



1 May 2019

ALTERNATIVE BETA MATTERS

Quarterly Newsletter - Q2 2019

Introduction

Welcome to CFM's Alternative Beta Matters Quarterly Newsletter.

Within this report we recap major developments in the Alternative Industry, together with a brief overview of Equity, Fixed Income/Credit, FX and Commodity markets as well as Trading Regulations and Data Science and Machine Learning news. All discussion is agnostic to particular approaches or techniques, and where alternative benchmark strategy results are presented, the exact methodology used is given. It also features our 'CFM Talks To' segment, an interview series in which we discuss topical issues with thought leaders from academia, the finance industry, and beyond.

We have included an extended academic abstract from a paper published during the quarter, and one white paper. 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.

Contact details



Call us +33 1 49 49 59 49

Email us cfm@cfm.fr

CONTENTS

3

Quarterly review

11

Extended abstract

How should you discount your
backtest PnL?

12

CFM Talks To

Professor Johannes Muhle-Karbe
Director of the CFM-Imperial Institute
of Quantitative Finance

15

Other news

16

Whitepaper

Packed in like sardines: how
crowding in trade flows can adversely
affect execution costs

Quarterly review

Quantitative overview of key developments in Q1 2019

Alternative industry performance

A distinct V-shaped recovery was observed in global equity markets during the first quarter of 2019. An even-handed outcome to trade negotiations in sight; central banks rotating to become more dovish; slowdown worries in economic growth turning less acute; and companies engaging in a record amount of buy-backs all contributed to a 13.1% rally by the S&P500 (+13.7% for the total return variant). This after suffering a slump of 14% in Q4 2018.

Alternative managers enjoyed an equally welcome rally, with the HFRX Global Hedge Fund Index gaining 2.6%, with typically high beta strategies such as Equity Hedge (+6%) and Relative Value Arbitrage (+2.6%) doing best. Within the stable of HFRX indices, Emerging Markets Composite underperformed, dropping -1.6%. The HFRX Equity Market Neutral Index chalked up a fifth consecutive negative monthly performance, ending the quarter slightly down (-0.6%). Within alternative risk premia, performance was largely positive, with the Société Générale Multi Alternative Risk Premia Index¹ finishing 3.2% higher.

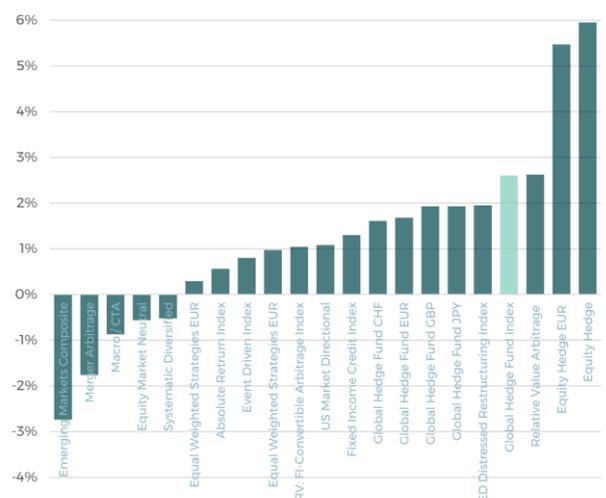
The hedge funds industry saw assets rise to \$3.2 trillion in Q1, largely thanks to the good performance, and, increased despite \$10.7 billion in redemptions.

Commodity Trading Advisors (CTAs) endured a challenging 2018, a year which was marked by abrupt market volatility. In the final quarter of 2018, however, CTAs performed better relative to the market, with correlation to the S&P 500 dipping into negative territory (and increasing steadily until mid-March). CTAs benefited from the rally in both equity and bond prices (and, also, the continued upwards swing in energy contracts) with the Société Générale CTA² Index posting positive, yet lower returns relative to the market. The index, notwithstanding the first weeks of January as CTAs grappled with a severe market reversal (on short positioning coming into 2019) as

global markets rallied, rounded off the first quarter of 2019 with a 1.9% gain. The Barclay CTA Index³ (~1.50% over the quarter) registered similar performance.

The average absolute correlation between futures contracts, often taken as an indicator of CTAs' ability to diversify, continued to trend up from Q4 2018, and reached 17% at the end of May. The correlation between bonds and equities (with the US 10-year and mini S&P 500 taken as proxies) has remained negative, and increased from ~25% to ~30%. Meanwhile, the correlation between the MSCI World and Emerging Market indices fell slightly, to approximately 76%.

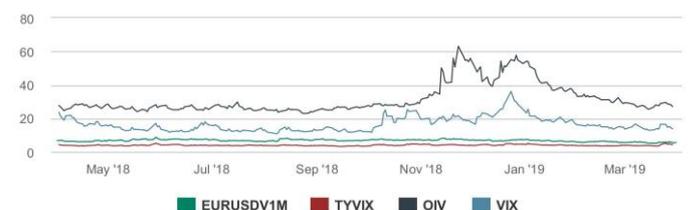
HFRX Indices quarter performance



Total return for Equity Market Neutral (EMN) and CTA hedge fund indices over the past year⁴



The principal implied volatility indices across four asset classes over the past year⁵



¹ The Société Générale Multi Alternative Risk Premia index is an equal-weighted index of funds, capturing the returns of managers employing multi risk premia investment strategies across multiple asset classes.

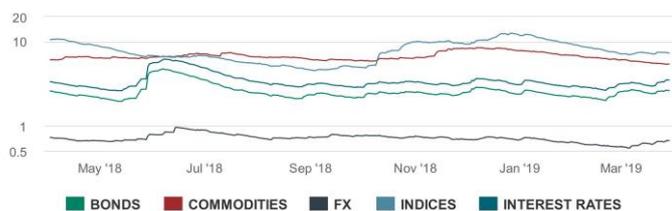
² The Société Générale CTA index is an equal-weighted index of the twenty largest (as measured by assets under management) trend following CTAs, who are recognised as such within the industry and are open to new investment. For construction methodology and a full list of constituents, see: <https://cib.societegenerale.com/en/prime-services-indices/>

³ The BarclayHedge CTA Index provides monthly performance data for a large selection of managed future managers, going back to 1980. Constituents and methodology can be obtained on the BarclayHedge website: <https://www.barcleyhedge.com/research/indices/btop/>

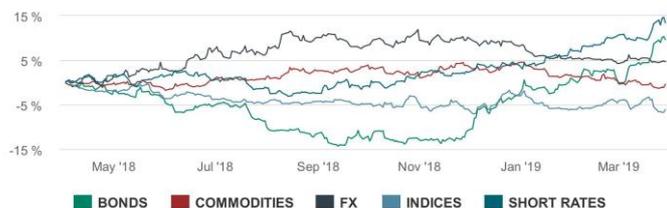
⁴ The EMN index is that calculated by HFR, while the CTA index is calculated by Société Générale

⁵ For the EUR/USD exchange rate we use the Bloomberg defined EURUSDV1M ticker. The VIX, TYVIX, and OIV indices are calculated and published by the CBOE

The log of the dollar risk weighted average daily volume across futures on the four asset classes over the past year⁶



The return of the generic trender⁷ referenced in the text over the past year



Equity indices

The New Year started with renewed risk appetite, as concerns that acted as a drag on performance in Q4 2018 dissipated. Some popular indicators pointed to a bullish sentiment, such as the Dow Jones Transportation Average which gained 13.5% in Q1. The index, a price-weighted average of 20 transportation stocks, is often used as a short hand reflection of the expectation of economic activity in the US. Global developed markets enjoyed one of the best quarterly performances since Q3 2010, with the MSCI World Index posting an 11.9% gain. Developing nations performed nearly as well, with the sister MSCI Emerging Market Index gaining 9.6%. These markets were particularly boosted by Chinese equities, which, after a dismal 2018, rebounded in dramatic fashion as the FTSE China A50 index gained nearly 30%. It was as such the most overbought index, with the highest Relative Strength Index (RSI)⁸ of 61 points on March 5. The S&P 400 Mid-cap index, however, had the lowest RSI of 37 points, right at the start of the month on January 4.

In the US, the S&P 500 surged 13.1%, helped in particular by the Information Technology sector which performed best, outpacing the broad index by 6.3%. As such, the technology packed NASDAQ 100 Index notched up an impressive 16.6% gain. Nevertheless, performance was

broad-based, with all industries of the S&P 500 showing positive performance, with the number of constituents of the S&P 500 that reached a 4-week high having consistently exceeded those that reached a 4-week low (83% of the time in Q1). The strongest returns were booked in January, with investors, subsequent to the Federal Reserve's (Fed) FOMC meeting in March, digesting the overtly dovish tone as worrying for sustained growth (the Fed also lowered economic growth forecasts). While still positive, returns in March were a much more modest 1.8%.

The rally in US (and global) equity markets, nevertheless, was likely more the result of lower real interest rates and central banks' about turn (see Fixed Income section), than expectations of higher company earnings. Earnings data shows that the S&P 500, for example, registered a -3.9% decline in earnings growth in Q1, with analysts lowering EPS estimates by 7.2%.⁹

European equity markets also booked good returns, with the Eurostoxx 50 up by 9.4% in Q1. Returns were slightly more subdued in Europe, with the health of the German economy weighing on investors' sentiment. Key German macro indicators are pointing to a slowdown in economic activity, as the Markit Manufacturing PMI registered an eighth month of consecutive declines in March, printing 44.1 – well below the threshold of 50 (the threshold above which indicates expansion), and the most recent high of 63.3 of December 2017. The Dax, as such, underperformed and gained 7% (and exhibited slightly higher levels of volatility: the VIX¹⁰ implied volatility index averaged 17 points against the 15.5 points of the V2X index of the Eurostoxx 50). The Dax index also featured slightly more intraday volatility when compared to the S&P 500 for example, with 14 out of 62 trading days (23%) during the quarter where daily returns exceeded $\pm 1\%$. The S&P 500 index only had 11 (or 18%) out of the 60 trading days where returns exceeded the same thresholds. Meanwhile, the FTSE All Share Index, despite being battered by lingering Brexit uncertainty, rose 10.3%.

Australian stocks fared particularly well, with the S&P/ASX 200 benchmark index gaining 10.3% over the quarter. The Australian benchmark index is heavily represented by energy, material, and industrial securities – constituting 37% of the total market capitalisation of the index (1.9 trillion AUD as of the end of March). As commodities picked up, these sectors rallied and outperformed the broader index, with the average return of 16% of the

⁶ 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

⁷ Our generic trender is calculated as laid out in our 'Two centuries of trend following' paper, which is available on our website: <https://www.cfm.fr/insights/two-centuries-of-trend-following>. The trend signal is calculated as the difference of the last price and an exponential moving average of the past 5 months' prices, divided by the volatility: $S_n(t) = \frac{p(t) - \langle p \rangle_{n-1}}{\sigma_n(t-1)}$. The instruments are equally risk weighted in the portfolio

⁸ Defined according to <https://www.investopedia.com/terms/r/rsi.asp>. The RSI varies between 0 and 100 with 70 implying an instrument is overbought and 30 implying the instrument is oversold.

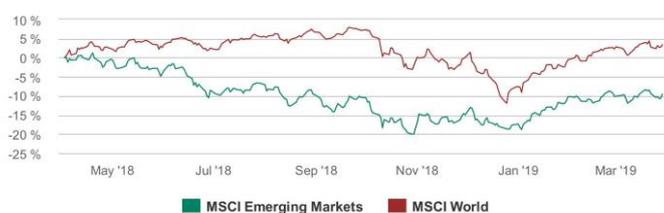
⁹ Data from the Factset Earnings Insight Report, March 29, 2019.

¹⁰ The VIX and V2X are the implied volatility measures of the Deutsche Börse DAX and Eurostoxx 50 indices respectively. The indices computes the square root of implied variance across at- and out-of-the-money options traded on the respective indices. These implied volatility indices indicate, as such, an expectation of realised volatility of the underlying index in 30 days.

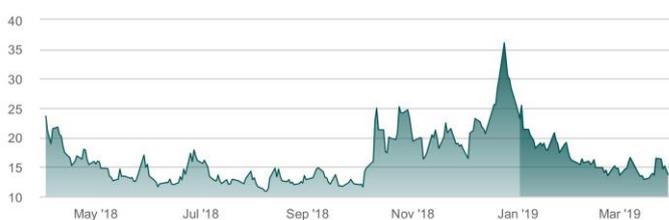
Energy sector second only to the Information Technology sector. As a result, when applying our generic trender signal,¹¹ it was the Australian index that performed best in Q1. Staying in Asia-Pacific, the Nikkei, the Japanese index typically sensitive to global disruption in trade, was sent from pillar to post as investors tried to ascertain the narrative of the trade negotiations playing out between Washington and Beijing. The Nikkei 225, notwithstanding a 5.6% gain in Q1, was one of the worst performers among international bourses, and also the worst index with our generic trender applied.

Volatility was muted, with the CBOE VIX index drifting lower throughout the period, and ending at 13.7 points, 10 points lower than at the start of 2019. Realised 10, 30, and 50-day volatilities of the S&P 500 all trended lower, with all measures reaching their lowest levels since September of 2018. Meanwhile, the CBOE Skew index, a widely tracked measure to gauge investors' sensitivity to skew risk, *i.e.* the likelihood of large 'outlier' returns in the S&P 500, drifted largely sideways (after an initial spike during the beginning of the year when markets lurched).¹²

The return of the MSCI World and the MSCI Emerging Markets indices for the past year



CBOE VIX index



Stocks and equity factors

Factor-based investment strategies withstood a slightly negative quarter, with the HFRX Equity Market Neutral Index (HFRXEMN) down -0.6%. During a poor 2018, culminating in four consecutive monthly returns, the strategy came under increasing scrutiny, with investors

questioning its efficacy as an uncorrelated strategy. While industry commentators hastily laid the blame on 'crowding', *i.e.* too many investors chasing the same risk premia (owing, some claim, to the rise of factor-based investment strategies), as a firm we have been unable to detect such effects¹³. As of the end of 2018, the HFRXEMN Index has remained, since inception, the only strategy amongst other major alternative hedge fund styles having provided positive returns in both bull (+0.63%) and bear (+0.06%) markets since inception.

Overall, performance in both the US and Europe was comparably consistent with low volatility and value securities performing best and worst respectively in both regions. In Japan, however, it was low volatility stocks that underperformed, with the quality factor that fared best.

Looking at long only implementations of factors, the MSCI World Quality Index performed best over Q1, gaining 15.7%. The MSCI World Growth Index, like other similar growth indices, are dominated by high performing technology stocks. With Information Technology stocks again outshining other sectors in Q1, the MSCI Growth Index ranked second only after the Quality Index, gaining 14.8%. Growth indices, owing to this heavy tech component, have continued to outperform Value indices, typically carrying a large weighting in securities in the Financials sector. Financials were under pressure due to the prospect of a low interest rate environment to persist well into 2019, and, likely into 2020. As a result, the MSCI World Value Index performed worst amongst the key risk premia styles – but still positively: gaining 10.2%. The MSCI World Momentum Index, a beneficiary of the spurt in most global markets, was just behind quality and growth, gaining 13.1%.

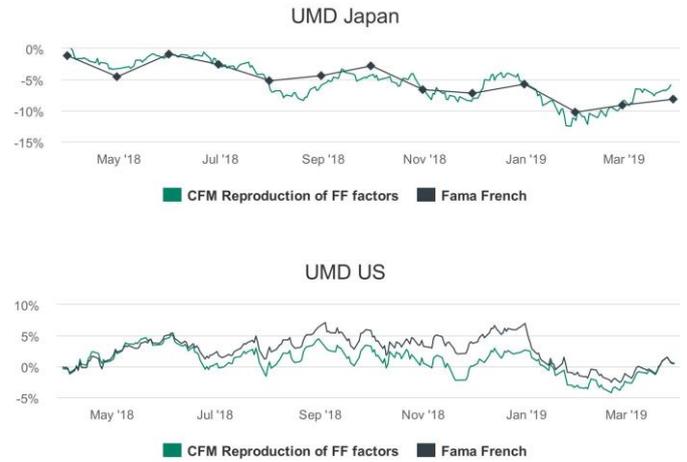
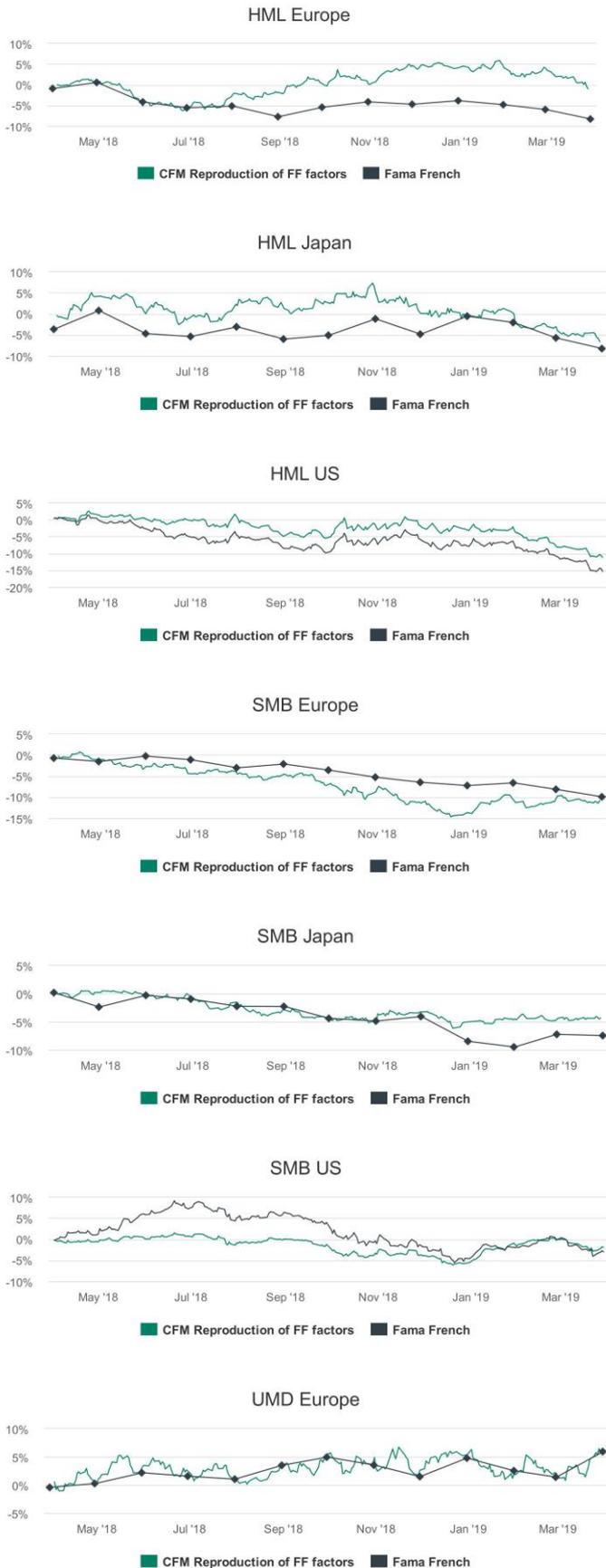
In a reproduction of the Fama-French-Carhart factors, European small-cap equities eclipsed those in the US, with the Small Minus Big (SMB), or Size factor, delivering positive performance throughout Q1 in that region. Japanese small-caps, meanwhile, drifted sideways. In the High Minus Low (HML) factor, all regions lost, with US Value stocks faring the worst. US Value stocks have now overtaken Japanese Value securities as the worst region over a 12-month period. Momentum stocks in the Up Minus Down (UMD) factor benefitted from the strong reversal at the end of 2018, with European and Japanese stocks returning similar positive performance, ahead of the US that lagged slightly behind the other regions.

¹¹ Our generic trender is calculated as described in our 'Two centuries of trend following' paper, which is available on our website: <https://www.cfm.fr/insights/two-centuries-of-trend-following>. The trend signal is the sign (either +1 or -1) of the difference of the last price and an exponential moving average of the past 5 months' prices, divided by the volatility: $S_n(t) = \frac{p(t-1) - (p)_{5,t-1}}{\sigma_n(t-1)}$

¹² For more information on the CBOE Skew Index, please refer to the official documentation and the methodology on the official website: <http://www.cboe.com/products/vix-index-volatility/volatility-indicators/skew>

¹³ Please refer to our white paper at the back of this newsletter for a discussion of crowding in trade flow

The Fama-French factors for the last year in Europe, Japan and 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 grey line is downloaded from Kenneth French's website, while the green 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.

Fixed income

Policy makers were closely scrutinised during the first quarter, with a flood of dovish actions and comments coming from the main central banks. Reflecting a gloomier global macroeconomic backdrop towards the end of Q1, global bond prices rose with the FTSE World Government Bond Index (WGBI) gaining 1.7%. Meanwhile, the Bloomberg Barclays Multiverse – the biggest (and broadest) global fixed income benchmark index – gained 2.4%.

The US Federal reserve sounded the first dovish call, stating in the FOMC statement released on January 30 that the “Committee will be patient as it determines future adjustment to the target range”. The sudden change in guidance was blamed on the severe market sell-off in Q4 2018, but it may likely have been the FOMC responding to rising global economic risks. Moreover, some suggest that the Fed may be responding to an upswing in serious delinquencies – defined as those cases where debt repayments are more than 90 days in arrears. Highly sensitive to interest rate rises, these delinquencies have risen steadily, especially in consumer credit (where the rate is the highest since Q2 2012) and auto loans sectors. The Fed's dovish overtone was cemented during

Chairman Jerome Powell's Congressional testimony in February (stating that no rate hikes are envisaged for 2019, with the likelihood of only one hike in 2020 – and that, only if economic data justifies such a move). Inflation also remains sticky, with the Fed's preferred inflation measure, the price index for core personal-consumption expenditures (or PCE) that strips out volatile food and energy components, having risen by 1.79% YoY in January: an 11-month low; below the Fed's 2% target; and further buttressing the argument for lower rates.

On the other side of the Atlantic, this dovish sentiment was echoed by the European Central Bank (ECB). Not only did the Governing Council, on March 7, announce a push back in the expected rate rise pencilled in for the summer of 2019, but, also reiterated the continued reinvestment of principal payments from maturing securities. The Council moreover announced a fresh round of so-called 'Long Term Refinancing Operations', or LTROs. Bonds duly rallied on the announcement, with yields on the German 10-year Bund following the US 10-year tenor lower, and dipped below 0% on March 22.

Towards the end of the period, following the FOMC meeting where being "patient" was restated, FOMC members, as illustrated by the 'Dot-plot', lowered their median expectation for the year-end 2019 target rate to 2.4%, from the 2.875% median during the December 19 meeting. The Fed also revised down their growth expectations for the US government (2.1% for 2019, down from the 2.3% December forecast). US sovereign bonds rallied after the announcement, with the yield of the benchmark 10-year slipping from 2.52% on March 20, to 2.36% on March 27. The bullish sentiment was reflected in the Commitment of Traders (CoT) data showing that non-commercial traders pared the net short position, from -277k contracts on January 1, to slightly less than -80k at the end of March.

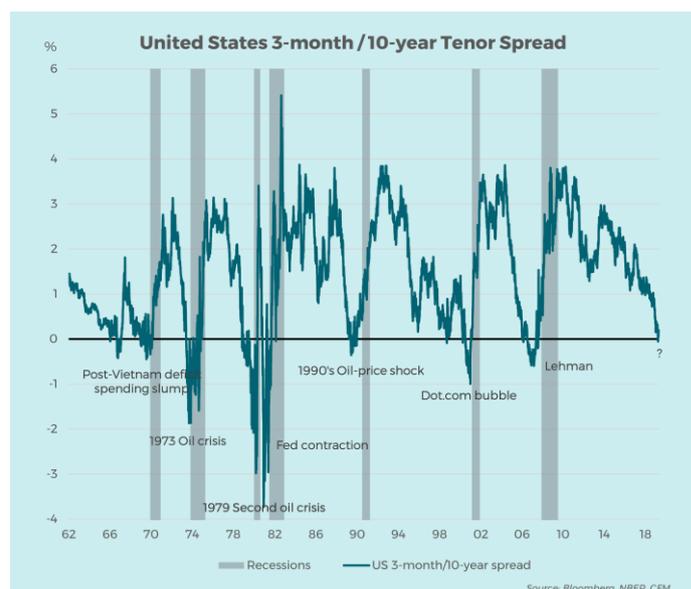
Implied and realised volatility consequently increased, with implied volatility, the CBOE TVIX acting as proxy, hitting a 12-month high of 5.24 points on March 25. The CME FedWatch Tool¹⁴ not only indicates no expectation for a rate hike in 2019, but shows an increased probability of 26% for a December 2019 cut in interest rates (with data as of the end of March).

A brief US yield curve inversion followed, sending market commentators into a frenzy about the predictive powers of such an inversion for recession. On March 22, the US 3-month – 10-year yield 'inverted', so that the yield of the 3-month note exceeded that of the 10-year. [See the

coloured box below, showing, how indeed, every recession since the 1960s was preceded (with a lag of ~12 months) by an inversion of the US yield curve.]

Further afield, the Australian benchmark 10-year yield tumbled 54 basis points (much more aggressively than its US counterpart with the spread between the two respective tenors reaching 67 basis points by March 31, up from the 37 basis point spread at the beginning of the year). The yield on the Australian 10-year reached a record low of 1.7% on March 28, shortly following the US yield curve inversion. The Reserve Bank of Australia (RBA) has strongly pivoted towards a neutral stance, fanning speculation that the next RBA move might be an interest rate cut. Australia is the developed nation whose economy is most closely reliant on the health of the Chinese economy, with policy makers and markets there keeping a close eye on Sino-American trade negotiations. When applying our generic trender, the Australian 10-year was the best performing bond. UK Gilts were the worst performer (still positive), with the lowest RSI of 50 reached on March 1. The Japanese 10-year JGB recorded the highest RSI of 68 on January 7.

The benchmark Barclays Global Aggregate suite of indices offered mixed returns: the Total Return Index (unhedged) returned 2.2% over the period (3% for the hedged version), while the sister Global Aggregate Corporate Total Return Index (unhedged) gained 4.2%. Corporate bonds (especially non-investment grade) outperformed, with the High Yield Total Return Index (unhedged) jumping 7.3%.

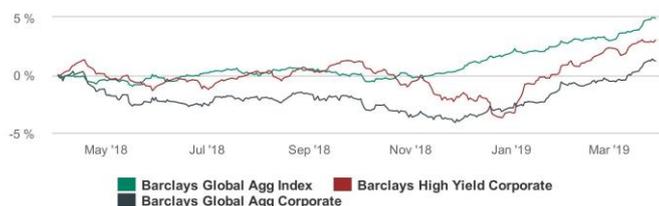


A yield curve inversion, or the negative spread between any two different durations of bonds of the same credit quality (or credit rating), are termed an inversion. The spread can be measured between any two tenors of differing maturity,

¹⁴ The probabilities of the CME Group FedWatch Tool are calculated on 30-day Fed Fund futures contract prices, with further details and methodology to be found on their website: <https://www.cmegroup.com/trading/interest-rates/countdown-to-fomc.html>

typically a longer-dated tenor such as the benchmark 10-year tenor for example, and a shorter-dated note. This spread is positive most of the time, as longer-dated bonds are typically higher yielding, owing to a premium/duration risk that an investor has to bear. As such, the yield curve, ranging from 1-month bills, all the way to 30-year ultra-long bonds, commonly features an arching, upward slope. The US 3-month/10-year tenor spread inverted on March 22, and remained as such for a period of 5 days. The inversion was, in large part, a response to dovish central bank policy: markets reacted bearishly to lower growth expectations and investors rushed into the most liquid longer-dated 10-year benchmark (pushing yields down). Since an inverted yield curve has preceded every one of the last seven US recessions, it is commonly regarded as a harbinger of an impending turn in the business cycle. As short-term yields (more sensitive to the current interest rate policy of central banks) climb, and climb above those of longer-dated tenors (more sensitive to future inflation expectations and future central bank policy), short-term borrowing costs increase in respect to longer-dated ones, making consumer credit more expensive, and companies (often, especially for smaller firms) more reluctant to borrow and invest. This contraction may stymie economic expansion, and is why markets commentators are so quick to point to the recession predictability of an inversion.

The return of Barclays Global Aggregate Bond Indices for the last year



Commodities

Raw materials saw a bounce in Q1 2019, with the S&P Goldman Sachs Commodity Index (SPGSCI) lifting 16%.

Energy markets in particular found new vigour, with the front month future price for Brent crude settling at \$67.5 at quarter end, a 26% increase from the start of January. The gain in the non-Energy version of the SPGSCI (the SPGSNE index) was therefore much more modest, registering a 2.6% increase. The rally was largely the result of supply dynamics that egged oil prices higher, with markets expecting supply to remain tight in the coming months: the spread between the front and 13th month has moved from negative -1.73, gradually to a positive 2.46 during the quarter as the front-month delivery price of Brent became more expensive than delivery in the future. OPEC+ (a joint undertaking by OPEC and non-OPEC

participating countries) renewed its commitment to “market stability” at its latest, March 18 meeting, with conformity of agreed output cuts reported at 90% for February, an increase of 7% from January. Reduced output (OPEC production in March, for instance, plunged by 534,000 barrels) was further exacerbated by a continuing drop of output in sanction and power-cut burdened Venezuela (exports from the embattled nation fell 40% in February).

Amongst metals, the standout story is Copper: after suffering in 2018 its worst year since 2015, the orange metal found some buyers in Q1. Monitored as a bellwether for expected commodity demand and economic expansion (especially in China – the largest consumer of the metal), it recorded its first positive quarter in five, with the contract gaining 11.6% increase in price.

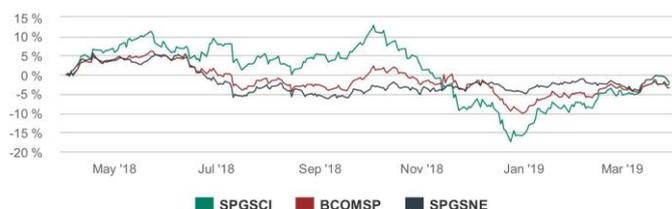
On the other end of the spectrum stood Grains and Soft commodities that were lower over the quarter. Agricultural products sold off, with the S&P GSCI Agriculture Index surrendering 4.5% in Q1. One glaring exception was the price of lean hogs which jumped +26.9%, and took podium as the top performing commodity contract in Q1 on surging demand from China. The prices of both Wheat and Coffee, however, plunged. The price of coffee futures is highly correlated with the US dollar-Brazilian real exchange rate as a weaker real increases export sales, pushing coffee prices down. The real depreciated 1% against the greenback in Q1 on uncertainty about the much-touted social reform plans of new President Bolsonaro. Prices, as such, suffered – hitting a 13-year low in Q1 on the lower real and record supplies (production in Brazil in 2018 was 17% higher than in 2017).

Wheat prices were under strain for similar reasons. Good weather conditions in major growing regions has prompted the United Nations Food and Agriculture Organization to forecast a 4% increase in output in 2019. A bumper crop expected in Russia has led to a forecast of a global glut, with additional increased competition from rival exporters. The price of its cousin grain, Corn, has also been slipping, with domestic demand in the US falling by 2%, while farmers are increasing acreage planted under corn by 4.1% as per the US Department of Agriculture (USDA) – in part by replacing soybeans production as this foodstuff is under strain from the indeterminate outcome of the trade negotiations. The price of Corn fell steadily over the period, down 5% by quarter-end (following the 5.3% decline in 2018). When applying our generic trender, it was the best performing commodity contract on a short position.

The price of Sugar, another of Brazil's core exports, while range bound over the quarter, endured a volatile quarter. As a result, the directionless movements of sugar prices

made the contract the worst performer with our generic trender applied. Gold, meanwhile, recorded the highest RSI of 63 points on February 21, with Wheat the lowest: 35 points on March 12.

The one year return of the S&P GSCI, CSCI Non-Energy, and Bloomberg Commodity Spot indices



FX

The dollar, despite a pause in the tightening monetary policy cycle, registered its fourth consecutive quarterly gain, climbing 1.2% as per the DXY dollar index. The first week of the period saw an increased appetite for riskier assets, as sentiment improved amidst the US-Chinese trade talks, with the dollar slipping three out of the first four weeks of the year. CoT data showed the long non-commercial futures position remaining stable up until mid-March, after which the long position was pared back slightly.

The Canadian dollar was a key beneficiary of the rebound in energy prices as the currency of oil-rich and fourth largest producer Canada, strongly correlated with the move in the price of oil, gaining nearly 3% against the dollar during the first two weeks of the month. A reversal during March undid some of the earlier gains, as weak GDP figures (annualised QoQ GDP growth for Q4 came in at 0.4%, lower than the 1% median economists' forecast, and the 2% registered in Q3 2018). This pointed to a likely dovish tilt from the Canadian central bank. The Canadian dollar ended the period 2.2% stronger against the greenback, with the strong reversal observed towards the end of the period making it the worst performer when the generic trender is applied. The Chinese yuan on the other hand, was the best performing currency on a long position (the US dollar lost 2.4% of its value against the yuan in Q1).

Traders in the British pound remained susceptible to Brexit news, with the fast shifting political manoeuvring creating heightened volatility in the Cable under continued uncertainty as to the final relationship status with the EU. Sterling intra-day volatility far outstripped other major currency pairs, with the total, absolute percentage change against the dollar over 30-minute intraday periods reaching 175%. By this volatility measure, the pound far outranks the moves observed in other dollar

currency pairs, and is significantly higher than the 118% of the yen, and much higher than the 107% of the euro. The 1-month at-the-money implied volatility of the pound lumbered in a range from 10 to 14, down from the nearly 15 points maximum achieved in Q4 2018. The greenback gained 2.1% against sterling over the quarter.

Emerging market currencies had their best quarter since Q1 2018, as the MSCI EM Currency Index gained 1.6%. This was in part thanks to the resurgence in the risk appetite of investors during January, with the index moving largely sideways thereafter. Greater gains were foiled by the troubles with the Turkish lira, which, in a moment of *déjà vu* with last summer, gave up 5% against the dollar. The lira came under renewed stress as the Turkish central bank paused its FX intervention measures, and as unease about municipal election increased.

The Indian rupee attained the highest RSI (61 points on March 19), while the Swedish krona recorded the lowest (39 points on March 8).

Dollar Index (DXY) vs MSCI Emerging Market Currency Index



Trading news and regulation

Trading "speed bumps" – the intentional addition of trade latency by exchange matching engines to counter high-frequency traders – remain a hotly discussed topic ever since the introduction of such a latency by IEX, the US equities exchange of Flash Boys fame. Last September the CEO of Eurex, a major European exchange, [openly discussed plans](#) to add a similar feature to their order books starting with fixed-income options (a relatively small segment of electronic trading for Eurex). These plans seem delayed as the exchange's website no longer shows reference to the launch. The initiative, however, has definitely not been scrapped entirely: in a circular to clients in March the speed bump (or, as they call it, "Passive Liquidity Protection") has resurfaced in which they propose a pilot introduction in June 2019, specifically for German and French equity options, another relatively small electronic segment. The idea is to delay all aggressive orders upon arrival to the book by 1-3 milliseconds. Naturally the exchange does not wish to disrupt trading of their flagship equity index and fixed

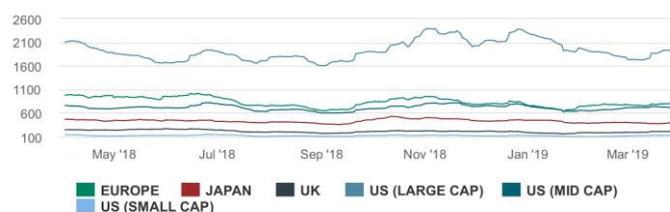
income futures offerings just yet, but this may be a sign of things to come.

The Intercontinental Exchange (ICE) has also [filed documents with the CFTC](#) for their own, basically equivalent, “Passive Order Protection” functionality. Initial testing was proposed on two minor futures contracts which they claim suffer particularly from [high-frequency manipulation](#). [The Wall Street Journal reports](#) that the Commission plans a thorough review of the proposal in the coming months before reaching a decision.

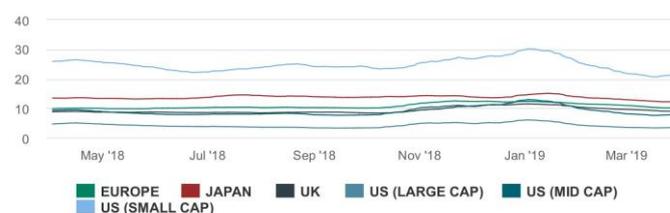
Beyond speed bumps, the other widely debated contemporary market microstructure topic has to be the occurrence of flash crashes. Last quarter’s Alternative Beta newsletter reported on the incident on 3 January, when the Japanese yen strengthened suddenly against the US dollar. [New analysis published by the Royal Bank of Australia](#) dissects this flash event which rapidly spread to other currencies including a sudden drop in the Australian dollar. While the precise cause of the incident [remains debated](#), consensus is growing that low liquidity and the withdrawal of automated traders from the market might have been key factors. In such cases even relatively small directional orders can cause disruption, even if under normal conditions they could be absorbed by the market.

Credit default swap (CDS) markets are back under direct scrutiny following multiple recent events that may have shaken investor confidence in the integrity of this segment. In January, [Bloomberg reported](#) on a case where a CDS was traded on an entity that no longer actually had any debt issued, rendering the CDS worthless. The market did not seem to notice. More worrisome is the practice of manufactured defaults ([see the Financial Times for an in-depth look](#)) whereby a buyer of CDS protection approaches the underlying debtor company and incites late payment of a debt in order to trigger a CDS payoff. This practice clearly undermines trust in the product itself, and [a change has been proposed by ISDA](#) (the organisation issuing the legal definition of standard CDS) which would only accept, as triggering event, a genuine deterioration of the company’s creditworthiness. The effectiveness of such a “quick fix” is [not obvious](#), but it would be rather important to find a viable, long-term solution. Credit derivatives provide an important boost to the liquidity of an otherwise very fragmented corporate debt market.

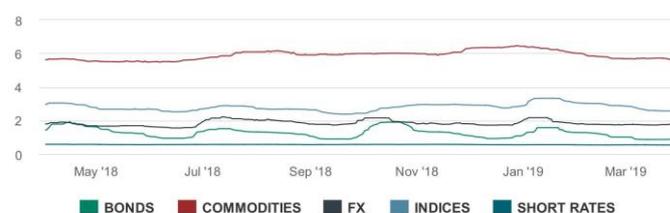
Average monthly dollar equity market volume in billion USD



Typical bid-ask spread in six major groups of equities in basis points



Average bid-ask spread on five future asset classes in basis points



Data Science & Machine Learning

CFM supports academic research through various partnerships at various prominent institutions. The [CFM-Imperial Institute of Quantitative Finance](#) at Imperial College London and the [CFM-ENS Data Science Chair](#) in partnership with École Normale Supérieure in Paris are well-established initiatives, offering support and researcher funding along with hosting various seminars, conferences, and lecture series.

A third partnership was established in February earlier this year with the Louis Bachelier Institute and École Polytechnique, a leading institution near Paris. Christened the [Econophysics & Complex Systems Chair](#), the Polytechnique research team will be working alongside researchers from CFM on a wide range of projects, key of which is an analysis of the mechanics of market impact and market instabilities, which are of fundamental importance for understanding the functioning of society and the role of finance.

CFM also continues to support the machine learning and data science ecosystem: CFM hosted 120 guests (and more

online) during the Paris Machine Learning Meetup in March. Participants learned about artificial intelligence in computer vision; the ethical use of artificial intelligence; and also the interpretation of the often seeming black-box-like prediction techniques of machine learning. CFM strongly believes that understanding how a specific machine learning model makes its prediction is key to asset management, as it allows experts to validate the conclusions of the process, which in turn helps in the selection of models that are logically underpinned and capable of making robust predictions.

Extended abstract

How should you discount your backtest PnL?

Paper by Adam Rej, Philip Seager and Jean-Philippe Bouchaud

Any strategy, whether of discretionary or systematic nature, and which is appraised using a backtest is at risk of being 'over fitted'. In other words, part of its performance (or the entirety in extreme cases) may be due to a favourable alignment of market forces. Such a windfall performance is of course not to be counted upon in the future. In the language of stochastic processes, favourable or unfavourable market conditions simply represent pure noise. Taking favourable noise realisations at face values is thus an important source of overfitting. There is however another equally important contributing factor: if a research team has reason to believe that their strategy is sound, but, nevertheless, the backtested PnL does not meet their expectations, they are most likely not to discard it arbitrarily. Instead, the strategy will be dissected into elementary building blocks and each one of them carefully studied. The research team may then propose one or a series of improvements to these building blocks so as to result in an acceptable performance from the backtest. Did this procedure truly improve the strategy? In most cases the answer is no. The performance enhancement simply comes from an improvement of the noise realisation of the original strategy. Even if the improvement is genuine, there is no way of corroborating it. It is thus prudent to assume a no improvement base case scenario. This paper concretizes and quantifies these above arguments and proposes a simple, yet powerful framework that allows one to model and quantify in-sample PnL overfitting. This allows a researcher to compute the factor appropriate for discounting PnLs of in-sample investment strategies. It is found that for typical CTA investment strategies, the applicable discount factor is close to 2, which is the (empirical) industry standard.

CFM Talks To

Professor Johannes Muhle-Karbe

We had the pleasure of welcoming Professor Johannes Muhle-Karbe, the new director of the CFM-Imperial Institute of Quantitative Finance to our Paris office to talk about the future ambitions of the Institute, his research and his view on the state of quantitative finance. Johannes joins Imperial College London from Carnegie Mellon University where he taught courses on Stochastic Control and its Application in Finance, Market Microstructure and Advanced Derivative Models amongst others. During his time in Pittsburgh, he was also a member of the steering committee for the Center for Computational Finance. Johannes took up his current role as Director of the Institute in January after the departure of Professor Rama Cont.



Machine learning is like a big, brand new hammer. But what is the right nail we should try to hit with it?



CFM: *Thank you for coming to speak to us about the Institute and the work you will be doing there. Can you briefly tell us a bit about your background, and what led you to the Institute?*

JMK: My journey started during my undergraduate degree in mathematics at TU Munich, where I became fascinated with probability and stochastic processes. The professor who taught these courses later became my PhD advisor and also introduced me to Mathematical Finance. And I got hooked. I started doing stochastic optimisation and research on transaction costs during my PhD and completed my degree in 2009, also at TU Munich. After a one year post-doc in Vienna, I moved to Switzerland to take up an assistant professorship at ETH Zurich. I stayed for five years and then moved to the US, where I first joined the University of Michigan and later Carnegie Mellon. Wanting to move back to Europe, Imperial offered me an incredible opportunity. It has a fantastic math

department with a Fields medallist in stochastic analysis, for example. Along with the connection to CFM through the institute and the finance industry in London, it was a perfect fit.

CFM: *The Institute is part of the Mathematics department of Imperial?*

JMK: Yes. The mathematics department at Imperial has a number of different sections: pure and applied mathematics, statistics, and mathematical finance. The Institute is a partnership between Imperial College's Mathematical Finance Group and CFM. The mathematical finance section is one of the largest research groups in this field worldwide, and also has close connections to industry through the Master in Quantitative Finance we offer. As a hub for quantitative research in London, it was a natural partner for CFM.

CFM: *What are the key objectives and mandates of the Institute?*

JMK: The Institute is an initiative to promote research in quantitative finance and modelling. Particular emphasis lies on interdisciplinary projects that have mathematical aspects, but also connections to statistics, econophysics, finance, and real-life problems from industry.

CFM: *How does the institute specifically promote these research initiatives? What ambitions do you have for the institute?*

JMK: One of the mainstays of the Institute has been the biannual 'Market Microstructure Workshop', which alternates between Paris and London. The next edition will take place in London on December 12-13 later this year. It is perhaps the only, truly interdisciplinary conference where academics with backgrounds in math, physics, finance, and other disciplines get together with practitioners from the finance and asset management industry.

Another key outreach project is the monthly 'CFM-Imperial Seminar', where high profile speakers are invited to give lectures on a wide range of contemporary topics. The talks are deliberately aimed at a diverse audience, and are scheduled in the early evening to also allow practitioners to attend. The goal is to have big picture, broad-audience talks to ignite discussion about the future challenges in Quantitative Finance. The first two seminars for the fall have been scheduled beginning in October. Details can be found on the Institute's website.

CFM: *So it seems fair to say that the Institute places a high premium on pushing interdisciplinary studies and research?*

JMK: Yes. But it always is a challenge to engage with people who don't have similar training. Whilst my background is in mathematics, I gradually became more interested in economics and finance. To get up to speed with research in these communities, I had to spend a lot of time talking to researchers with this kind of training and reading their papers. Interdisciplinary scientific work is challenging, because it is like learning a new language: the problems are different, the style is different, and the traditions are different. But, if you can manage to establish a working relationship with a diverse set of researchers, it can be extremely fruitful.

CFM: *Do you have any ideas of how to leverage the Institute to address the difficulties of promoting interdisciplinary collaboration?*

JMK: One of the things I'm currently pushing for is to establish joint activities with the Imperial College Business School. Imperial has a fantastic finance group, with

research projects similar to the ones pursued within the institute. Market microstructure is one prominent example. Historically, these two groups have operated largely on their own, but the institute is a perfect vehicle to foster collaboration between them. In May 2020, for instance, we are jointly organising a conference on 'Frictions in Finance', where junior researchers in finance and mathematics will have the chance to learn about topical research questions and methods from some of the leading figures in both fields.

CFM: *Any particular research area that is ripe for such a tie-up?*

JMK: There are researchers in both groups, the business school and mathematical finance that work on analysing and understanding the flaws and frictions observed in financial markets, such as asymmetric information, transaction costs etc. The style of research is a bit different, and the strengths each brings to the table are different. However, once the two sides get to know each other, we will hopefully be able to realise a lot of synergies. I had a very positive experience in Pittsburgh, where the Masters programme (Carnegie Mellon's MSc in Computational Finance) has had great success as a collaborative effort between four departments: mathematics, statistics, computer science and the business school. The idea right from the beginning was that learning about finance requires a broad curriculum, often campaigning competing points of view. Of course, another benefit is that the master programme forms a connection between the different departments. In London, the CFM-Imperial Institute should ideally become such a point where faculty can naturally rally around.

CFM: *Business schools' teaching of 50 years ago is vastly different than what the representative student will encounter today, with more focus on quantitative techniques, interdisciplinary teaching and the like. What do you think was the genesis of this new paradigm?*

JMK: Yes, I agree, and business schools have accordingly become more technical. When modern business schools and MBA programmes first took off, their curricula were not very technical. MIT, Stanford, and also Carnegie Mellon then played big roles in hiring mathematically well-trained faculty and students, pushing academic teaching of finance into a much more quantitative direction. Now again, with the rise of Artificial Intelligence, Machine Learning, and Big Data, graduates are under increasing pressure to acquire these skills. I think the skills from traditional MBA training are still crucial, but demand from industry is making proficiency in advanced programming and data manipulation indispensable as well. At Imperial, we just restructured our master programme in Quantitative Finance to make sure that our students

remain up to date both with respect to programming and statistics. It is clear that such cross-disciplinary training is vital for a successful career in the finance industry.

CFM: *And talking about these new buzzwords of finance, Machine Learning and Big Data. Barely a day goes by without an article, or new research being published on these (or related fields) and how it is set to dramatically alter the world of finance. Is there a similarly robust focus within academia, as there seems to be in the industry?*

JMK: I would argue there is generally more inertia in academia, but there is now a large push towards machine learning and AI as well. Many academics, myself included, have started to use and experiment with some of the new numerical methods. However, in my own research, I feel the jury is still out on which research questions you may want to answer with these new tools. It is clear to me that we academics need to learn about these new developments to teach them to our students. Calibration, optimisation problems along with data analysis etc. - there is no doubt in my mind that these will continue to grow in importance in the industry. Regarding academic research, the path ahead is less clear. What is the general principle I could uncover, what is the mechanism I could understand with these methods? What problem should we try to solve with these new tools? In this context, machine learning is like a big, brand new hammer. But what is the right nail we should try to hit with it?

There is exciting ongoing work in computer science, complexity theory, and mathematics on when and why these new tools work. But more from the finance side of things, what are the economic questions we can answer with all this computational power? I think this is a key question and the answer is not clear to me yet.

CFM: *With this advent of Big Data came an industry awash with 'alternative' data providers, offering new data on consumer spending patterns, satellite imagery showing levels of oil and gas storage etc. These are just a few among a near countless assortment, all holding the promise of profiting from advanced knowledge when using these tools. Do you believe that this data may hold some new information?*

JMK: This is something that I believe holds promise. I think if you want to make short term predictions using this data, by employing non-linear learning algorithms, one could very well be able to make more sophisticated forecasts. I think this is a well-defined problem, and the industry relevance is clear. However, as a researcher, you would also like to uncover the mechanism by which, for example, consumer behaviour fluctuates. Or, as a policy maker, you would like to understand how consumer spending may be stimulated. Bringing tools from data science to bear on

questions of this kind is more difficult, but an exciting challenge with potentially high payoff.

CFM: *Crowding, especially in alternative risk premia, is a topic that makes many investors nervous. With many practitioners starting to use similar tools and techniques, do you think this will ultimately lead to a crowded space?*

JMK: I have done quite a bit of work on game-theoretic models where a number of strategic agents trade in the same market, accessing the same trading opportunities and the same pool of liquidity. This naturally leads to crowding. However, to bring such models closer to practice, a key feature will be to model endogenous information acquisition, such as investment in new data sources or trading algorithms.

“ **Remaining up to date regarding new tools and theoretical discoveries will be a challenge for policy makers and regulators, too.** ”

CFM: *Do you think the finance industry has reached a point where asset managers who fail to adopt this slew of new tools are bound to become irrelevant in coming years?*

JMK: I think technical know-how is now clearly more important than ever. The competition from the tech industry, in terms of talent attraction and breakthrough research, is contributing to this trend. One should however not discount the 'old school' skillset which will remain important. So, while the momentum of change is undisputed, I don't expect things will change as quickly as many claim, also because many of the key decision makers and processes are unlikely to change overnight. Nor will non-technical skills suddenly become unimportant.

CFM: *You mentioned some inertia with regards to academia. Do you observe this from policy makers too?*

JMK: Monetary policymaking, for instance, is still very much dominated by economists, with mathematicians, physicists, computer scientists and others very much underrepresented. Accordingly, remaining up to date

regarding new tools and theoretical discoveries will be a key challenge for policy makers and regulators, too.

Thus, another goal of the Market Microstructure Conference in December will be to explore how artificial intelligence is shaping the industry, how its consequences should be measured and interpreted, and how it should be regulated. We hope to bring people from technology companies, regulators, and from the finance industry together to discuss this.



Disclaimer

THE TEXT IS AN EDITED TRANSCRIPT OF AN INTERVIEW WITH PROFESSOR MUHLE-KARBE ON APRIL 25, 2019 AT CFM'S OFFICES IN PARIS. THE VIEWS AND OPINIONS EXPRESSED IN THIS INTERVIEW ARE THOSE OF PROFESSOR MULHE-KARBE AND MAY NOT NECESSARILY REFLECT THE OFFICIAL POLICY OR POSITION OF EITHER CFM OR ANY OF ITS AFFILIATES. THE INFORMATION PROVIDED HEREIN IS GENERAL INFORMATION ONLY AND DOES NOT CONSTITUTE INVESTMENT OR OTHER ADVICE. ANY STATEMENTS REGARDING MARKET EVENTS, FUTURE EVENTS OR OTHER SIMILAR STATEMENTS CONSTITUTE ONLY SUBJECTIVE VIEWS, ARE BASED UPON EXPECTATIONS OR BELIEFS, INVOLVE INHERENT RISKS AND UNCERTAINTIES AND SHOULD THEREFORE NOT BE RELIED ON. FUTURE EVIDENCE AND ACTUAL RESULTS COULD DIFFER MATERIALLY FROM THOSE SET FORTH, CONTEMPLATED BY OR UNDERLYING THESE STATEMENTS. IN LIGHT OF THESE RISKS AND UNCERTAINTIES, THERE CAN BE NO ASSURANCE THAT THESE STATEMENTS ARE OR WILL PROVE TO BE ACCURATE OR COMPLETE IN ANY WAY.

Other news

- ▶ CFM was ranked as one of the top places to work in 2019 by 'Great Place to Work' in France. See more details on their website:
<https://www.greatplacetowork.fr/>
- ▶ Philip Seager, Head of Alternative Beta Strategies, presented research on Agnostic Risk Parity in directional strategies as part of our ongoing 'Food for Systematic Thought' (FFST) series of lunches in the US and Canada in February. Please contact your Investor Relations representative for more information on upcoming events in the series.
- ▶ Our Head of Alternative Beta Research, Stefano Ciliberti, presented on Trend Following and its defensive and diversification properties at the Institutional Investor Forum in San Francisco in January. More details about the conference and the topics can be found here:
<https://www.iiconferences.com/Institutional-Investor-Forums/RiskAndLiquidity>
- ▶ Stefano was also in Australia in February where he presented our research on ESG during two FFST lunches in Sydney and Melbourne respectively. He spoke about implementing ESG information and equity factors in systematic quantitative investing.
- ▶ Laurent Laloux, Chief Product Officer, spoke about the history of machine learning and its application in asset management during the Institutional Money Kongress in Frankfurt in February. See a column by Laurent on the topic of machine learning and AI recently published in Pensions & Investments:
https://www.pionline.com/article/20190415/CUSTOM_MEDIA/190409966/separating-myth-from-reality-in-ai/
- ▶ Machine learning and AI is an important topic of research for CFM, and we often take the opportunity to share our research. Martin Jost, Product Specialist based in our Paris office, presented on the topic in Luxembourg as part of our FFST series. To read more, please see our insight piece entitled "AI: Perspectives from the quant coalface" here:
<https://www.cfm.fr/insights/artificial-intelligence-perspectives-from-the-quant-coalface/>
- ▶ Tess Shih, Executive Director in the New York office, spoke at Markets Group's 6th Annual Central States Institutional Forum in St Louis, Missouri on Alternative Beta and its place in a diversified portfolio. More details can be found on the official website:
<https://www.marketsgroup.org/forums/central-states-institutional-forum-2019?platform=hootsuite>

- ▶ Steve Shepherd, CFM's head of Asia Pacific, spoke as part of panel on how to select funds that win. Held as part of the H&B Wealth Symposium, more details can be found here: <https://www.hannemannandbrown.com.au>
- ▶ Senior Research Advisor, Charles-Albert Lehalle, and Guillaume Simon both spoke as part of separate panel sessions on Trading Liquidity, and Factor and Risk Premium respectively during the 12th Financial Risks International Forum in Paris in March. More details can be found here: <https://www.risks-forum.org/>
- ▶ CFM's Chairman, Jean-Philippe Bouchaud contributed to a forum entitled "Economics After Neoliberalism" and published in the Boston Review in March. Read the article here: <http://bostonreview.net/forum/economics-after-neoliberalism/complexity-economists-inclusive-economics-complexity-economics>
- ▶ See the details of all our other upcoming events here: <https://www.cfm.fr/events/>
- ▶ Below is a selection of our recent papers:
 - > Are trading invariants really invariant? Trading costs matter: <https://arxiv.org/abs/1902.03457>
 - > Will a Large Economy Be Stable? <https://arxiv.org/abs/1901.09629>
 - > How should you discount your backtest PnL? <https://arxiv.org/abs/1902.01802>

Whitepaper

Packed in like sardines: how crowding in trade flow can adversely affect execution costs

Executive summary

Alternative Risk Premium strategies have received investor attention over the past few years and consequentially assets allocated to these strategies have increased. This, in turn, has given rise to a fear of concentration, most commonly referred to as crowding. Moreover, a spell of modest returns – especially in 2018 – has led investors to question the efficacy of these strategies, with the blame for sub-par performance often ascribed to crowding. Investors are not only concerned that a crowded market or strategy results in deteriorating returns as participants chase the same opportunities, but that sell-off risk, when large positions in the same assets are liquidated at the same time, also increases. In this note, we instead discuss a simple, yet real example of how crowding in trade flow may result in deteriorating returns by increasing the cost of execution. We show how, with a dedicated and bespoke execution solution, we can reduce some of the risk that arises from participating in a crowded trade

Introduction

The topic of crowding has garnered much attention of late, with many investors fretting about the consequences for Alternative Risk Premium (ARP) strategies. Any strategy could be called 'crowded' if too much capital is deployed in said strategy given its usual reward and market liquidity [1]. This crowding is generally thought of as being in the positions of an asset, while less literature exists on the subject of crowding in typical trade flow.

If a strategy is taking advantage of mispricing it may be that the existence of many players chasing the same opportunity reduces the magnitude of such an opportunity.¹⁵ Academic literature often discusses how the market is exposed to systemic risk when similar portfolios are held by a large number of investors. This concentration, or crowdedness, may have a material impact in the event that investors simultaneously head

¹⁵ Especially true for convergent strategies. Such a mechanism for divergent (trend) strategies is less clear!

towards the exit. Liquidation by a large actor, or the concurrent liquidation by a set of smaller investors, can depress valuations, with resulting losses causing further liquidations and eventually cascading losses among all participants [1, 2, 3]. Such tail risk events are significant but rare. In traditional markets they commonly go under the name of 'bubbles' while examples such as the Quant Crunch of August 2007 [1] reveal the existence of exactly equivalent effects in a market neutral setting.

We address in this paper a less discussed aspect of crowding, due to correlated trade flow that is detrimental to a strategy's performance even under normal, everyday conditions. The work is discussed in detail in [4] and is the subject of this short note.

Transaction costs and price impact

Once a trading strategy has been identified in a paper traded backtest, an execution strategy needs to accompany its passage through to being used in an investment program. The resulting execution can be done in various ways, ranging from traditional voice broking, simply calling and placing an order with a broker over the phone, to developing algorithms that will automatically, and systematically analyse the most optimal execution strategy. All solutions have one thing in common: the final trades almost never occur at the exact same price as what prevailed at the time when the order was placed. This discrepancy is called 'slippage' and it has several origins.

Trading is not free, it commonly involves brokerage and exchange fees borne by the investor, as well as a component related to the bid-ask spread. Beyond that, for institutional investors, the largest contribution often comes from 'price impact' whereby repeatedly buying the same asset in order to build up the desired long position will drive its price up, or selling it will drive its price down.

We discussed in a prior note [5], that when trading Q shares in total, trading cost per share is well approximated by the square root formula:

$$C \approx \text{constant} \times \sqrt{\frac{Q}{V}}$$

Here V denotes the total market volume traded on the day, the ratio of Q and V is thus one's own rate of market participation. What the formula as such represents, is the slippage per share. Therefore, in order to calculate the total execution cost for the trade one needs to multiply the result by the number of shares executed Q .

Price impact and the capacity of a trading strategy

Let us take a concrete example. Imagine a trade idea on the shares of Company X that is expected to generate 8 cents of profit. The liquidity of this stock is around 15M shares exchanged per day, so trading 1% of the market allows one to open a position of 150,000. If this trade could be entered into for free, one would expect a profit of $\$0.08 \times 150,000 = \$12,000$. Using actual figures, the above square root formula predicts an execution cost of \$3,900 on the same trade, leaving us with a more realistic final gain of \$8,100, which is still reasonable. Note that one would still have to exit the position to recover such gains, again incurring cost. For the sake of simplicity, we are going to neglect this cost for the purpose of this paper.

In order to establish, in our example, a position of 150,000 shares, several individual trades will be required to fully execute the order. Figure 1 illustrates that these consecutive trades, on average, would happen at gradually higher prices ever closer to the price target, due to price impact and following the square root rule.

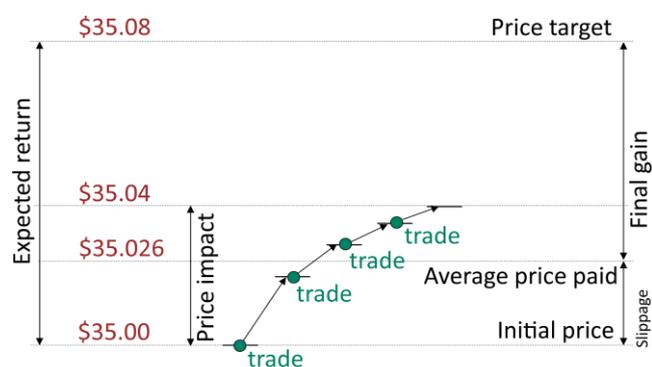


Figure 1: The expected trajectory of market price in an example of buying 150,000 shares of Company X. As the consecutive trades are executed, the price increases gradually due to price impact.

The total expected gain of the position grows proportionally to the size: if instead of 150,000 we trade 600,000 shares, gains are expected to increase fourfold. However, costs do not increase linearly, but grow more quickly: every time we enlarge a position it costs progressively more to execute. Consequently, 600,000 shares will incur eight times more execution cost than trading 150,000 shares would. This effect on the final gain is illustrated in Figure 2.

Profits very quickly fall short of naïve expectations. Increasing trade size above a certain limit no longer results

in increased profits, and even becomes counterproductive once the price is pushed beyond our own price target.

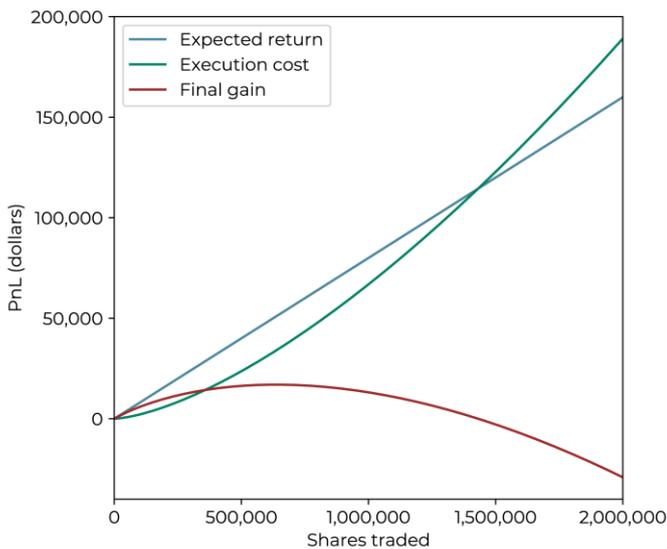


Figure 2: A profitability analysis of the example trade shows that expected returns grow proportionally to the number of shares traded (blue curve), but, execution cost (green curve) increases at a faster rate. The final gain (the difference of the two, and illustrated by the red curve) reaches a maximum at a given level of trading and then decreases with order size.

A sure-fire way to increase expected gains is by limiting the total cost of execution despite the placement of a larger order. This is done by deploying better, bespoke execution algorithms. Eventually, however, costs always catch up and overtake expected gains. This effect of diminishing returns with ever larger orders is what limits the ‘capacity’ of investment vehicles, and it is the principal reason why successful funds are often closed to further investment. They have then reached a size beyond which there is little room left to invest gainfully and adding more assets, or increasing leverage becomes detrimental to performance.

Impact and capacity with crowded flows

A recent empirical paper [6] has shown that the price impact of buying/selling a given amount in a stock is the same regardless of whether the trade is executed by a single large investor, or by an accumulation of multiple smaller investors acting simultaneously. The authors coined the term ‘co-impact’ to describe this collective effect of supply and demand. As a consequence of this, the capacity of any trading strategy is shared among all market participants, thus giving rise to the concept of

‘crowded’ trades that potentially increase a given strategy’s execution cost and reduce its potential to generate gain.

Let us return to the example of the Company X trade in the previous section. This trading strategy returned 8 cents per share if it could trade for free. Figure 3 shows the final gain curves corresponding to different scenarios measured using the academic trade database as described in [6]:

- ▶ The blue curve illustrates the theoretical gain given the average quality of execution combined with the *typical* level of crowding experienced by institutional investors. In this scenario, gains of up to \$5,400 could be extracted
- ▶ If the trade is executed on a day *typically less* crowded than average, the maximum gain increases to \$16,000
- ▶ On days *typically more* crowded than average the maximum gain dwindles to just \$640

We will return to the interpretation of the two remaining dashed curves shortly.

These differences are large and explained by the extra contribution to cost arising from executing with or against the net flow of trades of all investors pursuing a given strategy. It is no longer just the trades of one investor that count towards the cost of trading but also how similar that trading is to all other trades in the market.

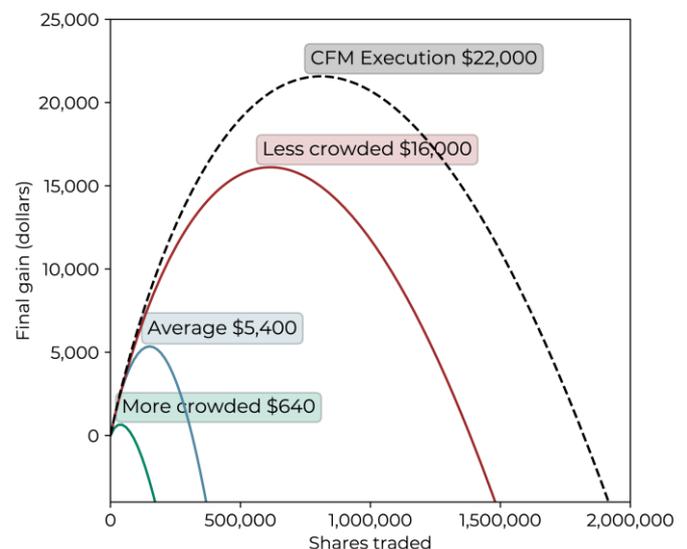


Figure 3: The final gain of the example trade of Company X under the same 8 cents of expected return assumption, but with different scenarios for execution costs. In each case, gains first grow as the sizing of the trade increases, before saturating at different maximum levels and subsequently decreasing due to the increasing, and dominant contribution from execution cost. One expects lower gains in the case of a crowded strategy, as the variation of the solid curves obtained from measured costs in the academic database as described in [6]. Also overlaid is a curve corresponding to CFM’s execution of both its Alpha and

Alternative Beta programs. Both of these have sizeable assets under management, and their measured costs for similarly sized orders are statistically indistinguishable. As described in the text, an understanding of execution research and a knowledge of crowding are essential to increasing the overall net gain.

The capacity of Alternative Risk Premium strategies

A recent study [7] analysed the capacity of investing in the 'Fama-French' factors in the US equity market including both commissions and trading costs. It was found that the Size, Value and Momentum factors can manage around \$30B, \$1.5B and less than \$100M, respectively. These numbers are defined as the level of assets above which the costs exceed expected returns. They are low and definitely below the actual assets managed in such factor strategies. In fact, it is estimated that global ARP assets under management have reached \$150 - \$200 billion [8]. The construction of the Fama-French factors and the subsequent portfolio construction is somewhat academic in nature and certainly not built for running a scalable ARP program.

There are, however, ARP funds that have delivered tangible gains over the past decade. Not all ARP strategies are affected equally by crowding. Let us yet again return to our example of the Company X trade, but this time using CFM's own trades, measured using the same method as in [6], and applying the usual 8 cents of expected gain. We find a maximum gain of \$22,000, illustrated by the dashed black line 'CFM Execution' in Figure 3. The measured cost of trades generated by CFM's ARP offering is statistically consistent with that of its (a priori less crowded) Alpha strategies.

The fact that the results are similar indicates that CFM's ARP products, in terms of crowding, are indistinguishable from those of CFM's more bespoke hedge-fund type Alpha strategies. The crowded trade flow may exist but is not large enough to be measured with the current level of statistics. As we accumulate more data, maybe these differences will be detected, but, for the moment at least, we can conclude that such effects are small.

How does CFM deal with crowding?

Non-standard implementation

Strategies in the ARP space are well documented in the academic literature, and it is advisable to avoid the most widely known implementations, for example the ones proposed by Fama and French. By taking a different, non-standard strategy and portfolio construction approach, CFM can both improve performance and alleviate crowding effects. A non-standard implementation of robust, and persistent ARP, will exhibit greater expected returns since trading will not consume liquidity concurrently with others at times of rebalancing.

Lower turnover

The best way to reduce execution costs is to not trade at all! One can make large savings by reducing the turnover of the strategies. This is typically achieved by designing strategies that rely on slower models, combining multiple signals, and trading in a controlled manner when they are aligned.

Targeted liquidity

When a portfolio requires rebalancing, it is prudent to concentrate the largest trades on the most liquid products, and to avoid excessively pushing the price of illiquid ones, where co-impact/crowding effects may be largest.

Bespoke execution algorithm

Finally, execution costs and the ability to navigate a market with many participants does depend on one's trading style. We have developed a proprietary execution platform over the past 15-20 years with our in-house algorithms and market connectivity tailored precisely to the needs of each strategy. By crafting a bespoke execution algorithm, we can both better time, and size orders for each strategy.

Take-home message

Execution costs have a very significant impact on the profitability of trading strategies. Crowded trade flow increases such costs, and substantially diminishes the net gains of a portfolio. While crowding concerns in ARP strategies warrant an assessment, our own research reveals that we cannot confirm the presence of crowding, nor does it seem to affect the performance or execution capabilities of CFM's ARP offering.

CFM remains committed in our pursuit of applied research on this topic, and continues in its invaluable collaboration with academic researchers on the subject of co-impact. Upcoming papers will include further direct measures on ARP crowding in order books and trade flow. We hope to share detailed results on these topics in the near future.

References

- [1] Kandhani and Lo, 'What happened to the quants in August 2007', *Journal of Investment Management* 5, 5-54, 2007.
- [2] Coval and Stafford, 'Asset fire sales (and purchases) in equity markets', *Journal of Financial Economics* 86, 479-512, 2007.
- [3] Barroso *et al.*, 'Institutional crowding and momentum tail risk', Working paper, 2017.
- [4] Lou and Polk, 'Comomentum: Inferring arbitrage activity from return correlations', Working paper, 2013.
- [5] Capital Fund Management, 'Executing With Impact: Why the price you want is not the price you get!' 2016.
- [6] Bucci *et al.*, 'Co-impact: Crowding effects in institutional trading activity', arXiv:1804.09565, 2018.
- [7] Raboun *et al.*, 'Stock market liquidity and the trading costs of factors', To be published, 2019.
- [8] MJ Hudson Allenbridge, *Alternative Risk Premia Fund Review*, 2019.

Disclaimer

ANY DESCRIPTION OR INFORMATION INVOLVING MODELS, INVESTMENT PROCESSES OR ALLOCATIONS IS PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY.

ANY STATEMENTS REGARDING CORRELATIONS OR MODES OR OTHER SIMILAR BEHAVIORS CONSTITUTE ONLY SUBJECTIVE VIEWS, ARE BASED UPON REASONABLE EXPECTATIONS OR BELIEFS, AND SHOULD NOT BE RELIED ON. ALL STATEMENTS HEREIN ARE SUBJECT TO CHANGE DUE TO A VARIETY OF FACTORS INCLUDING FLUCTUATING MARKET CONDITIONS, AND INVOLVE INHERENT RISKS AND UNCERTAINTIES BOTH GENERIC AND SPECIFIC, MANY OF WHICH CANNOT BE PREDICTED OR QUANTIFIED AND ARE BEYOND CFM'S CONTROL. FUTURE EVIDENCE AND ACTUAL RESULTS OR PERFORMANCE COULD DIFFER MATERIALLY FROM THE INFORMATION SET FORTH IN, CONTEMPLATED BY OR UNDERLYING THE STATEMENTS HEREIN.

CFM has pioneered and applied an academic and scientific approach to financial markets, creating award winning strategies and a market leading investment management firm.

**Capital Fund Management S.A.**

23, rue de l'Université, 75007

Paris, France

T +33 1 49 49 59 49

E cfm@cfm.fr**CFM International Inc.**The Chrysler Building, 405 Lexington Avenue - 55th Fl.,

New York, NY, 10174, U.S.A

T +1 646 957 8018

E cfm@cfm.fr**Capital Fund Management LLP - Sydney branch**

Level 16, 333 George Street

Sydney, NSW, 2000, Australia

T +61 2 9159 3100

E cfm@cfm.fr**CFM Asia KK**

9F Marunouchi Building, 2-4-1, Marunouchi, Chiyoda-Ku,

100-6309 Tokyo, Japan

T +81 3 5219 6180

E cfm@cfm.fr**Capital Fund Management LLP**

64 St James's Street, London

SW1A 1NF, UK

T +44 207 659 9750

E cfm@cfm.fr