The Low Beta Anomaly

Ed Fishwick

This version of this presentation was prepared for the Northfield's Annual Research Conference, Stowe Mountain Lodge, Vermont, October 2014

The low beta 'anomaly'

- This presentation is based on the forthcoming paper:

  'The Low Beta 'Anomaly' and Other Mysteries'

  Cherry Muijsson, Ed Fishwick and Steve Satchell ~ Forthcoming 2014

- The above paper builds on previous work:

  'Taking the Art out of Smart Beta'

  Muijsson, Fishwick, Satchell ~ Sydney University discussion paper, 2014

  'Dynamic CAPM Geometry'

  Fishwick and Satchell ~ London Quant Group presentation, 2013

  'Risk & Resilience: Patterns in Equity Returns'

  Fishwick, Kosterich, Cameron-Watt ~ BlackRock Investment Institute, 2013

The low beta 'anomaly'

- This work is concerned with the low beta 'anomaly', and by extension equity strategies that have permanent low volatility characteristics relative to a market portfolio
- Strategies with permanent low beta might include high income, low or 'minimum' volatility, and perhaps value, in addition to those which simply exhibit low beta
- We argue (and demonstrate) that returns to such strategies should be (and are) dependent on economic conditions, and specifically interest rate expectations
- This said, it is rare that a single factor explains everything about an investment outcome and we do not argue that this is necessarily the case in the context of low beta
- Also, strategies that exhibit low beta may be very different in other ways (for instance high yield and minvol have differing risk exposures) and this will impact their risk and return
- Nonetheless, we do argue that the environment plays an important role
- An overarching theme here is the distinction between things that are 'permanent', and things that are dependent on a particular environment and thus transitory

The low beta ‘anomaly’ – an example

Long-Short Low Beta-High Beta Portfolio, US Large Cap, 1973 through 2012

Above shows cumulative returns to a portfolio long 10 lowest beta industries and short 10 highest beta industries, equal weighted by volatility contribution

Source: BlackRock / MSCI Barra

A selection of related literature

- 1972 Haugen & Heins “On the evidence supporting risk premiums in the capital market”
- 1998 Black “Beta and Return”
- 2010 Baker & Haugen “Low risk stock outperform in all markets”
- 2010 Wurdley et al “Benchmarks as limits to arbitrage: understanding the low vol anomaly”
- 2010 Clarke etc al “Minimum variance portfolio composition”
- 2010 Scherer “A new look at minimum variance investing”
- 2011 Deutsche Bank “Minimum variance: Exposing the magic”
- 2011 Anderson, Bianchi & Goldberg “Will my risk parity strategy outperform?”
- 2011 Sefton “Why is low-risk investing successful?”
- 2012 diBartolomeo “Low volatility equity investing”
- 2013 Klepfish “Is my portfolio beta too big?”

Existing explanations for the low beta ‘anomaly’

- Causes of 'anomaly' heavily investigated in the literature
- Could be attributed to many factors
- Mismeasurement due to volatility effects
- Role of unobservables
- Failure to account for risk factors
- Dynamic betas
- Asymmetric Volatility
- Delegated portfolio management
- Leverage aversion and/or non-availability of leverage
- Agency issues and investor bias
- Behavioural finance

The Human condition, statistical theory, and CAPM

- Previous explanations involve the human condition and statistical theory
- Psychological ‘certainties’ that depend upon human frailty, or
- Statistical complexity that produces ‘certainty’
- The implication being that these are ‘permanent’ anomalies
- But ignore a critical fact: widely differing exposure to economic risk
- The exceptions are Scherer (2010) and Sefton (2011)
- We consider the relationship between ‘theory’, asset pricing, and economic risk
- This may have wide implications for “equity” as a “strategic asset”
- We frame this in terms of a simple model relating return to risk - CAPM

Theoretical framework: Rewriting the CAPM

- Under traditional CAPM, we write the expected return to an asset (r):

$$r_i = \frac{E(P_{i,t+1})}{P_{i,t}} - 1$$

$$r_i = r_f + \beta_i(r_m - r_f)$$

- As aside we note

$$r_i = (1 - \beta_i)r_f + \beta_i r_m$$

- Then write price as

$$P_{i,t} = \frac{E_t(P_{i,t+1})}{\left(1 + r_f + \beta_i(r_m - r_f)\right)}$$

Theoretical framework: Rewriting the CAPM

- Partially differentiating price with respect to the risk free rate gives:

$$\frac{dP_{i,t}}{dR_f} = \frac{-E_t(P_{i,t+1})}{\left(1+r_f+\beta_i(r_m-r_f)\right)^2}(1-\beta_i)$$

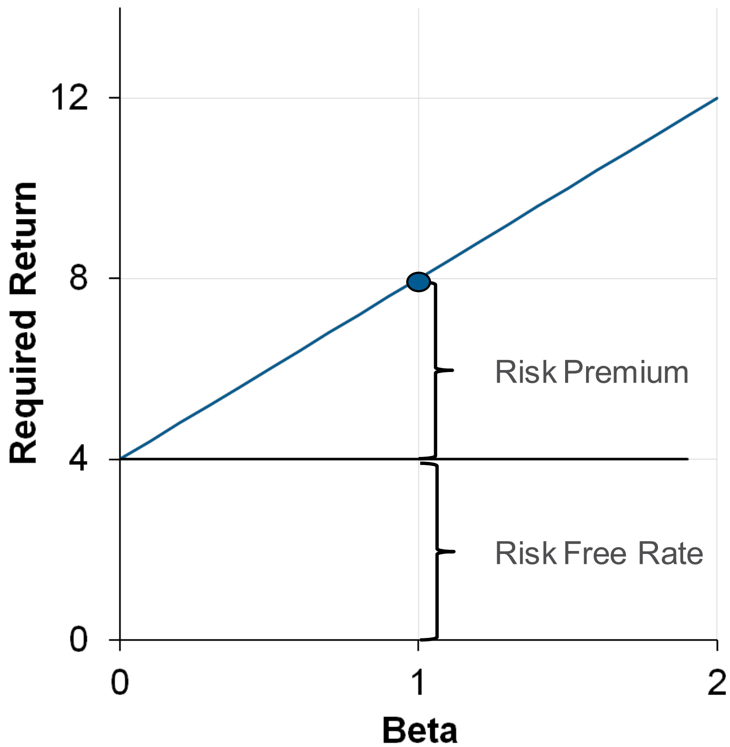
- Partially differentiating price with respect to the market return gives:

$$\frac{dP_{i,t}}{dR_m} = \frac{-E_t(P_{i,t+1})}{\left(1+r_f+\beta_i(r_m-r_f)\right)^2}\beta_i$$

- The combined relationship between price, expected market return and the risk free-rate is:

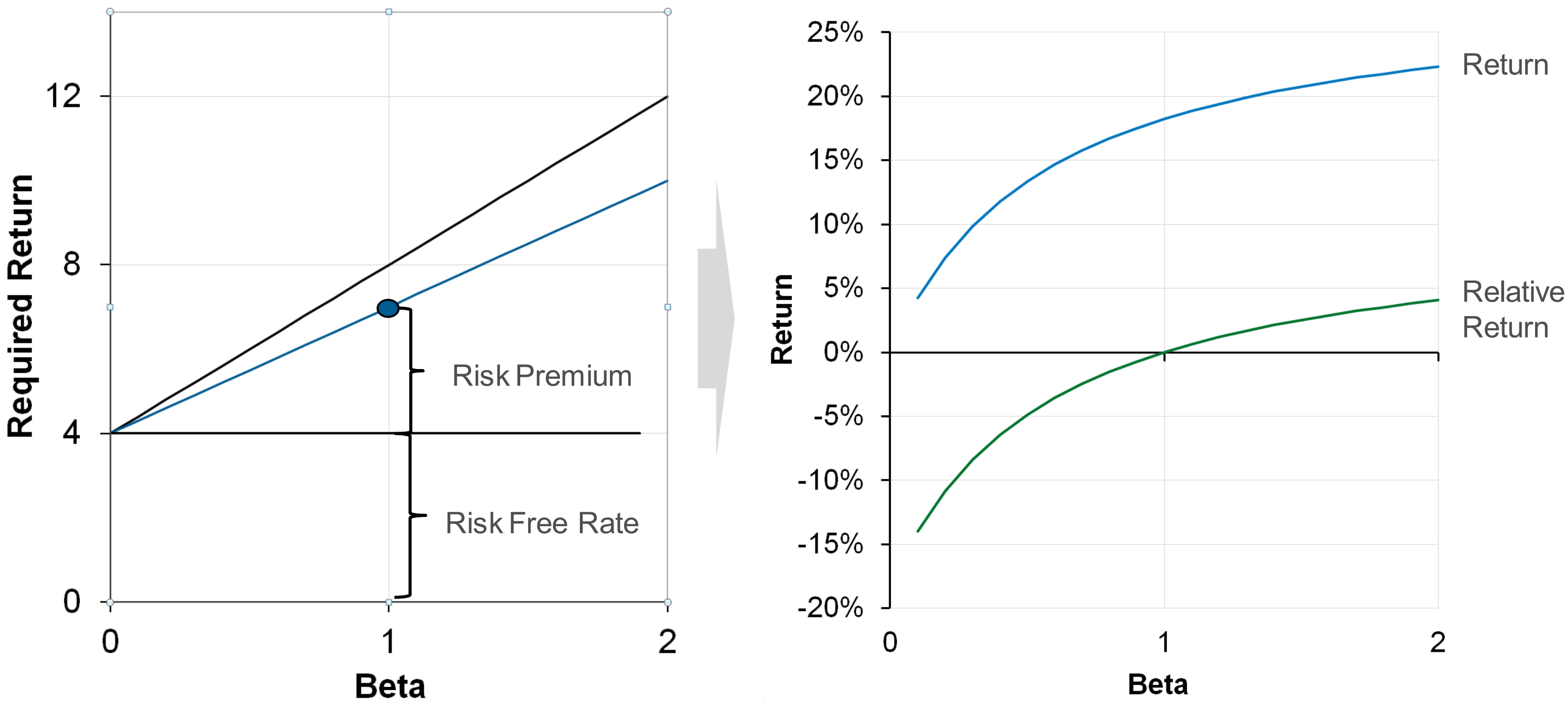
$$dP_{i,t} = \frac{-E_t(P_{i,t+1})}{\left(1+r_f+\beta(r_m-r_f)\right)^2}\left(dr_f + \beta_i(dr_m - dr_f)\right)$$

CAPM Geometry (Finance 1.01)



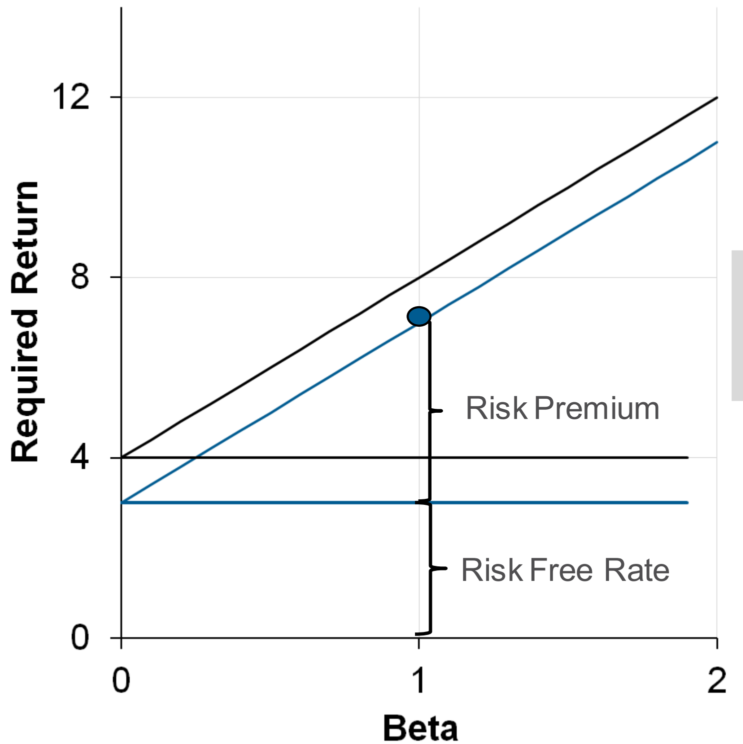
- This is extremely familiar territory
- Prices are set so that ex-ante return is a linear function of ex-ante beta
- It has a property that is sometimes forgotten
- It is a story about ex-ante risk and return
- Ex-post the risk-return relationship will reflect any changes over the period
- Thus the ‘geometry’ of CAPM is dynamic..

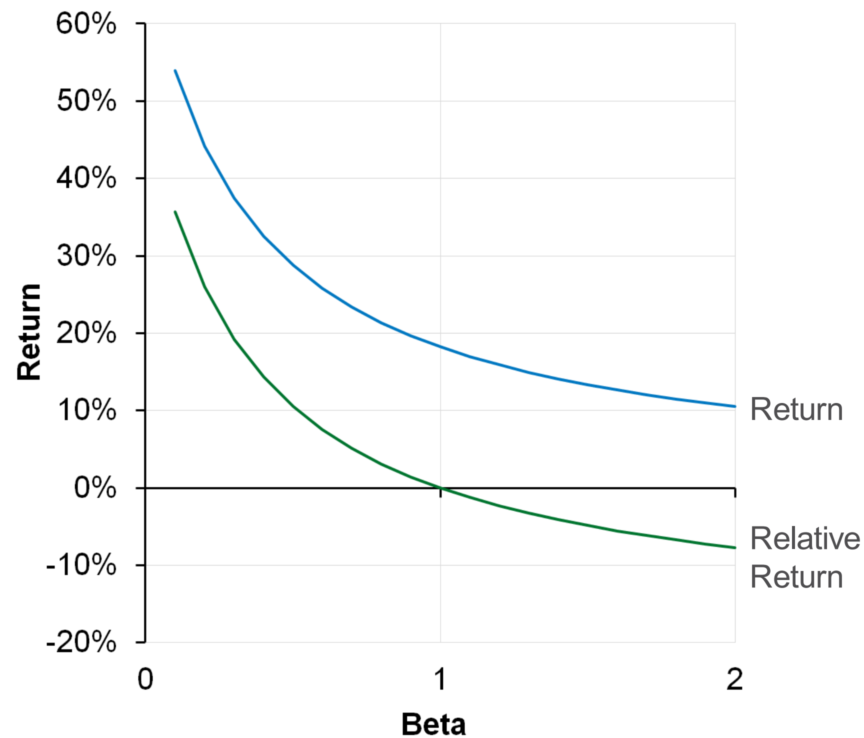
‘Dynamic’ CAPM Geometry: Decline in risk premium



- Here a fall in the risk premium causes absolute prices to increase
- High beta stocks outperform the rising market
- Low beta stocks underperform the rising market

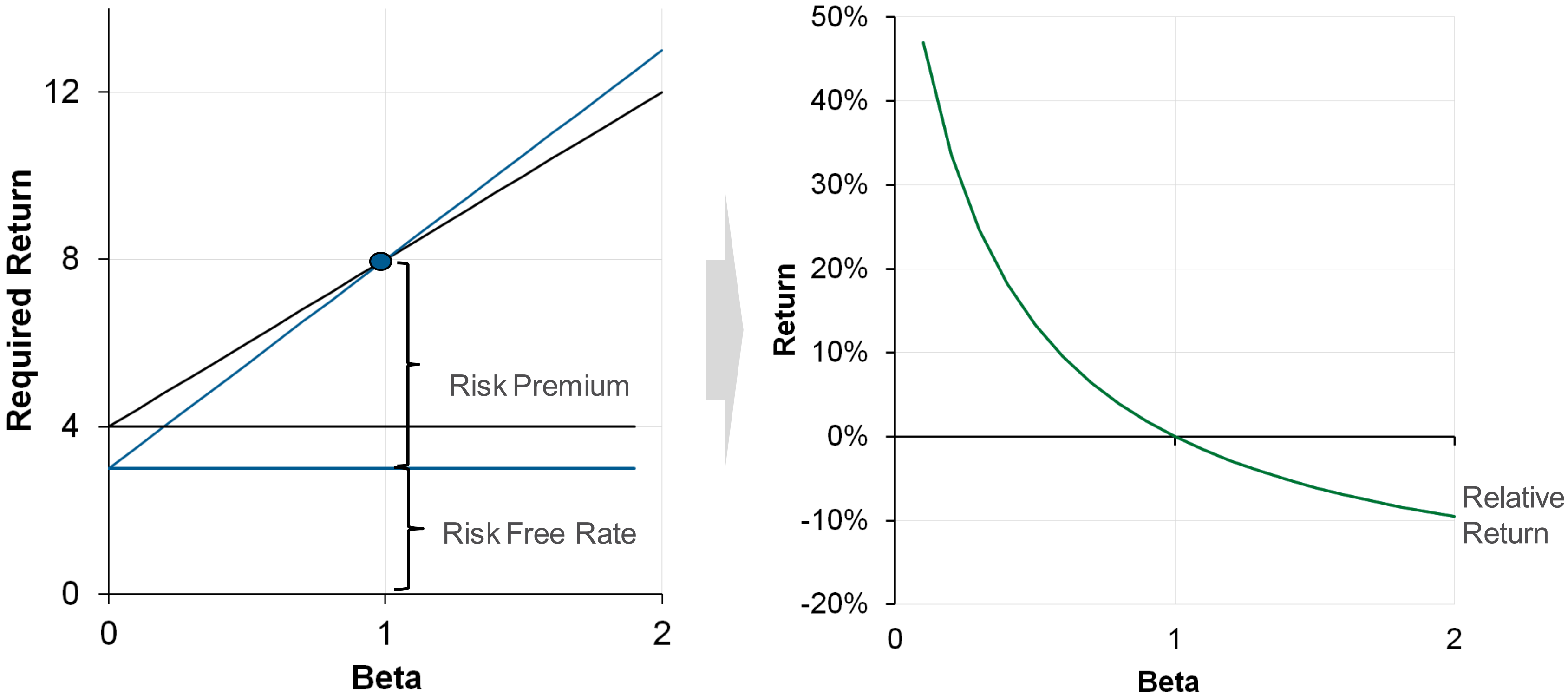
‘Dynamic’ CAPM Geometry: Fall in risk free rate





- Here a fall in the risk free rate causes absolute prices to increase
- Low beta stocks outperform the rising market
- High beta stocks underperform the rising market

‘Dynamic’ CAPM Geometry: Fall in risk free rate, increase in risk premium



- Here a fall in the risk free rate is exactly offset by an increase in the risk Premium
- Overall the market – beta = 1 – is unchanged
- Relative prices change - low beta stocks outperform high beta stocks

US Bond Yields: 10 Year Treasuries 1953 - 2012

Source: BlackRock / Bloomberg

Long run analysis of beta at industry level

- We use long run industry level data to analyse beta effects
  - Fama - French industry level monthly data
  - 43 industry groupings
  - 1953.01 through 2012.12 (720 months)
- We calculate
  - Full sample betas
  - Split sample betas
- Identify industries with betas statistically different from one in both full and split sample
- Industry betas were calculated on both an equally weighted and cap weighted basis
- While the betas were closely matched in both cases, industry betas which were consistently and significantly different from one were not the same.
- We form an cap weighted portfolio of the relevant 9 industries to form a ‘high beta’ portfolio, and 5 industries to form a ‘low beta’ portfolio
- We note that the main conclusions are not altered if we use equally weighted portfolios

Industry betas – 1953.01 through 2012.12

- We estimate OLS betas for the 43 FF industries in full and split sample
- β_1 is1953.01 – 2012.12; β_2 is 1953.01 – 1979.12; β_3 is 1980.01 – 2012.12
- Define “low” and “high” beta industries as those where β_1 ,β_2 , and β_3 have same sign
- And betas are statistically different from one (t>|2.56|)

	BETA(1)	BETA(2)	BETA(3)	T(1)	T(2)	T(3)	
Agric	0.88	1.01	0.79	-2.73	0.17	-3.64	
Food	0.70	0.85	0.59	-11.85	-5.51	-10.40	LOBETA
Beer	0.76	0.95	0.64	-7.29	-1.32	-7.57	
Smoke	0.67	0.72	0.64	-7.40	-5.36	-5.40	LOBETA
Toys	1.16	1.30	1.08	3.62	3.79	1.47	
Fun	1.35	1.45	1.29	8.75	7.43	5.38	HIBETA
Books	1.07	1.16	1.02	2.42	3.17	0.47	
Hshld	0.84	1.02	0.72	-6.36	0.52	-8.07	
Clths	1.08	1.11	1.07	2.41	2.17	1.41	
MedEq	0.91	0.97	0.87	-2.89	-0.54	-3.56	
Drugs	0.84	1.01	0.72	-5.48	0.20	-7.17	
Chems	1.05	1.05	1.05	1.88	1.42	1.31	
Rubbr	1.07	1.12	1.04	2.10	2.28	0.87	
Txtls	1.11	1.07	1.14	2.64	1.55	2.11	
BldMt	1.16	1.18	1.14	5.97	6.15	3.53	HIBETA
Cnstr	1.29	1.31	1.28	7.67	5.50	5.44	HIBETA
Steel	1.30	1.14	1.41	8.13	3.19	7.39	HIBETA
Mach	1.21	1.14	1.26	8.47	4.96	6.83	HIBETA
ElcEq	1.21	1.19	1.23	7.83	4.64	6.24	HIBETA
Autos	1.13	1.01	1.20	3.33	0.16	3.57	
Aero	1.12	1.22	1.05	2.95	3.25	1.08	
Ships	1.07	1.07	1.08	1.68	1.37	1.15	
Mines	1.09	1.01	1.15	2.06	0.11	2.22	
Coal	1.16	1.18	1.15	2.37	2.27	1.45	
Oil	0.81	0.88	0.77	-5.62	-3.12	-4.58	LOBETA
Util	0.55	0.70	0.44	-17.37	-8.82	-14.96	LOBETA
Telcm	0.75	0.61	0.84	-9.61	-11.25	-4.35	LOBETA
PerSv	1.09	1.23	0.99	2.04	3.12	-0.19	
BusSv	1.22	1.10	1.30	8.16	2.33	8.57	
Comps	1.24	1.10	1.33	6.21	1.94	6.08	
Chips	1.40	1.35	1.44	11.30	7.02	8.76	HIBETA
LabEq	1.31	1.30	1.32	8.93	5.60	6.95	HIBETA
Paper	1.02	1.13	0.94	0.51	2.42	-1.42	
Boxes	0.98	1.03	0.94	-0.77	0.79	-1.23	
Trans	1.08	1.19	1.00	2.70	4.60	0.04	
Whlsl	1.05	1.18	0.97	2.05	4.10	-0.93	
Rtail	0.98	1.00	0.96	-0.93	-0.08	-1.05	
Meals	1.05	1.35	0.86	1.56	5.90	-3.48	
Banks	1.03	1.01	1.05	1.01	0.21	1.04	
Insur	0.96	1.06	0.90	-1.09	1.01	-2.52	
RlEst	1.21	1.42	1.07	4.45	5.64	1.19	
Fin	1.23	1.16	1.27	9.72	5.54	7.86	HIBETA
Other	1.13	1.21	1.08	3.43	3.21	1.75	

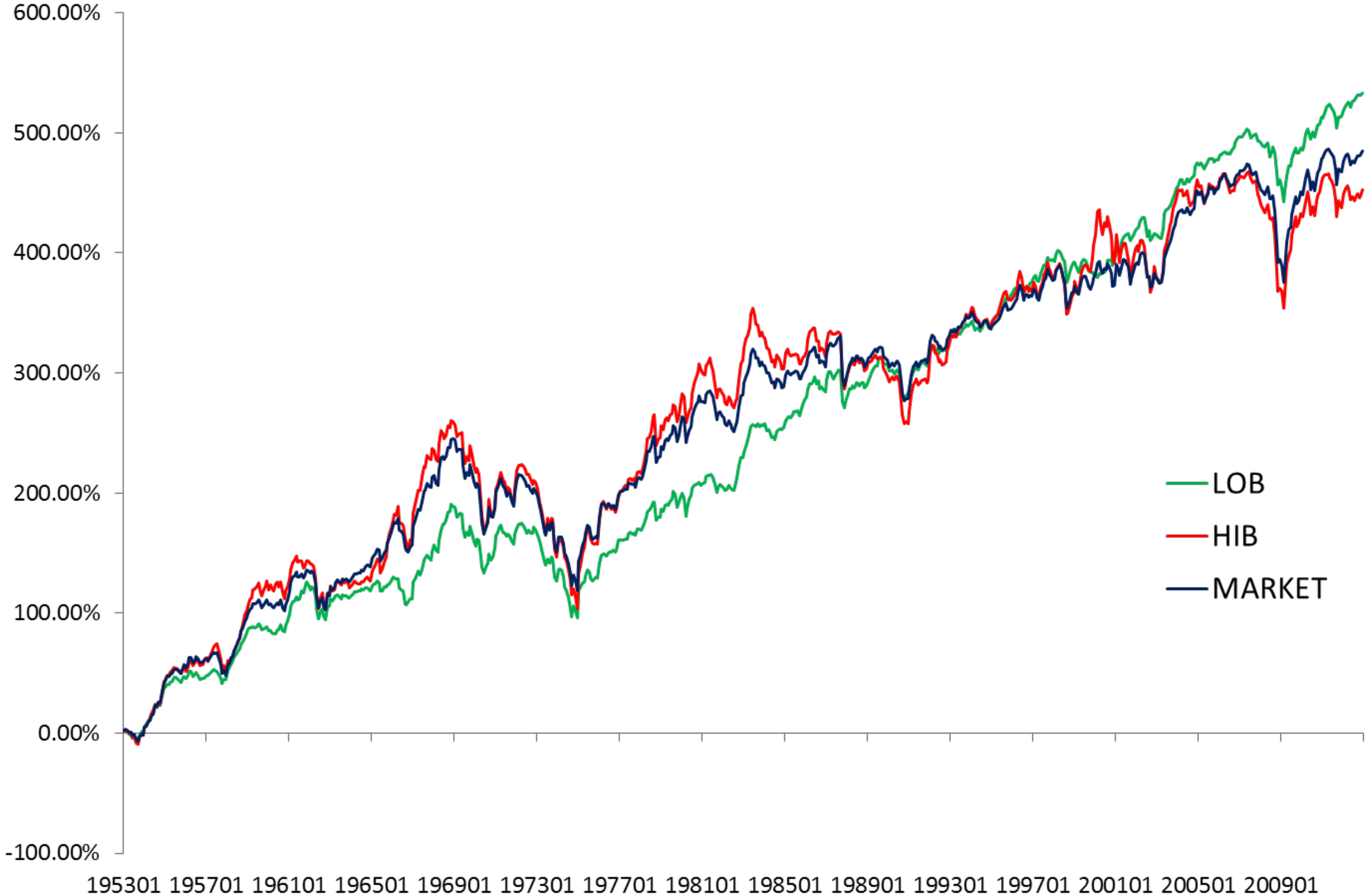
	BETA(1)	BETA(2)	BETA(3)	T(1)	T(2)	T(3)	
Agric	**0.95**	**0.98**	**0.94**	**-1.35**	**-0.42**	**-1.38**	
Food	**0.68**	**0.80**	**0.60**	**-20.95 ***	**-10.37 ***	**-18.02 ***	**LOBETA**
Beer	**0.66**	**0.84**	**0.55**	**-13.84 ***	**-4.81 ***	**-12.98 ***	**LOBETA**
Smoke	**0.60**	**0.64**	**0.58**	**-9.50 ***	**-11.28 ***	**-6.19 ***	**LOBETA**
Toys	**1.13**	**1.30**	**1.02**	**4.80 ***	**6.75 ***	**0.54**	
Fun	**1.11**	**1.16**	**1.07**	**4.33 ***	**4.42 ***	**2.11**	
Books	**0.96**	**0.98**	**0.94**	**-1.61**	**-0.59**	**-1.49**	
Hshld	**1.00**	**1.10**	**0.94**	**0.08**	**5.14 ***	**-2.62 ***	
Clths	**0.99**	**1.09**	**0.92**	**-0.48**	**2.81 ***	**-2.41**	
MedEq	**1.07**	**1.04**	**1.09**	**3.05 ***	**1.02**	**3.18 ***	
Drugs	**1.14**	**0.90**	**1.30**	**5.06 ***	**-2.78 ***	**7.20 ***	
Chems	**0.91**	**0.96**	**0.89**	**-5.13 ***	**-2.50**	**-4.37 ***	
Rubbr	**1.04**	**1.17**	**0.96**	**1.85**	**4.78 ***	**-1.55**	
Txtls	**1.02**	**1.12**	**0.96**	**0.80**	**3.83 ***	**-0.96**	
BldMt	**1.00**	**1.12**	**0.92**	**0.02**	**5.70 ***	**-1.39**	
Cnstr	**1.17**	**1.25**	**1.12**	**6.23 ***	**6.23 ***	**3.23 ***	**HIBETA**
Steel	**1.08**	**1.04**	**1.11**	**3.64 ***	**1.57**	**3.18 ***	
Mach	**1.05**	**1.05**	**1.04**	**3.34 ***	**3.33 ***	**2.00**	
ElcEq	**1.13**	**1.24**	**1.07**	**7.79 ***	**8.76 ***	**3.12 ***	**HIBETA**
Autos	**1.09**	**1.13**	**1.06**	**4.09 ***	**5.80 ***	**1.82**	
Aero	**0.99**	**1.22**	**0.84**	**-0.31**	**4.84 ***	**-3.86 ***	
Ships	**0.98**	**0.93**	**1.02**	**-0.45**	**-1.93**	**0.35**	
Mines	**0.98**	**0.94**	**1.01**	**-0.50**	**-1.47**	**0.12**	
Coal	**0.91**	**0.91**	**0.91**	**-1.70**	**-1.60**	**-1.10**	
Oil	**0.94**	**0.95**	**0.94**	**-1.65**	**-1.49**	**-1.14**	
Util	**0.37**	**0.49**	**0.29**	**-33.67 ***	**-18.66 ***	**-27.68 ***	**LOBETA**
Telcm	**1.15**	**1.01**	**1.24**	**6.93 ***	**0.20**	**7.93 ***	
PerSv	**0.97**	**1.06**	**0.92**	**-1.04**	**1.29**	**-2.89 ***	
BusSv	**1.20**	**1.09**	**1.26**	**10.79 ***	**3.07 ***	**11.80 ***	**HIBETA**
Comps	**1.41**	**1.37**	**1.43**	**17.00 ***	**10.32 ***	**13.42 ***	**HIBETA**
Chips	**1.41**	**1.37**	**1.44**	**18.14 ***	**10.31 ***	**14.99 ***	**HIBETA**
LabEq	**1.20**	**1.19**	**1.20**	**9.89 ***	**5.69 ***	**8.28 ***	**HIBETA**
Paper	**0.90**	**0.94**	**0.87**	**-4.75 ***	**-1.78**	**-4.58 ***	
Boxes	**0.88**	**0.99**	**0.81**	**-5.04 ***	**-0.34**	**-5.15 ***	
Trans	**0.96**	**1.07**	**0.90**	**-1.91**	**2.48**	**-4.09 ***	
Whlsl	**1.05**	**1.14**	**0.98**	**2.95 ***	**5.25 ***	**-0.86**	
Rtail	**1.00**	**1.01**	**0.99**	**-0.07**	**0.32**	**-0.23**	
Meals	**1.00**	**1.18**	**0.88**	**-0.18**	**4.70 ***	**-4.10 ***	
Banks	**0.70**	**0.85**	**0.60**	**-13.99 ***	**-4.78 ***	**-13.83 ***	**LOBETA**
Insur	**0.73**	**0.85**	**0.65**	**-12.85 ***	**-4.03 ***	**-14.38 ***	**LOBETA**
RlEst	**1.06**	**1.35**	**0.88**	**1.94**	**6.34 ***	**-3.12 ***	
Fin	**0.86**	**0.97**	**0.80**	**-9.14 ***	**-1.61**	**-10.04 ***	
Other	**1.01**	**1.13**	**0.94**	**0.55**	**2.42**	**-2.18**	

Source: BlackRock / Fama/French

Low and High Beta Industries

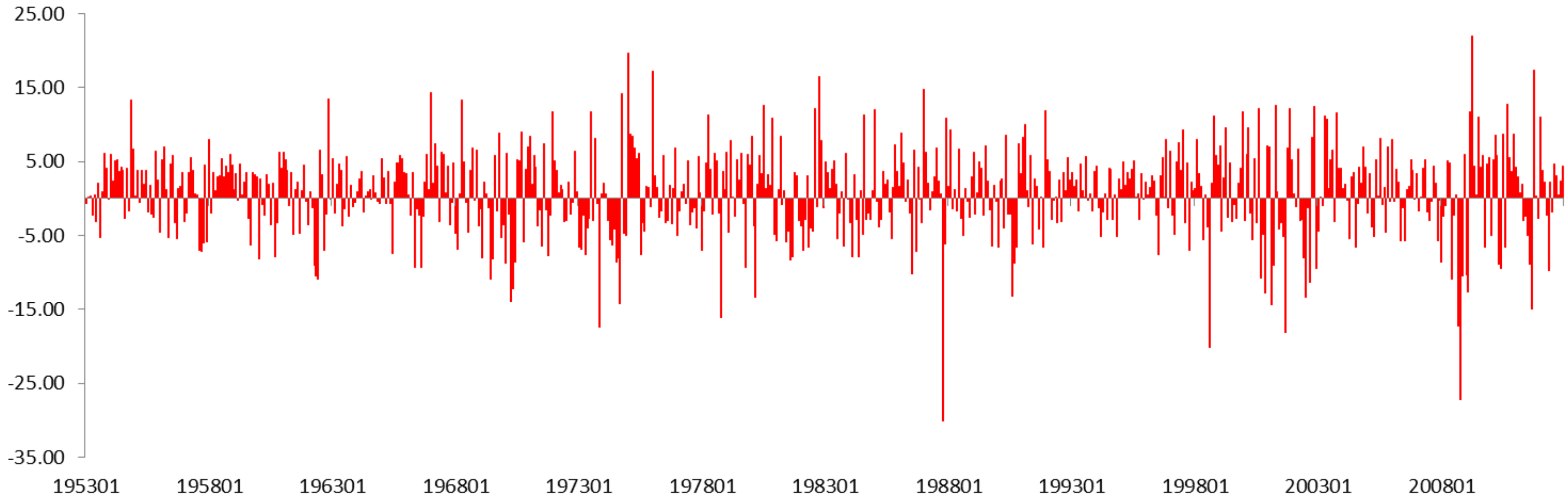
- Cap Weighted
  - High beta: Building Materials; Steel ; Construction; Machinery; Electrical Equip; Chips; Lab Equip; Financials
  - Low beta: Food; Tobacco; Oil; Utilities; Telcom
- Equal Weighted
  - High Beta: Construction; Electrical Equip; Business Services; Computers; Chips; Lab Equip
  - Low Beta: Food; Beer; Tobacco; Utilities; Banks; Insurance

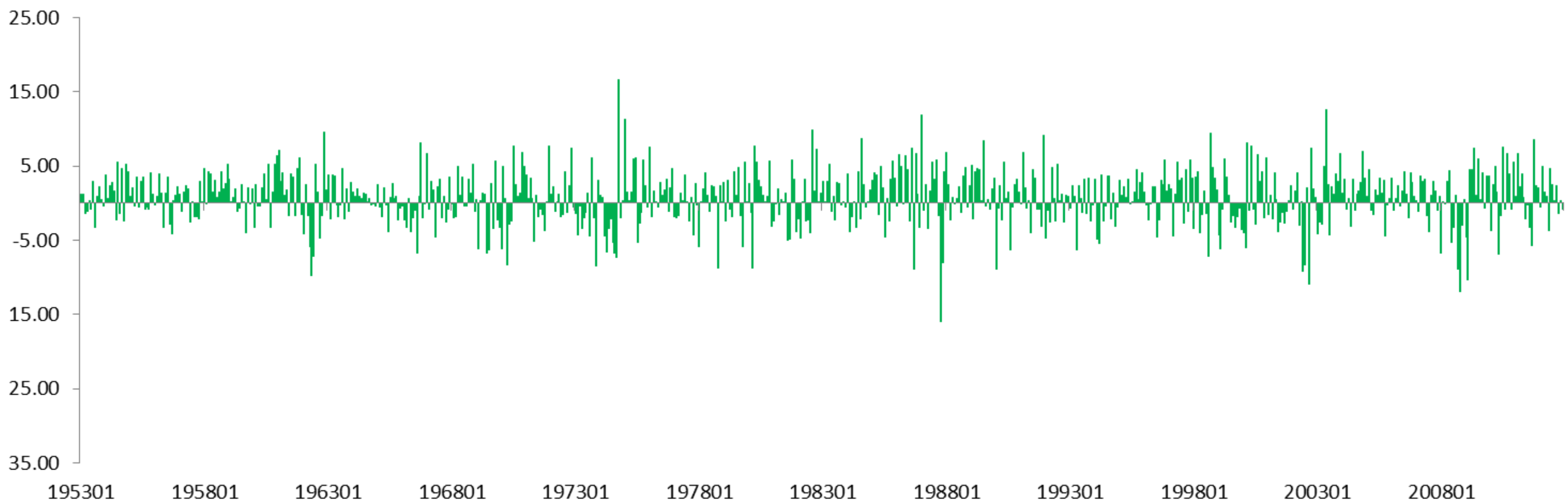
HIB and LOB – Cumulative Returns



Source: BlackRock

High Beta (HOB) and Low Beta (LOB) Portfolios





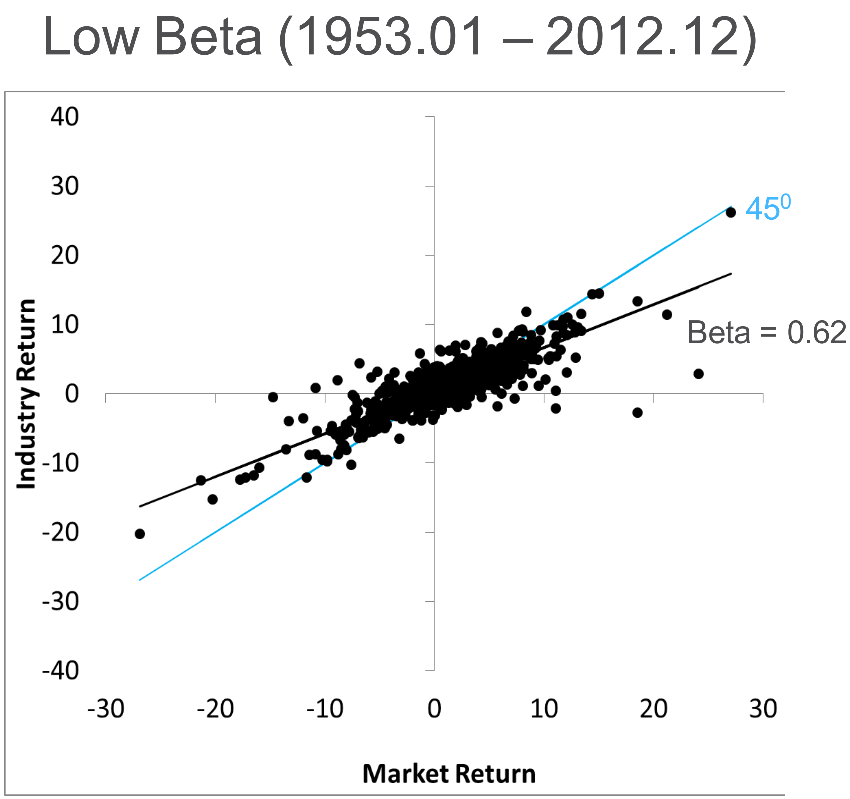
Source: BlackRock

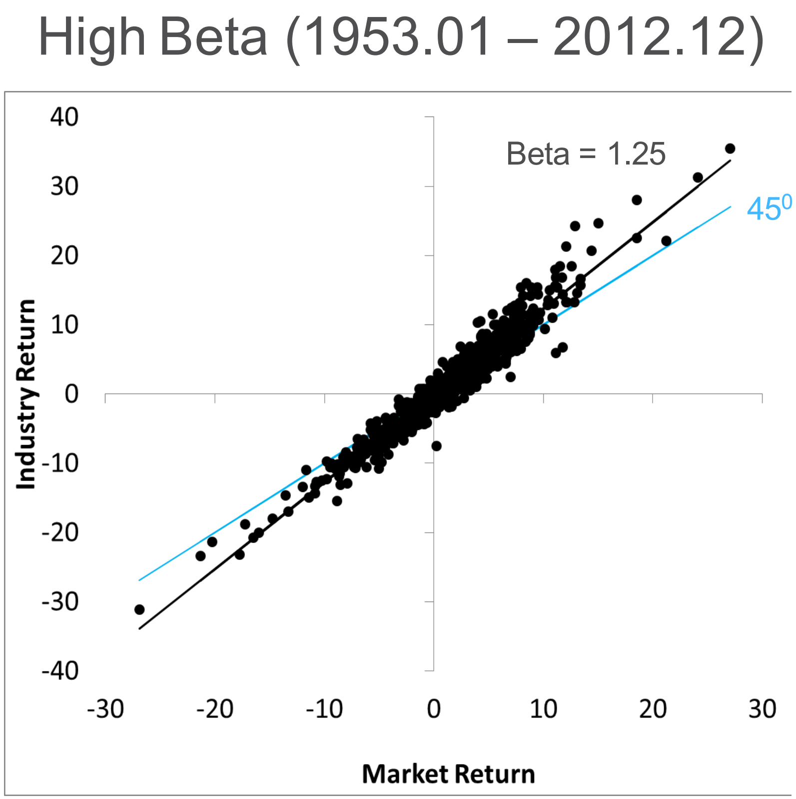
High Beta (HOB) and Low Beta (LOB) Portfolios

	All		1953 - 1980		1980 - 2012	
	HIB	LOB	HIB	LOB	HIB	LOB
Arithmetic Mean	0.69	0.69	0.69	0.55	0.69	0.80
Geometric Mean	0.51	0.62	0.55	0.49	0.48	0.72
Median	1.08	0.87	0.97	0.64	1.20	0.96
Standard Deviation	5.86	3.63	5.32	3.38	6.27	3.83

Source: BlackRock

LOB and HOB - Full Sample Regression

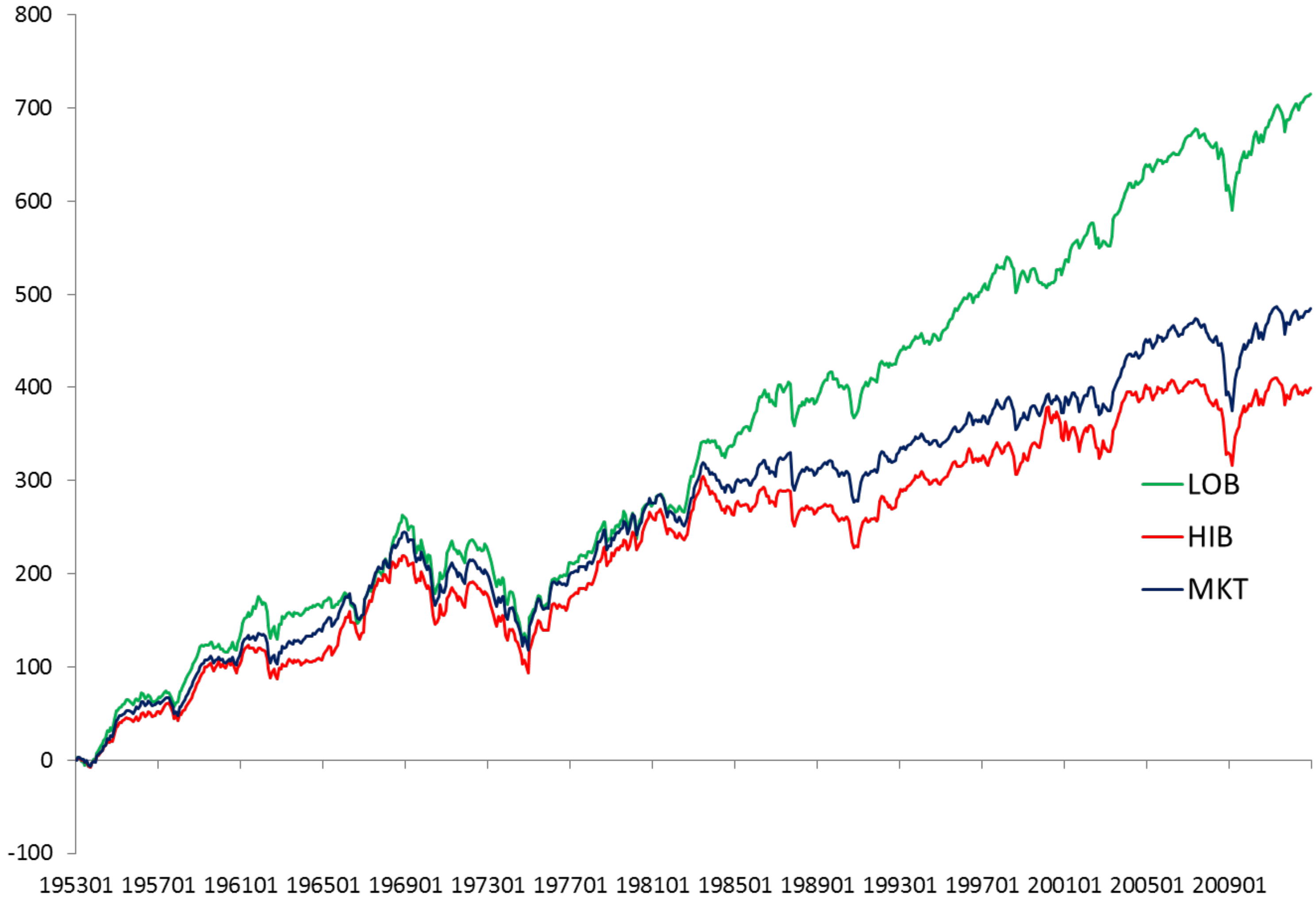




Source: BlackRock

BlackRock®

HIB and LOB – Cumulative Returns – Unit Beta

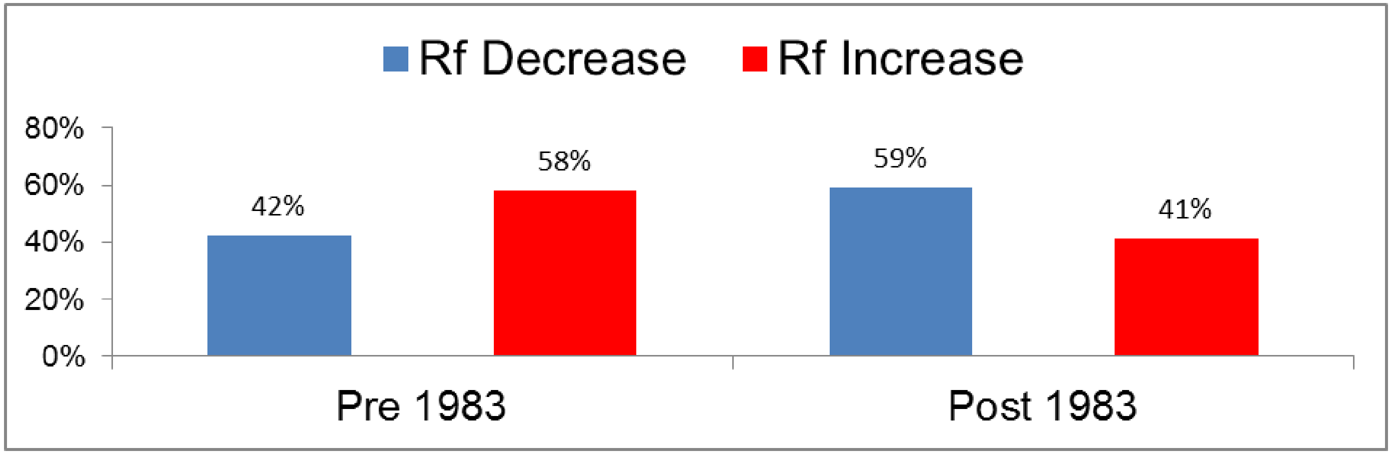


Source: BlackRock

US Bond Yields: 10 Year Treasuries 1953 - 2012

Source: BlackRock / Bloomberg

HOB and LOB – Returns Conditional on Interest Rate Change



	Δrf(Δrf>0)	Δrf(Δrf<0)	HIB(Δrf>0)	HIB(Δrf<0)	LOB(Δrf>0)	LOB(Δrf<0)
Arithmetic Mean	0.016	-0.016	0.568	0.803	0.003	1.354
Standard Deviation	0.016	0.018	5.891	5.829	3.514	3.630
Skewness	2.504	-3.224	-0.592	-0.340	-0.533	0.021
Kurtosis	10.903	15.475	3.407	0.880	1.384	1.259

- The lower panel demonstrates a strong relationship between the sign of interest rate changes and the behaviour of the LOB portfolio in particular

Source: BlackRock

CAPM and Interest Augmented CAPM

- Sharpe's market model: $r_t = \alpha + \beta r_m + v_t$
- Augmented for interest rates: $r_t = \alpha + \beta r_{m,t} + \gamma \Delta r_{f,t} + v_t$
- If the coefficient γ is statistically significantly different from zero, interest rate changes affect our portfolio returns
- We expect that there are substantial differences in interest rate sensitivity for high and low beta portfolios
- We also check whether a different interest rate regime exists pre and post 1983, estimating the relationship: $r_t = \alpha + \beta r_{m,t} + \theta {i_t}^{1983} + v_t$
- Here, θ tests the existing of a regime of this form

CAPM and Interest Augmented CAPM

- Sharpe's market model: $r_t = \alpha + \beta r_m + v_t$

	α	t(α)	β	t(β)	R2
HIB	-0.007	-0.102	1.274	81.138	0.902
LOB	0.307	4.096	0.696	40.857	0.699

- Augmented for interest rates: $r_t = \alpha + \beta r_{m,t} + \gamma \Delta r_{f,t} + v_t$

	α	t(α)	β	t(β)	γ	t(γ)	R2
HIB	-0.011	-0.154	1.282	81.324	10.740	3.569	0.903
LOB	0.313	4.254	0.681	40.267	-17.585	-5.448	0.711

Source: BlackRock

CAPM and Interest rate Augmented CAPM

- The interest rate augmented CAPM result confirms the powerful influence of interest rates on the performance of HIB and LOB
- The γ coefficients are highly significant, and show a positive relationship between interest rate change and the return to HIB, and a negative relationship between interest rate change and LOB
- Thus, as anticipated, LOB performs well as interest rates fall
- However, the introduction of the interest rate change has little or no impact on the alphas of LOB and HIB
- Crucially it remains the case that the LOB has a highly significant positive alpha

Structural break at 1983

- We also check whether a different interest rate regime exists pre and post 1983, estimating the relationship: $r_t = \alpha + \beta r_{m,t} + \theta {i_t}^{1983} + v_t$
- Here, i_t is 1 prior to 1983 and zero thereafter

	α	t(α)	β	t(β)	θ	t(θ)	R2
HIB	-0.061	-0.612	1.273	80.863	0.113	0.792	0.903
LOB	0.404	3.911	0.702	40.982	-0.201	-1.332	0.711

- As anticipated the returns to low (and high) beta are higher (and lower) after 1983, consistent with a structural break, but the result is not statistically significant

Source: BlackRock

Interest rate sign changes and switch points

- The CAPM is a one period model, sign and persistence of interest changes may be more important than magnitude for expectations
- We therefore fit a model using interest rate sign changes:

$$r_t = \alpha_1 i_t + \alpha_2(1 - i_t) + (\beta_1 + \beta_2(1 - i_t))r_{m,t} + v_t$$

- Where

$$i_t = \begin{cases} 1 \ if \ \Delta r_{f,t} > 0 \\ 0 \ if \ \Delta r_{f,y} < 0 \end{cases}$$

- We check for an estimated reference point for the interest change break point using a grid search around the likelihood function and bootstrapping the standard errors

‘Double Alpha’ Model: Alpha is interest rate change sign dependent

- ‘Double alpha’ model, where alpha depends on interest rate sign change:

$$r_t = \alpha_1 i_t + \alpha_2 (1 - i_t) + \beta r_{m,t} + v_t$$

- Where

$$i_t = \begin{cases} 1 \; if \; \Delta r_{f,t} > 0 \\ 0 \; if \; \Delta r_{f,y} < 0 \end{cases}$$

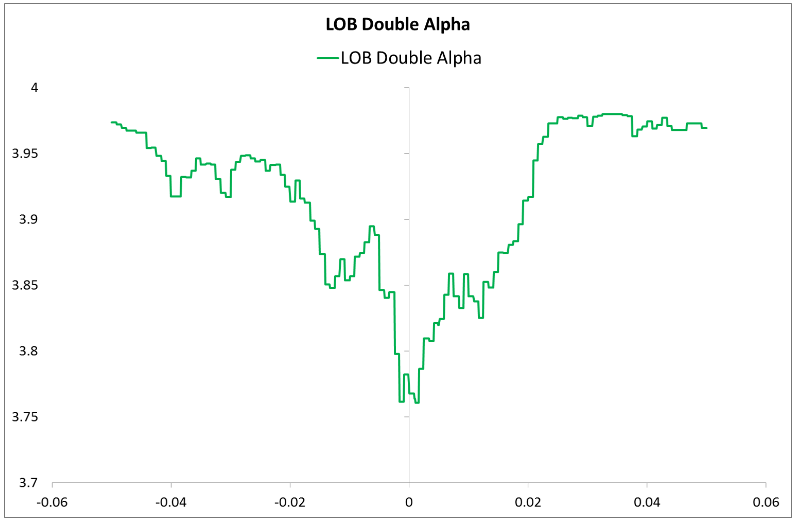
	α1	t(α1)	α2	t(α2)	β	t(β)	R2
HIB	0.269	2.789	-0.282	-2.928	1.278	82.087	0.904
LOB	-0.159	-1.540	0.770	7.496	0.688	41.424	0.716

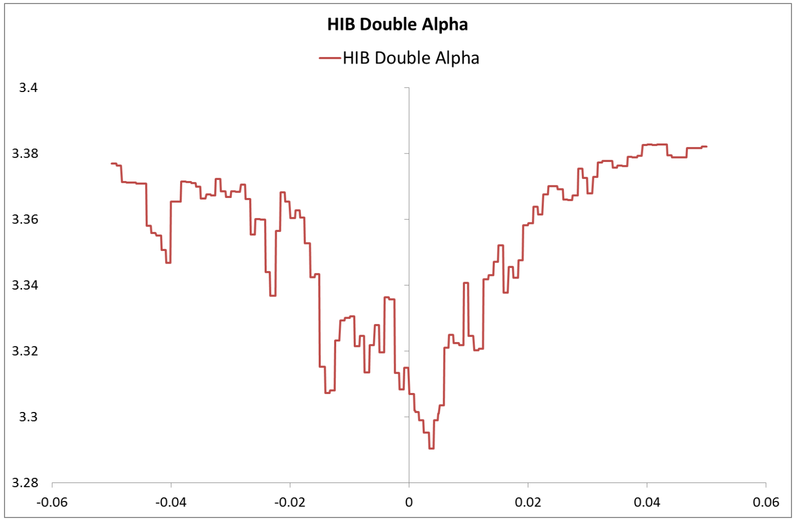
- In months where the interest sign change is negative LOB beats HIB by an annualised 12.6%. When the sign change is negative HIB beats LOB by an annualised 5.1%.
- HIB is roughly symmetric in interest rate change. LOB is highly asymmetric.

Source: BlackRock

Threshold Estimation ("Switch Point") of Sign Changes

- We check for the robustness of the model by estimating the threshold or 'switch point' for the rate sign change variable
- We run a grid search along the likelihood function of the model, and bootstrap the standard errors to estimate the minimum point

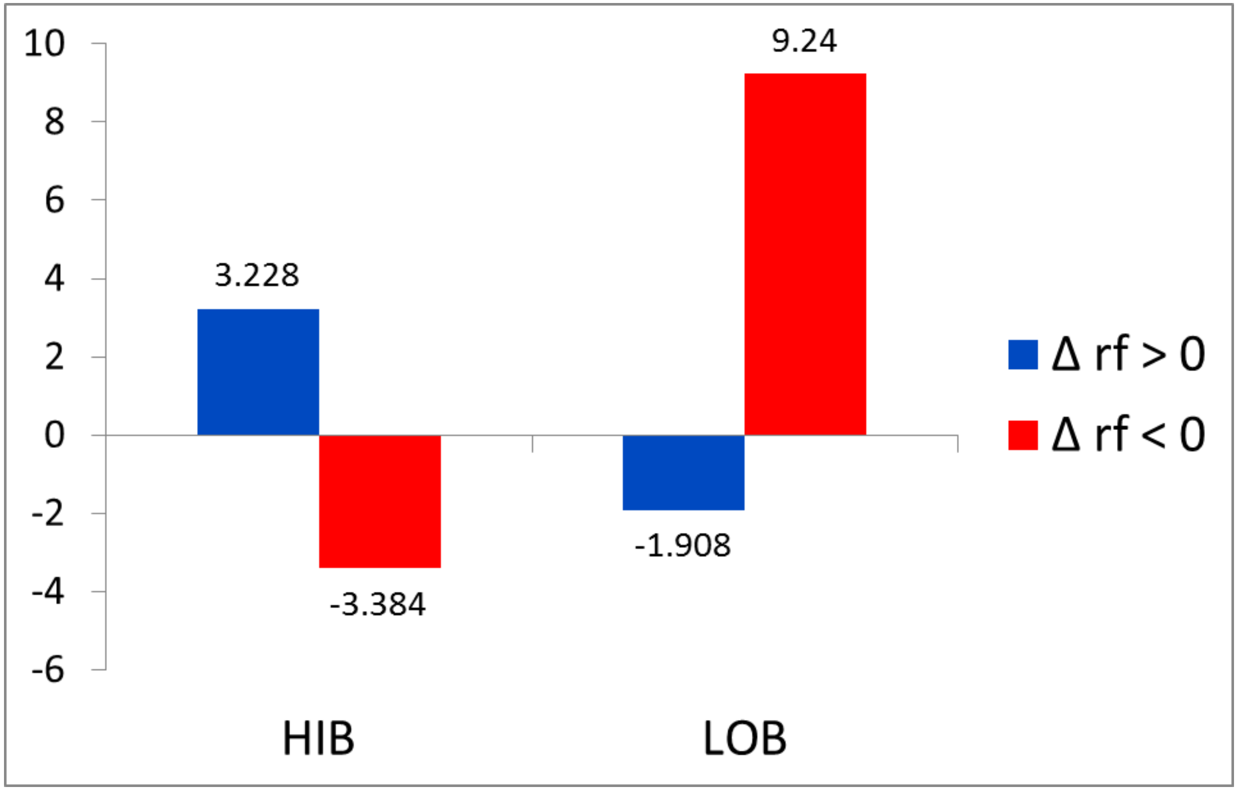




- We find that the zero reference point is accurate – model fit is maximised at a rate change threshold value of zero (ie as predicted by the theory)

Source: BlackRock

Rate Change Sign Dependency, and Asymmetry in LOB and HIB



- In months where the interest sign change is negative LOB beats HIB by an annualised 12.6%. When the sign change is negative HIB beats LOB by an annualised 5.1%.
- HIB is roughly symmetric in interest rate change. LOB is highly asymmetric.

Source: BlackRock

‘Double Alpha’ ‘Double Beta’ Model

- ‘Double Alpha’ ‘Double Beta’ Model where alpha and beta depend on sign of interest rate change:

$$r_t = \alpha_1 i_t + \alpha_2(1 - i_t) + (\beta_1 + \beta_2(1 - i_t))r_{m,t} + v_t$$

- Where

$$i_t = \begin{cases} 1\ if\ \Delta r_{f,t} > 0 \\ 0\ if\ \Delta r_{f,y} < 0 \end{cases}$$

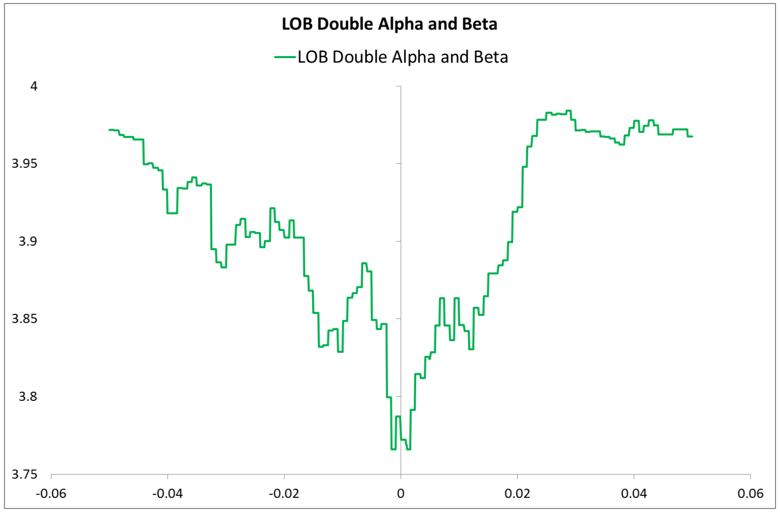
	α1	t(α1-α2)	α2	t(α2)	β1	t(β1-β2)	β2	t(β2)
HIB	0.275	3.997	-0.270	-2.852	1.284	0.347	1.273	57.730
LOB	-0.157	-6.402	0.766	7.381	0.683	-0.297	0.693	29.466

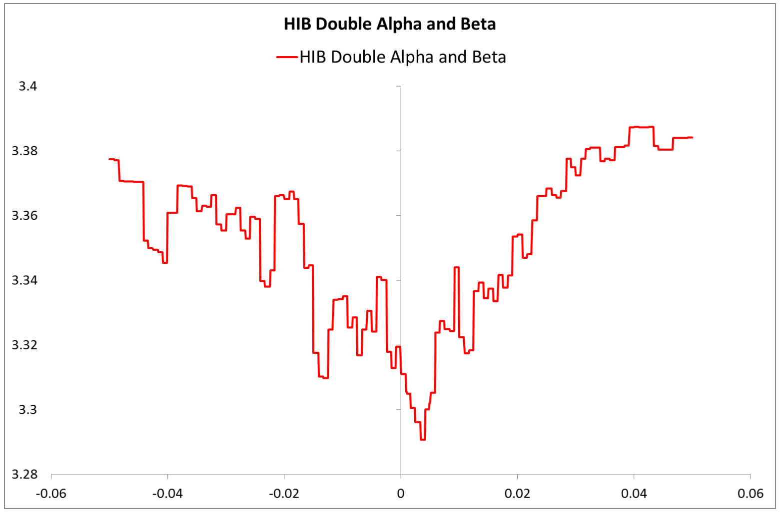
- The use of the interest rate variable has no relevance for the beta estimation

Source: BlackRock

Threshold Estimation ("Switch Point") of Sign Changes

- Again we check for the robustness of the model by estimating the threshold or 'switch point' for the rate sign change variable in the vase of double alpha and beta
- We run a grid search along the likelihood function of the model, and bootstrap the standard errors to estimate the minimum point





- We find that the zero reference point is accurate – model fit is maximised at a rate change threshold value of zero (ie as predicted by the theory)

Source: BlackRock

Comparing & cap and equal weights

- Here we compare equal and cap weight results for the full sample (1953 – 2012)
- The use of equal weights does not change our conclusiuons
- Interest rate augmented CAPM:

	a	t(a)	b	t(b)	c	t(c)	R2
HIB=	-0.13605	-2.28914	1.209777	114.5464	0.681985	3.173825	0.948325
HIBCW	-0.01062	-0.15504	1.282464	81.32223	0.894818	3.56835	0.903375
LOB=	0.24897	4.545665	0.697217	71.63194	-2.18922	-11.0551	0.883102
LOBCW	0.312578	4.25552	0.681154	40.26793	-1.46553	-5.4485	0.711207

- For the double alpha mode in full sample the conclusions are also the same:

	a1	t(a1)	a2	t(a2)	b	t(b)	R2
LOB==	-0.27781	-3.50772	0.758292	9.675916	0.704778	71.07586	0.882591
LOB=	0.063486	0.543273	0.692954	5.951882	0.823881	43.73883	0.742425
LOBCW	-0.16286	-1.57938	0.769903	7.494323	0.688387	41.4173	0.72552
HIB==	0.085309	1.01685	-0.34627	-4.17119	1.207661	114.9735	0.949434
HIB=	0.693696	3.327904	-0.37328	-1.7974	1.311706	39.03935	0.685442
HIBCW	0.270429	2.798058	-0.28168	-2.92535	1.27793	82.03045	0.905178

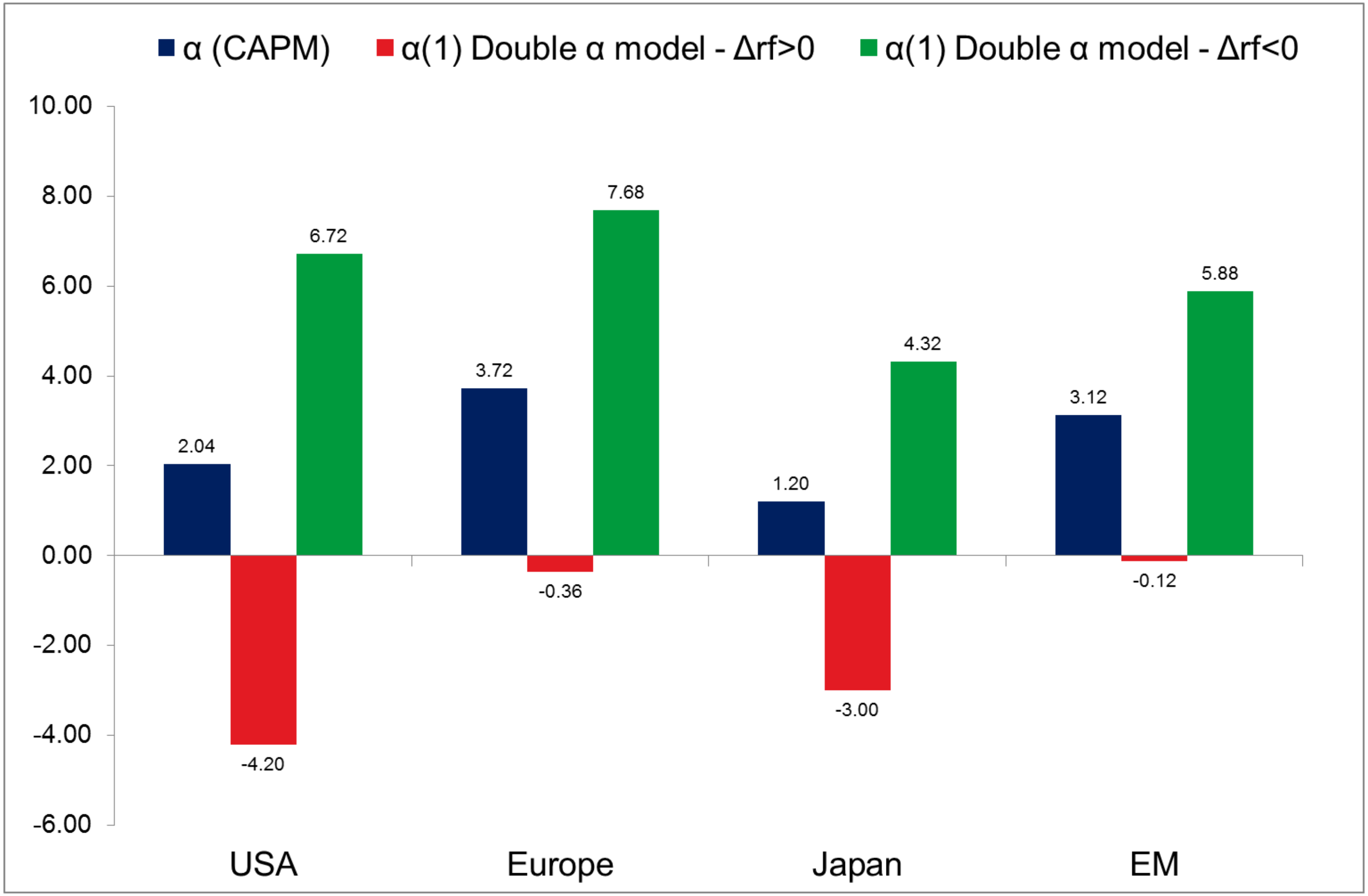
- Her CW denotes cap weight, == denotes equally weighted regressed on = weighted market, = denotes equal weight regressed on cap weighted market

Minimum volatility portfolios: 1988 – 2013

	α	t(α)	α1	t(α1)	α2	t(α2)	β	t(β)
MSCI Japan min vol - CAPM	0.10	1.18					0.77	-15.24
MSCI Japan min vol - Double Alpha			-0.25	-1.96	0.36	3.30	0.77	-15.30
MSCI Europe min vol - CAPM	0.31	2.74					0.67	-12.46
MSCI Europe min vol - Double Alpha			-0.03	-0.17	0.64	4.06	0.67	-12.48
MSCI USA min vol - CAPM	0.17	2.31					0.71	-17.36
MSCI USA min vol - Double Alpha			-0.35	-3.30	0.56	6.10	0.72	-18.00
MSCI EM min vol - CAPM	0.26	2.26					0.74	-16.15
MSCI EM min vol - Double Alpha			-0.01	-0.06	0.49	3.21	0.74	-16.09

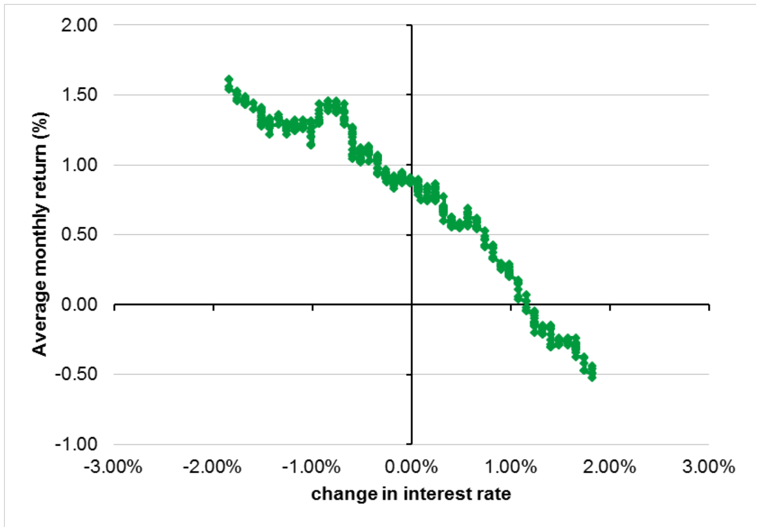
Source: MSCI / BlackRock

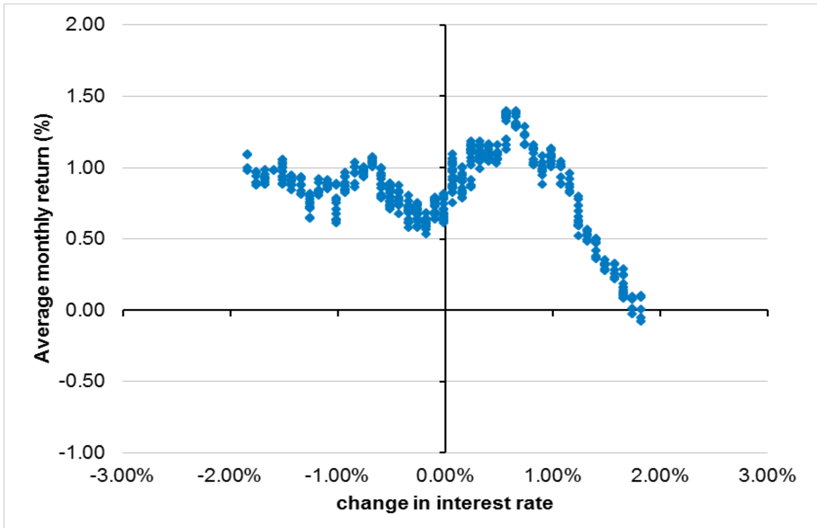
Minimum Volatility Indexes – annualised alphas 1988 - 2013



Source: BlackRock

LOB, HOB and rate changes, 1953 - 2013





- The relationship between LOB and rate change over the full sample is strongly linear
- The relationship between HIB and rate change exhibits strong non-linearity

Source: BlackRock

Some Conclusions

- We suspect that there may be several reasons why low beta portfolios have performed well
- As predicted by theory, interest rate changes appear to have a significant impact on the returns to the HIB and LOB portfolios, which is confirmed on other portfolios
- We show that there is a double alpha effect for both portfolios using a sign change specification of interest rates
- Alpha is positive (negative) for high (low) beta portfolios when interest rates increase and vice versa. The results are statistically significant in most cases
- All of the interest rate impact occurs only in the domain of alpha, the betas estimates being remarkably stable across all model specifications
- Exogenous macro factors causing out of equilibrium movements thus seem to drive much of the anomaly, and explain in part the returns to low beta
- A number of questions seem worthwhile in terms of further analysis, among them:
  - The asymmetric return pattern for LOB in contrast to the symmetry of HIB
  - The role of real versus nominal interest rates
  - The calibration of the interest rate effect
  - The non-linearity exhibited by HIB in contrast to the linearity of LOB in interest rate change
- Nonetheless, the analysis suggests that the prospective interest rate environment might play an important role in the determination of low beta returns

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