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ALTERNATIVE BETA MATTERS

Quarterly Report – Q3 2016

All Data as of 30 September 2016

Introduction

Welcome to CFM's "Alternative Beta Matters" Quarterly Report.

Within this report we recap major developments of the quarter for Equities, Fixed Income / Credit, FX and Commodities, as well as Alternatives. All discussion is agnostic to particular approaches or techniques, and where alternative benchmark strategy results are presented, the exact methodology used is given.

We have also included one white paper and an extended academic abstract from a paper produced during the quarter. Our hope is that these publications, which convey our views on topics related to Alternative Beta that have arisen in our many discussions with clients, can be used as a reference for our readers, and can stimulate conversations on these topical issues.

MODELLING FORWARD LOOKING RETURNS AND COMBINING TRADITIONAL AND ALTERNATIVE BENCHMARKS

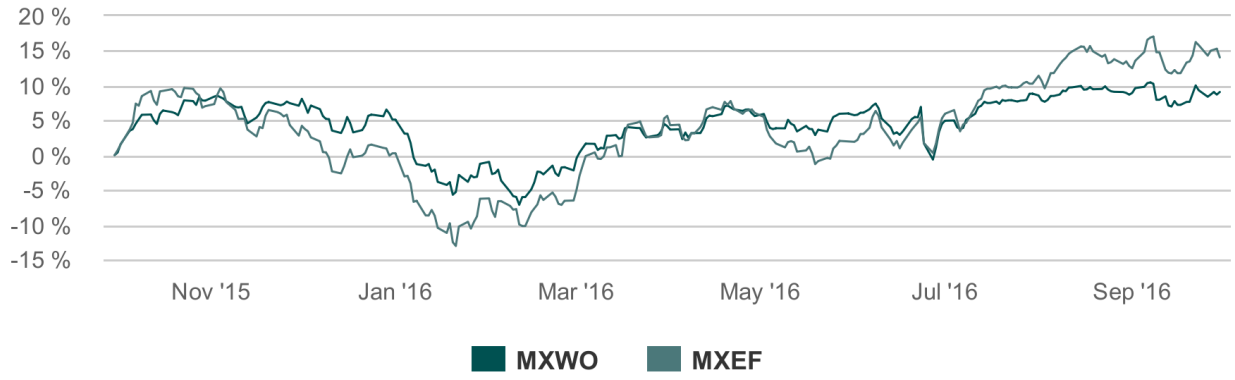
This white paper discusses a study of objective measures of forward looking performance based only partly on in-sample back-tests. When building a portfolio, investors are unwittingly fooled by past performance. This discussion note is a complement to our work on in-sample biases and looks at techniques for getting a handle on realistic expected future excess returns. Armed with this information we look at the effect of combining an alternative benchmark strategy, that of long term trend following, with a more traditional benchmark portfolio made up of equities and bonds.

AGNOSTIC RISK PARITY: TAMING KNOWN AND UNKNOWN-UNKNOWNS

This academic paper describes an extension of Markowitz's classic Mean Variance Optimization that, based on symmetry arguments, builds portfolios that achieve equal realized risk on all the principal components of the covariance matrix. This "Agnostic Risk Parity" portfolio minimizes unknown-unknown risks generated by over-optimistic hedging of the many different possible bets.

Equity indices

The third quarter of 2016 was generally good for equities with most markets seeing out the quarter positively. Emerging markets outperformed their developed market peers as central banks remained accommodative leading investors to focus on high yielding assets - the MSCI World equity index, made up of 23 developed country equity indices, returned 4.4% through Q3, while the MSCI EM index, made up of 23 emerging countries, returned 8.3%. The correlation between the two indices dipped slightly but remained above 85%, a level still below the last peak seen in 2012.



The returns of the MSCI World and the MSCI Emerging Market indices for the past year

Among the key events for equities were the continued expectations for a Fed rate increase before year-end; the absence of further commitment to QE from the ECB; the return of a certain stability in the UK following the Brexit referendum; and a convincing win for Abe in Japan's upper house elections. The S&P 500 rallied 3.3% through Q3 with the technology sector and financials leading the way while European stocks generally rose despite lacklustre growth and low inflation. UK equities had a strong quarter as the appointment of Theresa May as Prime Minister brought some much needed political stability to the country. In Japan, the Nikkei 225 rose a convincing 5.6% with a firmer tone arising from a stronger mandate for Japanese Prime Minister, Shinzo Abe, following the Upper House elections. With his position reinforced, Mr Abe renewed focus on longer term structural reforms.

The generic trender[1] applied to equity indices delivered slightly positively this quarter, picking up on a gentle drift north from a solid but uneventful quarter. The best performers were the UK's FTSE 100 and the Chinese A50 traded on the Simex, the worst performer was the Nikkei 225. The RSI[2] applied to the main equity index future contracts showed a maximum at 57 for the FTSE 100 on August 16 and a minimum at 44 for the Nikkei 225 at the beginning of the quarter.

The VIX relaxed to surprisingly low levels following the Brexit surprise, with such lows only seen a handful of times in the past 25 years, while European index implied volatility similarly shook off the UK referendum result by mid to late July. The VNKY[3], meanwhile, remained at elevated levels until the Bank of Japan's surprise announcement to not boost JGB buying at the end of July. Equity implied volatilities were briefly lifted in September before falling once more at the end of the quarter. Risk weighted liquidity in the equity index sector fell slightly relative to the rest of the year, consistent with a lull in activity through the European and US summer months.

Equity index valuation measures, such as price to earnings, CAPE[4], price to book value and price to dividends show that the most expensive market is that of the US and has been for some time. It is interesting to ask if

1 The trender used here is defined as the sign (either +1 or -1) of the difference of a 50 day exponentially weighted moving average (EWMA) and a 100 day EWMA. This methodology remains general and is not explicitly used in any CFM product.

2 Defined according to https://en.wikipedia.org/wiki/Relative_strength_index using 100 day exponentially weighted moving averages. The RSI varies between 0 and 100 with 70 implying an instrument is overbought and 30 implying the instrument is oversold.

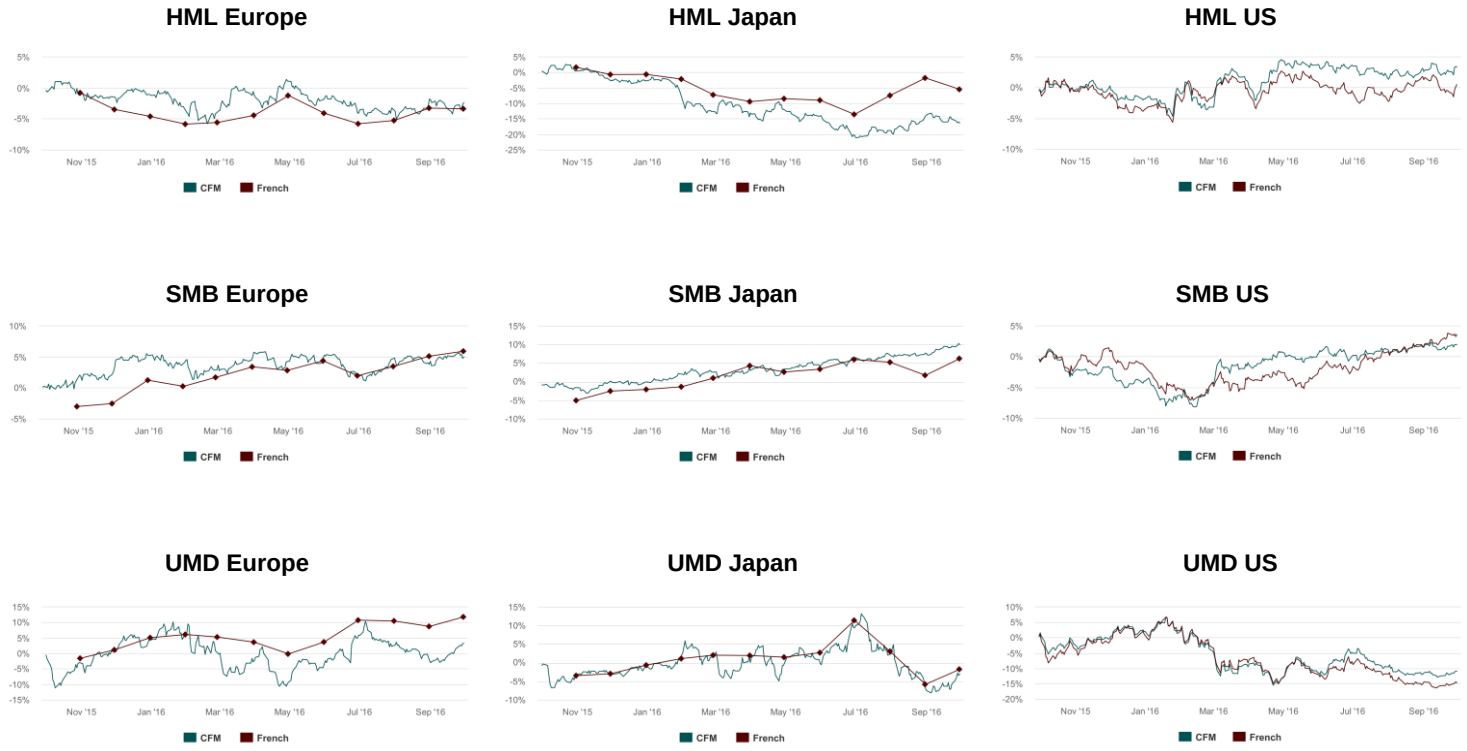
3 The VNKY is the Nikkei Stock Average Volatility Index, calculated using prices of Nikkei 225 futures and options on the Osaka Stock Exchange

4 CAPE is the Cyclically Adjusted Price to Earnings ratio as defined by Schiller http://www.econ.yale.edu/~shiller/data.htm Only US data comes from this site. For the other indices Global Financial Data is used http://www.globalfinancialdata.com

the market is as expensive as it was at the height of the tech bubble at the end of the last century. At that time, overvaluation was confined to a few sectors, in particular high-tech companies, with stocks from other sectors more reasonably priced. Today's valuations, on the other hand, seem to point to all sectors being expensive, with no particular outlier. Not only is the US stock market expensive but the median US stock is also running at record levels of leverage as a fraction of assets and/or total equity.

Stocks and factors

2016 has been a difficult year for many Equity Market Neutral (EMN) factors and our reproduction of the Fama French methodology[5] shows that UMD (EMN Momentum) has been a wild ride. Despite a brief uptick in performance in July, the rest of the quarter was back to business as normal with a sell-off through to quarter-end. Given the rally (or recovery) in equity markets in that period, it is perhaps not surprising that UMD suffered, a familiar pattern given the strategy's relationship with risk-on moves. The volatility of the UMD factor has also continued to be the most elevated of the factors through the year. EMN Value factors have generally performed better than momentum in 2016, a fact that may not be reflected in the performance of the HML Fama French factor which has fared little better than UMD. The SMB Fama French factor meanwhile has continued to perform well, small cap stocks continuing to outperform their more developed large cap peers, with a continued and persistent low level of volatility.

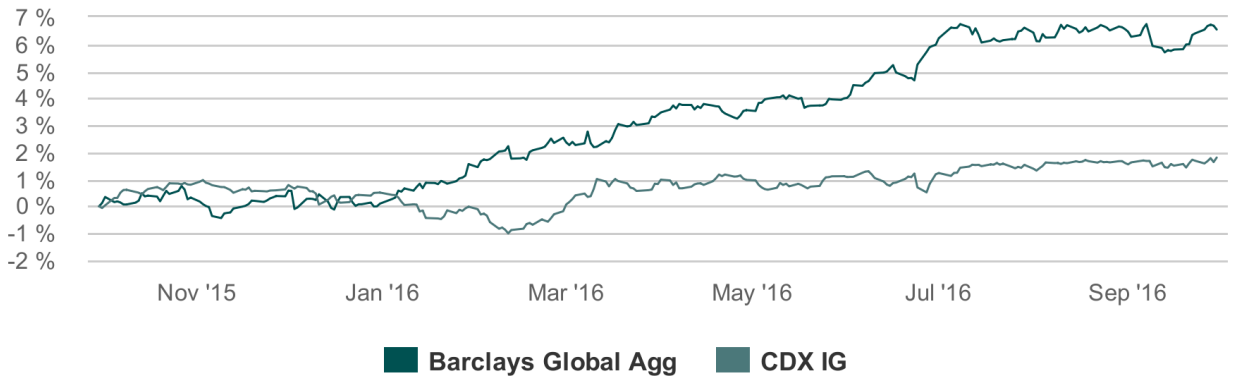


The Fama-French factors for the last year in the three geographical zones of Europe, Japan and the US. High Minus Low (HML) corresponds to a market neutral (MN) portfolio long the high book to price stocks and short the low book to price stocks. Small Minus Big (SMB) corresponds to a MN portfolio long the small market cap stocks and short the large market cap stocks. Up Minus Down (UMD) corresponds to a MN portfolio long the historical winners and short the historical losers. In each case, the red line is downloaded from Kenneth French's website, while the blue line is the CFM reproduction of the Fama-French portfolios. The methodology can be attributed to Eugene Fama and Kenneth French and is not explicitly used in any CFM product.

[5] We use a CFM version of the Fama French implementation for momentum (UMD), value (HML) and size (SMB) and have tested the convergence with the data from Kenneth French's website. We note that other implementations, notably from brokers, are broadly in line with our conclusions for momentum and value. We hope to soon include discussion of a generic quality factor in this publication. Research is ongoing in this direction

Fixed Income and Credit

Q3 was a positive quarter for bond holders with the Barclays Hedged Global Aggregate Bond Index returning 0.5%. In the US, attention quickly moved from Brexit back to anticipation of the Fed's next move, the implied market probability of a December rate hike moving from 0% at the beginning of the quarter to almost 60% following the September Federal Open Market Committee. The CFTC's Commitments of Traders (CoT) also showed a big move towards net short positioning for non-commercials in the Eurodollar. The 10-year treasury climbed from 1.47% to 1.59%[6] through the quarter with three officials dissenting at the September FOMC, favouring a 0.25% increase. The Bank of England's post-Brexit decision to reduce rates in August pushed Gilt yields lower while at the ECB's September meeting, Mario Draghi disappointed by stating that an extension to QE had not been discussed. Bund yields barely moved through Q3. JGBs experienced a sharp sell-off at the end of July after the Bank of Japan's plans to ease monetary policy disappointed investors who had put their hope in additional bond purchases. The September meeting saw volatile trading after the BoJ introduced an explicit target for the 10-year bond yield of around zero percent.



The return of the Barclays Hedged Global Aggregate Bond and the CDX Investment Grade indices for the last year.

The reversals in the US treasury and JGB markets proved difficult to navigate for the generic trender. The overall performance for bonds was positive with Gilts and Bunds providing most of the performance and the US 10-year being the biggest detractor. The maximum RSIs came from Gilts at 65 and the JGB at 66 on the 11 July in both cases. The lowest RSI also came from the JGB at 46 on the 9 August, following the collapse in the market after the BoJ's disappointing plans for further easing.

Implied volatilities in the fixed income markets fell following the Brexit vote and through Q3. Risk weighted liquidity fell during the northern hemisphere summer period and subsequently rose to levels consistent with the rest of the year in September. Liquidity conditions remain good in the interest rate sectors.

Following the bout of volatility subsequent to the Brexit vote, credit markets enjoyed a strong July and August with a weaker September, sterling credit outperformed while Euro and US dollar credit markets delivered similar levels of excess return. The sterling market was supported by the announcement of the Bank of England's corporate bond purchase program in August with purchases beginning in late September while the ongoing bond purchase activity of the ECB was also supportive.

[6] Generic 10 year yields as obtained from Bloomberg

Commodities

Commodities went sideward in Q3 with the energy heavy GSCI returning -2.6%. The CBOT complex of soybean, wheat and corn tumbled with favourable weather conditions in the US creating plentiful supply and pushing prices lower. Energy prices also fell, Brent crude was down 1.8% over the quarter, despite a September rally as OPEC looked to be getting closer to cutting a deal for an output cut. The details of the agreement are expected to be finalised at a further meeting in November. The correlation between Crude and the S&P 500 was stable at about 45%, having increased significantly in 2016. US Natural Gas futures rallied in Q3 due to strong demand for air conditioning and falling production. Precious metals fell slightly through the quarter, after having benefited from the flight-to-quality moves post-Brexit, while base metals increased slightly on mine closures and production cuts. Hog prices fell as livestock producers continued to increase supply with the US hog herd rising to be the largest on record.

The one year return of the S&P GSCI.

The generic trender applied to commodities gave the worst performance among the four sectors this quarter. The biggest detractor came from Brent and Crude, reversing the trend in July and reversing once more later in the quarter. According to the CoT report, speculative Crude sellers increased shorts up until mid-August then held stable positions up until the end of the quarter. Copper also proved a difficult market to navigate, ranging its way through Q3 with no clear direction. At the opposite end of the performance spectrum was Wheat, continuing its downward price trend from June all the way through the quarter and providing the lowest RSI score of 35 on the last day of Q3. The highest RSI was for Silver, the precious metal providing a score of 68 on the 7 July at the peak of the excess following the Brexit vote, prices reverted back through the remainder of the quarter. Corn CoT data showed non-commercials move from net long to short through the quarter. While the Soybean and Wheat data showed a similar pattern, moving towards shorter positioning, Soybean non-commercials stayed long while Wheat non-commercials stayed short.

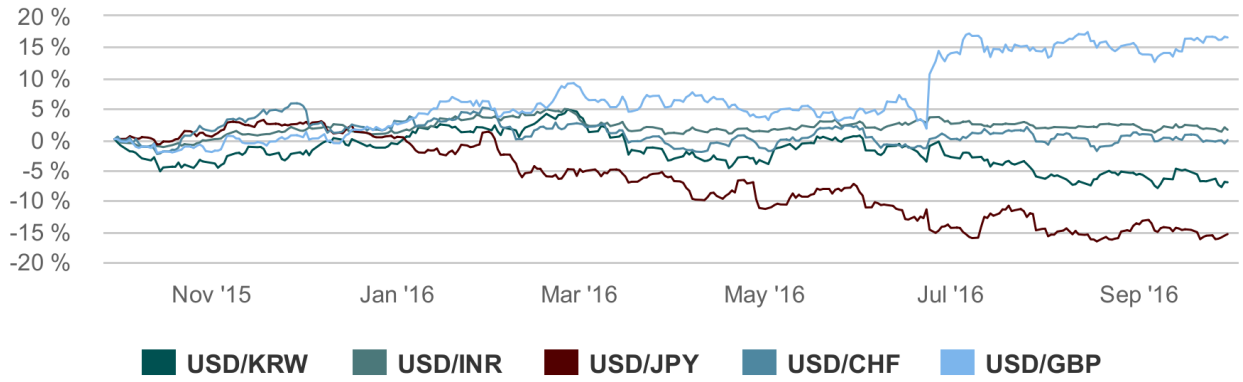
Implied volatilities remained subdued for Crude and Gold while the Grain markets had a rollercoaster ride, spiking in July and relaxing by quarter-end, with the summer uncertainty coming principally from a prolonged warm snap. Liquidity conditions in the commodity sector peaked mid-July and fell through to quarter-end.

FX

The dollar remained stable in Q3 with the DXY, a trade weighted dollar index, down 0.7%, the market's attention switched from Fed watching to forecasting the outcome of the upcoming presidential election. The correlation between the DXY and the MSCI World has flipped from 20% to -20% since the Brexit vote, representing a potential regime shift. The pound stabilised around a new post-Brexit level of 1.3 against the dollar and lost further ground against the Euro, with the Euro/GBP exchange rate falling 3.7% through the quarter. The CoT reports showed net non-commercial shorts reaching record levels in August. The BoJ created gyrations for the Japanese Yen, disappointing markets with their underwhelming monetary policies at the end of July and setting a target for 10-year yields at zero percent at the end of the quarter. The Korean Won was one of the best performers this quarter as S&P raised its rating for the country's debt, Fed chatter related uncertainty increased the Won's volatility in September but not enough to see the currency losing its Q3 gains.

The generic trender applied to FX saw slightly positive performance in Q3. The best performer was the Korean Won with the Indian Rupee coming in second. The worst performer was the Swiss Franc which reverted against the trend as European currencies strengthened against the dollar. The lowest RSI was for the British Pound, hitting 37 early in Q3 on the 8 July as the currency came out of its post-Brexit freefall. The highest RSI was for the Japanese Yen, hitting 64 on the 11 July, as the currency came to the end of its precipitous 2016 climb against the dollar.

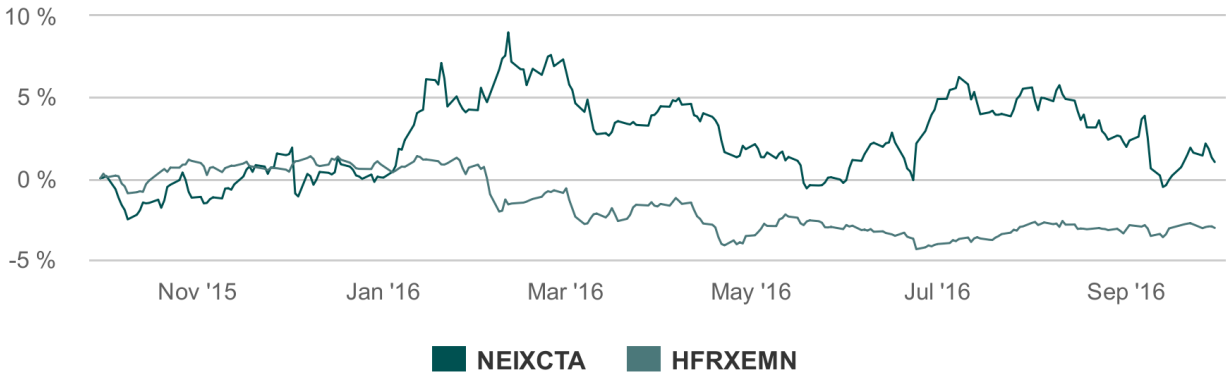
Implied volatilities were globally down from the Brexit spike at the end of June, in particular for European currencies. The British Pound reached an implied volatility of 28 points at its peak and by the end of Q3 had fallen to only 8.5 points. Japanese Yen implied volatility oscillated through Q3 with primarily BoJ generated volatility, reaching a high of 16 points and a low of 9 points by quarter-end. Liquidity conditions remain good in Q3, having fallen from the surge in activity post-Brexit and increasing once more in September.



The return of one US dollar measured in South Korean Won, Indian Rupee, Japanese Yen, Swiss Franc and the British pound for the past year.

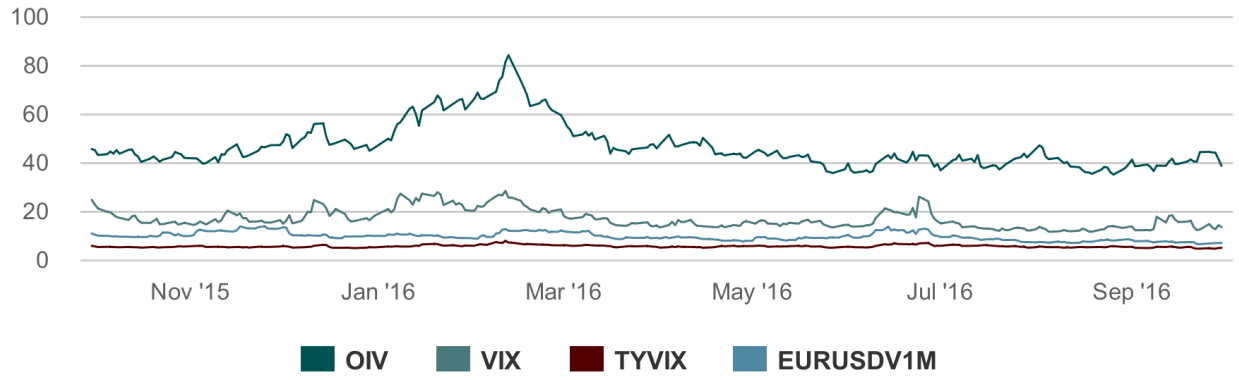
Alternative Industry Performance

Trend followers have continued to move sideward in 2016 with the Societe Generale CTA index[7] delivering -3.1% in Q3 and the YTD performance coming to 0.9%. Our generic trender, once corrected for manager fees and execution costs exhibits a similar pattern. Average absolute correlations between the tickers of the trend following universe fell slightly through Q3. Equity Market Neutral strategies have generally experienced a tough year in 2016, after having been among the best performers last year. The HFRX EMN index, nonetheless, delivered slightly positively in Q3 with a return of 1.1%, with a YTD return of -3.9%. Out of the spectrum of available HFRX indices the best performer in Q3 was the HFRX ED Distressed Restructuring Index with a return of 5.8% while the worst was the HFRX Macro/CTA Index with a return of -0.8%.

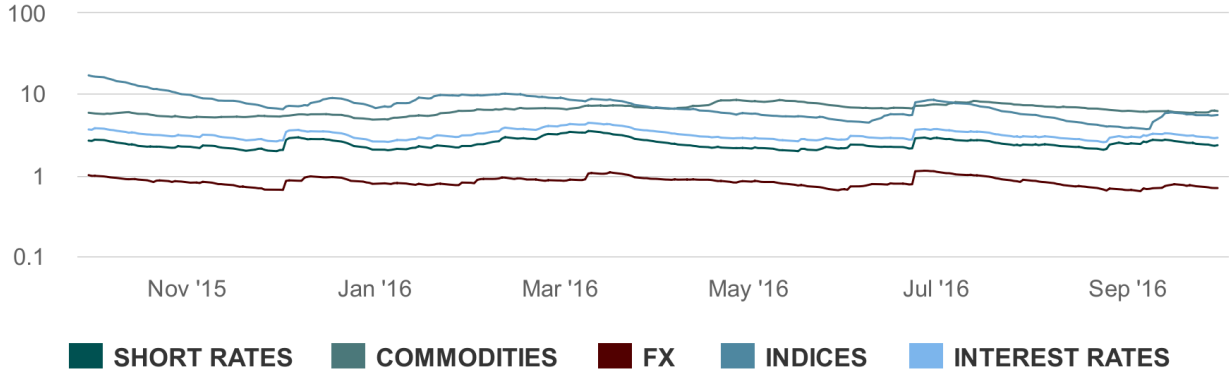


Total returns for equity market neutral (EMN) and CTA hedge fund indices over the past year. The EMN index is that calculated by HFR, while the CTA index is calculated by the Société Générale[7]

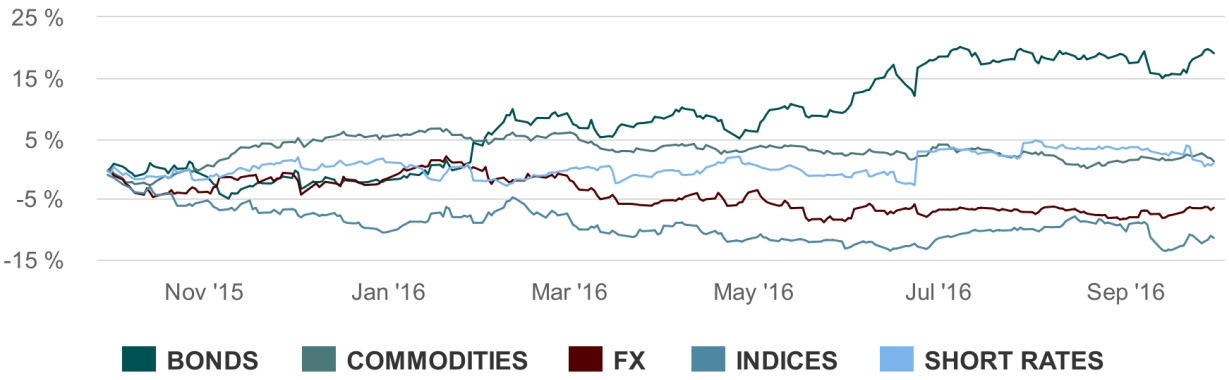
[7] https://cib.societegenerale.com/en/sg-prime-services-indices/



The principle implied volatility indices across the four asset classes over the past year. For the EUR/USD exchange rate we use the Bloomberg defined EURUSDV1M ticker; the TYVIX and VIX indices are both calculated and published by the CBOE, while the OIV index is published by the CBOE and NYMEX exchanges.



The log of the dollar risk weighted average daily volume across futures on the four asset classes over the past year. We estimate effective FX volumes to be a factor of 5-10 more than this due to the extra liquidity available through the spot markets.



The total return of the trender defined in the text over the past year.

Modelling Forward Looking Returns and Combining Traditional and Alternative Benchmarks

EXECUTIVE SUMMARY

Back-tests are frequently used to gauge the quality of an investment strategy or the usefulness of a particular instrument to a portfolio. These simulated results are however susceptible to many sources of bias. In this short note we discuss how best to estimate the future performance of a selection of traditional benchmarks together with one alternative benchmark, that of long term trend following, in order to guide us in allocating to non-traditional investments within a typical portfolio.

INTRODUCTION

The allocation of strategies and assets in a portfolio is a non-trivial task for investors. If we suppose we have a basket of investments from which to build our portfolio and we know which strategy gains the most, in order to maximize the total dollar gain we should allocate maximally to that best performer and even double up on the allocation through the use of leverage. This optimal solution is clearly absurd as one cannot know the future returns of strategies but shows to what extent a good estimate of future returns is important to allocation! Because of the inherent and necessary uncertainty of future returns a statistical approach is necessary in which, nonetheless, a knowledge of future returns is generally required as input to the problem before solving to obtain the maximum gain adjusted for risk – or Sharpe ratio.

Various optimization techniques exist which require not only strategy returns but also inter-strategy correlations and which can easily and significantly improve any number of in-sample back-tests. As any serious investor knows, however, improvements to strategies and the use of optimizers rarely lead to improvements in realized returns. Generally these techniques involve in-sample optimisation with returns and correlations that are known perfectly in-sample ie in the past, but which can change and evolve in the future. These in-sample quantities are thus biased and often poor estimators of future returns and correlations and therein lies the problem.

This white paper accompanies our work on biases in investing[8] and should serve as a guide to the techniques of getting (hopefully) robust estimates of future performance which can then be used in optimisation techniques (or simpler techniques, which are often even better!) to mitigate expectations and allocate to the best of one's ability to the investments available.

In this short note we begin with some examples of how traditional investments in equities and bonds can be deceptive with past performance a misleading estimator of the future. We next discuss some ideas on how to objectively evaluate the forward looking performance of such strategies. We then move on to the archetypal alternative benchmark of trend following on equity indices, bonds, commodities and FX before also tentatively touching on some of the equity market neutral (EMN) factors much popularised by the work of Kenneth French and Eugene Fama. We then attempt to build estimates of forward looking performance of each strategy before looking at the results of a combined portfolio of traditional investments with a long term trend following approach.

SOME CLASSIC PITFALLS ILLUSTRATED USING TRADITIONAL BENCHMARKS

The misleading assumption of the extrapolation of future returns from good past performance, or in-sample bias, is perhaps best illustrated with the example of long term interest rates in developed markets. From the late 1980s to today developed market central banks have steadily been gaining control over inflation and have been reducing interest rates accordingly in order to keep real interest rates at a level conducive to positive growth. The crisis of 2008 was particularly extreme and pushed central banks across developed markets to reduce rates to historical lows. With rates that low, central banks have had little room to manoeuvre requiring

[8] See, for example, our white paper "In-sample Overfitting – Avoiding the Pitfalls in Datamining", available on the CFM website

many to resort to further unconventional monetary policy to bring rates even lower than a zero rate. The rather spectacular performance of developed market bonds in this period is seen in Figure 1 and a naïve bond investor could easily be misled into thinking that rates of return from holding bonds are much better than is reasonable for a world where rates are now floored at zero. A fuller history of these bonds is also seen in Figure 1 and shows that the return characteristics are much more in line with a more modest Sharpe ratio. Expectations of bond returns need to be managed, therefore, with this example clearly demonstrating that past returns cannot be a good indicator of future returns due to the fact that yields cannot go too far below zero.

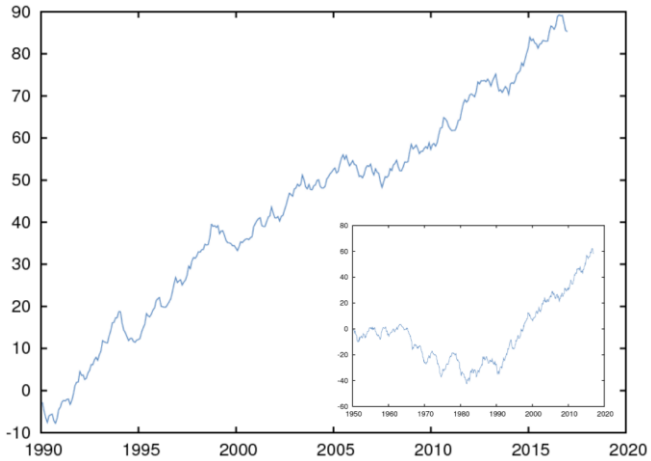


Figure 1: The performance of an equally weighted basket of 10-year sovereign debt from the following countries – US, UK, Australia, Canada, Switzerland, Japan and Germany. The inset plot shows the performance of these same bonds since 1950, illustrating that the post-1990 drift upwards is atypical.

Another topical example of unreasonable return expectations comes from developed market equity indices which have risen spectacularly since the 2008 financial crisis, again on the back of central bank interest rate cuts producing asset price inflation with an ever decreasing discount factor in the valuation of future cashflows from dividends and earnings. As the year 2008 becomes further relegated to history, investors are more and more inclined to extrapolate post 2008 performance into the future. In Figure 2 we plot the S&P 500 index since the 2008 financial crisis showing a spectacular surge in performance. However, if we open up the history further to include the period since 2000 we see that performance over the past 16 years has actually been somewhat more modest. As a new generation of investors comes to the market then the crash of 2008 becomes a historical relic of past Wall Street excesses and fades in the memories of investors. In order to evaluate the actual long term premium from holding equities one needs to go much further back in history. In Figure 2, below, we list the average volatilities and returns for a range of equity index markets across the world. This is a much better indication of what equity markets have in store and is taken as an estimate of future returns in what follows.

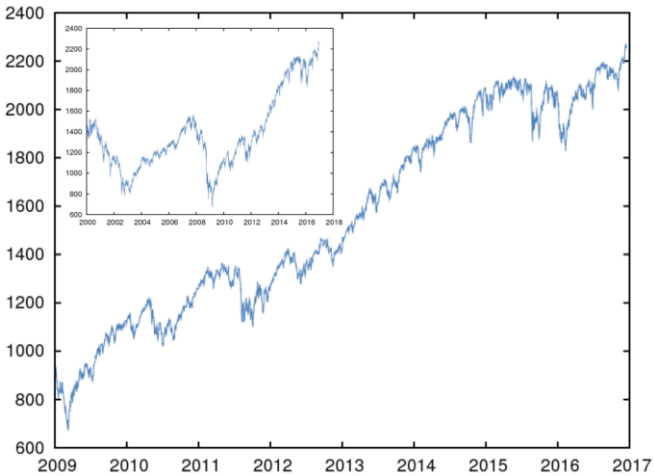


Figure 2: The S&P 500 index following the 2008 global financial crisis. The inset plot shows a zoom out of the index since 2000 illustrating that the post-2009 period is atypical.

Another source of overoptimistic performance expectations comes from survivorship bias. This is a strong

effect that arises from inadvertently selecting winners from a data-base where the losers are either absent or penalised in the filtering of the data. For example, selecting investment managers from a data-base gives a biased optimistic view of fund performance due to the fact that managers don't necessarily report funds that have underperformed and conversely will be more likely to quickly report an outperforming fund. A more commonplace example can be seen in the stock market, investors can be blinded by the performance of success story stocks such as Apple, Amazon and Google as shown in Figure 3. When viewed in isolation investors confuse the performance of these outperformers as being reflective of the performance of the stock market as a whole which can induce a false sense of security that the potential upside for stocks is bigger than that of a portfolio chosen without these glitzy stocks. This is often also true of the real estate market in certain parts of the world that give residents of such places an inflated opinion of the future return potential of real estate.

Figure 3: Apple, Amazon and Google stocks traded in the US over a recent history. These stocks are well known outliers and can give investors and false sense of comfort that stock picking and investing is easy!

A RECIPE FOR GETTING ESTIMATES OF FORWARD LOOKING PERFORMANCE

Our objective estimates for forward looking performance depend on whether we are considering an instrument that has clearly defined future cashflows, and if not then we attempt to gauge future performance being guided by back-tests and attempting to garner as much information as possible regarding the in-sample bias of these simulated results.

Fixed Income instruments have very clearly defined future cashflows that can be valued according to the yield curve. One can also convert the price of the instrument into a yield – given an investment of $1, how much would a bond yield from now until maturity. If interest rates do go down, as they did through the nineties and noughties then a bond holder makes money. However, an objective expectation for return should assume that rates stay where they are today and therefore the yield to maturity for a fixed income interest is a good objective measure of forward looking return. This yield should then have the risk free rate removed from it to give an estimate of excess return. The volatility for these bonds is based on an analysis of the historical time-series.

The above logic for fixed income instruments also applies to corporate debt with the exception that one also has to consider the possibility of default. The yield to maturity of a bond assumes that the coupons and principal get paid back at the end of the life of the bond and does not account for the possibility of a government or company defaulting on the payments. If the issuing entity looks likely to default then the price of the bond goes down and the yield goes up in order to entice people in to buy the bond with a higher return but with a higher probability of loss from default. The yield therefore contains some Risk Premium, or an extra yield boost that compensates the bond holder for this possibility of default. Averaging over a basket of bonds, therefore, one should not receive the advertised yield but instead we need to discount for the loss incurred, on average, from default. In order to get an estimate of this expected loss we have calculated an average historical break even credit spread (the fair price of the insurance in a CDS without the extra premium for the risk) which is added to the corresponding risk free sovereign debt for the tenor of the corporate bonds. The volatility for the bond index is again based on a historical measure.

For equity indices we cannot employ the same logic, as equities do not pay out with a fixed schedule of dividends and earnings can be retained in the company. The market does indeed quote earnings and dividend

yields but these are not instructive in the same way due to the inherent uncertainty and ambiguous nature of the cashflow to a shareholder, which can be distributed as dividends and buy backs or simply retained on the balance sheet. In order to address the problem of future return estimates therefore we instead focus on averaging the past performance of equity indices across geographical zones and across time, covering many economic cycles in order to get as unbiased an estimate possible of what equity indices actually deliver to investors. The results of this study[9] are seen in Table 1 and the average annualised excess return of stock indices was estimated to be ~5%.

Country	Start date	Risk Premium (%/y)	Vol. (%/y)
Australia	1983	4.77	16.7
Canada	1934	4.44	14.8
Germany	1870	4.23	19.6
France	1898	6.65	19.7
Finland	1970	8.09	23.1
Italy	1925	6.24	26.6
Hong Kong	1996	5.24	26.1
Hungary	1999	2.51	24.7
India	1988	13.6	30.3
Indonesia	2009	13.8	20.4
Japan	1980	2.04	18.7
South Korea	2000	9.33	24.3
Malaysia	1974	6.32	28.2
Mexico	2001	10.1	18.2
The Netherlands	1957	4.57	16.9
New Zealand	1984	3.02	17.8
Norway	1969	5.21	24.3
Philippines	1996	-1.96	26.6
Poland	1999	2.29	23.3
Singapore	1973	7.51	24.7
South Africa	1983	5.26	20.4
Spain	1948	5.25	18.3
Sweden	1960	6.69	17.1
Switzerland	1966	4.58	15.6
Thailand	1997	5.25	35.1
United Kingdom	1958	5.71	18.8
United States	1871	5.33	15.2

Table 1: The result of our study of the Equity Risk Premium using stock markets from a range of different countries

ALTERNATIVE BENCHMARKS – TREND FOLLOWING AS A CLASSIC EXAMPLE

Alternative investment has recently become commoditized with the availability of alternative benchmark strategies at low fee levels and with high levels of manager transparency. We begin with the archetypal alternative benchmark – Long Term Trend Following. We have previously presented a study of trend following over a period of 200 years[10] using equity indices, bonds, commodities and FX and found a remarkably stable effect that has persisted with a high level of statistical significance. In Figure 4 we show the key result from the study. This same research varied the timescale of the trend and noted the sensitivity of the Sharpe ratio to this variation, the observation being that performance varies little out to trends of about a year with Sharpe ratios that remain at about 0.8 for such slow timescales. This is definitely a positive point for the robustness of the strategy that changing the parameters makes little difference to the performance. Positioning ourselves at slow trend timescales then has the advantage of being relatively insensitive to costs, and with a simple conservative analysis we can deduct 0.3 from the Sharpe ratio as an estimate of realistic performance expectations[11].

[9] See our academic paper, "Risk Premia: Asymmetric Tail Risks and Excess Returns", available on the CFM website

[10] See our academic paper, "Two centuries of Trend Following", available on the CFM website

[11] The Trend Following strategy used in the study is generic and is not employed in any program at CFM

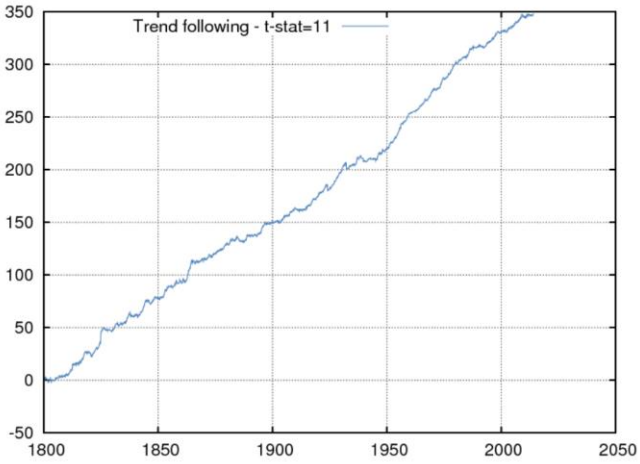


Figure 4: A plain vanilla Trend Following strategy applied to equity indices, bonds, FX and commodities over 200 years of data. The resulting performance is highly statistically significant

This research is interesting indeed but we can also complement these results with the observation of a successful CTA industry that has experienced excess returns with an approach based predominantly on trend following[12] showing that these results are not in-sample artefacts of over-fitting. The study applying the trend to 200 years of data is also out-of-sample in the sense that this extra data had not been observed and used to tune the parameters of the trend following approach.

It is this style of reasoning that helps us to establish that a particular strategy has a chance of delivering performance in the future, which is of course what every investor is trying to achieve. The strategy is slow enough to be insensitive to costs and has sufficient independent out-of-sample tests to give us confidence in its robustness. The EMN factors first described by Fama, French and Carhart are also examples of strategies that are slow, insensitive to parameters, have earnt money for the industry and have been tested with data not used by the initial study. The original work was completed in 1993 and therefore significant forward looking performance tests are available. We will not dwell on these equity factors, however, as these factors have more "moving parts" than a long term trend approach but EMN momentum and value are good alternative benchmark candidates for the reasons cited.

EXPECTED EXCESS RETURNS FOR A SET OF BENCHMARKS

We now have some tools and ideas to give us a feel of what to expect from a few benchmark strategies. We have chosen developed and emerging market equities and sovereign debt, European and US corporate bonds and long term trend following. In the below we detail what we believe to be the most objective and agnostic estimates of the future looking returns.

- Developed market (DM) equities: we feel the best estimate of equity returns comes from the above cross sectional study of the excess returns of equity indices across historical periods and across countries (see Table 1 above). The returns across countries are in a range of 3-9% for a volatility of ~15%
- Emerging market (EM) equities: we use the same estimate of equity returns as seen for DM equities but with a higher estimate of volatility
- Developed market (DM) sovereign bonds: the proposed excess return is based on the current 10-year yield to maturity (over risk free rate) with a volatility expectation in line with historical measurements using bond prices in developed countries[13]
- US corporates: Based on a historical study of credit spreads, the return for High Yield (HY) corporate credit is taken as the sum of the 5 year risk free rate (the sovereign yield at 5 years) and half of the current spread of the corresponding credit index. Investment Grade (IG) corporate bonds do not seem to lose much yield due to default and the same historical analysis shows that one can use the full corresponding credit index spread. In each case the excess return is calculated over the risk free rate. The volatilities are based on historical analyses of total return indices and found to be 7.7% for High

[12] We can model CTA indices obtaining correlations of more than 85% with trend following approaches with a Sharpe ratio which is comparable to the index after accounting for costs and manager fees

[13] We are using excess returns of 10-year bonds in the following countries: US, Germany, Japan, UK

Yield and 3.3% for Investment Grade bonds.

- Cash: Yields zero with an assumed volatility of zero
- Long Term Trend Following: We estimate the forward looking Sharpe ratio to be 0.5. This comes from an analysis of the performance of the CTA industry using manager data-bases and CTA indices. We are also guided by including a conservative estimate of costs into a two century back-test which exhibits a stable long term performance. We assume a volatility of 10% as being a typical volatility offered by a trend follower and thus have an expected excess return of 5%.

This is summarised below in table form[14] for each of the asset classes where we show our preliminary picture of a traditional 60/40 portfolio. Trend following is also included, albeit with zero weight for the moment.

Component	Weights	Excess Return	Annual Volatility
Developed Market (DM) Sovereign Bonds	25%	0.9%	6%
US IG Credit	5%	1.7%	3.3%
US HY Credit	5%	1.6%	7.7%
Cash	5%	0%	0%
Global DM equities	30%	5.3%	15%
Emerging Market (EM) equities	30%	5.3%	20%
Trend Following	0%	5%	10%

We can simplify the traditional basket of instruments by grouping categories together to give the below for our 60/40 portfolio. We assume a 100% correlation between DM and EM equities and between HY and IG credit.

Broad category	Weight	Return over RfR	Volatility
DM Bonds	25%	0.9%	6%
US Credit	10%	1.6%	5.5%
Money market	5%	0%	0%
Equities	60%	5.3%	17.5%

A SIMPLIFIED CORRELATION STRUCTURE

In order to obtain the expected return of a portfolio of instruments one needs to assume a correlation structure across these broad asset class categories. We suggest the correlation structure below, where we maintain strong and significant correlations and set others to zero. Note that the true level of correlation between cash and bonds is irrelevant, given their weak volatility there is little effect on the result.

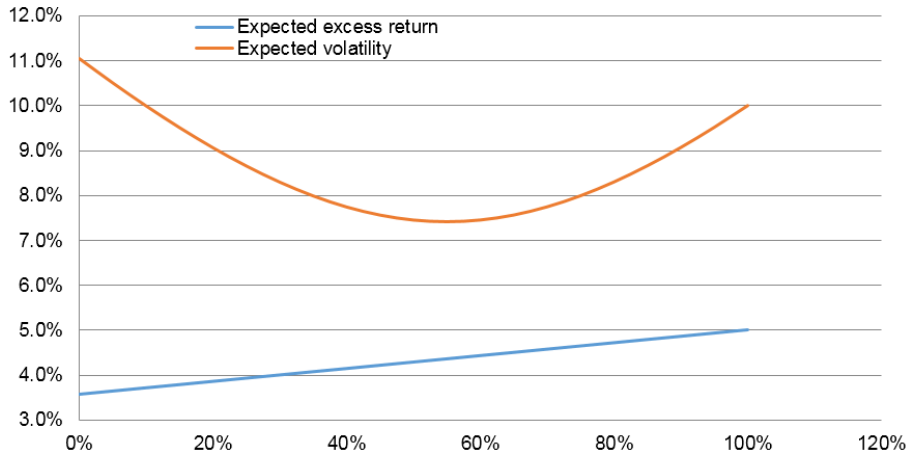
	DM Bonds	US Credit	Money market	Equities	Trend Following
DM Bonds	1	0	0	0	0
US Credit	0	1	0	0.8	0
Money market	0	0	1	0	0
Equities	0	0.8	0	1	0
Trend Following	0	0	0	0	1

[14] All yields are as of December 2016

RETURN AND VOLATILITY FOR THE TRADITIONAL PORTFOLIO WITH/WITHOUT TREND FOLLOWING

Just considering the traditional portfolio we can now combine the above hypotheses (return and volatility for the portfolio's components as well as the correlation structure[15]) to obtain an expected excess return of 3.6% over the risk free rate with an expected volatility of 11%.

This traditional portfolio can now also be combined with trend following. Rather than making a choice on the amount of weight we allocate to trend following we prefer to give results for the range of weights from zero to one. The below figure shows how the expected return and volatility varies as a function of the weight allocated to a trend following approach.



As we can see, with the reasonable hypotheses of future returns, we can improve the outlook for the traditional portfolio by combining with long term trend following. There is a mechanical improvement due to the fact that trend following has a higher Sharpe ratio than the traditional portfolio and is zero correlated with it. This would be the case for any such strategy with the same risk/return characteristics. This leads to an improvement in risk adjusted returns for the traditional portfolio along with a reduction of expected drawdowns. The maximum Sharpe ratio is achieved with an approximately 60% allocation to Trend Following, improving the objective return expectation of the traditional portfolio from 3.6% to 4.5% while reducing its volatility from 11% to 7.5%.

CONCLUSIONS

We have presented realistic expectations of future excess returns for a range of traditional strategies together with realistic correlations in order to get a corresponding estimate of future excess return and volatility for the combined portfolio. We then combine the traditional benchmark with a trend following approach, again with realistic expectations of future excess returns, in order to see the effect of combining such a strategy with the benchmark portfolio. These excess returns are also agnostic to base currencies as a hedged position will deliver the same excess return in a different currency. Getting a handle on these realistic return expectations is crucial in being able to allocate across strategies and is often overlooked (mostly unknowingly) in favour of a biased view based on often over-fitted back-tests.

[15] Volatility depends on the category weights W_i and cross category correlations C_{ij}: $\sigma = \sqrt{\sum_{j=1}^{K}\sum_{i=1}^{K} W_i . W_j . C_{ij}}$

Agnostic Risk Parity: Taming Known and Unknown-Unknowns

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Diversification is the mantra of rational investment strategies. Harry Markowitz proposed a mathematical incarnation of that mantra which is common lore in the professional world. Unfortunately, the practical implementation of Markowitz's ideas generally fails to deliver out-of-sample diversification. In recent years, several solutions have been proposed to address this shortcoming, by adding to the standard risk-return objective function some extra penalty terms that enforce diversification. This has led to important breakthroughs, such as the concept of "Maximally Diversified Portfolios".

Although interesting, there is a hidden assumption in these penalty terms, which is the choice of the assets one considers as "fundamental". The point is that a maximally diversified portfolio for one asset basis can in fact become maximally concentrated in another! In other words, the very concept of maximal diversification is not invariant under a redefinition of the assets considered as "fundamental". Our approach is based on symmetry arguments, leading to portfolios that achieve equal realized risk on all the principal components of the covariance matrix. Our central formula, which generalizes Markowitz's, reads:

$$\pi \propto C^{-1/2} Q^{-1/2} p$$

Where the πs are the portfolio weights, p the predictors of future returns, and C and Q are, respectively, the covariance matrices of the returns and the predictors.

Now, the naïve choice for the indicator covariance matrix Q should be proportional to the return covariance matrix itself, ie Q ∝ C. In a stationary world where the indicators really statistically predict future returns, this assumption would be natural, and recovers exactly the standard Markowitz optimal portfolio: $\pi \propto C^{-1} p$. However, this is a highly over-optimistic view of the world that only deals with "known unknowns". The most agnostic choice, less prone to unknown unknowns, is to choose $Q \propto \mathbb{I}$, ie no reliable correlations between the realized predictions, and the same amount of predictability (or expected Sharpe ratio) on all assets. This leads to our "Agnostic Risk Parity" (ARP) portfolio, which minimizes unknown-unknown risks generated by over-optimistic hedging of the different bets. We found that in practice such an allocation significantly over-performs Markowitz's portfolios when applied to classic technical (CTA style) strategies, such as (universal) trend following.

Other News

- An ongoing research project to build a database of publically available equity factor data is in progress; this data will be used in future Alternative Beta Matters reports
- The CFM Foundation for Research has committed to funding a new research chair at the Ecole Normale Supérieure (ENS) in Paris. This new research chair is dedicated to “modelling and data sciences”, working through a collaboration between the departments of Biology, Economics, Computer Science, Geophysics, Mathematics, Physics, Cognitive Sciences and several branches of Humanities and Social Sciences. The aim is to create a close link between the complex system models developed in each discipline and the mathematical models derived from the data analysis. The team will focus on improving the understanding of algorithms whose use is becoming more widespread across a range of important fields from healthcare to robotics.
- Our paper, “Price impact without order book: A study of the OTC credit index market”, has been submitted to Market Microstructure and Liquidity
- Our paper, “Dissecting cross-impact on stock markets: An empirical analysis”, has been accepted by the Journal of Statistical Mechanics
- Our paper, “Cleaning Large Correlation Matrices: Tools from Random Matrix Theory”, has been accepted by Physics Reports

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