Understanding Momentum and Reversal

Authors: Bryan Kelly, Tobias Moskowitz, and Seth Pruitt

Discussant: **Andrei S. Gonçalves**

FRA 2019

Outline

Once Upon a Time...

- CAPM:

$$\mathbb{E}_t[r_{i,t+1}] \; = \; \beta_i^m \cdot \overline{R_m - R_f}$$

- CAPM Anomalies:

$$\mathbb{E}_t[r_{i,t+1}] \; = \; a \; + \; b \cdot z_t$$

- Fama and French (1993, JFE):

"One of our central themes is that if assets are priced rationally, **variables that are related to average returns...must proxy for sensitivity to common risk factors** in returns"

$$\mathbb{E}_t[r_{i,t+1}] \; = \; \beta_i^m \cdot \overline{R_m - R_f} \; + \; \beta_i^h \cdot \overline{HML} \; + \; \beta_i^s \cdot \overline{SMB}$$

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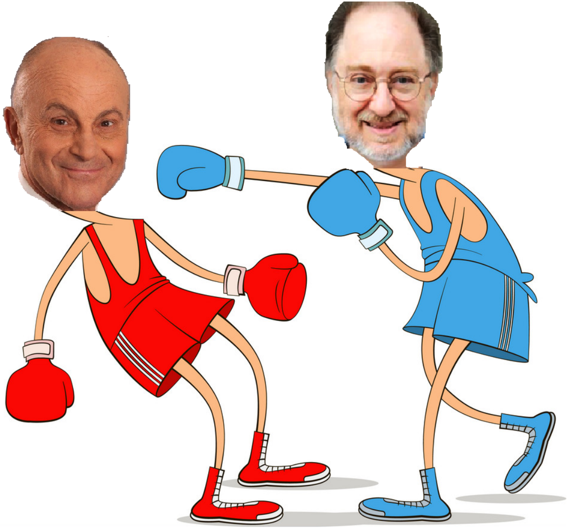

The "βs vs Characteristics" Fight Begins...

- Davis, Fama, and French (2002, JF)

The "βs vs Characteristics" Fight Begins...

- ...and the fight is still happening

Cross-Sectional Asset Pricing with Individual Stocks: Betas versus Characteristics

61 Pages • Posted: 15 Jan 2015 • Last revised: 14 Jan 2019

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Date Written: November 2017

Abstract

We develop a methodology for bias-corrected return-premium estimation from cross-sectional regressions of individual stock returns on betas and firm characteristics. Over the period 1963-2014, there is some evidence of a negative premium on the size factor and positive beta premiums for the profitability and investment factors as well as the market factor (though not for the CAPM). There is no pricing evidence for the book-to-market and momentum factors with all characteristics included. Characteristics consistently explain a much larger proportion of variation in estimated expected returns than factor loadings, even with time-varying return premia

Keywords: Asset Pricing, Individual Stocks, Factor Loadings, Characteristics, Errors-in-Variables

JEL Classification: G10, G12

Momentum: Fama's Achilles Heel

- Eugene Fama in an interview at Chicago Booth Review:

  "...[**momentum**] could be explained by risk, but if it's risk, **it changes much too quickly** for me to capture it in any asset-pricing model"

- Firm momentum lasts for only a few months

- Paper's Insight: because momentum "changes much too quickly", one needs a **conditional** asset-pricing model that allows firm-level βs to change quickly as well

- The paper explains momentum (and reversal) using the Instrumented PCA model of Kelly, Pruitt, and Su (2019, JFE)

- **Conclusion**: "momentum and long-term reversal...[are] explained by conditional betas in a no-arbitrage factor model"

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Is Momentum Empirically Linked to β?

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Tables I & II
Predicting Realized Beta With Momentum

	Factor				
	MKTRF	SMB	HML	RMW	CMA
One-month					
Slope	0.19	−0.01	−0.08	0.18	−0.01
	(9.72)	(−0.54)	(−2.31)	(4.83)	(−0.17)
R^2 (%)	0.04	0.00	0.01	0.01	0.00
Adjusted R^2 (%)	7.44	0.01	1.86	1.86	0.02
Twelve-month					
Slope	0.14	−0.09	−0.10	0.24	−0.12
	(9.47)	(−4.80)	(−4.00)	(9.38)	(−3.90)
R^2 (%)	0.19	0.03	0.05	0.09	0.02
Adjusted R^2 (%)	3.97	0.63	1.04	1.88	0.42
Multivariate Reg					
Slope	0.18	0.12	−0.06	0.05	0.05
	(9.97)	(5.23)	(−1.77)	(1.33)	(1.21)
R^2 (%)	1.90	0.46	0.25	0.24	0.10
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Instrumented PCA

- We can model the link between βs and characteristics in a **conditional** factor model (e.g., Lewellen 1999):

$$r_{i,t+1} \;=\; \beta_{i,t} \cdot f_{t+1} \;+\; \widetilde{\epsilon}_{i,t+1}$$

with

$$\mathbb{E}_t[r_{i,t+1}] \;=\; \beta_{i,t} \cdot \lambda$$

and

$$\beta_{i,t} \;=\; z^{'}_{i,t}\Gamma_{\beta}$$

- Kelly, Pruitt, and Su (2019, JFE) generalize this method to estimate the fs in the process instead of prespecifying them

- Their method (called IPCA) is effectively a PCA that allows βs to depend on firm-level characteristics

- The model implies z affects expected returns only through β

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The "βs vs Characteristics" Test for Momentum

- Momentum is a signal for $\mathbb{E}[r]$:

$$r_{i,t} = \mathbb{E}_{t-1}[r_{i,t}] + \epsilon_{i,t}$$

- Under the IPCA model, however, this happens because Momentum proxies for β:

- To perform the "βs vs Characteristics" test, the paper compares three $\mathbb{E}[r]$ signals:

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Momentum vs $\beta' \lambda$

Momentum vs $\beta'\lambda$

Table III
Momentum and the IPCA Model

A. Univariate Regressions

	Raw signal			Rank signal		
	$\bar{r}$	$\beta'\lambda$	$\bar{\epsilon}$	$\bar{r}$	$\beta'\lambda$	$\bar{\epsilon}$
Constant	0.01	0.00	0.01	0.01	0.01	0.01
(t-stat)	(3.87)	(0.74)	(4.05)	(4.06)	(4.04)	(4.06)
Coeff	0.00	0.86	−0.00	0.87	1.92	0.72
(t-stat)	(0.12)	(11.48)	(−0.04)	(3.39)	(11.10)	(2.83)
R^2 (%)	0.00	0.13	0.00	0.02	0.12	0.02

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	Average return			Sharpe ratio		
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Q1	5.97	0.01	6.81	0.23	0.00	0.27
Q2	8.11	6.82	8.62	0.44	0.38	0.46
Q3	9.90	9.88	9.55	0.59	0.54	0.57
Q4	11.87	13.77	11.33	0.69	0.70	0.66
Q5	14.99	20.36	14.51	0.68	0.94	0.66
Q5–Q1	9.02	20.35	7.69	0.53	1.71	0.45
(t-stat)	(3.75)	(12.21)	(3.22)	(3.73)	(11.54)	(3.04)

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C. Bivariate Regressions

	Raw signal			Rank signal		
	1	2	3	4	5	6
Constant	0.00	0.00	0.00	0.01	0.01	0.01
(t-stat)	(0.68)	(0.64)	(1.93)	(4.04)	(4.04)	(4.06)
$\bar{r}$	−0.00		0.04	0.29		5.25
(t-stat)	(−0.73)		(4.95)	(1.01)		(7.37)
$\beta'\lambda$	0.92	0.90		1.82	1.85	
(t-stat)	(8.75)	(9.85)		(8.68)	(9.61)	
$\bar{\epsilon}$		−0.00	−0.04		0.31	−4.45
(t-stat)		(−0.66)	(−5.07)		(1.15)	(−6.50)
R^2 (%)	0.14	0.14	0.03	0.12	0.12	0.04

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Momentum and the IPCA Model

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	Raw signal			Rank signal		
	1	2	3	4	5	6
Constant	0.00	0.00	0.00	0.01	0.01	0.01
(t-stat)	(0.68)	(0.64)	(1.93)	(4.04)	(4.04)	(4.06)
$\bar{r}$	−0.00		0.04	0.29		5.25
(t-stat)	(−0.73)		(4.95)	(1.01)		(7.37)
$\beta'\lambda$	0.92	0.90		1.82	1.85	
(t-stat)	(8.75)	(9.85)		(8.68)	(9.61)	
$\bar{\epsilon}$		−0.00	−0.04		0.31	−4.45
(t-stat)		(−0.66)	(−5.07)		(1.15)	(−6.50)
R^2 (%)	0.14	0.14	0.03	0.12	0.12	0.04

Reversal vs $\beta' \lambda$

Reversal vs $\beta'\lambda$

Table VI
Other Formation Windows

Formation		Rank signal regressions				
		Univariate		Bivariate		
		$\bar{r}$	R^2 (%)	$\bar{r}$	$\beta'\lambda$	R^2 (%)
2	12	0.87	0.02	0.29	1.82	0.12
		(3.39)		(1.01)	(8.68)	
13	24	−0.46	0.01	−0.16	1.80	0.11
		(−2.62)		(−0.91)	(10.84)	
25	36	−0.26	0.00	0.05	1.78	0.11
		(−1.77)		(0.37)	(11.02)	
1	1	−1.70	0.09	−0.92	1.52	0.14
		(−7.07)		(−3.21)	(7.13)	

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Outline

Conclusion: “momentum and long-term reversal...[are] explained by conditional betas in a no-arbitrage factor model”

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		Individual stocks	*portfolios*
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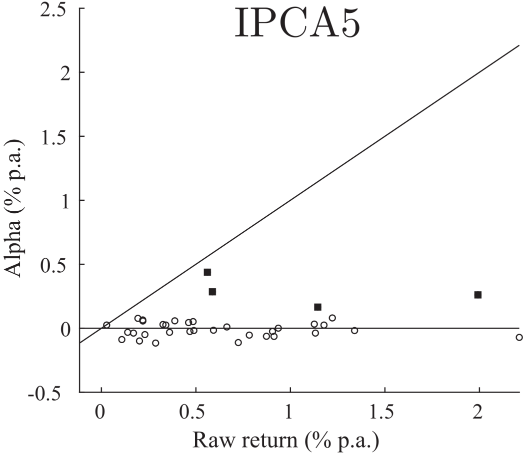

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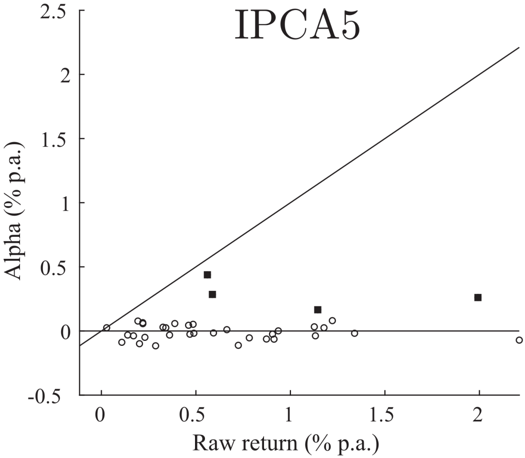

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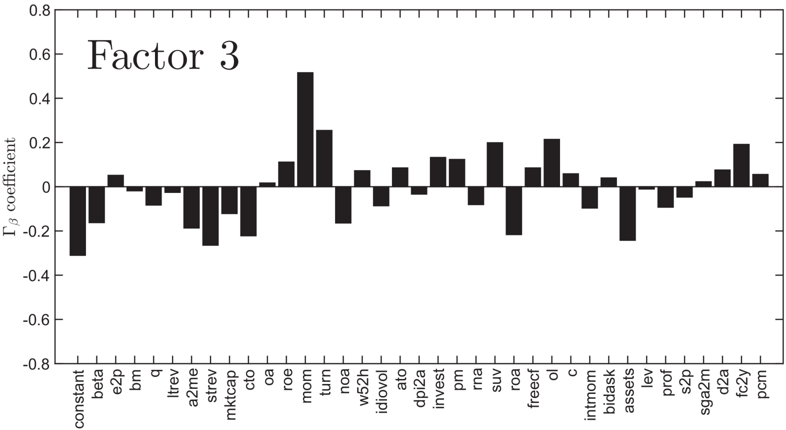

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&= a_t \quad - \quad b_{2,t} \times f_{2,t+1} \quad - \quad \sum_{i \neq 2} b_{i,t} \times f_{i,t+1}
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- $Cor(r_w, f_2) = 85\% \Rightarrow f_{-2}$ captures investment opportunities

(3) What Risks are the IPCA Factors Capturing?

- Most Macro-Finance Models can be written as an ICAPM:

$$
\begin{aligned}
m_{t+1} &= \frac{\partial_W V(W_{t+1,}, s_{t+1})}{\partial_W V(W_{t,}, s_t)} \\
&\approx a_t \quad + \quad W_t \frac{\partial_{WW} V_t}{\partial_W V_t} \times \frac{\Delta W_{t+1,}}{W_t} \quad + \quad \frac{\partial_{Ws} V_t}{\partial_W V_t} \times \Delta s_{t+1} \\
&= a_t \quad - \quad \gamma_t \times r_{w,t+1} \quad - \quad \sum_i \phi_{i,t} \times \Delta s_{i,t+1}
\end{aligned}
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- Factor Structure in IPCA implies (Cochrane 2005, Ch 6):

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- If momentum was not known before publication, then near-arbitrage opportunities might have existed prior to 1993

- From Kozak, Nagel, and Santosh (2018, JF), mispricing is more likely to explain momentum if risk-premium (pre-publication) is due to high-order factors (beyond 6?)

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- Novy-Marx (2012, JFE): R_{t-12} to R_{t-7}
- Hou, Xue, and Zhang (2014, RFS): q-factor model captures momentum
- $\mathbb{E}[r] = \beta_i^{'}\lambda$ vs $\mathbb{E}[r] = a + b^{'}X$ (Lewellen 2015, CFR)
- VW returns + KPS sample + out-of-sample analysis
- Value-weighted IPCA: $\underset{\Gamma_\beta, f}{\text{Min}} \sum_t vw \times \tilde{\epsilon}_t^{'}\tilde{\epsilon}_t$
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Outline

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- Reading it was fun (definitely recommend)
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