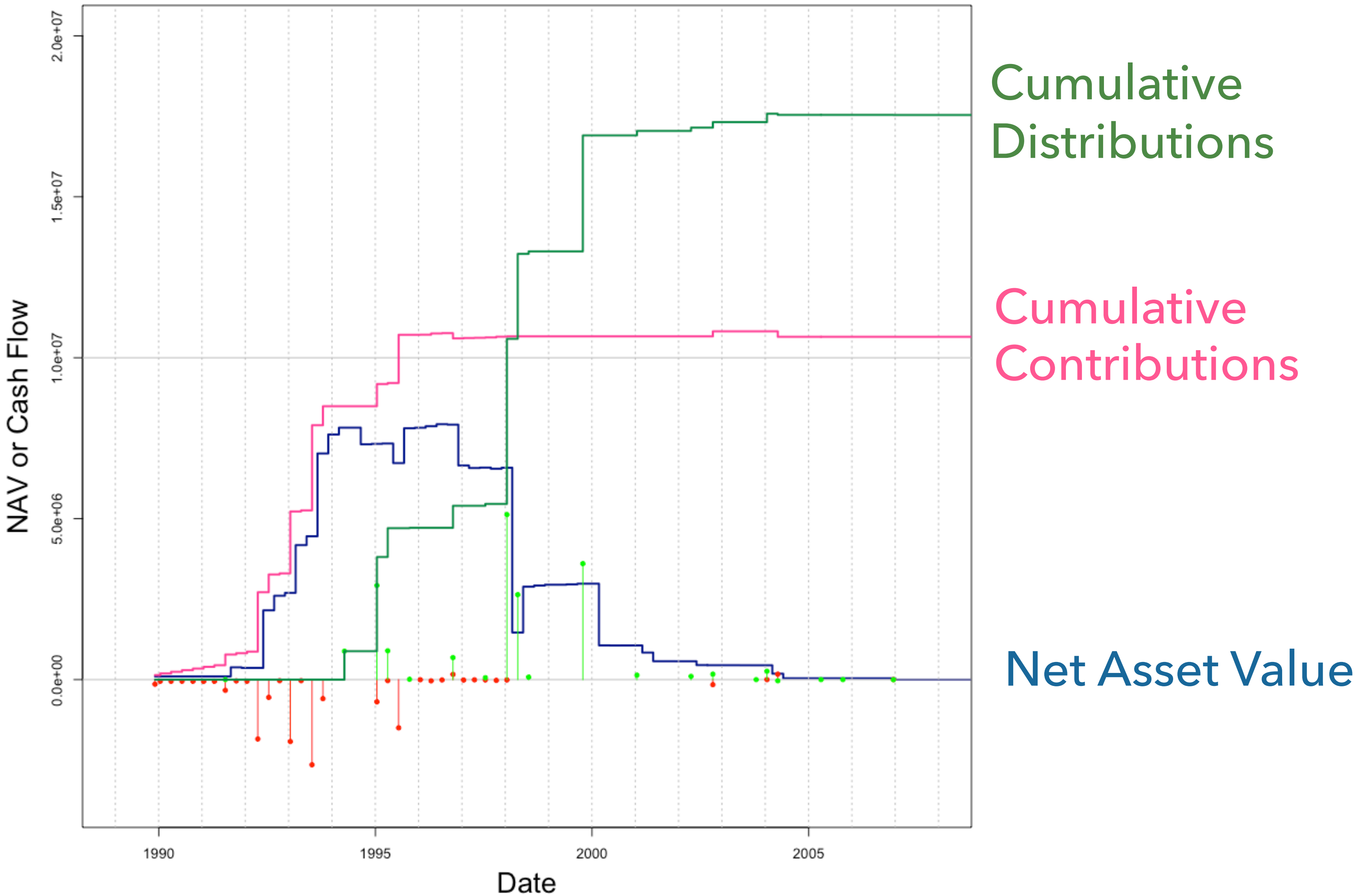
Private Capital Fund Risk Modeling

A simulation approach customized for the Solvency II framework

Focus On
Monte Carlo Simulation

Private Capital Fund Investment Style



Solvency II Framework

- The Solvency Capital Requirement (SCR) „shall correspond to the **Value-at-Risk** of the basic own funds of an insurance or reinsurance undertaking subject to a **confidence level of 99,5%** over a **one-year period**”. (*see Article 101 (3) of Directive 2009/138/EC*)

- Internal model for portfolio of Private Capital Funds

Performance Measure

- Standard Private Capital performance measures like TVPI and IRR are not suitable to measure performance/risk over a **one-year horizon**

- Performance measure has to incorporate intermediate Net Asset Values (NAVs) —> dubious

- NAV Return concept:

$$R_{t_n}^{NAV} = \frac{NAV_{t_n} + \triangle NCF_{t_n,4q}}{NAV_{t_{n-4q}}} - 1$$

Monte Carlo Simulation

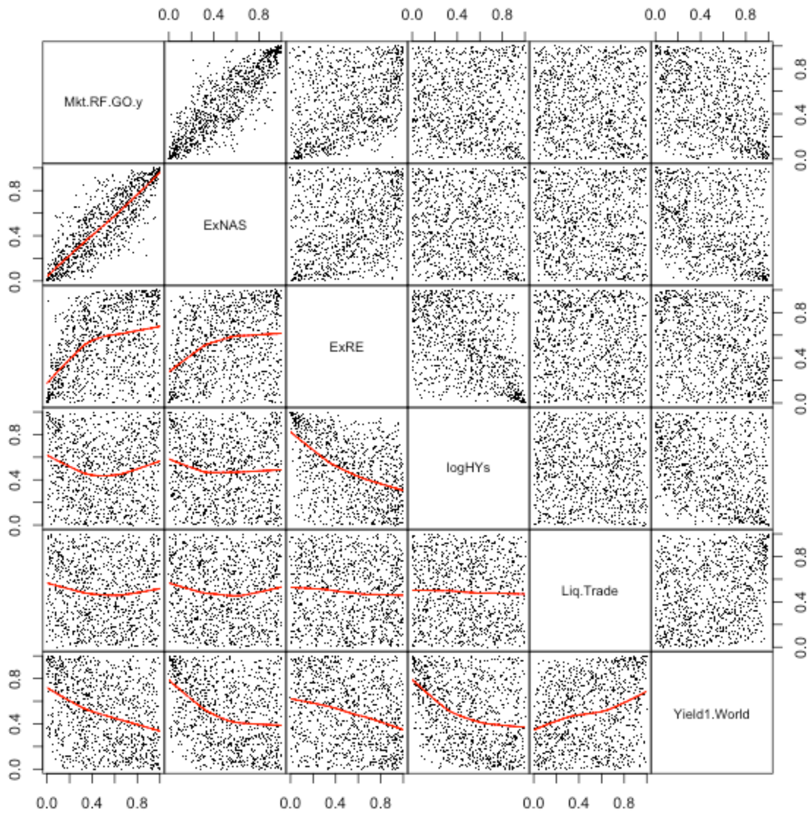
General Idea:

- Construct linear multi-factor models to decompose (excess) NAV Returns —> $Y = X\beta + \epsilon$
- Generate (reasonable, but random) X-scenarios
- Simulate (excess) NAV Returns —> $Y = \beta X + \epsilon$

X-generation

Copula:
Separate dependency modeling from specifying the marginal distribution

Pair-Copula-Construction
—> R-Vines
—> sophisticated



R Code: („VineCopula“ package)

PSC <- as.copuladata(pobs(Public.Data))	Data (Pre-)Processing
RVSS <- RVineStructureSelect(PSC)	Fit R-Vine Copula Model
pairs(RVineSim(1000, RVSS))	Simulate 1000 pairs of uniforms

AMT-factor-models

- AMTs: BO, VC, FoF, DD, RE, MEZZ, NatRes, Infra
- **Idea**: separate beta estimation from error modeling
  - **Beta estimation**: index time-series for each AMT
  - **Error modeling**: direct sampling from empirical residuals on single fund level

Beta Estimation

commitment weighted Index Quagging OLS-estimate

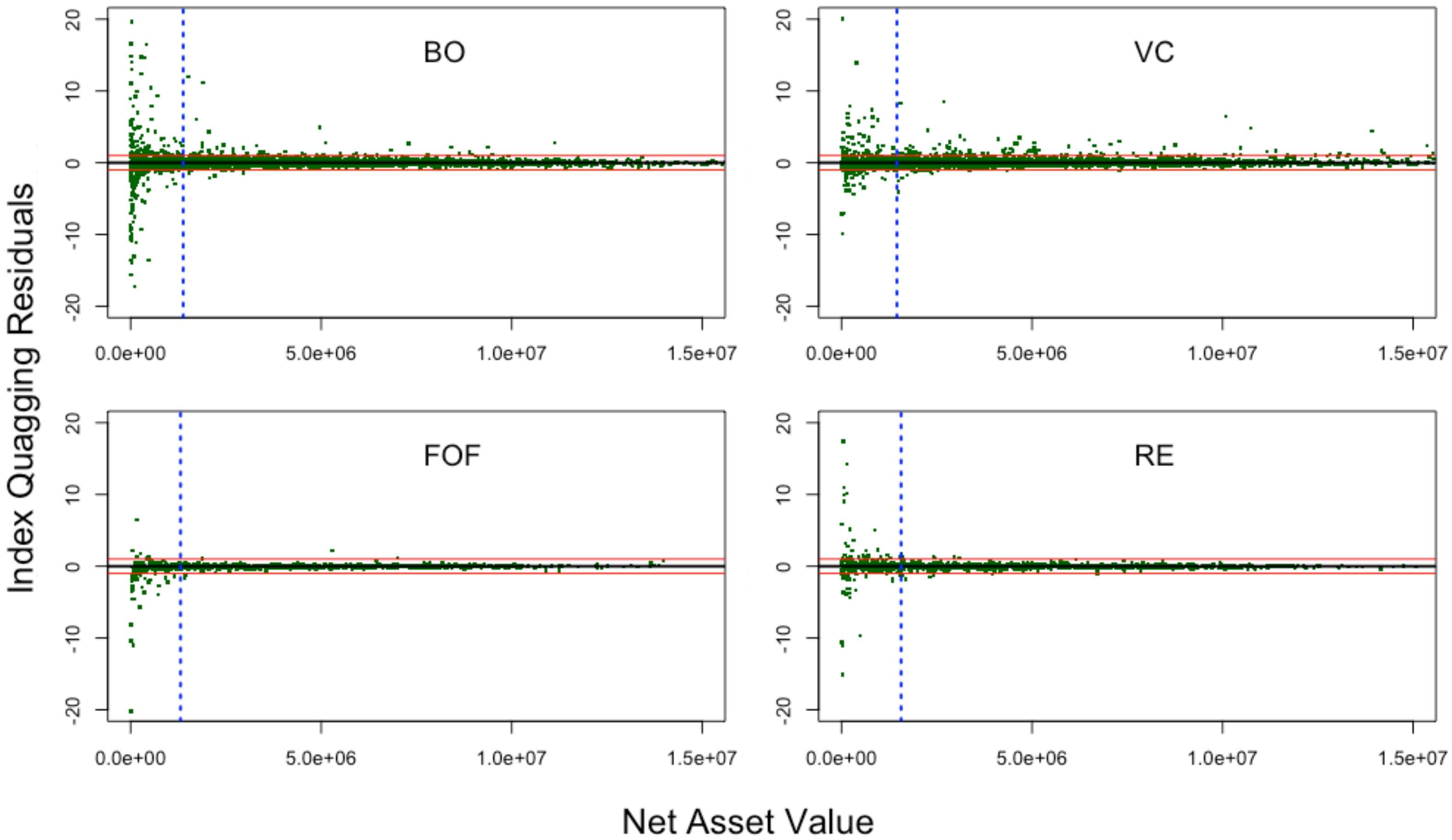
AMT	deterministic			stochastic							
	(Int)	Bias Corr	High Yield Spread	Excess Index Returns: World Equity	Excess Index Returns: NAS DAQ	Excess Index Returns: US-RE	Liq 10-1 PF	Q1 adj. R^2	Q2 adj. R^2	Q3 adj. R^2	Q4 adj. R^2
BO	0.188	?	-2.020	0.573	-	-	-	0.60	0.47	0.55	0.66
VC	0.300	?	-4.249	-	0.993	-	-	0.34	0.31	0.28	0.29
FOF	0.058	?	-	0.830	-	-	-	0.14	0.17	0.10	0.11
RE	0.141	?	-1.759	-	-	1.095	-	0.55	0.64	0.74	0.54
DD	-	?	1.036	0.562	-	-	-	0.62	0.63	0.62	0.61

commitment weighted Index Quagging MM-estimate

AMT	deterministic			stochastic							
	(Int)	Bias Corr	High Yield Spread	Excess Index Returns: World Equity	Excess Index Returns: NAS DAQ	Excess Index Returns: US-RE	Liq 10-1 PF	Q1 adj. R^2	Q2 adj. R^2	Q3 adj. R^2	Q4 adj. R^2
BO	0.191	?	-2.079	0.584	-	-	-	0.78	0.51	0.53	0.69
VC	0.191	?	-3.372	-	0.510	-	-	0.66	0.52	0.66	0.50
FOF	0.084	?	-	0.419	-	-	-	0.04	0.11	0.05	0.40
RE	0.113	?	-1.392	-	-	1.050	-	0.84	na	0.72	0.83
DD	-	?	0.963	0.580	-	-	-	0.64	0.65	0.67	0.78

Error Modeling I

Errors
i.i.d. ?



Resolve NAV-heteroscedasticity —> Filter: NAV-partition

Error Modeling II

1. NAV-heteroscedasticity —> Filter
2. Calculate residuals —> Bias?
3. Modeling
    - Parametric (normal mixture)
    - Non-parametric (direct sampling)
4. Review for each beta-model

Monte Carlo Model

$$\mathbf{Y}^{(MC)}(\vartheta) = \beta_{\vartheta_{AMT,\beta}} \mathbf{X}_{\vartheta_{\mathbf{X}}} + \epsilon_{\vartheta_{AMT,\beta,\epsilon}} \tag{20}$$

with

$$\beta_{\vartheta_{AMT,\beta}} = \left(\beta_{i=\left(\vartheta_{AMT,\beta}\right)_i, j}\right)$$

$$\mathbf{X}_{\vartheta_{\mathbf{X}}} = \left(X_{j=\left(\vartheta_X\right)_j}\right)$$

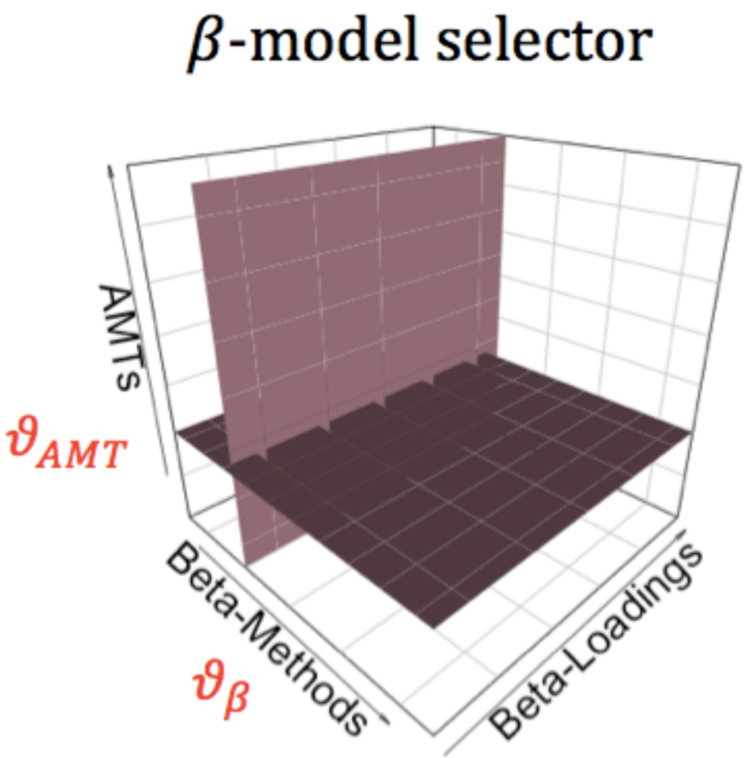
$$\epsilon_{\vartheta_{AMT,\beta,\epsilon}} = \left(\epsilon_{i=\left(\vartheta_{AMT,\beta,\epsilon}\right)_i}\right)$$

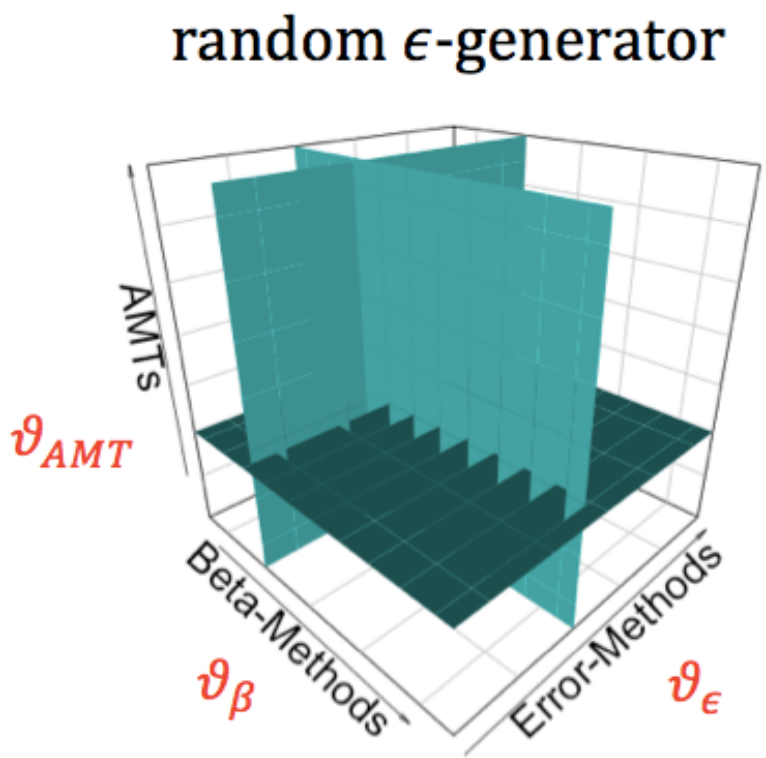
where $i \in [1, 2, ..., m]$, $j \in [1, 2, ..., d, d+1]$, m is the number of PCF portfolio components, and d is the (overall) number of factors in (all) MC β-models.

$$Y^{(PCF)} = \left(w_{NAV}\right)^T \mathbf{Y}^{(MC)} \tag{21}$$

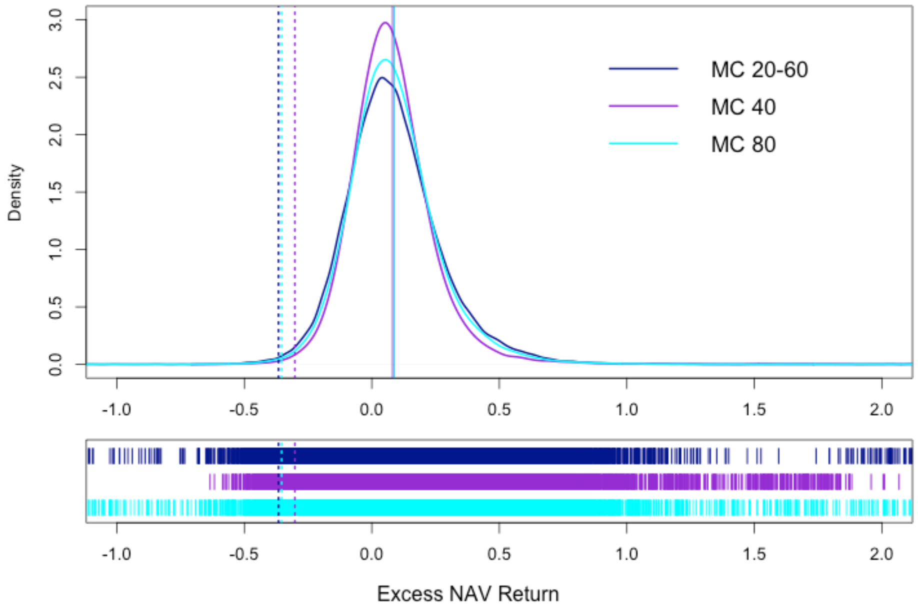
Beta-Model-Bagging

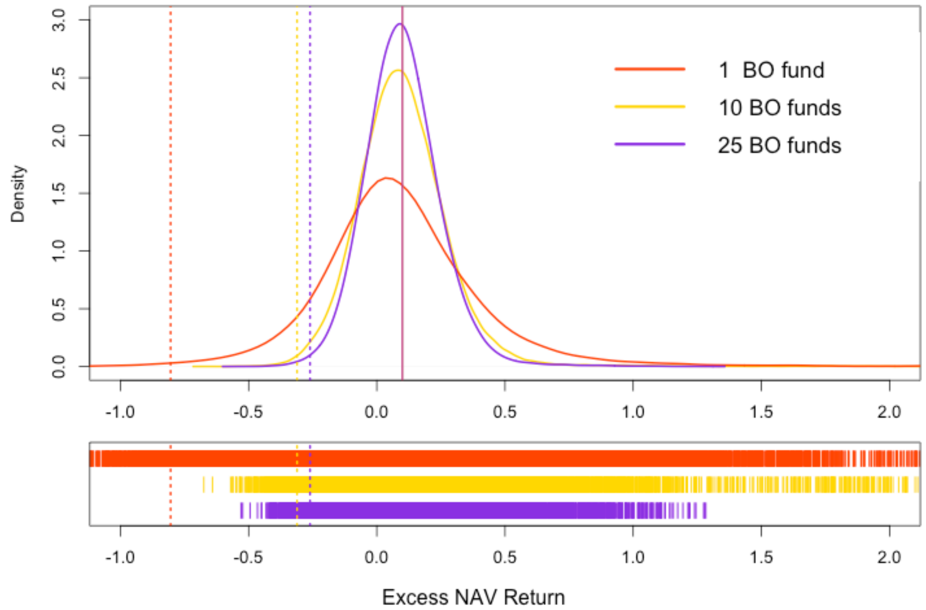
- Equivalent beta-models (4 quarters x 2 methods)
- Randomly sample out of the repertory of models
- But beta and error methods have to match

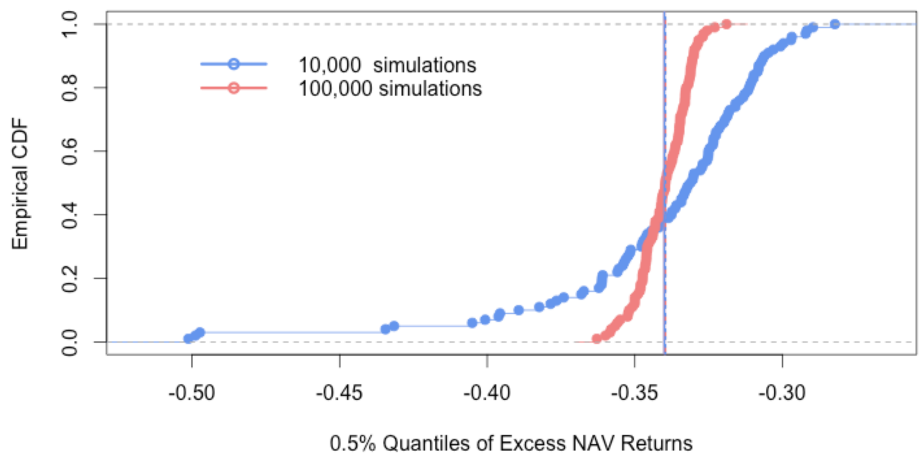


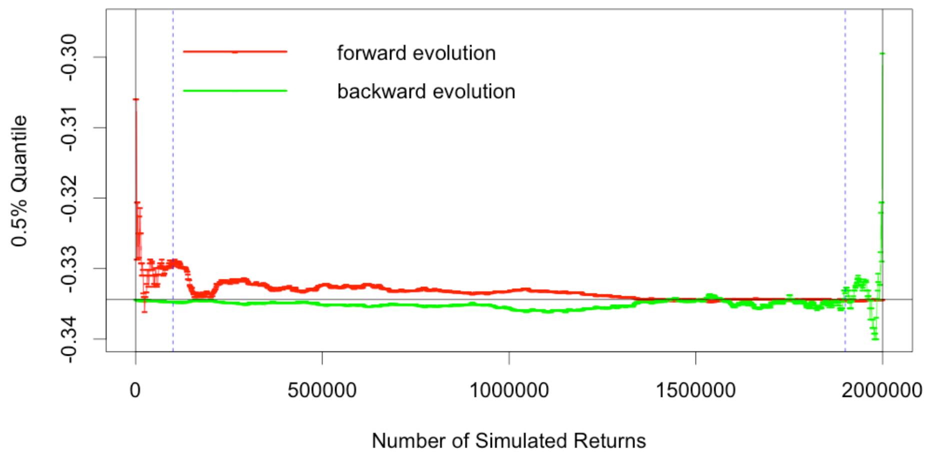


Monte Carlo Results









The end.