Factor Strength and Factor Selection

An Application to U.S. Stock Market

Research Plan Presentation

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Introduction and Motivation

Capital Asset Pricing Model (CAPM) is the benchmark of risk pricing.

$$r_{it} - r_{ft} = a_i + \beta_{im}(r_{mt} - r_{ft}) + \sum_{j=1}^{k} \beta_{ij} f_{jt} + \varepsilon_{it}$$

New factors are added into the model to enhance risk pricing.

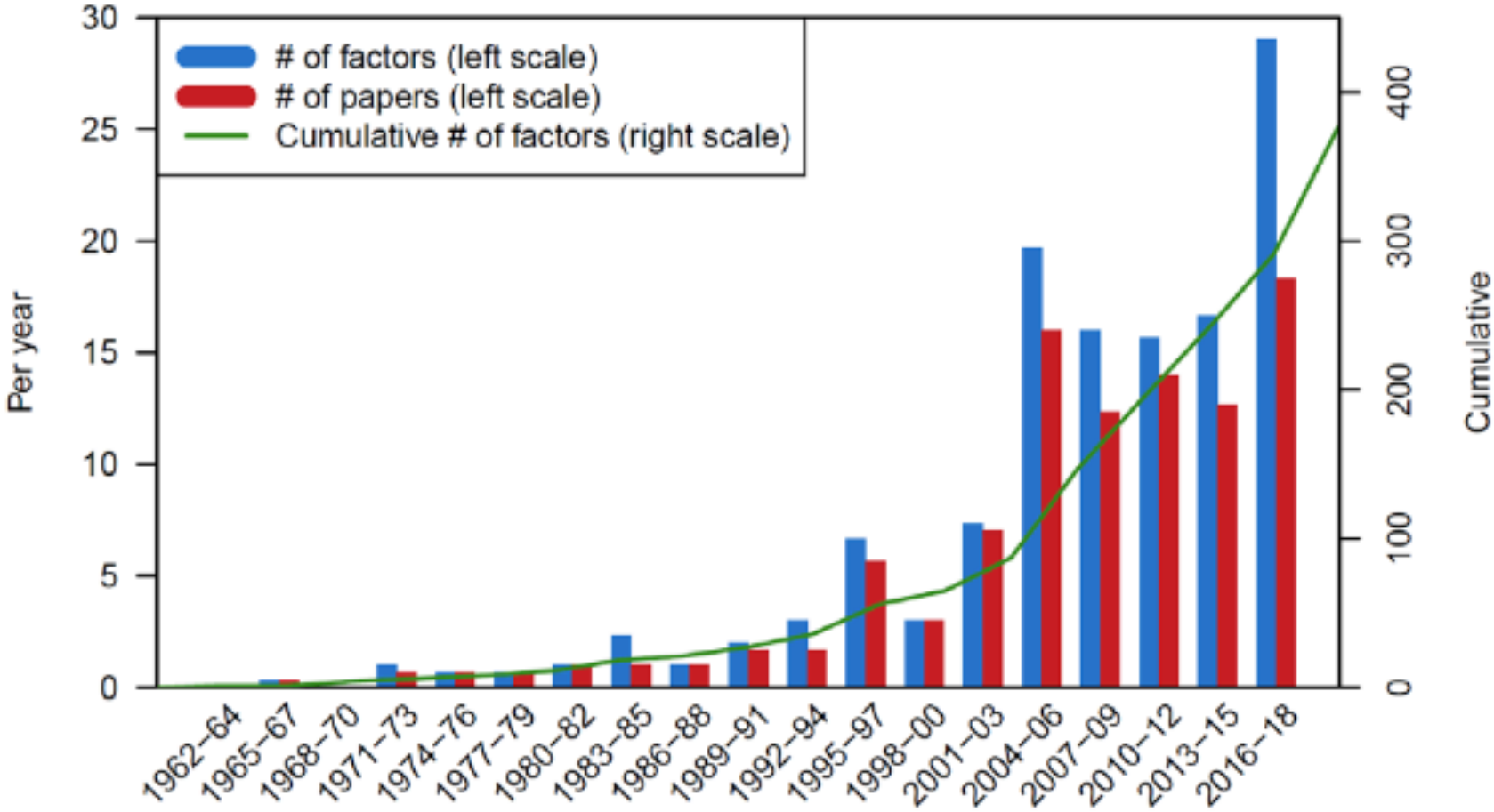

Figure: Factor amount growing through the year.

(Harvey & Liu, 2017)

Factor Strength

Factor strength $\alpha \in [0, 1]$ is the factor's pervasiveness.(Pesaran & Smith, 2019)
Strong factor $\Rightarrow$ price more asset's risk $\Rightarrow$ generate more significantly loadings.
Assume we have N different assets.

$$\beta_j \neq 0, j = 1, 2, 3, \cdots, [N^{\alpha_j}]$$
$$\beta_j = 0, j = [N^{\alpha_j}] + 1, [N^{\alpha_j}] + 2, [N^{\alpha_j}] + 3, \cdots, N$$

Introduction and Motivation

But some problems exist among all those factors.

- Including Factor without correlation with return in FM first-regression(Fama & MacBeth, 1973) will yield misleading second regression result (Kan & Zhang, 1999)
- If the factor loading is small, estimated risk premia will be spurious Kleibergen (2009)

Literature

- **Consequences of including weak factors**
  Kan and Zhang (1999), Kleibergen (2009), Kleibergen and Zhan (2015), Gospodinov, Kan, and Robotti (2017), Anatolyev and Mikusheva (2018)
- **Identify factors**
  Harvey, Liu, and Zhu (2015), McLean and Pontiff (2016), Harvey and Liu (2017), Barillas and Shanken (2018),Pukthuanthong, Roll, and Subrahmanyam (2019)
- **Using machine learning method**
  Rapach, Strauss, and Zhou (2013), Feng, Giglio, and Xiu (2019),Gu, Kelly, and Xiu (2020), Lettau and Pelger (2020), Freyberger, Neuhierl, and Weber (2020), Kozak, Nagel, and Santosh (2020)

Main Problem

This project faces two challenges:

1. High dimensions of data group
   How to identify the significant one. $\Rightarrow$ use factor strength as criteria.
2. Correlation among factors
   Traditional variable selection algorithm (Lasso) can not handle this.

Elastic Net

Introduce by Zou and Hastie (2005), is a improved method to select factor.

$$\hat{\beta}_{ij} = \arg\min_{\beta_{ij}} \{ \sum_{i=1}^{n} [(r_{it} - r_{ft}) - \beta_{ij} f_{jt}]^2 + \lambda_2 \sum_{i=1}^{n} \beta_{ij}^2 + \lambda_1 \sum_{i=1}^{n} |\beta_{ij}| \}$$

The L_1 norm $\sum_{i=1}^{n} |\beta_{ij}|$ helps select the factor, reduce redundancy.
The L_2 norm $\sum_{i=1}^{n} \beta_{ij}^2$ helps handle the correlation.

Preliminary Result

Use Monte Carlo simulation to study the property of estimated factor strength.

- Overestimates occurs when strength is low
  $\alpha = 0.5, \hat{\alpha} \approx 0.7$
- But the precision improved with strength increase
  $alpha = 0.7, \hat{\alpha} = 0.8$
- When we have the strong factor, we have the unbiased estimator $\alpha = \hat{\alpha} = 1$

Future Plan

For the next step, we will start the empirical analyses.
We will collect and exam the data for the empirical research.
Assets: **Companies from Standard & Poor (S&P) 500 index**
We will use those securities return as the left hand side part of the CAPM.
Factor: **Factors from Harvey and Liu (2019)'s factor list**
Using factor strength as the criterion to trim first, and then applied the elastic net method.

Thanks for listening

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