Analyzing Illiquid and Opaque Returns

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Introduction: Dale

- My background $\Longrightarrow$ my biases, what I do.
- Basic: BS EE Cornell; PhD Stats UChicago+Northwestern visitor.
- Was: finance prof @ UIC, ND, UIUC; focus on liquidity, crises.
- Intern @ GS; Eq Derivs @ LTCM; Prop Algo Trader @ MS ETL.
- Now: Director of Derivatives Research at Parametric.
- One of the organizers of R/Finance→OSQF for. . . 15? 16? years.
- I believe Kurt Lewin: Nothing so practical as a good theory.
  - Lets us navigate uncharted waters, innovate.
- Think about incentives, externalities, macro+political economy.

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Introduction

- We often need to analyze investments. How to proceed?
- Could look at holdings (cf Barra, Aladdin) but this may have issues:
  - May be inaccurate: window dressing; 13-F missing; turnover/dynamic.
  - Might not have holdings: HFs, PE/VC/PC.
  - Might not clarify risk, *e.g.* stock YC/credit exposure, corporates beta.
- What if returns come from opaque or illiquid assets?
- I would argue that we should look at returns:
  - Audited, almost always available, less likely to misrepresent.
  - Variation of orthogonal covariates: best hope to infer the unseen.
  - For known, liquid assets: returns may reveal modeling errors.
- Problem: Illiquid assets may not trade daily $\implies$ updates delayed.
  - How do we modify our analysis to handle illiquidity?
  - Also: this helps analyze returns for hedge funds, private capital.

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Liquid Factors

- We usually work w/abnormal returns; see effects beyond market(s).
- Lately: working on, presenting (and USING!) a liquid factor model.
  - Factors easily, cheaply traded; chosen by market $\stackrel{?}{\Longrightarrow}$ meaningful.
  - Biased estimation (PLS) to drive out collinearity, stabilize estimates.
  - Found liquid factors did almost as well as accepted models.
  - Suggested OOS betas more stable over time; for our data: yes!
  - Sensible to first explain liquid parts of returns; then illiquid aspects.
- Liquid factor model *is* a multi-asset model, but...
- ...individual assets may be less liquid; some only report monthly.
- What happens if we analyze funds with illiquid assets?
- Illiquid assets may not trade every day $\Longrightarrow$ updates may be delayed.
- How do we modify our analysis to handle illiquidity?
- Also: this helps analyze returns for hedge funds, private capital.

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What Makes Coefficient Estimates Unstable?

- Recall that we want to see coefficient estimates as factor exposures.
- Liquid factor model handled collinearity, coefficient stability with:
  - *Feature engineering:* some variable combos more stable across time.
  - *Better estimation:* TIPLS=shrinkage/machine learning.
- Not accounting for lag relationships also adds uncertainty.
- Evidence that some funds smooth returns; obscures vol/beta.

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Why Liquid Factors

- Many findings in the literature suggest using liquid factors.
  - *Explanatory Power:* higher for tradeable factors (Connor 1995).
  - *Performance:* Liquid factors beat tradeable (Cremers *et al* 2012).
  - *Robustness:* Less hurt by misspecification (Kan and Robotti 2008).
  - *Durable Economics:* Revealed preference; market wants these factors.
- *Meaningful:* Also seek to make factors w/intuitive meaning.
- *Timely*: We finally have many liquid index products.
- Liquid factors also provide a cheap benchmark.
  - If a hedge fund is just cheap beta, why pay "2-and-20?"

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Creating Less-Correlated Factors: Basics

- Create less-correlated variables w/meaningful difference:
  - Equity Index: S&P 500.
  - S&P 500, Russell 2000: large- and small-cap indices.
    $\rightarrow$ R2KSPX := Russell 2000 $-$ S&P 500 $\sim$ "size."
  - Russell 1000 value and growth indices.
    $\rightarrow$ R1KVMG := R1K Value $-$ R1K Growth $\sim$ "value."
- Use Treasury (or Gilt) yields to get yield curve factors:
  - YCLevel := ΔAverage(3M, 2Y, 5Y, 10Y, 30Y yields). $\Longrightarrow$ *Duration*
  - YCSlope := ΔAverage(30Y$-$3M, 10Y$-$2Y) slopes.[2] (*0 Duration*)
  - YCBump := ΔDiff(30Y$-$5Y, 5Y$-$3M) slopes. (*0 Duration, Slope*)
- Can easily localize most of these:
  - FTSE 250 $-$ 100; Stoxx Europe 600 $-$ MSCI EurSC; TOPIX $-$ N225.
  - Value factor: hardest. Port US value, adjust w/MSCI Eur. V$-$G?
  - 3MSONIA+Gilts; BuBills/Schatz/Bobl/Bund/Buxl; JGBills+JGBs.

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[2] Slopes: divide by duration differences.

Creating Less-Correlated Factors: Newer Factors

- Work with zero-DV01 credit indices, meaningful difference:
  - IG10 := iBoxx IG − 10Y Treasury returns. (*0 Duration*)
  - HY5 := iBoxx HY − 5Y Treasury returns. (*0 Duration*)
  - → HY5IG10 := HY5−IG10 ∼ "credit spectrum."
- InflSurp5Y := 5YTIPS−5YUSTs, Δbreakeven inflation.
- Equity volatility: VIX
- These are harder (but mostly able) to localize:
  - iBoxx: GBP Liquid Corps, but HY? EUR Liquid Corps, HY.
  - Indexed Gilts, Bunds, JGBi's.
  - FTSE IVI; VSTOXX (ESX50 vol); Nikkei 225 VI.
- *Transparency:* can see factors on your phone right now.

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Estimation Method: Partial Least Squares

- While less-correlated factors help, also use our preferences.
- This is the idea behind *partial least squares* (Wold 1966):
  - Create orthogonal/less-correlated covariates (like PC rotations);
  - Regress factors in preference order (and cumulate intercepts);
  - Residuals from each stage become response in next stage.
  - ML angle: Can also be seen as a form of boosting!
- This *is* a form of biased estimation, like shrinkage.
- But bias is toward more liquid hedging instruments = OK.
- Here: theory-informed $\rightarrow$ create less-correlated covariates. (TIPLS)
- Is this mathematically OK? Do we have consistency? Yes.
  - Project on same space as joint OLS; just preferencing dimensions.

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Summary Statistics: Raw Variables

- To see this in action, grab data for models, some funds.
- Daily data from 20150101–20240329.

Daily Log Returns, Yield Changes (USTs, TIPS), and Changes (VIX): 2015–2024Q1

Instrument	Min	Mean	Median	Max	Std. Dev.	Ann. Vol.
S&P 500	-12.77%	4.4 bp	6.9 bp	8.97%	115 bp	18.2%
Russell 2000	-15.40%	3.7 bp	8.3 bp	8.98%	147 bp	23.2%
Russell 1000 Value	-12.80%	2.7 bp	5.8 bp	9.46%	113 bp	17.9%
Russell 1000 Growth	-13.18%	5.7 bp	9.7 bp	8.72%	130 bp	20.5%
3M UST ret.	-0.09%	0.0 bp	0.0 bp	0.06%	0.8 bp	0.1%
2Y UST ret.	-0.67%	-0.3 bp	0.0 bp	1.13%	10.2 bp	1.6%
5Y UST ret.	-1.47%	-0.5 bp	0.0 bp	1.51%	26.2 bp	4.1%
10Y UST ret.	-2.53%	-0.9 bp	0.0 bp	2.62%	46.5 bp	7.4%
30Y UST ret.	-5.57%	-1.5 bp	0.0 bp	5.95%	98.3 bp	15.5%
5Y TIPS ret.	-1.56%	-0.3 bp	0.0 bp	1.66%	27.0 bp	4.3%
3M UST Δyld	-23 bp	0.1 bp	0.0 bp	34 bp	3.0 bp	48 bp
2Y UST Δyld	-57 bp	0.2 bp	0.0 bp	34 bp	5.1 bp	81 bp
5Y UST Δyld	-32 bp	0.1 bp	0.0 bp	31 bp	5.5 bp	87 bp
10Y UST Δyld	-30 bp	0.1 bp	0.0 bp	29 bp	5.3 bp	84 bp
30Y UST Δyld	-31 bp	0.1 bp	0.0 bp	29 bp	5.1 bp	81 bp
5Y TIPS Δyld	-35 bp	0.1 bp	0.0 bp	33 bp	5.7 bp	90 bp
iBoxx IG	-5.13%	0.9 bp	3.4 bp	7.13%	54.9 bp	8.7%
iBoxx HY	-5.65%	1.4 bp	2.3 bp	6.34%	55.4 bp	8.8%
VIX	-17.64%	-2.4 bp	-12.0 bp	24.86%	1.91%	30.1%

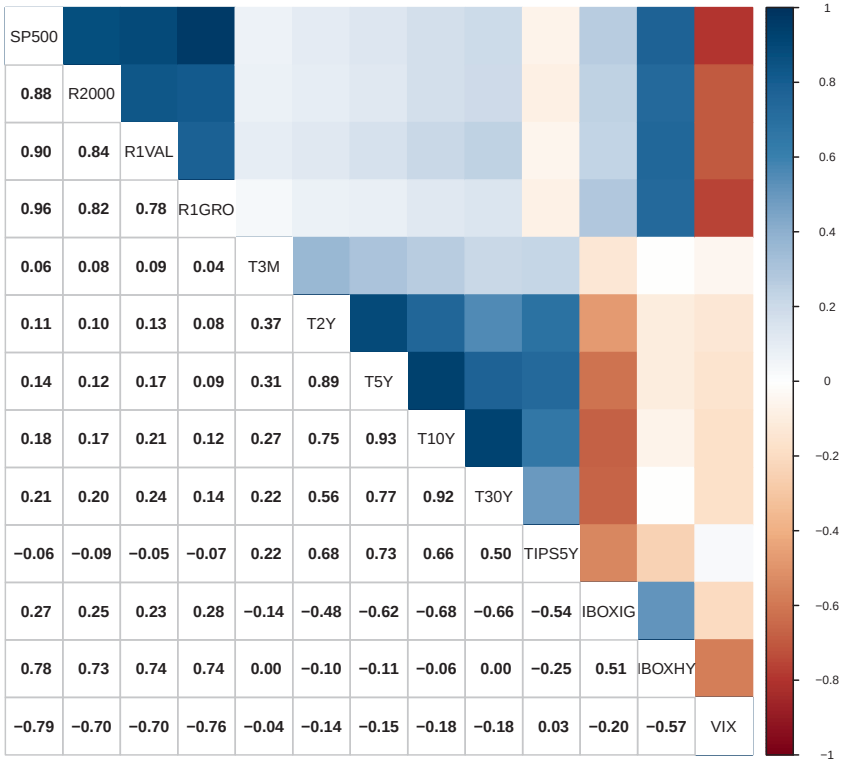
Summary Stats: Less-Correlated Variables

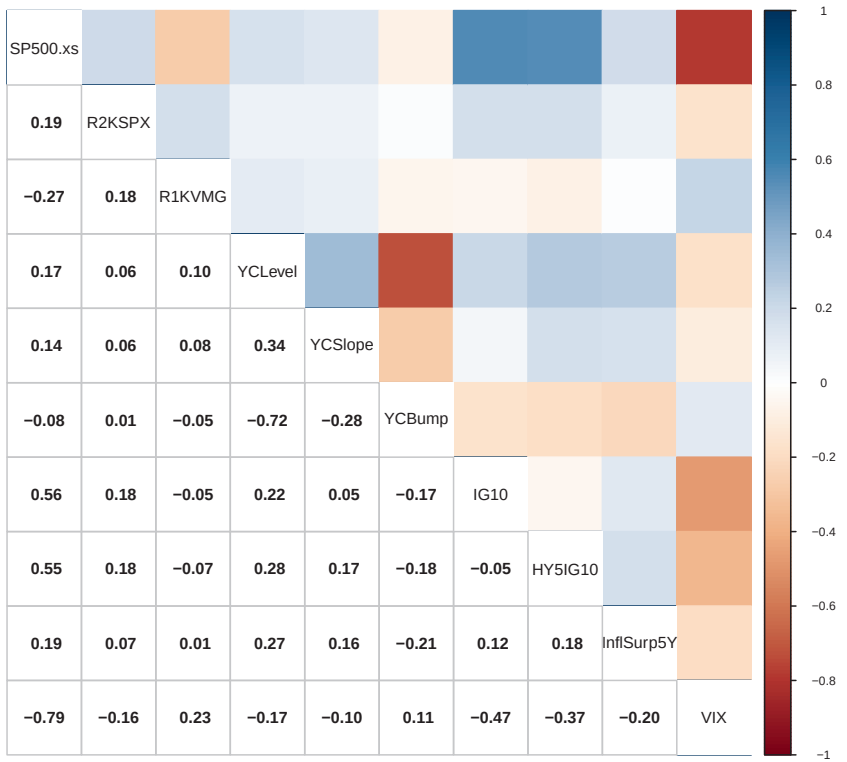
- Do the less-correlated variables remove some shared risks?
- Almost all non-SP500, non-VIX variances came down. Good!

Daily Liquid Factor Data: 2015–2024Q1						
Instrument	Min	Mean	Median	Max	Std. Dev.	Ann. Vol.
SP500.xs	-12.77%	3.8 bp	6.1 bp	8.97%	115 bp	18.2%
R2KSPX	-5.69%	-0.7 bp	-1.7 bp	6.13%	72 bp	11.4%
R1KVMG	-7.00%	-3.0 bp	-5.0 bp	5.98%	82 bp	12.9%
YCLevel	-0.24%	0.1 bp	0.2 bp	0.30%	4.1 bp	65 bp
YCSlope	-1.7 bp	0.0 bp	0.0 bp	3.5 bp	0.4 bp	6 bp
YCBump	-6.6 bp	0.0 bp	0.0 bp	8.4 bp	1.3 bp	21 bp
IG10	-5.59%	2.1 bp	2.2 bp	5.74%	42 bp	6.6%
HY5IG10	-8.02%	0.6 bp	0.9 bp	4.59%	44 bp	6.9%
InflSurp5Y	-25 bp	0.1 bp	0.0 bp	35 bp	5.7 bp	90 bp
VIX	-17.64%	-2.4 bp	-12.0 bp	24.86%	1.91 bp	30.1%

Correlations: Pre- and Post-Reduction

- Try it! Daily data from 20150101–20240329.
- Correlation matrices make the effect of transformation very clear.
- Clustering is greatly reduced by feature engineering.





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The Correlations All Go To One! (They Do Not.)

- So. . . we've had a bit of a week. Last week too.
- Often, people say that in crisis correlations "all go to 1."
- Sometimes, they add on the more-sophisticated "or minus-1"
- Except this is often untrue in the liquid factor lens!
- Last week some factors moved a lot, some did not:
  - Equity markets: $\approx$ -4σ (US, Europe), -2σ (Japan).
  - Size and value? $\pm$0.5σ in US, Europe, UK, Japan.
  - US YC: Level -1.7σ, Slope -0.6σ, Bump +1.3σ; Europe YC: All small.
  - Japan YC: Level -6σ (-22 bp), Slope -3σ, Bump +7σ.
  - US IG -1.6σ, US HY$-$IG -2.3σ; Euro IG +2σ, Euro HY$-$IG -1.4σ.
  - US Breakeven inflation: -2.4σ.
  - VIX: +7σ; IVI, VSTOXX, N225 VI: +5σ; KR: +2.6σ
- Intra-week: size and value moved down then reverted. Liquidity?
- Liquid factor lens gives us some discernment, even in times of stress.

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Fixed Income Fund

- Look at corporate bond fund: HY, $22 bn AUM, 15-year mgr, 4*.
- Fund charges a modest (but not low) expense ratio: 0.58%.

Daily Excess Log Returns for Investment Funds: 2015–2024Q1					
Min	Mean	Median	Max	Std. Dev.	Ann. Vol.
-4.28%	1.0 bp	0.0 bp	3.69%	46.5 bp	7.4%

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Compare Partial+Full Liquid Models, Fama-French (1993)

- Fama and French (1993) is a fixed income model.[3]
- Unfortunately, they do not make the FF93 data available!
- Let's be generous: create their model w/liquid factors = FF93L.

Liquid Factor Models, Increasing in Model Innovations: Fixed Income Fund, 2015–2024Q1 Daily Data

	Kitchen Sink			Corrected Covariates		Sequential Shrinkage = Full Liquid Model				FF93L		
Instrument	Est.	t	Factor	Est.	t	Est.	t	Order	ΔR^2	Est.	t	Order
Intercept	1.0 bp	1.8	Intercept	0.4 bp	0.7	0.4 bp	0.7	–		0.5 bp	0.7	–
T3M	-0.36	-1.8	YCLevel	**-3.12**	**-14.4**	**-0.66**	**3.1**	1	0.5%			
T2Y	-0.07	-0.3	YCSlope	-1.59	-1.0	1.88	0.8	2	0.0%	-3.66	-1.9	1
T5Y	**1.32**	**2.7**	YCBump	**1.39**	**2.2**	**6.33**	**13.8**	5	4.3%			
T10Y	0.10	0.2										
T30Y	-0.63	-1.7										
IBOXIG	**0.04**	**2.2**	IG10	**0.58**	**28.1**	**0.48**	**26.5**	3	24.9%	**0.44**	**24.3**	1
IBOXHY	**0.53**	**26.9**	HY5IG10	**0.54**	**26.9**	**0.44**	**30.8**	4	23.2%			
SP500	**-0.18**	**-4.6**	SP500.xs	0.00	0.2	**0.01**	**2.4**	6	0.1%	**0.09**	**15.2**	2
R2000	**0.02**	**2.0**	R2KSPX	**0.03**	**3.0**	**0.03**	**4.0**	7	0.4%	**0.09**	**8.4**	1
R1K Value	**0.09**	**5.6**	R1KVMG	**0.03**	**3.9**	**0.02**	**3.1**	8	0.2%	-0.02	-1.7	1
R1K Growth	**0.07**	**2.9**										
TIPS5Y	**-0.73**	**-4.8**	InflSurp5Y	-0.15	-1.4	**-0.32**	**-3.0**	9	0.2%			
VIX	**0.01**	**2.1**	VIX	**0.01**	**2.1**	0.00	1.0	10	0.0%			
R^2 (in-sample)		57.5%			57.2%				53.8%			32.7%

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[3] Cannot use Bai, Bali, Wen (2019): retracted!

Fixed Income Fund: Uff Da!

- 33% R^2 from the *liquid* Fama-French (1993) model?
- Even the liquid factor model is explaining only 54% of returns!
- *Co słychać, stary? Dlaczego jest kicha?*
- *Pomiętaj!* What do we know about fixed income?
- Bonds, like puppies, find forever homes; tend to be less liquid.
- Often "marked to matrix" (or not!) until they really trade.
- Typical advice in this situation: use monthly returns.

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Compare Partial+Full Liquid Models, FF93L: Monthly

Liquid Factor Models, Increasing in Model Innovations: Fixed Income Fund, 2015–2024Q1 Monthly Data

	Kitchen Sink			Corrected Covariates		Sequential Shrinkage				FF93L		
Instrument	Est.	t	Factor	Est.	t	Est.	t	Order	ΔR^2	Est.	t	Order
Intercept	5.2 bp	1.0	Intercept	**-18.5 bp**	**-2.6**	**-18.5 bp**	**-2.6**	–		-19.8 bp	-1.7	–
T3M	**1.06**	**2.9**	YCLevel	**-2.95**	**-6.0**	**-0.67**	**3.1**	1	0.3%			
T2Y	-1.38	-1.8	YCSlope	1.97	0.4	-20.50	-1.4	2	1.7%	-8.83	-1.0	1
T5Y	2.20	1.6	YCBump	**6.58**	**4.3**	**7.94**	**5.1**	5	3.9%			
T10Y	1.84	1.8										
T30Y	-0.76	-0.7										
IBOXIG	**0.18**	**2.9**	IG10	**0.99**	**14.0**	**1.19**	**16.0**	3	68.6%	**1.16**	**13.8**	1
IBOXHY	**0.81**	**15.3**	HY5IG10	**0.74**	**11.1**	**0.55**	**7.0**	4	9.1%			
SP500	**-0.57**	**-3.7**	SP500.xs	**0.08**	**2.5**	0.00	0.1	6	0.0%	0.08	-0.5	2
R2000	-0.01	-0.5	R2KSPX	0.05	1.9	-0.02	-0.6	7	0.1%	0.06	1.3	1
R1K Value	**0.27**	**3.3**	R1KVMG	-0.03	-1.1	**-0.07**	**-2.2**	8	0.7%	**-0.12**	**-2.6**	1
R1K Growth	**0.32**	**3.7**										
TIPS5Y	**-0.80**	**-2.0**	InflSurp5Y	**-2.55**	**-2.6**	**-3.09**	**-2.4**	9	0.8%			
VIX	0.00	0.2	VIX	**0.05**	**2.8**	**0.03**	**2.0**	10	0.5%			
R^2 (in-sample)		96.1%			92.5%				85.7%			73.1%

- More explanatory power; liquid factor model still beats FF93L.
- Move to monthly also shifts attribution as risk premia grow.
  - HY $\rightarrow$ IG (HY leads?); equity exposure fades.
- Fund has significant alpha: *negative* alpha. Ouch.

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Some Funds Are Bigger Than Others

- Some funds are harder to analyze: multi-asset, complicated strategies.
- What do we do in these circumstances? Give up? Never!
- High turnover funds: holdings useless; returns may capture *process*.
- These are the cases when we *most* need guidance.
- Worse: the funds may have big costs: illiquid, high-fee.
- Biggest: hedge funds, private capital (PE/VC/PC); even prop desks.
- Most investors in these know *nothing* about these exposures.
- Analysis can give guidance on exposures, vol, alpha. (alpha?)
- A hedge fund might not be sophisticated (*e.g.* low-vol fund @ GM).

Costly Quant Funds

- What if we look at some multi-asset funds.
- These funds have high fees and are quantitatively managed.
- Might expect some regularity of process, analysis expertise.
- Use just the full liquid factor model: Sequential Shrinkage.

Fund	AUM (USD)	Expense Ratio	Average Ann Ret	Volatility	Sharpe Ratio	Data Start	Fund Rating	Dominant Asset
A	1–2 bn	1.25+%	10%	5%	1.5	20150102	5*	Bonds
B	0.5–1 bn	1.25+%	13%	6%	1.6	20200611	5*	Equities
C	<0.5 bn	1.25+%	8%	10%	0.6	20150102	4*	Bonds
D	1–2 bn	1.25+%	23%	12%	1.6	20150102	5*	Equities
E	<0.5 bn	1.50+%	13%	16%	0.6	20150102	3*	Bonds
F	<0.5 bn	1.25+%	14%	11%	1.0	20150102	4*	Equities
G	<0.5 bn	1.25+%	25%	12%	1.5	20211217	—	Equities
H	<0.5 bn	1.25+%	11%	12%	0.9	20170920	4*	Equities
I	1–2 bn	1.50+%	15%	15%	0.2	20150102	5*	Equities
J	1–2 bn	1.25+%	13%	18%	0.6	20160406	3*	Equities
K	0.5–1 bn	1.50+%	4%	5%	0.4	20150102	4*	Bonds
L	1–2 bn	1.25+%	14%	13%	0.8	20150102	3*	Equities

- ⚠ *Vorsicht!* Big tables ahead! It will be OK.
- Ignore the numbers. Just look at the overall pattern.

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Costly Quant Funds, Daily Returns: Much Index-y

Coefficient		A	B	C	D	E	F	G	H	I	J	K	L
Full Liquid Models, Estimated on Daily Data, 2015–2024Q1													
Intercept	Est.	0.8 bp	**3.8 bp**	0.7 bp	**2.8 bp**	0.0 bp	**2.1 bp**	**6.5 bp**	0.9 bp	1.8 bp	0.9 bp	0.0 bp	0.5 bp
	t-stat	1.6	**3.0**	0.7	**2.4**	0.0	**2.0**	**2.3**	0.7	1.2	0.6	0.7	0.6
SP500.xs	Est.	**0.04**	0.00	**-0.03**	**0.36**	-0.02	**-0.03**	**0.27**	**-0.03**	**-0.05**	**0.61**	**0.05**	**0.50**
	t-stat	**7.7**	0.0	**-3.2**	**33.2**	-1.0	**-2.5**	**10.3**	**-2.8**	**-3.9**	**40.1**	**7.6**	**58.3**
R2KSPX	Est.	**0.10**	0.00	**0.04**	**-0.09**	-0.04	**-0.11**	**-0.09**	**-0.10**	**-0.12**	**0.46**	-0.00	**0.07**
	t-stat	**13.2**	0.3	**2.6**	**-5.1**	-1.6	**-6.7**	**-2.1**	**-5.2**	**-5.5**	**21.6**	-0.1	**4.9**
R1KVMG	Est.	-0.00	**0.08**	**0.07**	**0.23**	-0.04	**0.16**	**0.25**	**0.16**	**0.26**	**0.27**	-0.00	**0.13**
	t-stat	-0.2	**6.9**	**5.7**	**15.9**	-1.9	**12.2**	**9.1**	**10.7**	**14.4**	**15.5**	-0.0	**10.9**
YCLevel	Est.	**0.66**	**1.94**	**2.96**	**1.86**	**4.19**	**1.88**	**2.10**	**4.23**	**3.22**	0.70	**1.02**	0.40
	t-stat	**4.3**	**7.5**	**11.3**	**6.6**	**8.6**	**7.1**	**4.5**	**13.6**	**9.0**	1.0	**5.7**	1.7
YCSlope	Est.	-0.40	**-9.14**	**-19.7**	-4.29	**-36.5**	-5.42	-1.41	**-14.4**	**-13.4**	6.99	-1.27	1.31
	t-stat	-0.2	**-3.2**	**-7.0**	-1.4	**-6.9**	-1.9	-0.2	**-4.2**	**-3.5**	1.8	-0.6	0.5
YCBump	Est.	**3.91**	0.21	**-3.90**	-0.19	**-11.0**	-0.63	2.24	-1.59	-1.03	-0.26	**2.22**	-0.51
	t-stat	**9.1**	0.3	**-4.9**	-0.2	**-7.5**	-0.8	1.6	-1.6	-0.9	-0.2	**4.2**	-0.7
IG10	Est.	**0.23**	0.07	-0.03	**0.08**	**-0.30**	0.01	**0.36**	0.04	0.06	**0.18**	**0.18**	0.03
	t-stat	**15.9**	1.6	-1.1	**2.8**	**-6.4**	0.5	**4.2**	1.4	1.8	**5.3**	**10.4**	1.3
HY5IG10	Est.	**0.19**	0.05	**-0.13**	-0.01	**-0.34**	-0.01	**0.32**	0.01	-0.01	**-0.08**	**0.15**	**-0.06**
	t-stat	**14.8**	1.4	**-5.5**	-0.4	**-7.7**	-0.5	**4.4**	0.2	-0.3	**-2.2**	**9.5**	**-2.5**
InflSurp5Y	Est.	-0.06	**0.49**	-0.10	-0.21	0.03	-0.19	-0.00	-0.00	-0.30	0.10	0.17	-0.20
	t-stat	-0.6	**2.4**	-0.5	-1.0	0.1	-1.0	-0.0	-0.0	-1.2	0.4	1.4	-1.2
VIX	Est.	-0.00	**-0.03**	**-0.02**	**-0.04**	**-0.02**	**-0.04**	-0.03	**-0.03**	**-0.03**	**0.02**	**-0.01**	-0.00
	t-stat	-0.1	**-4.7**	**-3.0**	**-7.2**	**-2.1**	**-6.6**	-1.3	**-4.5**	**-3.7**	**2.0**	**-2.5**	-0.1
R^2		30.8%	15.3%	12.7%	45.0%	12.7%	13.0%	36.8%	21.6%	15.4%	63.6%	13.7%	64.4%

- Low R^2's: explain 13%–37% of returns!? (Except D, J, L: index-y!)
- High *t*-stats for S&P 500, YCLevel for most funds!

➤ Parametric

Costly Quant Funds, Daily Returns: Alpha?

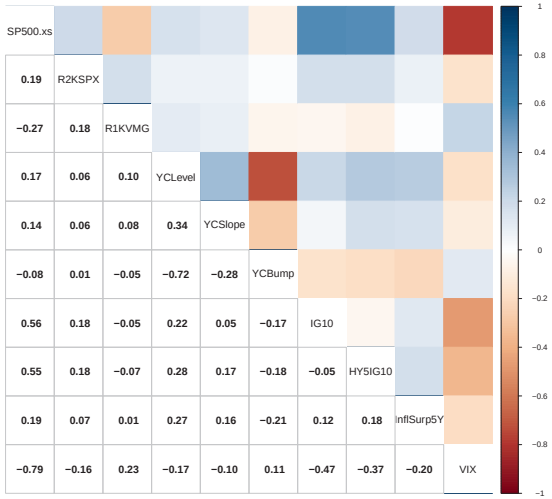
Coefficient		A	B	C	D	E	F	G	H	I	J	K	L
Full Liquid Models, Estimated on Daily Data, 2015–2024Q1													
Intercept	Est.	0.8 bp	**3.8 bp**	0.7 bp	**2.8 bp**	0.0 bp	**2.1 bp**	**6.5 bp**	0.9 bp	1.8 bp	0.9 bp	0.0 bp	0.5 bp
	t-stat	1.6	**3.0**	0.7	**2.4**	0.0	**2.0**	**2.3**	0.7	1.2	0.6	0.7	0.6
SP500.xs	Est.	**0.04**	0.00	**-0.03**	**0.36**	-0.02	**-0.03**	**0.27**	**-0.03**	**-0.05**	**0.61**	**0.05**	**0.50**
	t-stat	**7.7**	0.0	**-3.2**	**33.2**	-1.0	**-2.5**	**10.3**	**-2.8**	**-3.9**	**40.1**	**7.6**	**58.3**
R2KSPX	Est.	**0.10**	0.00	**0.04**	**-0.09**	-0.04	**-0.11**	**-0.09**	**-0.10**	**-0.12**	**0.46**	-0.00	**0.07**
	t-stat	**13.2**	0.3	**2.6**	**-5.1**	-1.6	**-6.7**	**-2.1**	**-5.2**	**-5.5**	**21.6**	-0.1	**4.9**
R1KVMG	Est.	-0.00	**0.08**	**0.07**	**0.23**	-0.04	**0.16**	**0.25**	**0.16**	**0.26**	**0.27**	-0.00	**0.13**
	t-stat	-0.2	**6.9**	**5.7**	**15.9**	-1.9	**12.2**	**9.1**	**10.7**	**14.4**	**15.5**	-0.0	**10.9**
YCLevel	Est.	**0.66**	**1.94**	**2.96**	**1.86**	**4.19**	**1.88**	**2.10**	**4.23**	**3.22**	0.70	**1.02**	0.40
	t-stat	**4.3**	**7.5**	**11.3**	**6.6**	**8.6**	**7.1**	**4.5**	**13.6**	**9.0**	1.0	**5.7**	1.7
YCSlope	Est.	-0.40	**-9.14**	**-19.7**	-4.29	**-36.5**	-5.42	-1.41	**-14.4**	**-13.4**	6.99	-1.27	1.31
	t-stat	-0.2	**-3.2**	**-7.0**	-1.4	**-6.9**	-1.9	-0.2	**-4.2**	**-3.5**	1.8	-0.6	0.5
YCBump	Est.	**3.91**	0.21	**-3.90**	-0.19	**-11.0**	-0.63	2.24	-1.59	-1.03	-0.26	**2.22**	-0.51
	t-stat	**9.1**	0.3	**-4.9**	-0.2	**-7.5**	-0.8	1.6	-1.6	-0.9	-0.2	**4.2**	-0.7
IG10	Est.	**0.23**	0.07	-0.03	**0.08**	**-0.30**	0.01	**0.36**	0.04	0.06	**0.18**	**0.18**	0.03
	t-stat	**15.9**	1.6	-1.1	**2.8**	**-6.4**	0.5	**4.2**	1.4	1.8	**5.3**	**10.4**	1.3
HY5IG10	Est.	**0.19**	0.05	**-0.13**	-0.01	**-0.34**	-0.01	**0.32**	0.01	-0.01	**-0.08**	**0.15**	**-0.06**
	t-stat	**14.8**	1.4	**-5.5**	-0.4	**-7.7**	-0.5	**4.4**	0.2	-0.3	**-2.2**	**9.5**	**-2.5**
InflSurp5Y	Est.	-0.06	**0.49**	-0.10	-0.21	0.03	-0.19	-0.00	-0.00	-0.30	0.10	0.17	-0.20
	t-stat	-0.6	**2.4**	-0.5	-1.0	0.1	-1.0	-0.0	-0.0	-1.2	0.4	1.4	-1.2
VIX	Est.	-0.00	**-0.03**	**-0.02**	**-0.04**	**-0.02**	**-0.04**	-0.03	**-0.03**	**-0.03**	**0.02**	**-0.01**	-0.00
	t-stat	-0.1	**-4.7**	**-3.0**	**-7.2**	**-2.1**	**-6.6**	-1.3	**-4.5**	**-3.7**	**2.0**	**-2.5**	-0.1
R^2		30.8%	15.3%	12.7%	45.0%	12.7%	13.0%	36.8%	21.6%	15.4%	63.6%	13.7%	64.4%

- Maybe 4 funds have alpha: B, D, F, G intercepts?
- Harder to find FI alpha? (A, C, E, K intercepts, R^2s)

➤ Parametric

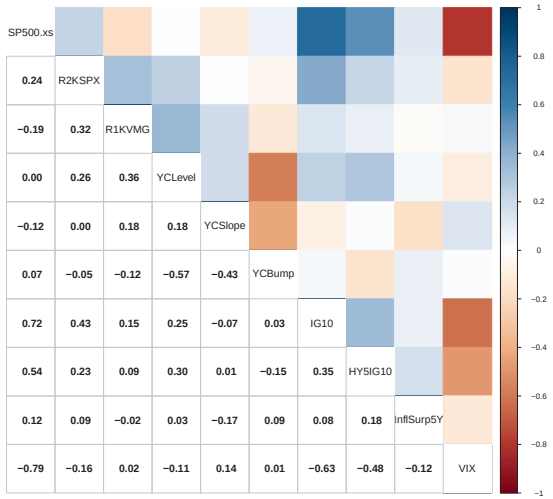
Daily to Monthly: Lagging Returns, and Risk Premia

- Many of these funds: opaque investments $\implies$ illiquidity.
- Illiquid investments: pricing lags, may update slowly/monthly.
- Bid-ask bounce may also add noise to daily returns.
- Try using longer returns. We see change in dynamics:
  - As risk premia escape noise, correlations $\uparrow$, harder to tell factors apart.
  - Loss of efficiency: we are using less data, see less variation.
  - Should see higher R^2's but less discernment b/w factors.



Daily Returns

$\sum$ lower $\triangle = 0.95$



Monthly Returns

$\sum$ lower $\triangle = 1.81$

▶ Parametric

Costly Quant Funds, Monthly Returns

Coefficient		A	B	C	D	E	F	G	H	I	J	K	L
Full Liquid Models, Estimated on Monthly Data, 2015–2024Q1													
Intercept	Est.	20.9 bp	**43.7 bp**	28.3 bp	46.9 bp	34.8 bp	39.2 bp	29.9 bp	-1.7 bp	39.7 bp	43.1 bp	9.3 bp	-14.5 bp
	t-stat	1.5	**3.5**	1.4	1.7	0.8	1.5	1.4	-0.1	1.1	1.6	0.6	-0.7
SP500.xs	Est.	0.01	0.03	-0.00	**0.33**	-0.01	-0.10	0.11	-0.01	-0.01	**0.47**	0.05	**0.59**
	t-stat	0.5	0.9	-0.1	**5.2**	-0.1	-1.7	2.4	-0.3	-0.1	**7.4**	1.5	**13.1**
R2KSPX	Est.	**0.17**	0.03	**0.12**	-0.07	0.01	-0.09	-0.07	-0.08	-0.05	**0.33**	**-0.11**	-0.10
	t-stat	**3.8**	0.7	**2.0**	-0.7	0.0	-1.0	-1.0	-1.0	-0.4	**3.6**	**-2.3**	-1.5
R1KVMG	Est.	-0.07	**0.20**	0.07	**0.49**	0.12	**0.43**	0.24	**0.39**	**0.62**	**0.39**	0.03	0.10
	t-stat	-1.6	**5.2**	1.2	**5.8**	1.0	**5.2**	3.5	**5.3**	**5.6**	**4.6**	0.6	1.5
YCLevel	Est.	0.95	0.38	**4.99**	0.67	**5.13**	0.41	-2.09	**2.99**	1.16	-1.58	-0.56	-0.77
	t-stat	1.1	0.6	**5.1**	0.5	**2.3**	0.3	-2.1	**2.7**	0.7	-1.2	-0.7	-0.7
YCSlope	Est.	-4.69	1.53	-19.9	10.4	-32.3	3.63	-8.69	-18.5	3.15	8.79	16.2	**34.8**
	t-stat	-0.4	0.2	-1.6	0.6	-1.1	0.2	-0.7	-1.3	0.1	0.5	1.6	**2.6**
YCBump	Est.	1.83	-1.72	**-6.58**	0.81	**-14.2**	1.03	0.83	0.52	2.40	0.70	-2.67	2.68
	t-stat	0.8	-0.9	**-2.1**	0.2	**-2.1**	0.2	0.3	0.1	0.4	0.2	-1.1	0.8
IG10	Est.	**0.56**	-0.06	-0.11	0.15	**-1.06**	0.12	0.11	0.01	-0.01	-0.03	0.14	0.06
	t-stat	**6.4**	-0.9	-1.0	1.0	**-4.4**	0.8	0.9	0.1	-0.0	-0.2	1.5	0.5
HY5IG10	Est.	0.04	0.16	-0.05	-0.05	-0.24	-0.03	0.23	0.30	0.37	-0.12	0.14	0.05
	t-stat	0.4	1.8	-0.4	-0.3	-0.8	-0.1	1.5	1.9	1.5	-0.6	1.3	0.4
InflSurp5Y	Est.	-2.70	3.02	1.40	**8.92**	5.98	**9.23**	6.65	**6.52**	**12.6**	**8.88**	2.74	**9.12**
	t-stat	-1.4	1.9	0.5	**2.5**	1.1	**2.7**	2.4	**2.2**	**2.7**	**2.5**	1.4	**3.4**
VIX	Est.	-0.05	0.00	0.00	-0.04	0.02	-0.02	0.06	0.03	0.02	-0.02	0.00	-0.02
	t-stat	-0.1	0.2	0.2	-1.0	0.1	-0.6	1.8	0.8	0.3	-0.6	0.1	-0.5
R^2		42.5%	27.0%	29.1%	43.5%	24.9%	28.3%	27.3%	33.1%	29.6%	54.2%	15.8%	69.0%

- Diffusion: A, C, E, G, J, K, L loaded on HY5IG10, now IG10, InflSurp.
- S&P 500 betas for D, J, L: moderated but still index-y.

➤ Parametric

Another Way to Handle Lagging Returns

- Using monthly returns did increase the explanatory power of model.
- However, daily to monthly move entails a loss of efficiency.
- Maybe fund's illiquid holdings update a few days later?
- If so, we should add lags to capture those late-arriving returns.
- What is the real beta then? Hard to say; philosophical:
  - Chen and Greenberg (2017): $\hat{\beta} = \sum_{\text{sig.}} \widehat{\phi_t \beta}$.
  - Are we estimating lag effects or β in liquid times?
  - Hedge may have tracking error in illiquid times.
- I would argue that we need to sum insignificant lags a bit also.
  - Suppose delays $\sim$ Exp(λ); have effect *and* lag decay.
  - Decaying $\hat{\phi}$'s eventually fall below significant cutoff.
  - So we might want to change/reduce cutoff.
- Only get monthly data (and lagged still!); efficiency loss a given.

▶ Parametric

Other Issues with Lagging Returns

- Lagging returns: major issue w/private capital, hedge fund returns.
  - Getmansky, Lo, and Makarov (2004): Funds seem to smooth returns.[4]
  - Only get monthly data (and lagged still!); efficiency loss a given.
- Net effect: an investment with an artificially low volatility.
- Cannot properly assess risk-return if variance estimate is wrong.
- Say observed returns R_t^o are a function of actual returns R_t:

$$R_t^o = \theta_1 R_{t-1} + \theta_2 R_{t-2} + \cdots + \theta_k R_{t-k}, \quad \text{and} \sum_{j=1}^{k} \theta_j = 1. \tag{1}$$

- Vol of observed returns $<$ vol of actual returns:

$$\text{Var}(R_t^o) = \text{Var}(R) \sum_{j=1}^{k} \theta_j^2 \ll \text{Var}(R - t). \tag{2}$$

- Fit an MA model and invert.[5]

[4] Also many accusations of NAV smoothing.

[5] See also: Couts, Gonçalves, Rossi (2024).

▶ Parametric

Costly Quant Funds: Daily Returns With Lags

Coefficient		A	B	C	D	E	F	G	H	I	J	K	L
Full Liquid Models, with 1-day Factor Lags, Estimated on Daily Data, 2015–2024Q1													
Intercept	Est.	0.7 bp	**3.2 bp**	0.7 bp	**2.7 bp**	0.0 bp	**2.2 bp**	**5.7 bp**	0.8 bp	1.7 bp	1.0 bp	0.4 bp	0.6 bp
	t	1.4	**2.6**	0.7	**2.4**	0.1	**2.1**	**2.1**	0.6	1.1	0.7	0.6	0.6
SP500.xs	Est.	**0.04**	0.00	**-0.03**	**0.36**	-0.02	**-0.03**	**0.27**	**-0.03**	**-0.05**	**0.61**	**0.05**	**0.50**
	t	**7.7**	0.0	**-2.9**	**33.2**	-1.1	**-2.5**	**10.3**	**-2.8**	**-3.9**	**40.1**	**7.9**	**58.3**
lag SP500.xs	Est.	0.01	0.00	-0.00	**0.03**	-0.01	**-0.03**	-0.05	0.01	**0.03**	**0.03**	0.00	**0.02**
	t	1.8	0.3	-0.1	**2.4**	-0.9	**-2.6**	-1.7	1.1	**2.4**	**2.1**	0.4	**2.1**
R2KSPX	Est.	**0.10**	0.00	**0.04**	**-0.09**	-0.04	**-0.11**	**-0.09**	**-0.10**	**-0.12**	**0.46**	-0.00	**0.07**
	t	**13.2**	0.3	**2.7**	**-5.1**	-1.6	**-6.7**	**-2.1**	**-5.2**	**-5.4**	**21.7**	-0.1	**5.0**
lag R2KSPX	Est.	**0.02**	0.02	**0.04**	0.02	**-0.05**	0.01	-0.01	0.00	0.01	**0.07**	-0.00	-0.01
	t	**2.6**	1.5	**3.0**	0.9	**-2.0**	0.4	-0.2	0.2	0.4	**3.3**	-0.3	-0.4
R1KVMG	Est.	-0.00	**0.08**	**0.07**	**0.22**	-0.04	**0.17**	**0.26**	**0.16**	**0.26**	**0.26**	0.00	**0.13**
	t	-0.4	**6.8**	**5.5**	**15.5**	-1.8	**12.6**	**9.4**	**10.5**	**14.0**	**15.0**	0.3	**10.6**
lag R1KVMG	Est.	**-0.02**	**0.04**	-0.00	**0.10**	0.03	**0.09**	**0.12**	**0.06**	**0.11**	0.02	0.01	**0.05**
	t	**-3.2**	**3.7**	-0.1	**7.2**	1.5	**6.9**	**4.3**	**3.6**	**6.1**	1.3	1.0	**4.0**
YCLevel	Est.	**0.66**	**1.90**	**2.96**	**1.85**	**4.19**	**1.78**	**1.97**	**4.22**	**3.22**	**0.72**	**1.02**	0.42
	t	**4.3**	**7.4**	**11.3**	**6.7**	**8.6**	**6.8**	**4.3**	**13.6**	**9.1**	**2.0**	**5.7**	1.8
lag YCLevel	Est.	**-0.36**	**0.82**	**0.94**	**0.89**	-0.28	**0.85**	**1.33**	0.60	**1.14**	**0.72**	-2.07	-0.19
	t	**-2.3**	**3.2**	**3.6**	**3.2**	-0.6	**3.3**	**3.0**	1.9	**3.2**	**2.0**	-1.2	-0.8
YCSlope	Est.	-0.34	**-9.39**	**-19.9**	-4.05	**-36.4**	**-6.23**	-2.59	**-14.3**	**-13.1**	7.64	-1.23	1.59
	t	-0.2	**-3.3**	**-7.1**	-1.3	**-6.9**	**-2.2**	-0.5	**-4.2**	**-3.4**	1.9	-0.6	0.6
lag YCSlope	Est.	-1.27	-4.37	-4.51	**-7.42**	**-12.0**	-5.34	4.67	**-11.6**	**-9.99**	-4.60	-3.49	0.89
	t	-0.7	-1.6	-1.6	**-2.5**	**-2.3**	-1.9	0.8	**-3.4**	**-2.6**	-1.1	-1.8	0.3
YCBump	Est.	**3.95**	0.12	**-3.98**	-0.28	**-10.9**	-1.03	1.60	-1.64	-1.07	-0.09	**2.29**	-0.49
	t	**9.2**	0.2	**-5.0**	-0.3	**-7.5**	-1.3	1.2	-1.7	-1.0	-0.1	**4.3**	-0.7
lag YCBump	Est.	-0.48	-0.08	-0.64	-0.25	-0.85	0.01	1.56	-0.77	-1.23	-0.68	-0.74	-0.16
	t	-1.1	-0.1	-0.8	-0.3	-0.6	0.0	1.2	-0.8	-1.1	-0.6	-1.4	-0.2
IG10	Est.	**0.23**	0.06	-0.03	**0.06**	**-0.30**	0.00	**0.35**	0.03	0.05	**0.16**	**0.18**	0.03
	t	**16.0**	1.5	-1.2	**2.4**	**-6.5**	0.2	**4.2**	1.1	1.4	**4.8**	**10.3**	1.2
lag IG10	Est.	-0.01	0.01	0.03	0.04	-0.02	0.04	0.09	-0.00	0.01	-0.04	**-0.05**	0.04
	t	-0.4	0.3	1.3	1.4	-0.4	1.5	1.1	-0.1	0.4	-1.3	**-3.2**	1.8
HY5IG10	Est.	**0.19**	0.06	**-0.13**	0.00	**-0.34**	-0.01	**0.32**	0.01	0.00	-0.06	**0.15**	**-0.05**
	t	**14.7**	1.7	**-5.3**	0.0	**-7.8**	-0.4	**4.7**	0.4	0.1	-1.8	**9.5**	**-2.5**
lag HY5IG10	Est.	-0.00	0.01	0.02	-0.04	-0.04	-0.02	0.09	0.00	-0.02	**-0.07**	0.02	**-0.05**
	t	-0.1	0.2	0.6	-1.4	-0.9	-1.0	1.3	0.0	-0.7	**-2.0**	1.5	**-2.5**
InflSurp5Y	Est.	-0.09	**0.62**	0.08	0.02	-0.10	-0.08	0.15	0.11	-0.02	0.22	0.10	-0.14
	t	-0.9	**3.1**	0.4	0.1	-0.3	-0.4	0.4	0.5	-0.1	0.8	0.9	-0.8
lag InflSurp5Y	Est.	-0.10	0.10	-0.02	-0.14	-0.07	-0.22	-0.43	-0.21	**-0.51**	0.19	0.06	-0.11
	t	-1.1	0.5	-0.1	-0.7	-0.2	-1.2	-1.2	-0.9	**-2.0**	0.7	0.5	-0.7
VIX	Est.	-0.00	**-0.03**	**-0.02**	**-0.05**	**-0.02**	**-0.04**	-0.03	**-0.03**	**-0.03**	0.01	**-0.01**	-0.00
	t	-0.2	**-4.7**	**-2.9**	**-7.9**	**-2.0**	**-6.7**	-1.7	**-4.8**	**-4.1**	1.9	**-2.2**	-0.5
lag VIX	Est.	0.00	**-0.02**	-0.01	**-0.01**	-0.01	**-0.01**	-0.02	-0.01	-0.01	-0.00	0.00	-0.01
	t	1.8	**-2.2**	-1.1	**-2.2**	-1.5	**-2.0**	-1.1	-1.3	-1.0	-0.6	0.2	-1.1
R^2		31.9%	18.9%	13.8%	47.0%	13.4%	16.5%	42.1%	23.3%	17.8%	63.8%	14.6%	64.9%

- For now: Look at it like a picture.
- Most equity lags: R1KVMG, SP500.
- YCLevel lags most.
- Fewer lags: YCSlope, credit.
- Mild improvement in explanatory power.
- Lag effects longer than 1 day?
  - ➤ Parametric

Other Notes, Whither Alpha?

- FI funds tend to be discernable from YCBump.
- For daily returns: many equity funds w/significant YCLevel.
  - FI managers surely hedge duration; not equity managers?
  - Seems to moderate for equity funds at monthly time scale.
- For daily returns, 4 significant alphas; for monthly: 1 significant.
- We are testing 12 funds; what is P(1 head|12 funds, p=0.05)?
  - P($\geq$1 significant $\hat{\alpha}$) $= 1 - (1 - 0.05)^{12} = 46\%$.
  - So does fund B have alpha? Not clear.
- Is the extra noise + opacity a bug. . . or feature?
  - Noise can obscure lack of alpha; eases selling "just a bad year."

▶ Parametric

Conclusion

- Seen how illiquidity complicates analysis.
- Illiquidity can make strategy appear to have alpha.
- Cross-asset factors are not confined to a particular asset class:
- Simplest approach: go to a coarser time grid.
- Better, if possible: use finer grid w/appropriate lags.
- Lag structure seems to vary by factor and fund.

Parametric