Quantitative Monographs
Exploiting predictable forecast errors

Equities

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A compelling earlier finding

In this brief report, we explore further a compelling finding from our earlier research on seasonality; why do analyst forecast errors have seasonal components, and how can quantitative investors benefit from the systematic mispricing that this error generates?

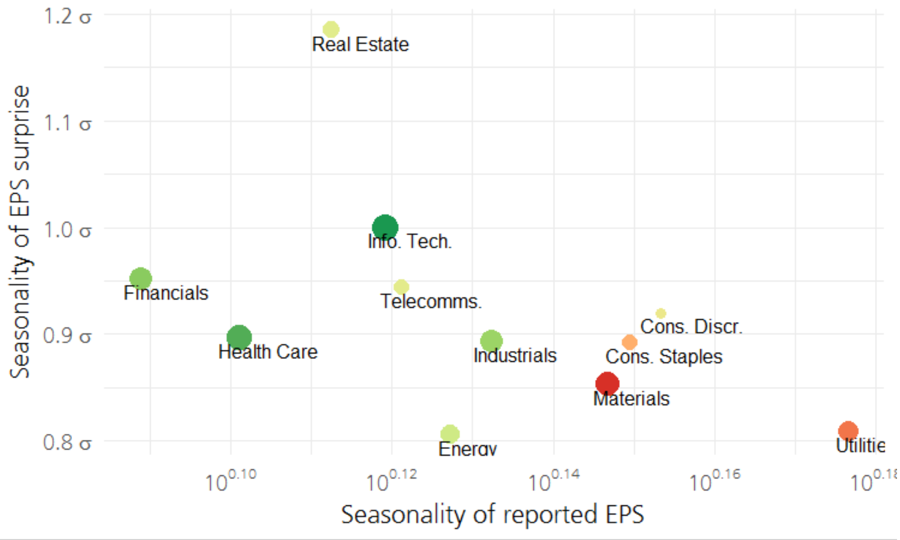
A simple model

We adopt a very simple and popular time series decomposition method to extract and analyse the components of earnings seasonality. We find that earnings surprises are less pronounced in the first calendar quarter, and less pronounced later in the fiscal year—however, this still does not account for the extent of earnings surprises we observe. We describe how deficient seasonal modelling might induce 'noisy' components in earnings revisions, which impacts performance and causes unnecessary turnover.

The key takeaway

Our results suggest the mispricing arises in unexpected places; the most seasonal earnings (utilities, materials, and consumer sectors) have the smallest seasonal influences in their earnings surprises; the market prices these accordingly and seasonal adjustment of their revisions does more harm than good. Conversely, the less seasonal the underlying earnings (financials, healthcare, and real estate sectors), the higher the extent of surprise seasonality, and the more value the seasonal adjustment adds to the investment signal.

Figure 1: Earnings seasonality, and the analyst/market under-reaction



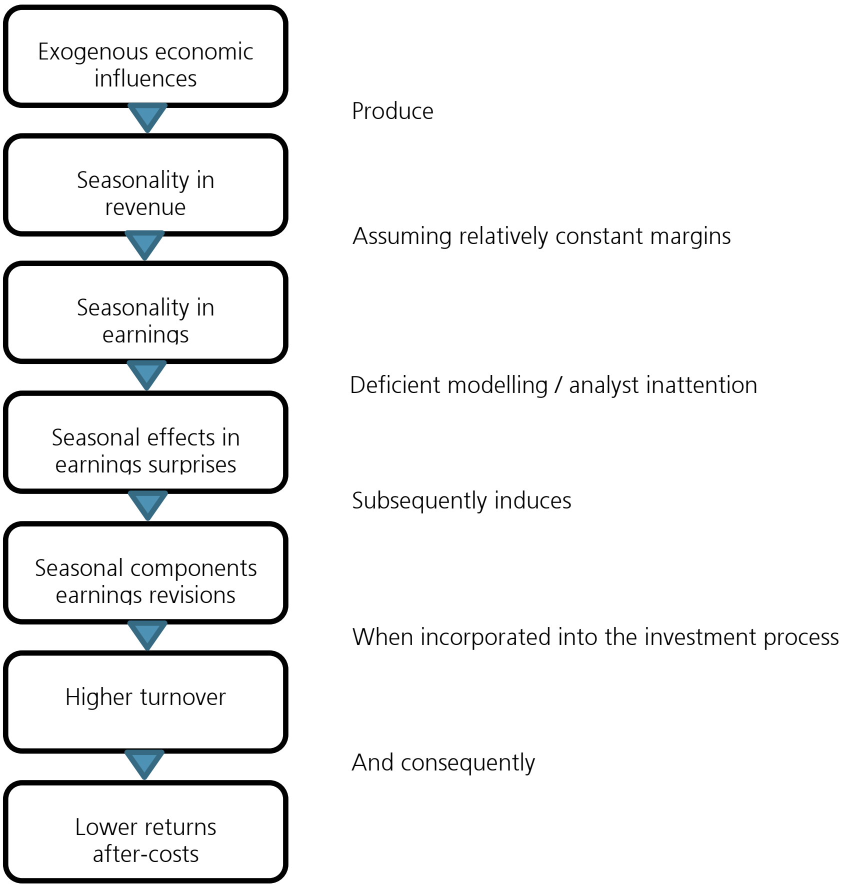
Source: MSCI, IBES, FactSet, UBS Quant

Introduction

Our earlier report on seasonality (link) briefly touched on the unexpected seasonal component identified within earnings surprises as a potential source of seasonal patterns observed within style returns. We further explore this finding in this report and detail the implications of this recurring forecast error in the investment process.

For clarity, we outline our thesis below; the boxes link through to the relevant sections.

Figure 2: The short story



Source: UBS Quant

Anecdotally, some unexpected client feedback from our recent report exploring seasonality was how unsurprising our findings were. The seasonal influences are so pervasive that clients not only accepted their premise, but justified them in terms of their institutional causes, e.g. de-risking their books before the year-end when staffing is light, or prior to their reporting schedule

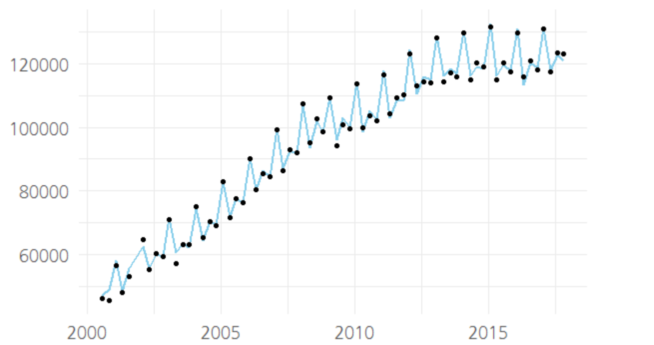
Seasonality in revenue and earnings

While not every business is as seasonal as an ice-cream vendor, we essentially take it as self-evident that many companies experience seasonal revenue. A popular explanation posits that exogenous influences from the economy then induce these effects in markets. Indeed the seasonal relationship induced between the market and the economy has been explored extensively throughout the literature[1].

Many industries obviously have seasonal influences in their revenue

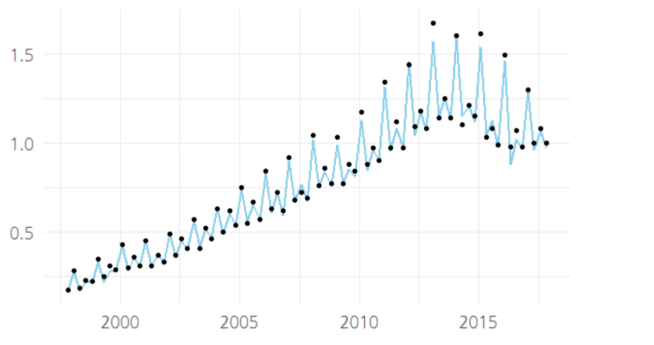
It should also be obvious that analysts are already forecasting with this seasonality in mind; it is inherently predictable and analysts are of course incentivized to produce the most accurate forecasts possible. Below are the quarterly reported and estimated earnings and sales for Walmart (WMT US). There is a clear seasonal influence in both the reported figures (black dots) and their estimate[2] (blue line).

Figure 3: WMT US: Actual vs Estimated Sales (US$ m)



Source: IBES, FactSet, UBS Quant

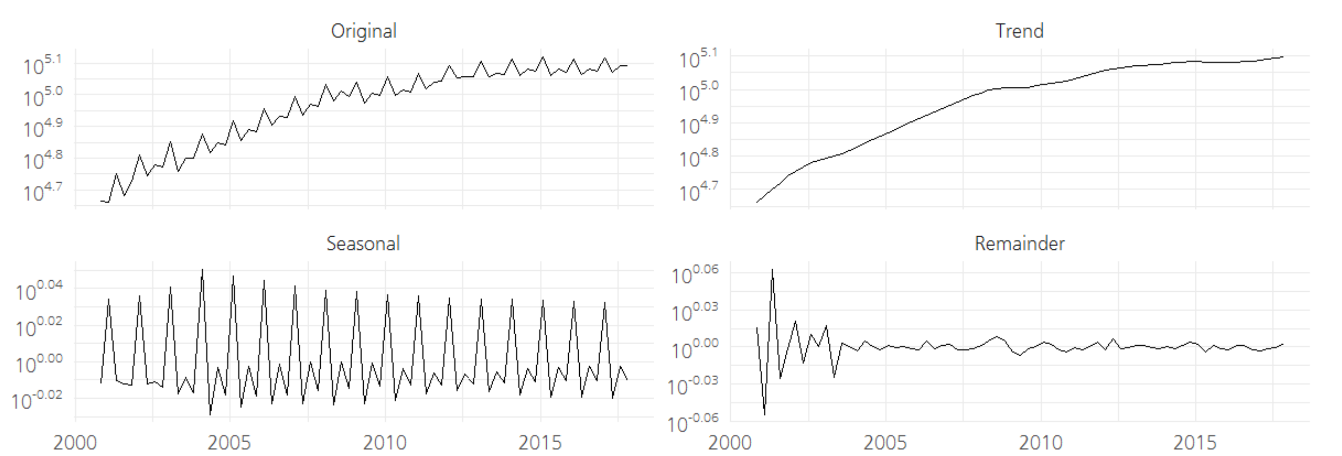
Figure 4: WMT US: Actual vs Estimated EPS



Source: IBES, FactSet, UBS Quant

Using a popular time series decomposition technique known as STL[3], we can break this series into three components: the trend; a seasonal; and the remainder. These components identically sum to form the original time series. Importantly, we first take the log of the original data, which has the effect of extracting a multiplicative rather than an additive decomposition, better suited to the inherently geometric growth of earnings and revenue.

Figure 5: A STL decomposition of Walmart's sales



Source: FactSet, UBS Quant

[1] Fama (1981, 1990), Schwert (1990), Fama, French (1989), Barro (1990), Cochrane (1991)
[2] The consensus estimate is calculated as of the date prior to the quarterly earnings release
[3] Seasonal-Trend Decomposition Procedure Based on Loess, (Cleveland, 1990)

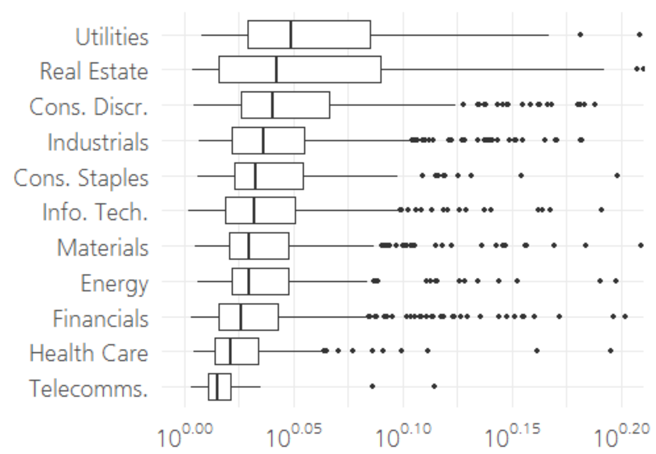
Figure 5 shows a STL decomposition of Walmart's quarterly log-revenue, in which both the trend and seasonal components are clearly identifiable. Under the log transform, the original time series is now the *product* of these trend, seasonal and remainder components.

Naturally some industries have more pronounced seasonal influences than others. We can quantify the seasonality of an earnings/revenue stream as the "amplitude" of the seasonal component shown in Figure 5, more concisely as the interquartile range of the time series (the spread between the 75th and 25th percentiles).

We quantify the seasonality as the "amplitude" of the extracted seasonal component

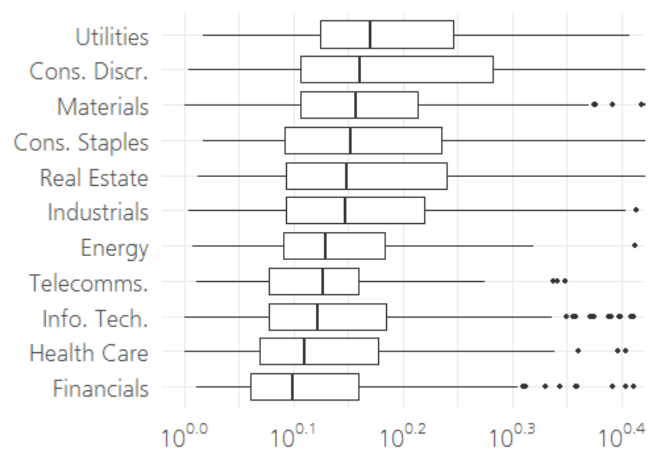
Direct interpretation of this statistic is somewhat obscure, but given a quarterly time series this essentially captures the range between the bottom of the biggest quarter and the top of the smallest quarter, expressed as a percentage relative to the trend. Walmart's seasonality as above has an IQR of $10^{0.016}$, i.e. roughly 4%.

Figure 6: MSCI ACWI Revenue seasonality by sector



Source: IBES, FactSet, UBS Quant

Figure 7: MSCI ACWI EPS seasonality by sector



Source: IBES, FactSet, UBS Quant

Figure 6 above shows that the most seasonal sectors (by reported revenue) are utilities, real estate and consumer discretionary, as might be expected from weather/cultural influences throughout the year. The least seasonally impacted sectors by revenue are financials, healthcare and telecommunications, with much more consistent demand throughout the year.

We also note that EPS yields much stronger seasonality by this metric; however, the log transformation obviously cannot be applied to negative earnings, in which case we take the longest contiguous series of positive quarterly earnings in the company's history (of length at least 10 years), so the sample size is much smaller and heavily biased to mature businesses.

Negative earnings present a challenge for the multiplicative decomposition

Nonetheless the rankings amongst the EPS and sales seasonality are largely similar; real estate and materials show surprisingly large jumps, however.

Seasonality in surprises

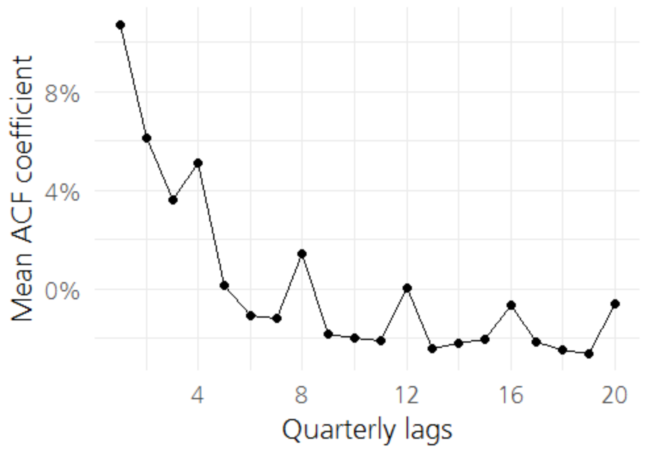
Our earlier research on seasonality confirmed evidence of seasonal components in earnings surprises, i.e. analysts are being surprised by the unsurprising[4]. Below we show the average autocorrelation of the quarterly earnings surprises as measured by the absolute surprise unexplained earnings (SUE) within the MSCI AC World index; over 120,000 surprises in total. The SUE is simply calculated as:

Earnings surprises conceivably should have no seasonal components

$$SUE = \frac{\text{Actual EPS} - \text{Surprise Mean EPS}}{\text{Standard Deviation of EPS}}$$

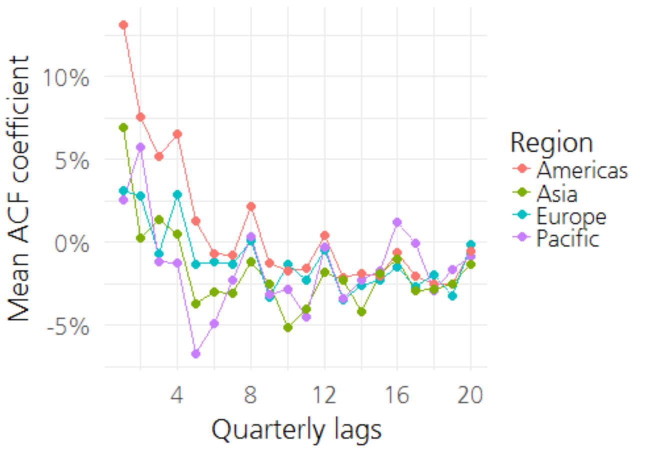
First consider the features of Figure 8. The largest lag coefficient appears at one quarter, i.e. high earnings surprises tend to be adjacent in time; for example, a high 2Q earnings surprise is likely to be succeeded by a high 3Q earnings surprise. This is reasonable; a period of high earnings uncertainty may be sustained for more than a single quarter due to many reasons: difficult business conditions, a period of poor corporate visibility, temporary suspension of informative coverage, etc.

Figure 8: Mean ACF of EPS surprise



Source: IBES, MSCI, UBS Quant

Figure 9: Mean ACF of EPS surprise by region



Source: IBES, MSCI, UBS Quant

However, what is more interesting is that this decline in earnings opacity is punctuated by spikes occurring at the annual frequencies. This invites the question: are these jumps in earnings surprises occurring at a particular time of the calendar year, fiscal year, or are just coincident with the highest-revenue quarter.

To explore this further, we consider the relationship between (the magnitude of) the seasonal components in the earnings surprises versus the seasonal components in the underlying earnings; a reasonable assumption is that this analyst error is borne of deficient seasonal modelling, which is presumably common to all analysts.

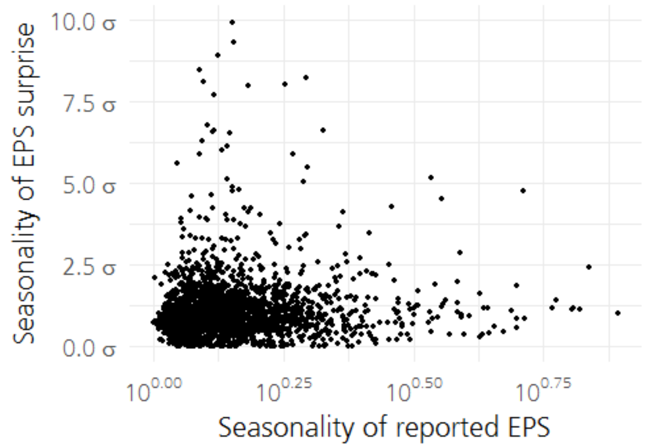
Our initial assumption is that analysts are conducting deficient seasonal modelling

Figure 10 shows unexpected evidence against this hypothesis: there is *effectively no relationship* (over the broad market, at least) between the seasonality we observe in the underlying earnings stream versus the earnings surprise itself.

[4] To borrow the phrase from the original research: "Being Surprised by the Unsurprising: Earnings Seasonality and Stock Returns; Chang, Hartzmark, Solomon, Soltes (2014)"

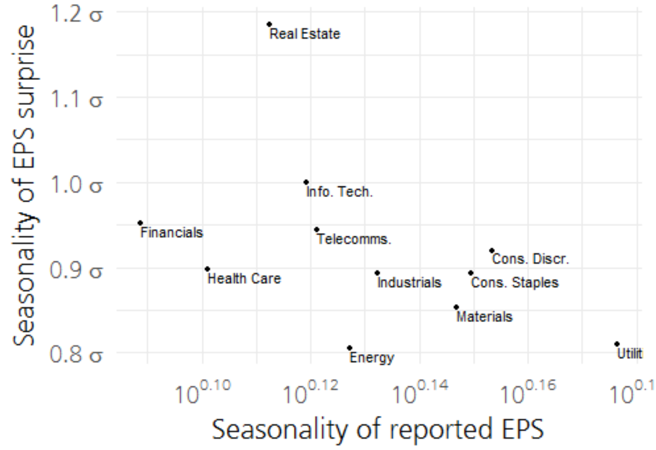
Figure 11 shows the median seasonality by sector[5], which actually suggests that a higher extent of seasonality in the underlying earnings is *negatively* associated with the seasonality in the surprise; it is seemingly accounted for in the obvious places, but appears to be overlooked amongst the financials, healthcare, and information technology sectors.

Figure 10: Estimated vs reported EPS seasonality



Source: IBES, FactSet, UBS Quant

Figure 11: Median est. vs act. EPS seasonality by sector

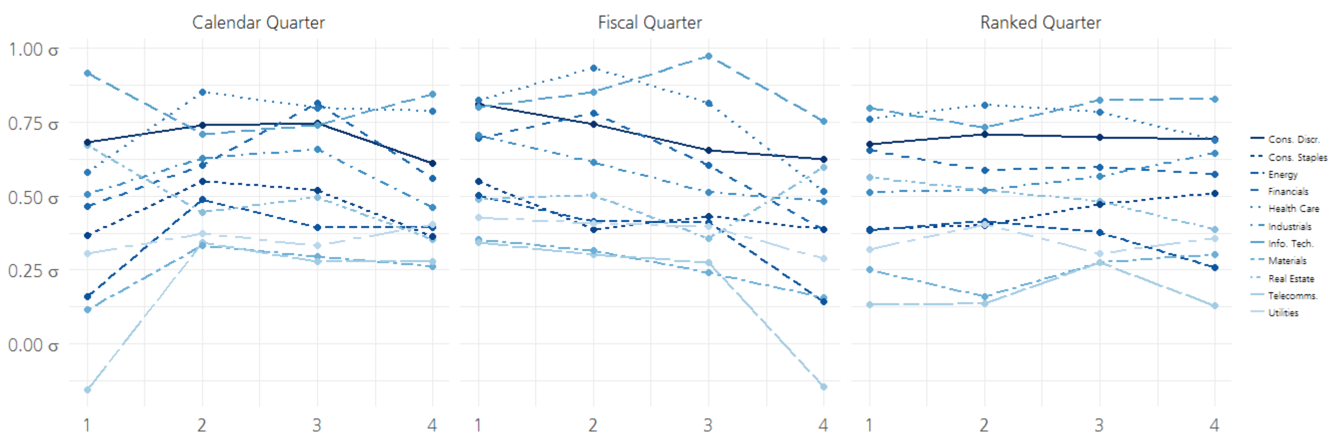


Source: IBES, FactSet, UBS Quant

We then consider the relationship between the calendar quarter (CQ), the fiscal quarter (FQ), and the ranked quarter (RQ), the last of which is the quarter ranked from smallest to largest by its seasonal component. As above, there is no visible distinction across the broad market (not shown); however at the sector level there are some subtle trends that appear (Figure 12).

- The first calendar quarter has disproportionately low earnings surprises across almost all sectors
- Earnings visibility seemingly improves towards the end of the fiscal year, as might be expected
- The quarters as ranked by their seasonality have little bearing on the earnings surprises, which is a somewhat unexpected result.

Figure 12: Median sector SUE by quarter



Source: IBES, FactSet, UBS Quant

[5] Note in Figure 11 that only the complete pairs were used to in the graph, so the reported seasonal median (x-axis) differs slightly from that shown in Figure 7.

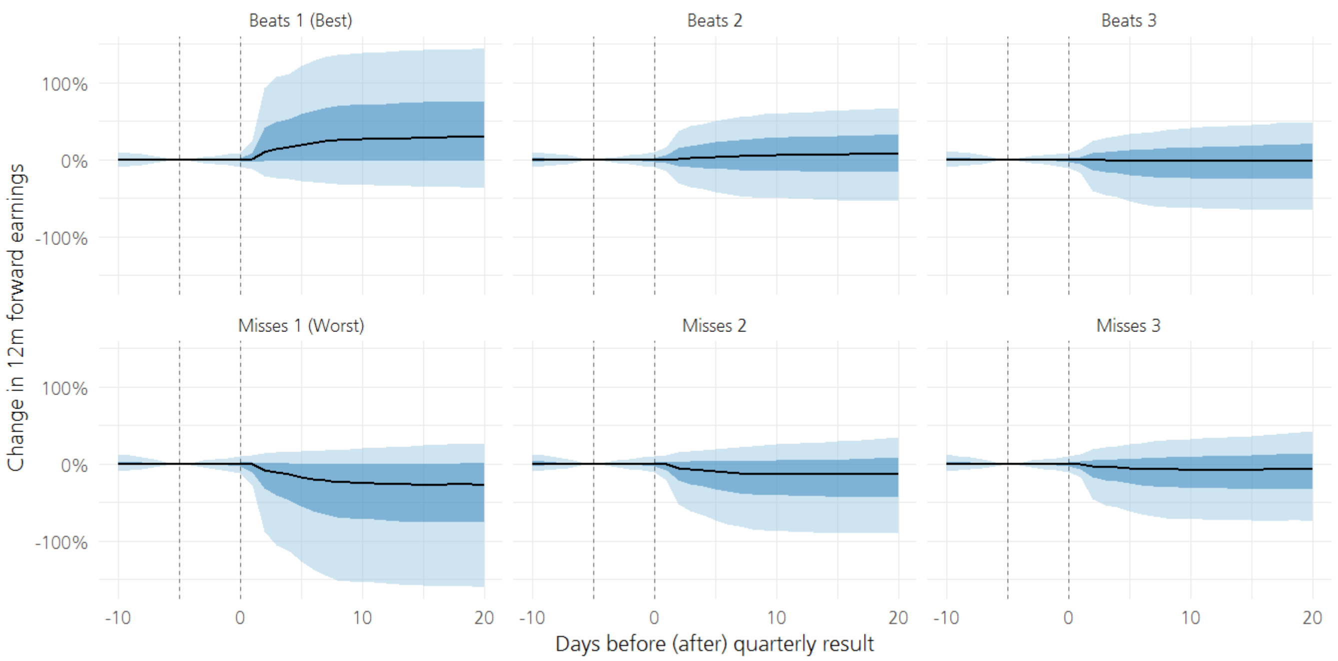
The earnings revisions reaction

Full-year earnings forecasts should be insulated from seasonal artefacts in theory

Evidently analyst forecast errors have seasonal components, despite their best efforts to model such predictable events. We now consider the impact of such beats and misses on the subsequent earnings revisions. Note, however, these are calculated using the conventional full-year earnings estimates and therefore should be insulated from any seasonal effects.

Figure 13 below shows the full-year earnings revisions reaction surrounding the quarterly beats and misses; it is essentially an event study showing the reaction to daily earnings revisions rather than the stock price reaction. The beats and misses are defined as ±0.5, and ±1.5 standard deviation events (measured by the SUE); which roughly correspond to the 30th and 70th percentiles, respectively. The earnings revisions are then simply defined as the change in the time-weighted full-year earnings (in the consensus currency), rebased 5 days prior to the result date.

Figure 13: The earnings revision reaction to beats/misses (10/25/50/75/90th percentiles shown)



Source: IBES, FactSet, UBS Quant

However, the earnings revisions update following earnings surprises

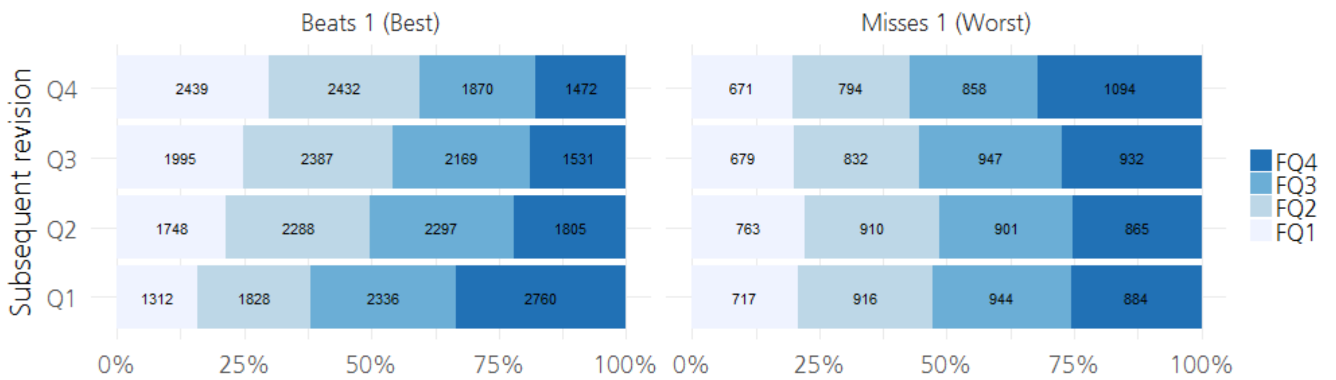
As can be seen, following a large surprise the earnings revisions subsequently adjust to account for this new information content. Typically this occurs in the same direction as the earnings surprise itself, e.g. the dark blue band of the largest beats shows the 25th percentile is roughly 0% following this event, i.e. three-quarters of companies experience a subsequent positive upwards revision.

This could be explained as the full-year estimate updating to account for the new information

This is understandable; the stronger (weaker) than expected quarter does need to be baked into the full-year figure after all. However, this raises the question of whether the 25% of names that beat and subsequently revise downwards (or conversely miss and revise upwards) are simply the names that just reported their 4Q; in which case there is no need to subsequently revise to keep the arithmetic in check—unless there is perhaps some seasonality forecasting error at play.

Figure 14 then shows a fiscal-quarter breakdown of the event study shown above, showing the quartile cross-section of the earnings revisions at 10 days after the result date. The bottom row on the leftmost chart shows that the names in the lowest subsequent revisions quartile do correspond to a disproportionate amount of FQ4 results; however this is far from the majority. Conversely, the misses that go on to revise upwards more often occur in the FQ4, but this is again far from the dominant result.

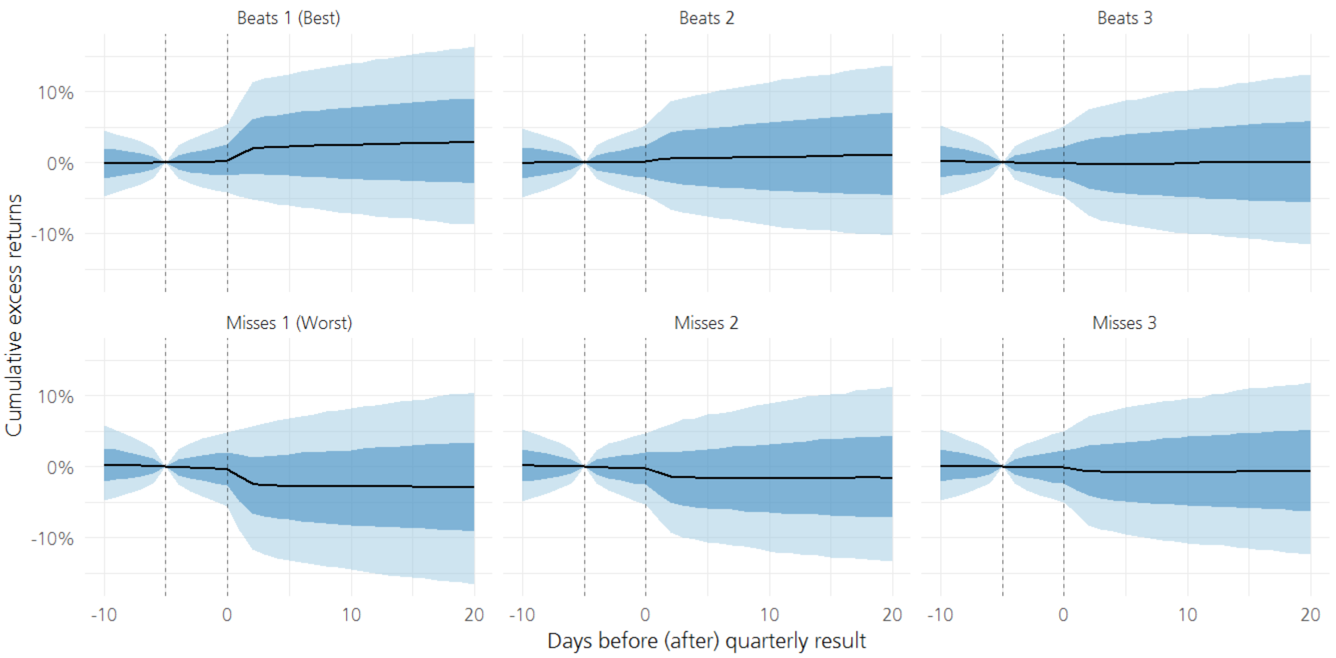
Figure 14: Breakdown of the T+10 earnings revisions by fiscal quarter (# quarterly observations as shown)



Source: IBES, FactSet, UBS Quant

We also know that the market price reaction to earnings surprises follows a similar pattern to Figure 13—albeit at a faster pace. Below we show the cumulative abnormal returns to these quarterly earnings surprises; it stands to reason that any systematic errors generated from earnings surprises produce a comparable reaction in the market—which presents a source of opportunity for quantitative investors.

Figure 15: The market reaction to beats/misses (10/25/50/75/90th percentiles shown)



Source: IBES, FactSet, UBS Quant

Seasonal adjustment of earnings revisions

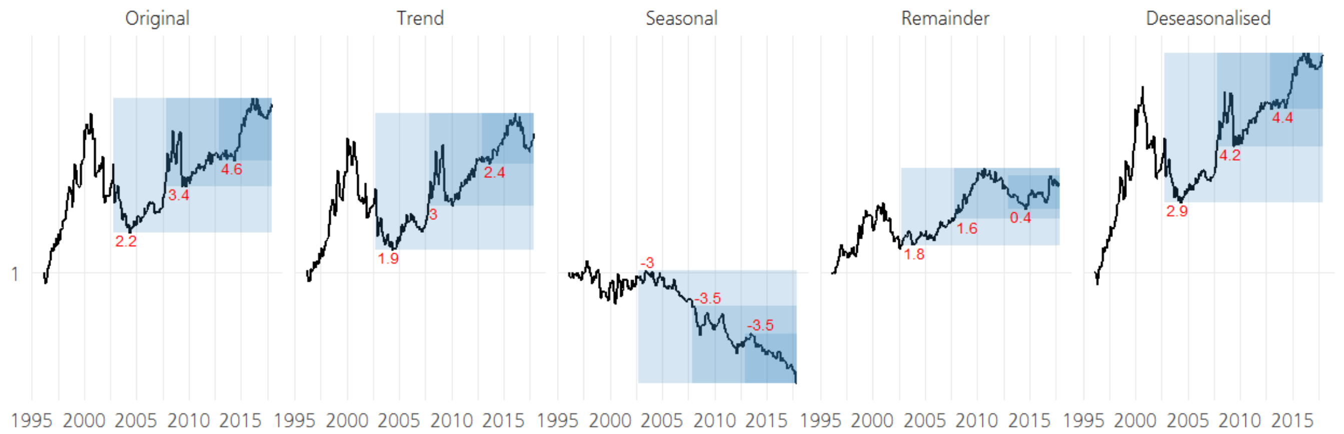
Finally we consider the implications these seasonal influences in earnings revisions, by seasonally adjusting earnings revisions as used in an investment process. There are many ways of approaching this problem; in our earlier report (link) we adopted a powerful technique known as a Bayesian structural time series model.

We adopt a very simple and popular technique known as STL

However, this procedure is far too slow to run for a global benchmark[6]; each model took perhaps 10 minutes to run on modern hardware. A popular and much faster alternative is the STL procedure described earlier; while it has some deficiencies (it cannot handle trading day changes, holidays, missing values, etc.), it is nonetheless well-suited to the task at hand[7].

We now refer to our standard tool: the long-short backtest. In this, we take the original 3-month earnings revisions[8] and simply run the STL procedure on it. Note this procedure is run fully out-of-sample; we re-estimate the model each month only using data known as of the rebalance period to avoid foresight bias.

Figure 16: Backtest results over MSCI ACWI, 3M earnings revisions and its components



Source: IBES, FactSet, UBS Quant

Figure 16 shows the results of a monthly rebalanced backtest conducted over the MSCI ACWI (point-in-time), cumulative long-short USD total returns of market-cap weighted quintiles, excluding trading costs. The figures in red show the annualised performance over 5/10/15 year horizons.

A number of interesting results emerge from this at first glance:

The trend component delivers a low-turnover exposure to the earnings revision strategy

The **trend component** has a remarkably similar profile to the original data. Given that the trend component is essentially just a cleverly smoothed version of the raw data, this means that exposure to earnings revisions could conceivably be achieved through far lower turnover. Indeed Figure 17 shows the turnover of this strategy is roughly halved relative to the original.

[6] Under these timings the same method would take ~2,500 stocks × 12 months × 20 years × 10 minutes, or roughly over a decade
[7] Another popular technique is known as "X-13ARIMA-SEATS", used by the US census bureau and many other statistical authorities. An interactive online dashboard of this method can be found at the following URL: http://www.seasonal.website.
[8] Defined as the (12m fwd EPS[now]-15m fwd EPS[-3m])/std dev.(15m fwd EPS[-3m])

The **seasonal component** detracts value on a standalone basis. This return profile bears no similarity to the original data, and this component is seemingly incurred through systematic errors in the consensus forecasting. Furthermore, because high seasonality in one month requires lower seasonality in another month (i.e. seasonal effects are zero-sum), this component tends to drive stocks from the long to short baskets—the seasonal influences are very high turnover.

The seasonal detracts value in all markets and has the highest turnover of all components

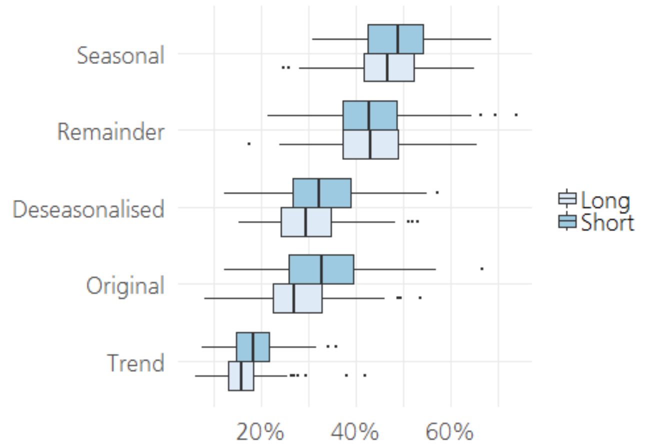
The **remainder** cannot be explained by either the seasonality or the trend, i.e. it is the residual. Given that this essentially captures the idiosyncratic earnings revisions component, it is surprising that performance of this factor is so subdued. We expect that signal is rich in information content; surprise positive revisions in a turnaround story or a tipping point in a market favourite—however the turnover of such a signal is naturally also very high.

The remainder may be rich in information content, but is noisy and suffers high turnover

The **deseasonalised** series is simply calculated as the original less the seasonal (or equivalently the trend plus remainder) at the stock level at each point in time. This largely delivers the return profile of the original data (including the unimpressive drawdowns); however it suggests a slight improvement in the Sharpe[9] ratio, which we observe in Figure 18. Surprisingly, the turnover of the deseasonalised strategy is comparable to the original signal, however.

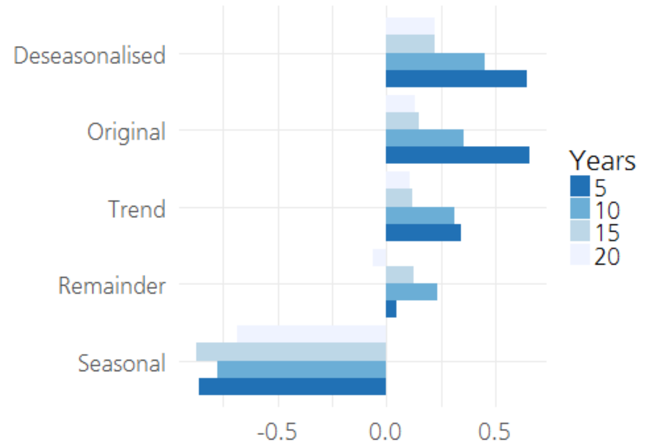
The deseasonalised series yields an improvement in risk-adjusted returns globally

Figure 17: One-way monthly turnover



Source: MSCI, FactSet, UBS Quant

Figure 18: Annualised Sharpe ratio



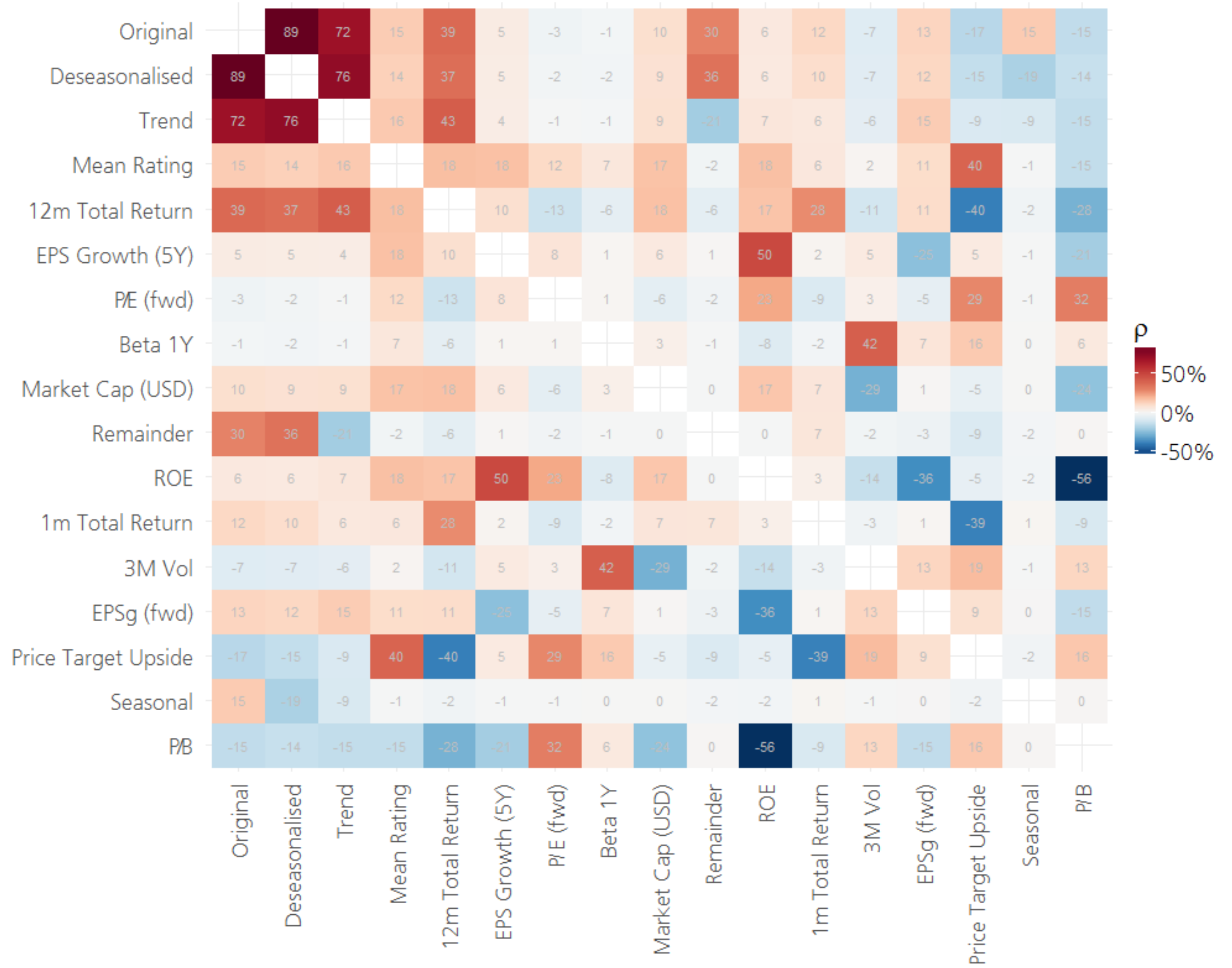
Source: MSCI, FactSet, UBS Quant

Figure 19 shows the median cross-sectional correlation matrix of these signals, including a number of the standard factors. Unsurprisingly the original 3-month earnings revisions, the trend, and the deseasonalised series are all highly correlated with each other. Note the remainder and seasonal components show essentially no correlation with any of the standard factors and only a weak correlation with the other components, as expected.

The components all show weak correlation to each other

[9] Calculated as the annualised ($\times \sqrt{12}$) monthly Sharpe ratio, relative to the US 3mo T-Bill

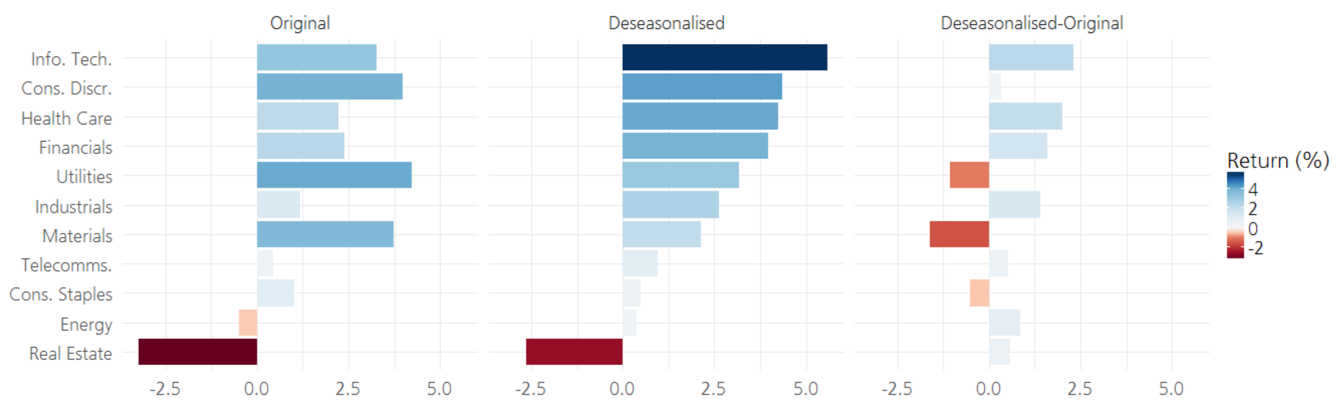
Figure 19: Median cross-sectional correlation matrix



Source: MSCI, FactSet, UBS Quant

Earlier results uncovered marked differences between seasonality within the sectors and across the broad market (Figure 11). We might expect similar differences between the performance of the seasonally-adjusted earnings revisions strategy relative to the original strategy accordingly.

Figure 20: The decomposition of the sector-level backtests (MSCI ACWI)



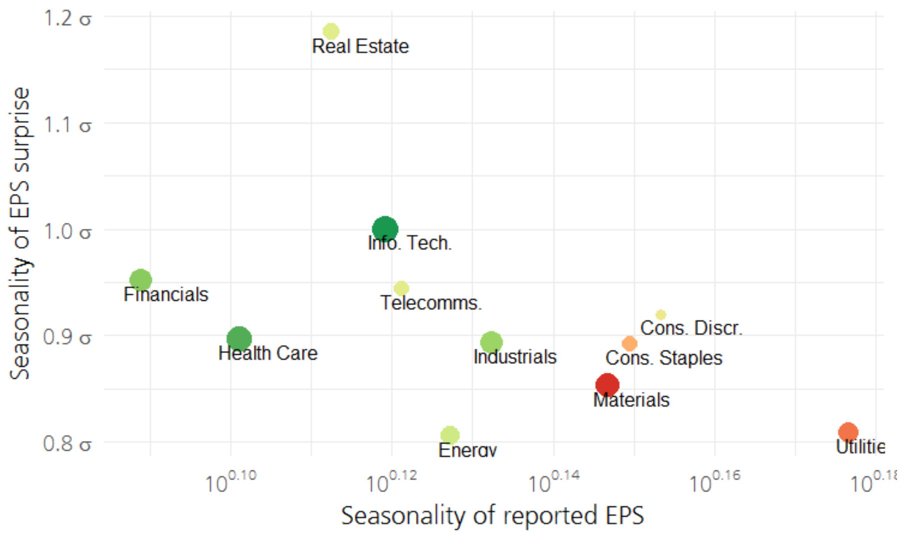
Source: MSCI, FactSet, UBS Quant

Figure 20 shows the annual return to the full-sample long-short backtest as in Figure 16 above; however the backtests are constructed entirely within the sector. The original strategy speaks to the information content of the earnings revisions within the sector, and more importantly how they are interpreted by investors. However, the more interesting chart is shown on the far right; the performance delta between the seasonally adjusted strategy and the original.

The more seasonal the earnings are, the less seasonal the earnings surprise is

Interestingly, there is a seeming relationship between the seasonality in earnings surprises, the underlying earnings stream and the performance gain from seasonal adjustment of the earnings revisions signal. Figure 21 shows the same data from Figure 11, in which the points are coloured by the sector-level performance gain as in the rightmost plot in Figure 20.

Figure 21: Earnings seasonality, and the analyst/market under-reaction



Source: MSCI, FactSet, UBS Quant

The investor inattention claim posits that seasonal effects exist because they are easily overlooked

Evidently the more seasonal the sector earnings are, the less seasonal the earnings surprise is, and the less value the seasonally adjustment of the earnings revisions bears. Conversely, the least seasonal earnings might suffer from seasonal forecast "oversight", which then yields a meaningful performance improvement once the seasonal adjustment has taken place.

Conclusion

One of the most compelling arguments for the continued existence of seasonal effects within markets is that of investor inattention. These results suggest a similar pathology exists within both analyst forecasts and the market reaction thereto.

Earnings streams with the highest seasonality have the lowest seasonality in their earnings surprises, and seasonally adjusting these revisions detracts value from this investment signal; the market already prices in the obvious candidates. Conversely, the more subtle the seasonal influence within a company's earnings, the more likely the seasonal modelling is deficient, producing unnecessary surprises and subsequently negative-value components within the earnings revisions.

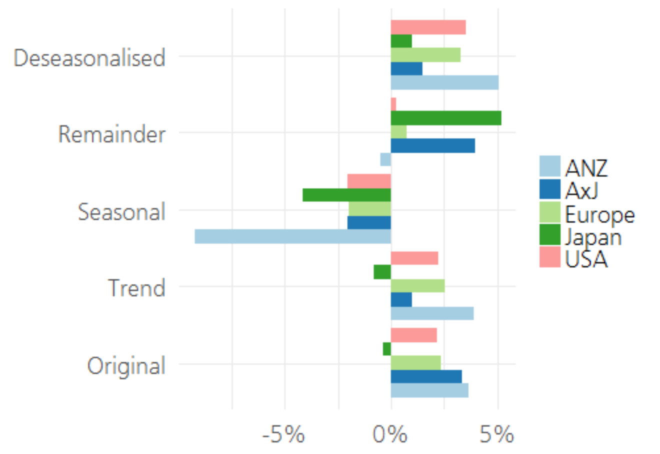
Seasonal methods are under-utilised in the investment process

Despite the obsession with alternative data, we believe that many alpha generation opportunities are still hiding in plain sight; borne of institutional and behavioural pressures. Seasonal methods are stable, fast and freely available; we argue their use in the investment process is underappreciated.

Appendix

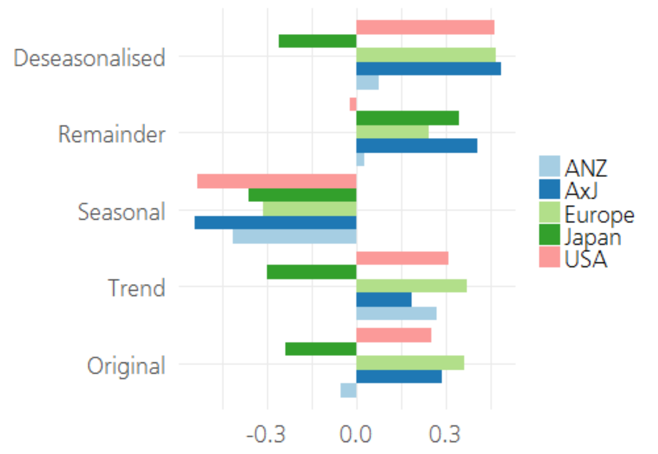
The results in this report were all conducted on a global benchmark, the MSCI AC World index. Figure 22 shows the backtest breakdown of this index into its regional components. The global findings are largely consistent throughout the regional results, with the exception of Asia ex-Japan, which had a period of sharp drawdowns to the deseasonal strategy near the start of the backtest period.

Figure 22: Regional Backtest: annual return



Source: MSCI, FactSet, UBS Quant

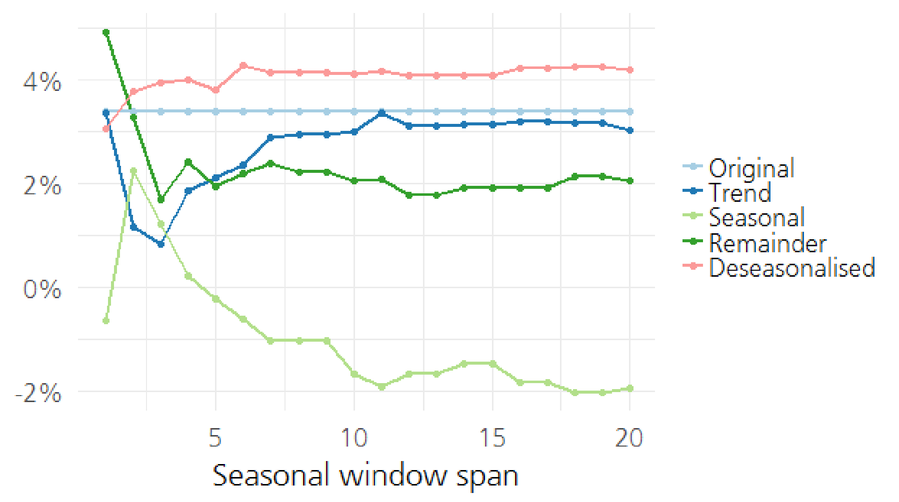
Figure 23: Regional Backtest: Sharpe (rel. US 3mo T-bill)



Source: MSCI, FactSet, UBS Quant

Finally, an omitted technical detail in the report was the seasonal window duration parameter provided to the STL function. Essentially this determines how long the seasonal effects should be estimated over, e.g. a value of say 5 in a quarterly series means that the 1Q component is estimated using a locally smoothed polynomial fit (essentially just a clever moving average) over the 1Q figure for the surrounding 5 years. These seasonal components are subtracted from the original data, and then smoothed to yield the trend; the process is repeated a handful of times to stabilise the results and the remainder is simply what is leftover.

Figure 24: Sensitivity to the seasonal window parameter (MSCI ACWI)



Source: MSCI, FactSet, UBS Quant

Lest we be accused of overfitting our backtests, the sensitivity of our backtests to this parameter is shown in Figure 23. We used a "periodic" seasonal window, which takes the long-term average of these seasonal components (effectively a parameter value of ∞). However, the process was recalculated at each point in time using data only available up to then, i.e. we used an expanding periodic window. Nonetheless, the backtests are stable to values of this parameter beyond 5 (years). Note that we only use pairwise complete observations between these comparisons, i.e. where no seasonal figure was available due to lack of data, the original data was also excluded, to produce a meaningful comparison.

Required Disclosures

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12-Month Rating	**Definition**	**Coverage[1]**	**IB Services[2]**
Buy	FSR is > 6% above the MRA.	46%	27%
Neutral	FSR is between -6% and 6% of the MRA.	39%	24%
Sell	FSR is > 6% below the MRA.	16%	13%
Short-Term Rating	**Definition**	**Coverage[3]**	**IB Services[4]**
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

Source: UBS. Rating allocations are as of 31 December 2017.
1:Percentage of companies under coverage globally within the 12-month rating category.
2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
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