Do low volatility stocks have interest rate risk?

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Low risk investing: setting the scene

- Low risk investing within equities has been a very successful strategy over the past few years, benefiting from its "quality" tilt (especially within Europe).
- The anomaly is also visible within government bonds, at least from around 1995.
- However, the question has been raised as to whether the anomaly is (partly) driven by falling interest rates.
- We aim to investigate this question, and find that although the alpha to low risk investing falls when interest rates rise, rarely do they rise enough to make the alpha fall to zero.

Low-risk investing: setting the scene

Potential explanations of the empirical anomaly:

1. Incentive-driven explanations:
   a) Delegated money management industry and benchmarking; Baker, Bradley and Wurgler (2011), Brennan, Cheng and Li (2012)
   b) Leverage aversion and margin constraints; Asness, Frazzini and Pedersen (2012), Frazzini and Pedersen (2014)
2. Behavioural explanations:
   a) High-volatility stocks treated like like lottery tickets; Barberis and Huang (2008)
   b) Excess demand for high-volatility 'glittering' stocks ; Barber and Odean (2008)
   c) Sell-side tendency for optimistic forecasts for high-volatility stocks; Hsu, Kudoh and Yamada (2013)
3. Mechanical explanation:

   Time-variation of stock betas; see our Q-Series: Low-risk Investing (23 September 2011) and our Quantitative Monograph: 3 reasons why High-risk underperformed (4 December 2013)

Low risk investing and interest rates - literature

- Muijsson et al (2015), following on from Fishwick (2014) address the question of interest rate sensitivity in the CAPM directly. The first point they make is that the CAPM addresses the expected return to an asset. Their argument is that one can rearrange the CAPM formula and show that if interest rates fall unexpectedly then the current price rises and in particular low beta stocks outperform high beta stocks.
- In an empirical study (from 1953) they find that the alpha for low beta industries is positive when rates fall and negative when rates rise. The opposite is true for high beta industries. The only weakness in their study is they use ex-post betas for the 43 industry portfolios (from Ken French) to define the low and high beta portfolios.
- In Chow et al (2014) the authors find that there is a duration exposure in all their low volatility portfolios. They suggest that this is intuitive: "very low-volatility (and high-yielding) stocks can often be used as fixed-income replacement by investors. These high-yielding low-volatility stocks could be bid up by investors seeking yield and safety when interest rates are low. This then injects duration exposure into low-volatility portfolios."

Low risk investing and interest rates – UBS PAS

- We generated a minimum variance fund using the UBS PAS system using the S&P 500 as a universe (with a 5% limit on any one holding). The analysis shows:

	Benchmark Wts * Factor Beta	Portfolio Wts * Factor Beta	Active Wts * Factor Beta	Contribution to Active Variance	Percentage Contribution to Active Variance	Annual Standard Deviation	Active Weight
US S+P 500	1	0.52	-0.48	46.89	68.32	14.28	
Benchmark Risk				**46.89**	**68.32**		
US 10 Year Yield	-0.01	-0.16	-0.15	1.54	2.24	8.33	
MacroFactors=US Rates				**1.54**	**2.24**		
Energy	0.05	0.06	0.01	0.07	0.1	16.95	-3.1
Materials	0.03	0.02	0	0.01	0.01	11.25	-2.4
Industrials	0.09	0.12	0.03	0.05	0.07	5.82	-5.5
Consumer Discretionary	0.13	0.17	0.04	-0.1	-0.15	6.42	3.3
Consumer Staples	0.11	0.24	0.13	1.65	2.4	7.43	11.3
Health Care	0.13	0.1	-0.03	0.09	0.14	9.08	-7
Financials	0.15	0.14	-0.01	0.03	0.04	6.09	2
Information Technology	0.19	0.08	-0.12	1.23	1.79	6.65	-9.2
Utilities	0.03	0.17	0.14	4.33	6.31	13.76	12.3

Source: UBS Portfolio Analysis System. For illustrative purposes only.

UBS

Section 1

A long term view of low risk investing

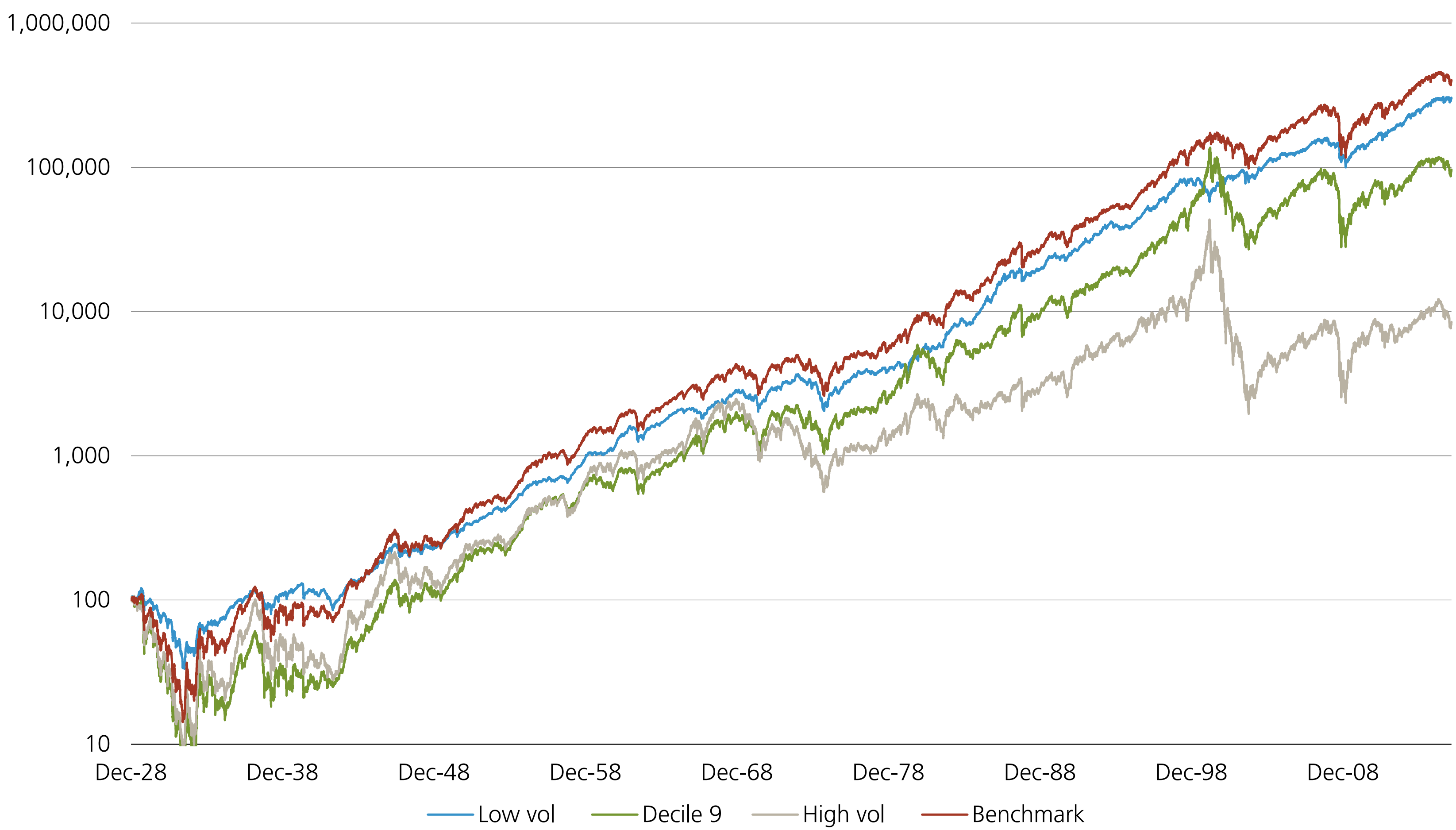
UBS

Data

- The data source is CRSP from Dec 1928 to December 2015.
- Our default universe is the largest 500 names in CRSP where the share code is < 13.
- Our base volatility metric is the 6 month volatility of daily returns – results for other measures of "risk" give similar results.
- The portfolios are rebalanced quarterly to equal weights.
- Sharpe ratios are calculated using the 10 year Treasury interest rate.

Returns to selected portfolios

- We look at the performance of various volatility based portfolios in the US

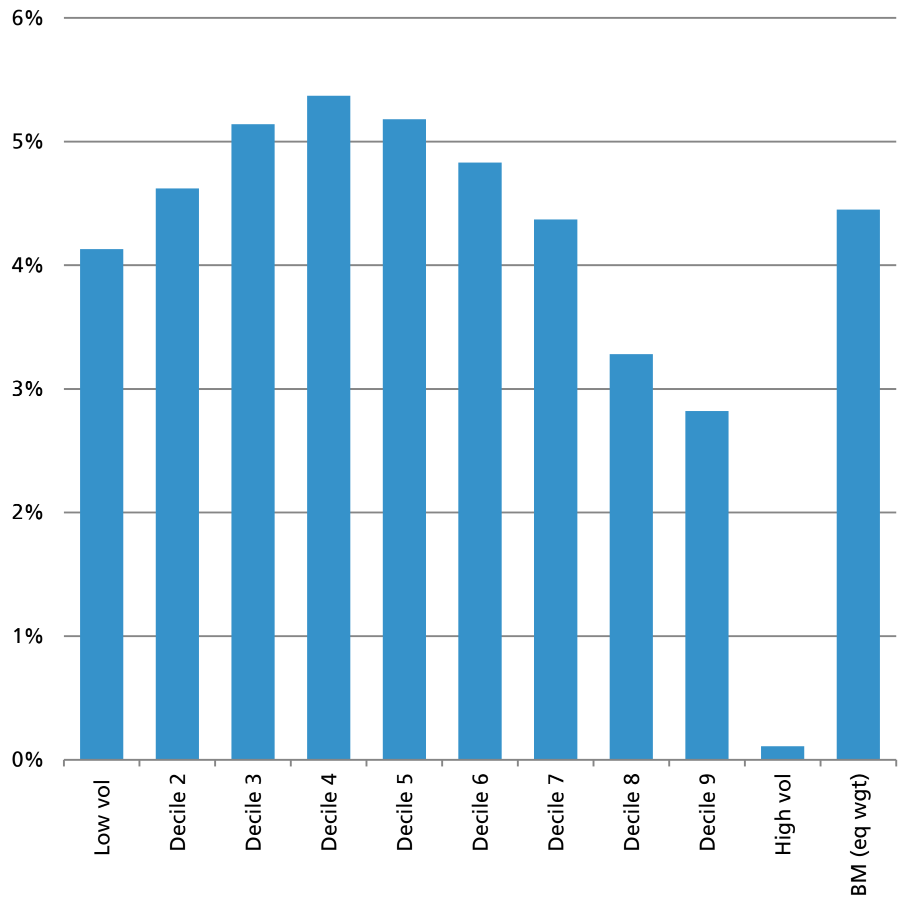


Source: UBS. The portfolios are created from the CRSP database using the largest 500 names by market cap. The volatility metric used is the 90 day volatility of daily returns and the portfolios are rebalanced quarterly to equal weights. The Sharpe ratios are calculated using the 10 year Treasury interest rate. The data goes from Dec 1928 to June 2015.

UBS

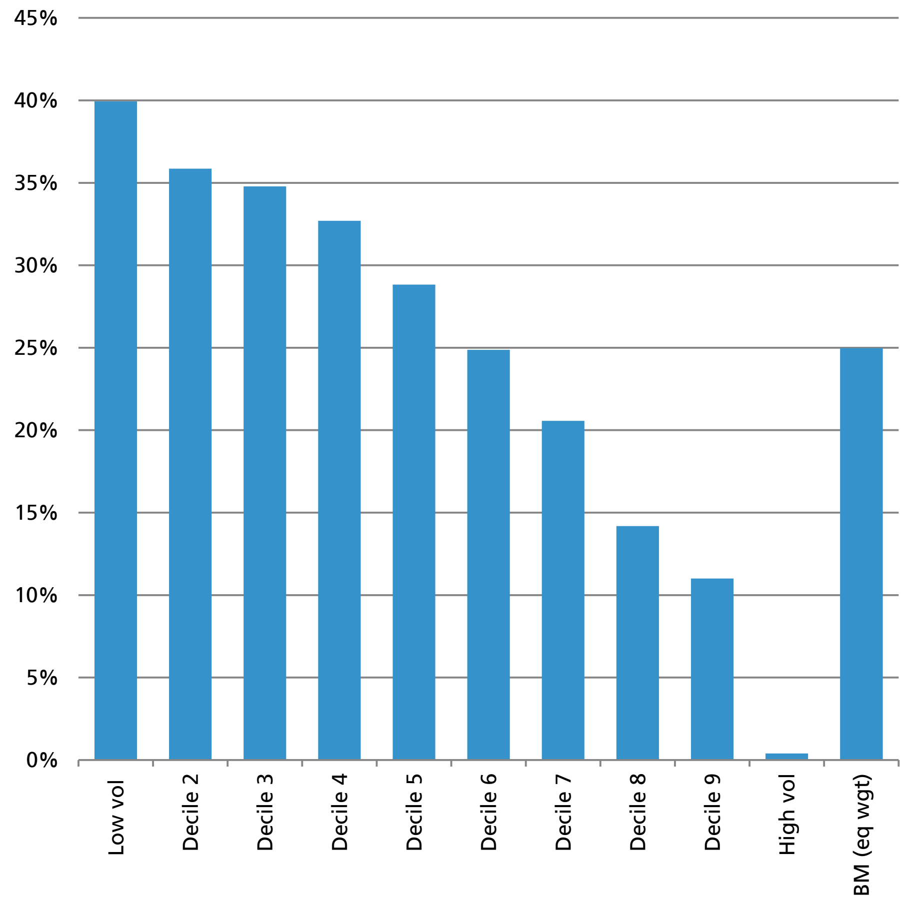
Returns and Sharpe ratios

Returns to portfolios



Source: UBS

Sharpe ratios for portfolios



Source: UBS. Sharpe ratios calculated using 10 year rates.

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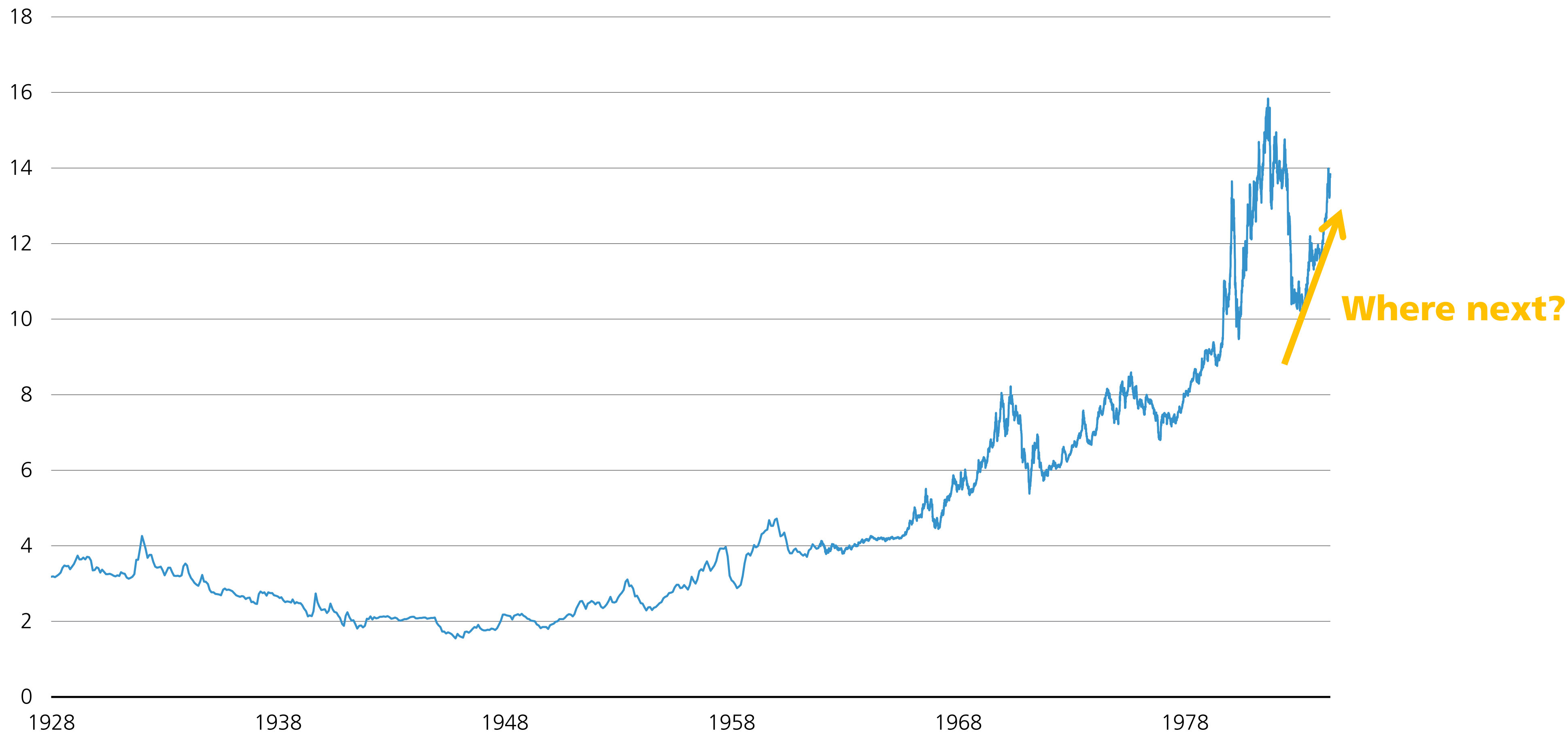
Section 2

A long term view of interest rates

UBS

Interest rates – which way are they going?

- Which direction are interest rates going?

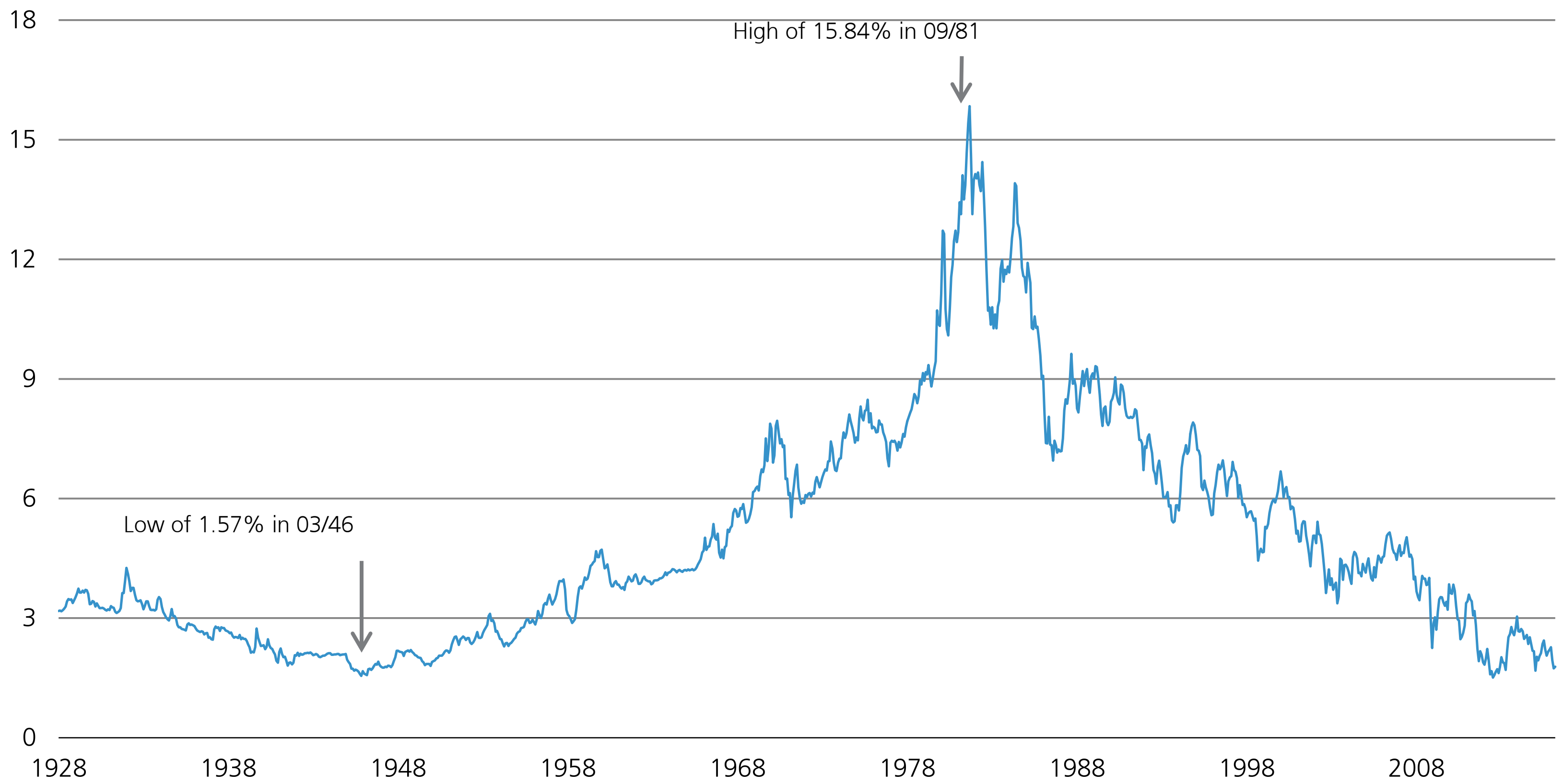


Source: Global Financial Data

UBS

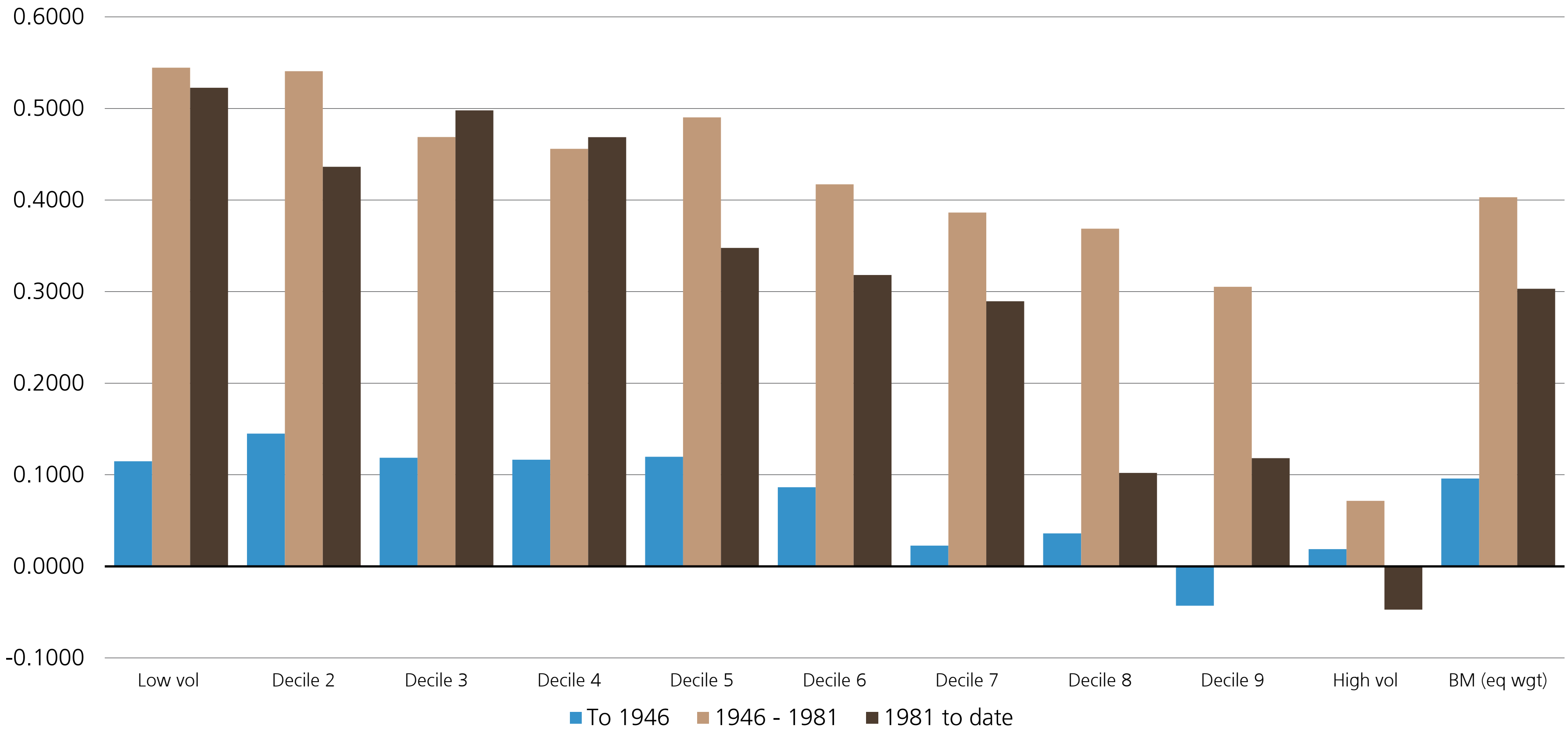
Interest rates – which way are they going?

- 10 year bond yields in the US have gone through three long term trends from 1928.



Source: Global Financial Data

Three big periods – Sharpe ratios



	Low vol	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	High vol	BM
To 1946	0.1147	0.1449	0.1186	0.1165	0.1197	0.0864	0.0226	0.0359	-0.043	0.0188	0.0959
1946 - 1981	0.5445	0.5407	0.4688	0.4559	0.4903	0.4172	0.3864	0.3687	0.3052	0.0715	0.4031
1981 to date	0.5226	0.4363	0.498	0.4686	0.3477	0.3182	0.2895	0.102	0.1181	-0.0472	0.3031

Source: UBS

Three big periods (continued)

- We show the results of a CAPM regression over the three periods

	Decile 1 – low vol		Decile 10 – high vol	
	Alpha	Beta	Alpha	Beta
To 1946	0.84%	0.422	3.17%	1.011
	(1.40%)	(0.003)	(4.87%)	(0.012)
1946 - 1981	1.53%	0.483	-4.21%	1.458
	(0.66%)	(0.003)	(1.52%)	(0.008)
1981 to date	3.02%	0.532	-5.88%	1.520
	(1.10%)	(0.004)	(3.32%)	(0.012)

Source: UBS. The standard errors of the values are shown in parenthesis. For illustrative purposes only

- We note that prior to 1946 the (equally weighted) high risk portfolio had a beta of just 1.01 against a value weighted index.

Three big periods – Fama-French regressions

- Running against the Fama-French factors

	Decile 1 – low vol				Decile 10 – high vol			
	Alpha	Market	SMB	HML	Alpha	Market	SMB	HML
To 1946	0.04%	0.454	0.19	0.00	-3.14%	1.065	1.09	0.47
	(1.29%)	(0.004)	(0.01)	(0.01)	(3.31%)	(0.010)	(0.02)	(0.02)
1946 – '81	0.79%	0.504	0.26	0.07	-5.33%	1.505	0.68	0.02
	(0.62%)	(0.003)	(0.01)	(0.01)	(1.41%)	(0.007)	(0.02)	(0.02)
81 to date	2.15%	0.549	-0.06	0.22	-4.57%	1.560	0.85	-0.53
	(1.04%)	(0.004)	(0.01)	(0.01)	2.89%	(0.011)	(0.02)	(0.02)

Source: UBS. For illustrative purposes only. The standard errors of the values are shown in parenthesis

Section 3

An aside: Our explanation of the low risk anomaly

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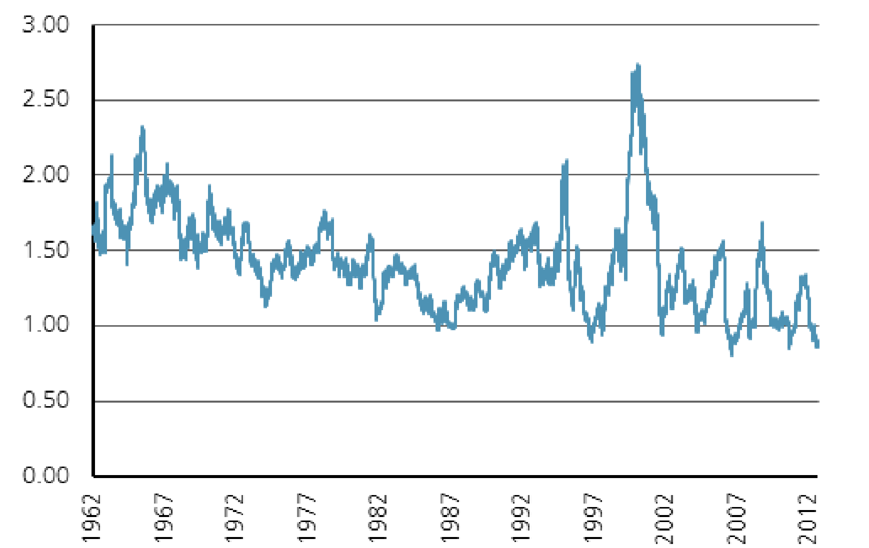
Our explanation of the low risk anomaly

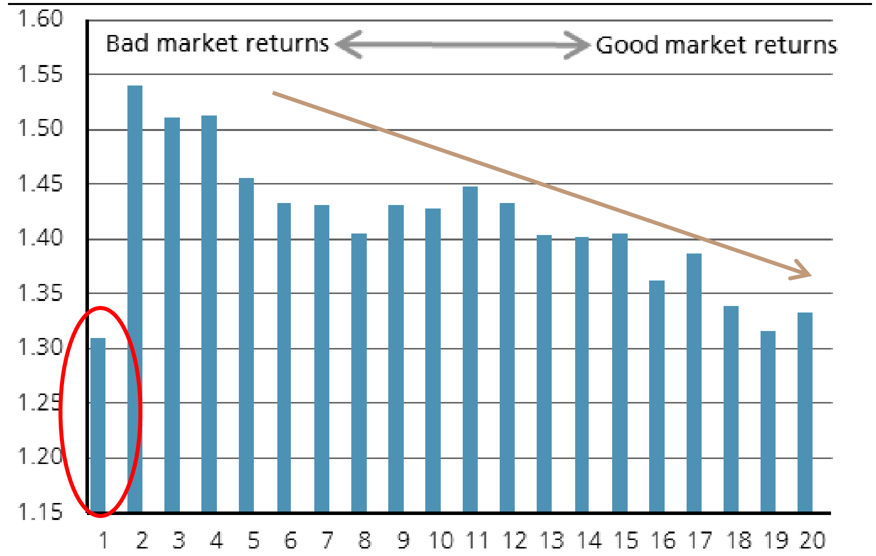
- Our explanation of the low risk anomaly is different and derives from the empirical observation that market betas (and volatilities) vary greatly over time.

Market beta dispersion



Source: UBS Quants

Beta dispersions and market returns



Source: UBS Quants

The market beta of each stock is estimated using the previous 6 months of daily returns. The dispersion is measured as the difference between the median market beta in the top and bottom quintiles. In the second figure we split all the observations into 20 equal sized baskets depending on the size of the market return during each period (in ascending order).

If the difference between the market betas of high and low-risk companies is narrow during rising markets, low-risk companies will underperform but only moderately. During downturns the gap between the betas widens causing lower risk companies to outperform by a significant amount. In the long-run this asymmetry will cause lower risk companies to outperform.

The hypothesis

- Betas are tight during market rallies so a low beta portfolio only mildly underperforms a higher beta portfolio
- Betas are dispersed during a market fall so a low beta portfolio significantly outperforms a higher beta portfolio.
- Average this over a cycle and low beta outperforms, at least in a risk adjusted and perhaps in an absolute sense.

A Formal Test – Llewellen and Nagel (2006)

- An estimate of unconditional alpha is the constant in a full sample regression

1981 **2015**

$$r_t - r_{f,t} = \alpha + \beta\left(r_{Mkt,t} - r_{f,t}\right) + \varepsilon_t$$

- They suggest splitting the sample into many small non-overlapping windows

2015

1981 **Period 1** **Period 2** **Period *n***

$$r_t - r_{f,t} = \alpha_1 + \beta_1\left(r_{Mkt,t} - r_{f,t}\right) + \varepsilon_t$$

$$r_t - r_{f,t} = \alpha_n + \beta_n\left(r_{Mkt,t} - r_{f,t}\right) + \varepsilon_t$$

$$r_t - r_{f,t} = \alpha_2 + \beta_2\left(r_{Mkt,t} - r_{f,t}\right) + \varepsilon_t$$

- If beta constant $\beta_1 = \beta_2 = \ldots = \beta_n$ then $E(\alpha_i) = \alpha$
- Else if $E(\alpha_i) \neq \alpha$ then the unconditional α is due to time-varying beta exposures, i.e. $\beta_1 \neq \beta_2 \neq \ldots \neq \beta_n$

Full sample CAPM regressions

- The estimate of the unconditional alpha to a long low risk – short high risk is of the order of 6% in 1946 – 1981 and 8% in the more recent period

	Decile 1 – low vol		Decile 10 – high vol	
	Alpha	Beta	Alpha	Beta
1946 - 1981	1.63%	0.483	-4.26%	1.455
	(0.66%)	(0.003)	(1.53%)	(0.008)
1981 to date	2.85%	0.533	-5.75%	1.521
	(1.09%)	(0.004)	(3.30%)	(0.012)

Source: UBS. For illustrative purposes only. The standard errors of the values are shown in parenthesis.
Note these are slightly different periods to the previous slide to line up with the 6 month windows

Non-Overlapping Window Regressions

- Use 70 windows of 6 months of daily data between Jun 46 and Jun 81 and 68 windows from 1981 onwards
- Explains roughly 35% of the low risk price anomaly in the second (falling rate) period but very little in the first period.

	Conditional Alpha			Full Sample Alpha		Beta		Std Dev of Beta	
	Low	**High**	**Diff**	**Diff**	**Reduction**	**Low**	**High**	**Low**	**High**
1946 - 1981	2.69%	-3.05%	5.73%	5.89%	-3%	0.483	1.455	0.09	0.28
'81 to date	2.54%	-3.32%	5.87%	8.60%	-32%	0.533	1.521	0.14	0.42

Source: UBS. For illustrative purposes only.

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Repeat the analysis using Fama-French Regressions

- Now use the standard Fama-French regressions in full sample and windows

$$r_t - r_{f,t} = \alpha + \beta\left(r_{Mkt,t} - r_{f,t}\right) + \beta r_{HML,t} + \beta r_{SMB,t} + \varepsilon_t$$

- In Full Sample regressions alpha difference is slightly smaller

	Low volatility				High volatility				
	Alpha	Beta	SMB	HML	Alpha	Beta	SMB	HML	Diff
1946 - 1981	0.86%	0.50	0.25	0.07	-5.58%	1.50	0.69	0.04	6.43%
1981 to date	1.91%	0.55	-0.05	0.22	-4.07%	1.56	0.85	-0.54	5.99%

- With non-overlapping windows returns to low volatility fall

	Conditional Alpha			Full Sample Alpha	
	Low	High	Diff	Diff	% reduct
1946 - 1981	2.21%	-3.07%	5.29%	6.43%	-17%
1981 to date	1.34%	-3.32%	4.66%	5.99%	-22%

UBS

Source: UBS. For illustrative purposes only.

Section 4

Adding in interest rates

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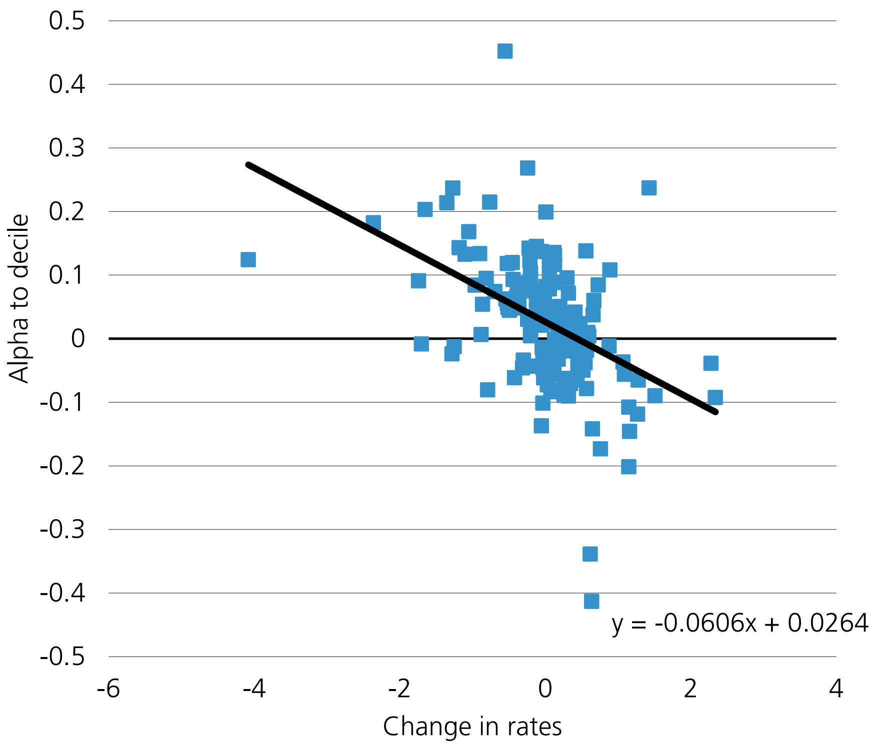
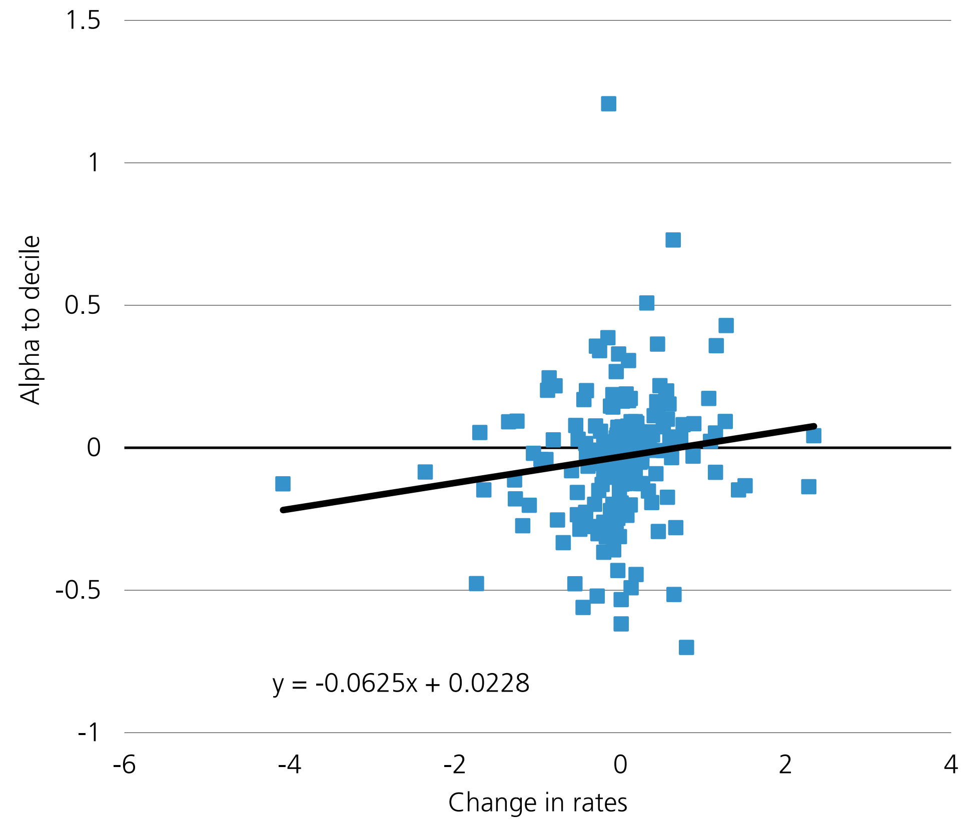
Interest rates and alpha

- We start by looking at the relationship between the 6 month alpha and the change in the 10 year rate (first difference) over the same period. We find a negative relationship for the low volatility alpha (left hand chart), and a positive relationship for the high volatility alpha (right hand chart).





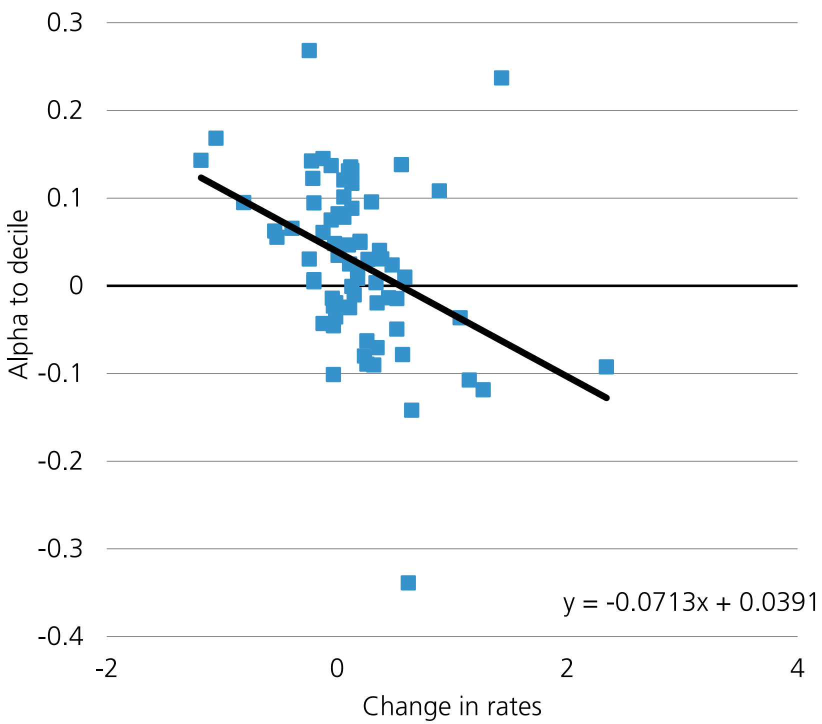
Source: UBS

UBS

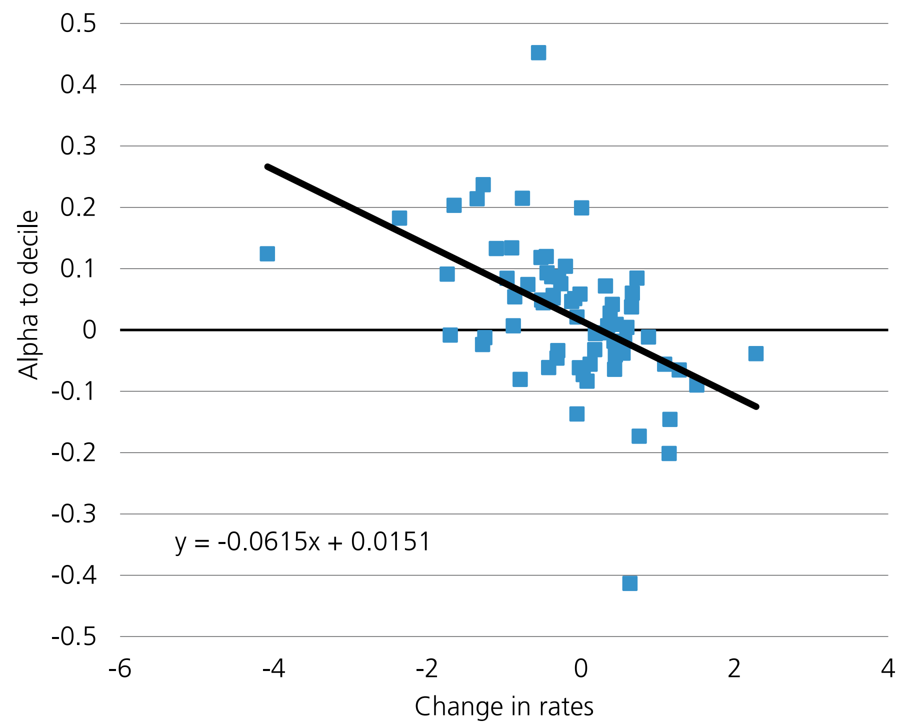
Interest rates and alpha (cont.)

- Focussing in on the low volatility part, we reproduce the above charts for the 1946 – 1981 and 1981-date periods. The slope of the relationship is similar in both cases, but the intercept is larger in the rising rate period.

Alpha vs change in rates – 1946-1981



Alpha vs change in rates –1981 to date



Source: UBS

UBS

Interest rates and alpha

- How do we make sense of the two results? When we look over the whole of the rising rate period we get a positive alpha for low risk, but looking at the sub-periods (with time varying betas) we obtain a negative relationship between changes in rates and the alpha to low risk.
- The answer comes in the regression equation

$$E(\alpha_t) = -0.0709 * \Delta r_t + 0.0381$$

- In order to have a negative alpha we need a change in interest rates of more than 54 basis points. Out of our 70 half year periods when rates were rising, this only happened in 11 of them.
- If we take the current falling rate period then the zero alpha point is when rates rise by more than 25 basis points.

What happens if we lag interest rates?

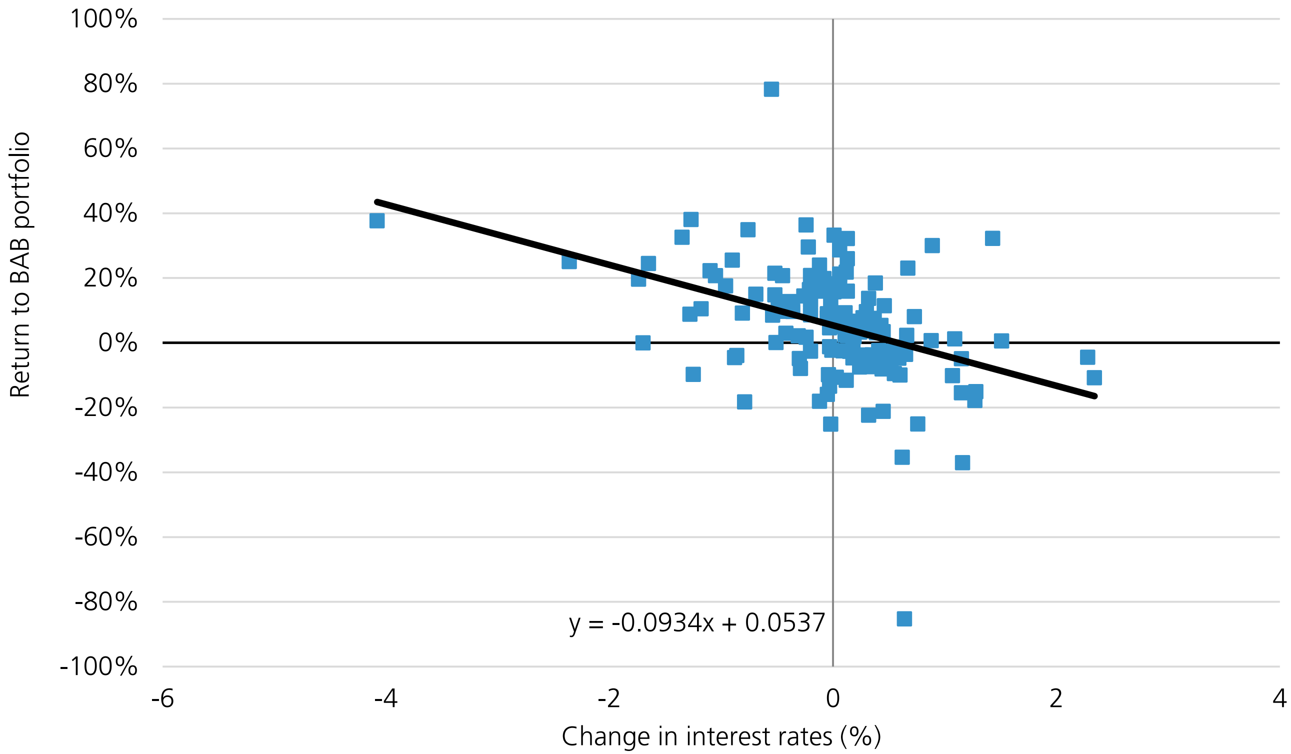
- Does a change in interest rates have a lagged effect? It could be the case for distressed companies that rising rates don't have an effect instantly.

	Low volatility		High volatility	
	1946-1981	1981 to date	1946-1981	1981 to date
No lag	-0.071	-0.062	0.062	0.057
	(-3.45)	(-4.75)	(1.60)	(1.95)
6m lag	-0.012	-0.004	-0.16	0.009
	(-0.51)	(-0.29)	(-0.39)	(0.30)
12m lag	-0.043	0.018	-0.002	0.003
	(-1.59)	(1.21)	(-0.05)	(0.10)

Source: UBS. Table shows the regression coefficients of the alpha to the low or high decile return against the change in 10 year rates. T-stats are shown in brackets.

Does Betting against Beta have the same problem?

- We created a betting against beta style portfolio, rebalanced on a 6 month basis using the preceding 6 months' betas to scale the long and short sides. The returns to this portfolio have a similar relationship with rates.



Source: UBS. The chart shows the six month returns to a betting against beta strategy against changes in 10 year rates. The slope has a t-stat of -5.34 and the intercept one of 3.93. The -85% return occurs in the last six months of 1999.

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Section 5

Can we remove the interest rate sensitivity?

Industry neutrality

- Our first approach to removing the interest rate sensitivity of our low risk portfolio is to impose some form of industry neutrality.
- The implementation of industry neutrality leads to two important questions. The first is a practical one – what industry classification system can we use which goes back to 1946 (or even 1928)? The second is a definitional one – when we say "neutral", to what are we neutral?
- To answer the first question we are fortunate in that Ken French has devised a mapping from SIC codes to a 10 industry classification, which we used together with the temporal SIC code data from CRSP.
- The second question is harder to answer and there is no one way to approach the problem. We start with a universe of the largest 500 names in CRSP. Two benchmarks were calculated – one market cap, and one equal weighted. Our low risk portfolios are made up of the lowest 10% of names in each of the 10 industries either equal weighted (so approximately matching the industry weights of the equal weighted benchmark) or market cap weighted but with the industry weights rescaled to match the cap weighted benchmark.

Industry neutrality – results (1)

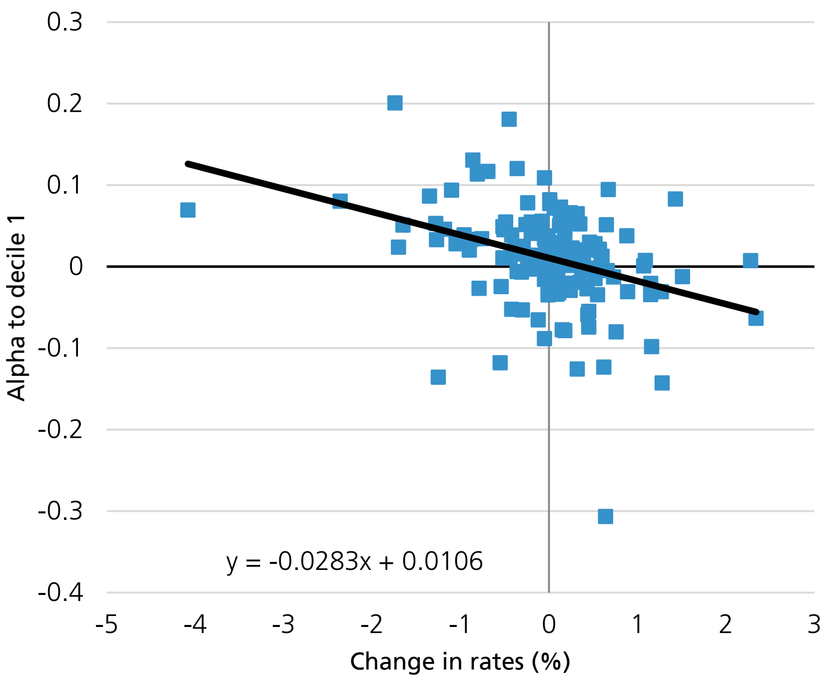
- The Sharpe ratios are shown below. We note
  - The cap weighted Sharpe ratios are uniformly lower than the equal weighted.
  - The size of the low risk effect is larger for the equal weighted portfolios
  - The Sharpe ratios of the equal weighted portfolios are almost identical to the non-industry neutral portfolios

	Equal Weighted		Cap weighted	
	Low volatility	Benchmark	Low volatility	Benchmark
Full Period	0.394	0.250	0.306	0.202
To 1946	0.127	0.096	0.087	0.010
1946-1981	0.532	0.403	0.448	0.360
1981 to date	0.513	0.303	0.383	0.264

Source: UBS, The portfolios are created from the CRSP database using the largest 500 names by market cap. The volatility metric used is the 90 day volatility of daily returns and the portfolios are rebalanced quarterly to either equal or market cap based weights. The portfolios are industry neutralised using Ken French's 10 industry classification. The Sharpe ratios are calculated using the 10 year Treasury interest rate.

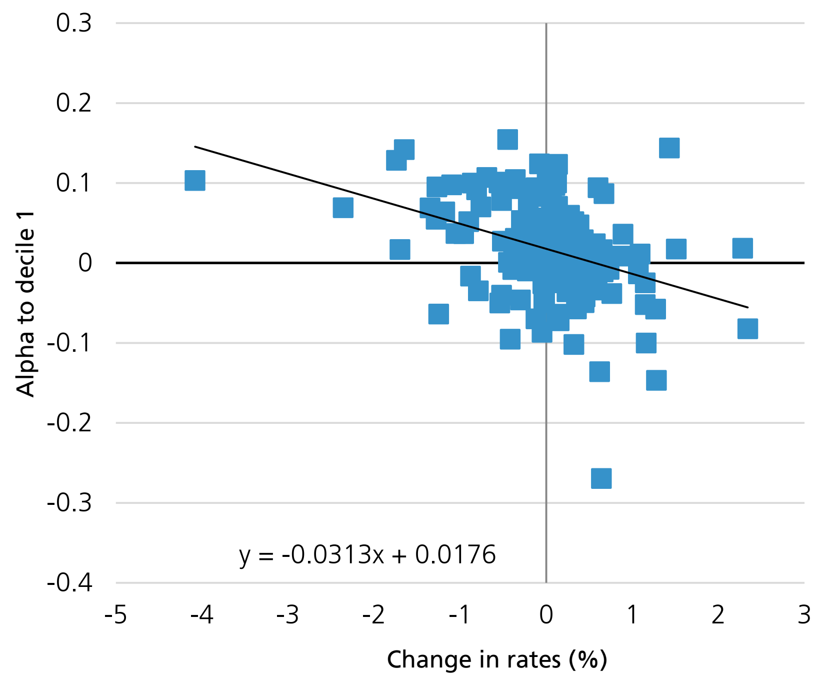
Industry neutrality – results (2)

Equal weighted alpha vs change in rates



Source: UBS. Chart shows the regression of the alphas to the equal weighted industry neutral low volatility decile estimated over non-overlapping six month periods against the contemporaneous change in US 10 year rates from Jan 1946 to December 2015. The standard errors for the parameters are 0.005 for the intercept (a t-stat of 2.36) and 0.006 (a t-stat of -4.40) for the slope.

Cap weighted alpha vs change in rates



Source: UBS. Chart shows the regression of the alphas to the cap weighted industry neutral low volatility decile estimated over non-overlapping six month periods against the contemporaneous change in US 10 year rates from Jan 1946 to Dec 2015. The standard errors for the parameters are 0.006 for the intercept (a t-stat of 3.48) and 0.009 (a t-stat of -3.86) for the slope.

Creating a sector neutral portfolio – UBS PAS

- We generated a minimum variance fund using the UBS PAS system using the S&P 500 as a universe (with a 5% limit on any one holding) and added in the active weight by sector must be < 50 basis points. The analysis shows:

	Benchmark Wts * Factor Beta	Portfolio Wts * Factor Beta	Active Wts * Factor Beta	Contribution to Active Variance	Percentage Contribution to Active Variance	Annual Standard Deviation	Active Weight
US S+P 500	1.00	0.63	-0.37	27.43	63.38	14.28	
Benchmark Risk				**27.43**	**63.38**		
US 10 Year Yield	-0.01	0.00	0.01	0.01	0.01	8.33	
MacroFactors=US Rates				**0.01**	**0.01**		
Energy	0.05	0.05	0.00	0.04	0.09	16.95	-0.5
Materials	0.03	0.04	0.01	0.02	0.04	11.25	-0.5
Industrials	0.09	0.15	0.06	0.21	0.48	5.82	-0.5
Consumer Discretionary	0.13	0.12	-0.01	0.02	0.04	6.42	0.5
Consumer Staples	0.11	0.17	0.06	0.36	0.83	7.43	1.5
Health Care	0.13	0.09	-0.04	0.17	0.40	9.08	0
Financials	0.15	0.16	0.01	0.01	0.01	6.09	-0.37
Information Technology	0.19	0.03	-0.16	1.48	3.41	6.65	-1.13
Utilities	0.03	0.07	0.04	0.50	1.15	13.76	0.5

Source: UBS Portfolio Analysis System. For illustrative purposes only.

Dividend yield neutrality

- Why should dividend yield neutrality make sense? Consider a (too) simple DDM

$$P_0 = \frac{D_1}{((1-\beta)r_f + \beta r_m - g)}$$

- Differentiating with respect to rates gives

$$\frac{\partial P_0}{\partial r_f} = -\frac{D_1}{\left((1-\beta)r_f + \beta r_m - g\right)^2}(1-\beta)$$

- Dividing through by the price and rearranging gives

$$\frac{\partial P_0}{P_0} = -\frac{D_1/P_0}{\left((1-\beta)r_f + \beta r_m - g\right)^2}(1-\beta)\partial r_f$$

- The return is a function of the yield multiplied by the change in rates. The beta controls this sensitivity. If the beta is below (above) one then if rates fall then the price should rise (fall). Hence falling rates should be good for low risk names.

- And if our yield is zero then the price is insensitive to changes in rates.

Low volatility and dividend yields

- Carrying out a double sort on the data gives us the following results. We separate out the results for zero yield companies (where we expanded the universe to the top 1000 US companies to have a reasonable universe)

Whole period

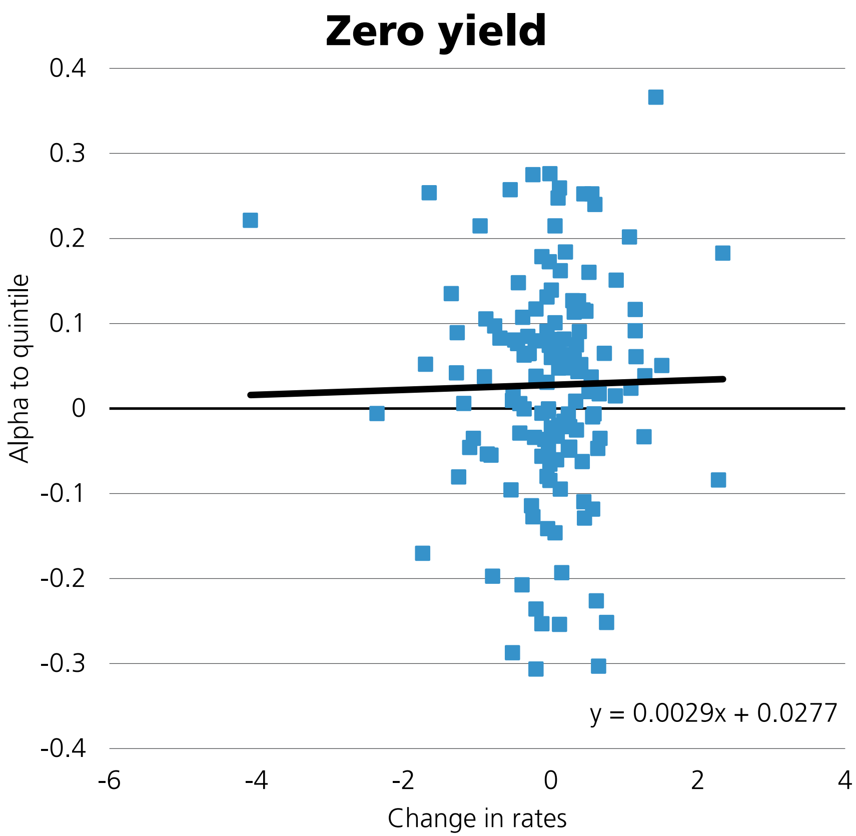
		Volatility					
		Low	Q2	Q3	Q4	High	
Dividend Yield	Low	0.3542	0.2536	0.1718	0.1097	0.0695	0.2186
	Q2	0.2655	0.2595	0.1869	0.1649	0.0851	0.2306
	Q3	0.2931	0.2879	0.2528	0.2589	0.1824	0.3157
	Q4	0.4056	0.3036	0.4	0.2421	0.2258	0.3818
	High	0.3724	0.1752	0.2389	0.2672	0.2107	0.3208
		0.4077	0.3173	0.3187	0.2634	0.202	0.314

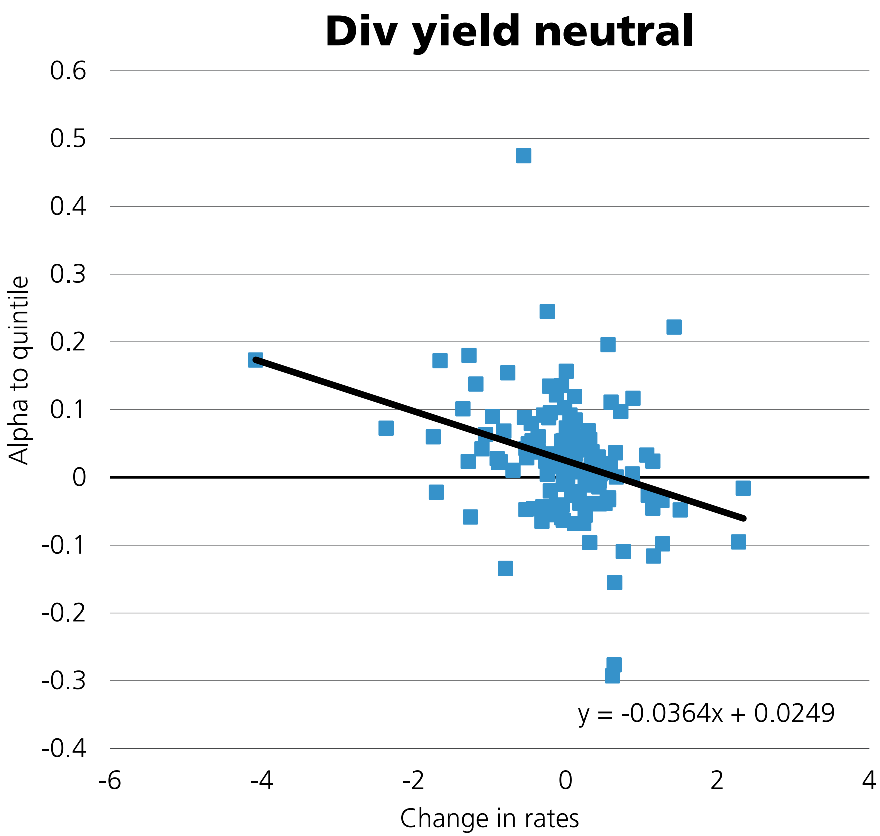
Zero yield	0.3157	0.2312	0.1935	0.1152	-0.0922

Source: UBS. Table shows the Sharpe ratios of strategies. The data is first sorted on dividend yield and then on 90 day volatility. The universe for the top table is the biggest 500 names in CRSP filtered by those which paid a dividend in the previous 12 months; for the bottom the biggest 1000 names is filtered for a zero yield.

Low volatility and dividend yields (2)

- Repeating the rolling 6m analysis first on the zero yield portfolio and then on the dividend yield neutral portfolios gives the following charts of alphas for the low volatility portfolios over the whole period.



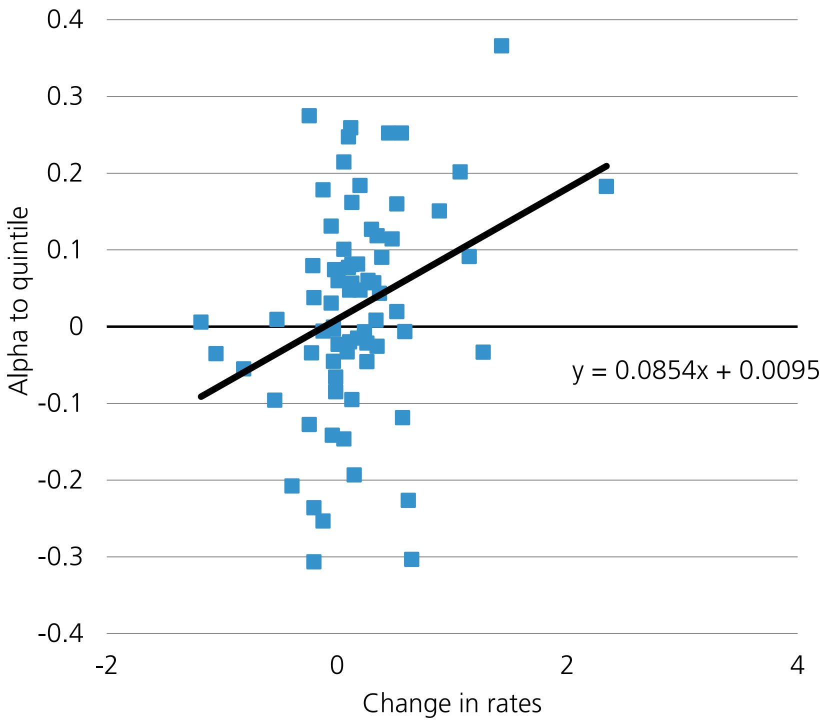


Source: UBS

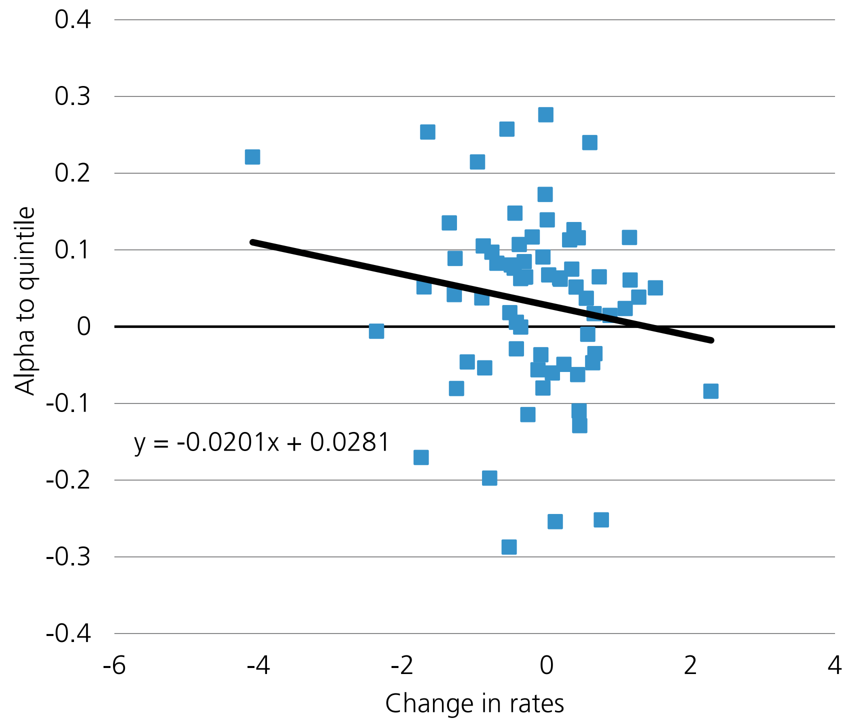
Low volatility and dividend yields (3)

- Repeating the previous subperiod analysis, here for the zero yield low risk portfolios we obtain a remarkable result in the first period.

Alpha vs change in rates – 1946-1981



Alpha vs change in rates –1981 to date



Source: UBS

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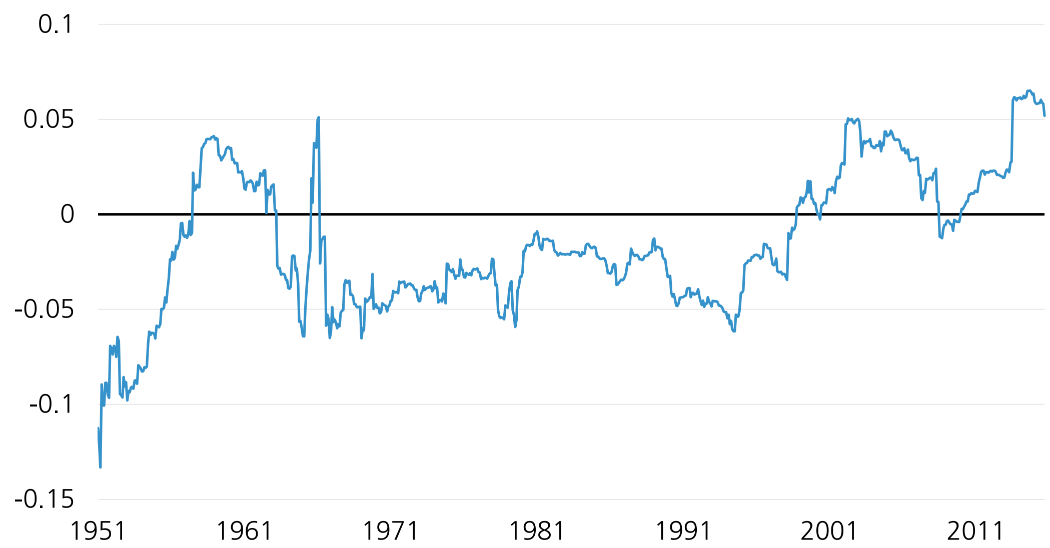
Is true interest rate neutrality possible?

- The above analysis shows the sensitivity of the alpha for the zero yield portfolio to changes in rates.
- If we look at the absolute returns for this strategy then this has a negative sensitivity to rate changes – so our absolute return falls if rates rise. Is it possible to build a low volatility portfolio with a zero sensitivity to rate changes? We carry out the regression

$$r_{low\ risk,t} = \alpha + \beta_t \Delta r_{f,t} + \epsilon_t$$



Source: UBS. Chart shows the rolling beta of the excess return of the zero-yield low-volatility portfolio regressed on changes in US 10 year rates. A rolling window of 60 months was used.

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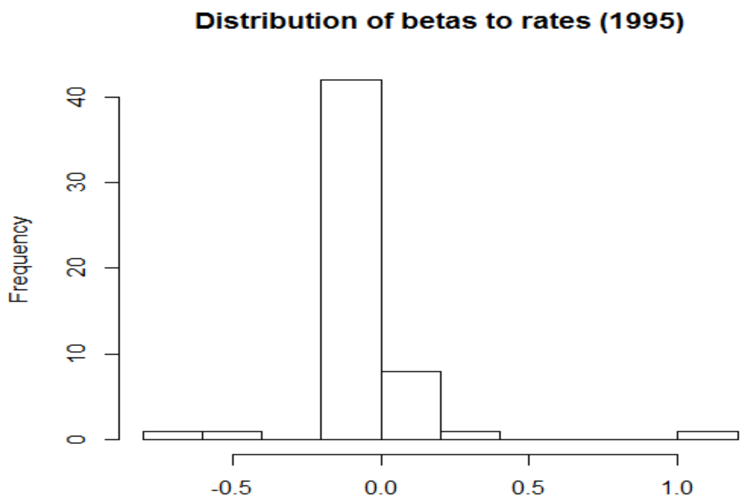
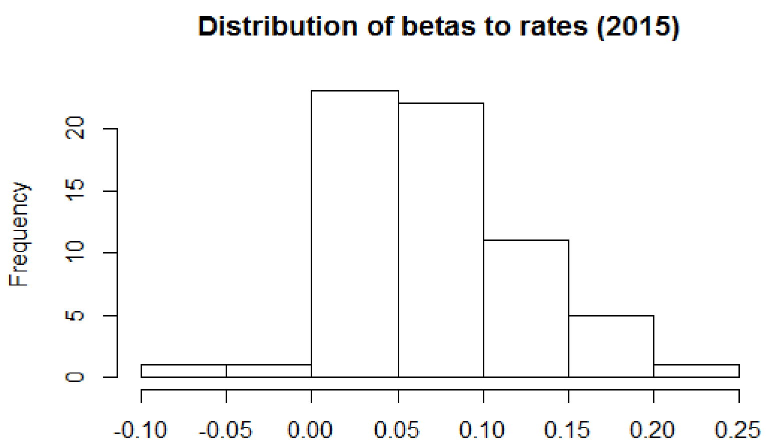
Is true interest rate neutrality possible?

- It depends! If we go back to 1995 then over 80% of our low volatility / zero yield names have a negative sensitivity to interest rates. So back then it would have been very hard to create a portfolio with a positive or zero sensitivity.
- At the end of December 2015 our zero-yield low-volatility portfolio had 64 constituents. Of these only two have a negative beta to changes in rates – the other 62 have a positive sensitivity.





Source: UBS. Charts show the distribution of the betas of low volatility / zero yield names to changes in 10 year rates, calculated using 5 years of monthly data.

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Sell	FSR is > 6% below the MRA.	15%	21%
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