as treasuries (and other low risk sovereign debt, gold, and especially the currencies of the US, Japan, and Switzerland) can be called upon to hedge equity exposure in periods of high (and often continued) market stress and significant drawdowns.

However, this market feature, looking back over the past 60 years, has only recently been available to investors.

In table F we show all equity drawdowns greater than 10% since the 1960s. We tabulate the total return of the S&P 500 from peak to trough, along with the comparative total return of US treasuries along with other major safe-haven assets. There is a distinctive pattern, corresponding with the correlation structure of equities and bonds as discussed above.

Before the end of the 90s, bonds typically moved in lockstep with equities, offering no protection to investors during these, the most severe drawdowns. Even in the couple of cases it did, the returns were marginal. However, after the end of the 90s, the pattern changed markedly, when, in most cases, bonds acted as an effective hedge against the equity sell-off.

	Event	Peak	Trough	S&P 500	US 10-year	Gold	US Dollar	JPY-USD	CHF-USD	Δ
Negative Correlation	GFC 2007-2009	10/10/2007	09/03/2009	-56.8	19.6	25.0	13.3	18.5	2.2	0.14
	Dot.com bubble	27/03/2000	09/10/2002	-49.1	30.0	12.3	2.1	-13.3	9.7	0.67
	Covid-19	20/02/2020	23/03/2020	-33.9	8.1	-3.6	2.8	0.1	-0.1	0.12
	Fed hike	21/09/2018	24/12/2018	-19.8	3.3	5.1	2.8	1.8	-2.8	0.04
	China market turbulence	22/05/2015	11/02/2016	-14.2	5.5	3.5	0.3	7.7	-3.7	0.17
	NFP scare	29/01/2018	08/02/2018	-10.2	-1.6	-2.3	1.3	-0.1	-0.2	0.06
Positive Correlation	1973-74 Oil crisis	12/01/1973	03/10/1974	-48.2	-14.9	137.5	-7.1	0.8	27.8	0.00
	1968-70 US recession	02/12/1968	26/05/1970	-36.1	-21.7	-10.5	-0.5	NA	NA	-0.25
	Black Monday	26/08/1987	04/12/1987	-33.5	-2.4	8.4	-7.6	7.8	10.2	0.42 (0.72†)
	Carter stagflation	01/12/1980	12/08/1982	-27.1	-8.0	-46.0	34.8	-17.7	-19.5	-0.09
	Iraq war	17/07/1990	11/10/1990	-19.9	-4.7	6.8	-8.2	13.9	9.7	-0.21
	LTCM / Russia default	20/07/1998	31/08/1998	-19.3	5.5	-6.4	-0.4	0.2	5.0	0.20
	Secular bear	11/10/1983	24/07/1984	-14.4	-17.4	-15.6	11.0	-6.2	-14.5	0.12
	Inflation fears	19/07/1999	15/10/1999	-12.1	-3.9	24.1	-6.8	14.7	8.2	-0.13
	Asian contagion*	08/10/1997	27/10/1997	-10.8	1.2	-6.1	-0.1	0.3	0.4	0.37
	Friday the 13th	10/10/1989	30/01/1990	-10.2	-4.9	15.2	-6.8	-0.8	10.6	0.35
	??	26/09/1967	05/03/1968	-10.1	-2.1	0.7	1.9	NA	NA	-0.13

Source: Bloomberg, CFM

**Table F:** The total returns of the S&P 500 and of corresponding 'safe-haven' assets during the deepest equity market drawdowns.<sup>12</sup> The table is split into two periods, before and after the flip of the correlation structure (around the end of 1997), with the rows then ranked by the deepest equity market drawdowns within each period. For most of the deepest drawdowns before 1998, bonds provided none or scant protection, with the pattern shifting after 1998. Gold as a hedge against inflation is seen, especially during those periods where markets were anticipating a spike in inflation: during the 1973 oil crisis, when oil rose nearly 300% pushing inflation higher, along with the period at the end of 1999 – following a substantial economic expansion – fanned rising wholesale inflation (and an overtly hawkish Greenspan), which triggered a broad sell-off at year-end. The delta is the change in the correlation structure from peak to trough: a positive number indicates that the correlation decreased, i.e. became more negative and vice versa. This change is also consistent with the regime of correlation – before 1998 the correlations tended to become more negative during the worst drawdowns, whereas before 1998, correlations remained mostly unchanged, or became slightly more positive. \*The Asian crisis marks the period when the correlation flipped dramatically. †Excludes Black Monday.

## How well do bonds hedge the worst equity tail events?

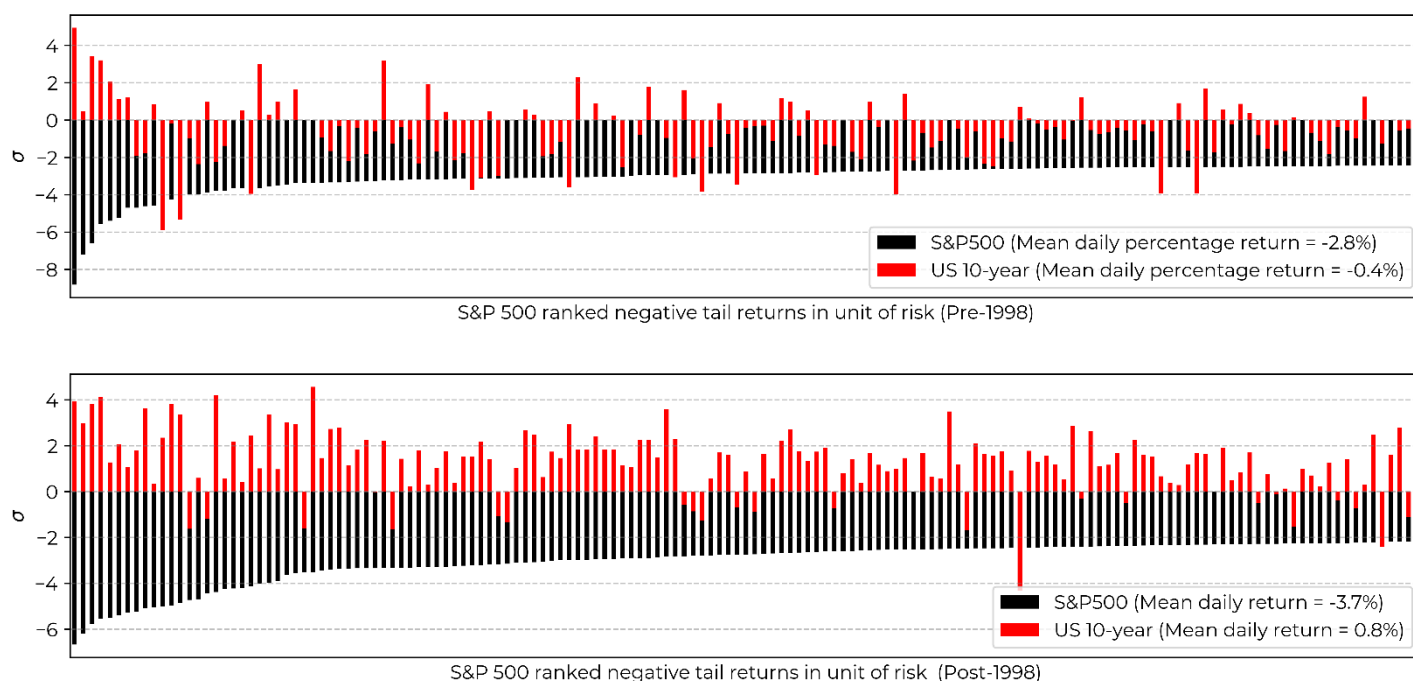
For many investors and managers, the hedging opportunity of bonds becomes especially pertinent in times of severe market stress. This naturally leads one to ask: what is the correlation structure of bond and equity returns in the 'tails', i.e. the correlation structure only in those most extreme, shock events.

<sup>12</sup> It is worth remembering that anti-correlation between two asset classes can also be accompanied by negative performance for both those asset classes over an extended period of time.

And, moreover, how does the pattern of bond vs equity returns look before and after the 90s? We can investigate this disparity pre-and-post 1998, by looking at only the most extreme returns, and discerning the pattern between equity and bond returns in the tail of the distribution.

The results show a pattern that is consistent with the overall correlation structure and the returns during the largest drawdowns. In figure G(i) and G(ii) we plot only the most negative one percent of volatility standardised S&P 500 and corresponding bond returns, for the period pre and post-1998 respectively.<sup>13</sup> The comparative pattern within the tails are telling: before the end of the 90s, equities and bonds (except during the less than ~10 most negative events in the one percent of worst equity returns) moved broadly in the same direction, with the average returns of bonds over this slice of the return distribution also being negative.

After 1998, the pattern inverts. Bond returns are now positive on average, with the vast majority of all the most negative equity returns accompanied by positive bond returns.



Source: Bloomberg, CFM

**Figures G(i) and G(ii):** Figures G(i) (before 1998) and G(ii) (after 1998) we plot the most negative one percent volatility standardised daily returns of the S&P 500 with corresponding US 10-year treasury returns.

Another neat way to measure the correlation of tail events is the use of conditional probabilities. If we consider the usage of bonds to hedge the most extreme equity moves then the quantity of interest to measure is:

$$P(r_{bonds} > 90\% CL \mid r_{equities} < 10\% CL)$$

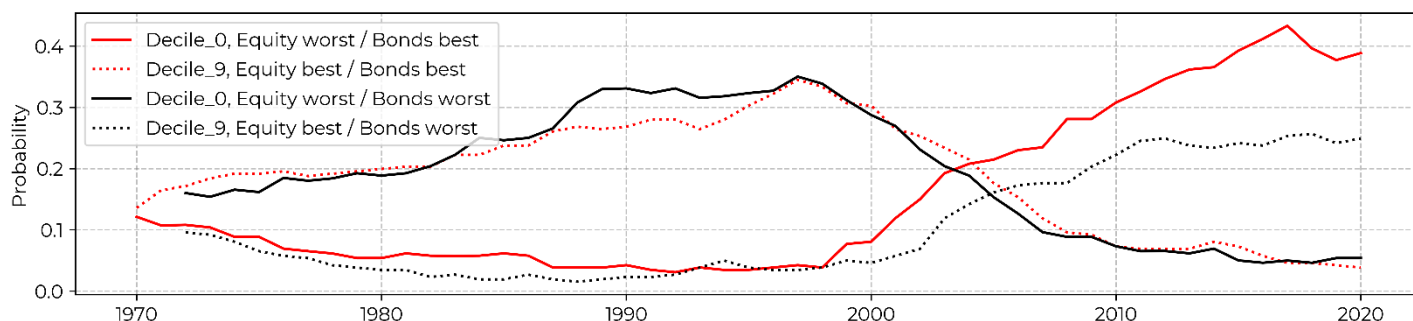
Where  $r_{bonds}$  and  $r_{equities}$  are the returns of the bonds and equities considered. Put into words, we would like to know what the probability is of bond returns being in their 10% best moves (over the entire time period), when equities are in their 10% worst returns. This then becomes an exercise in counting. The returns can be daily or weekly and the confidence limit can equally be set at different levels. This quantity is plotted below (in fig G(iii)), while we also plot the complement to the above as:

$$P(r_{bonds} < 10\% CL \mid r_{equities} < 10\% CL)$$

... to know if the tails are correlated in the opposite direction, especially when bonds and equities are positively correlated prior to 1998.

<sup>13</sup> As a reminder, we measure volatility as the rolling two year standard deviation of daily returns of both equities and bonds.

The pattern of correlation in the tails is similar to that of the bulk with a shift at the same point, approximately at the start of 1998. It is even striking that leading up to 1998 equity crashes became ever more likely to be accompanied by a bond crash with the change post 1998 being as dramatic as the change of the bulk correlation from positive to negative.



Source: Bloomberg, CFM

**Figure G(iii):** The solid red line, Decile\_0, represents the probabilities of equity returns being in the bottom 10% of daily returns (in level of risk), along with bonds being in the top 10% of returns. In other words, at any point of time and looking at the worst 10% of equity returns, what is the probability of bonds being in the best 10% of returns? Before the flip in the correlation (end of the 90s), the probability of bond returns being in their best decile when equity was in their worst decile was very low. That probability has increased dramatically, coinciding with the flip of the correlation, and reaching above 40% recently. The inverse of the above is also shown, i.e. the probability of equity returns being in the bottom 10% of risk-adjusted returns, along with bonds also being in the bottom 10% of returns. In other words, at any point of time and looking at the worst 10% of equity returns (Decile\_0, solid black line), what is the probability of bonds also being in the worst 10% of returns. Before the flip in the correlation, the probability of bond returns being in their worst decile when equity was in their worst decile was high. The probability of that happening has, however, all but disappeared, falling from above 30% to ~0%.

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