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## Short and Long Horizon Behavioral Factors

*A Review Submitted to Prof. Suman Saurabh*

*Summary by Lubdhak Mondal*

### Motivation

The motivation is, John Cochrane in presidential address talked about the zoo of new anomalies, he asked a few key questions, for example,

- a) Which characteristics really provide independent information about the cross-section of expected returns?
- b) Can the cross-section of expected returns be parsimoniously explained by just a few characteristics/factors?

So these are the key questions that are tested in the paper.

### Goal and Overview of the Methodology

The approach is,

- Propose a 3-factor risk-and-behavioral composite model
  - *Market factor + two theory-based behavioral factors*
- Behavioral factors capture distinct short- and long-term components of common mispricing.
- Categorize anomalies into short-horizon vs. long-horizon
- Explore what factors important for explaining short- vs. long-horizon anomalies

The goal of this paper is to see whether this three factor accounting model can provide a parsimonious and a better description of the cross session of expected return.

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## Why Behavioural Factors?

Behavioral theories suggest return comovement associated with common stock mispricing.

### **Barberis & Shleifer Style Investing Model (2003)**

- Investors categorize assets into different styles, allocate funds at style level
- Correlated sentiment shocks induce return comovement of assets sharing same style, even when cash flows uncorrelated

### **Daniel, Hirshleifer & Subrahmanyam Overconfidence Model (2001)**

- Investors misinterpret signals about fundamental economic factors.
- Stocks with similar exposures to given economic factors have incremental mispricing-driven comovement

Behavioral theories suggest that it could be helpful if authors can incorporate behavioral factors into asset pricing models and authors may have a better understanding about the cross section of expected return.

### **Risk factors**

- *Fama & French (1993)* construct factors based on characteristics that may capture risk exposure.
- Firms with exposure to risk factors earn risk premia.

### **Behavioral factors proposed in the paper**

- Based on characteristics expected to be associated with mispricing
- Firms with exposure to behavioral factors comove with
  - Sentiment shocks to certain styles
  - Shocks to mispriced fundamental factors

## Two Behavioral Factors

### Long Horizon Factor

The paper proposes two behavioral factors. The first one is the **Long Horizon** behavioral factor based on the security issue on the repurchase. There is a familiar idea that firms tend to issue overvalued equity and the buyback undervalued equity. And the story is that managers who know the true value of their firms tend to exploit the pre existing mispricing by trading their shares. And of course, this mispricing can come from many possible sources.

*But how do these financing proxies predict future returns?*

- Managers issues, repurchases shares to benefit existing shareholders.
- Overconfident investors hold to their beliefs, under reacts to signal implicit manager's actions
  - *Daniel, Hirshleifer & Subrahmanyam(1998)*
- Stubborn mispricing not corrected instantly upon observation of new issues and repurchases
- Financing variables can predict returns in the long horizon such as three to five years.

The conjecture that a factor from down these financing activities should be helpful to capture all sources, mispricing that managers try to exploit.

### Hirshleifer and Jiang(2010)

- Underpriced-minus-Overpriced(UMO) based on the firm's external financing events.
- UMO loadings predicts cross-section of returns, even for firm not engaged in new issue, repurchase

### **The Financing Factor(FIN) proposed in the paper based on firms financial variables of annual accounting reports**

- Based on 1-year net share issuance, 5-year composite share issuance
  - *Ponti & Woodgate (2008); Daniel & Titman (2006)*
- Both significantly predict returns, incremental to each other
- 2-by-3 sorts on size, financing characteristic (50/50 of NSI, CSI)
- Value-weighted portfolios, annually rebalanced

## What Does FIN Tell Us?

- FIN factor captures primarily longer-term mispricing ( $> 1$  year).
- Managers less likely to issue, repurchase shares to exploit relatively short-term mispricing
  - Disclosure, legal, underwriting, other costs of issuance, repurchase
  - Investor skepticism about high-frequency issuance, repurchase
    - Myers & Majluf (1984)

## Short Horizon

The second behavioral factor authors propose is the **short horizon** factor based on *quarterly earnings announcements*(QEA). So there's a familiar idea about the *post earnings announcement drift*(PEAD). So firms who report positive earnings surprises tend to outperform those reporting negative earnings surprises in the subsequent six to nine months. So one leading explanation is investor limited attention and tend to under react to the implication in current earnings surprises about future earnings.

*A factor based on earnings surprises should capture short-term mispricing, caused by limited investor attention to QEAs.*

- QEA not the only source of fundamental news that investors underreact to at quarterly frequency
- But a good window, highly relevant for fundamental value, arrive regularly for all firms
- Ultimately, all value-relevant news manifested in earnings

## The PEAD factor

- Based on cumulative abnormal returns (CAR) around latest QEA dates
- 2-by-3 sorts on size,  $CAR(t - 2, t + 1)$
- Value-weighted portfolios, monthly rebalance

## A Risk-Behaviour Composite Model

Authors constructed a A three-factor composite model based on MKT(market), PEAD, FIN

The emphasis should be given on the parsimony feature of the constructed model, and compared to other models in the literature, it is built on fewer factors and fewer economic characteristics to form these factors. So the main key job of this paper is to compare this proposed model to other models in the literature and check how well it is performing, and in the

light of Barillas & Shanken (2016) it suggests that when comparing asset pricing models, it's important to compare their ability to price all assets, not only both test assets and also traded factors. So authors then form these two sorts of tests in pricing treated factors, and they will look at how behavioral factors price other factors vice versa, and in tests in pricing test assets, authors examine how well does this count in the model explained portfolio returns are associated by various return anomalies.

## Comparing Factor Models PEAD & FIN

- Behavioral factors: PEAD, FIN
  - Built on 3 characteristics: size, nancing, earnings surprises
- A traditional factor model (Carhart factors)
  - Market (MKT), size (SMB), value (HML), momentum (MOM)

*Recently prominent factor models*

**Novy-Marx (2013):** 4 factors, 5 characteristics

MKT, HML\*, MOM\*, PMU, industry-adjusted

**Fama & French (2015):** 5 factors, 4 characteristics

MKT, SMB\*, HML, CMA, RMW

**Hou, Xue & Zhang (2015):** 4 factors, 3 characteristics

MKT, SMB\*, IVA, ROE

**Stambaugh & Yuan (2017):** 4 factors, 12 characteristics

MKT, SMB\*, MGMT, PERF

Factor Premia						
	Mean	Std	t-value	SR	N. obs	Sample period
MKT	0.53	4.59	2.62	0.12	510	1972:07 – 2014:12
SMB	0.17	3.13	1.19	0.05	510	1972:07 – 2014:12
SMB(HXZ)	0.29	3.14	2.06	0.09	510	1972:07 – 2014:12
SMB(SY4)	0.41	2.81	3.28	0.15	498	1972:07 – 2013:12
HML	0.41	2.94	3.14	0.14	510	1972:07 – 2014:12
HML(NM)	0.44	1.49	6.43	0.29	486	1972:07 – 2012:12
MOM	0.68	4.44	3.45	0.15	510	1972:07 – 2014:12
MOM(NM)	0.61	2.90	4.6	0.21	486	1972:07 – 2012:12
CMA	0.37	1.95	4.27	0.19	510	1972:07 – 2014:12
IVA	0.43	1.86	5.23	0.23	510	1972:07 – 2014:12
PMU	0.27	1.18	5.06	0.23	486	1972:07 – 2012:12
RMW	0.34	2.24	3.44	0.15	510	1972:07 – 2014:12
ROE	0.56	2.59	4.88	0.22	510	1972:07 – 2014:12
MGMT	0.67	2.87	5.24	0.23	498	1972:07 – 2013:12
PERF	0.65	3.90	3.73	0.17	498	1972:07 – 2013:12
<b>FIN</b>	<b>0.80</b>	<b>3.92</b>	<b>4.6</b>	<b>0.20</b>	510	1972:07 – 2014:12
<b>PEAD</b>	<b>0.65</b>	<b>1.85</b>	<b>7.91</b>	<b>0.35</b>	510	1972:07 – 2014:12

This table shows that the FIN factor in the bottom two rows here, the FIN factor has the highest monthly factor premium on average, and the PEAD factor has a five very high monthly premium as well 65 basis points per month, and it also has the highest Sharpe ratio point three five among all the factors.

Correlation Matrix												
	MKT	SMB	HML	MOM	CMA	IVA	PMU	RMW	ROE	MGMT	PERF	FIN
CMA	-0.39	-0.12	<b>0.69</b>	0.02								
IVA	-0.37	-0.23	<b>0.68</b>	0.04	<b>0.90</b>							
PMU	-0.29	-0.27	-0.10	0.25	-0.03	0.03						
RMW	-0.21	-0.22	0.01	0.21	-0.03	0.00	<b>0.57</b>					
ROE	-0.19	-0.38	-0.10	<b>0.49</b>	-0.08	0.06	<b>0.59</b>	<b>0.58</b>				
MGMT	-0.54	-0.39	<b>0.72</b>	0.06	<b>0.76</b>	<b>0.76</b>	0.16	0.16	0.09			
PERF	-0.26	-0.09	-0.30	<b>0.72</b>	-0.06	-0.06	<b>0.59</b>	<b>0.48</b>	<b>0.63</b>	0.01		
<b>FIN</b>	-0.50	-0.49	<b>0.65</b>	0.09	<b>0.58</b>	<b>0.66</b>	0.35	0.35	0.33	<b>0.80</b>	0.15	
<b>PEAD</b>	-0.10	0.03	-0.16	<b>0.46</b>	0.00	-0.04	0.09	0.07	0.22	0.00	<b>0.38</b>	-0.05

In terms of correlation, authors found that the financing the FIN factor is highly correlated with value, and the two investment factors CMA and IVA and also highly, extremely strongly correlated with the management factor (MGMT) upon eight correlation. This is probably because the management by a factor is a constant factor from several characteristics including financing and the P factor is strongly correlated with momentum and PERF.

## Ex post Tangency Portfolios

	Portfolio Weights													Tangency Portfolios		
	MKT	SMB*	HML*	MOM*	RMW	CMA	PMU	IVA	ROE	MGMT	PERF	FIN	PEAD	Mean	Std	SR
FF3	0.29	0.15	0.56											0.41	1.86	0.22
Carhart	0.23	0.09	0.43	0.26										0.49	1.58	0.31
FF5	0.17	0.06	-0.01		0.31	0.47								0.38	1.06	0.36
NM*	0.10		0.40	0.11			0.39							0.40	0.70	0.57
HXZ*	0.14	0.13						0.44	0.29					0.46	1.08	0.43
SY4*	0.22	0.17								0.43	0.18			0.59	1.20	0.50
<b>BF3</b>	0.19											0.26	0.55	<b>0.66</b>	<b>1.29</b>	<b>0.52</b>
<b>BF3 + PMU</b>	0.16						0.29					0.17	0.39	0.55	1.01	<b>0.54</b>
<b>BF3 + RMW, CMA</b>	0.16				0.10	0.19						0.13	0.41	0.56	1.05	<b>0.54</b>
<b>BF3 + IVA, ROE</b>	0.16							0.25	0.09			0.11	0.40	0.58	1.06	<b>0.55</b>
<b>BF3 + MGMT, PERF</b>	0.20									0.27	0.07	0.06	0.39	0.64	1.15	<b>0.56</b>
<b>All factors ex. BFs</b>	0.15	0.15	-0.01	-0.02	-0.04	-0.09	0.25	0.14	0.13	0.28	0.05			0.47	0.86	<b>0.54</b>
<b>All factors</b>	0.12	0.11	0.01	-0.05	-0.02	-0.13	<b>0.23</b>	<b>0.17</b>	0.08	<b>0.20</b>	0.02	0.00	<b>0.26</b>	0.49	0.76	<b>0.65</b>

- Sharpe ratios (SR) of ex post tangency portfolios
  - Novy-Marx 4 factors offer highest SR, BF3 factors second highest
  - Adding other factors to BF3 model does not substantially increase SR

## Pricing Traded Factors: Spanning Tests

The main method used is a time series regression of monthly returns of one factor and on monthly returns of a set of other factors. And it focuses on the regression intercept of the fall. So if one factor can be fully captured by other factors, and authors expect the alpha to be close to zero.

### In Summary

*Do other factors price behavioral factors?*

- None of the prices PEAD.
- Most do not price FIN, except Novy-Marx, Stambaugh & Yuan factors.

Do behavioral factors price other factors?

- PEAD, FIN together price many other factors.
  - HML, MOM Carhart model
  - RMW, CMA Fama & French model
  - ROE Hou, Xue & Zhang model
  - MGMT, PERF Stambaugh & Yuan model

But do not price

- SMB
- PMU Novy-Marx model
- IVA Hou, Xue & Zhang model

## How Well Do Alternative Factor: Model Price Test Assets?

34 anomalies were listed for these tests, those closely following *Hou, Xue & Zhang (2015)*. And again those are further classified into,

### 12 short-horizon anomalies

- Earn substantial abnormal returns for < 1 year after portfolio formation
- Include earnings momentum, return momentum, short-term profitability

### 22 long-horizon anomalies

- Earn substantial abnormal returns for > 1 year post-formation
- Include long-term profitability, value, investment, financing, intangibles

## Comparing Model

The main test was authors compare how well does the complete model explain this set of 34 anomalies.

### The composite model created BF3

- 3 factors, 3 characteristics
- MKT, PEAD, FIN

And it has been compared against few traditional models as well as a few recent prominent factor models.

### Traditional factor models

- CAPM, FF3, Carhart models

### Recently prominent factor models

- Novy-Marx (2013, NM4): 4 factors, 5 characteristics
- Fama & French (2015, FF5): 5 factors, 4 characteristics
- Hou, Xue & Zhang (2015, HXZ4): 4 factors, 3 characteristics
- Stambaugh & Yuan (2017, SY4): 4 factors, 12 characteristics

The methodology used is factor regression, authors run time series regression of factor, a longshot factor returns on each factor model, and authors examine the regression intercept of  $\alpha \approx 0$  and they explore five common performance measures from the literature.

## Summary of Model Performance

### Model performance measures

- Number of significant alphas at 5% level
- Average (absolute) alpha, average (absolute) t-value of alphas
- F-statistic =  $\text{Average } t^2 / \text{Average } t^2_{\text{null}}$  m= BF3
  - Tests whether  $t^2$  of alphas under a model significantly larger than  $t^2_{\text{null}}$
- Gibbons, Ross & Shanken (GRS, 1989) F-statistic
  - Tests null hypothesis of all alphas jointly zero
- Hansen & Jagannathan (HJ, 1997) distance
  - Measures maximum pricing errors generated by a model

## A Glance Of The Tests Results

### *Short-horizon anomalies (12)*

- BF3 fully explains all anomalies.
- Outperform all other models

### *Long-horizon anomalies (22)*

- BF3 fully explains all but 3 anomalies.
- Perform equally well as NM4, SY4 models
- Better than FF5, HXZ4 models

### *All anomalies (34)*

- BF3 fully explains all but 3 anomalies.
- Outperform all other models
- Remaining anomalies for competing models
  - NM4 (5), HXZ4 (6), SY4 (7)


*Parsimony:* BF3 uses fewer factors, characteristics

The authors believe that it is not correct, it's not right to determine which one is the winner model and it is not right to fully look at the model performance of their model fit. And if this was the right way, then authors can imagine that a factor model with 1 million factors will easily be the winner, but no one will take seriously about a factor model with 1 million factors. So the balance there is a balance between model fit and parsimony. And authors think the brief criteria is to have a model that better price procession return at at the same time is also parsimonious using less factors and characteristics.

Authors also run some cross sectional tests to see whether behavior factor beta predicts returns. And authors also run a set of robustness tests related to limits to arbitrage to extend the idea that these two factors indeed capture economies pricing.

## Parsimony Test

The authors want to fully test ideas that are less parsimonious models more subject to overfitting problems? And in terms of describing the patrimonial criteria, authors think that both the number of factors and the number of economic characteristics matters for parsimony. And authors create two parsimonious indexes. And the first index is the negative of the sum of characteristics used to build each factor. and higher is bounded above by zero. So higher value means more parsimonious. The second index, it's the sum of factors plus the sum of characteristics. So the



difference here is that this index does not penalize a model for using the same characteristics multiple times in for several factors such as size, and again, it's bounded above by zero. So higher value wins means more parsimonious, and authors examine these four model fit measures. So our main method is to run this regression and the authors regress the model to fit our model performance measures on each model's parsimonious index value. And note that the higher for example, using a few the number of second significant offer as the model fit measure, the higher value means the worst performance worse model fit. So authors see authors observe this upward sloping that upward sloping relation between model faith and the parsimony that means for less parsimonious model on the left hand side, parsimonious model has better fit, and the more parsimonious model has respect. So indeed, authors do see some overfitting problem for factor models. And authors also want to focus on the residual. So if authors look at the residual of the BF3 model, authors see that it has the most negative residual that means after corrected or adjusted for parsimony, and the ps3 model gives the best performance. And the results are pretty similar, very similar for if we're using other performance measures, metrics such as business etc.

## CONCLUSION

*Propose two theoretically-motivated behavioral factors*

- Each based on a single return predictor
- Each captures distinct short- vs. long-term component of mispricing
- One dominant in explaining short-horizon anomalies, one in long-horizon anomalies


*Propose a three-factor composite model*

- Augments CAPM with two behavioral factors\
- Parsimony, fewer factors & characteristics for forming factors
- Provides better description of cross-section of returns

Useful to consider both traditional risk factors, behavioral factors to understand cross-section of expected returns.

Our conceptual contribution is not in devising novel factors.

- It is to suggest
- Based on theoretical considerations, behavioral effects are captured well by two behavioral factors that effect short- and long-horizon mispricing.
- When combined with market factors (to capture rational risk premium), the resulting factor model captures a cross-section of returns very effectively.



Our empirical contribution is to show this is indeed the case.

Partially address prevalent data-mining concern in anomaly literature

- Abnormal returns are partly due to overfitting rather than mispricing.
  - McLean & Ponté (2016); Harvey, Liu & Zhu (2016); Linnainmaa & Roberts (2018)
- Anomalies identified in US are substantial in five non-US markets, suggesting robust mispricing.
  - Lu, Stambaugh & Yuan (2017)

Two behavioral factors contribute heavily to fitting many well-known anomalies. It suggests that many important anomalies are about mispricing. If anomalies can be explained by just a few economically-motivated factors, it suggests that they are far from wholly spurious.

