



1 February 2020

ALTERNATIVE BETA MATTERS

Quarterly Newsletter - Q1 2020

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 whitepaper. 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.

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Quarterly review

Quantitative overview of key developments in Q4 2019

Alternative industry performance

Global trade uncertainty and central bank policy intervention were the two main drivers of markets in 2019. The final quarter stuck to this playbook: a decline in all manner of risks and uncertainties (Brexit, trade) and support by monetary policy easing pushed risk assets higher. Most asset classes made high single-digit gains, with volatility sagging. Global equity markets rallied, with a ~8.6% quarterly jump for developed, market-cap weighted indices, while a basket of global investment grade bonds (sovereign and corporate) gained 0.5%.

Alternative asset managers made good, if not stellar gains. The benchmark HFRX Global Hedge Fund Index gained 2.6% - a fourth consecutive quarter of positive returns, and the best annual performance since 2009 (+8.6%). The solid headline performance hid, nevertheless, a stark difference between strategies, with the leading strategy (Event-driven) outperforming the worst (Systematic Macro CTA) by more than 7% over the quarter. In the risk-on regime, strategies with lower beta exposure tended to underperform - such as Systematic Macro (an average slightly negative beta of -0.05% over 2019) and Equity Market Neutral (flat beta). Equity market neutral strategies lost -0.6% and -1.9% for the quarter and the year respectively.

Amongst alternative risk premia strategies, returns were, as in previous quarters, dented by the underperformance of equity market neutral portfolios. The Société Générale Multi Alternative Risk Premia Index¹ posted a 0.9% negative return over the quarter (settling on a modest 3.9% gain over the full year).

Whilst Commodity Trading Advisors (CTA) enjoyed a bumper year until September, the Société Générale (SG) CTA² Index registered a loss of 2.2% over Q4. Other SG

Prime Indices revealed similar performance: the SG Trend Index finished down 3.9% for the quarter - but still showing a 9.2% gain for the year. Poor performance was most prominent in the months of October (the then hitherto primary performance driver, bonds, detracted as yields jumped), and December (aggregate long positioning of CTAs in the greenback detracted as the US dollar lost nearly 2% on higher risk appetite). Finally, the BarclayHedge CTA Index³ (-0.3% over the quarter) registered similar performance.

Looking at the non-specific returns across asset classes with the application of a generic trender signal,⁴ performance among interest rate asset classes delivered the worst performance, with the majority of contracts showing negative performance. Returns within the Commodity sector showed particularly wide spreads between the best and worst performers, while dollar positioning suffered against most currencies. Equity index contracts, however, were nearly uniformly positive.

The one year rolling average absolute correlation between all futures contracts, taken as an indicator of CTAs' ability to diversify, continued to fall further during Q4, reaching close to 14% at the end of December (similar levels from one year earlier). The correlation, between bonds and equities (with the US 10-year and US benchmark indices taken as proxies), increased marginally, finishing the year at -45%. This constitutes a near 20 percentage point increase in the negative correlation from the beginning of 2019.

Hedge Funds saw \$4.45 billion of inflows in November, breaking an eight month streak of monthly redemptions from the industry. Assets, nonetheless, declined overall in 2019.

Total return for Equity Market Neutral (EMN) and CTA hedge fund indices 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.

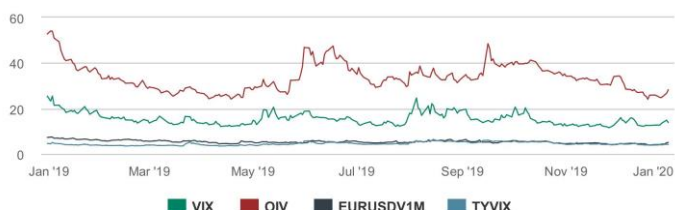
² The Société Générale CTA index is an equal-weighted index of the twenty largest (as measured by assets under management) trend following CTAs, who are recognised as such within the industry and are open to new investment. For construction methodology and a full list of constituents, see: <https://cib.societegenerale.com/en/prime-services-indices/>

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 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: $S_n(t) = \frac{p(t-1) - (p)_{n,t-1}}{\sigma_n(t-1)}$

⁵ The EMN index is that calculated by HFR, while the CTA index is calculated by Société Générale.

The principal implied volatility indices across four asset classes over the past year⁶



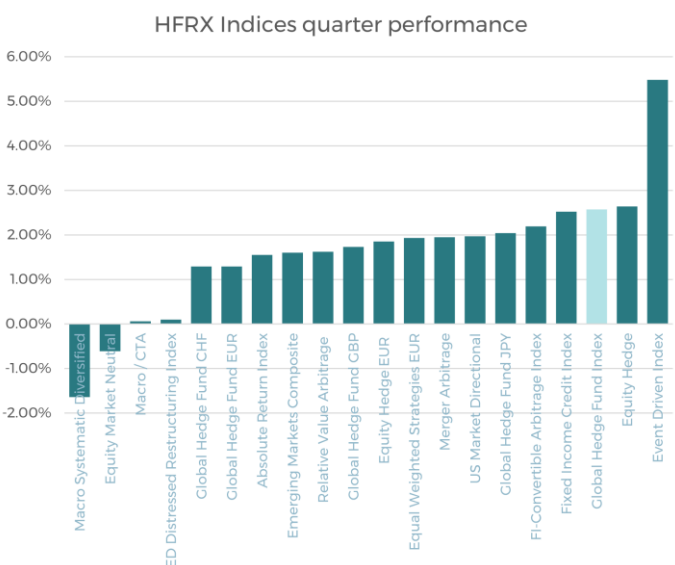
The log of the dollar risk weighted average daily volume across futures on the four asset classes over the past year⁷



The return of the generic trender⁸ referenced in the text over the past year



HFRX Indices quarter performance



⁶ For the EUR/USD exchange rate we use the Bloomberg defined EURUSDVIM ticker. The VIX, TYVIX, and OIV indices are calculated and published by the CBOE.

⁷ 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.

Trading news and regulation

The goal of “research unbundling” in MiFID II, i.e. requiring asset managers to explicitly pay for broker research, was to resolve concerns over conflict of interest with clients. Previously, it had been common practice to pay with soft dollars, i.e. directing more business (such as trades and prime brokerage) of the funds managed towards preferred brokers. Then, commissions paid by the funds, not the manager, would finance research, potentially at the expense of final investors. In November [the SEC announced](#) a long awaited extension to uphold the validity of this MiFID II principle in the US, [as was hinted earlier](#). They found that [the rule is working well](#), and it leads to savings for investors by improving asset managers’ accountability on costs. Under SEC rules, broker-dealers were prohibited from receiving payment up until 2017, the reverse of the MiFID II position.

The other hotly debated conflict of interest topic is around [rebates for order flow](#) from exchanges to brokers. These risk incentivising traders to send orders that are not necessarily in the best interest of the client, in order to be paid “kickbacks” by the exchange. This is becoming ever more problematic now that major retail brokerage platforms are waging a price war: many of them have slashed their nominal fees to zero, a change that went live in October. In order to compensate for lower per trade revenue, platforms are looking to make up in volume. They are trying to [attract clients with less savings](#) by [allowing trades in fractions of a share](#). (Indeed, in some popular listed companies a single share may cost too much for the average retail investor.) The retail landscape ultimately affects market microstructure and in turn institutional access to liquidity. It is worthwhile keeping an eye out for further developments in this space.

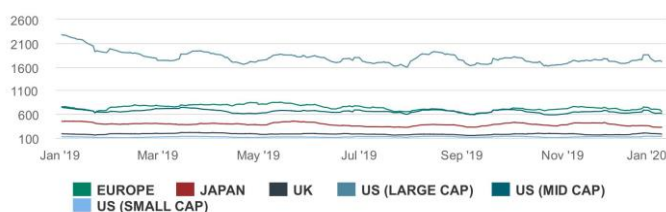
Index investing has been tremendously successful over the past decade. The “Big 3” firms now manage a combined \$15 trillion in assets, and the [sector is under increasing scrutiny](#). Beyond questions of whether such mega-firms are too big to fail from an investment point of view, they also [strongly concentrate voting power](#) for listed equities. Investors have overlooked some concerns thanks to the cheapness of such funds which puts [downward pressure on management fees](#) and the decade-long equity bull run. Is this success, however, likely to last?

Another major stakeholder in the passive investing business is a multitude of index providers who create the

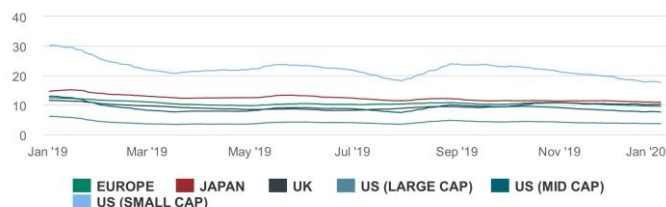
⁸ Our generic trender is calculated as laid out in our ‘Two centuries of trend following’ paper, which is available on our website: <https://www.cfm.fr/insights/two-centuries-of-trend-following>. The trend signal is calculated as the difference of the last price and an exponential moving average of the past 5 months’ prices, divided by the volatility: $S_n(t) = \frac{p(t-1) - (p)_{n,t-1}}{\sigma_n(t-1)}$. The instruments are equally risk weighted in the portfolio.

methodology for what passive funds actually invest in. Index composition is ultimately a discretionary choice, [which leaves room for deals and politics](#). The providers propose their services to managers who wish to “replicate” index performance in products for a licensing fee whose level varies quite significantly. The upside of index tracking is that it limits the ability of managers to take large discretionary bets. On the other hand the underlying methodology is mostly public, and readily reverse engineered by hedge funds to front-run the passive funds. Because fees in passive management have dwindled, the index providers themselves also face fee competition. A subsidiary of Deutsche Börse has recently announced a [do-it-yourself platform](#) for investors looking to create cheap, customisable indices.

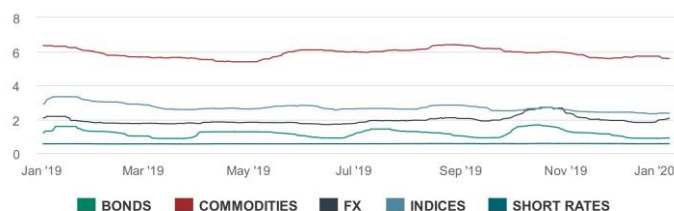
Average monthly dollar equity market volume in billion USD



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

The Jupyter notebook is used by millions of data scientists for tasks such as data manipulation, visualisation and machine learning. The code of its interactive widgets was in need for an overhaul so as to make these even more powerful: CFM hosted a dozen international contributors (half of them from the core Jupyter team) for a full week of

collaboration and coding. Outcomes included the release of a new version of the interactive map widget [ipyleaflet](#), [drag and drop in widgets](#), and more generally great progress towards the release of ipywidgets 8.0, which will provide features for the more modern Jupyter Lab notebook.

At the turn of the year, CFM's 2019 Challenge Data on return prediction [concluded](#), whilst the 2020 Challenge Data on the [prediction of the next trading venue](#) was launched. The [Challenge Data](#), which is sponsored by CFM, is going from strength to strength: this year, as many as 17 companies and institutions are offering challenges. As always, professors are welcome to let their students enroll in the Challenge for a given period of time – the website automatically gathers student scores and reports and is ideal for student projects. Thanks to the CFM Challenge Data, professors thus have a very convenient way of testing the mastering of machine learning techniques applied to finance.

Market highlights

Equity indices

Equity markets delivered a consistent upward grind in Q4, with global developed equity markets delivering ~8.6% in Q4 (and 27.7% for 2019 – the best yearly performance since 2009). Underlying this surge in equity performance were four main exogenous drivers: improving trade expectations (US-China trade negotiations improved and culminated in the promise of a 'Phase 1' deal), easing of monetary policy (near-synchronised interest rate cuts and liquidity injections by major central banks), an improved economic outlook (macro indicators, especially related to the US consumer), and removal of key political uncertainties (predominantly Brexit where PM Johnson convincingly carried the UK General Election in early December).

In the US, the S&P 500 gained 8.5% in Q4 (9.1% for the total return variant), and 29% for 2019. Equity sector performance showed distinctly heterogeneous returns: defensive sectors trailed (Real Estate was down -1.34% and the only sector not delivering positive gains in Q4), while Information Technology surged 14% (the best performer and ostensibly a key beneficiary of improved trade relations). These large differentials have been cited as one reason why active managers underperformed the market: having been underweight in the Technology sector (a feasible proposition given the uncertainty about trade

negotiations for much of the year), would certainly have led to trailing the market.

Volatility was low: yearly volatility lows for 10, 30, and 50-day rolling standard deviation of the S&P 500 were registered Q4, while implied volatility – as proxied by the CBOE VIX Index – tumbled from above 20 points during the first week of October, to below 12 points by end-November. Heightened implied volatility during early December as trade-talks looked shaky was short-lived, with the VIX settling at below 13 points at year-end.

Whilst the majority of developed markets made strong gains, it was emerging market bourses that benefitted most from the risk-on mood that took hold in Q4. Asian stocks, and especially Chinese firms, shined. The Shanghai CSI 300 index jumped 10.3%, while the beleaguered Hang Seng gained 8.7%.

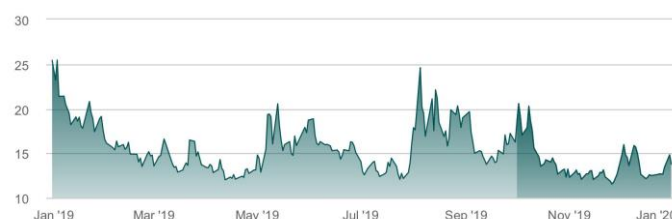
When applying our generic trender signal, the future contract on the Taiwanese benchmark Index, listed on the Singapore SGX, emerged as the best performer. The Taiwanese benchmark gained 18% in Q4, given impetus by the improving trade landscape in general, and, by extension, the global semiconductor business (with technology stocks making up half of the Taiwanese stock market). Taiwan Semiconductor Manufacturing Company – the world's largest semiconductor foundry, and major constituent in the index (~37% weight), raced 26.3% higher in Q4 (in US dollar terms). The Taiwanese contract was, accordingly, the most overbought index, reaching a maximum Relative Strength Index (RSI)⁹ of 69 points on 7 November. Considering volatility index futures as inherently part of the equity index stable, the VIX futures contract featured the lowest RSI of 37 points, registered on 29 November, with implied volatility reaching its lowest level since October as the US-China trade negotiation standoff relaxed.

Contrarily, the UK benchmark featured the worst performance with our trender applied. The UK benchmark has been subject to wild swings, with investors subject to lingering uncertainty about UK politics, Brexit, and the direction of the pound. The index lost 2.2% in October (in sterling), before recovering in November and December (but not before a nearly 1.5% sell-off during the first week of December).

Finally, the CBOE Skew index¹⁰, a widely tracked measure to gauge investors' sensitivity to skew risk, i.e. the likelihood of large 'outlier' returns in the S&P 500, jumped to its highest level since September 2018 (reaching 150

points – a level closer to 100 indicates a normally perceived distribution of returns). Following the burst of volatility during the first week of December, as uncertainty about future trade negotiations returned, the index suggested markets assigned a higher probability of additional large returns. The index, however, swiftly retracted but still closed out at a yearly high.

CBOE VIX index



Stocks and equity factors

Factor-based investment strategies recorded a negative quarter, with the HFRX Equity Market Neutral Index (HFRXEMN) down -0.6%. The EMN strategy recorded a negative year overall, with the index registering a -1.9% return. Q4 saw a strong preference for cyclical and high volatility securities – concomitant with the risk-on sentiment among investors subsequent to the broadly positive-received US-China trade negotiations.

In a reproduction of the Fama-French-Carhart factors, the Small Minus Big (SMB), or Size factor showed the best returns in Europe, followed by the US, while the factor was flat in Japan. The impetus for the equity rally in Q4 was in large part the optimism about less restrictive global trade, inherently less relevant for smaller companies that typically have a stronger domestic focus.

The significant rotation from Momentum (and Quality) into Value stocks in Q3 seemed to have been short-lived. The High Minus Low (HML) factor registered negative returns in both the US, and Japan in Q4. Meanwhile, the returns in European Value stocks were flat.

After the havoc caused by the rotation in September Q3, all regions showed positive performance in the Momentum (Up-Minus-Down or UMD) factor, with the US leading.

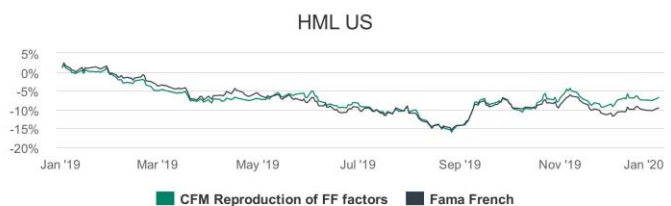
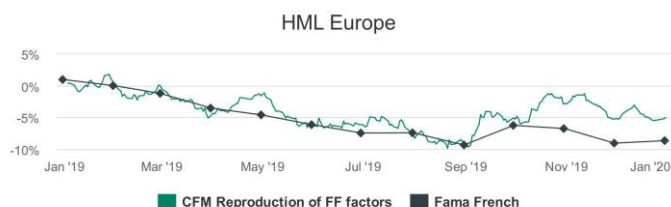
Turning to the long only implementations of factors, Quality Indices performed the best over Q4. Quality stocks, especially in the US, registered good returns: this factor is biased to the Technology sector, those firms showing

⁹ 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.

¹⁰ 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>

good profitability metrics (combined with lower debt levels). The Tech sector was the best performing sector in Q4 in the US, with the Nasdaq gaining 12.2%, compared to the S&P 500 which increased 8.5%. Value indices, favoured during the Q3 “Momentum crash”, lagged along with Momentum.

The Fama-French factors for the last year in Europe, Japan & 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

Global fixed income delivered positive returns in Q4, with a basket of investment grade sovereign and corporate bonds gaining 0.5%. Riskier fixed income categories such as high yield and emerging market bonds fared better than investment grade, in part reflective of the improved mood amongst market participants – the Bloomberg Barclays Global High Yield TR Index rose 3.5%.

The average yield on investment grade continued to fall: the yield on US investment-grade corporate bonds fell from 4.1% at the beginning of 2019, to ~2.8% by Christmas. By year-end, the spread between AAA corporate bonds and US 10-year yields reached 108 basis points (the lowest since February 2018), from the high of 144 basis points in early August, supporting the narrative that investors have greater peace of mind in the growth and earnings

prospects of US firms following the preliminary outcome of the trade talks. Meanwhile US BBB credit spreads also narrowed, reaching a low for the quarter (and year) of 1.25% on 31 December.

While US treasuries rallied through 2019, Q4 featured a discernible reversal: US 10-year yields finished 28.2 basis points higher. The yield curve also steepened, with shorter-dated notes falling (e.g. 1-month dropping 32 basis points), as the longer-dated end rose. This trend received a boost in October, when the US Federal Reserve cut interest rates for a third time in 2019 (on the 30th) to a range of 1.5%-1.75%, but hinting that there won't be any further monetary policy easing in the immediate future: as per Fed Chairman Powell, "we see the current stance of monetary policy as likely to remain appropriate." Volatility of bonds also relaxed, with the TVIX Index (the options derived volatility of US 10-year futures in 30 days) falling to its lowest level since May (reaching 3.87 points mid-December, from 5.7 points on 1 October).

When applying our generic trender, the German Bund was the best performing contract, while the Australian 10-year the worst. The German 10-year benchmark jumped 38 basis points in Q4, markets positioning towards riskier assets. Germany avoided a recession in the third quarter, GDP growing by 0.1%. The Bundesbank predicted weak, but positive growth in the fourth quarter of 2019, while noting – supported by macro data – that the country's industrial sector is stabilising. The spread between the US 10-year benchmark and the German 10-year Bund narrowed slightly, from 2.2% at the end of Q3, to 2.1% at the beginning of 2020.

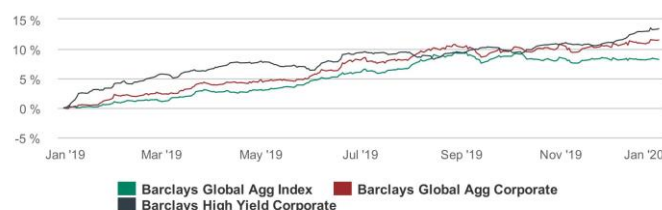
The Australian 10-year featured a choppy quarter. The yield gained 12 basis points in October, largely on data showing the seasonally adjusted unemployment rate fell to 5.2% (in September), investors betting the data was good enough to keep the Reserve Bank of Australia (RBA) from cutting rates at their November meeting. Yields however retreated 11 basis points in November (as the Sino-US trade talks were looking shaky), before jumping 37 basis points in December (the Australian mid-year budget update delivered in December, included a downgrade of economic growth and wages).

The lowest RSI of 40 points was reached on 24 December by the Japanese 10-year Bond, while the Australian 10-year recorded the highest RSI of 61 points on 8 October. The highest RSI in Short Term Interest rates, meanwhile, was that of the Short Sterling (66 points), attained on 9 October following heavy buying going into Q4.

The benchmark Barclays Global Aggregate suite of indices offered positive returns: the Total Return Index (unhedged)

returned 0.49% over the period (-0.49% for the hedged version), while the sister Global Aggregate Corporate Total Return Index (unhedged) gained 1.8% (+0.82% for the hedged derivative).

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



Commodities

On aggregate, commodities settled higher, boosted by the improving economic outlook. The Bloomberg Commodity index rose 4% in dollar terms, owing largely to the strong performance by its biggest constituent, Gold (~14% weight in the index).

The rally in Gold continued, in similar fashion to the previous quarter, gaining 3% (ending 15.5% higher for the year). Safe-haven buying given the high levels of geopolitical uncertainty (Brexit, US-China trade, Iran); dovishly-tilting global central banks (and those same banks buying 12% more gold from one year earlier); along with record inflows into Gold ETFs all contributed to the metal reaching a decade high.

However, Palladium was the best performing precious metal (and commodity) in Q4. The contract surged 16.4%, by the perfect cocktail of lower supply (rolling black-outs have hampered production in South Africa which is responsible for 40% of total global output) with substantial and growing demand (80% of total output of metal is used in catalytic converters which are becoming indispensable under more stringent air quality and pollution regulations).

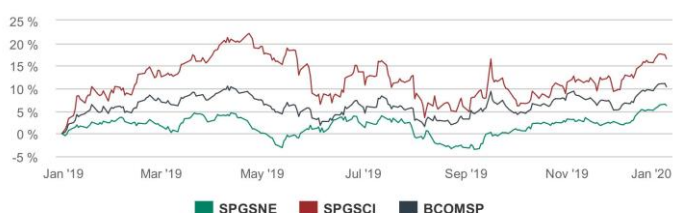
Staying amongst metals, the price of copper trended lower for much of the year on lingering recession fears. In early November, however, the metal benefitted from a shot in the arm – the announcement that the US and China were working towards a 'phase one' trade deal. Copper is particularly sensitive to economic prospects in China, and, by extension the Asian region. China itself is responsible for nearly half of all copper imports, with Japan and South Korea combined accounting for nearly a fifth. With economic prospects improving, the metal gained 8% in Q4. With the generic trender applied, Copper was the worst performer. A short position – on

account of a consistent downward price pressure in Q2 and Q3 – detracted as the metal spiked early on in Q4.

Contrarily, Coffee was the best performer with our generic trender applied. The global benchmark Arabica contract surged 12.9% in November, reflective of lower production yields expected in Brazil, the world's largest producer. (Exports from Brazil fell 9.8% in September, exacerbating supply constraint fears going into Q4). The weakness of the Brazilian real in November (-5.1% against the greenback) also played a supportive role in the spike. Overall, the contract registered a 23.8% gain in Q4 – the best quarterly performance since Q1 2014. Consequently, the Arabica contract recorded the highest RSI, reaching 65.5 on 13 December and close to overbought territory. However, its Soft Commodity peer, Soybeans, recorded the lowest RSI of 42 on 3 December. Uncertainty about the outcome of US-China trade negotiations (the Middle Kingdom is by far the largest consumer, importing two-thirds of global output) kept downward pressure on soy prices for most of the quarter (only marginally better than flat in October, but -5.7% in November).

Meanwhile, the market for Energy ticked higher, with the benchmark Brent contract gaining 8.6% – interrupting a two-quarter losing streak. Oil prices gained impetus on the prospect of a US-China trade deal, OPEC and its allies having clinched a deal to deepen cuts by a total of 1.7 million barrels a day, and new regulations cutting sulphur content in marine fuel also favouring 'sweeter' Brent and Crude. The CBOE/Nymex Oil Volatility Index ticked lower three months on the trot, dipping from ~40 points at end Q3, to below 30 at month-end December.

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



FX

The US dollar gained 3.4% YTD as of 30 September, with investors seeking out safe-haven assets amidst the ongoing trade war, the US economy looking less shaky than its G10 peers, and relatively higher interest rates than the rest of the developed world (this despite the Fed cutting interest rates). However, the greenback fell 3% as per the DXY Dollar index in Q4 – its worst quarter since Q2

2017 – and erasing most of the gains in Q1-Q3. The euro, the largest weighting in the DXY Index (57.6%), gained 2.9% against the greenback – most of these gains booked in October as Brexit optimism surged (see pound performance below). Meanwhile the Fed's Trade-Weighted (or Broad) index, dominated by the major trading partners of China, Canada, Mexico, and the Euro-area, receded 1.2%.

The US dollar fell victim to further downward pressure as the Fed cut interest rates. Moreover, expectations for interest rates by Fed officials were also revised downward during the quarter: the Fed's 'Dot-plot' – FOMC members' expectation for future interest rates – showed a lowering of the median year-end 2020 target rate to 1.625% (following the December meeting), down from the 1.875% median at the September meeting.

Applying our generic trender, the British pound was the best performer among G10 currencies. Sterling has been strained under incessant Brexit uncertainty, much of which started to moderate in October. The pound rallied 5.3% higher in October as talks between Boris Johnson and EU negotiators looked like producing a result before the then 31 October deadline. A disorderly no-deal exit from the EU, the biggest risk to the currency, had thus been mitigated. The gain was accompanied by increased volatility: one-month-at-the-money implied volatility reached 14 points mid-month – the highest level since November 2018, and the highest for any G10 currency in 2020). The pound moved sideways in November, but gained further momentum in the final months after Boris Johnson and his Conservative party won a clear majority in the general election on 12 December. Sterling ended the quarter 7.9% better against the greenback.

Contrarily, the Canadian dollar was the worst performer. The loonie endured a tumultuous period, gaining 0.6% in October on improving trade prospects supporting the major oil exporting dependent economy (the marginal MoM gain hid a 1.8% intra-month gain), only to forfeit 0.9% in November (after the Bank of Canada cut its economic growth forecast accompanied by indications that monetary policy is likely to become more accommodative). Then, the loonie increased 2.2% against the greenback in the final month as news that the US and China will sign their phase one trade deal in January 2020 (a fifth straight month of job growth also supported).

Amongst all currencies, the Russian rouble was the best performing currency in Q4 when the generic trender is applied. The rouble gained 4.5% against the dollar, fanned by strong OFZ (Russian bond) buying, improving trade prospects, and the Fed lowering rates in the US. The rouble, consequently, reached the highest RSI of 63 points

on the last day of the year. The lowest RSI was attained by the Chinese yuan (37 on 3 October), which, after a tumultuous Q3, continued to make modest gains and moved back close (and on occasion) below the symbolic 7 yuan-to-the-dollar mark. The majority of emerging market currencies enjoyed a welcome rebound from Q3 in the risk-on environment, with the JP Morgan Emerging market currency index gaining 1.9%.

Extended abstract

Conditional correlations and principal regression analysis for futures

Paper by Armine Karami, Raphael Benichou, Michael Benzaquen and Jean-Philippe Bouchaud

We explore the effect of past market movements on the instantaneous correlations between assets within the futures market. Quantifying this effect is of interest to estimate and manage the risk associated to portfolios of futures in a non-stationary context. We apply and extend a previously reported method called the Principal Regression Analysis (PRA) to a universe of 84 futures contracts between 2009 and 2019. We show that the past up (resp. down) 10 day trends of a novel predictor – the eigen-factor – tend to reduce (resp. increase) instantaneous correlations. We then carry out a multifactor PRA on sectorial predictors corresponding to the four futures sectors (indexes, commodities, bonds and currencies), and show that the effect of past market movements on the future variations of the instantaneous correlations can be decomposed into two significant components. The first component is due to the market movements within the index sector, while the second component is due to the market movements within the bonds sector.

Other news

- ▶ CFM won *Quant Hedge fund Manager of the Year* and *Alternative Risk Premia Manager of the Year* at the Professional Pensions Investment Awards in October in 2019. For all the details, see their website: <https://www.investmentawards.co.uk/static/home>
- ▶ CFM collected the best Diversified CTA award for our Discus Programme at the HFM European Quant Awards 2019. Details are on the website of HFM:

<https://hfmeuquantperformanceawards.awardstage.com/#Winners>

- ▶ CFM hosted, as part of the ongoing CFM-Columbia University Data Initiative, its inaugural event on the Columbia campus in New York entitled *Leveraging Big Data to Manage Extreme Weather Risks?* Please find additional information on this initiative and upcoming events here: <https://econ.columbia.edu/event/leveraging-big-data-to-manage-extreme-weather-risks/>
- ▶ In November we hosted our annual European Autumn Seminar in London. The afternoon was rounded off by a keynote speech from Lord Jim O'Neil on Global Risks in a Changing World. Read the highlights here: <https://www.cfm.fr/assets/Uploads/European-Autumn-Seminar-2019-summary.pdf>
- ▶ The 3rd biannual Market Microstructure workshop was hosted by the CFM-Imperial Institute for Quantitative Finance in December. For details, and how to get involved in future editions, see the event's website: <https://www.market-microstructure.net/home>
- ▶ Philip Seager, Head of Quantitative Investment Solutions, was interviewed by Institutional Investor on the topic of trend following. Read the interview here: <https://www.institutionalinvestor.com/article/blj68nkcjr08rc/diversification-underpinned-by-science>
- ▶ Oliver Schupp, Head of Investor Relations for North America, took part in a Pensions & Investments roundtable discussion on Factor Investing and Smart Beta. The full discussion is available here: <https://www.pionline.com/fismrt19>
- ▶ Laurent Laloux, Chief Product Officer, talked to the Investor Daily about artificial intelligence (AI) and its application in investment management. Read the interview here: <https://www.investordaily.com.au/analysis/45982-is-human-intelligence-redundant-in-investment-management>
- ▶ Charles-Albert Lehalle, Head of Data Analytics, presented on "Improving Reinforcement Learning Algorithms" at NYU Courant as part of their Quant Finance & Financial Data Science Working Group seminar series. More details are available on the NYU website: <https://math.nyu.edu/dynamic/calendars/seminars/mathematical-finance-seminar/3078/>
- ▶ We hosted nearly a dozen of our very successful and popular 'Food for Systematic Thought', or FFST lunches in Q4. Please get in touch with your CFM representative for further details on upcoming events near you.
- ▶ See the details of all our other upcoming events here: <https://www.cfm.fr/events/>
- ▶ Below is a selection of our recent papers:
 - > Beauty and structural complexity [arXiv:1910.06088](https://arxiv.org/abs/1910.06088) [pdf, other]
 - > Endogenous Liquidity Crises [arXiv:1912.00359](https://arxiv.org/abs/1912.00359) [pdf, other]

CFM Talks To

Jim O'Neill

Lord O'Neill has had an illustrious career spanning more than three decades, much of which was spent at Goldman Sachs where he was named Chief Economist. He ultimately became Chairman of Goldman Sachs Asset Management before retiring from the firm in 2013. Amongst his many accolades, he perhaps became most known and associated with the term 'BRICs', coined in a landmark 2001 paper entitled 'Building Better Global Economic BRICs'. He subsequently served as Commercial Secretary to the Treasury, and was appointed in 2014 by then Prime Minister Cameron to head an international review on global antimicrobial resistance. He is currently the Chairman of Chatham House, sits on the board of various think tanks and international organisations, and remains an active contributor for various media outlets. We had the pleasure of meeting Lord O'Neill at The Arts Club in London for a chat on noise, narratives, and natural language processing.



“ I occasionally ask:
“Where is AMR’s
Greta Thunberg?!”

CFM: *Noise...! We deal with evermore, and endless streams of ‘information’. What is your approach as an economist on cutting through the noise?*

JN: During my whole professional career, I used to think it was my most important task: to figure out what was noise, and what was news. Most of what we absorb every day is mostly noise, and the advent of social media, at least superficially, makes distinguishing between noise, and what is significant much harder. It is one of the reasons why I personally chose to avoid social media. I never had Facebook, nor twitter, for I can’t see, other than for increasing the amount of noise in my life, how it can be constructively beneficial.

However, although it might seem particularly crazy these days, I’m not sure it’s much different to what it’s ever been. Sure, if you get sucked into modern communication channels then it can feel that the noise-to-news ratio has changed, but I don’t believe it has.

CFM: *Would you subscribe to the notion that the bevy of new tools such as Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP) etc. have the potential to cut down that ratio?*

JN: I think the obsession about AI etcetera is part of the noise. From a forty-thousand feet view, you see ourselves living through an era of incredible tech-related developments, supposed to be improving our lives, a boon for productivity, yet, at least with the data we have, measured productivity throughout the Western world has collapsed. Do these things truly increase productivity, or do they too often act as an unnecessary distraction – I am not yet that convinced of the former.

CFM: *The European Central Bank (ECB) recently released a cache of speech transcripts, hoping, amongst others that it “will stimulate natural language processing research on the impact of our speeches on the market and beyond”. Do you have any confidence in NLP*

techniques, apart from the benefit of speed, capturing the importance or sentiment from such communications?

JN: Mario Draghi delivered, arguably, his most important speech here in London, one day before the start of the Olympics. I was sitting twenty yards away from the podium when he said that the ECB will do “whatever it takes to preserve the euro”.

I was still at GSAM [Goldman Sachs Asset Management], and hundreds of the world’s most significant asset managers were sitting in the room. I immediately realised the gravity of his words, and discussed it with him afterwards. But, I would imagine, if you did testing on that particular speech, it would be many standard deviations away from the regular stuff that is likely to register as a ‘significant’ event. For those savvy enough, they however would have been quick to react. Anyone who bought Italian bonds at that time for instance, would have been a very happy chap.

Having an algorithm or a tool delving into the weeds of everything the ECB has ever published, or ECB Executive member ever said, academically might be curious, and, if part of a business is uniquely to deal with ECB reaction functions, it might reveal some marginal interesting results. But in the scheme of things, there are, I would call it no more than ten moments in the entire history of the ECB where what was said was truly important.



CFM: *Turning to some contemporary economic topics. A theory of ‘secular stability’ has been proposed to explain*

lower volatility – not only in financial markets, but also in global economic data. How do you think this low volatility marries with a seemingly endless list of uncertainties and risks in the world today?

JN: Two things. First, linked to our discussion thus far – I am not sure it is as uncertain as everyone claims. From my experience, things are always uncertain. What is different, nowadays, is that many more have confidence about there being uncertainty. I think that the perception of uncertainty is often overblown by professionals. Markets are, and have always been uncertain. I don’t think they are necessarily more uncertain than in the past.

And secondly – much of this uncertainty is ascribed and linked to the rise of less-conventional political forces in Western countries. That is not so obviously peculiar to me, given what has transpired over the past twenty years. Arguably, capitalism has not worked as it was supposed to in textbooks, and it moreover coincided with a period when the mainstream political classes moved to the centre. Those who were left unable to benefit from the remarkable twenty years of globalisation, needed a new voice to protest. So whether it be the Five Star movement in Italy or Nigel Farage here [in the UK], or Trump – there is a certain logic to what has transpired, which in my opinion, other than the fact that it is frustrating for many of us who have come from this highly centralised ‘elite’... for want of a better word, does not translate into uncertainty. From a narrowly educated and trained point of view it might seem uncertain, as opposed to something that hasn’t been properly anticipated. But there is a difference.

“ From my experience, things are always uncertain. What is different, nowadays, is that many more have confidence about there being uncertainty. ”

CFM: *I think you’ll then agree with Robert Shiller’s new book “Narrative Economics”, in which he draws the parallel between people’s obsession and fear about losing their jobs due to AI today, and that of ‘Labour saving machines’ in the late 19th century, and ‘Automation’ in the 1950s? It is the same thing he claims, but merely a different set of events, circumstances and taxonomy in the past, and in fact, the level of ‘uncertainty’ was much higher in the past than today.*

JN: I completely agree with that. We have seen this play out in all of human history. People get sucked into fads

and fashions. There is, however, notwithstanding the danger of oversimplification, little evidence to support that this time will be any different to the past.

CFM: *A clear candidate for becoming the defining 'narrative' and one of the definitive driving forces in the economy over the coming decades is climate change. Do you agree?*

JN: Let me start by making, again, a possibly controversial statement. It is certainly one of, if not the biggest societal market failures, but, I am not wholly convinced it is the most important.

I am particularly sensitive to this debate, having spent a large part of the past five years working on, and advocating for research in antibiotic, or antimicrobial resistance (AMR), which, in terms of killing people over the coming decades, is highly likely to be much more devastating than climate change. It intrigues me that there isn't as much attention on AMR as there is on climate change. I occasionally ask: "Where is AMR's Greta Thunberg?!"

And, I facetiously wonder whether the scale of the obsession of climate change has an element of noise in it? I equally wonder why society isn't as focussed on solving AMR problems, as it is on solving climate change.¹¹

“ I facetiously wonder whether the scale of the obsession of climate change has an element of noise in it? ”

In any event, I think we are in the very early stages of an era where there will be a resolve of business to play a much more inclusive role to address society's most pressing issues, whether it be climate change, or whether it be AMR. I suspect business will have to discover more purpose beyond delivering pure returns to shareholders, to play a more active role in solving these issues.

CFM: *Where to for oil & gas companies? How do you respond to those that advocate for the divestment from these firms?*

JN: We at Chatham House have discussed this very topic as it relates to our own endowment, and considered

whether we should guide our investment managers to limit their exposure to fossil fuel companies.

My take, and the analogy I used, is that one of these companies may very well be the modern version of Nokia – who used to be one of Finland's major, if not the major pulp and paper producer. It reinvented itself to become, albeit for a brief period of time, the leading mobile phone producer in the world. To divest from all these companies, in an apparent bid to force them out of business, I don't think is particularly wise.

Some of these large oil and gas companies have every chance of reinventing themselves. Helping them with incentives to be at the centre of finding solutions for the problem is in my view the best policy.

“ Many investors are grappling with the same dilemma – they might say “I don't care if I'm being illogical, I just don't want to be on the TV with Greta Thunberg pointing her finger at me.” ”

CFM: *This is a popular counter argument. Why do you think some investors remain adamant about excluding these firms?*

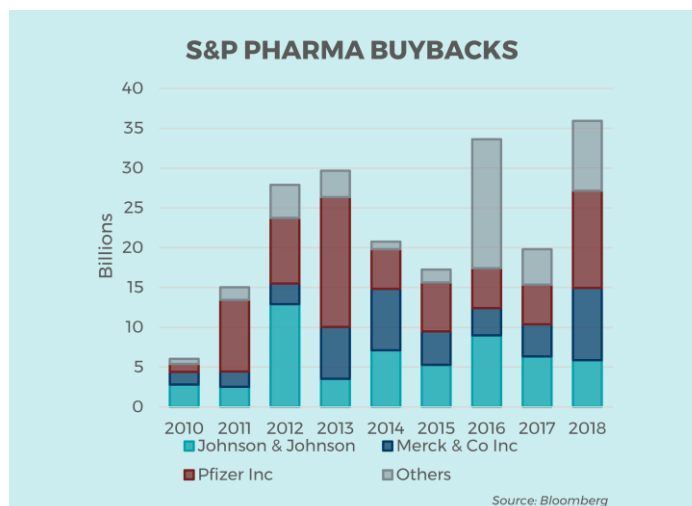
JN: It partly goes back to what we discussed earlier – investors have to contend with popular, human fads. I chair a board who are rightly wary of being blamed for anything related to fossil fuels and climate change. Many investors are grappling with the same dilemma – they might say “I don't care if I am being illogical, I just don't want to be on the TV with Greta Thunberg pointing her finger at me”.

There are, incidentally, plenty of tangential things with AMR, which our review¹² projects will cause 10 million deaths by 2050. To meaningfully address this threat, we estimate, would require funding of \$42 billion. But pharmaceutical firms are slowly getting out of the business, largely owing to a lack of returns in the short-term. And, to put that figure into perspective, I offer this statistic: in the first five years of the 2010s, J&J, Merck and Pfizer alone bought more than \$42 billion of their own stock. And yet, society is faced with a dilemma that is likely to cause millions of deaths.

¹¹ For further reading, a recent opinion piece by Lord O'Neill on Project Syndicate is recommended: <https://www.project-syndicate.org/commentary/amr-deaths-costs-climate-change-by-jim-o-neill-2019-12>

¹² Review of Progress on Antimicrobial Resistance, Chatham House, October 2019

The way to solve this impasse, is not to force companies out of business, but to prompt a change in the risk-returns calculation of the CEO and management of those companies, with the same logic for climate change. Adjusting capital adequacy ratios for targeted investment purposes such as clean energy businesses, or AMR, is I think one policy worth exploring.



Graph showing the buybacks of the largest pharmaceutical firms listed in the US. J&J, Merck and Pfizer alone were responsible for an average of 85% of all buybacks in the pharmaceutical sector between 2010 and 2018.

CFM: In summary then, and as you alluded earlier, common thinking about shareholder vs. stakeholder maximisation are parting ways with the Friedman doctrine...What do you think might be the optimal balance between regulation, and self-regulated business incentives?

JN: Rules and regulations force behaviour down a certain path. If you want to change the path, change the rules by changing the incentives and the risk-reward dynamics. Of course, the difficult bit is that regulators are typically reactive, responding to the past, rather than anticipating the future.

CFM: Any outrageous predictions you care to make for 2020?

JN: I do wonder – not with any great amount of confidence – but I do wonder whether we are getting more ingredients that will usher in the end of the fixed income bull market. It seems to me there are essentially three ingredients that drove the past forty year bull market in bonds: suppression of inflation; the past decade of quantitative easing (QE); and fiscal respectability. All three of these forces are changing.

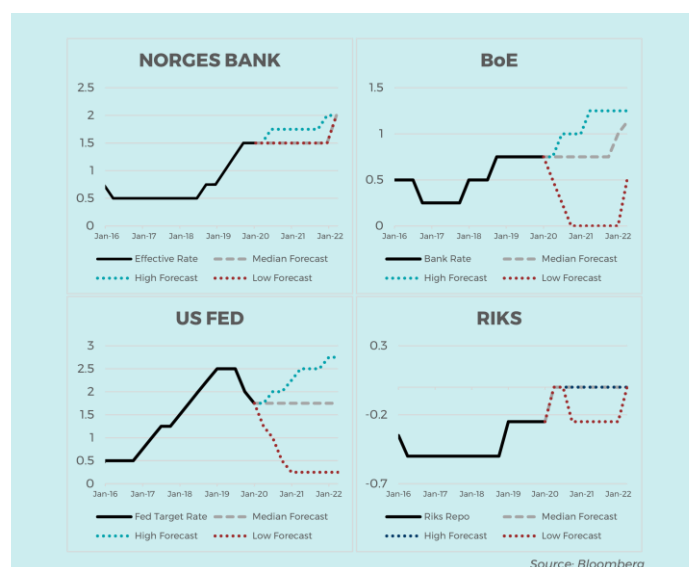
Firstly, owing to the social challenges of income and wealth inequality in particular, a number of large Western nations

are deliberately changing minimum income laws – in the UK for example, during the election [the 12 December 2019 UK general election], both major parties voiced their intention to raise minimum wages significantly.

Secondly, there is likely to be substantial fiscal expansion in the UK, and likewise in Germany and Japan.

And lastly, some of the leading, independent central banks are coming to the view that unconventional monetary policy has become counterproductive. The Swedish Riksbank, who, in my view, is one of the sharpest thinkers on inflation targeting and QE, have been raising rates. And I foresee a shift, a change in the mindset in the same direction.

Going into 2020, these three things are likely to collide, making it not inconceivable that we are moving into a more volatile period for bonds.



The median economist forecast is for rates at most central banks to remain stable up until the end of 2020. The forecasts for the Bank of England see the most dispersion, presumably on account of Brexit uncertainty and ambiguity about how the negotiations with the European Union might play out. While the median forecasts hints at little or no changes in monetary policy (the Main Financing Rate of the European Central Bank is, for instance, expected to remain at 0% at least until Q1 2022), the rates of the Riksbank and Norges banks are expected to rise slightly. The Norges Bank is seen as particularly hawkish in comparison to other central banks, with its governor having said in the past that monetary policy in Europe “has been the only player in town – too much so”.

CFM: Picking up on your comments about monetary policy, do you think it is a natural conclusion that central banks might move away from inflation targeting, or at the very least, effect a major rethink about the target levels as was hinted by Mario Draghi?

JN: I think central banks should move away from thinking of economics as a science. I think getting rid of the 1960s/70s problem of vicious inflation cycles has been a good thing, but it has been replaced by an excessive, and lingering confidence in the Phillips curve. Macroeconomic analysis has for decades relied on the trade-off between unemployment and inflation – a tenet of economic orthodoxy that has not born out since at least 2008.

CFM: *In Mario Draghi's farewell remarks, he called for a more "active fiscal policy in the euro area". Do you think new President Mme Lagarde has the ability to curry enough favour in European capitals to promote fiscal expansion?*

JN: I think she is fortunate that it is becoming so obvious, especially in Germany, that it might be easier to persuade them. For the monetary union to ultimately survive, Germany needs to loosen its rigid stance on fiscal policy. If the ECB's inflation target is, or remains just below 2%, that requires a country like Germany to occasionally, and willingly have inflation running quite a bit more than 2%. Otherwise one is subject to the likes of Italy in permanent monetary deflation – a situation which is untenable.

“ At the core of many Chinese challenges for the first half of the next decade is being wiser about their own presence in the world.

CFM: *Switching briefly to the dominant theme of 2019. Having spent a large chunk of your career analysing the Chinese economy - do you think they have the economic firepower to withstand an extended, and uncertain trade war with the US?*

JN: This can keep us busy for hours, but let me summarise:

- A. I don't know.
- B. I do worry about certain aspects of China, more than I've ever done.
- C. Because China has become one of the dominant economic powers, it is struggling to deal with its global importance. The one-party system isn't trained to deal with those who are not part of the one-party system – you observe this in the scraps China have picked up expanding its Belt and Road Initiative, and equally with the Huawei debacle and the trade negotiations. At the core of many Chinese challenges for the first half of the next decade is being wiser about their own presence in the world.

- D. This unawareness is also observed in the behaviour of Chinese business interests and tourists abroad, and the perception that is being formed in Western nations. The Chinese will need to improve this perception – China will need to deliver a bit more subtlety.
- E. China already has four times as many citizens, that every year earn as much as the average British or French person. There is no other place, other than the US, that has created that large a middle class. And yet, they still have half a billion people – at least – in low to very low income groups. Trying to keep both those groups content, is, I think, the greatest challenge facing Chinese policy makers. Lifting up the bottom part of the Chinese citizenry is the key to the sustainability of the Chinese model – if they can't, it is very likely that the central party state might start losing control.

- For more information about Chatham House, please see their website: www.chathamhouse.org
- Lord O'Neill regularly contributes to Project Syndicate. See their website for a full history of his opinion pieces: <https://www.project-syndicate.org/columnist/jim-o-neill>

Lord O'Neill spoke with André Breedt, Research Associate in the Paris offices of CFM.

Disclaimer

THE TEXT IS AN EDITED TRANSCRIPT OF AN INTERVIEW WITH LORD O'NEILL IN DECEMBER 2019 IN LONDON. THE VIEWS AND OPINIONS EXPRESSED IN THIS INTERVIEW ARE THOSE OF LORD O'NEILL 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.

Whitepaper

Extracting the News(worthy) from the Noise - Central Bank Topic and Sentiment analysis using Natural Language Processing

Executive summary

Global central banks laboured under increased scrutiny following the Global Financial Crisis (GFC) of 2008. Having embarked on extraordinary monetary policy experiments, it followed that considering shifts in prevailing central bank policy, and extrapolating any likely effects became an expedient tactic.

In the spirit of such goals, and given the European Central Bank (ECB) recently made public a cache of two decades worth of speeches, we introduce the reader to a low-level text analysis using commonly available Natural Language Processing (NLP) tools.

We highlight characteristics of the text data; reveal extractable features of central bank vernacular; identify main themes and their evolution; apply a sentiment extraction engine to measure an aggregate disposition of policy makers; and, finally, test the foretelling ability of sentiment vis-à-vis changes in monetary policy.

Introduction

In the summer of 2012, the European project was in peril. Its member countries' economies were shaky, and the euro had lost 17.2% against the greenback since its previous high in February of 2011. Then, on 26 July 2012, in a speech widely acknowledged as the most important and influential of his tenure, European Central Bank President Mario Draghi announced that the [ECB] will do "whatever it takes to preserve the euro".¹³

Reaction to his remark was immediate and significant – see the intraday euro vs. dollar exchange rate in figure 1. His commitment, in hindsight, provided enough linguistic firepower for markets to take comfort in the longevity of the euro as the single currency made positive gains against the dollar for the next six consecutive months.

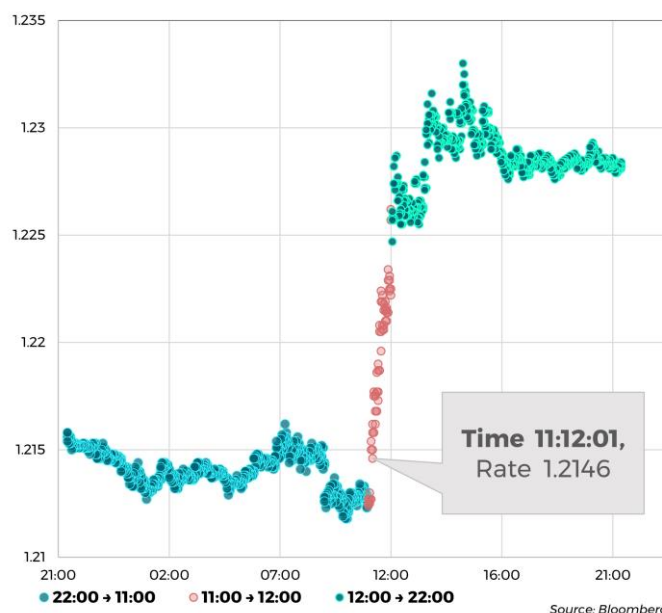


Figure 1: Intraday tick movement of the euro-dollar exchange rate over a 24-hour period from 10pm on 25 July – the day before Mario Draghi's speech, up until 10pm on the day of his speech. The euro immediately jumped on Draghi's "whatever it takes" comments, delivered briefly after the start of his speech. Compare the Bloomberg news reel time-stamps in table 2 in the appendix, and the corresponding market reaction in this figure.

Scrutinising central bank press releases, minutes of monetary policy meetings, interviews, and speeches such as Draghi's in London is routine for market professionals.

This preoccupation is in large part owing to the pivotal role central banks have played in markets since the GFC using monetary (and extraordinary monetary) policy to inject liquidity into financial markets to stimulate growth. There is, for example, common agreement that the stellar performance of equity markets, especially in 2019, was in large part due to coordinated monetary policy easing by global central banks.

Having knowledge, or even prior knowledge of monetary policy decisions can be advantageous.^{14,15}

¹³ Draghi's speech, entitled "How To Manage Current Global Challenges" was one of 18 speeches and panels during The Global Investment Conference hosted by the UK Department of Trade and Investment on July 26, 2012. Watch his speech in its entirety here: <https://www.youtube.com/watch?v=hMBI50FXDps>

¹⁴ The recent scandal that purported an advance audio feed of the Bank of England press conferences to traders support this practice, but also shows the importance of 'latency' – having access to potentially market moving information before the rest of the Street (even if only seconds or milliseconds).

¹⁵ Of the whole gamut of central bank communications, the most widely scrutinised, however, are post monetary policy meeting press releases (and often the press conferences that follow), as well as minutes of those meetings. There are various academic papers that have attempted to gauge the impact of central bank press conferences. Reeves, R. and Sawicki, M. "Do financial markets react to Bank of England communication?" European Journal of Political Economy Volume 23, Issue 1, March 2007; and Gürkaynak, Refet S. and Sack, Brian P. and Swanson, Eric T., Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements (November 2004). FEDS Working Paper No. 2004-66, are two papers which shows that BoE and FOMC statements respectively both affect interest rate expectations and asset prices.

Appreciative of its importance of this information, we explore the efficacy of extracting meaningful information from central bank communications in a systematic process. Such an approach could eliminate bias, and automation will greatly improve productivity given the vast amount of material produced by all global central banks.

In the spirit of the ECB having released a large cache of speeches, and Madame Lagarde having recently taken the reigns in Frankfurt, in this note we highlight features of European Central Bank (ECB) speeches¹⁶ using standard machine learning and NLP tools. We automate the detection of “topics”, and extract and aggregate an “off the shelf sentiment” score of the ECB. We finally test the correlation of changes in sentiment to that of key ECB policy rates.

To avoid hampering the reader with excessive technicalities, the note is not intended to comment on, nor give any mathematical details on the tools used.¹⁷ Computational linguistics is a rich and fast-developing field, and this note is an attempt to showcase some of its uses using a familiar and hotly debated topic in the contemporary economic discourse.

NLP on ECB

In October 2019 the ECB made publicly available a cache of speeches in the hope to “stimulate natural language processing research on the impact of our speeches on the market and beyond.”

The dataset holds 2,362 speeches, delivered between February 1997 and January 2020, labelled by *date*, *title* and *subtitle*, name of *speaker*, and *contents* of each entry.¹⁸ The dataset is substantial: altogether, the speeches total 7,339,742 words, which, for perspective, is approximately 13 times Tolstoy’s *War and Peace*.

See figures 2.a, 2.b, and 2.c for a breakdown of the number of annual speeches; the average length; and the observed seasonality in the speeches respectively.

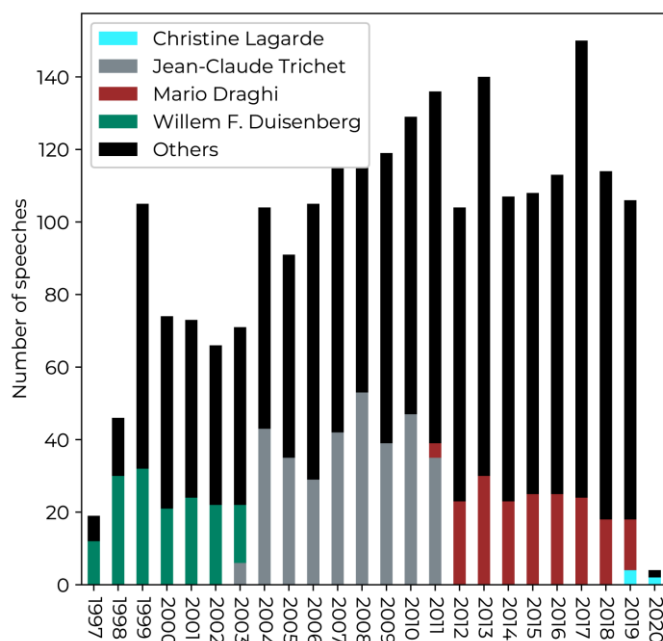


Figure 2a: The total number of speeches per year split between the respective ECB Presidents and rest of the Executive Board. Jean-Claude Trichet was a particularly prolific speaker, with a total of 329 speeches to his name – this might be due to his tenure during the financial crisis. Making up the rest of the podium is Mario Draghi, with 185 and Benoît Cœuré with 184.

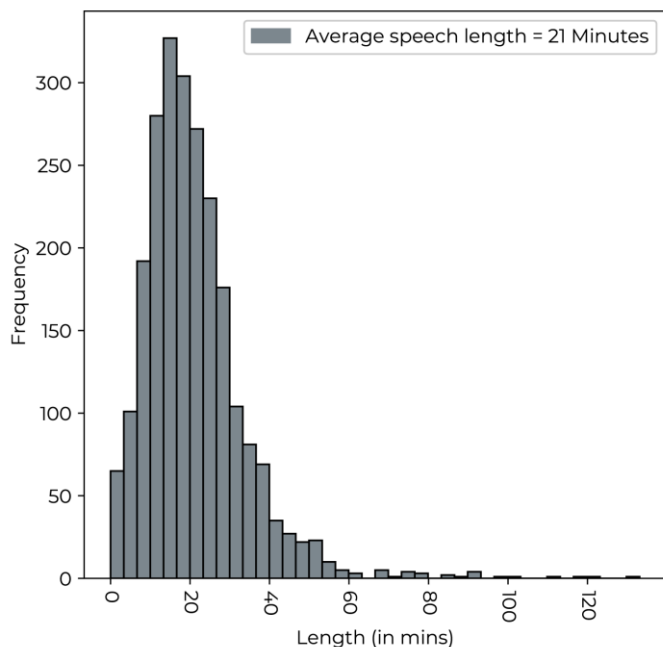


Figure 2b: A histogram of the average length of speeches in minutes. We calculate the length in time from the total word count per speech, assuming an average ~150 words per minute delivery pace. The average ECB speech comes in at 21 minutes,

¹⁶ European Central Bank. (31 January 2019). Speeches dataset. Retrieved from: <https://www.ecb.europa.eu/press/key/html/downloads.en.html>. As per the ECB’s website, the ‘Speeches dataset’ will be updated every two months. As of writing, the dataset was last updated on 31 January 2019.

¹⁷ We will make reference throughout of the tools and techniques used for analysis – many of which are open-source and come with comprehensive documentation. We will refer to these, and a selection of academic journals and blogs where appropriate.

¹⁸ The vast majority of speeches are in English (93%). Out of the six remaining languages, the majority is split between German and French with 4% and 2% of the total speeches respectively.

Month	Total Number of Speeches
J	130
F	155
M	170
A	185
M	225
J	235
J	110
A	35
S	250
O	235
N	310
D	125

ECB topic modelling

After the text is cleaned and standardised,¹⁹ a word cloud is generated as a first data consistency check. The word cloud in figure 3 confirms a prior expectation of what might be expected from central bank communications.



Whilst a variety of topic modelling algorithms exist, we employ the commonly used 'Latent Dirichlet Allocation', or LDA approach. For the purposes of this note, it suffices to know that LDA is an unsupervised learning algorithm that, given a set of text (speeches), is a mathematical method for estimating both 1). The mixture of words that is associated with a topic, while, at the same time, also determining 2). The mixture of topics that best describes each document (speech).

The LDA technique does not automatically detect the number of topics, but this, rather, needs to be determined before analysis. With prior knowledge of central bank documentation, supported by the result of the word cloud, we are confident in limiting the LDA process to *five* topics.

The output is a set of key terms sorted in five individual sets (the five topics), with each set assigned to that speech that corresponds with the highest probability to the terms in the set. We manually interpret and categorise each of these sets of terms – see figure 4.

frequently paired together – 'monetary policy', 'euro area' etc.). Finally, pre-defined 'stop-words' (as, to, on, etc.) are removed, and a 'lemmatisation' process (where inflectional endings are removed in order to return only the dictionary form of a word, known as the *lemma*, e.g. 'am', 'are', 'is', becomes 'be') completes the cleaning process.

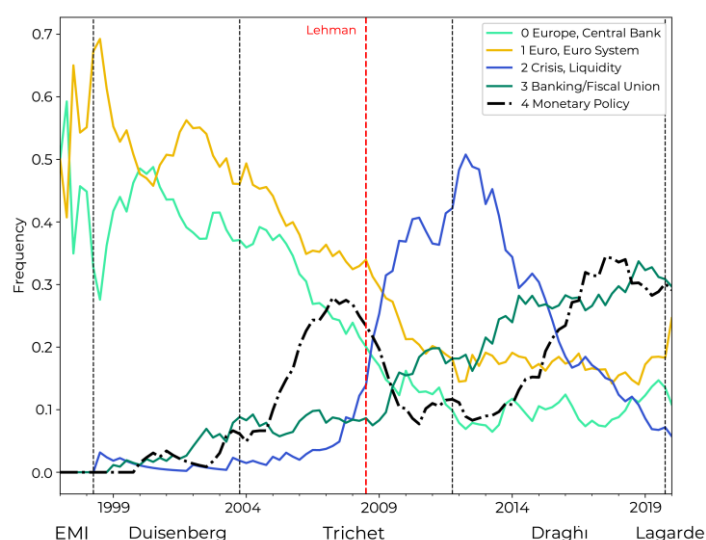


Figure 4: Key topics in ECB speeches since 1997, resampled per quarter. The series is normalised to account for the smaller number of speeches during the period of the EMI (European Monetary Institute) and the formative years of the ECB. Unsurprisingly, topics during and before the establishment of the ECB (1 June 1998) were dominated by and related to the European Union, integration, and the establishment of a central bank. There seems to be a clear transition in the dominant topics around the 2007-2008 financial crisis (the collapse of Lehman Brothers – 15 September 2008 is indicated by the dashed red line) – with many more speeches about ‘credit’ and global risks. At least until 2014, surprisingly, a downward trend in monetary policy related topics is detected. Post GFC and from the beginning of 2014 (when the ECB was exploring QE), however, has been dominated by monetary policy and the debate about closer cooperation between member states, especially around a banking union and closer fiscal alignment – consistent with what we know to be a priority for policy makers.

We conclude that topic modelling is a useful tool to monitor changes in dominant themes and to understand any policy preoccupation or thematic agenda of the ECB. Nevertheless, note that the whole dataset was used for the topic extraction algorithm.²⁰ A real time casual exercise would be more difficult and noisy.

ECB speech sentiment analysis

In order to extract ‘sentiment’ from ECB speeches, we apply a popular ‘lexical sentiment classifier’, VADER²¹ (Valence Aware Dictionary and Sentiment Reasoner), to discern an aggregate tone or disposition of each individual ECB speech.²² This classifier relies on a pre-existing, manually constructed ‘lexicon’, i.e. a list of words that are labelled according to their semantic orientation (being, e.g., either positive or negative). We use the ‘Loughran and McDonald’ lexicon that is specifically constructed for use on finance text.²³

VADER is sensitive to both the polarity (positive / negative) of words; the intensity of text; and also accounts for contextual features and qualifiers: for example: ‘not good’ will invert the valence of ‘good’, flipping the polarity (sentiment) from positive to negative.

The VADER analysis outputs a positive, negative, neutral, and compound score for any given set of text. See, for example, the scores for Draghi’s “whatever it takes” speech in table 1.

date	compound	negative	neutral	positive	speaker	title	subtitle	contents
26/07/2012	-0.9924	0.116	0.792	0.093	Mario Draghi	Verbatim of the remarks made by Mario Draghi	Speech by Mario Draghi, President of the European Central Bank at the Global Investment Conference in London 26 July 2012	I asked myself what sort of message I want to give to you; I wouldn't...

Table 1: The positive, negative, and neutral scores all range between 0 (least positive/negative/neutral) and 1 (most positive/negative/neutral). The compound score is a non-linear combination of the three other scores and is ranked from -1 (most negative) to +1 (most positive). Here, for illustrative purposes, we show the output of Mario Draghi’s “whatever it takes speech”. Paradoxically to the events that unfolded, and the commonly agreed significance of his statement, VADER assigned an overall higher negative sentiment to his speech.

²⁰ For example, we would not have known that banking and Fiscal Union would have been a key topic prior to the GFC.

²¹ C.J. Hutto and Eric Gilbert. 2014. Vader: A parsimonious rule-based model for sentiment analysis of social media text. In Proc. ICWSM-14.

²² A set of text cleaning procedures similar to those for the topic modelling exercise is affected. The text is moreover converted to lower case and we identify and remove those entries containing less than 100 words – these produce no discernible sentiment, and, a manual study found these often not to be genuine speeches (typically introductions or references).

²³ ‘Loughran and McDonald’ is an English sentiment lexicon created for use with financial documents. This lexicon labels words with six possible sentiments important in financial contexts: ‘negative’, ‘positive’, ‘litigious’, ‘uncertainty’, ‘constraining’, or ‘superfluous’. While it is fair to assume that this lexicon is an appropriate benchmark, we can do better by designing our own lexicon, which is uniquely suited to macro topics routinely discussed by central banks. This is however outside the scope of this note which is intended as an introduction to commonly used sentiment analysis tools and procedures. For further details: <https://srafi.nd.edu/textual-analysis/resources/>

In figure 5 we respectively plot the positive, negative, neutral, and compound scores of all speeches since 1997. The results are both noisy, and confirm an intuition that the majority of speeches are fairly ‘mundane’, given, as is evident from the plot, the high level of neutrality.

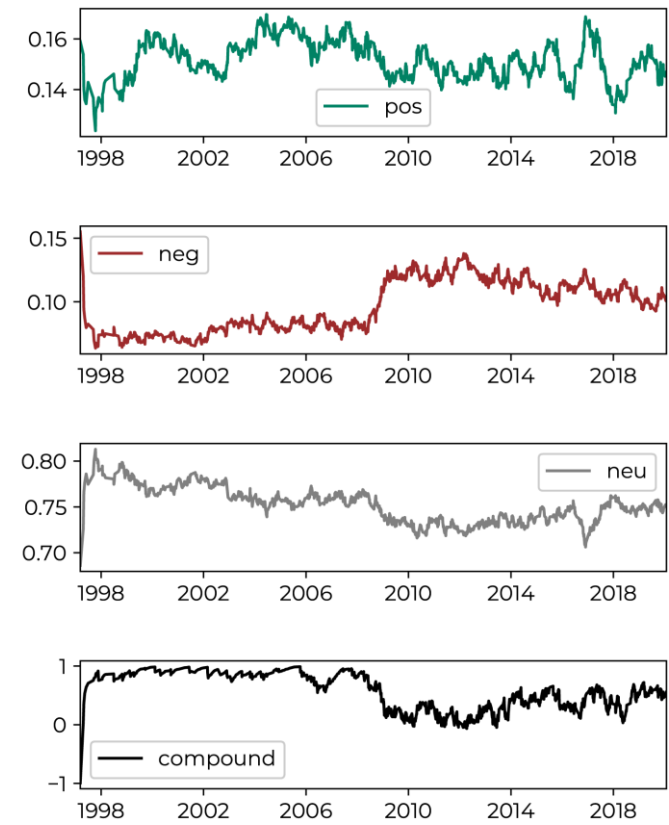


Figure 5: VADER output for each of the positive, negative, neutral, and compound scores applying a 1-month weighted moving average. We can make some initial comments: our intuition that the majority of speeches are balanced is supported, given the high level of neutrality. This neutrality is moreover comparatively persistent (bar the dip during and after the financial crisis). We observe a spike in the level of negative sentiment around 2008 – during the financial crisis, sustained throughout the 2011-2013 European debt crisis, before trending lower post-2014. It is also evident that the positive and negative sentiment scores are not symmetrical, a downward spike (or trend) in either positive or negative sentiment does not necessarily mirror its counterpart.

As the majority of speeches feature a high level of neutrality, the non-linearly combined VADER compound score regularly produces a highly binary output (slight positivity or negativity tips the balance) – see figure 6 showing the distribution of VADER compounds scores.

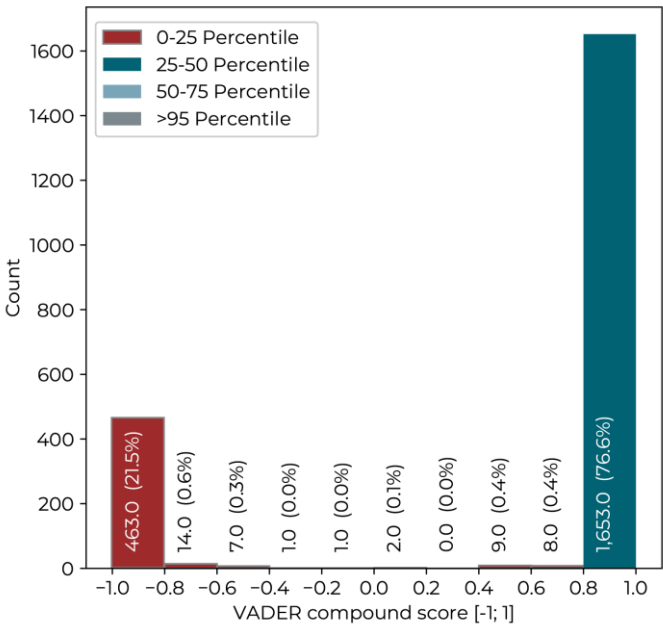


Figure 6: The distribution of the VADER compound score. The VADER sentiment analysis produces an acute binary compound score, and, moreover given the higher average ‘pos’ score (especially up until the GFC), is highly skewed towards being positive.

Given this high polarity, we favour converting the overall ‘pos’ and ‘neg’ scores into our own composite score, by taking the positive sentiment and dividing by the sum of the positive and negative sentiment scores for an output between 0 (most negative) and +1 (most positive).

$$Score_{composite} = \frac{Vader_{pos}}{Vader_{pos} + Vader_{neg}} \quad (1)$$

Also, since the *level* of sentiment is less meaningful than the *change* of the sentiment, we compute an exponentially weighted moving average in the variation of our composite sentiment measure.²⁴ See the result in figure 7.

²⁴ A merely positive or negative score in and of itself is not meaningful without any benchmark or intuition about the level of what constitutes positive or negative.

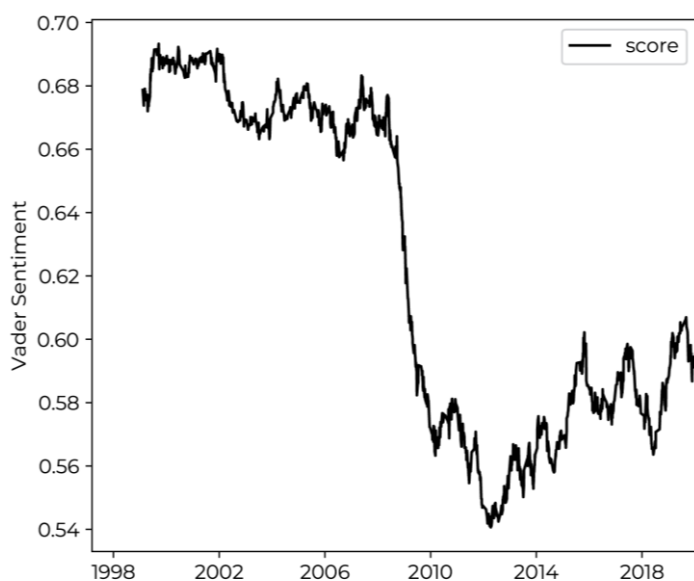


Figure 7: The 125-day (6-month) exponentially moving window of the composite sentiment score from one meeting to the next. The sentiment of the ECB is consistent and coherent with market events, but dominated by the substantial drawdown leading up to, and following the GFC. A two-regime state is observed: relatively stable (but decreasing) sentiment before 2008, and relatively stable (but increasing) sentiment after 2013.

We can conclude, given the high ‘neutrality’ score of most ECB speeches that, at least for a sentiment analyser, a neutral score is the most likely result given the majority of speeches typically consist of ‘noise’ and central bank platitudes (and ‘Greenspeak’²⁵).

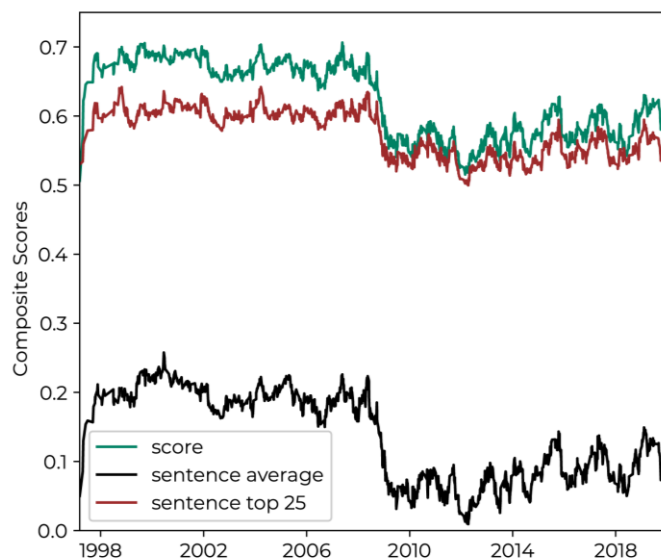
However, this high neutrality is likely an effect of any meaningful messages being ‘hidden’ amongst often verbose text. To test this theory, we extend the analysis by tokenising²⁶ each speech into its component sentences so as to minimise the dilution of the classifier over larger sections of text. The sentiment analyser is re-run, but, this time, on each unique sentence. As before, this produces distinct positive, negative, neutral, and compound sentiment scores – see table 3 in the appendix.

We use the tokenised sentiment analysis output in two ways:

- ▶ We repeat the calculation as in (1) for each sentence, producing a composite ‘sentence score’. We compute the average of all the sentence scores (of each speech), to arrive at a new composite speech score. This is labelled *sentence average*.
- ▶ To amplify the polarity even further, we repeat the process in A. above but limit the computation to only

the top 25 most positive/negative sentences of each speech, to arrive at a new composite speech score. This is labelled *sentence top 25*.

The results of this additional data wrangling does not yield meaningfully different results from the overall composite score – see figure 8. Given the high level of correlation between the competing composite score computation, we continued the analysis using the original composite score.



	Score	Sentence average	Sentence top 25
Score	1	0.96	0.91
Sentence average	0.96	1	0.89
Sentence top 25	0.91	0.89	1

Figure 8: The 1-month weighted moving average comparison of the three competing approaches of computing the composite scores for each unique speech. The cross correlation is also shown, and is high, ~ 90-96%.²⁷

Does sentiment predict policy shifts?

Using NLP to extract sentiment from ECB speeches is shown to be consistent with overall market events. Our results, however, beg the question whether changes in aggregate sentiment are indicative of future changes in monetary policy (all else being equal).

We test the correlation between aggregate ECB sentiment and monetary policy changes, using the main composite

²⁵ Fed Chair Alan Greenspan was famous for his often difficult to follow remarks. So skilled in obfuscation – a tactic commonly employed by central bankers – that these types of statements are often referred to as ‘Greenspeak’. Despite policy makers now aiming for less ambiguity, given its particular vernacular and style, extracting sentiment from central bank communications is still likely to be hampered by this feature.

²⁶ Tokenisation is a process where text is split into say, words or sentences.

²⁷ At this point, we also tested the correlation between speech length and the various sentiment scores and found no meaningful relationship.

score along with key ECB policy rates. The correlation between changes in aggregate sentiment of a preceding year, and changes in policy rates in a successive year is only ~10%, leading us to conclude that sentiment changes, in this particular type of communication, are not indicative of any changes in monetary policy. The result is seen in figure 9.

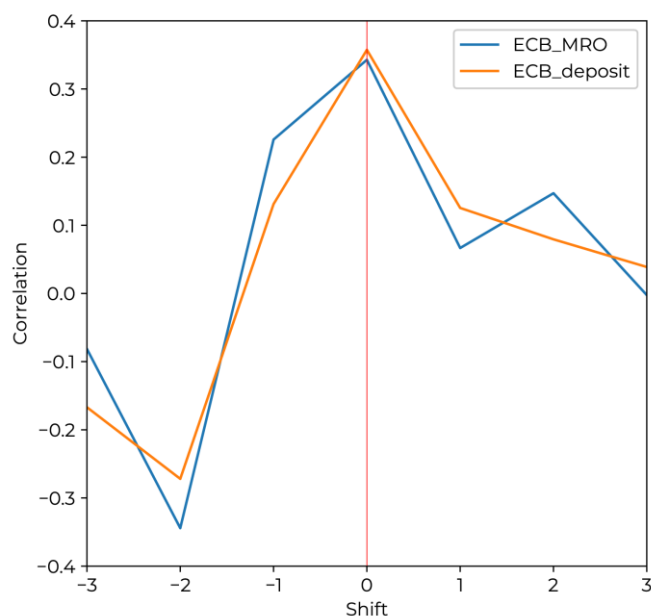


Figure 9: The correlation of the annual difference (over various annual lags on the x-axis) of ECB sentiment and key ECB policy rates. The x-axis indicates the period over which the correlation is tested: during the same annual window ('0' on the x-axis), the changes in sentiment and rates have a nearly 40% correlation – this seems intuitively coherent: when the sentiment is positive, rates are likely to be increased (a hawkish disposition), while negative sentiment is likely to go hand-in-hand with monetary policy easing (a dovish disposition). Shifting by one year (+1 on the x-axis), i.e. testing whether any changes in sentiment one year in the past are likely to be reflected in future interest rate changes shows a non-statistically significant correlation of ~10%. Controlling for the previous year's rate change does not alter the result.

Whatever it takes

We have shown a consistency between historical events and the aggregate evolution of ECB sentiment. VADER, however, is not always effective in capturing the most fitting sentiment.

The “whatever it takes” speech of Draghi is a point in case. Recall that VADER assigned an overall negative score to his speech. Refer again to table 3, noticing the highlighted section (sentences 35-42) where the individual words as per the Loughran and McDonald dictionary are tagged. VADER assigns, for example, a negative sentiment to the

sentence “And so we view this, and I do not think we are unbiased observers, we think the euro is irreversible.” In the context of the time this speech was given, an informed observer would have recognised this as positive. However, given that the word ‘irreversible’ is assigned a negative polarity, the sentence is assigned a negative sentiment.

Whilst VADER in this use case is capable of extracting a coherent aggregate, there will be those instances where it will be unable to detect slight nuances in communications, delivered in a particular context, which, moreover, as in the case of a speech like Draghi's, was time dependant. The market reaction was potent, because the simple likelihood is that the markets reacted in accordance to the prevailing economic conditions and market sentiment at the time. A month earlier, in June, the ‘sentix Euro Break-up Index’ was launched, having showed a perceived probability of 73% that at least one euro-member country would be leaving the single currency within the next 12 months.²⁸ Moreover a European Commission survey of economic sentiment hit the second lowest ever level leading up to his speech (a level that was, at that point, not seen since the GFC).

The market reaction on the day was a result of savvy, experienced traders and investors able to digest the gravity and importance of his commitment in real-time. An aggregate sentiment extraction algorithm is unable to make such a granular assessment.

Conclusion

The promise of being able to extract useful, actionable information in a fast and systematic fashion is becoming an indispensable asset for asset managers. NLP and related tools are powerful in not only mitigating the need for manual, laborious analysis of large volumes of text, but allow researchers to identify salient and important information without introducing bias or unforced errors.

We have shown in our low-level analysis that it is possible to extract topics and sentiment from ECB speeches that are consistent with history. This type of analysis is therefore, at minimum, useful in forming a global view about policy and policy direction and can be consulted especially if there are meaningful shifts.

However, it is also evident that NLP, in this particular use case, is prone to inaccuracies given the particularities of the corpus, the lexicon used, and the underlying subject matter analysed. It is an aid and not a fool-proof magic solution with results often still in need of interpretation

²⁸ The highest level the index ever reached, having fallen significantly in the months after Draghi's speech.

through an informed and knowledgeable lens. In our use-case, speeches that are likely to have a significant effect on the markets are difficult to identify, and, those which are known to have had substantial effects on the market *a posteriori*, are few and far between, making it difficult to draw any statistically significant conclusions.

Moreover, one could question the relevance of this analysis. Policy rates are expected to remain low²⁹, and there is wide agreement that any additional liquidity is unlikely to meaningfully change business investment or consumer spending, making monetary policy or central bank actions less relevant. There is equally doubt about the credibility of central banks – a critical component to enforce the effectiveness of monetary policy.

Finally, it is wise to bear in mind that central bank behaviour is not static, communication often responds to the underlying environment, and, moreover, has undergone profound changes – it has become deliberately more transparent (and more frequent). Top positions at central banks also change, with new policy makers bringing their own style and policy convictions.

All of this would necessitate an even shrewder analysis of central bank communications, making an even stronger case for developing a bespoke lexicon.

Further research

While the use of NLP tools applied to central bank speeches does not yield easily actionable insight, there are various extensions and alternatives to this low-level analysis. The first obvious effort is to include and compare the style, sentiment and cadence with other ECB (and other G7 central bank) communications.

There are also more sophisticated methods to improve the sentiment extraction, isolating only certain text that is relevant to the topic, and creation of a targeted and bespoke macroeconomic lexicon – not relying on a catch-all solution.

Moreover, it would be interesting to analyse the evolution of topics of ECB speeches now that Madame Lagarde has taken the reins in Frankfurt. In her first ECB press conference, she announced her intention to bring her own unique way of communicating to the ECB.³⁰ She cautioned the gathered audience: “don’t over interpret, don’t second-guess, don’t cross reference”. Regime shifts in style, communication methods, patterns, frequency,

policy strategies³¹, as well as changes in the timeliness of updates are all risks of blindly incorporating NLP into an investment process.

²⁹ Mario Draghi proclaiming during his final monetary policy meeting as ECB President on 24 October (when the governing council kept rates unchanged), that rates would not rise “until it has seen the inflation outlook robustly converge to a level sufficiently close to, but below, 2 per cent within its projection horizon”. The inflation print for December 2019 came in at 1.3% (same for the core rate that strips out energy prices).

³⁰ ECB Press Conference, Frankfurt, 12 December 2019: <https://www.ecb.europa.eu/press/pressconf/2019/html/ecb.is191212-c9e1a6ab3e.en.html>

³¹ The ECB for instance has launched a wide-ranging ‘monetary policy strategy review’, including a reassessment of its inflation target.

Appendix

News reel

*DRAGHI SAYS EURO-AREA MUCH STRONGER THAN PEOPLE ACKNOWLEDGE	BN	11:04:26 GMT
*DRAGHI SAYS EURO-AREA MUCH STRONGER THAN PEOPLE ACKNOWLEDGE	BN	11:04:26 GMT
*ECB'S DRAGHI MADE COMMENTS AT CONFERENCE IN LONDON TODAY	BN	11:04:26 GMT
*DRAGHI SAYS EURO-AREA PROGRESS IN PAST SIX MONTHS EXTRAORDINARY	BN	11:05:39 GMT
*DRAGHI SAYS LAST SUMMIT WAS 'REAL SUCCESS'	BN	11:06:59 GMT
Draghi Says Euro-Area Much Stronger Than People Acknowledge	BN	11:07:43 GMT
*DRAGHI SAYS FIREWALLS 'READY TO WORK MUCH BETTER THAN IN PAST'	BN	11:08:40 GMT
*DRAGHI SAYS DON'T UNDERESTIMATE POLITICAL CAPITAL IN THE EURO	BN	11:09:04 GMT
*DRAGHI SAYS THE EURO IS IRREVERSIBLE	BN	11:09:15 GMT
*DRAGHI SAYS THE ECB IS READY TO DO WHATEVER IT TAKES FOR EURO	BN	11:09:34 GMT
*DRAGHI SAYS 'BELIEVE ME, IT WILL BE ENOUGH'	BN	11:09:45 GMT
*DRAGHI SAYS ECB WILL DO WHATEVER NEEDED TO PRESERVE THE EURO	BN	11:10:00 GMT
Draghi Says the Euro is Irreversible	BFW	11:13:07 GMT
European stocks Climb on Draghi Comments; Stoxx 600 Gains 0.4%	BN	11:14:56 GMT
*IRISH TWO-YR NOTE YIELD DROPS BELOW 4%, 1ST TIME SINCE NOV 2010	BN	11:17:28 GMT
U.S. Stock Futures Erase Losses as Draghi Pledges to Defend Euro	BN	11:19:38 GMT
German Stocks Erase Decline as Draghi Pledges Defense of Euro	BN	11:26:53 GMT
Draghi Says Yields That Disrupt Monetary Policy Are In Remit	BN	11:28:02 GMT
*ITALIAN 2-YR NOTES EXTEND ADVANCE: YIELD DROPS 29 BPS TO 4.65%	BN	11:28:36 GMT
Euro Climbs Against Dollar: Draghi Says Currency is Irreversible	BN	11:29:14 GMT
Treasuries Decline; 10-Year yield Rises 2 Basis Points to 1.42%	BN	11:30:34 GMT
U.K. Stocks Climb as Draghi SAYS ECB Will Act to Preserve Euro	BN	11:31:38 GMT
German Bunds Fall, Reversing Gain; 10-Year Yield Rises to 1.30%	BN	11:32:04 GMT
MORE: Yields Disrupting Policy Transmission in ECB Remit: Draghi	BFW	11:33:35 GMT
U.S. Stock-Index Futures Climb as Draghi Pledges to Defend Euro	BN	11:39:54 GMT
Crude Erases Loss in New York as Euro Recovers Against Dollar	BN	11:40:07 GMT
Spain, Italy Bonds Advance After Draghi Pledges to Preserve Euro	BN	11:42:46 GMT
Draghi Says ECB to DO Whatever Needed as Yields Threaten Europe	BN	11:43:09 GMT
European Stocks, Spanish Bonds Rise on Draghi as Dollar Slides	BN	11:44:15 GMT
European stocks Rally as Draghi Pledges to Preserve the Euro	BN	11:48:00 GMT
Crude oil Pares Weekly Loss After ECB Says Euro Will Survive	BN	11:49:45 GMT
Emerging Stocks Rise First Day in 5 on Earnings, Stimulus Hopes	BN	11:56:37 GMT
*EURO EXTENDS GAIN VS DOLLAR TO TRADE 0.6% STRONGER AT \$1.2228	BN	11:58:03 GMT
*DRAGHI COMMENTS 'VERY POSITIVE,' SANTANDER CEO SAENZ SAYS	BN	11:59:04 GMT
European stocks Rally as Draghi Pledges to Preserve the Euro	BN	11:59:39 GMT
*DRAGHI SAYS EURO AREA MUCH STRONGER THAN SOME PEOPLE SAY	BN	11:04:26 GMT

Table 2: Extract from all Bloomberg 'Top Stories' restricted to those news pieces referencing news on Mario Draghi and the ECB from 11:00 to 12:00 GMT. (Rolling news banners are also included, but limited from 11:00 to 11:10 GMT. An asterisk indicates the absence of text, i.e. is only a headline.

Whatever it takes speech

document id	compound	neg	neu	pos	sentence id	sentence
1317	0.7582	0	0.908	0.092	0	verbatim of the remarks made by mario dragh...
1317	-0.3612	0.131	0.787	0.082	1	and the first thing that came to mind was some...
1317	0	0	1	0	2	this is a mystery of nature because it shouldn...
1317	0.3384	0	0.821	0.179	3	so the euro was a bumblebee that flew very wel...
1317	0	0	1	0	4	and now – and i think people ask “how come?” –...
1317	-0.6124	0.211	0.789	0	5	now something must have changed in the air, an...
1317	0	0	1	0	6	the bumblebee would have to graduate to a real...
1317	0	0	1	0	7	and that’s what it’s doing.
1317	0.8885	0	0.687	0.313	8	the first message i would like to send, is tha...
1317	0.8674	0	0.813	0.187	9	not only if you look over the last 10 years bu...
1317	-0.7579	0.351	0.649	0	10	then the comparison becomes even more dramatic...
1317	-0.872	0.522	0.478	0	11	the euro area has much lower deficit, much low...
1317	-0.5086	0.164	0.836	0	12	and also not less important, it has a balanced...
1317	0.2716	0	0.901	0.099	13	that is a very important ingredient for undert...
1317	0.7579	0	0.755	0.245	14	the second point, the second message i would l...
1317	0.6124	0	0.867	0.133	15	if you compare today the euro area member stat...
1317	0.6124	0	0.6	0.4	16	and this progress has taken different shapes.
1317	0.75	0	0.878	0.122	17	at national level, because of course, while i ...
1317	0.8462	0	0.843	0.157	18	but i would say that over the last six months...
1317	0.5574	0.204	0.408	0.388	19	the progress in undertaking deficit control, s...
1317	0	0	1	0	20	and they will have to continue to do so.
1317	-0.4215	0.123	0.877	0	21	but the pace has been set and all the signals ...
1317	0	0	1	0	22	it’s a complex process because for many years...
1317	0.7579	0	0.621	0.379	23	but a lot of progress has been done at suprana...
1317	0.6124	0	0.714	0.286	24	that’s why i always say that the last summit w...
1317	0	0.08	0.84	0.08	25	the last summit was a real success because for...
1317	-0.2263	0.101	0.899	0	26	a europe that is founded on four building bloc...
1317	-0.2263	0.046	0.954	0	27	these blocks, in two words – we can continue d...
1317	0	0	1	0	28	then in the banking union or financial markets...
1317	0.5093	0	0.867	0.133	29	and to show that there is full determination t...
1317	0	0	1	0	30	so in a month.
1317	0.3167	0	0.828	0.172	31	and i think i can say that works are quite adv...
1317	0.8674	0	0.724	0.276	32	so more europe, but also the various firewalls...
1317	0.6478	0	0.752	0.248	33	the second message is that there is more progr...
1317	0.1154	0	0.884	0.116	34	but the third point i want to make is in a sen...
1317	-0.8402	0.16	0.84	0	35	when people talk about the fragility of the euro and the increasing fragility of the euro, and perhaps the crisis of the euro, very often non-euro area member states or leaders, underestimate the amount of political capital that is being invested in the euro.
1317	-0.6249	0.231	0.769	0	36	and so we view this, and i do not think we are unbiased observers, we think the euro is irreversible .
1317	-0.528	0.15	0.79	0.06	37	and it’s not an empty word now, because i preceded saying exactly what actions have been made, are being made to make it irreversible .
1317	0.1154	0	0.847	0.153	38	but there is another message i want to tell you.
1317	0.3612	0	0.857	0.143	39	within our mandate, the ECB is ready to do whatever it takes to preserve the euro.
1317	0	0	1	0	40	and believe me, it will be enough.
1317	-0.6124	0.333	0.667	0	41	there are some short-term challenges , to say the least.
1317	-0.6124	0.174	0.826	0	42	the short-term challenges in our view relate mostly to the financial fragmentation that has taken place in the euro area.
1317	0	0	1	0	43	investors retreated within their national boun...
1317	0	0	1	0	44	the interbank market is not functioning.
1317	0.4767	0	0.86	0.14	45	it is only functioning very little within each...
1317	-0.6652	0.164	0.792	0.045	46	and i think the key strategy point here is tha...
1317	0	0	1	0	47	there are at least two dimensions to this.
1317	-0.6124	0.118	0.882	0	48	the interbank market is not functioning, becau...
1317	0	0	1	0	49	so the first reason is that regulation has to ...
1317	-0.8402	0.211	0.789	0	50	the second point is in a sense a collective ac...
1317	0	0	1	0	51	and they ring fenced liquidity positions so il...
1317	-0.6124	0.222	0.778	0	52	so even though each one of them may be right, ...
1317	-0.6124	0.308	0.692	0	53	and this situation will have to be overcome of...
1317	-0.6124	0.5	0.5	0	54	and then there is a risk aversion factor.
1317	-0.7269	0.587	0.413	0	55	risk aversion has to do with counterparty risk.
1317	-0.6124	0.174	0.826	0	56	now to the extent that i think my counterparty...
1317	0	0	1	0	57	but it can be because it is short of funding.
1317	0.4939	0	0.882	0.118	58	and i think we took care of that with the two ...
1317	0.4939	0	0.556	0.444	59	we took care of that.
1317	-0.8402	0.308	0.692	0	60	then you have the counterparty recess related ...
1317	0	0	1	0	61	we can do little about that.
1317	-0.2023	0.083	0.917	0	62	then there’s another dimension to this that ha...
1317	-0.631	0.171	0.829	0	63	these premia have to do, as i said, with defau...
1317	0	0	1	0	64	now to the extent that these premia do not hav...
1317	0	0	1	0	65	they come within our remit.
1317	-0.6124	0.148	0.852	0	66	to the extent that the size of these sovereign...
1317	0	0	1	0	67	so we have to cope with this financial fragmen...
1317	-0.296	0.167	0.833	0	68	i think i will stop here; i think my assessmen...
1317	0.3612	0	0.286	0.714	69	thank you.

Table 3: The sentiment output of each individual sentence of Draghi’s “whatever it takes” speech. The computational approach remains unchanged, except VADER assigns the same set of four scores to each sentence individually. An extract of the speech (sentences 35-42) is highlighted, and those words and their affiliations that appear in the Loughran and McDonald dictionary tagged.

Legend: **Negative** **Litigious** **Uncertain**

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