

Even sillier seasonality

Using machine learning to find a seasonal edge

- ◆ We are seasonal sceptics, finding time and again very little evidence to support strong seasonal patterns in markets
- ◆ But what if seasonality shows up in a non-linear fashion, maybe in some kind of predictable quarter-end rally?
- ◆ To debunk this latest hypothesis we used tree-based machine-learning models on the S&P 500

We are strong seasonal sceptics. If anything, the only reliable seasonal pattern we see in financial markets is the time of the year that financial media suggest seasonality could be a dominant driver. This timing is reflected in our publications on seasonality:

- ◆ [Silly seasonality](#) (4 Sep 2023)
- ◆ [Seasonal silliness](#) (10 Aug 2020)
- ◆ [Losing steam](#) (7 May 2019)
- ◆ [The seasonality illusion](#) (3 May 2017)

But one thing we hadn't tested is if there is any non-linearity for seasonal movements in financial markets. Here we turn to tree-based machine-learning models.

Applying tree-based models to seasonality

If seasonality is non-linear, then it could express itself in a quarter-end equity rally (e.g. end of Q1, Q2, etc), or, more specifically, in a brief post-August dip? These are just two specific examples we discuss below.

To test seasonality more broadly at such times, we turned to using a random forest to pick out on any specific non-linear relationships for seasonality with the S&P 500.

For the input X variables, we used many categorical calendar variables (table 1). Using all these variables we ran a random forest against each of the y-target variables in table 1: first on one-week forward returns in the S&P 500, then a separate model for two-week forward returns, and so on. As in many of our machine-learning models, these forward performances are binary – representing a 1 if the S&P 500 rises over that future window, and a 0 otherwise.

For each of these models the training period was 1970-2005. We then had two out-of-sample periods to assess the model performance on validation from 2005 to 2015, and to test from 2015 to today.

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1. Inputs and target variables attempted

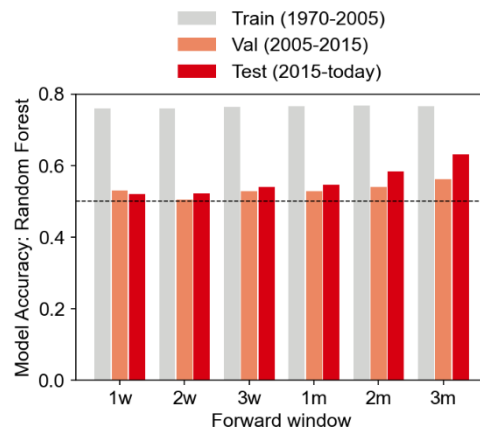
X-variables	y target variables attempted
Day (of month)	1-week forward S&P 500 performance
Weekday	2-week forward S&P 500 performance
Week (of year)	3-week forward S&P 500 performance
Month	1-month forward S&P 500 performance
Quarter	2-month forward S&P 500 performance
Leap year (1 if yes, 0 if no)	3-month forward S&P 500 performance
Trading day	
Business day	
Business month end	
Business month start	
Business quarter end	
Business quarter start	
Week of month	
Week of quarter	
Days until quarter end	
Weeks until quarter end	

Source: HSBC

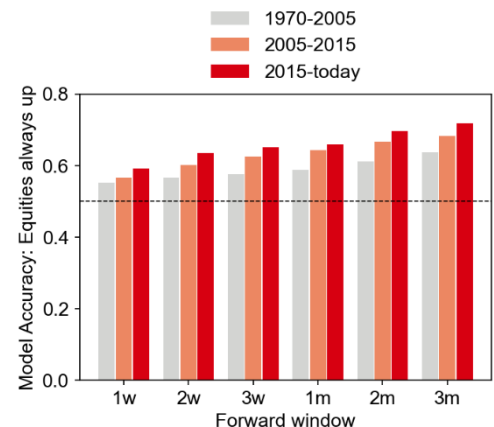
Chart 2 shows the performance of each of these random forest models. Of course, the training set has a much higher level of accuracy given the model was trained on that data. But for validation and test periods, model accuracy is often barely above 50% (for a primer to understanding machine-learning datasets see [Machine learning 101](#), 11 March 2019; for a primer on tree-based models see [Machine learning 102](#), 1 May 2019).

Compare that to the better accuracy of chart 3. Here the model is simple, with a 1 for every prediction, such that the model is always predicting equities to go up.

2. *Random Forest* accuracy on S&P 500 forward performance

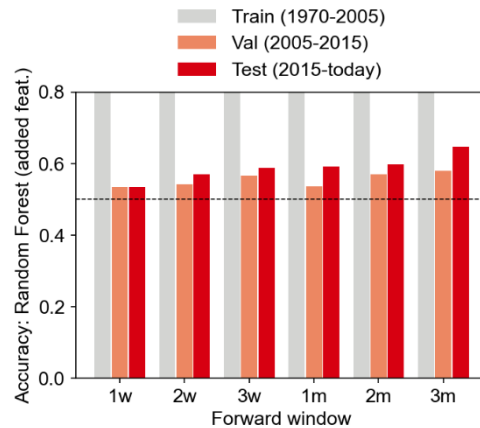


3. *“Equities always go up”* accuracy on S&P 500 forward performance



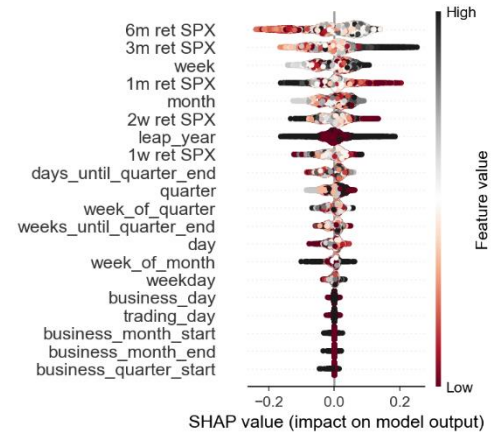
In a third attempt, we combined calendar data with momentum data for the S&P 500, thinking perhaps there's a strong quarter-end rally only when the S&P 500 has been falling in the month prior, or something similar. So, for each of the random forests, we added the return of the S&P 500 over the prior week, two weeks, one month, three months, and six months. Out-of-sample accuracy improved a little (chart 4), but still lagged behind the *“equities always go up”* predictor.

4. Random Forest accuracy on S&P 500 forward performance with momentum



Source: HSBC

5. SHAP plot on 3m model from chart X4

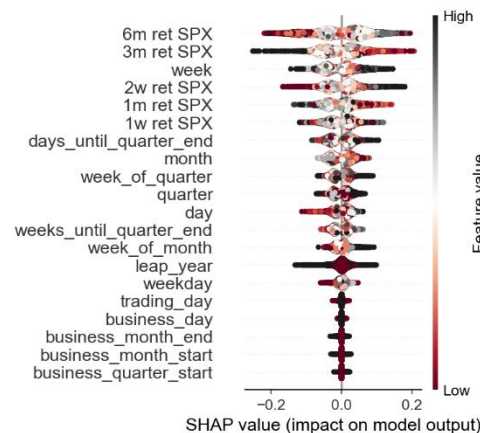


Source: HSBC, Bloomberg

The relationships learnt by these new models were dominated by momentum. Chart 5 shows the SHAP summary plot for the model that predicts 2m forward S&P 500 performance. This shows the relationships between the X input variables and predictions. The most important features are at the top, as they more often have a bigger SHAP value that contributes more to the model's predictions. So, the most important features are almost exclusively momentum-based. Beneath that, the relationships look very muddled.

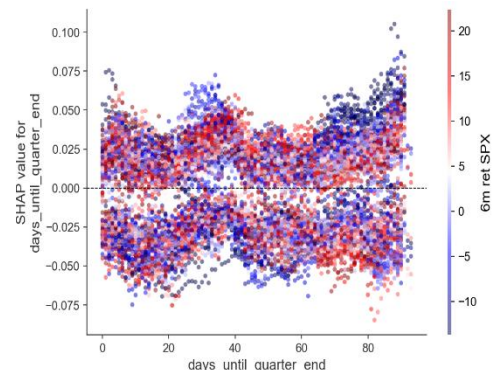
The same relationships are picked out if we look at the SHAP plots of the other models. Chart 6 plots the same SHAP plot for the model where two-week forward S&P 500 performance is the target variable.

6. SHAP plot on 2w model from chart X4



Source: HSBC, Bloomberg

7. Dependence on days until quarter-end



Source: HSBC, Bloomberg

Given the low predictive power of these models, it's not worth delving into too much detail on the relationships learnt. Chart 7 is a case in point of how muddled the relationships these calendar features are with the random forest's predictions. That shows the SHAP values for the feature "days until quarter end". As we near the end of the quarter, there is barely any consistent relationship – a rather damning assessment for any quarter-end rebalancing effect. SHAP plots for other features like this were a similarly colourful mess. So, despite the pretty abstract art that chart 7 produces, it once again highlights the poor predictive power of seasonality in financial markets.

ML model updates

See [Meet MARVIN](#) for further details

MARVIN (Multi-Asset Relative Value Indicator)

MARVIN is a tactical model that predicts the likelihood that global equities will outperform DM sovereigns over the following month. Its current probability sits at 64%.

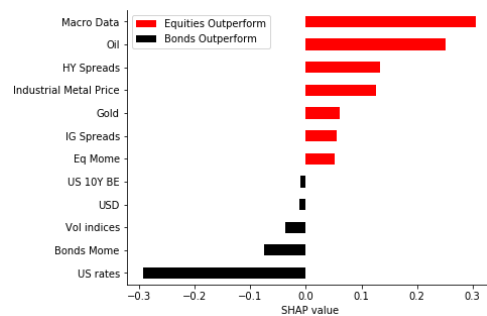
MARVIN prediction through time (high probability = favours equities over bonds)



Source: HSBC, Bloomberg, FTSE Russell

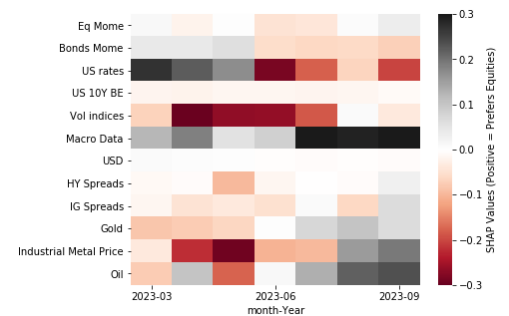
Below we use SHAP values to show the current drivers of this prediction and highlight the changes in SHAP values over the past month.

Explanation for current MARVIN prediction



Source: HSBC, Bloomberg, FTSE Russell

Recent changes to MARVIN SHAP values



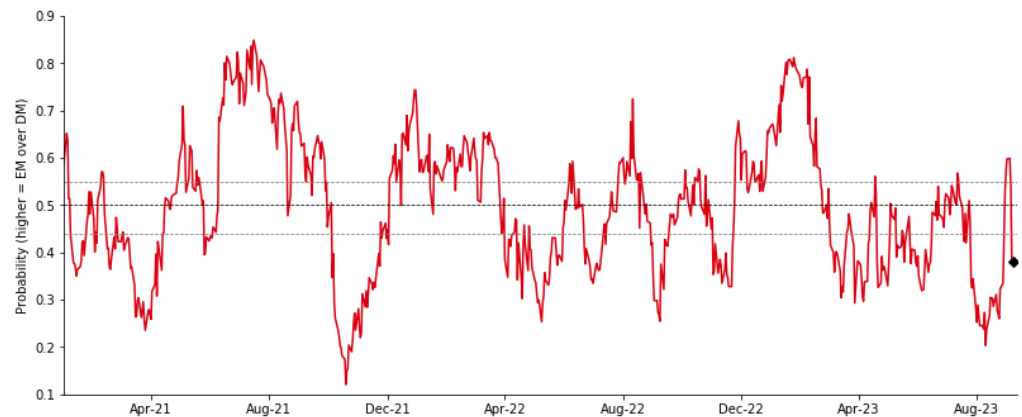
Source: HSBC, Bloomberg, FTSE Russell

See [Introducing REMI](#) for further details

REMI (Relative Emerging Markets Indicator)

REMI is a tactical model that predicts the likelihood that EM equities will outperform DM equities over the following month. Its current probability sits at 38%.

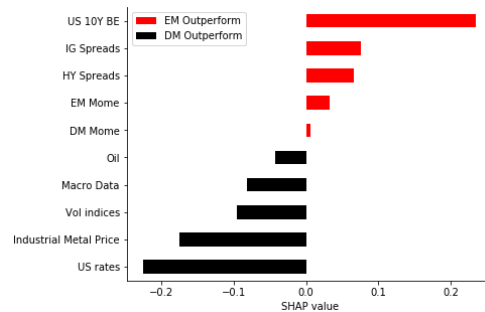
REMI prediction through time (high probability = favours EM over DM)



Source: FTSE Russell, Bloomberg, HSBC

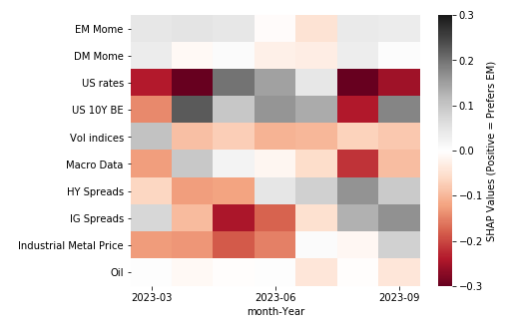
Below we use SHAP values to show the current drivers of this prediction and highlight the changes in SHAP values over the past month.

Explanation for current REMI prediction



Source: FTSE Russell, Bloomberg, HSBC

Recent changes in REMI SHAP values



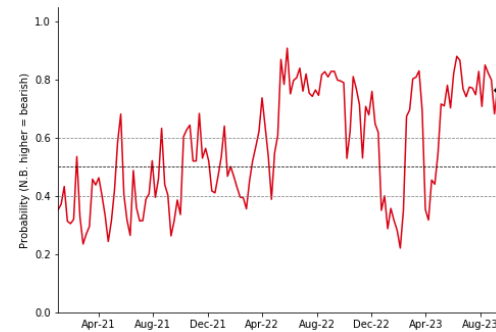
Source: FTSE Russell, Bloomberg, HSBC

Predicting Pullbacks

See [Predicting Pullbacks](#) and [Data Matters](#) for more details about these models

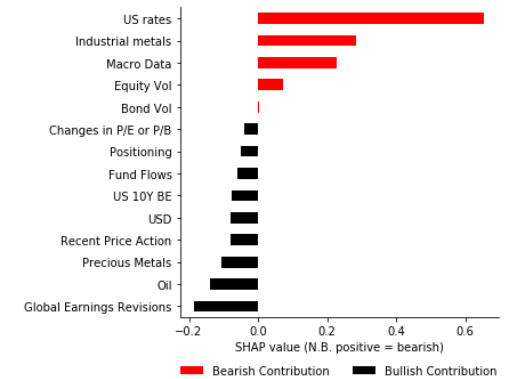
These models predict the likelihood that equities will fall over the following month. We have models for global equities and for 10 local markets. A higher number is negative for the equity market in question.

Global Equity Pullback Probability



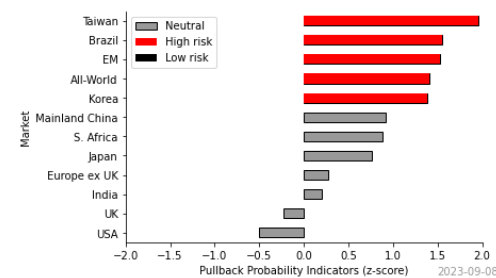
Source: HSBC , FTSE Russell, FactSet, Bloomberg, EPFR

Aggregate SHAP values



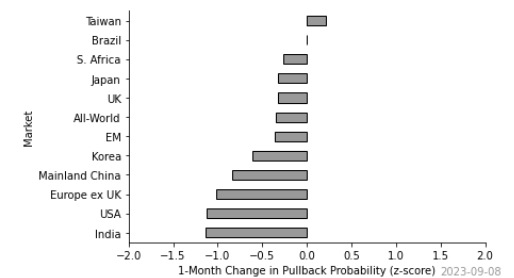
Source: HSBC , FTSE Russell, FactSet, Bloomberg, EPFR

Regional Pullback Models



Source: HSBC , FTSE Russell, FactSet, Bloomberg, EPFR

Change in prediction over past month

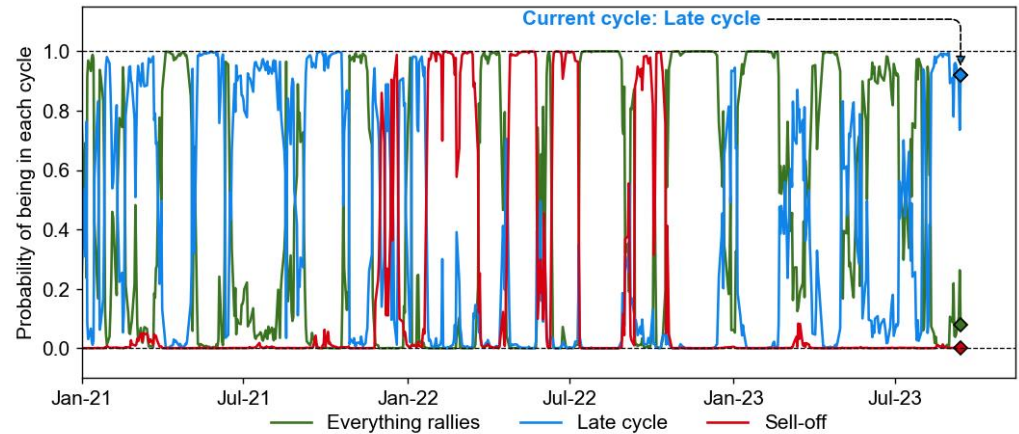


Source: HSBC , FTSE Russell, FactSet, Bloomberg, EPFR

ECCLES – Equity Cycle Selector

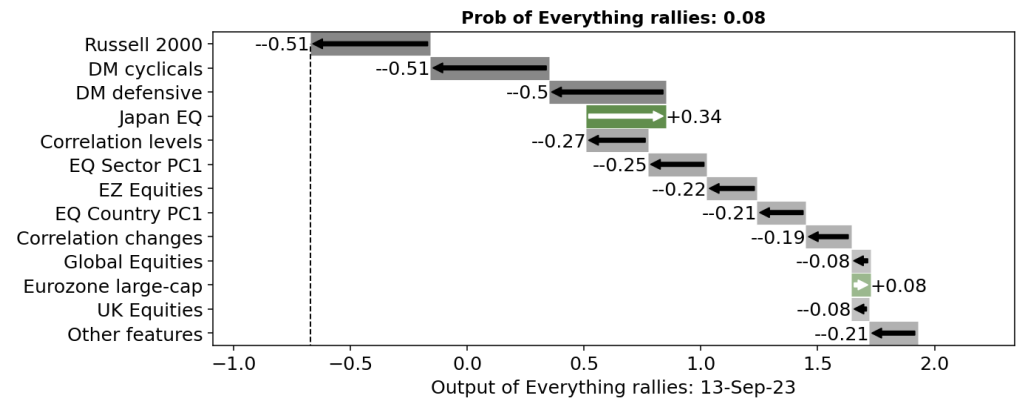
Introducing ECCLES 23 Jan;
ECCLES Exposed 20 Jun

1. ECCLES probability of each cycle



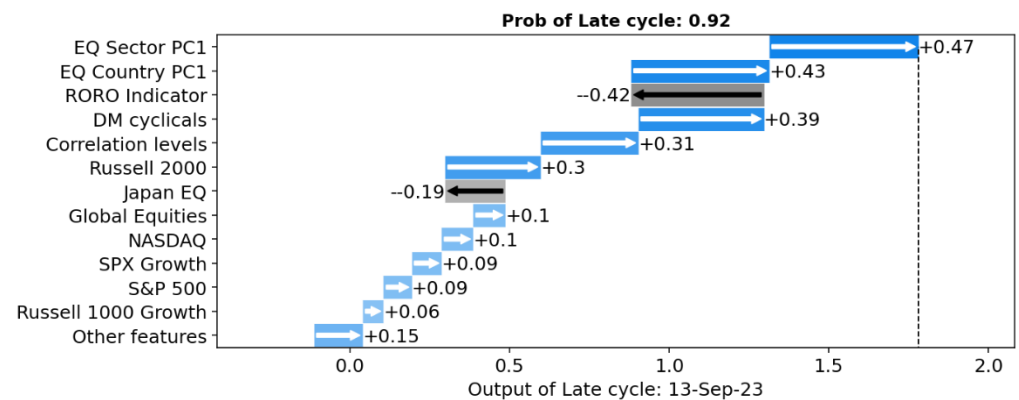
Source: HSBC.

2. Drivers of Everything Rallies



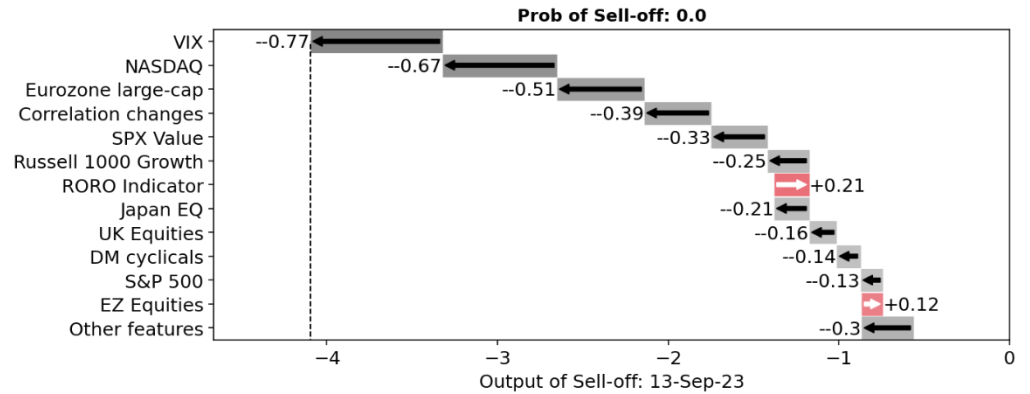
Source: HSBC, Bloomberg, FactSet, Refinitiv Datastream

3. Drivers of Late Cycle



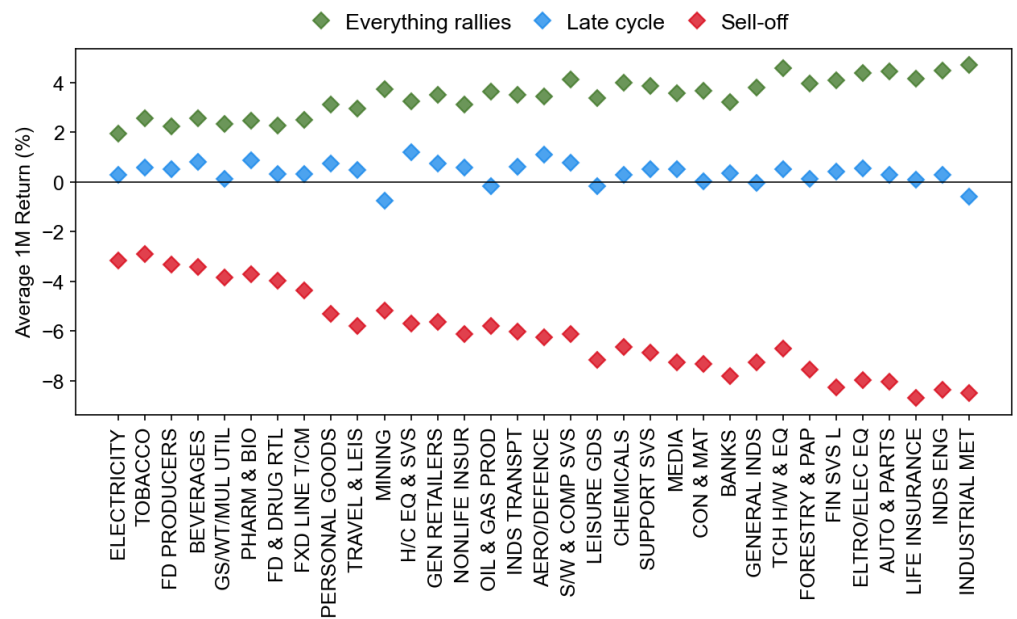
Source: HSBC, Bloomberg, FactSet, Refinitiv Datastream.

4. Drivers of Sell-Off



Source: HSBC, Bloomberg, FactSet, Refinitiv Datastream.

5. Sector performance in each cycle

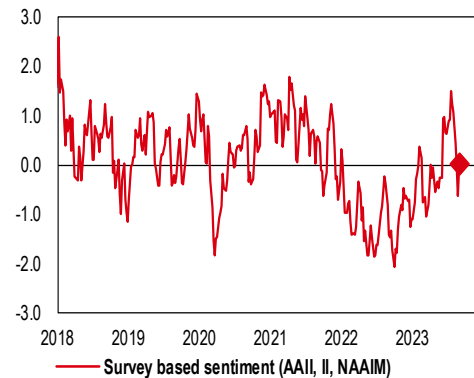


Source: HSBC, Bloomberg, FactSet, Refinitiv Datastream.

Multi-Asset Chartpack

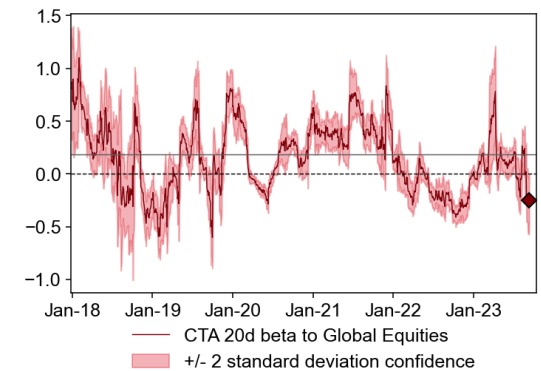
Sentiment / Positioning (1)

1. Survey-based sentiment



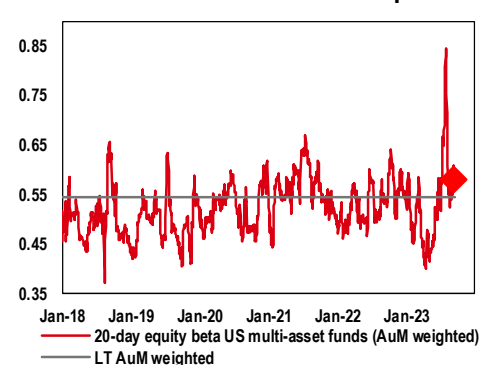
Source: Bloomberg, Refinitiv Datastream, NAAIM, HSBC

2. Hedge fund sensitivities to equities



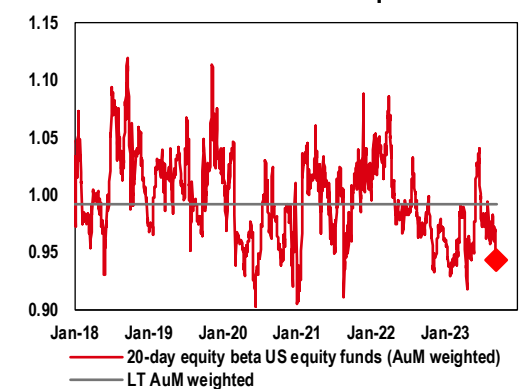
Source: Bloomberg, HSBC

3. USD MA fund sensitivities to equities



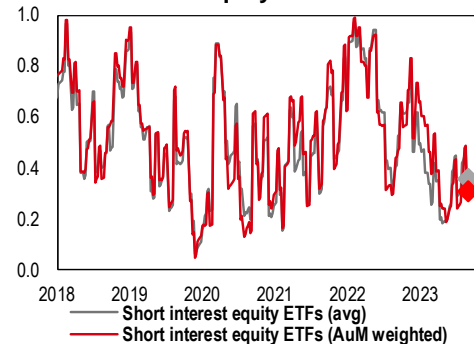
Source: Bloomberg, EPFR Global, Morningstar, HSBC

4. US EQ fund sensitivities to equities



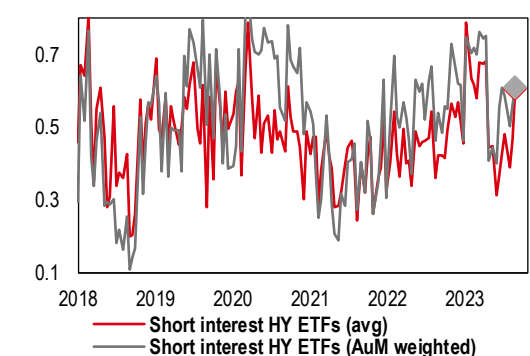
Source: Bloomberg, EPFR Global, Morningstar, HSBC

5. Short interest equity ETFs



Source: Bloomberg, HSBC; in percentiles

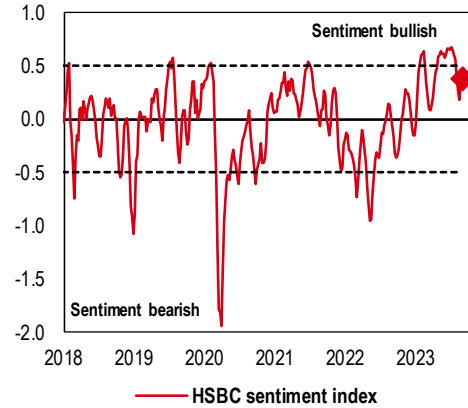
6. Short interest HY ETFs



Source: Bloomberg, HSBC; in percentiles

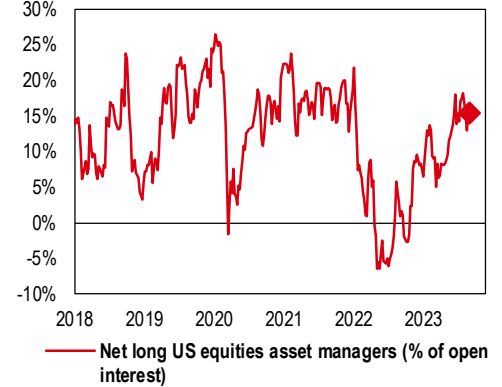
Sentiment / Positioning (2)

7. HSBC equity sentiment index



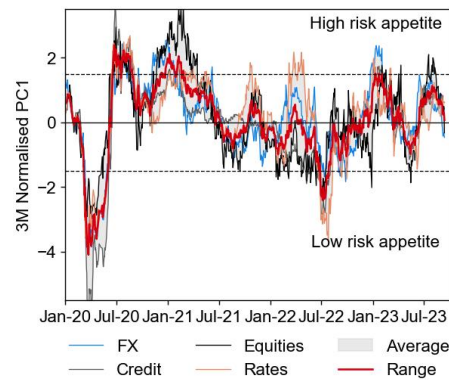
Source: Bloomberg, EPFR Global, HSBC

8. Net long US equities (% of open interest)



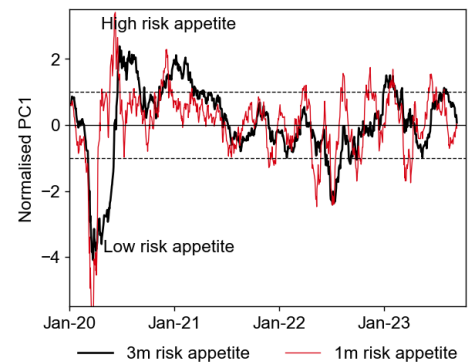
Source: Bloomberg, HSBC

9. HSBC risk appetite indices



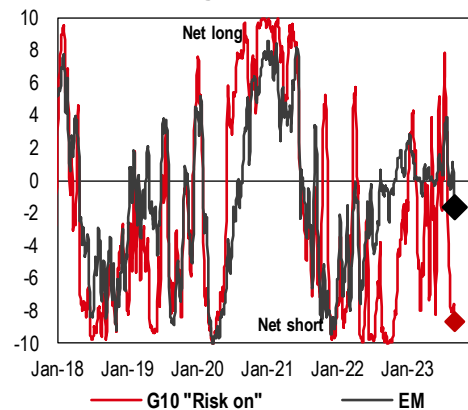
Source: Bloomberg, FactSet, Refinitiv Datastream, HSBC

10. HSBC risk appetite indices



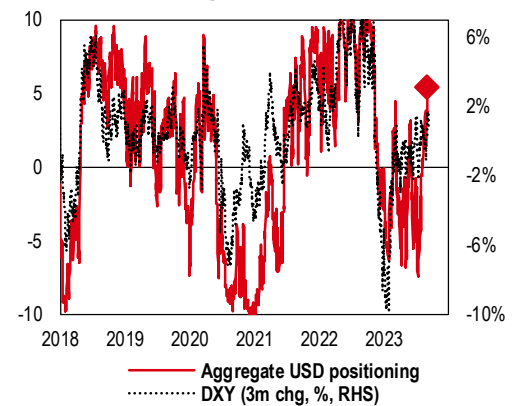
Source: Bloomberg, FactSet, Refinitiv Datastream, HSBC

11. FX positioning



Source: Bloomberg, HSBC; EM now also includes KRW, INR, ZAR, MXN

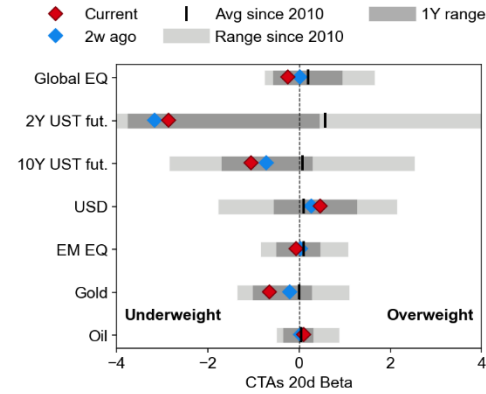
12. FX positioning



Source: Bloomberg, HSBC

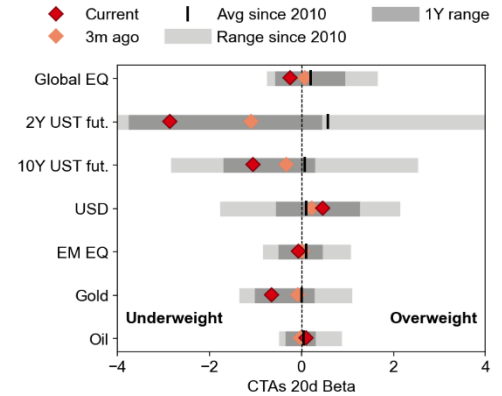
Sentiment / Positioning (3)

13. CTA positioning vs 2w ago



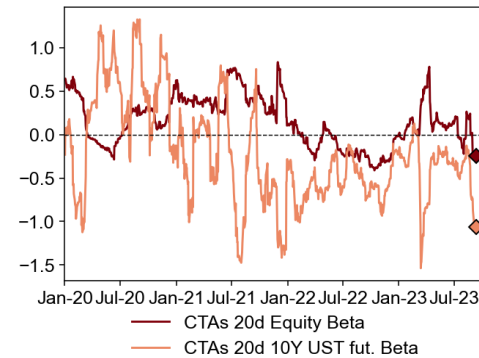
Source: Bloomberg, HSBC

14. CTA positioning vs 3m ago



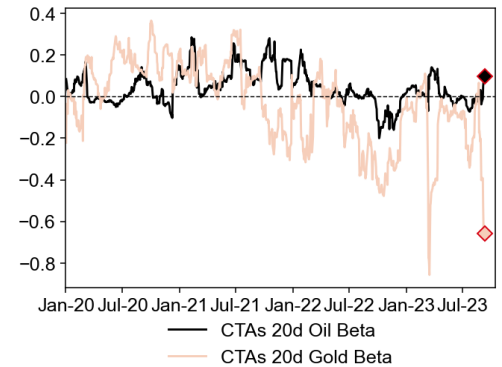
Source: Bloomberg, HSBC

15. Global Equity and 10Y UST CTA betas



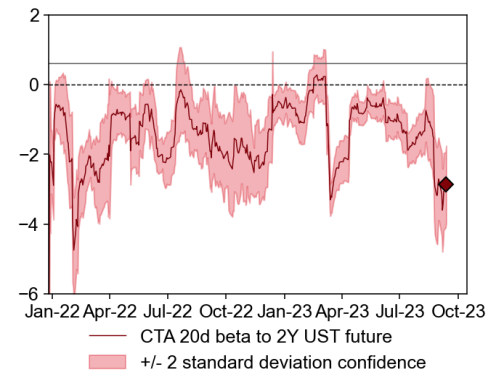
Source: Bloomberg, HSBC

16. Oil and gold CTA betas



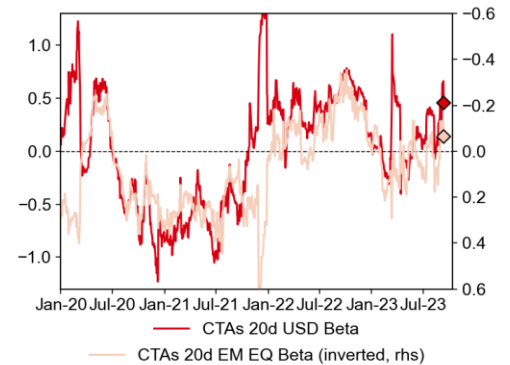
Source: Bloomberg, HSBC

17. Short-end rates CTA beta



Source: Bloomberg, HSBC

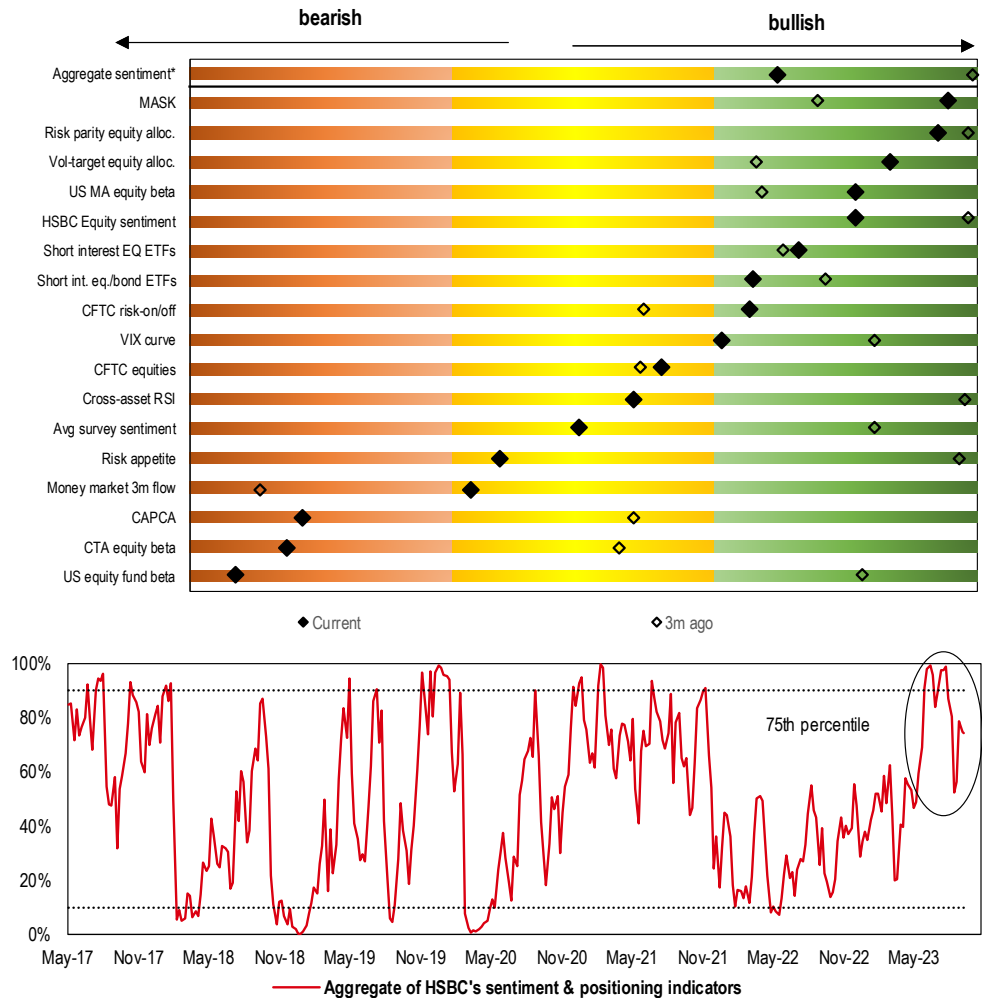
18. USD and EM Equity CTA betas



Source: Bloomberg, HSBC

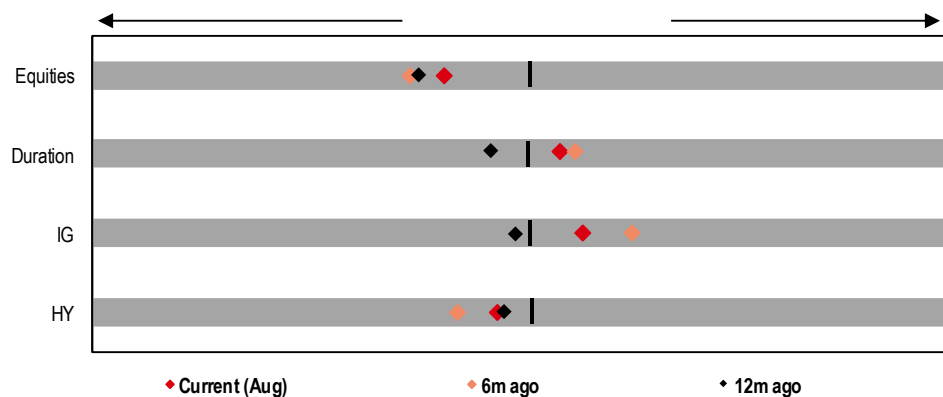
Sentiment / Positioning (4)

19. HSBC's aggregate sentiment & positioning indicators



Source: HSBC, Bloomberg, Refinitiv Datastream, FactSet, ICI, NAAIM, Morningstar. *Represents the percentile of the average sentiment across all our indicators.

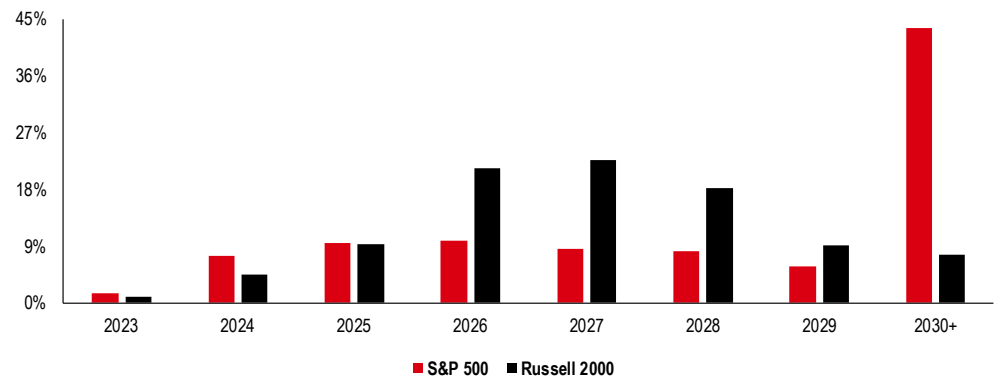
20. Aggregate real money investor positioning



Source: HSBC, Company websites

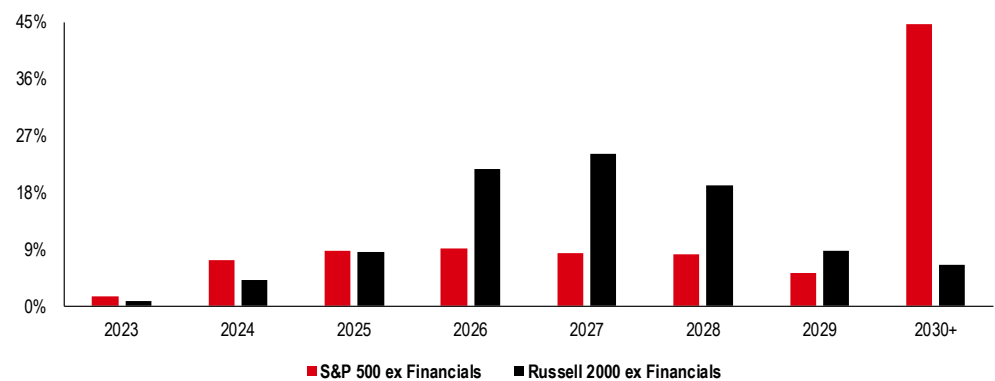
Macro (1): Debt maturity profile as a % of total corporate debt outstanding

1. SPX vs RTY



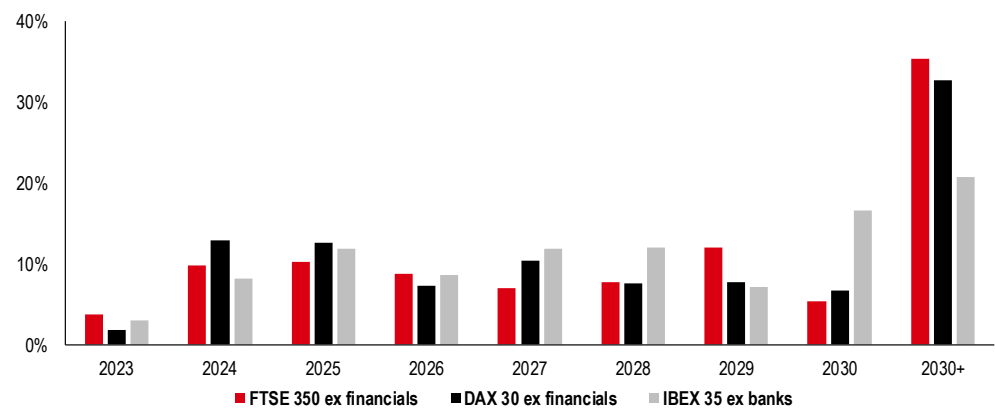
Source: Bloomberg, HSBC. Note: Includes Corporates, Loans (Deals & Tranches) in USD terms

2. SPX vs RTY ex Financials



Source: Bloomberg, HSBC. Note: Includes Corporates, Loans (Deals & Tranches) in USD terms

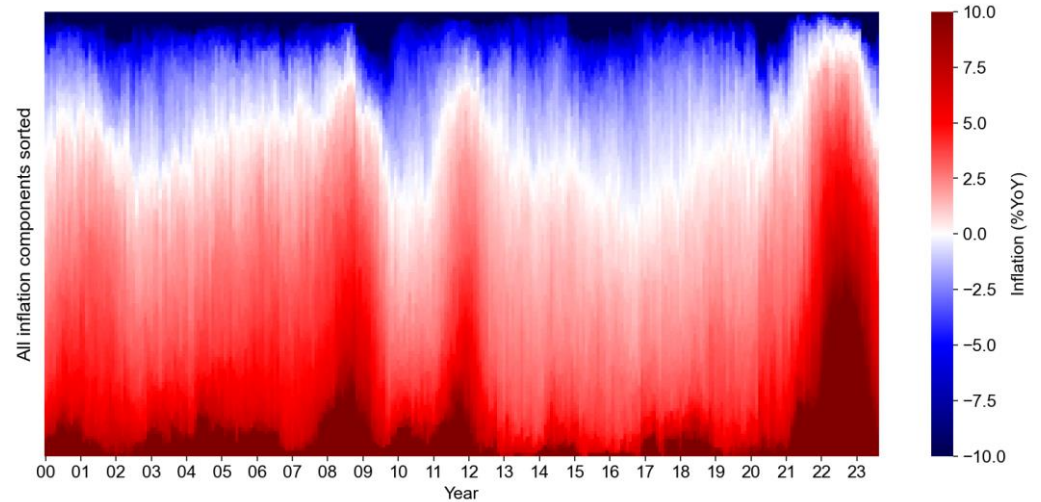
3. FTSE 350 vs DAX vs IBEX



Source: Bloomberg, HSBC. Note: Includes Corporates, Loans (Deals & Tranches). Used GBP and EUR as a common currency for FTSE 350, DAX and IBEX respectively.

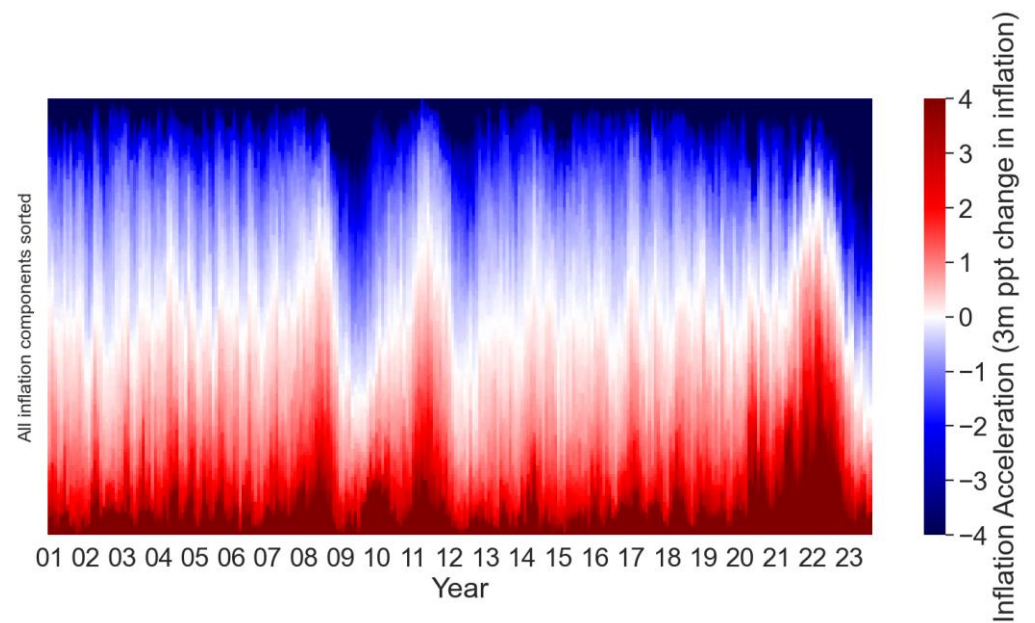
Macro (2): Inflation

1. US CPI



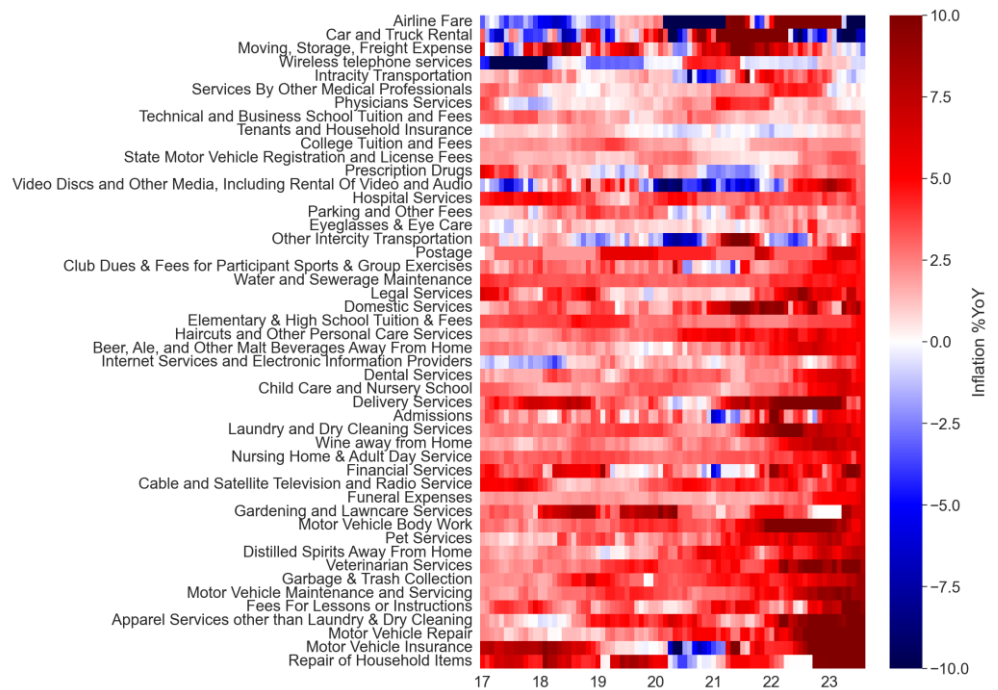
Source: Bloomberg, HSBC

2. US CPI Acceleration



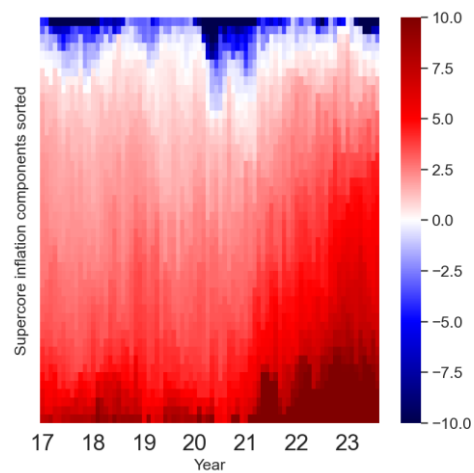
Source: Bloomberg, HSBC

3. US inflation – Supercore heatmap



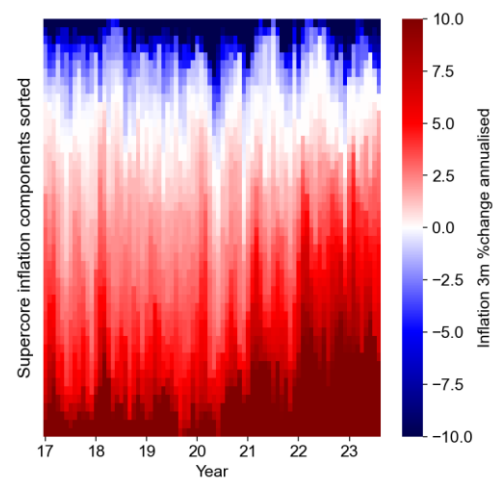
Source: Bloomberg, HSBC

4. US Supercore CPI YoY



Source: Bloomberg, HSBC

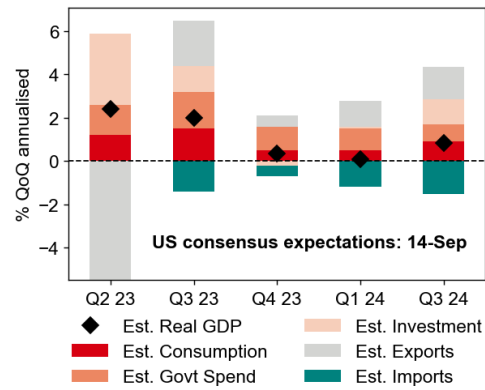
5. Supercore CPI 3m %change ann.



Source: Bloomberg, HSBC

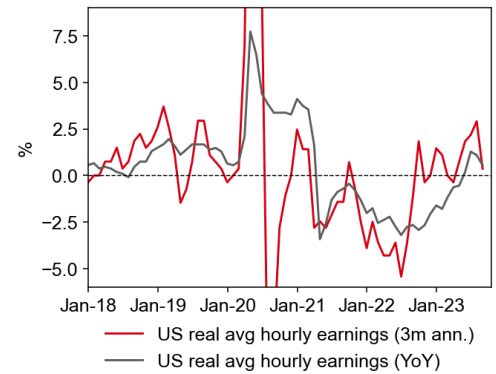
Macro (3)

1. US GDP consensus expectations



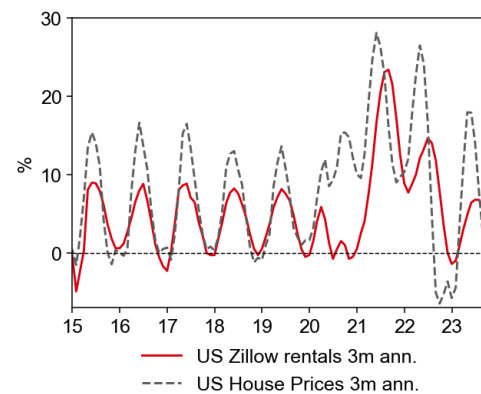
Source: Bloomberg, HSBC.

2. US real wages



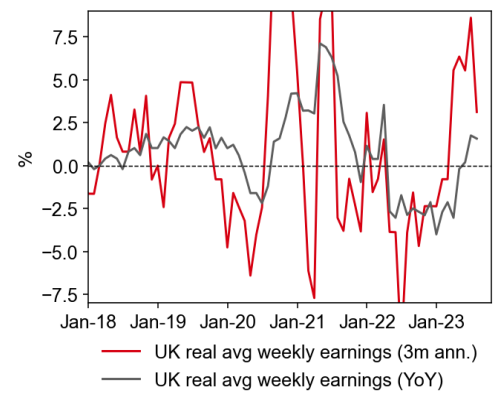
Source: Bloomberg, HSBC.

3. US rents vs house prices



Source: Bloomberg, HSBC.

4. UK real wages



Source: Bloomberg, HSBC.

Disclosure appendix

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Definitions for currency trades on DFs and NDFs

Buy: refers to buying the first currency in the named pair in exchange for the second currency in the named pair.

Sell: refers to selling the first currency in the named pair in exchange for the second currency in the named pair.

The tenor of the instrument will be denoted and will refer to a settlement date relative to the opening date of the trade idea e.g. 1m refers to a settlement date 1 month forward from the open date of the trade idea. NDF trades normally fix two working days prior to the settlement date.

Distribution of currency trades

The nature of foreign exchange forward trade ideas is such that there will always be an equal number of buy and sell trades (buying one currency in exchange for selling another), both outstanding and historically.

Equities: Stock ratings and basis for financial analysis

HSBC and its affiliates, including the issuer of this report ("HSBC") believes an investor's decision to buy or sell a stock should depend on individual circumstances such as the investor's existing holdings, risk tolerance and other considerations and that investors utilise various disciplines and investment horizons when making investment decisions. Ratings should not be used or relied on in isolation as investment advice. Different securities firms use a variety of ratings terms as well as different rating systems to describe their recommendations and therefore investors should carefully read the definitions of the ratings used in each research report. Further, investors should carefully read the entire research report and not infer its contents from the rating because research reports contain more complete information concerning the analysts' views and the basis for the rating.

From 23rd March 2015 HSBC has assigned ratings on the following basis:

The target price is based on the analyst's assessment of the stock's actual current value, although we expect it to take six to 12 months for the market price to reflect this. When the target price is more than 20% above the current share price, the stock will be classified as a Buy; when it is between 5% and 20% above the current share price, the stock may be classified as a Buy or a Hold; when it is between 5% below and 5% above the current share price, the stock will be classified as a Hold; when it is between 5% and 20% below the current share price, the stock may be classified as a Hold or a Reduce; and when it is more than 20% below the current share price, the stock will be classified as a Reduce.

Our ratings are re-calibrated against these bands at the time of any 'material change' (initiation or resumption of coverage, change in target price or estimates).

Upside/Downside is the percentage difference between the target price and the share price.

Prior to this date, HSBC's rating structure was applied on the following basis:

For each stock we set a required rate of return calculated from the cost of equity for that stock's domestic or, as appropriate, regional market established by our strategy team. The target price for a stock represented the value the analyst expected the stock to reach over our performance horizon. The performance horizon was 12 months. For a stock to be classified as Overweight, the potential return, which equals the percentage difference between the current share price and the target price, including the forecast dividend yield when indicated, had to exceed the required return by at least 5 percentage points over the succeeding 12 months (or 10 percentage points for a stock classified as Volatile*). For a stock to be classified as Underweight, the stock was expected to underperform its required return by at least 5 percentage points over the succeeding 12 months (or 10 percentage points for a stock classified as Volatile*). Stocks between these bands were classified as Neutral.

*A stock was classified as volatile if its historical volatility had exceeded 40%, if the stock had been listed for less than 12 months (unless it was in an industry or sector where volatility is low) or if the analyst expected significant volatility. However, stocks which we did not consider volatile may in fact also have behaved in such a way. Historical volatility was defined as the past month's average of the daily 365-day moving average volatilities. In order to avoid misleadingly frequent changes in rating, however, volatility had to move 2.5 percentage points past the 40% benchmark in either direction for a stock's status to change.

Rating distribution for long-term investment opportunities

As of 30 June 2023, the distribution of all independent ratings published by HSBC is as follows:

Buy	61%	(13% of these provided with Investment Banking Services in the past 12 months)
Hold	33%	(13% of these provided with Investment Banking Services in the past 12 months)
Sell	6%	(7% of these provided with Investment Banking Services in the past 12 months)

For the purposes of the distribution above the following mapping structure is used during the transition from the previous to current rating models: under our previous model, Overweight = Buy, Neutral = Hold and Underweight = Sell; under our current model Buy = Buy, Hold = Hold and Reduce = Sell. For rating definitions under both models, please see "Stock ratings and basis for financial analysis" above.

Fixed income: Basis for financial analysis

This report is designed for, and should only be utilised by, institutional investors. Furthermore, HSBC believes an investor's decision to make an investment should depend on individual circumstances such as the investor's existing holdings and other considerations.

HSBC believes that investors utilise various disciplines and investment horizons when making investment decisions, which depend largely on individual circumstances such as the investor's existing holdings, risk tolerance and other considerations. Given these differences, HSBC has two principal aims in its fixed income research: 1) to identify long-term investment opportunities based on particular themes or ideas that may affect the future earnings or cash flows of companies in corporate credit and based on country-specific ideas or themes that may affect the performance of these bonds in the case of covered bonds, in both cases on a six-month time horizon; 2) to identify trade ideas on a time horizon of up to four months, relating to specific instruments, which are predominantly derived from relative value considerations or driven by events and which, in the case of credit research, may differ from our long-term opinion on an issuer. Buy or Sell refer to a trade call to buy or sell that given instrument; HSBC has assigned a fundamental recommendation structure, as described below, only for its longer-term investment opportunities.

HSBC believes an investor's decision to buy or sell a bond should depend on individual circumstances such as the investor's existing holdings and other considerations. Different securities firms use a variety of terms as well as different systems to describe their recommendations. Investors should carefully read the definitions of the recommendations used in each research report. In addition, because research reports contain more complete information concerning the analysts' views, investors should carefully read the entire research report and should not infer its contents from the recommendation. In any case, recommendations should not be used or relied on in isolation as investment advice.

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Definitions for fundamental credit and covered bond recommendations

Overweight: For corporate credit, the issuer's fundamental credit profile is expected to improve within the next six months. For covered bonds, the bonds issued in this country are expected to outperform those of the other countries in our coverage over the next six months.

Neutral: For corporate credit, the issuer's fundamental credit profile is expected to remain stable for up to six months. For covered bonds, the bonds issued in this country are expected to perform in line with those of the other countries in our coverage over the next six months.

Underweight: For corporate credit, the issuer's fundamental credit profile is expected to deteriorate within the next six months. For covered bonds, the bonds issued in this country are expected to underperform those of other countries in our coverage over the next six months.

Definitions for trades (Rates & Credit)

Buy and **Sell** refer to a trade call to buy or sell a bond, option on an interest rate swap ("**swaption**"), interest rate cap or floor, inflation cap or floor, or Total Return Swap ("**TRS**"). The buyer/seller of a TRS receives/pays the total return of the underlying instrument or index at the end of the period and pays/receives the funding leg.

Buy protection and **Sell protection** refer to a credit default swap (CDS): the protection buyer/seller is effectively selling/buying the reference entity's credit risk.

Pay and **receive** refer to a trade call to pay or receive the fixed leg of an interest rate swap (IRS), a non-deliverable IRS, the first-named leg of a basis swap, the realised inflation leg of an inflation swap, or a forward rate agreement (FRA). An investor that executes a pay or receive trade is said to be "**paid**" or "**received**."

Payer and **receiver** refer to inflation caps or floors and to swaptions: a payer is an option giving the right but not the obligation to enter a paid position in an interest rate or inflation swap, and a receiver is an option giving the right but not the obligation to enter a received position in an interest rate or inflation swap.

ASW (also asset-swap, Buy on asset swap, Buy on an asset-swapped basis): Buy a bond packaged with a swap that is tailored to eliminate the bond's interest rate risk, effectively transforming the bond to a floating rate instrument whilst preserving the credit exposure to the bond issuer.

RASW (also reverse asset-swap, Sell on asset swap, Sell on an asset swapped basis): Sell a bond packaged with a swap that is tailored to eliminate the bond's interest rate risk, effectively transforming the bond to a floating rate instrument whilst preserving the credit exposure to the bond issuer.

Distribution of fundamental credit and covered bond recommendations

As of 30 June 2023, the distribution of all independent fundamental credit recommendations published by HSBC is as follows:

Overweight	38%	(24% of these provided with Investment Banking Services in the past 12 months)
Neutral	41%	(14% of these provided with Investment Banking Services in the past 12 months)
Underweight	22%	(16% of these provided with Investment Banking Services in the past 12 months)

For the purposes of the distribution above the following mapping structure is used: Overweight = Buy, Neutral = Hold and Underweight = Sell. For rating definitions under both models, please see "Definitions for fundamental credit and covered bond recommendations" above.

Distribution of trades

As of 30 June 2023, the distribution of all trades published by HSBC is as follows:

Buy	81%	(48% of these provided with Investment Banking Services in the past 12 months)
Sell	19%	(50% of these provided with Investment Banking Services in the past 12 months)

For the purposes of the distribution above the following mapping structure is used: Buy/Sell protection/Receive/Buy Receiver/Sell Payer = Buy; and Sell/Buy protection/Pay/Buy Payer/Sell Receiver = Sell. ASW is counted as a buy of the bond and a paid swap, and RASW as a sell of the bond and a received swap. For rating definitions under both models, please see "Definitions for trades (Rates and Credit)" above.

For the distribution of non-independent ratings published by HSBC, please see the disclosure page available at <http://www.hsbcnet.com/gbm/financial-regulation/investment-recommendations-disclosures>.

Recommendation changes for long-term investment opportunities

To view a list of all the independent fundamental ratings/recommendations disseminated by HSBC during the preceding 12-month period, and the location where we publish our quarterly distribution of non-fundamental recommendations (applicable to Fixed Income and Currencies research only), please use the following links to access the disclosure page:

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