Quantitative Monographs

Should smart beta factors be orthogonalised?

Equities

Global

Quantitative

Should you orthogonalise smart beta factors to each other? Probably not.
Clients often ask us about "pure" signals, i.e. style factors which have been orthogonalised to the other common style factors. We do not support the idea. There are statistical problems and the resulting smart beta signals are so different from the originals that they often do not behave as we expect.

You need to be very careful about your orthogonalisation
For noisy data (and all financial data is noisy), simple linear regressions can give misleadingly small betas. You need to make a statistical correction for that or your supposedly orthogonal factors won't really be orthogonal.

And the resulting signal is not very intuitive
If you orthogonalise a factor to a long list of other factors, it will not resemble the original factor very much at the end of the process. As a result, you lose the intuition about how it will behave (e.g. will it perform well during recessions? Is the performance in the extremes?).

Making price momentum orthogonal reduces its performance significantly
For the momentum style, time varying exposures to the styles is part of what makes the strategy effective. If you remove those exposures, it will not work as well.

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Introduction

What is orthogonalisation?

The classic style factors are not independent. For example, a high quality portfolio will typically tilt towards large-caps and away from value. Some investors dislike this. They would prefer to have "pure" smart beta portfolios with minimal exposure to the other styles because this simplifies their risk budgeting. For example, if you increase your exposure to the quality portfolio, you may not want to increase your tilt towards size at the same time.

This can be accomplished by a series of cross-sectional regressions:

- You leave the first factor unchanged.
- For the second factor, you regress it onto the first factor and then take the residuals. These residuals are your new second factor.
- For your third factor, you regress it onto both your first and second factors, and take the residuals. These residuals are your new third factor.
- You continue in this fashion until you have a list of orthogonal smart beta factors.

Orthogonalisation makes risk budgeting simpler …

You can then apportion your risk budget between these independent smart beta factors, so that increasing your weight towards one factor does not change your weight in another.

… but loses the intuition about the factor,

We generally think orthogonalisation is a bad idea. When you orthogonalise a factor, you can end up with a signal which does not bear much resemblance to the original, and style baskets constructed with the new orthogonalised signal may no longer behave according to your intuition. For example, a quality signal which has been orthogonalised to momentum, size, value and beta may no longer tend to outperform during drawdowns as we would expect a quality signal to do.

We think that you are better off spending time modelling and studying the relationships between simple factors which you do understand, than creating these artificial and unintuitive factors.

… causes higher turnover,

Orthogonalised signals also tend to be less stable than more simply defined signals. This leads to higher turnover in your smart beta portfolios and hence higher trading costs.

… has statistical problems,

There is also a serious and often ignored statistical issue with orthogonalisation. For noisy data, simple linear regressions will often significantly underestimate the betas. That means that, even after orthogonalisation, the smart beta factors will not be truly independent of each other. That can cause investors to misunderstand the risk of their portfolios. Investors who do want to orthogonalise their smart beta factors need to be very careful.

… and for momentum, may weaken performance

For the momentum factor, there is also another reason. We believe that the time varying style exposure of the momentum factor is part of the reason for its outperformance. This was discussed in detail in our September 2016 publication "Are you already timing styles successfully?". If you orthogonalise the signal to the other smart beta factors, and hence remove the inherent style rotation in the price momentum strategy, it may also reduce its return.

Data

Universe and time period

We consider multiple different regions in this analysis. In each case our universe is the MSCI index restricted down to stocks from that region e.g. MSCI Europe. In each case we use the same time period, the 20 years from January 1997 to June 2017.

Construction of our factor baskets

For each signal, whether a simple smart beta factor or an orthogonalised version of it, we use the same portfolio construction method. We identify the top and bottom quintiles of stocks and equal weight them to create two portfolios. Then we take a positive weight in the high portfolio and a negative weight in the low portfolio to create a long-short portfolio. This portfolio is rebalanced monthly.

Normalisation of the factor data

We use many of the common smart beta factors. This factor data (like all financial data) will often have some extreme outliers. Since orthogonalisation requires regression, these outliers could strongly distort our beta estimates. To get around this issue, we normalise each factor:

1. We start with a linear transformation of each factor.

$$x: \to \frac{x - median(x)}{median\ absolute\ deviation\ (x)}$$

2. Then we winsorise the factor scores at -/+ 4.

3. Finally, we adjust each factor to have a mean of zero.

This normalisation has the added advantage that the beta coefficients of our regressions will be on the same scale, so they can be fairly compared to each other.

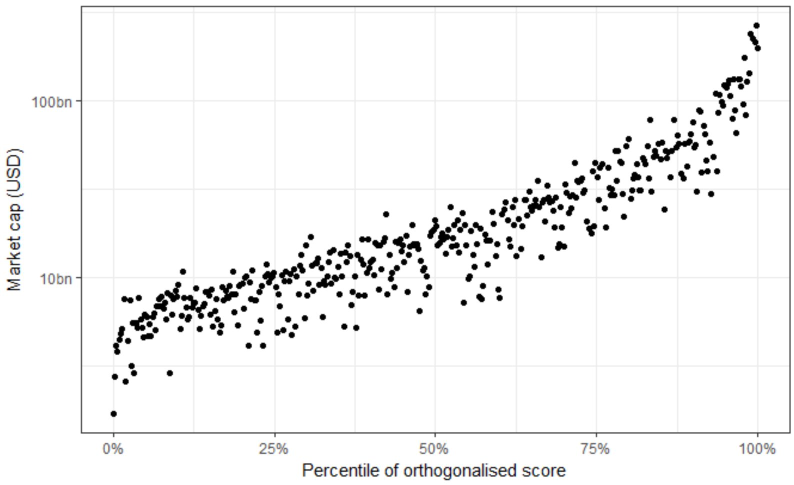
Orthogonalisation sacrifices intuition about smart beta factors

Orthogonalising your signals may change your portfolio and its performance in ways you might not expect

Orthogonalised signals are often quite different from the original smart beta signals. For example, if we orthogonalise market cap to volatility, earnings yield, ROIC and price momentum, some of your stocks which score highly on your size score will not necessarily be very large cap.

For example, if we run the orthogonalisation with May 2016 data, the smallest market-cap of stock in the top half of the universe by size is 15.1bn USD. In contrast, the smallest market-cap of a stock in the top half by the orthogonalised size score is just 7.3bn USD.

Figure 1: Market cap vs orthogonalised size score



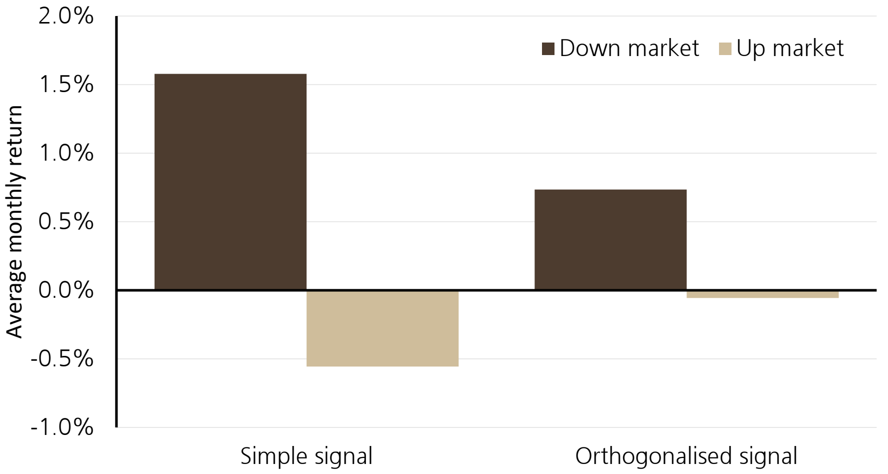
Source: UBS Quantitative Research, European universe Note: Data as of 30th June 2017.

E.g. an orthogonalised quality signal has much weaker outperformance during drawdowns than a simple quality signal

Orthogonalisation can also have implications on how your portfolio behaves. For example, investors turn to the quality style for safety, because it tends to outperform when the market is falling, but will a quality signal that has been orthogonalised to multiple smart beta factors (size, value, momentum and risk) still have that characteristic?

In Figure 2, we show the average monthly return to the quality style either when the market is up or down for that month. For the simple factor, there is a big difference. On average, the long-short style has outperformed by about 1.5% during market down months and underperformed by about -0.5% during market up months. If we use the orthogonalised signal, that effect is still present, but it is much weaker. On average, the orthogonalised signal would have been roughly flat during up months and up by around 0.7% during down months.

Figure 2: Effect of orthogonalisation on quality strategy



Source: UBS Quantitative Research, European universe

Statistical problems with orthogonalising smart beta factors

Orthogonalising smart beta factors is more complicated than it would appear at first glance. Simple regressions can give misleadingly small betas when working with noisy data (and all financial data is noisy). That means that your residuals are not truly orthogonal to the prior signals, which may lead to investors misunderstanding the risks in their portfolios. Investors who want to orthogonalise need to be quite careful.

Over the next few pages we give an extended case study illustrating this problem for orthogonalising price momentum to earnings momentum.

Case study: orthogonalising price momentum to earnings momentum

Summary

- Price momentum and earnings momentum are very similar signals. So, if you orthogonalise price momentum to earnings momentum and then look at the residuals you should expect something close to random noise.

- However, a strategy based on these residuals appears to have been successful historically.

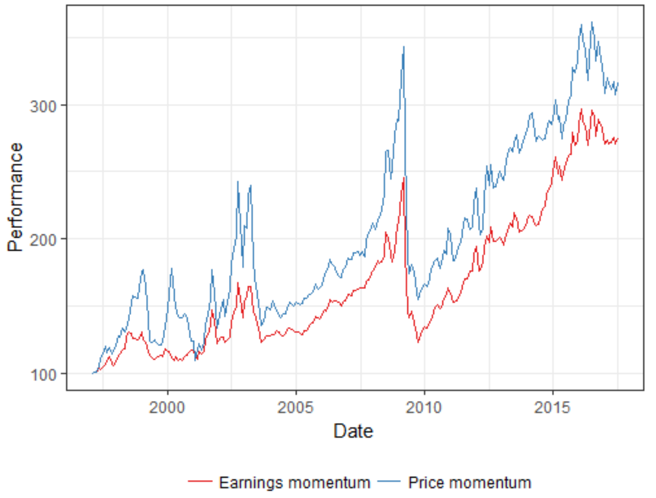
- This is because of what is known as an "errors in variables" problem, which causes our regression to systematically underestimate the beta between these two signals. If we re-estimate this regression using earnings revisions as an instrumental variable, we get consistently larger betas.

- If we use these new betas to estimate the residuals then a strategy based on these residuals would have been much less successful.

Price momentum and earnings momentum are strongly interconnected. Both forms of momentum reflect the changing popularity of stocks. There are also direct relationships: analysts upgrading their forecasts for a stock can cause stock prices to move and stock price moves often reflect news about a stock which is subsequently incorporated into analyst forecasts. It is therefore not surprising that the time series of the factor portfolios for these two signals are very strongly correlated (see Figure 3 and Figure 4).

Price momentum and earnings momentum are very similar factors …

Figure 3: Performance of long-short price and earnings momentum (Europe)



Source: UBS Quantitative Research

Figure 4: Scatterplot of monthly returns to long-short price and earnings momentum (Europe)

Source: UBS Quantitative Research

Suppose we try to orthogonalise price momentum against earnings momentum. First we run this cross-sectional regression:

$$Price\ momentum_i = \alpha + \beta \cdot Earnings\ momentum_i + \varepsilon_i,$$

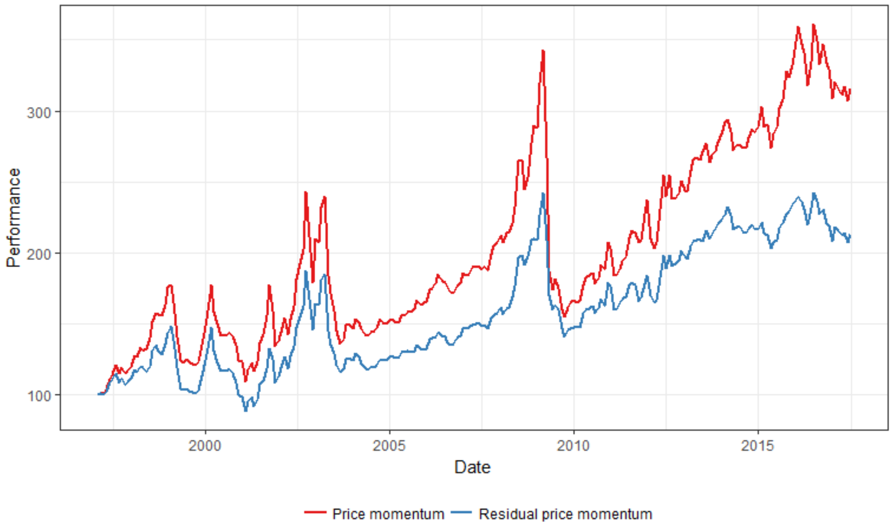
Then we take ε_i, the residuals of the regression, as our new trading signal. We can run a backtest based on this new signal. Figure 5 shows how this would have performed historically.

It appears that a strategy based on the residuals would have outperformed on a long-short basis, with an annualised return of 3.8% over our sample period. This is puzzling. If you regress a factor onto a very similar factor, the residuals should be little more than random noise and random noise should not be a profitable trading signal.

… yet a strategy based on price momentum orthogonalised to earnings momentum still works

A puzzle!

Figure 5: Performance of a long-short price momentum and residual price momentum strategy (Europe)



Source: UBS Quantitative Research

"Errors in variable" problem: our estimated beta was too small

The problem appears to be coming from the regression. There is a serious errors in variable issue. There is a more complete description of this in the Appendix, but in brief, this means that the data we use in our regression is very noisy and leads to the beta in our regression being misestimated as closer to zero than it really is.

If our estimated beta is too small then our residuals are not really orthogonal to the earnings momentum signal. Some of the information from the earnings momentum signal has been "left in". As a result, the residuals remain similar to the original price momentum signal and the backtest still looks very similar to the original price momentum backtest.

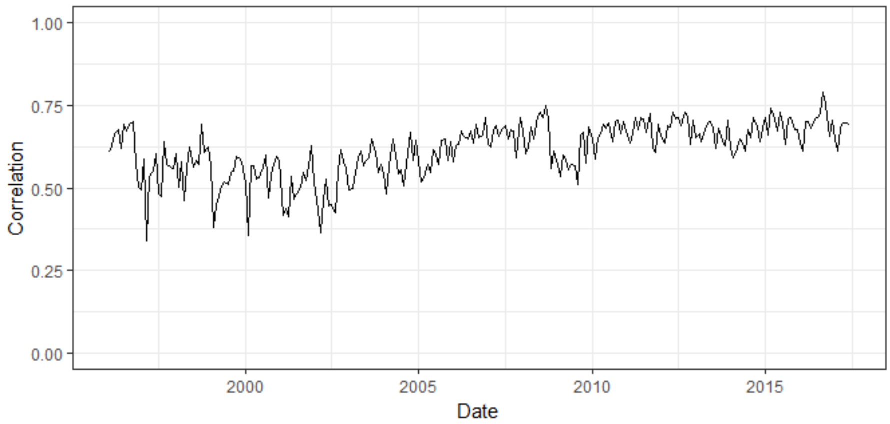
Use earnings revisions as an instrumental variable to get a new estimate for beta

To correct for the errors in variables problem we use earnings revisions as an instrumental variable (again, see the Appendix for a brief discussion of this) and try to re-estimate our beta:

$$New\ estimate\ of\ beta = \frac{cov(price\ momentum, earnings\ revisions)}{cov(earnings\ momentum, earnings\ revisions)}$$

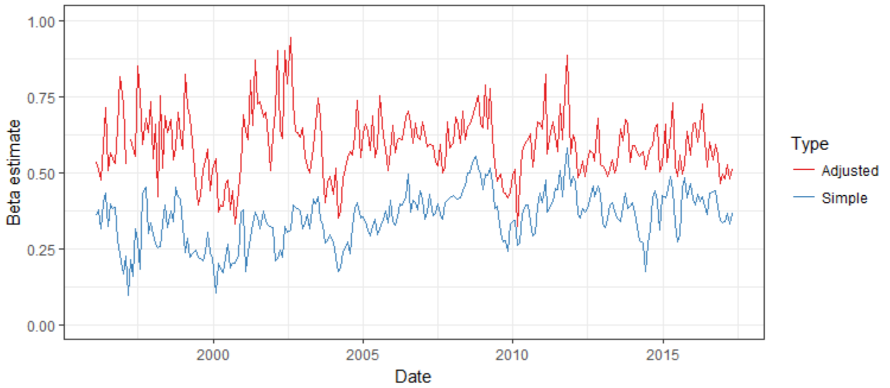
Figure 6 shows the cross-sectional correlation between earnings revisions and earnings momentum. It is consistently high and positive, which is what we need for an instrumental variable. Figure 7 shows our two estimates for the beta of price momentum on earnings momentum at each month end. The adjusted beta is consistently larger than the beta we estimate from the simple regression. This is strong evidence of an errors in variable problem.

Figure 6: High cross-sectional correlation between earnings revisions and earnings momentum – it *is* a suitable instrument



Source: UBS Quantitative Research

Figure 7: Estimated beta of price momentum vs earnings momentum



Source: UBS Quantitative Research

If we use our new, adjusted betas to compute the residuals, we can create a new residual price momentum signal. Finally, we can run a new backtest based on this signal.

Figure 8 illustrates the performance of this new signal. We can see that it is much less successful than the both the original price momentum signal and the simple (not adjusted) residual signal. This shows the impact of really removing earnings momentum from the price momentum strategy. You lose more than half of the return.

With the correct beta, the residual price momentum strategy looks much worse than the original

It is also noticeable that orthogonalisation greatly increases the turnover of the price momentum strategy because the residual signals are very noisy. That means that, after trading costs have been taken into account, the orthogonalised price momentum strategy would be even less successful.

Figure 8: Performance of a long-short price momentum and residual price momentum strategies (Europe)

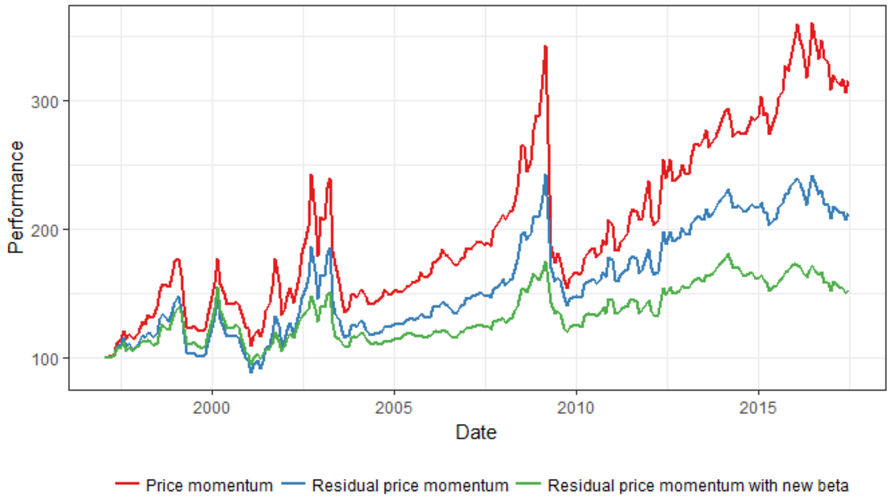


Figure 9: Statistics

	Price momentum	Residual price momentum	Residual price momentum with corrected beta
Return	5.8%	3.8%	2.1%
Volatility	21%	18%	13%
Risk adjusted return	0.27	0.22	0.16
Turnover	24%	33%	40%

Source: UBS Quantitative Research Note: Turnover is defined as the average proportion of names which either leave the long basket or the short basket each month (similar to 1-way turnover).

Orthogonalisation is negative for price momentum's performance

Price momentum has an inherent style rotation effect. If you remove it by orthogonalising, you typically reduce the return

Price momentum has a time varying exposure to the other smart beta factors. It is a chameleon. When high quality has outperformed, price momentum will tilt towards high quality and when value has outperformed, price momentum will tilt towards value.

These time varying tilts give price momentum an inherent style rotation strategy. In our September 2016 publication "Are you already timing styles successfully?" we discussed this in greater detail. We believe that this style rotation effect is driving a lot of the performance of the price momentum style. If you remove it, by orthogonalising the signal to the other smart beta styles, you will reduce the performance.

We look at the effect of orthogonalising price momentum after a series of factors: earnings momentum, forwards earnings yield, ROIC and volatility. We have checked these factors for the errors in variables problem and decided to instrument for earnings momentum (using earnings revisions) and the value factor (using trailing earnings yield), but not the quality factor. Please see the Appendix for more details of our rationale for this choice.

How does orthogonalising price momentum affect its performance?

In Europe, momentum is clearly negatively affected by orthogonalising against other smart beta factors. Figure 10 and Figure 11 show how any form of orthogonalisation reduces the return to the strategy, and generally, the more factors you orthogonalise to, the worse the situation becomes.

In Europe, orthogonalisation is mostly bad for price momentum

An exception to this is the uptick in performance when you orthogonalise to volatility. This is mostly due to the superior performance of the strategy orthogonalised to volatility during market rallies.

Why does orthogonalising to volatility improve performance?

Price momentum tends to strongly underperform at market turning points. This is because during market drawdowns, high beta names underperform low beta names, so the long-short price momentum strategy takes on a negative beta exposure. When the market rallies again, that negative beta exposure leads to strong underperformance.

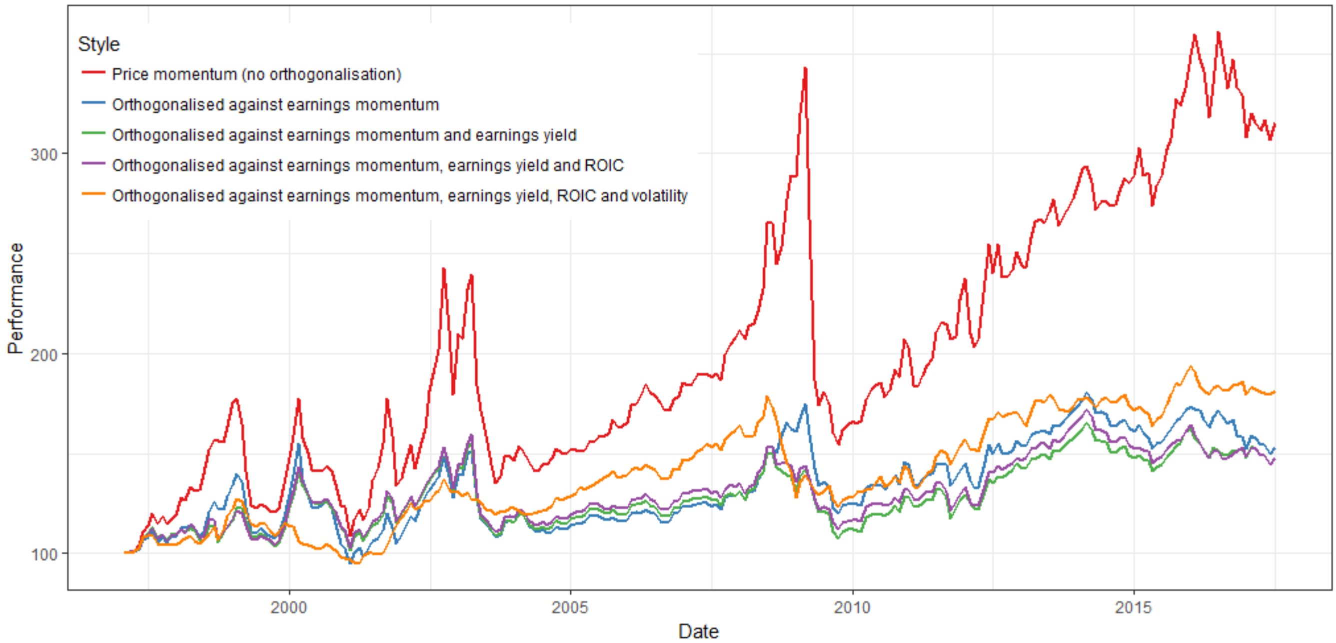
Orthogonalising to volatility reduces the tilts towards negative beta during the drawdown and hence improves the performance of momentum. A more effective alternative approach is to volatility target a simple (not orthogonalised) price momentum.

Figure 10: Statistics on price momentum performance

	Return	Risk	Risk adjusted return	Turnover
Price momentum (no orthogonalisation)	5.8%	21%	0.27	24%
Orthogonalised against earnings momentum	2.1%	13%	0.16	40%
Orthogonalised against earnings momentum and earnings yield	1.9%	12%	0.16	40%
Orthogonalised against earnings momentum, earnings yield and ROIC	1.9%	12%	0.16	40%
Orthogonalised against earnings momentum, earnings yield, ROIC and volatility	3.0%	9%	0.34	38%

Source: UBS Quantitative Research Note: Turnover is defined as the average proportion of names which either leave the long basket or the short basket each month.

Figure 11: Performance of European price momentum subject to different specifications of orthogonalisation



Source: UBS Quantitative Research

What happens in other regions?

Results in other regions more mixed

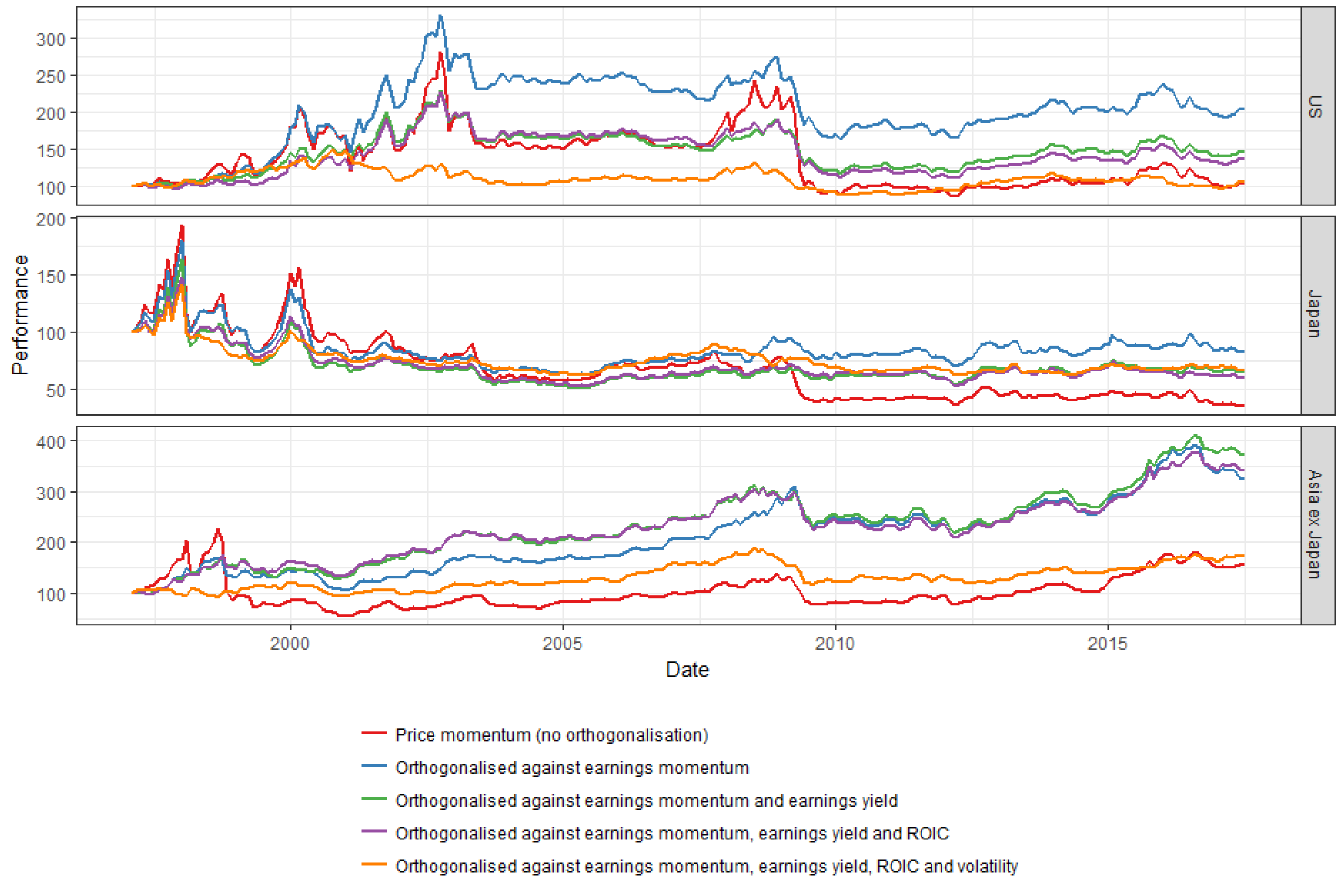
If we look at the other regions, the picture is less clear cut. Figure 12 shows the performance of long-short price momentum with different specifications of the orthogonalisation procedure.

In the US, orthogonalised price momentum outperforms the simple, not orthogonalised signal over the full period, due to the smaller drawdowns suffered by the orthogonalised portfolios during momentum's periodic crises. At other times, the strategies perform broadly in-line.

In Japan, price momentum is not a successful signal. The simple long-short price momentum style would have lost around -4.4% per year over our sample period. The orthogonalised price momentum strategies *do* outperform the simple, not orthogonalised strategy, because they have flatter performance, not because they are particularly successful.

The real outlier is Asia ex Japan. In this region, orthogonalisation would have been successful. Removing the earnings momentum tilt from price momentum greatly improves performance. However, even here, the outperformance is not steady. The great majority of this outperformance happens during a brief period around Sep – Dec 1998. Since then all of the strategies have performed broadly in-line.

Figure 12: Performance of orthogonalised price momentum across different regions



Source: UBS Quantitative Research

Figure 13: Statistics on the performance of orthogonalised price momentum across different regions

	US				Japan				Asia ex Japan			
	Return	Risk	Risk adjusted return	T/O	Return	Risk	Risk adjusted return	T/O	Return	Risk	Risk adjusted return	T/O
Price momentum (no orthogonalisation)	0.2%	24%	0.01	26%	-5.0%	24%	-0.21	26%	2.2%	23%	0.10	25%
Orthogonalised against earnings momentum	3.5%	16%	0.22	38%	-0.9%	20%	-0.05	39%	5.9%	13%	0.47	42%
Orthogonalised against earnings momentum and earnings yield	1.9%	13%	0.14	38%	-2.1%	18%	-0.11	39%	6.6%	11%	0.58	43%
Orthogonalised against earnings momentum, earnings yield and ROIC	1.5%	14%	0.11	38%	-2.4%	16%	-0.15	40%	6.2%	12%	0.51	43%
Orthogonalised against earnings momentum, earnings yield, ROIC and volatility	0.3%	10%	0.03	37%	-1.9%	13%	-0.14	39%	2.7%	11%	0.24	42%

Source: UBS Quantitative Research Note: Turnover (T/O) is defined as the average proportion of names which either leave the long basket or the short basket each month.

Again, as in Europe, we see an increase in the turnover. Turnover is almost 60% higher in the orthogonalised strategies compared to the simple price momentum strategy.

Conclusions

Orthogonalisation can be tempting to portfolio managers because it offers an appealing simplicity to risk budgeting and to performance attribution, but we think this is a siren call.

There are four main rationale for our argument:

- Orthogonalisation can make smart beta factors unintuitive.
- There are statistical problems with orthogonalisation that most investors do not realise.
- Orthogonalised signals are less stable and so increase turnover.
- For price momentum and maybe other factors, orthogonalisation can reduce performance.

Loss of intuition

Experienced portfolio managers will have a strong intuitive understanding of how smart beta factors behave and interact with each other. For example, they will know what kinds of economic environments different factors do well in e.g. quality outperforms during downturns, and what kind of implementation problems each factor faces e.g. small-cap portfolios may be illiquid.

If you orthogonalise a smart beta factor, your new signal may not behave as you expect. For example, we found that an orthogonalised quality factor would be much less effective as a hedge against market drawdowns. Losing this kind of intuition can make portfolio managers less effective.

Statistical problems

The typical approach to creating orthogonal factors will often fail due to a statistical problem that can happen with noisy data (such as financial data) called errors in variables. There are statistical techniques which will help to with this problem, but it is difficult to fully correct for. That means that supposedly orthogonalised factors won't really be orthogonal and any risk budgeting or performance attribution based on that assumption will be fatally flawed. That is dangerous for portfolio managers making decisions based on this analysis.

Greater turnover

Orthogonalisation can often be unstable. If you run cross-sectional regressions every month, you will notice that the coefficients can change a lot from month to month. As a result, the residuals of these regressions (which are the orthogonalised smart beta signals) will jump around a lot from month to month, even when you start from slow moving signals such as beta or ROIC. Faster moving signals will typically lead to higher turnover and so higher trading costs in your portfolio.

Orthogonalised price momentum underperforms

For price momentum, orthogonalisation is particularly problematic. Price momentum has time varying factor tilts, depending on which smart beta factors have outperformed recently. This factor rotation is an important part of why price momentum works, and, if you orthogonalise price momentum and remove the factor tilts, it will not perform as well.

We believe that investors would be better off getting to grips with the relationships between simple, intuitive smart beta factors than creating artificial, and unintuitive, orthogonalised factors and putting their faith in an orthogonalisation process which is unlikely to deliver what it promises.

Appendix:

Summary of "errors in variable" problem

The errors in variable problem occurs in regressions when one or more of your explanatory variables is very noisy and leads to your estimates for the betas being too small.

If your data is very noisy, you are likely to underestimate your betas

This sort of problem is very common in finance because almost all our data is very noisy. For example, if you are comparing PEs of the stocks in your universe, some firms' PEs may include earnings that others would consider extraordinary events and exclude.

Mathematical explanation:

For the sake of simplicity, we will only consider a regression with one variable, but the same results apply to multivariate regression. Suppose there is a linear relationship between y and x:

$$y = \beta x + \varepsilon$$

We want to estimate β, but, unfortunately, we don't have data on x, only on $x^* = x + \eta$, because x is measured with error.

Our estimate for the beta coefficient is (in expectation):

$$\begin{aligned} Estimate &= \frac{cov(x^*, y)}{var(x^*)} \\ &= \frac{cov(x+\eta,\ \beta x + \varepsilon)}{var(x+\eta)} \\ &= \frac{\beta\sigma_x^2}{\sigma_x^2 + \sigma_\eta^2} \\ &= \frac{\beta}{1 + \sigma_\eta^2/\sigma_x^2} \end{aligned}$$

Note that the bottom line is always bigger than one, so our estimate for beta is expected to be a bit smaller than its true value. If our measurement of x is very noisy, so the ratio of the variance of the error term, η, to the variance of the true variable, x, is large, then our estimate for the beta coefficient will be much too small.

Let's look at this problem empirically. We have created some random data such that:

Empirical example with random data

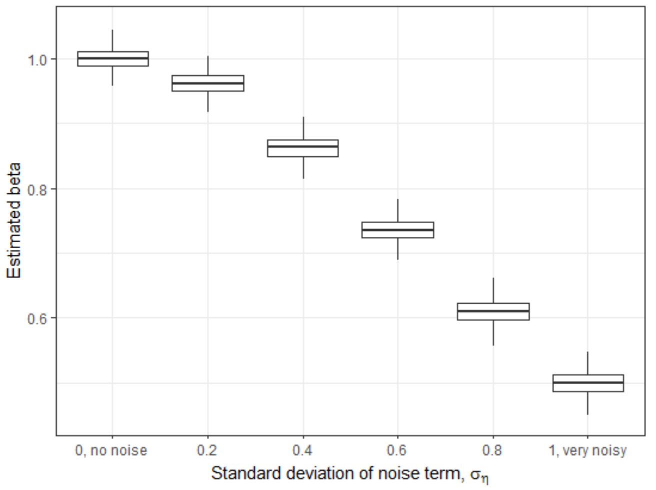
$$\begin{aligned} y &= x + \varepsilon, \qquad where\ x \sim N(0,1), \varepsilon \sim N(0, 0.5) \\ x^* &= x + \eta, \qquad where\ \eta \sim N(0, \sigma_\eta^2) \end{aligned}$$

We then estimate the beta of y against x*, our noisy estimate for x. By construction, the "true" beta here is 1, but the errors in variables problem means that our beta estimate may be considerably smaller.

We repeat this process many times to see the distribution of our beta estimates and then see how this changes as we change σ_η^2, the variance of our noise term. The boxplot in Figure 14 illustrates the results.

When the variance is 0, our estimate for beta is typically very close to 1 (by construction, the true beta). However, as the variance increases our estimate for beta decreases. When our data is very noisy, with a variance of 1, then the estimate for beta is around 0.5.

Figure 14: As the noise term increases, our estimate for the beta decreases



Source: UBS Quantitative Research

Figure 15: R code for this empirical example

```
#Matrix to store our results
betaMatrix = matrix(nrow=500, ncol=6)

#Loop over different standard deviations for the noise term
for(SD in 0:5/5)
{
 for(iteration in 1:500)
 {
  #y = x + error
  x = rnorm(1000)
  y = x + rnorm(1000, sd=0.5)

  #Add some noise to the x variable
  noisyX = x + rnorm(1000,sd=SD)

  #Compute the beta of y versus noisy x
  betaMatrix[iteration,SD*5+1] = lm(y~noisyX)$coef[2]
 }
}
boxplot(betaMatrix)
```

Source: UBS Quantitative Research

What can we do about it?

Find another variable highly correlated to the explanatory variable, but uncorrelated to the noise term

There are simple techniques to get around this issue. You need to find an instrumental variable, z, which is strongly correlated to your explanatory variable, x, but which is uncorrelated to the noise in that data or to the error term in the linear regression.

For example, if you suspect that your PE data is too noisy, and this is causing you to underestimate your betas, then you can try using another value metric as your instrument, z, e.g. price to book or trailing PE.

Then we can get a new estimate for the beta as the ratio of the covariance of y and z and the covariance of your explanatory variable and z. If there was an errors in variable problem, you will see that the new estimate for the beta is consistently larger than the estimated beta from a normal regression.

Mathematical explanation:

Suppose we have found a variable z, which is correlated to x, but not to the noise term, η, or to the error term, ε. Then we can get a new estimate for the beta as the ratio of the covariance of y and z and the covariance of x* and z:

$$New\ estimate = \frac{cov(y,z)}{cov(x^*,z)}$$

$$= \frac{cov(\beta x + \varepsilon, z)}{cov(x + \eta, z)}$$

$$= \frac{\beta\sigma_{x,z} + \sigma_{\varepsilon,z}}{\sigma_{x,z} + \sigma_{\eta,z}}$$

Provided that your variable z really is uncorrelated to the noise and error terms then the expected value of our new estimate simplifies down to β.

Empirical example with random data

Again, we can see this empirically. As before, we create some random data such that:

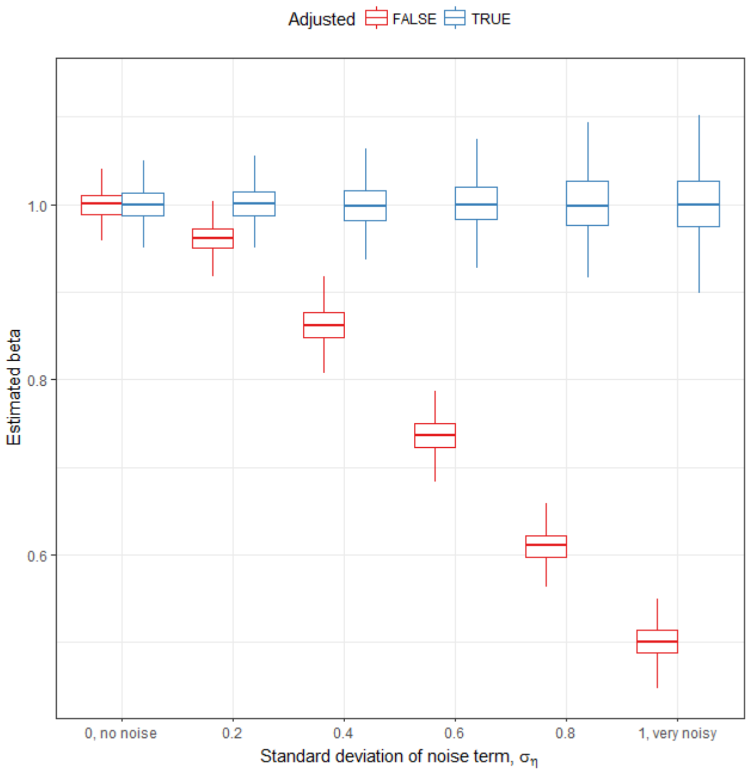
$$y = x + \varepsilon, \quad where\ x \sim N(0,1), \varepsilon \sim N(0, 0.5)$$
$$x^* = x + \eta, \quad where\ \eta \sim N(0, \sigma_\eta^2)$$

But this time we also create a variable z, which is highly correlated to x. Then we estimate the beta of y versus x*, our noisy measure of x, either using the normal regression method, or adjusting for the errors in variables problem.

Once again, we run 500 simulations to see what the distribution of the beta estimates look like, and then repeat this process to see how that distribution changes as the variance of the noise term (σ_η^2) changes.

As the variance increases our estimate for beta using the simple linear regression decreases, but if you adjust for the errors in variables problem, then the estimate for beta remains stable close to the true beta of 1.

Figure 16: As the noise term increases, our estimate for the beta decreases, unless you adjust for the errors in variables



Source: UBS Quantitative Research

Figure 17: R code for this empirical example

```
#Matrix to store our results
betaMatrix = matrix(nrow=500, ncol=6)
betaHatMatrix = matrix(nrow=500, ncol=6)

#Loop over different std deviations for the noise term
for(SD in 0:5/5)
{
 for(iteration in 1:500)
 {
  #y = x + error
  x = rnorm(1000)
  y = x + rnorm(1000, sd=0.5)

  #Add some noise to the x variable
  noisyX = x + rnorm(1000,sd=SD)

  #create a variable correlated to x
  z = 3*x + rnorm(1000, sd=2)

  #Compute the beta of y versus noisy x
  betaMatrix[iteration,SD*5+1] = lm(y~noisyX)$coef[2]

  #compute the beta of y versus noisy x,
  #BUT adjusting for errors in variables
  betaHatMatrix[iteration,SD*5+1] = cov(y,z) / cov(noisyX,z)
 }
}

par(mfrow=c(1,2)); boxplot(betaMatrix); boxplot(betaHatMatrix)
```

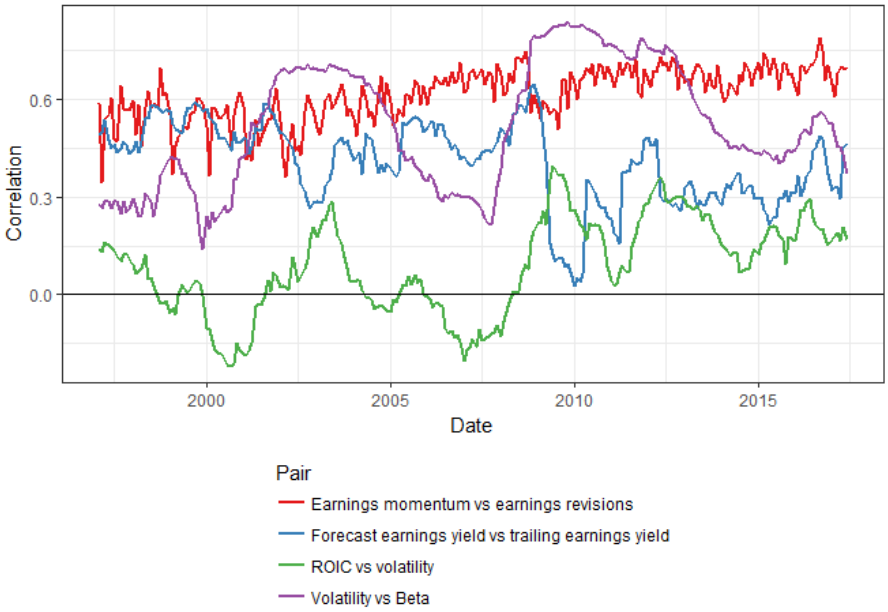
Source: UBS Quantitative Research

Should we adjust the betas for our smart beta factors for errors in variables problems?

Before we try to orthogonalise price momentum against our list of three smart beta factors, we need to check for errors in variables issues.

Firstly, we need to identify sensible instrumental variables. These should have a high correlation to the original factor. We tried earnings momentum vs earnings revisions, forwards earnings yield vs trailing earnings yield, ROIC vs volatility and volatility vs beta.

Figure 18: Cross-sectional correlations between variables and possible instrumental variables



Source: UBS Quantitative Research Please note that we have inverted the score for volatility and beta, so that a high score is "good".

Poor correlation between ROIC and possible instrumental variables

As you can see from the correlations in Figure 18, the relationship between ROIC and volatility is not stable. We tried a number of other quality variables and did not succeed in finding a suitable variable, so we are not going to take instrumenting any further for quality.

Secondly, we run univariate regressions, with three separate regressions of price momentum onto each factor in turn, either adjusting for errors in variables or not. Figure 19 shows our beta estimates at each month end.

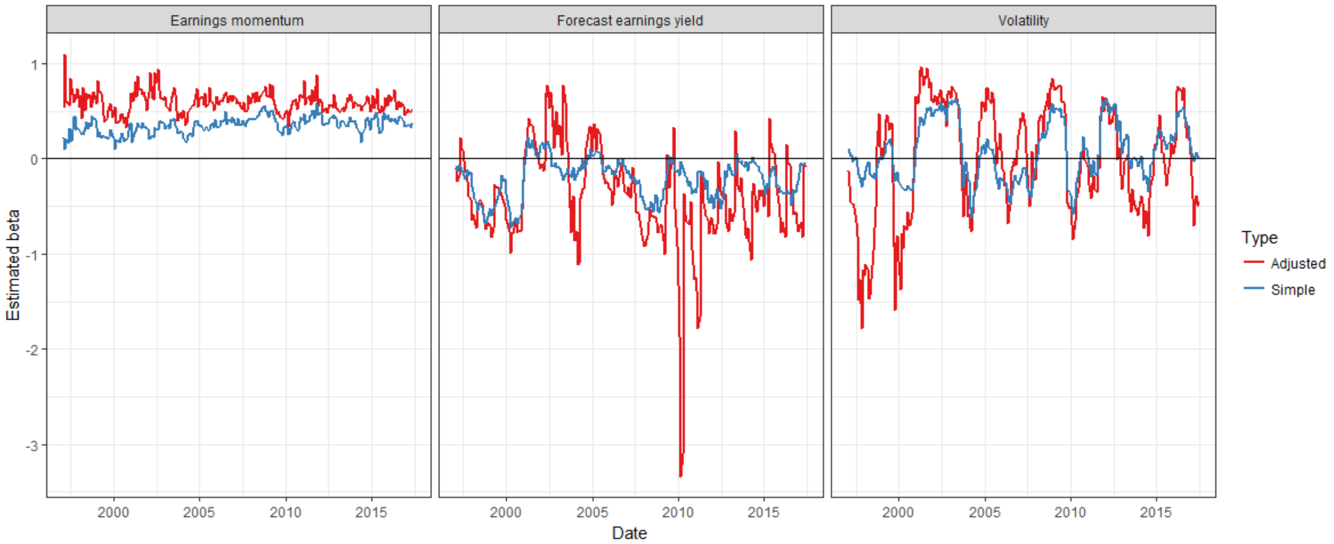
Price momentum's constant tilt towards earnings momentum is unusual. For the other smart beta styles, price momentum has time varying exposures because it tilts towards which ever style has recently outperformed. This makes it harder to judge whether there is an errors in variables problem. If there is such a problem, then we should expect the adjusted beta to have the same sign as the original, simpler beta, but to be more extreme i.e. have a larger absolute value.

For volatility, there does appear to be an errors in variables problem, but for the forecast earnings yield the adjusted estimates for beta are highly unstable and not reliably the same sign as the simple estimate. That suggests there isn't an errors in variables problem there.

As a result, we will not adjust the value factor for the errors in variables in our orthogonalisation calculations.

Adjust earnings momentum and volatility factors for errors in variables

Figure 19: Result of adjusting for errors in variables issue



Source: UBS Quantitative Research

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