Quantitative Monographs

How to improve an Australian risk model

Equities

Global
Quantitative

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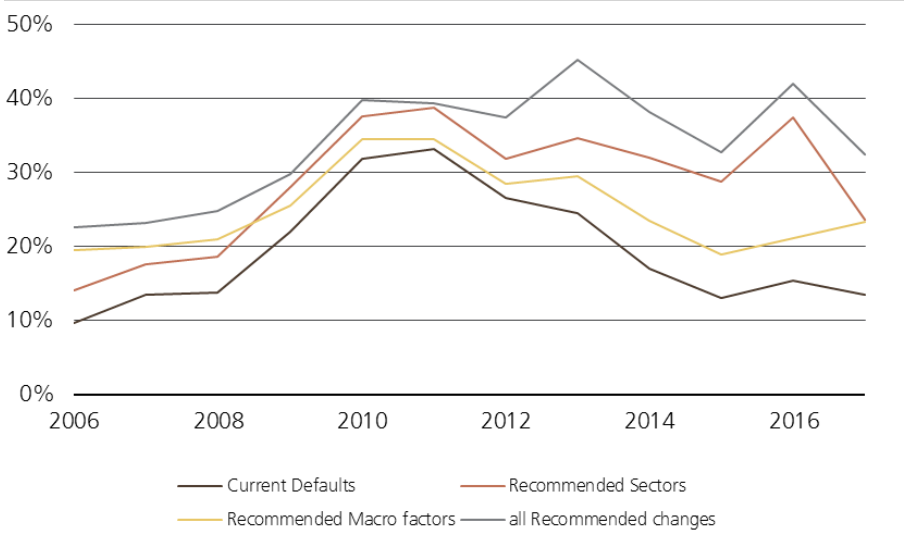
Is there a better sector classification for Australia? Why not use GICS sectors?
The GICS top-level sector structure is in common use in Australia. However the unique nature of the Australian market, its concentration in terms of size, and the dominance of financials and resources companies mean that a generic sector model doesn't capture risk that well. We describe an 8-sector model that we consider more appropriate for the Australian market.

Why is it important to include macro factors?
The explanatory power of macro factors as drivers of portfolio risk and return has risen over time and remains elevated. We propose a selection of macro factors appropriate for the local market and discuss the criteria that should be used for their selection.

Choosing better defaults for sector, style and macro factors
Using the selection of sectors, styles and macro factors in this note may significantly improve the adjusted r-squared of a risk model. In particular, macro factors and sector selection dominate.

UBS PAS: The UBS Portfolio Analysis System
The UBS Portfolio Analysis System (PAS) is used to analyse both 'long-only' and 'long-short' equity portfolios to help explain the risks against a chosen equity or cash benchmark. In this note we show how to customise the PAS risk model with our recommended, or your own, risk factors.

Figure 1: Adjusted r-squared of Australian risk models showing the effect of adjusting sector and style factors, and the inclusion of macro-economic factors



Source: UBS Quantitative Research. Average r-squared calculated using a 3-year risk model formed at the end of February each year, using weekly data.

What is unique about Australia?

Our recent paper Understanding Investing in Australian Equities discusses a number of anomalies of the Australian markets. In particular we point out:

- Australia's market is highly concentrated in terms of market cap and liquidity with the highest decile (within the ASX300) of each comprising about 70% of market cap and liquidity; and
- Financials comprise nearly 40% of the market cap of the ASX 300, and Materials also form a significant proportion (and this proportion is quite volatile over time).

Sector tilts differ significantly from global benchmarks

We see many investors continue to use "global default" risk models in the Australian market. While these provide sensible defaults, in this note we consider how a flexible risk model can be best adapted for the local market.

With financials compromising 40% of the index, led by 4 large banks making up most of that, and a large (and volatile) resources industry, the top-level GICS sector structure is generally considered inappropriate for understanding portfolio risk in Australia. We introduce a sector structure that explains more of the idiosyncratic risk without resorting to data mining or model fitting.

Overweight banks and resources, structural macro dependency

At the same time as considering this we must consider the broader macro drivers of the market. Since 2010 in particular, macro risk has driven a considerable amount of the index return, and the nature of these macro risks changes over time. Being a small, open market with a structural dependence on exports, this is particularly relevant for Australia. We discuss the criteria for selecting macro factors and the importance of including factors that describe variance through the cycle rather than those that have the most significant current contribution.

What makes a good risk model?

… and how can we test this? People use risk models for a number of reasons and for each of these the measure of 'good' may differ. In our view there are at least four conceivable uses of risk models:

- Forecasting risk
- Understanding the sources of risk
- Portfolio construction
- Performance attribution

Risk attribution is harder than risk estimation! For risk forecasting we can measure how well the model is doing – the question of understanding the sources of risk however involves more judgement in developing the answer. For portfolio construction and performance attribution the real answer is to use one's own cross-sectional factors – we have tried below to choose factors with both risk and return in mind.

Choosing the defaults for measuring Australian risk

The UBS risk modelling framework is very flexible, allowing a choice of sector definitions and cross sectional factors. In this document we work down the risk model stack and set out what we consider are sensible defaults for an Australian

risk model, give some justification as to why these were chosen and illustrate how they can be used in the UBS PAS system.

Forecasting risk – not getting the best in-sample fit

While choosing these defaults we have had to make a number of interrelated choices, with which we aimed to both explain as much of the correlation between stocks as possible without having introduced a large number of factors. We have tried to not introduce complexity for its own sake. An overriding consideration is the fact that we are aiming to forecast risk rather than give the best in sample fit of a model. This means that we have to aim to come up with answers which seem to be generally true and useful rather than simply fitting the best model today. When in doubt, and in order to avoid over-fitting, we choose the same defaults as are used in similar markets.

The questions

What universe (or universes) should we use to calculate the risk model? If the universe is too small then the time series factors we use won't be representative; too broad and we won't necessarily capture the risk in the major stocks in the market.

Macro factors…?

The Australian market is structurally very dependent on exports and the macro-economic environment in which it operates. UBS PAS allows for the inclusion of macro factors within risk models, which we generally consider are appropriate for use in the Australian market. We set out a small number of macro-economic factors is appropriate for an Australian risk model.

UBS Sectors…?

What level of sector classification should we use? Too high and we don't capture all the common drivers of return; too low and there will not be enough stocks in each factor. For the Australian market we found it was necessary to use a customised set of sectors, to address the issue of the dominance and imbalance of the Resources and Financials sectors.

Which styles explain risk… and return?

Which cross sectional styles should we choose? Here we wish to default to factors which seem to explain cross sectional risk or which seem to be important in picking stocks within the market (so adding in the idea of using the risk models for performance attribution).

…and finally the gory details

Finally we also need to consider more technical details of the model, such as the length and frequency of the return history we use; the amount of shrinkage to our Bayesian priors; the half-life on the correlation estimates. PAS also has the option to change the weighting scheme used to calculate the returns to the time series factors (except the benchmark): the choice is to use weights proportional to the index weights or the square root of the index weights – for Australia we use the latter to address the skew of the market towards a small number of very large stocks.

For a technical exposition of our risk modelling framework, please see UBS Hybrid Risk Model (17 December 2010).

We discuss each of these questions in turn below, starting with the question of the calculation universe.

Benchmarks and Universes

The choice of universe used for calculating the risk model in PAS has two consequences. Firstly the current members of the universe are used to calculate the returns for the time series factors, and secondly the cross sectional factor returns are calculated using the same universe. As we have mentioned above, too small a universe will lead to either an apparent over-fitting of the model or misleading results.

We tend to think that the S&P/ASX 300 is the most appropriate broad universe to use for the Australian market. Local funds tend to be based on, and benchmarked to, either the S&P/ASX 200, or S&P/ASX 300, or some subset of these.

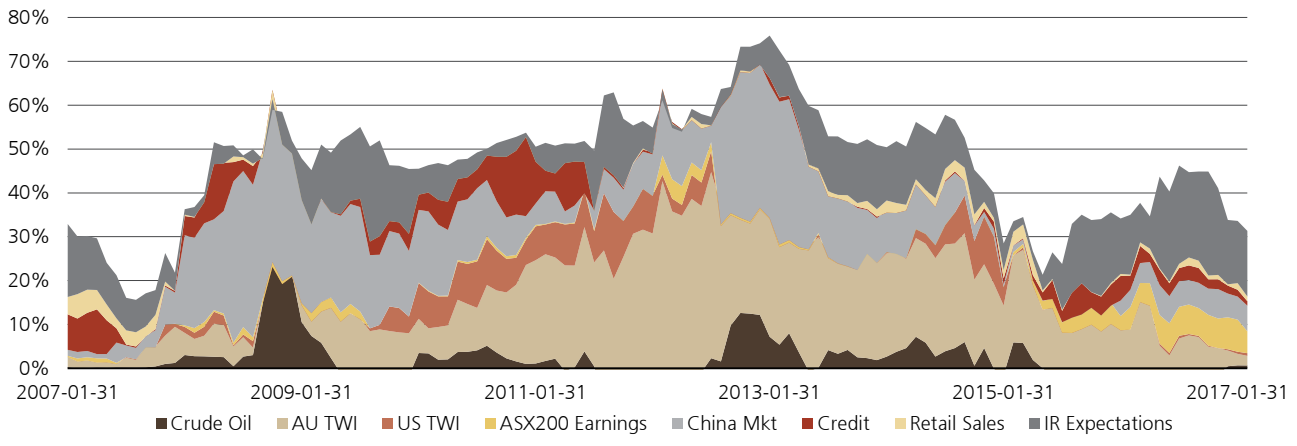
Macro factors

The Australian market is structurally very dependent on exports and the macro-economic environment in which it operates, and the proportion of market return that is attributable to macro risk has been high in recent years[1] - in a world of structurally low growth, macro factors are likely to remain important and hence our expectation is that whilst correlations are falling, they are still likely to remain elevated above pre-GFC levels. This is not bad news for active managers as dispersion is still likely to be high, however, active managers need to be more cognizant of macro factor risk than they have in the past

UBS PAS has the capability to include macro factors within risk models, and though these are not currently included by default in global models we consider are appropriate for use in the Australian market.

However as the following chart illustrates, choosing which macro factors to include is dependent on the dynamics of the market – what factors are significant now is substantially different from what you might have considered in previous years. Hence it is sensible to consider those that have contributed to return through the cycle.

Figure 2: Proportion of Australian market returns explained by macro-economic factors



Source: UBS Quantitative Database, FactSet. Proportions are determined by reference to the contribution to adjusted R-squared using a rolling 36 month window.

[1] Winter et al., Active vs Passive: How Will the World of Investing Evolve? UBS Investment Research, 2017.

For an Australian risk model we suggest the following macro factors could be included in a model:

We are guided by factors which are important at various stages through the cycle

- Crude Oil
- Australia trade-weighted index
- US trade-weighted index
- ASX 200 aggregate earnings
- China Market
- Credit
- Retail Sales
- Interest rate expectations

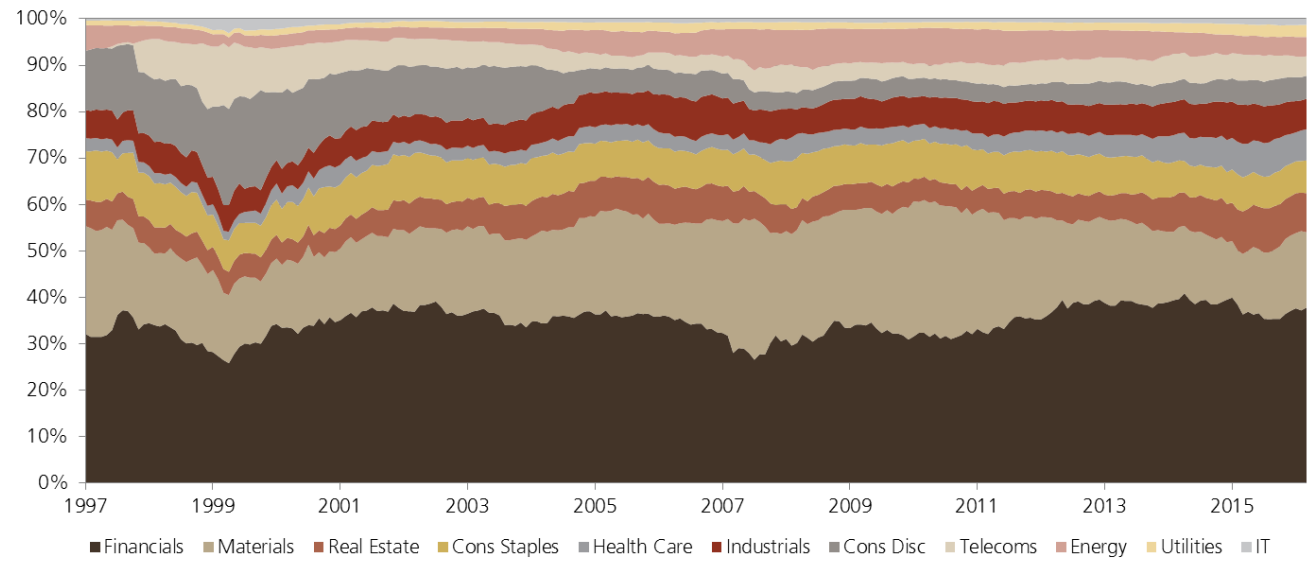
Clearly the choice of macro factors is individual and depends on a portfolio managers' views on what they consider the key macro drivers of their portfolio are – however this is a good starting point.

We can provide the data for these as a set that can be loaded into PAS.

Sector structure

Figure 3 below shows the GICS sector weights through time for the ASX 300. In recent research[2] we discussed the effects of splitting Financials, with Real Estate sectors separated. For this paper, we have assumed this split backwards through time (this is in line with UBS PAS which uses current sector mappings).

Figure 3: GICS sector weights through time in the S&P/ASX 300



Source: UBS Quantitative Database

[2] See Jones et al., What does splitting the Financials sector change? UBS Investment Research, 2016.

The previously discussed dominance of the financials and materials sector is clearly evident here. To allow a fairer distribution of risk, the Australian quant team have designed an alternative set of sector groupings, which aim of giving a clearer sector breakdown. The level of sector classification needs to strike a balance between capturing the common drivers of return and being representative of these common factors rather than stock-specific risks. In a risk model, we generally remove sectors with small numbers of stocks (typically less than 5).

These sector definitions have been developed using a combination of internal consultation, previous research and local market knowledge, and are described below.

Figure 4: UBS quant team sector groupings - Australia

Grouping	Notes and GICS mapping
Energy	Stocks from the GICS "Energy" sectors
Gold & Precious Metals	Stocks from the GICS "Gold" and "Precious Metals" sectors
Banks	Stocks from the GICS "Banks" sectors
REITs	Stocks from the GICS "Real Estate Investment Trusts" sectors
Other Financials	Stocks from the GICS "Financials" sectors, excluding those above
Defensive Industrials	Stocks from the sectors UBS classifies as Defensive (including Telecom, Consumer Staples, Healthcare and Utilities)
Cyclical Industrials	Stocks from the sectors UBS classifies as Cyclical (including Industrials and Consumer Discretionary)
Metals & Mining	Stocks from the GICS "Metals and Mining" sectors, excluding those above

Source: UBS Quantitative Research

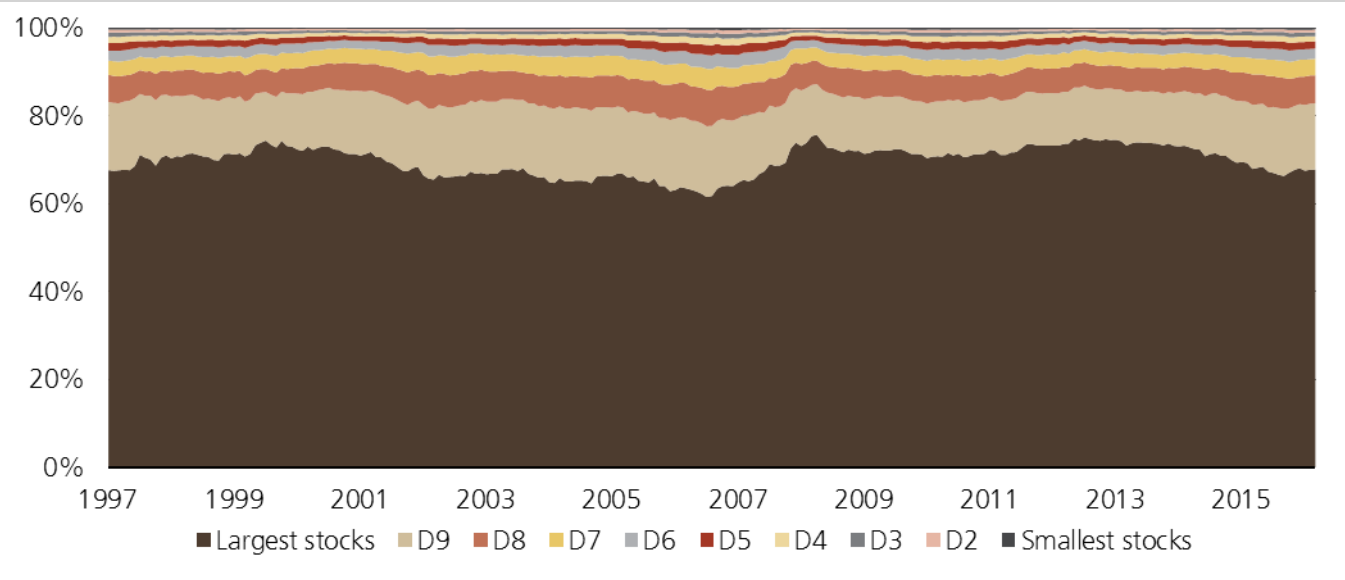
A common question to the team is based around splitting Cyclicals into "Global" and "Domestically exposed" stocks – in our view the inclusion of macro factors as well as size adjustment (the global stocks tend to be larger-cap) reduces the need for this distinction.

Please refer to Appendix B for more information on how these are accessed in PAS.

Sector concentration

As discussed previously the Australian market is very concentrated into a small number of stocks. Figure 5 shows that the largest 10% of stocks have formed on average 70% of the market cap by index over the last 20 years.

Figure 5: Proportion of market represented by size deciles - Australia



Source: UBS Quantitative Database. Figures based on weights within the S&P/ASX 300 index.

The dominance of a small number of large cap stocks across the market means there is significant concentration within many of the sectors in a small number of stocks, particularly within the large Resources and Financials super-sectors. Figure 6 below shows the sector concentration (using the above sector classifications), measured by both the Herfindahl index[3] and the weight of the largest stocks as a proportion of each sector's market weight.

Figure 6: Concentration of sectors as of February 2017

Sector	Weight in largest 3 stocks	Herfindahl concentration index
Banks	77.7%	0.245
Metals & Mining	75.2%	0.297
Gold & Precious Metals	74.2%	0.353
Energy	66.0%	0.202
Other Financials	45.8%	0.110
Defensive Industrials	44.6%	0.087
REITs	43.8%	0.102
Cyclical Industrials	18.1%	0.026

Source: UBS Investment Research

[3] The Herfindahl-Hirschmann concentration index is calculated using the square of market share of each competing firm, proxied in this case by its index weight.

Our recent research on Oligopolies[4] gives some insight into how this concentration relates to relative performance. In particular, we note that a sector with a concentration > 0.2 is generally considered an oligopoly – and a number of sectors (and a large portion of the market by weight) fall into that category.

This concentration of weightings suggests we should calculate sector factors based on the square root of the sector weights, such that we capture the drivers of the sector as a whole rather than just the drivers of the dominant stocks.

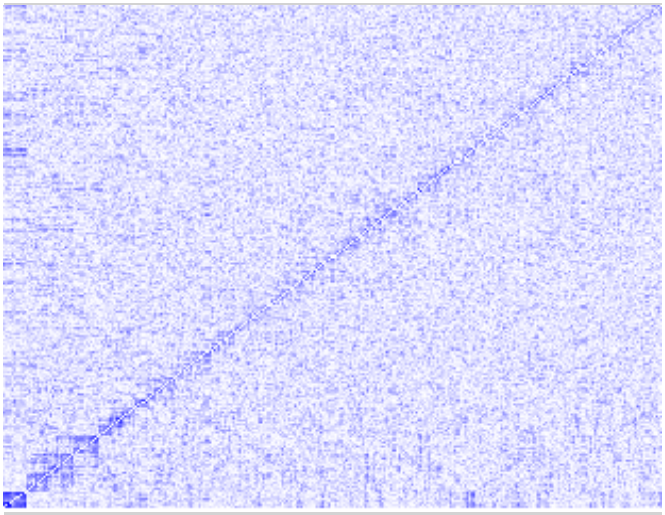
Do the new sectors explain risk better?

A new set of sectors has long been an item of discussion for local investors, but do they actually do a better job of explaining returns? We can assess this visually and statistically.

Figure 7 below shows a heat map of the correlation matrix of the residuals for the S&P/ASX 300 universe after we have removed the market and the top-level GICS sector effects (and also a default style set), calculating the sector returns using the current weights of the index. The chart shows the absolute value of the correlations where dark blue would be a value of 1 and white is a value of zero. What we would like to see would be all the off-diagonal elements either white or at least close to white, implying that there are no common drivers of return that we have been missed from our model.

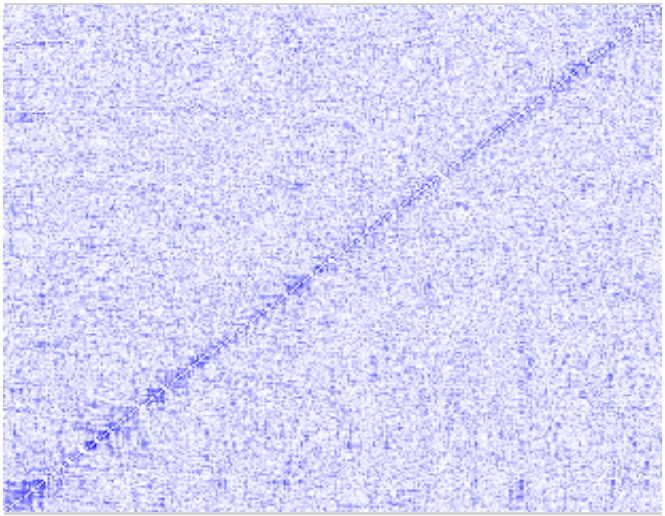
Using GICS top-level sectors there remains a reasonable amount of correlation visible in the bottom left of the figure. This is mainly from the Small Resources sector.

Figure 7: Heat map of correlation matrix of residuals using GICS sectors, end February 2017



Source: UBS Quantitative Research. Risk model controls for GICS top-level sectors and a default cross-sectional style set. Risk model estimated over 3 years of weekly data.

Figure 8: Heat map of correlation matrix of residuals using recommended sectors, end February 2017



Source: UBS Quantitative Research. Risk model controls for recommended sectors and a default cross-sectional style set. Risk model estimated over 3 years of weekly data.

[4] See Winter et al., Understanding Size Investing, UBS Investment Research, 2015.

Figure 8 shows the same heat map but now using the Australian quant team's sectors across the whole market and square-root weighting as discussed above. This seems to have removed the majority of the correlations.

We can also confirm this by analysing the residual returns with a statistical factor (or principal components) model. We show in Figure 9 the proportion explained by the first three factors, where lower implies you have less concentration and probably less residual correlation.

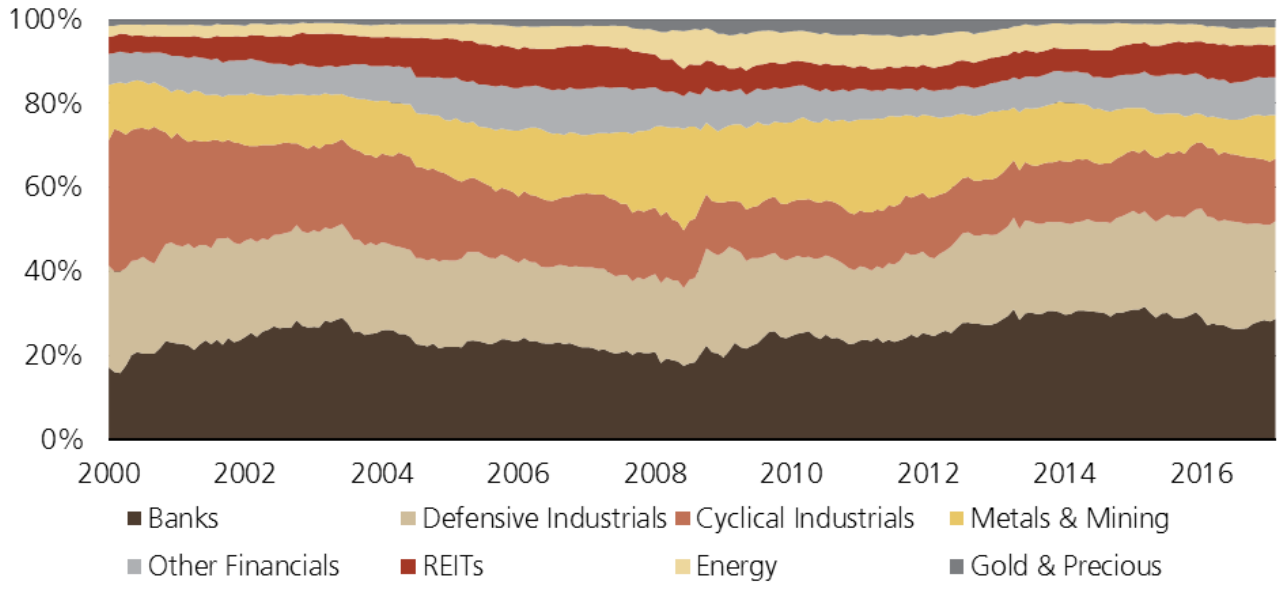
Figure 9: Proportion of residual return explained by statistical factors

	Cumulative variance explained by statistical factors		
	1	2	3
GICS (top level)	0.0867	0.1405	0.1857
Recommended sector structure	0.0571	0.1108	0.1561

Source: UBS Quantitative Research. Cumulative proportion of residual return explained by the first 3 statistical factors from a principal components model.

Given these results, we are comfortable with using this customised grouping as our sector definition. Figure 10 below shows the (market capitalisation) weights of stocks within each of the recommended sectors.

Figure 10: Sector market-capitalisation weights in the ASX 300 using the recommended sectors



Source: UBS Quantitative Database. Market capitalisation weights within the ASX 300.

Cross sectional factors – what works in Australia?

As well as sectors the PAS risk model can contain a block of style factors which are used in cross section. We consider the question of which styles to include in the model in this section of the publication, and we try to choose styles which explain risk and which can be used to generate return. We also include some default styles, such as size, which have been found to be important in the literature for explaining cross-sectional returns over long time histories and different markets. Thus we will always include a size factor even if this has not been particularly significant recently in the local market.

We need styles to explain risk as well as return

Styles which frequently have significant monthly ICs (the correlation between the excess return over the next month and the factor score) are important risk factors. We have examined the long-term performance of a large number of style factors and highlight the ten styles with the highest proportion of months with significant ICs.

Figure 11: Statistics on the performance of ten important style factors since 1997

Category	Style	% of months with significant IC	Annualised Return	Hit Rate
Quality	Volatility	39.6%	1.5%	39%
Beta	Beta	33.5%	0.7%	43%
Momentum	12 Month Price Momentum	31.3%	7.8%	68%
Value	Dividend Yield	25.2%	0.7%	60%
Momentum	6 Month Price Momentum	25.2%	5.1%	66%
Size	Market Cap	22.6%	2.4%	67%
Quality	Dividend Cover	20.9%	-0.8%	49%
Quality	Debt / EV	16.1%	-0.2%	58%
Momentum	Short-term Price Momentum	13.9%	-1.9%	56%
Value	EBIT Yield	11.7%	3.5%	62%

Source: UBS Quantitative Research. Performance of style factor portfolios. Please note (i) methodology is long-short, sector neutral, top third vs. bottom third, equal weighted, monthly rebalancing (ii) universe is S&P/ASX 300, (iii) time period is from 1997-12-31 up to 2017-02-28. We show the top 10 styles by proportion of months with significant IC.

Here we are measuring whether independently the factors explain cross sectional returns in either direction. The significance of the ICs does not depend on the sign of the correlation.

It is also interesting to see which factors have performed well (and poorly) over a long-term history – i.e. so more return factors than risk factors. Figure 12 and Figure 13 show the best and worst five factors (by information ratio).

Figure 12: Best 5 factors by Information Ratio since 1997

Style	Information Ratio	Annualised Return	Hit Rate
Earnings Momentum	0.56	7.3%	70%
Earnings Yield	0.44	5.6%	53%
12 Month Price Momentum	0.41	7.8%	68%
6 Month Price Momentum	0.36	5.1%	66%
Free Cash Flow Yield	0.33	4.1%	63%

Source: UBS Quantitative Research. Long-Short style returns December 1997 – February 2017; ASX 300 universe; cap-weighted thirds.

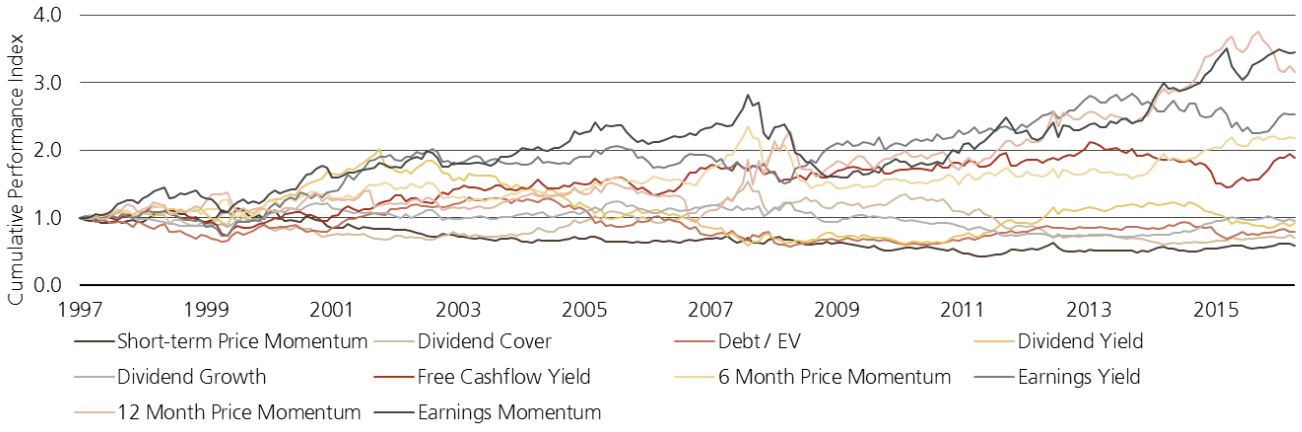
Figure 13: Worst 5 factors by Information Ratio since 1997

Style	Information Ratio	Annualised Return	Hit Rate
Short-term Price Momentum	-0.15	-1.9%	56%
Dividend Cover	-0.06	-0.8%	49%
Debt / EV	-0.01	-0.2%	58%
Dividend Growth	0.02	0.3%	62%
Dividend Yield	0.05	0.7%	60%

Source: UBS Quantitative Research. Long-Short style returns December 1997 – February 2017; ASX 300 universe; cap-weighted thirds.

The chart below shows the cumulative long-short return to the styles above:

Figure 14: Cumulative Long-Short returns to selected style factors



Source: UBS Quantitative Research.

A second approach we take is to fit a number of risk models through time using all of our cross sectional factors and then calculate the volatility of the cross sectional factor. This makes a more accurate adjustment for market and sector effects than the approach above. We look for those factors which are most volatile and are also consistently volatile.

Figure 15: Annualised standard deviation of returns for cross sectional factors in the Australia risk model

Style	2005	2007	2009	2011	2013	2015	2017
Dividend Yield	2.5%	3.3%	10.7%	9.1%	2.1%	3.1%	2.9%
Book / Price	3.3%	2.7%	9.0%	8.5%	3.0%	1.4%	4.3%
Volatility	4.1%	2.5%	4.5%	7.3%	1.4%	1.5%	4.6%
12 Month Price Momentum	3.4%	2.7%	5.5%	3.6%	2.9%	3.3%	3.1%
Earnings Yield	3.4%	3.4%	6.2%	2.8%	2.3%	3.0%	1.8%
PEG	4.0%	2.4%	4.4%	3.1%	3.5%	2.5%	2.0%
6 Month Price Momentum	3.3%	2.9%	5.0%	2.7%	2.1%	1.7%	3.6%
Beta	2.6%	2.4%	3.2%	3.5%	3.2%	1.8%	3.3%
Forecast Earnings Growth	4.0%	2.5%	3.9%	3.0%	2.9%	1.8%	1.6%
Short-term Price Momentum	2.4%	1.8%	3.7%	4.0%	2.2%	2.2%	2.1%
Debt / EV	2.1%	2.4%	4.3%	4.4%	1.3%	1.5%	1.6%
ROE	2.6%	1.8%	3.0%	4.1%	2.3%	1.4%	1.6%
Dividend Cover	2.0%	1.1%	3.2%	3.8%	2.0%	2.0%	2.1%
EBIT Yield	2.4%	1.5%	2.7%	4.4%	1.8%	1.9%	1.2%
Free Cash Flow Yield	2.2%	2.0%	2.4%	2.9%	1.9%	1.4%	2.1%
Historical Earnings Growth	1.6%	1.7%	2.8%	2.6%	2.6%	1.9%	0.8%
Market Cap	2.1%	1.4%	4.0%	2.2%	1.1%	1.4%	1.4%
ROIC	2.1%	1.4%	2.7%	2.2%	1.6%	1.4%	1.5%
Dividend Growth	1.7%	1.4%	2.5%	1.6%	0.9%	1.6%	1.0%
Earnings Momentum	1.5%	1.1%	1.7%	1.6%	1.2%	0.8%	1.2%

Source: UBS Quantitative Research. List is sorted by the average standard deviation across the periods. The top five in each period are highlighted.

In order to pull these results together, we also have to consider the correlation and coverage of the styles. Given all of the above we suggest the default cross-sectional factors[5] for the Australian model should be:

- Earnings Yield (as it is the best factor by Information Ratio)
- 12 Month Price Momentum
- Price Volatility
- Size (using the log of market capitalisation)
- Dividend Yield[6]
- Short-Term Price Momentum
- Debt/EV
- Forecast Earnings Growth

Compared to the default style factors within other markets in PAS, there is more emphasis on momentum and 'safety' factors within the local risk model. Generic quality and growth factors tend not to work particularly strongly in the Australian market. Future research may look at quality models which may be appropriate as risk factors.

[5] Refer to our Global Style Watch for style definitions that are used in our risk models.
[6] We consider zero a valid dividend yield – these data points are considered a low dividend yield.

Testing the model

As was discussed earlier in this note, there are a number of needs that a risk model may have to fulfil. Testing some of these (for example explaining the sources of risk) is difficult. In this section we aim to test how well the risk model does at forecasting risk and tracking error.

Within the PAS risk modelling framework there are a number of parameters that can be set to control the calculation of the risk model. These include:

Data frequency: Should the model use daily, weekly or monthly data? In general we suggest using weekly data. Monthly data is carried forward and subject to appropriate lags if required. We acknowledge that the way we combine these where some of the macro factors may have a lower frequency is not necessarily the optimal one – combining different frequencies of data is a topic for another day.

History length: how many data periods should the model use?

Tau: this is the measure of how much weight should be put on the Bayesian priors in the time series regression. It is scaled so 1 is a sensible default.

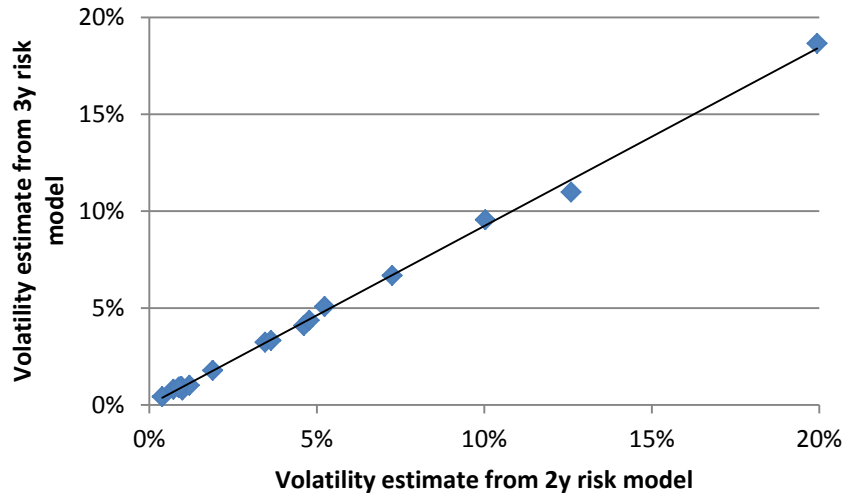
Half-life: within the PAS risk model the time series of returns are adjusted for changes in volatility so the half-life parameter only has an effect on the correlation estimates between the factors.

Forecast ahead: given we have the time series forecast of stochastic volatility we can choose over which period we want to forecast the market volatility. This changes the risk estimates by rescaling the volatility of the factors, but will not affect the risk attribution.

Within the PAS risk modelling framework we separate the estimate of the volatility of the market and the factors from the period over which we estimate the model. This is done by fitting a stochastic volatility model to the market factor and using this to both adjust the volatility of the rest of the data and also to forecast volatility going forward. This means that unlike models that are just fitted using a weighted moving average the sensitivity of the factor volatility estimates to the estimation period is much less. Also, the factor correlation estimates are not dominated by periods of high volatility.

Figure 16 below shows a plot of the estimated factor volatility at the end of February 2017 calculated using a two or a three year model. As can be seen the difference in volatility estimates is quite low.

Figure 16: Comparison of factor volatility estimates from a 2-year and a 3-year model

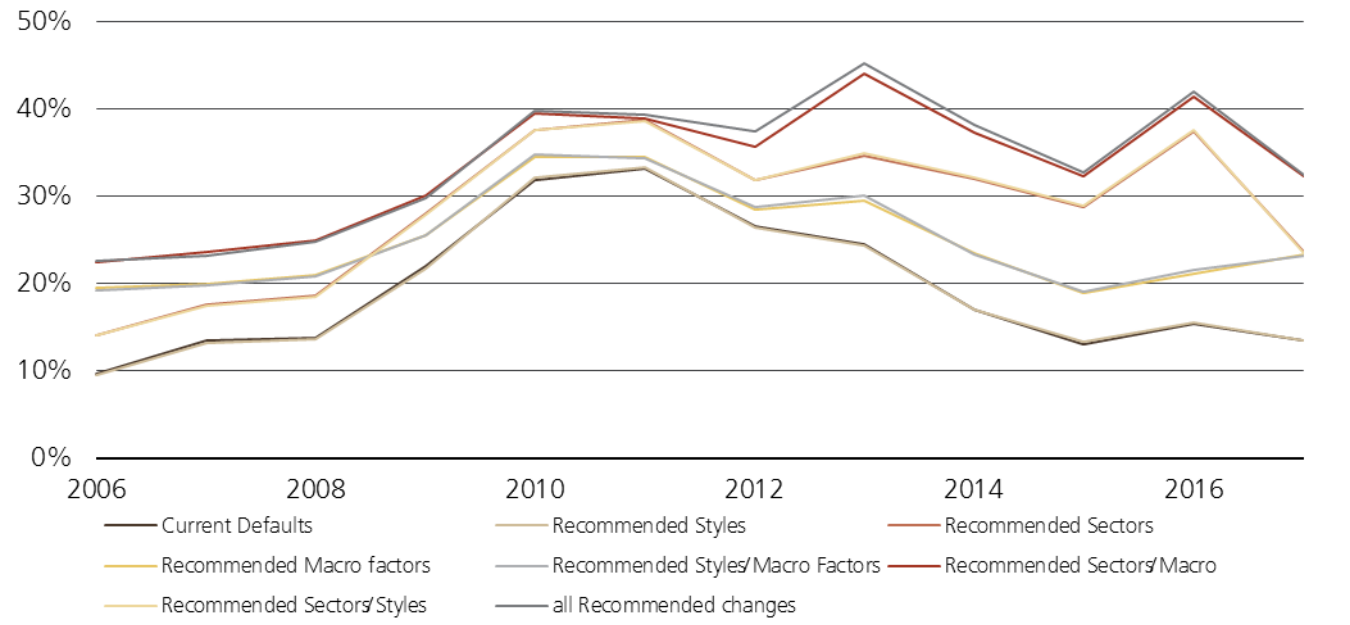


Source: UBS Quantitative Research.

This means the question of what length of history to use in order to build the model can be separated from the question of the responsiveness of the model to changes in market volatility.

A test to illustrate the effectiveness of the new risk model is to compare the adjusted R-squared of the new Australian model compared to the default model in PAS. This will show us whether our changes to sector selection, weighting and default styles have increased the explanatory power of the risk model.

Figure 17: Adjusted r-squared of Australian risk models showing the effect of adjusting sector and style factors, and the inclusion of macro-economic factors



Source: UBS Quantitative Research. Average r-squared calculated using a 3-year risk model formed at the end of February each year, using weekly data.

This evidence supports the local customisation of risk model factors:

- The use of custom sectors significantly increases the explanatory power of the model through the history;
- The proportion of variance explained by macro-economic factors has risen since the financial crisis, and inclusion of macro-economic factors increases the explanatory power of the model in the period since 2010;
- The selection of styles is not dissimilar to the defaults so does not make a great difference – it is clear that sector choice dominates style choice.

Key Conclusions

Our analysis of risk factors in the Australian market leads to three conclusions:

Market-relevant sector structure

- The GICS classification system, at its broad levels, is not optimally suited for the Australian market, with its significant sector concentration, and small number of very large stocks. Our recommended sector structure partitions the market into 8 broad sectors (**Banks, REITs, Other Financials, Metals & Mining, Gold, Energy, Defensive Industrials and Cyclical Industrials**) which are themselves defined in terms of GICS classifications.

Styles with better explanatory power

- The default global styles in PAS can be tailored to the local market. Historically Momentum and Volatility styles have had significance in terms of both risk and return. The recommended styles to include are: **Earnings Yield, 12 Month Price Momentum, Price Volatility, Size, Dividend Yield, Short-Term Price Momentum, Debt/EV and Forecast Earnings Growth**.

Macro factors should be included

- Given the Australian market is structurally very dependent on exports and the macro-economic environment in which it operates, we consider that the inclusion of macro-economic factors is appropriate for a local risk model. We propose a default set for Australia which are: **Crude Oil, Australia trade-weighted index, US trade-weighted index, ASX 200 Earnings, China Market, Credit, Retail Sales and Interest rate expectations**, recognising that the choice of macro factors can be tailored to support an individual portfolio managers' view of risk drivers.

Appendix B shows how these risk model changes can be implemented in PAS.

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Irrational Asset Management (Oct 2016)

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Relevant UBS PAS User Guides

PAS: A Quick Reference Guide

PAS User Guide: Reports

PAS User Guide: Macros

PAS User Guide: Risk Models

PAS User Guide: Advanced Analysis

Appendix A: Sample risk decomposition in PAS

In this section we show the output of PAS "Factor Risk" report, running against UBS' Australian Strategist's model portfolio (as of 1st March 2017) using two scenarios:

1. The standard PAS risk model (using a 3-year weekly risk model and the standard cross-sectional factors;

2. Recommended Australian risk model as described above, with customised sectors and styles, and macro-economic factors included.

The risk models are calculated as described above using an ASX 300 universe.

Figure 18: PAS risk decomposition of UBS Australia Strategists' model portfolio, using the current PAS default model

	Benchmark Total Risk	Portfolio Total Risk	Tracking Error			
	12.61	**13.32**	**2.21**			
	Benchmark Wts * Factor Beta	Portfolio Wts * Factor Beta	Active Wts * Factor Beta	Contribution to Active Variance	Percentage Contribution to Active Variance	Annual Standard Deviation
S&P/ASX 100 [XTO]	1.00	1.04	0.04	0.28	5.69	12.45
Benchmark Risk				**0.28**	**5.69**	
Energy	0.04	0.04	0.00	0.00	0.10	17.67
Materials	0.15	0.13	-0.02	0.05	1.07	13.75
Industrials	0.03	0.00	-0.03	0.05	0.98	7.72
Consumer Discretionary	0.01	0.04	0.04	0.04	0.91	8.76
Consumer Staples	0.06	0.04	-0.02	0.03	0.66	10.40
Health Care	0.07	0.09	0.02	0.07	1.42	11.80
Financials	0.38	0.37	-0.01	-0.02	-0.51	6.12
Information Technology	0.01	0.03	0.03	0.15	3.02	11.38
Telecommunication Services	0.03	-0.03	-0.06	0.59	12.11	11.57
Utilities	0.03	0.01	-0.02	0.13	2.68	11.57
Real Estate	0.08	0.04	-0.04	0.19	3.80	9.54
Sector Risk				**1.28**	**26.23**	
UBS Debt / EV	0.05	0.06	0.01	0.00	-0.06	2.80
UBS Earnings Momentum	0.16	0.16	0.00	0.00	0.00	1.75
UBS Earnings Yield	-0.01	0.05	0.06	0.00	0.05	2.55
UBS Medium term price momentum	0.07	0.12	0.06	0.04	0.91	4.14
UBS Short term price momentum	-0.07	0.02	0.09	0.05	0.95	2.20
UBS MktCap	0.51	0.49	-0.02	0.00	-0.03	1.26
UBS Return on Equity	0.11	0.12	0.01	0.00	0.01	1.44
UBS Volatility 12m	-0.19	-0.17	0.02	0.00	-0.03	3.48
Cross-Sectional Risk				**0.09**	**1.81**	
Total Weight	**100.00**	**100.00**	**0.00**			
Factor Risk				**1.64**	**33.74**	
Stock Specific Risk				**3.23**	**66.26**	
Total				**4.87**	**100.00**	
PASrm						

Source: UBS Portfolio Analysis System

Figure 19: PAS risk decomposition of UBS Australia Strategists' model portfolio, using the sectors, styles and macro factors described in this paper

	Benchmark Total Risk	Portfolio Total Risk	Tracking Error			
	12.65	**13.40**	**2.31**			
	Benchmark Wts * Factor Beta	Portfolio Wts * Factor Beta	Active Wts * Factor Beta	Contribution to Active Variance	Percentage Contribution to Active Variance	Annual Standard Deviation
S&P/ASX 100 [XTO]	1.00	1.05	0.05	0.35	6.52	12.45
Benchmark Risk				**0.35**	**6.52**	
CL1 (Oil - Crude)	0.00	0.01	0.01	0.14	2.63	28.36
AUD_index	0.00	-0.01	-0.01	0.00	-0.08	7.17
USD_Index	0.01	-0.02	-0.04	0.05	1.00	5.41
ASX200EPS	0.05	0.06	0.01	0.00	-0.03	2.76
ChinaMkt	0.00	0.02	0.01	0.05	0.99	17.03
AU_Retail_Sales	0.04	0.04	0.00	0.00	0.00	1.55
AU_Credit	0.03	0.01	-0.02	0.00	0.08	1.81
AU_IR_Exp	-0.01	-0.02	-0.01	0.03	0.50	10.28
MacroFactors=AUS Risk Model				**0.27**	**5.09**	
UBS Banks	0.21	0.21	0.01	0.03	0.59	7.06
UBS REITs	0.03	-0.02	-0.05	0.24	4.50	9.13
UBS OtherFins	0.03	0.05	0.02	0.09	1.74	8.85
UBS Defensive	0.14	0.07	-0.07	0.15	2.80	5.80
UBS Cyclical	0.04	0.12	0.08	0.16	3.07	5.87
UBS Mining	0.06	0.03	-0.03	0.31	5.85	19.70
UBS Energy	0.03	0.03	0.00	0.00	0.04	17.27
Sector Risk				**0.99**	**18.57**	
UBS Earnings Yield	-0.02	0.01	0.03	0.01	0.27	3.31
UBS 12 Month Price Momentum	0.00	0.00	0.01	0.00	0.04	4.50
UBS Volatility 12m	-0.12	-0.14	-0.01	0.00	0.03	3.22
UBS MktCap	0.34	0.34	0.01	0.00	-0.03	2.59
UBS Dividend Yield	0.00	-0.03	-0.03	0.01	0.24	3.27
UBS Short term price momentum	-0.02	0.03	0.05	0.01	0.21	2.38
UBS Debt / EV	0.08	0.06	-0.02	0.01	0.22	3.65
UBS Forecast EPS Growth	0.08	0.13	0.05	0.01	0.18	1.84
Cross-Sectional Risk				**0.06**	**1.16**	
Total Weight	**100.00**	**100.00**	**0.00**			
Factor Risk				**1.67**	**31.33**	
Stock Specific Risk				**3.66**	**68.67**	
Total				**5.33**	**100.00**	
PASrm, MacroFactors=AUS Risk Model, Fund sectors, None, XsFactors=AUS Risk Model, Sqrt Wt Time Series						

Source: UBS Portfolio Analysis System

Appendix B: How to use the new Australian Risk Model in PAS

The following PAS macro gives an illustration of how macro-economic data can be read into PAS, the custom sectors and styles defined, and used to run some analysis. We suggest talking to your usual PAS contact before running any of these.

For more information please see our **PAS User Guide: Macros**.

```
!First read in macro factor data from external files, if needed

read factor, 'S:\PAS Read in Macro Factors noFX.xls', No FX

read factor, 'S:\PAS Read in Macro Factors AUD.xls', AUD

!Run next three lines once per database, PAS will remember it
afterwards (watch out for the first line being wrapped round)

Macro Factor Block, Aus Macro, CL1 (Oil - Crude), AUD_index,
USD_Index, ASX200EPS, ChinaMkt, AU_Retail_Sales, AU_Credit, AU_IR_Exp

XS Factor Block, Aus Default, UBS 12 Month Price Momentum, UBS
Dividend Yield, UBS Earnings Yield, UBS Forecast EPS Growth, UBS
MktCap, UBS Short term price momentum, UBS Debt/EV, UBS Volatility 12m

Default Risk Model, Australian PASrm, PASrm, MacroFactors=Aus Macro,
XsFactors=Aus Default, Sqrt Wt Time Series, Universe=S&P/ASX 300 [XKO]

!Next line needs running each month after the update

Australian User Sectors

!And for each fund once, PAS will remember it afterwards (or can be
done with Fund, Edit dialog)

Use Default Risk Model, Australian PASrm

Sector Definition, USER

!And now do some reporting

Analysis Menu, Risk Statistics
```

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Our quantitative models rely on reported financial statement information, consensus earnings forecasts and stock prices. Errors in these numbers are sometimes impossible to prevent (as when an item is misstated by a company). Also, the models employ historical data to estimate the efficacy of stock selection strategies and the relationships among strategies, which may change in the future. Additionally, unusual company-specific events could overwhelm the systematic influence of the strategies used to rank and score stocks.

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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%

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