

Market-Beta and Downside Risk

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Oct 2018

Seawell Boardroom (B400), Bass Center, 655 Knight Way, Stanford, CA, 8:00am

Our paper has three connected parts:

1. All-days market-beta is a good measure of stocks' hedging aspects for bear and crash markets.
2. A strong critique of downside beta in equities
(Ang-Chen-Xing (2006), > 200 WoS > 800 Google)
 - ▶ Critique = Perspective. All results are replicable.
 - ▶ Definition: Down-beta is on days when $R_M < 0$.
3. A mild critique of downside beta in asset classes
(Lettau-Maggiore-Weber (2014)).

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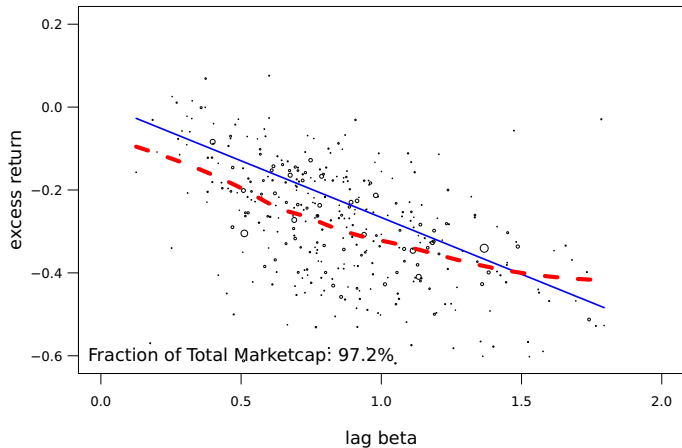
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Part 1: Plain Beta As Hedge Metric

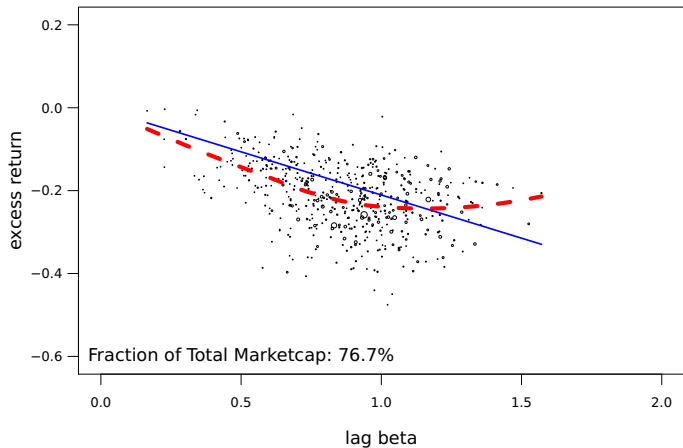
- ▶ Lots of detail (in the paper).
 - ▶ Daily-return “all-days” betas. OLS and/or others.
- ▶ Result: Plain=all-days beta is a good exposure measure also for down and crash markets.
- ▶ Will just show you the 3 extreme periods.
 - ▶ Betas are estimated ex-ante (all-days)
 - ▶ Market performance is realized in-time.
 - ▶ Select= Crash. Stocks. X-Axis is beta. Y-axis is returns.

1929: Oct 28, Oct 29, Nov 06

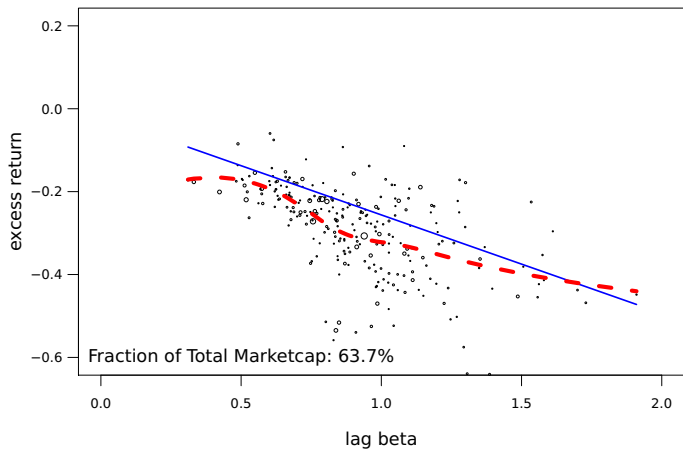


Blue = ex-ante OLS beta predicted slope
Red = loess realized smoothed fit ex-ante

1987: Oct 16, Oct 19



2008: Oct 7, 9, 15 + Dec 1



Part 2: Down-beta in Equities

- ▶ Can we improve (down-market) hedging?
- ▶ Estimate beta only on market **down**-days: $\hat{\beta}_y^-$
 - ▶ Estimate beta on market **up**-days $\hat{\beta}_y^+$, too.
- ▶ **Is down-beta the relevant risk measure?**
 - ▶ Roy (1952), Markowitz (1959), etc.
- ▶ Is there a premium for down-beta bearing?
- ▶ **Most Prominent: Ang-Chen-Xing (2006)**

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ACX Innovations

- ▶ Earlier tests used monthly betas and formed portfolios that destroyed variation in \hat{b}_y^- .
 - ▶ E.g., they may have sorted on \hat{b}_y .
 - ▶ it is better to work with individual stocks.
- ▶ ACX sometimes use set of low-volatility stocks.
 - ▶ LV = Low-Volatility.
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ACX Synopsis

1. Down-betas can forecast future down-betas.
2. Simultaneous Down-Beta Return Association.
 - ▶ The realized down-beta correlates strongly with **contemporaneous** average returns.
 - ▶ And this is also **not** mechanical. ✓
3. Some Down-Beta Future Return Evidence.
 - ▶ Down-betas can also predict quintile pfo returns.
 - ▶ (Plain, BkMkt+Sz+UMD adjusted)
4. Some significance in GMM on 25 FF pfios.

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Still Relevant?

- ▶ ACX remains highly influential.
 - ▶ >200 Web of Science, >800 Google Scholar
 - ▶ Influence is not declining.
 - ▶ Will become “home run” paper.

- ▶ We critique ACX’s inference, **but**
 - ▶ All ACX results are replicable.
 - ▶ There are no mistakes.
 - ▶ Our paper “only” revisits interpretation of evidence.

Descriptive Statistics

Low-Volatility (LV) Subsample:

		Mean	Sd	#days
All-days-Beta	\hat{b}_y	0.67	0.54	253
Down-Beta	\hat{b}_y^-	0.72	0.62	116
Up-Beta	\hat{b}_y^+	0.61	0.64	132
Abs(Down – Up )	$|\hat{b}_y^- - \hat{b}_y^+|$	0.40	0.43	

Calendar Year Betas. 240k firm-years. LV 1927-2016.

1. Down-betas can forecast future down-betas

- ▶ Of course, we all agree that investors care not about past but about future down-beta.
- ▶ ACXT7: down-beta can predict future down-beta:

$$\hat{b}_y^- \approx 0.56 \cdot \hat{b}_{y-1}^- + c + e, \quad R^2 \approx 30\%$$

ACXT7 is basically right!

$N \approx 240k$. i subscripts on \hat{b}_y^- and e . Panel or FM. se is tiny. estimates.

- ▶ But if you care about \hat{b}_y^- , can you do better?
- ▶ All-days beta \hat{b}_{y-1} always has about twice as many days for estimation as down-beta \hat{b}_{y-1}^- ,
- ▶ ...and it has more X-axis support,
- ▶ ...but if \hat{b}_y^- (process) is truly different, down-beta could predict itself better,
- ▶ ...or not.
- ▶ **Empirically easy to investigate.**
 - ▶ Not shown: our conclusions are **very** robust.

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- ▶ ACX: Predict \hat{b}_y^- with lagged down-beta:

$$\hat{b}_y^- \approx 0.56 \cdot \hat{b}_{y-1}^- + c + e, \quad R^2 \approx 30\%$$

- ▶ LW: Predict \hat{b}_y^- with lagged all-days betas:

$$\hat{b}_y^- \approx 0.72 \cdot \hat{b}_{y-1}^- + c + e \quad R^2 \approx 40\%$$

$$\hat{b}_y^- \approx 0.74 \cdot \hat{b}_{y-1}^-$$

$$-0.07 \cdot \hat{b}_{y-1}^+ + 0.05 \cdot \hat{b}_{y-1}^- + c + e \quad R^2 \approx 40\%$$

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▶ **If you care about the future down-beta, then forecast it with all-days beta, not with itself.**

▶ Or shrink \hat{b}_{y-1}^- away to almost nada.

▶ ...because

$$(\Delta_y \equiv) \hat{b}_y^- - \hat{b}_y^+ \approx c + 0.087 \cdot (\hat{b}_{y-1}^- - \hat{b}_{y-1}^+)$$

Most Δ_y is just estimation noise.

(PS: It is this noisy realized betas that is also the one used in ACX part 1. It must have huge EIV. (Not shown:) some is even harder-to-estimate time-variation in Δ .)

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Above was down-beta prediction.

Below is stock-return explanation/prediction.

2. Simultan Down-Beta vs Return

Philosophical Points, Ex-Post Ω

- ▶ First half of ACX uses ex-post simultaneous down-betas to explain rates of return.
- ▶ It is defensible that representative investors know stocks' **true** down-betas better than us.
 - ▶ But must be very smart aggregators for pricing!
- ▶ But it seems implausible that they know the **realized** down-betas (from the very same returns being predicted!), and/or any other single year.
 - ▶ At least, use many years [-4 to +4 = no results].

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ACX T2: Fama-Macbeth, Simul Realized

$$r_{yi} = \gamma_0 + \gamma_1 \cdot \hat{b}_{yi}^- + \gamma_2 \cdot \hat{b}_{yi}^+ + \dots$$

Beta	ACX RFS Simultans	Replic \hat{b}_y
\hat{b}^- (T)	0.062 (+6.0)	0.088 (+6.1)
\hat{b}^+ (T)	0.020 +2.3	0.002 +0.2
Sample	ACX 1963-2001	ACX

(Strong positive for \hat{b}^- only if betas are estimated simultaneous (or one future year). \hat{b}^- is not positive in longer windows around returns. Not shown, 90% of power is from all-days beta, too. Controls were included, but are not reported. About 500k obs/2.2m obs.)

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Beta	ACX RFS Simultans	Replic \hat{b}_y	Ex-Ante \hat{b}_{y-1}
\hat{b}^-	0.062	0.088	-0.009
(T)	(+6.0)	(+6.1)	(-1.6)
\hat{b}^+	0.020	0.002	-0.005
(T)	+2.3	+0.2	(-0.8)
Sample	ACX 1963-2001	ACX	ACX 1963-01

(Strong positive for \hat{b}^- only if betas are estimated simultaneous (or one future year). \hat{b}^- is not positive in longer windows around returns. Not shown, 90% of power is from all-days beta, too. Controls were included, but are not reported. About 500k obs/2.2m obs.)

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$$r_{yi} = \gamma_0 + \gamma_1 \cdot \hat{b}_{yi}^- + \gamma_2 \cdot \hat{b}_{yi}^+ + \dots$$

Beta	ACX RFS Simultans	Replic \hat{b}_y	Ex-Ante \hat{b}_{y-1}	
\hat{b}^-	0.062	0.088	-0.009	-0.022
(T)	(+6.0)	(+6.1)	(-1.6)	(-3.5)
\hat{b}^+	0.020	0.002	-0.005	-0.020
(T)	+2.3	+0.2	(-0.8)	(-3.6)
Sample	ACX 1963-2001	ACX	ACX 1963-01	Extd 1927-16

(Strong positive for \hat{b}^- only if betas are estimated simultaneous (or one future year). \hat{b}^- is not positive in longer windows around returns. Not shown, 90% of power is from all-days beta, too. Controls were included, but are not reported. About 500k obs/2.2m obs.)

Fama-Macbeth Gammas on

- ▶ 63-01: **Realized** down-betas $\hat{b}_y^- \xrightarrow{+}$ returns. (0.08)
- ▶ 63-01: “Placebo”
Ex-post (**plain**) betas $\hat{b}_y^+ \xrightarrow{+}$ returns. (0.18)
- ▶ 63-01: Ex-post competing effect:
 $\hat{b}_y = 0.21^{***}$ $\hat{b}_y^- = \mathbf{0.03}^{**}$ $\hat{b}_y^+ \approx -0.04$
- ▶ 63-01: **Ex-ante** any betas: $\xrightarrow{-}$ returns.
- ▶ 63-01: **Windowed 4yr** betas: $\xrightarrow{-}$ returns.
- ▶ **1963-2016**: \approx 63-01.

Defend Ex-Post Realized Beta?

- ▶ Fama: all AP tests are eqbm model and Ω .
- ▶ Judgment call: ex-post info seems better in IV regressions, agent-specific consumption, etc.
- ▶ Ex-post info could resolve many pricing mysteries.
- ▶ Most important, FM all-days beta \rightarrow stock returns:

with	<u>FM Gamma</u>	<u>(T-stat)</u>
... Ex-Ante Betas	-0.3%/year	(-0.22)
... Contemp Betas	+8.4%/year	(+3.84)

and 8.4% is even underestimated due to EIV. See original FM multi-sort, etc.

Above was ACX ex-post
down-beta evidence ($\overline{ACX}T2$ $\overline{ACX}T5$).

Below is ACX ex-ante
down-beta evidence ($\overline{ACX}T8$ $\overline{ACX}T10$).

... and GMM ($\overline{ACX}T6$)

3. Down-Beta Future Return Evidence

ACX Specification:

- ▶ Quintile test portfolios based on down-betas.
 - ▶ Short: Downbeta ≈ 0.2 .
 - ▶ Long: Downbeta ≈ 1.9 .
- ▶ Zero-Investment Portfolio Tests
 - ▶ Jensen-Black-Scholes (1972), Fama-French (1993).
- ▶ non-LV and LV sets.

ACX Tables 8-10

Lagged beta predicts future monthly stock returns:

	(not reported) \hat{b}_{y-1}^-	0.19	1.89	
	(not reported) \hat{b}_y^-	0.60	1.38	
	Quintile: Low \hat{b}_{y-1}^-	High \hat{b}_{y-1}^-		ΔT -stat
T8: Net of Risk-free	+0.6%	+0.7%		(0.6)
T9: LV Net of Rf	+0.6%	+0.9%		(2.3)
T10: LV Size/B-M Adj	-0.3%	+0.2%		(3.3)

(LV= Low Vltty. EW Quintiles. Excess= TB. 1963-2001)

Our Near Replication

\hat{b}_{y-1}^- -Spread Zero Pfiio. Time-Series Regs. %/mo.

	$\overset{ACX}{T}8$	$\overset{ACX}{T}9$	$\overset{ACX}{T}10$
ACX Alpha	0.11	0.23	0.44
(ACX T-stat)	(0.60)	(2.31)	(3.36)
			SMB
			HML
Sample:	All	LV	LV
Replication	0.11	0.30	0.50
(T-stat)	(0.60)	(1.85)	(3.37)

(Small differences in LV classification and SMB/HML adjustments.)

Placebo—Plain “All-Days” Beta

\hat{b}_y^- -Spread Zero Pfi. Time-Series Regs. %/mo.

Similar to:	T_8	T_9	T_{10}
ACX Alpha	.....	n/a	.....
(ACX T-stat)	.....	n/a	.....
			SMB
			HML
Sample		LV	LV
LW Alpha	0.03	0.20	0.45
(T-stat)	(0.15)	(1.08)	(2.63)

Placebo is a little worse, but really quite similar!

So, what, if anything, is wrong here?

Average XMKT/mo in ACX sample: 0.54%/mo:

$$\Rightarrow \hat{b}_y \cdot \text{XMKT} \approx 0.77 \cdot 0.54\% \approx 0.42\%/\text{mo}$$

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Time-Series (FF) Regs, \hat{b}_{y-1}^- -Sort

	ACX T8	ACX T9	ACX T10	N/A
ACX Alpha	0.11	0.23	0.44	n/a
(T-stat)	(0.60)	(2.31)	(3.36)	n/a
				XMKT
			SMB	SMB
			HML	HML
Sample		LV	LV	LV
LW Alpha	0.11	0.30	0.50	0.04
T-stat	(0.60)	(1.85)	(3.37)	(0.31)

Is Exposure Alpha?

- ▶ Go long stocks with high X exposure
Go short stocks with low X exposure
 - ▶ X can be a zero-investment currency pfio, or commodity pfio, or whatever.
- ▶ Look at a sample period in which $\bar{X} \gg 0$.
- ⇒ Portfolio should have pos avg rates of return.
- ▶ Average statement (not tautology).
- ▶ ACX looked at high-(down-)beta portfolios in a time of good stock-market performance.

Does FM Slope Imply FF Alpha?

- ▶ The 1-Factor CAPM model gives a prescription for how much p_{ffio} should have gone up.
 - ▶ FM Slope=Necessary, but not sufficient for FF Alpha.
- ▶ **In ACX, high-(down) beta p_{ffios} had higher rates of return only w/o XMKT control.**
- ▶ High-beta stocks ↑ more when/because market ↑.
- ▶ ...as they should have, given that they had positive exposures and the market went up,
- ▶ ...but high (down-)beta stocks did not even go up enough to “break even” in a “positive alpha” way.

What About Ex-Post Downbeta?

(ACX Fama-Macbeth Focus. Needed for Strong Positive.)

- ▶ We already know:
 - ▶ Down-betas \approx Plain all-days betas.
 - ▶ From 1963-01, $\hat{b}_y \xrightarrow{+} r$ was good.
 - ▶ **Marginal** FM $\hat{b}_y^- \rightarrow r$ was small 0.03.
 - ▶ Downbeta should be a little more positive in FF regs.
- ▶ So, was the marginal **realized simultaneous (ex-post)** \hat{b}_y^- predicted return even strong enough just to meet the 1-factor benchmark?

What About **Ex-Post** Downbeta?

	$\overset{ACX}{T}8$	$\overset{ACX}{T}9$	$\overset{ACX}{T}10$	N/A
ACX Alpha		.....n/a	.....
(T-stat)		.....n/a	.....
			SMB	XMKT SMB
			HML	HML
Sample		LV	LV	LV
LW Alpha	0.14	0.25	0.45	-0.89
T-stat	(0.63)	(1.33)	(2.67)	(-0.78)

FM Reassessment

- ▶ Yes, there was a positive FM association between **ex-post** down-betas and rates of return;
- ▶ ...but it was not enough merely to beat the 1-factor target benchmark.

But it's 2016 now. What is the best inference today?

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And in 2016? (Ex-ante \hat{b}_y^-)

Spec	$\overset{ACX}{T}8$	$\overset{ACX}{T}9$	$\overset{ACX}{T}10$	N/A
ACX Alpha (T-stat)				
			SMB HML	XMKT SMB HML
Sample		LV	LV	LV
LW Alpha T-stat	-0.28 (-1.32)	-0.02 (-0.11)	-0.02 (-0.12)	-0.44 (-4.27)

Time-Series (FF) Regs, \hat{b}_{y-1}^-

From 1963–2016:

- ▶ Higher \hat{b}_{y-1}^- stocks did not even have higher average rates of return;
- ▶ ...but XMKT continued to be very positive;
- ▶ ...thus 1-F alpha of \hat{b}_{y-1}^- was not just not positive, it was negative;
- ▶ ...just as it is for \hat{b}_{y-1} in Frazzini-Pedersen.

Did Down-Beta \hat{b}^- Give Pos Alpha?

Relative to what?

▶ Risk-Neutral Model?

A: Yes, as of 2001.

A: No, as of 2016.

▶ CAPM? A: Never.

▶ Fama-French 3F Model? A: Never.

▶ (Fama-French 5F+UMD Model? A: Never.)

▶ down-beta roughly similar to plain beta, never offering extra.

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▶ CAPM? A: Never.

▶ Fama-French 3F Model? A: Never.

▶ (Fama-French 5F+UMD Model? A: Never.)

▶ down-beta roughly similar to plain beta, never offering extra.

Important Warning

- ▶ To test a beta-risk-reward argument,
- ▶ do not form zero-investment test portfolio on the basis of difference of

$$\hat{b}_y^- - \hat{b}_y$$

- ▶ ...unless you want to learn whether \hat{b}_y^- has a less negative relation with future stock returns than \hat{b}_y !
- ▶ ...which would be sort of silly as an AP test whether investors need comp for (down-)beta risk
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4. GMM on 25 FF pfios (ACX T6)

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- ▶ Down-beta helps explain 25 FF portfolio returns.
 - ▶ remarkable, given motivation about pfio info destruction.
- ▶ ...but with the wrong sign ?!?

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T6 Spec II	1.35	-17.73	22.84
$E(l(x) \cdot r) = 0$	[8.70]	[3.03]	[2.16]

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We need to learn about down-beta, not win an argument.

We need to learn what we have missed.

We could not get a hold of ACX, so apologies for not considering and investigating more counterarguments.

Hopefully, we will soon improve paper with Andrew's comments. We want to end up with a better synthesis than his thesis and our antithesis.

...and of course, the **Critical Finance Review** is very interested in this kind of exchange between critique and authors.

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Part 3: Down-Beta in Asset Classes

- ▶ Lettau-Maggiore-Weber (2014).
- ▶ Uses **full-sample** betas, not realized betas.
- ▶ Like every paper, makes some choices. All ok.
- ▶ Common misconception, already nicely noted in LMW: Currencies are mostly just completely unrelated investments...like cash.

Ex-Ante vs Full-Window Betas

- ▶ Full-Window betas may be better than ex-ante,
- ▶ ...esp because we have low power on down-market classification.
- ▶ **Ex-Ante** Down-Beta Inference in FM:
 - ▶ some results become weaker (a few become stronger).
 - ▶ LMW's results do not generally reverse, unlike ACX's.(sovereign bonds may become more interesting with more data.)

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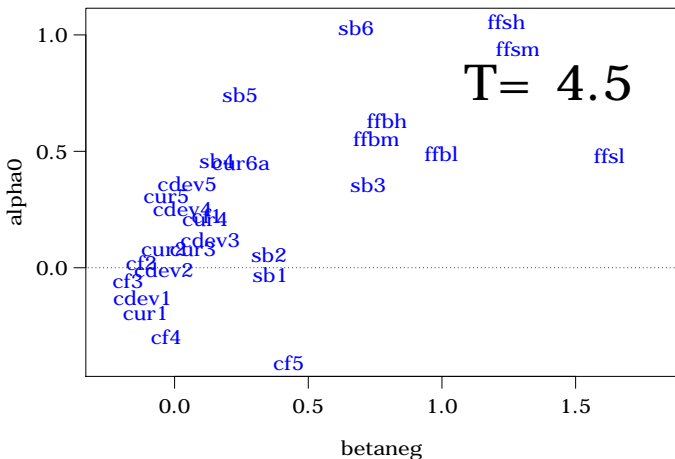
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Can CAPM or FFM explain Alphas?

Is Downbeta helpful?

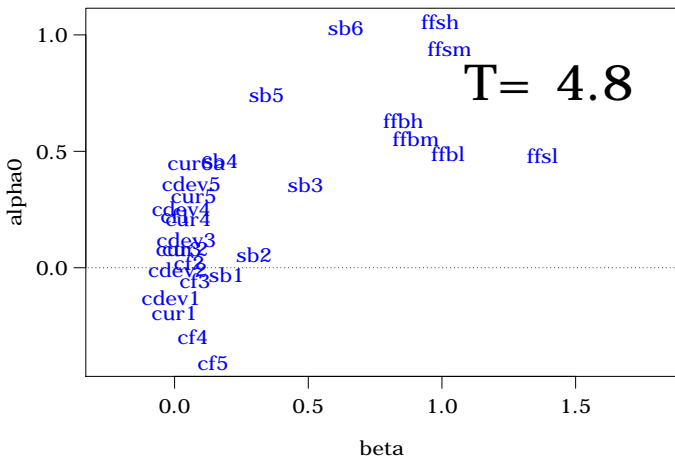
	Down- -Beta	All-Days Beta	Diff- erence
Rf	$\hat{b}^- \rightarrow \alpha_{0F}$	$\hat{b} \rightarrow \alpha_{0F}$	$\hat{b}_y^- - \hat{b} \rightarrow \alpha_{0F}$
CAPM	$\hat{b}^- \rightarrow \alpha_{1F}$	$\hat{b} \rightarrow \alpha_{1F}$	$\hat{b}_y^- - \hat{b} \rightarrow \alpha_{1F}$
FFM	$\hat{b}^- \rightarrow \alpha_{3F}$	$\hat{b} \rightarrow \alpha_{3F}$	$\hat{b}_y^- - \hat{b} \rightarrow \alpha_{3F}$

$$\hat{b}^- \longrightarrow \alpha_{0F}$$



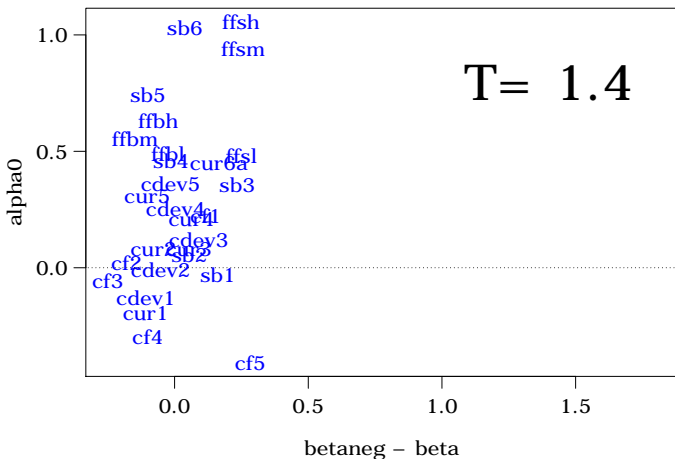
Positive between downbeta and risk-free adj returns.

$$\hat{b} \longrightarrow \alpha_{0F}$$



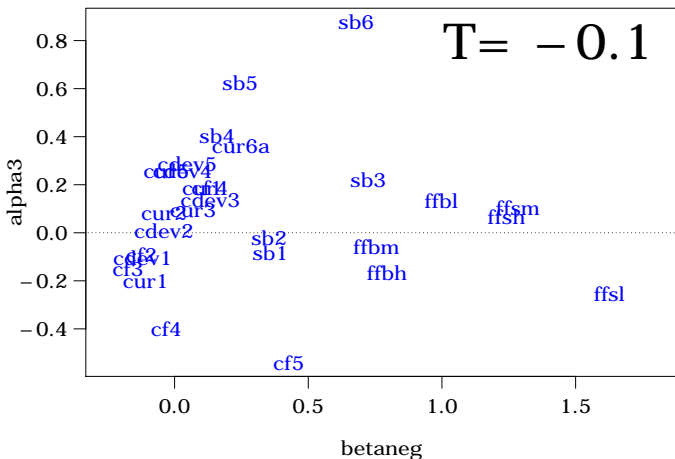
Positive between **plain** beta and risk-free adj returns.

$$\hat{b}^- - \hat{b} \longrightarrow \alpha_{0F}$$



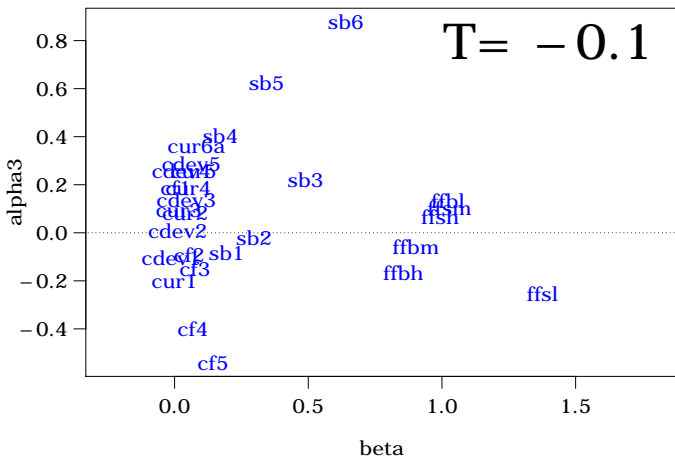
Positive between **delta beta** and risk-free adj returns.

$$\hat{b}^- \longrightarrow \alpha_{3F}$$



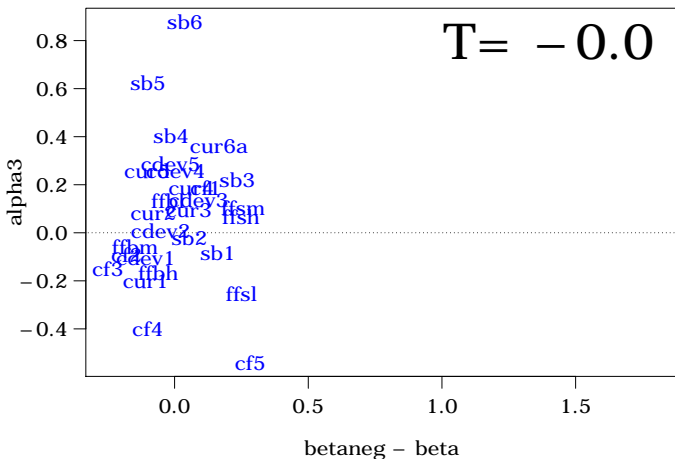
No association between down-beta and **FFM**-adj.

$$\hat{b} \longrightarrow \alpha_{3F}$$



No association between **plain** β and FFM-adj.

$$\hat{b}^- - \hat{b} \longrightarrow \alpha_{0F}$$



No association between **beta-diff** and FFM-adj.

Summary on Beta Prediction

- ▶ Plain all-days daily-return betas work great for down-markets, too.
- ▶ Est'd **ex-ante** down-betas are useless:
 - ▶ Even if you care only about down-beta
 - ▶ You are still better off using all-days daily returns.

Summary on Return Prediction

Despite positive **Fama-Macbeth** coefficients for **ex-post** down-betas associating with stock returns:

- ▶ For many investment strategies, differences between FM and FF tests are modest
 - ▶ but not in near-beta-related strategies,
 - ▶ where strategy has to beat market premium $ER_m - r_f$.
- ▶ Down-beta-sorted pfios, ex-ante or ex-post, have zero or negative **CAPM/FFM alphas**.
 - ▶ \hat{b}_y^- are primarily just (noisier) proxies for \hat{b}_y .
 - ▶ \hat{b}_y^- do not help resolve asset-pricing puzzles.
 - ▶ Returns were not unusual on down-beta dimension.