

# Gauging Form PF

## Data tolerances in regulatory reporting on hedge fund risk exposures

**Mark D. Flood (OFR)**

*Joint work with*

***Phillip Monin (OFR)***

***Lina Bandyopadhyay (FRB-Chicago)***

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**2015 RiskLab / BoF / ESRB Conference on Systemic Risk Analytics**

Helsinki, Finland – 25 September 2015

**Views and opinions expressed are those of the speaker and do not necessarily represent official OFR positions or policy.**

## Background on risk measurement for hedge funds

- Why measure hedge fund risks?
- How to measure hedge fund risks?

## What is Form PF?

- Structure of Form PF
- Industry summary

## Assessing risk measurement under Form PF

- Dispersion of risk under constraints (Form PF report)
- Benchmark funds – long-short, market-neutral, equities only
  - Momentum: Buy (sell) stocks with returns in the highest (lowest) quintile
  - Factor-alpha: Buy (sell) stocks in the highest (lowest) alpha quintile

## Wrap-up

- Results
- Next steps

## Anscombe's Quartet

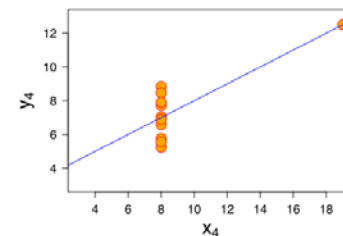
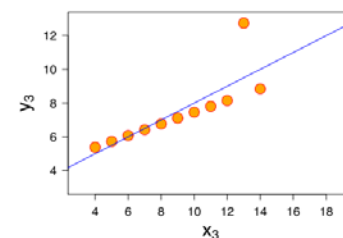
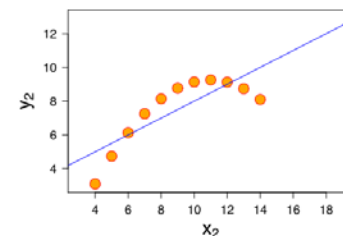
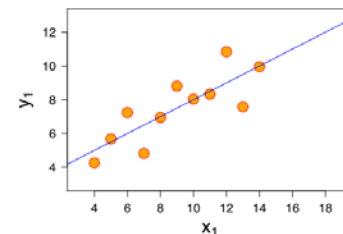


Image source : Wikipedia

# Why measure hedge fund risks?



## What is a “hedge fund”?

- Exemption under §3(c)(1) of the 1940 Act: <100 shareholders, no public offerings
- Exemption under §3(c)(7) of the 1940 Act: <2000 “qualified purchasers”

## Some history

- **Persistent growth over 25 years**
- **Concerns**
  - LTCM collapse
  - Madoff, Stanford scandals
- **Systemic risk debate**
  - House hearings (Mar/Jul/Oct 2007)
  - House hearings (Jul/Nov 2008)
  - Post-Lehman short-sale ban
- **Dodd-Frank Act §404 and Form PF**
  - Systemic risk (10)
  - Protection of investors (6)

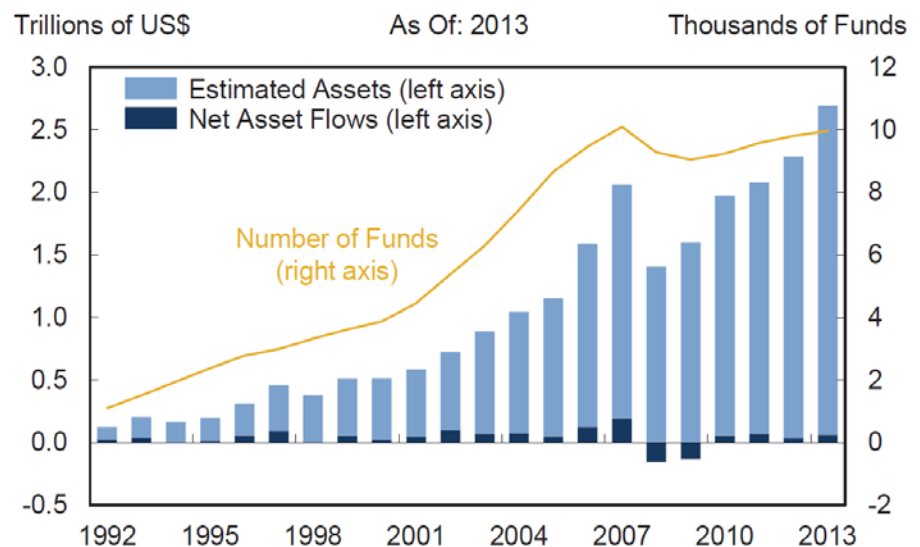


Image source : FSO 2014 Annual Report

## What about non-parametric distributions?

- Value at risk challenges
- Black swans and  $25\text{-}\sigma$  events

## Risk-adjusted performance measures

- Goetzmann, et al. (2007)
- Foster and Young (2010)

## Window dressing

- Munyan (2014) and Elton (2010)
- Patton and Ramadorai (2013)
- Bollen and Pool (2009)
- Agarwal, et al. (2013)

## Dimensionality mismatch

- Output space is infinite
- Regulatory reports are finite

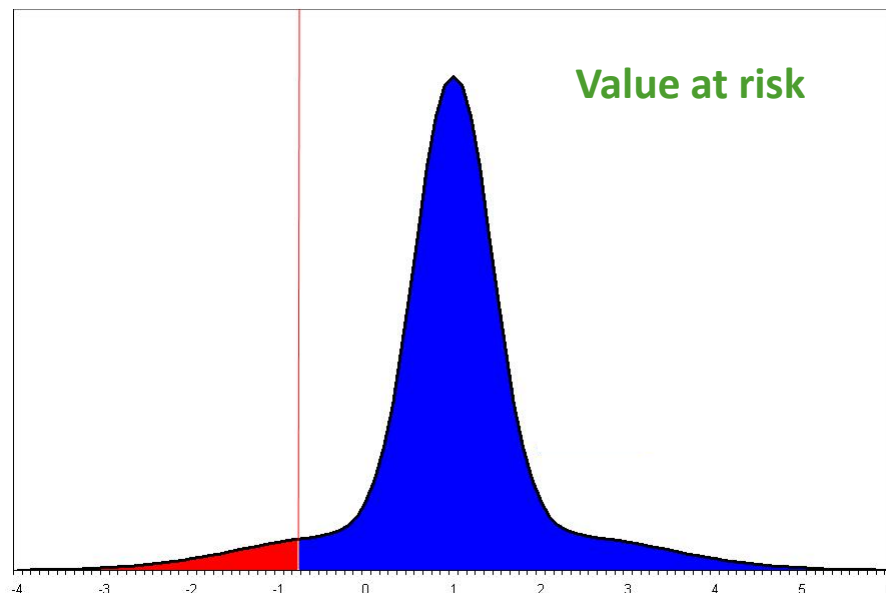


Image source : Wikipedia

Ideally (not reality), regulatory risk reports would form a sufficient statistic,  $t$

- $\mathbf{P}(X | t, \Theta) = \mathbf{P}(X | t)$  or, equivalently  $\mathbf{P}(\Theta | t, X) = \mathbf{P}(\Theta | t)$
- For example, for  $X \sim \mathbf{N}(\mu, \sigma)$  has:  $\Theta \equiv (\mu, \sigma)$  and  $t \equiv (\hat{\mu}, \hat{\sigma})$

## Traditional measurement tolerances

- Measurand has an unobserved true value,  $R^*$
- Measurement produces a noisy observation:

$$\tilde{R} = R^* + \tilde{\varepsilon}.$$

- Distribution of  $\tilde{\varepsilon}$  by repeated experimental observation

## Our challenges

- Portfolio risk is multidimensional (VaR, expected shortfall, etc.)
- Form PF measure is fixed – no repeated observations

## Our approach – constrained maximization of portfolio risk

- Fix a Form PF filing as a vector-valued constraint,  $\bar{R}$ ,
- Repeated **other** measures  $\hat{R}$  for portfolios satisfying  $\bar{R}$
- Dispersion of  $\hat{R}$  quantifies the measurement uncertainty

Form PF:

Others:

$$\begin{bmatrix} \bar{R}_1 \\ \vdots \\ \bar{R}_n \\ \hline \hat{R}_j \\ \vdots \\ \hat{R}_N \end{bmatrix}$$

## Coverage of Form PF:

- AUM
- NAV
- Financing
- Derivatives
- Concentrations
- Performance
- Strategy type
- Counterparties
- Asset class exposures
- Liquidity
- Sensitivity analysis
- VaR
- Investor liquidity

FORM PF (Paper Version) Reporting Form for Investment Advisers to Private Funds and Certain Commodity Pool Operators and Commodity Trading Advisors	OMB APPROVAL OMB Number: 3235-0679 Expires: December 31, 2014 Estimated average burden hours per response: 52.88
<b>Form PF: General Instructions</b> <span style="float: right;"><b>Page 1</b></span>	
Read these instructions carefully before completing Form PF. Failure to follow these instructions, properly complete Form PF, or pay all required fees may result in your Form PF being delayed or rejected.	
In these instructions and in Form PF, "you" means the <i>private fund adviser</i> completing or amending this Form PF. If you are a "separately identifiable department or division" (SID) of a bank, "you" means the SID rather than the bank (except as provided in Question 1(a)). Terms that appear in <i>italics</i> are defined in the Glossary of Terms to Form PF.	
<b>1. Who must complete and file a Form PF?</b>	
You must complete and file a Form PF, if:	
A. You are registered or required to register with the SEC as an investment adviser; <i>OR</i> You are registered or required to register with the CFTC as a CPO or CTA and you are also registered or required to register with the SEC as an investment adviser; <i>AND</i>	
B. You manage one or more <i>private funds</i> . <i>AND</i>	
C. You and your <i>related persons</i> , collectively, had at least \$150 million in <i>private fund assets under management</i> as of the last day of your most recently completed fiscal year.	
Many <i>private fund advisers</i> meeting these criteria will be required to complete only Section 1 of Form PF and will need to file only on an annual basis. <i>Large private fund advisers</i> , however, will be required to provide additional data, and <i>large hedge fund advisers</i> and <i>large liquidity fund advisers</i> will need to file every quarter. See Instructions 3 and 9 below.	
For purposes of determining whether you meet the reporting threshold, you are not required to include the <i>regulatory assets under management</i> of any <i>related person</i> that is <i>separately operated</i> . See Instruction 5 below for more detail.	
If your <i>principal office and place of business</i> is outside the United States, for purposes of this Form PF you may disregard any <i>private fund</i> that, during your last fiscal year, was not a <i>United States person</i> , was not offered in the United States, and was not beneficially owned by any <i>United States person</i> .	
<b>2. I have a <i>related person</i> who is required to file Form PF. May I and my <i>related person</i> file a single Form PF?</b>	
<i>Related persons</i> may (but are not required to) report on a single Form PF information with respect to all such <i>related persons</i> and the <i>private funds</i> they advise. You must identify in your response	

Image source : SEC

## Sections of Form PF

Section	Information about	To be completed by	Question	Regulator
1a	The filer and related persons	All Form PF filers	1–4	SEC & CFTC
1b	Private funds advised	All Form PF filers	5–17	SEC & CFTC
1c	Hedge funds advised	All Form PF filers that advise hedge funds	18–25	SEC & CFTC
2a	Aggregates on hedge funds advised	Large private fund advisers only	26–28	SEC & CFTC
2b	Qualifying hedge funds advised	Large private fund advisers only	29–50	SEC & CFTC
3	Liquidity funds advised	Large private fund advisers only	51–64	SEC only
4	Private equity funds advised	Large private fund advisers only	65–79	SEC only
5	Temporary hardship exemption request	Private fund advisers requesting exemption	---	SEC only

Image source : OFR analysis



## Aggregate hedge-fund exposures to equities and equity derivatives, Dec. 2013

- Investments in listed non-financials dominate

Investment Category	Long value at quarter end (\$ billions)	Short value at quarter end (\$ billions)
Listed equity – Issued by financial institutions	184.3	71.0
Listed equity – Other	1,009.5	485.7
Listed equity derivatives – Related to financial institutions	46.1	26.0
Listed equity derivatives – Other	469.2	349.3
Unlisted equities	128.1	1.6
Derivative exposures to unlisted equities	12.1	7.9
<b>Totals</b>	<b>1,849.3</b>	<b>941.4</b>

Image source : SEC, OFR analysis

## Number of Form PF filings by date, Q4 2013

- Majority of filings occur at the deadline (log scale)

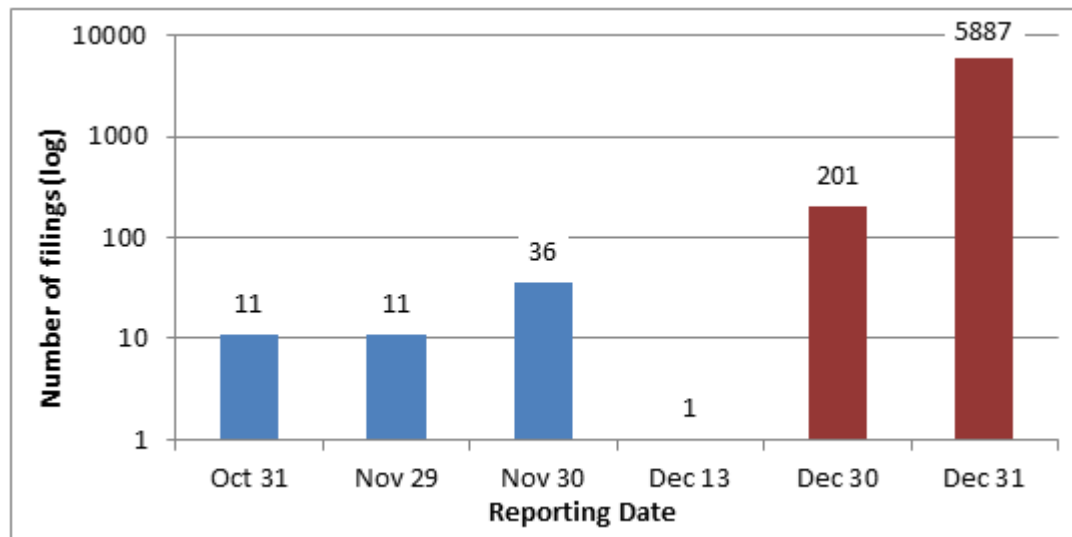


Image source : SEC, OFR analysis

## Aggregate hedge fund AUM as of Dec 2013, by fund strategy

- Equity strategies
- Event driven
- Relative value
- Macro
- Managed futures
- Credit
- Other

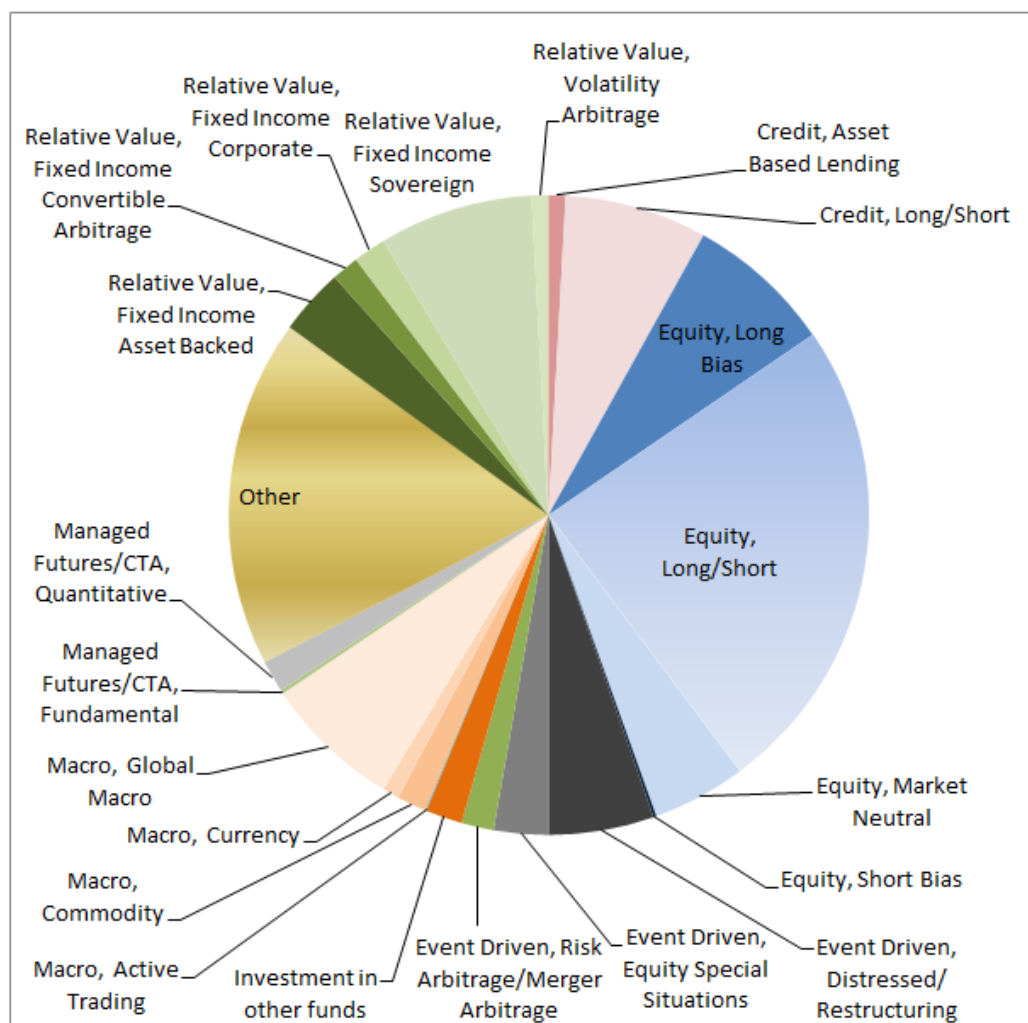


Image source : SEC, OFR analysis

## Aggregate hedge fund AUM as of Dec 2013, by fund strategy

- **Equity long/short dominates**
  - 24.31 percent of AUM
- **“Other” strategies are a very large component**
  - 17.60 percent of AUM

Fund Strategy	Aggregate \$AUM (\$ billions)	Percent	Number of Fund-strategies
Equity, Long/Short	995.0	<b>24.31%</b>	1482
Other	720.4	<b>17.60%</b>	1772
Relative Value, Fixed Income Sovereign	318.5	7.78%	221
Equity, Long Bias	303.5	7.42%	1008
Credit, Long/Short	294.5	7.20%	726
Macro, Global Macro	284.9	6.96%	454
Event Driven, Distressed/Restructuring	217.7	5.32%	729
Equity, Market Neutral	193.8	4.74%	250
Relative Value, Fixed Income Asset Backed	137.1	3.35%	390
Event Driven, Equity Special Situations	112.7	2.75%	356
Investment in other funds	76.0	1.86%	650
Relative Value, Fixed Income Corporate	67.8	1.66%	310
Event Driven, Risk /Merger Arbitrage	66.5	1.63%	221
Managed Futures/CTA, Quantitative	65.7	1.61%	183
Macro, Commodity	61.2	1.50%	215
Relative Value, Fixed Inc. Convert. Arbitrage	56.5	1.38%	183
Credit, Asset Based Lending	35.3	0.86%	252
Relative Value, Volatility Arbitrage	34.4	0.84%	127
Macro, Currency	34.3	0.84%	157
Managed Futures/CTA, Fundamental	8.2	0.20%	62
Equity, Short Bias	6.2	0.15%	46
Macro, Active Trading	2.4	0.06%	31
<b>Totals</b>	<b>4092.4</b>	<b>100.0%</b>	<b>9,825</b>

Image source : SEC, OFR analysis

## How much can actual risk vary, given a fixed picture on Form PF?

### Measure the actual risk of simulated funds (N = 100,000)

- Hedge funds: equities-only, long-short, market-neutral
- Filing Form PF on 12/31/2013
- \$500M in capital, \$450M to invest
- Cash equities only (CRSP), no derivatives
- Fixed leverage

### Two separate market-neutral strategies

- *Momentum screen*: Buy 25 (sell 20) stocks with returns in highest (lowest) quintile
- *Factor-alpha*: Buy 25 (sell 20) stocks in highest (lowest) Fama-French alpha quintile
- Cash collateral for shorts earns zero interest; no short rebate
- Shorts are equally weighted; choose weights for longs so that the total portfolio:
  - satisfies the “PF constraint”
  - remains beta- and dollar-neutral.

### Form PF Question 40 (value at risk)

- With VaR constraint
- Without VaR constraint

## Constraints on Form PF fields

**Our funds complete only a subset of all Form PF questions**

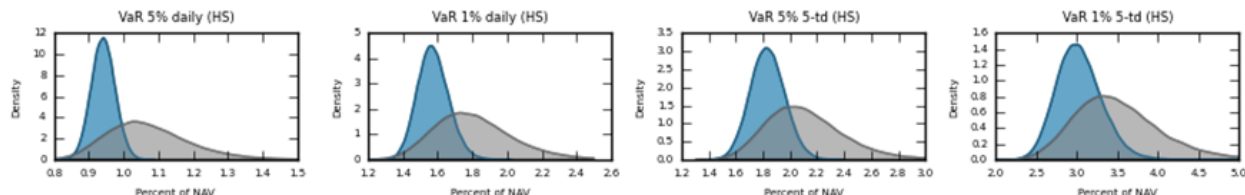
Form PF question	Description	Value
8	Gross asset value	\$950 million
9	Net asset value	\$500 million
12(a)	Dollar amount of total borrowings	\$450 million
13	Derivatives positions?	No
14	Level 1 Assets	\$950 million
	Level 1 Liabilities	\$450 million
19	Strategy category	Single primary strategy
20	Investment strategy	Equity, market neutral
26	Listed equity, issued by financial institutions LV	0
	Listed equity, issued by financial institutions SV	0
	Listed equity, other listed equity LV	\$450 million
	Listed equity, other listed equity SV	\$450 million
32	Liquidity – 1 day or less	100
35	Positions >5% NAV	N.A.
40	Value at risk (VaR)	$0.995 \leq 1\text{-day, } 5\%, \text{ parametric VaR} < 1.005$
41	Other risk metrics	ES, worst day, vol, skewness
42	Risk factors: Equity prices increase 5%	0
	Risk factors: Equity prices decrease 5%	0
	Risk factors: Equity prices increase 20%	0
	Risk factors: Equity prices decrease 20%	0
43(b)(i)(A)	Cash collateral posted with prime broker	\$500 million
43(b)(i)(B)	Securities collateral posted with prime broker	\$450 million
44	Aggregate derivatives	N.A.

# Results – Factor-alpha strategy

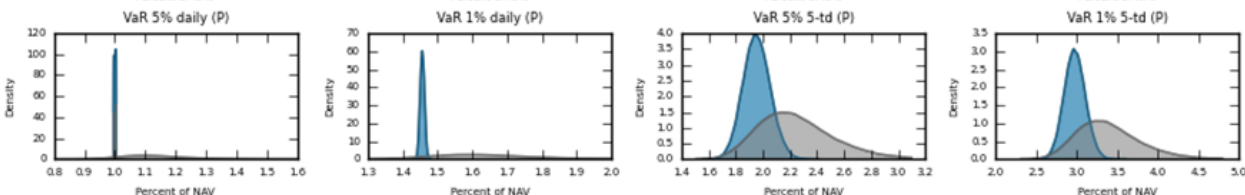


## Distributions of risk measures, factor-alpha strategy (N=100K)

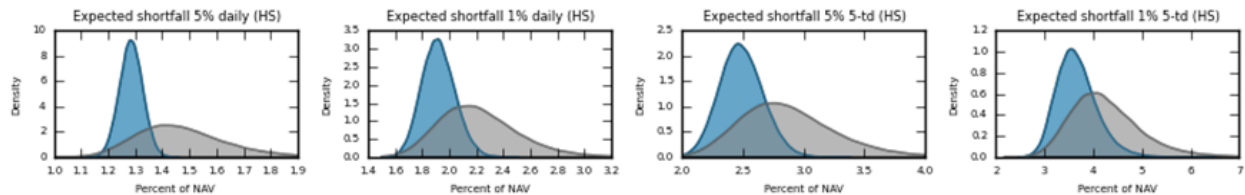
Value at Risk (HS):  
1-day and 5-day  
5% and 1%



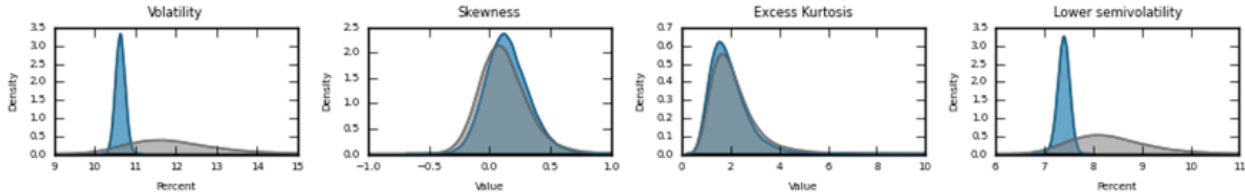
Value at Risk (P):  
1-day and 5-day  
5% and 1%



Expected shortfall (HS):  
1-day and 5-day  
5% and 1%



Distributional stats:  
volatility, skewness, excess kurtosis, lower semi-volatility



Worst loss (1-day, 5-day, 1 month)  
Sharpe ratio

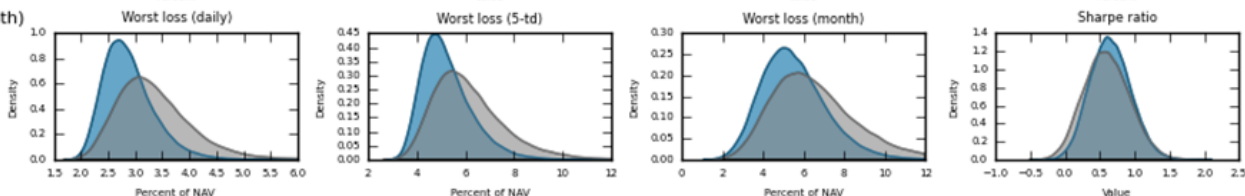
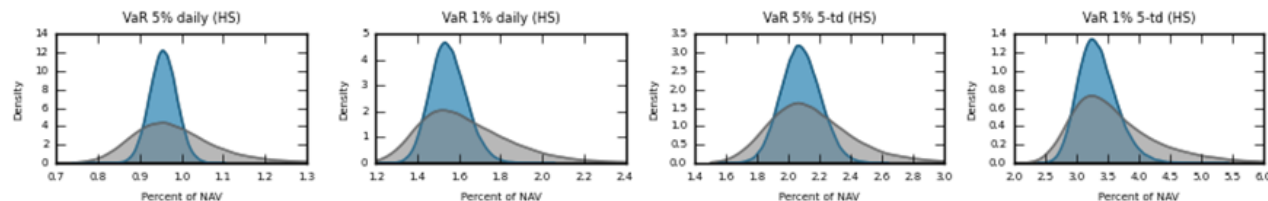


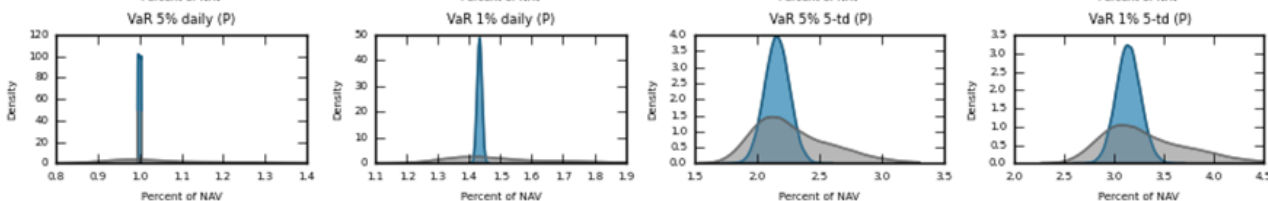
Image source : OFR analysis

## Distributions of risk measures, momentum strategy (N=100K)

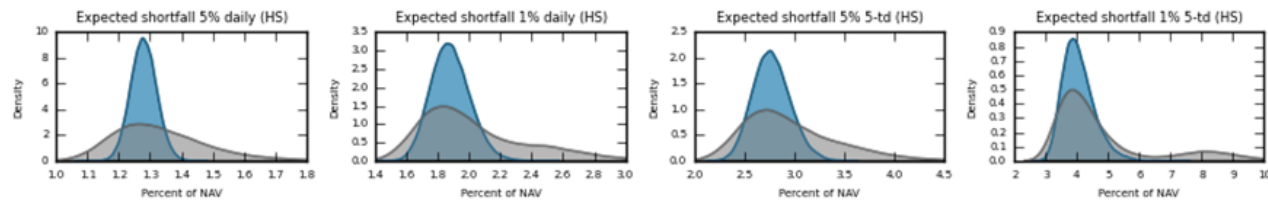
Value at Risk (HS):  
1-day and 5-day  
5% and 1%



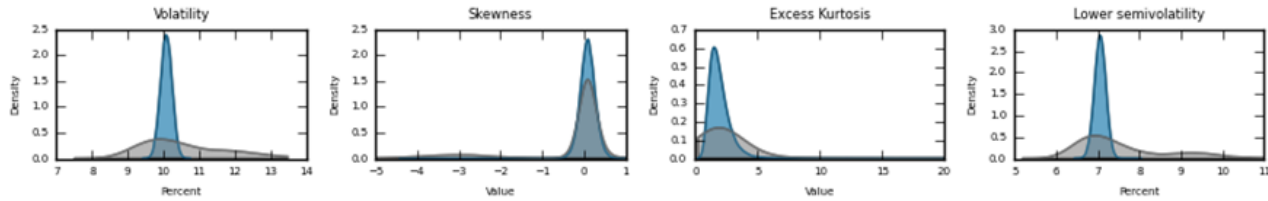
Value at Risk (P):  
1-day and 5-day  
5% and 1%



Expected shortfall (HS):  
1-day and 5-day  
5% and 1%



Distributional stats:  
volatility, skewness, excess kurtosis, lower semi-volatility



Worst loss (1-day, 5-day, 1 month)  
Sharpe ratio

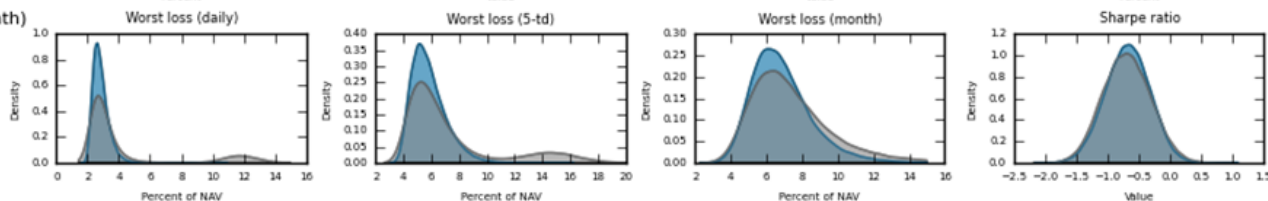


Image source : OFR analysis

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## Tolerance ratios – normalized measurement errors

- **TR1: Maximum scaled by median**

$$TR_1 = \frac{\max(Risk_j)}{\text{med}(Risk_j)} = \frac{\text{pct}_{100}(Risk_j)}{\text{pct}_{50}(Risk_j)}$$

- **TR2: Min-max range scaled by median**

$$TR_2 = \frac{\max(Risk_j) - \min(Risk_j)}{\text{med}(Risk_j)} = \frac{\text{pct}_{100}(Risk_j) - \text{pct}_0(Risk_j)}{\text{pct}_{50}(Risk_j)}$$

- **TR3: Interquartile range scaled by median**

$$TR_3 = \frac{\text{pct}_{75}(Risk_j) - \text{pct}_{25}(Risk_j)}{\text{pct}_{50}(Risk_j)}$$

# Distribution Summary – with VaR constraint



Risk measure	Factor alpha strategy									Momentum strategy										
	Avg	StD	Min	25%	50%	75%	Max	TR1	TR2	TR3	Avg	StD	Min	25%	50%	75%	Max	TR1	TR2	TR3
Value at Risk, hist. sim. 5% over 1 trading day	0.94	0.03	0.77	0.92	0.94	0.96	1.09	1.16	0.34	0.05	0.96	0.03	0.74	0.93	0.96	0.98	1.11	1.16	0.38	0.05
Value at Risk, hist. sim. 1% over 1 trading day	1.58	0.09	1.23	1.51	1.57	1.63	2.03	1.29	0.51	0.08	1.55	0.09	1.22	1.49	1.55	1.61	2.06	1.33	0.54	0.07
Value at Risk, hist. sim. 5% over 5 trading days	1.84	0.13	1.34	1.75	1.83	1.92	2.39	1.31	0.57	0.09	2.08	0.13	1.55	1.99	2.08	2.16	2.64	1.27	0.52	0.08
Value at Risk, hist. sim. 1% over 5 trading days	3.03	0.28	2.01	2.84	3.01	3.20	4.96	1.64	0.98	0.12	3.34	0.31	2.38	3.12	3.31	3.53	5.42	1.64	0.92	0.12
Value at Risk, parametric 5% over 1 trading day	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.01	0.01	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.01	0.01	0.01
Value at Risk, parametric 1% over 1 trading day	1.46	0.01	1.43	1.45	1.46	1.46	1.48	1.02	0.03	0.01	1.43	0.01	1.40	1.43	1.43	1.44	1.46	1.02	0.04	0.01
Value at Risk, parametric 5% over 5 trading days	1.95	0.10	1.55	1.89	1.95	2.02	2.42	1.24	0.44	0.07	2.16	0.10	1.72	2.09	2.16	2.22	2.60	1.21	0.41	0.06
Value at Risk, parametric 1% over 5 trading days	2.98	0.13	2.46	2.89	2.97	3.06	3.61	1.21	0.39	0.06	3.14	0.12	2.59	3.06	3.14	3.22	3.71	1.18	0.36	0.05
Expected shortfall 5% over 1 trading day	1.29	0.04	1.11	1.26	1.29	1.31	1.46	1.14	0.28	0.05	1.28	0.04	1.06	1.25	1.28	1.31	1.48	1.16	0.33	0.04
Expected shortfall 1% over 1 trading day	1.92	0.12	1.46	1.84	1.92	2.00	2.52	1.31	0.55	0.09	1.88	0.13	1.43	1.79	1.87	1.96	2.58	1.37	0.61	0.09
Expected shortfall 5% over 5 trading days	2.49	0.18	1.74	2.37	2.48	2.61	3.39	1.36	0.66	0.10	2.77	0.19	2.11	2.64	2.76	2.89	3.63	1.32	0.55	0.09
Expected shortfall 1% over 5 trading days	3.67	0.42	2.46	3.38	3.63	3.91	6.52	1.80	1.12	0.15	4.06	0.51	2.70	3.70	3.99	4.35	7.63	1.91	1.23	0.16
Volatility Annualized	10.6	0.12	10.1	10.5	10.6	10.7	11.1	1.05	0.09	0.02	10.0	0.16	9.43	9.97	10.0	10.1	10.7	1.07	0.13	0.02
Skewness 1 trading day	0.15	0.18	-0.69	0.03	0.14	0.26	1.67	12.3	17.4	1.71	0.10	0.19	-4.42	-0.02	0.10	0.22	1.86	19.2	64.9	2.43
Excess kurtosis 1 trading day	1.94	0.80	0.16	1.39	1.80	2.33	18.6	10.3	10.2	0.52	1.97	1.05	0.21	1.38	1.79	2.34	78.6	43.8	43.7	0.54
Lower semivol Annualized	7.40	0.12	6.74	7.32	7.40	7.49	7.95	1.07	0.16	0.02	7.06	0.14	6.44	6.97	7.06	7.15	8.05	1.14	0.23	0.03
Worst loss 1 trading day	2.88	0.47	1.70	2.55	2.82	3.14	6.70	2.38	1.77	0.21	2.84	0.51	1.63	2.48	2.75	3.10	10.9	3.98	3.38	0.23
Worst loss 5 trading days	5.24	1.03	2.79	4.51	5.07	5.81	11.8	2.34	1.79	0.26	5.83	1.24	3.09	4.93	5.62	6.51	16.2	2.89	2.34	0.28
Worst loss Monthly	5.53	1.60	1.09	4.40	5.36	6.48	18.5	3.46	3.26	0.39	6.87	1.72	2.29	5.67	6.62	7.77	19.6	2.97	2.62	0.32

Image source : OFR analysis

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# Distribution Summary – no VaR constraint



Risk measure	Factor alpha strategy									Momentum strategy										
	Avg	StD	Min	25%	50%	75%	Max	TR1	TR2	TR3	Avg	StD	Min	25%	50%	75%	Max	TR1	TR2	TR3
Value at Risk, hist. sim. 5% over 1 trading day	1.07	0.12	0.73	0.99	1.06	1.14	1.97	1.86	1.17	0.15	0.99	0.11	0.68	0.91	0.97	1.04	1.81	1.86	1.16	0.13
Value at Risk, hist. sim. 1% over 1 trading day	1.81	0.23	1.15	1.65	1.79	1.95	3.72	2.08	1.44	0.17	1.63	0.23	1.02	1.47	1.60	1.76	3.57	2.24	1.60	0.18
Value at Risk, hist. sim. 5% over 5 trading days	2.12	0.29	1.31	1.91	2.08	2.28	4.61	2.21	1.59	0.18	2.15	0.28	1.36	1.96	2.12	2.30	4.74	2.24	1.60	0.16
Value at Risk, hist. sim. 1% over 5 trading days	3.51	0.54	2.00	3.13	3.45	3.82	8.26	2.40	1.82	0.20	3.60	0.70	1.94	3.11	3.46	3.95	9.61	2.78	2.22	0.24
Value at Risk, parametric 5% over 1 trading day	1.14	0.12	0.80	1.05	1.12	1.20	2.30	2.06	1.34	0.13	1.06	0.14	0.74	0.96	1.03	1.14	2.10	2.05	1.33	0.18
Value at Risk, parametric 1% over 1 trading day	1.65	0.17	1.17	1.53	1.63	1.74	3.33	2.04	1.32	0.13	1.52	0.20	1.06	1.38	1.47	1.64	3.01	2.05	1.33	0.18
Value at Risk, parametric 5% over 5 trading days	2.25	0.29	1.43	2.05	2.22	2.42	4.77	2.15	1.51	0.17	2.29	0.34	1.52	2.05	2.23	2.49	5.17	2.32	1.64	0.19
Value at Risk, parametric 1% over 5 trading days	3.40	0.41	2.23	3.11	3.35	3.64	7.09	2.12	1.45	0.16	3.33	0.47	2.26	3.00	3.24	3.60	7.32	2.26	1.56	0.19
Expected shortfall 5% over 1 trading day	1.47	0.17	0.95	1.35	1.45	1.57	2.84	1.96	1.30	0.15	1.34	0.16	0.89	1.22	1.31	1.42	2.67	2.03	1.35	0.15
Expected shortfall 1% over 1 trading day	2.22	0.30	1.33	2.01	2.19	2.40	4.77	2.18	1.57	0.18	2.04	0.37	1.19	1.78	1.95	2.23	5.08	2.61	2.00	0.23
Expected shortfall 5% over 5 trading days	2.88	0.40	1.75	2.60	2.83	3.11	6.61	2.33	1.71	0.18	2.96	0.49	1.71	2.61	2.87	3.23	6.98	2.43	1.84	0.22
Expected shortfall 1% over 5 trading days	4.27	0.73	2.18	3.76	4.17	4.68	10.3	2.47	1.95	0.22	4.82	1.70	2.33	3.71	4.22	5.10	13.9	3.29	2.74	0.33
Volatility Annualized	11.9	1.17	8.67	11.1	11.8	12.5	23.8	2.02	1.29	0.12	10.6	1.37	7.37	9.68	10.3	11.4	21.2	2.04	1.33	0.17
Skewness 1 trading day	0.12	0.22	-1.29	-0.02	0.10	0.24	3.62	35.9	48.7	2.55	-0.37	1.21	-6.30	-0.12	0.06	0.20	5.00	80.0	181	5.10
Excess kurtosis 1 trading day	2.22	1.36	0.28	1.49	1.94	2.56	47.7	24.5	24.4	0.55	9.27	17.8	0.21	1.48	2.06	3.31	125	60.8	60.7	0.89
Lower semivol Annualized	8.35	0.83	5.89	7.76	8.25	8.83	15.7	1.91	1.19	0.13	7.59	1.14	5.20	6.78	7.26	8.14	14.7	2.03	1.31	0.19
Worst loss 1 trading day	3.36	0.71	1.68	2.87	3.26	3.73	13.6	4.20	3.68	0.27	4.32	3.29	1.42	2.54	2.96	3.76	16.4	5.57	5.09	0.42
Worst loss 5 trading days	6.15	1.47	2.65	5.10	5.91	6.93	17.2	2.92	2.47	0.31	7.33	3.50	2.65	5.05	6.06	7.90	22.0	3.64	3.20	0.47
Worst loss Monthly	6.60	2.19	1.32	5.04	6.27	7.79	23.8	3.81	3.59	0.44	7.43	2.34	2.26	5.79	6.97	8.54	27.9	4.00	3.68	0.39

Image source : OFR analysis

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## Precision of Form PF as a risk-measurement instrument

- **Novel portfolio simulation methodology**
  - Measure dispersion of actual risks
  - Form PF fields as a vector-valued constraint
- **Form PF has broad risk-measurement tolerances**
  - Significant “wiggle room”
  - Could obscure reporting funds’ actual risks

## Extending the methodology

- **Incorporate options and possibly other derivatives**
  - Form PF accounts for options using delta-adjusted notional values
- **Possible option strategies**
  - Capital Decimation Partners
  - Buying and selling volatility with option straddles
  - Compare:
    - Long stock + Long OTM put
    - Long stock + Short OTM put

**Thank you!**