Refactoring FactorAnalytics

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Objectives

- Discuss history and scope of FactorAnalytics package.
- Describe improvements to fundamental factor models (FFM) functionality developed during the “polar vortex of code”.
- Contrast the Industry Standard factor Model (ISM) with the new Ding Martin 2017 factor model, implemented in FactorAnalytics.
- Compare results for the two methods, as implemented in FactorAnalytics.

FactorAnalytics package

- Part of the PerformanceAnalytics suite of packages under development since 2013, led by Professors Eric Zivot and Doug Martin with a number of University of Washington graduate students.
- Covers Fundamental, Statistical and Time-series factor models.
- Includes fitting and risk analysis techniques with extensions for a variety of volatility estimation, return standardization and exposure standardization methods.
- Was discussed at earlier R/Finance conferences, as a lightning talk in 2016 and in a Tutorial in 2017 by Doug Martin.

New FFM functionality

- Use objects to streamline and modularize the code: Specffm object to which one can apply methods to standardize, lag, fit etc.
- Code for FFM refactored to use data.table for the purposes of:
  - faster and cleaner implementation of the variety of fit methods, standardization procedures and variance estimation.
  - allowing for unbalanced panels so that you do not have to have stocks with data for the whole time period.
- Implemented rolling and parallelization functionality to fit large scale models over a rolling or expanding window.

Fundamental Factor Models Definitions

Traditional Cross-Section Model for Special Case of a Single Factor

Residual returns

$$r_{i,t} = f_t X_{i,t-1} + \varepsilon_{it}$$

$f_t = \frac{cov(r_{i,t}, X_{i,t-1})}{var(X_{i,t-1})}$ empirically proportional but $\neq IC_t$

D&M 2017 Cross-Section Model for Special Case of a Single Factor

$$\tilde{r}_{it} = r_{it} / \sigma_{r_{it}}$$

$$\tilde{r}_{it} = f_t z_{i,t-1} + \varepsilon_{it}, \quad i = 1, \cdots, N, \quad t = 1, \cdots, T$$

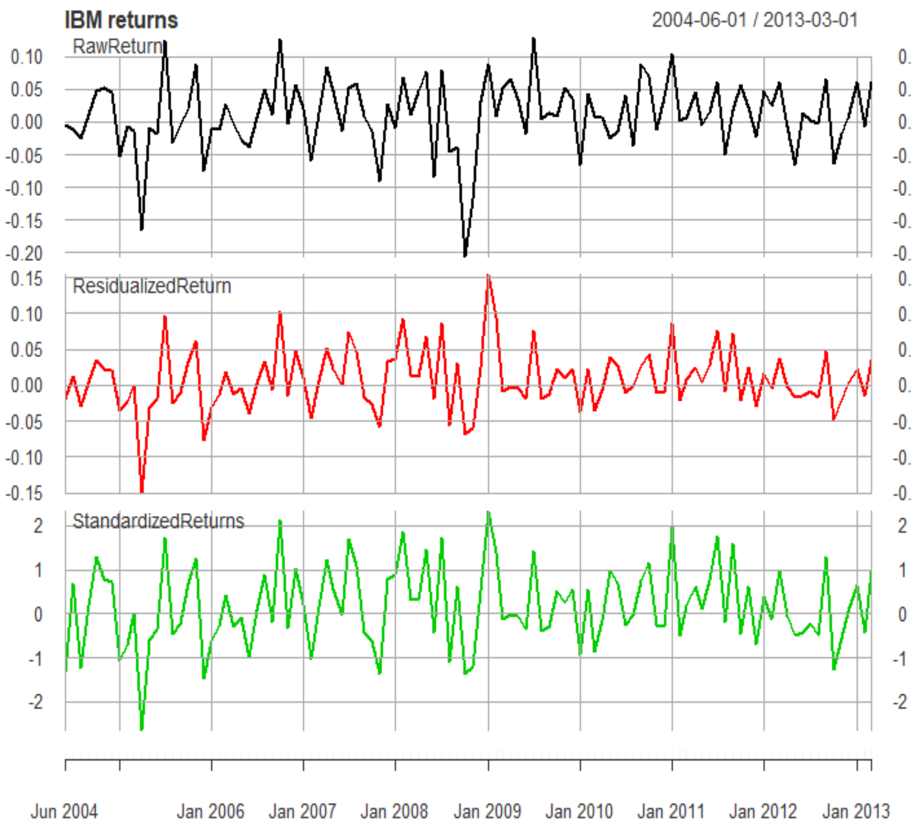
$\tilde{r}_{i,t} \sim N(0,1)$

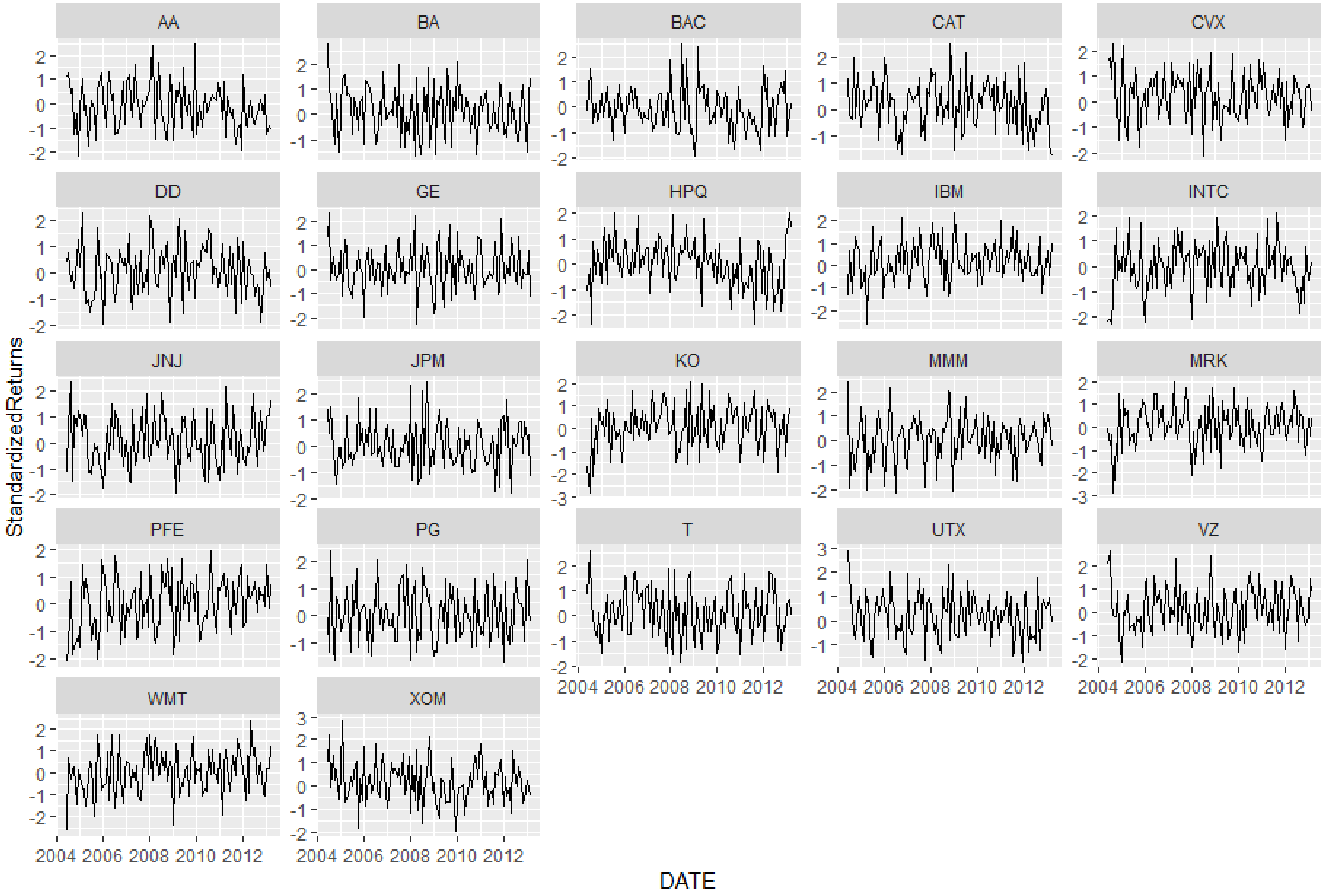
$z_{i,t-1} \sim N(0,1)$

$$f_t = \frac{cov(\tilde{r}_{i,t}, z_{i,t-1})}{var(z_{i,t-1})} = \frac{cov(\tilde{r}_{i,t}, z_{i,t-1})}{1 \times std(z_{i,t-1})} = \frac{cov(\tilde{r}_{i,t}, z_{i,t-1})}{std(\tilde{r}_{i,t}) std(z_{i,t-1})} = cor\left(\tilde{r}_{i,t}, z_{i,t-1}\right) = IC_t$$

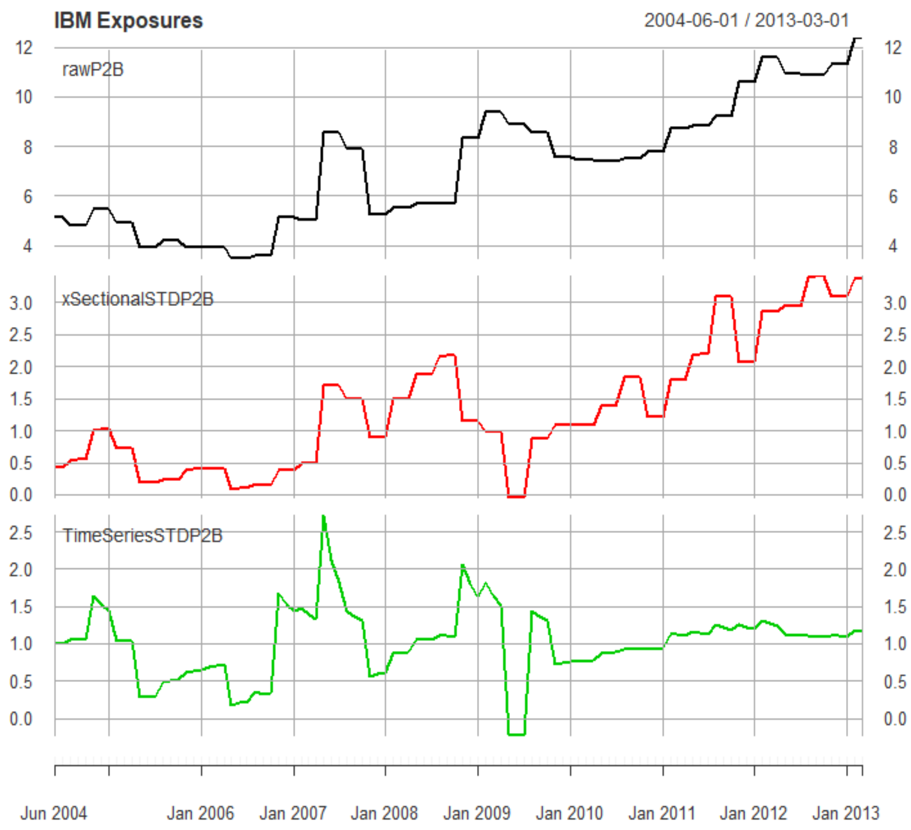
- *One unit of risk adjusted exposures to explain one unit of risk adjusted return for every asset*
- *Prevents high volatility assets from having undue influence*
- *This relates expected conditional return vector* $\alpha_{i,t}$ to IC's since $\alpha_{i,t} = f_t z_{i,t-1}$ *multiplied by* $\sigma_{r_{it}}$

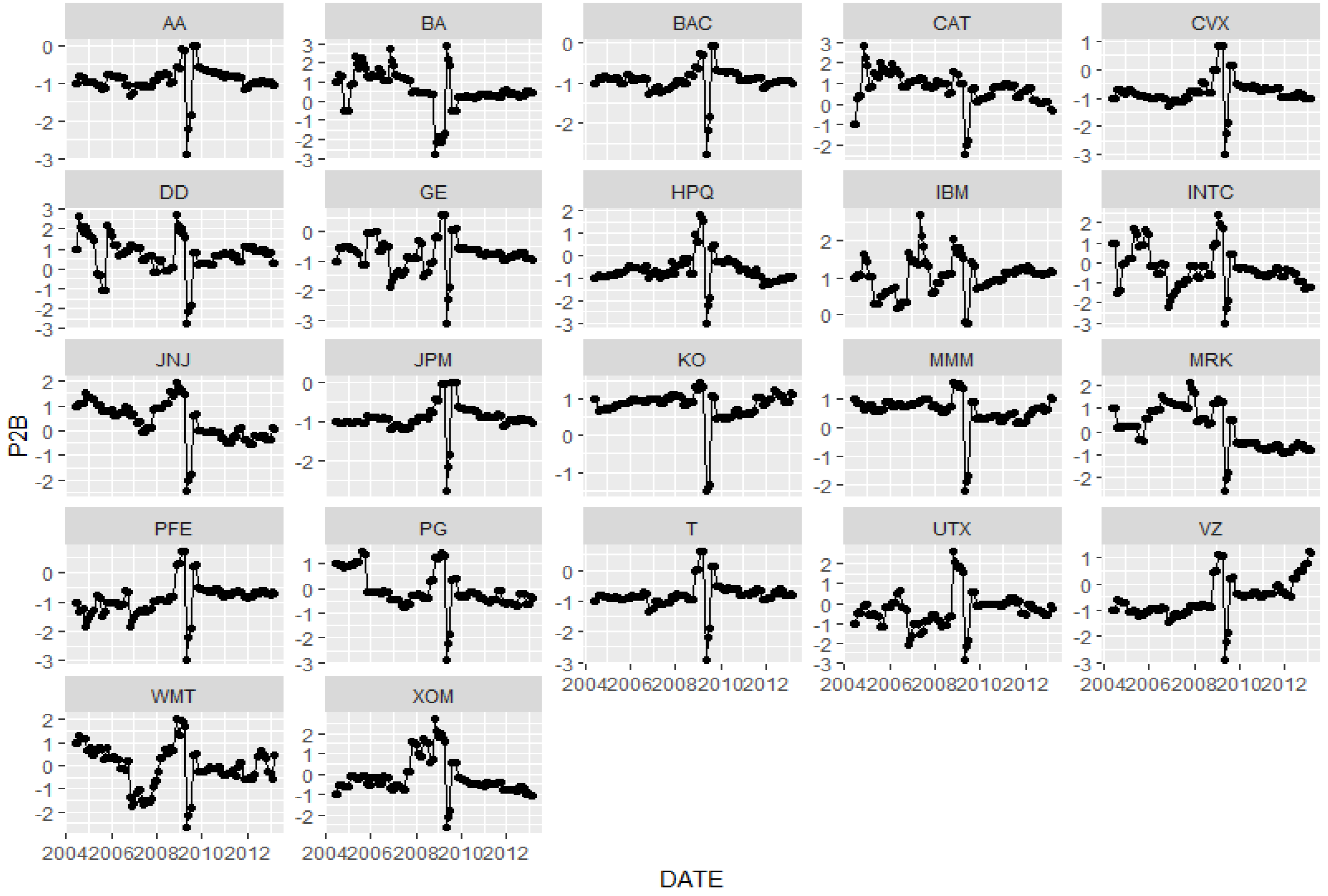
Return Standardization methods





Exposure Standardization methods





Simulation Results: 300 US stocks 1994-2015

Factor	Model	N	mean(IC)	std(IC)	IR_GK	IR_Inf	IR_N	IR_sim
BP	New	300	0.018	0.127	0.31	0.14	0.13	0.86
BP	ISM	300	0.025	0.145	0.43	0.17	0.16	0.56
EP	New	300	0.026	0.112	0.44	0.23	0.20	0.56
EP	ISM	300	0.016	0.139	0.28	0.12	0.11	0.08
DivYield	New	300	0.026	0.150	0.45	0.17	0.16	0.17
DivYield	ISM	300	0.003	0.153	0.05	0.02	0.02	0.28
EBITDAEV	New	300	0.031	0.113	0.53	0.27	0.24	0.82
EBITDAEV	ISM	300	0.014	0.079	0.24	0.17	0.14	0.48
PM12M1M	New	300	-0.002	0.156	-0.03	-0.01	-0.01	0.25
PM12M1M	ISM	300	-0.004	0.181	-0.07	-0.02	-0.02	0.15

Asymptotic IR, IR_Inf: $N \rightarrow \infty$ $\qquad IR = \frac{IC}{\sigma_{IC}}$

Ding and Martin IR, IR_N: $IR = \frac{\mu_{IC}}{\sqrt{\sigma_{IC}^2 + \sigma_\epsilon^2 / N}} = \frac{\mu_{IC}}{\sqrt{\sigma_{IC}^2 + (1 - \mu_{IC}^2 - \sigma_{IC}^2) / N}}$

Grinold and Kahn IR, IR_GK:IR $\frac{IC}{\sqrt{1 - IC^2}} \sqrt{N} \sim IC\sqrt{N}$

References

Ding, Zhuanxin & Martin, R. Douglas, 2017. "**The fundamental law of active management: Redux**," Journal of Empirical Finance, Elsevier, vol. 43(C), pages 91-114.