Fundamental Risk Sources and Pricing Factors

Zhanhui Chen Baek-Chun Kim

Nanyang Technological University

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Prevailing factor models: 15 pricing factors

- Fama-French 5- or 6-factor model (Fama and French, 2015, 2018)
  - FF5: MKTRF, SMB, HML, CMA, RMW
  - FF6: MKTRF, SMB, HML, CMA, RMW, UMD
- q- or q^5-model (Hou et al., 2015, 2018a)
  - HXZ: MKTRF, Q_{ME}, Q_{IA}, Q_{ROE}
  - HMXZ: MKTRF, Q_{ME}, Q_{IA}, Q_{ROE}, EG
- Mispring factors (Stambaugh and Yuan, 2017)
  - SY: MGMT, PERF; MIS
- Behavioral factors (Daniel et al., 2018)
  - DHS: FIN, PEAD

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  - DHS: FIN, PEAD
- How to interpret and differentiate them?
  - Econometric methods (Barillas and Shanken, 2018; Kozak et al., 2018; Kelly et al., 2018)
  - Cross-sectional tests (Hou et al., 2018b)

Explore fundamental risks behind pricing factors

- Neoclassical theory of investment: Linking stock returns with real investment returns
  - Cochrane (1991); Restoy and Rockinger (1994); Cochrane (1996); Berk et al. (1999); Zhang (2005); Liu et al. (2009); Hou et al. (2015)
- Asset risks arise endogenously from fundamental shocks.
- Different pricing factors capture different fundamental risks.
- Stocks comove because of sharing common fundamental risks.
- Suggesting an equivalent model: a productivity-based model.

Estimating firm-level total factor productivity

- Estimate firm-level TFP (Olley and Pakes, 1996; İmrohoroğlu and Tüzel, 2014) from a Cobb-Douglas production function:

$$Y_{it} = Z_{it} L_{it}^{\beta_L} K_{it}^{\beta_K},$$

where Y_{it}, Z_{it}, L_{it}, and K_{it} are value-added, productivity, labor, and capital stock of a firm i at time t, respectively.

- Sample
  - 1972-2015
  - All firms, excluding financial and utility firms.

Estimating systematic productivity factors

- Asymptotic principal component analysis (Connor and Korajczyk, 1987; Herskovic et al., 2016; Chen et al., 2018)

$$TFP_{NT} = B_{Nk} * PC_{kT} + \epsilon_{NT}$$

where PC is a $k \times T$ matrix of aggregate TFP shocks, B is the sensitivities matrix, and ϵ is the idiosyncratic TFP shocks.

- Select the first six principal components ▸ Details
  - Capture about 52% of TFP across firms.
  - The residual TFP can not predict stock returns.

Constructing mimicking productivity factors

- Using the projection method (Adrian et al., 2014; Chen and Yang, 2019)
  Project the principal TFP component PC_n onto a set of annual base asset returns $X^a_{t,n}$:

$$PC_n = \kappa_{0,n} + \kappa'_{x,n} X^a_{t,n} + u_t, n = 1, 2, ..., 6,$$

- Choosing 9 base assets Details
  - Using portfolios from Hou et al. (2015) and Stambaugh and Yuan (2017).
  - MKT + MIS + 7 size, investment, and profitability sorted portfolios

Fundamental shocks and pricing factors

Panel B: Correlations between 6 TFP components and pricing factors

	MKT	SMB	HML	CMA	RMW	UMD	Q_{ME}	Q_{IA}	Q_{ROE}	EG	MIS	FIN	PEAD
PC1	-0.01	0.01	-0.07	-0.14	0.11	-0.28	0.01	-0.14	-0.08	0.14	-0.01	-0.05	-0.22
PC2	0.12	-0.24	-0.14	-0.12	-0.16	0.17	-0.25	0.00	0.05	-0.24	0.09	0.05	0.20
PC3	0.19	0.06	-0.15	-0.07	-0.48	-0.06	0.01	-0.23	-0.42	-0.02	-0.18	-0.27	0.11
PC4	-0.14	0.28	0.21	0.50	0.00	-0.13	0.26	0.43	-0.22	0.12	0.03	0.17	-0.12
PC5	0.09	-0.10	0.01	-0.04	-0.09	0.35	-0.09	-0.07	0.13	0.09	0.17	-0.04	0.19
PC6	0.34	-0.14	-0.23	-0.29	-0.44	-0.17	-0.18	-0.26	-0.29	-0.27	-0.35	-0.48	-0.07

Fundamental shocks and pricing factors

Panel B: Correlations between 6 TFP components and pricing factors

	MKT	SMB	HML	CMA	RMW	UMD	Q_{ME}	Q_{IA}	Q_{ROE}	EG	MIS	FIN	PEAD
PC1	-0.01	0.01	-0.07	-0.14	0.11	-0.28	0.01	-0.14	-0.08	0.14	-0.01	-0.05	-0.22
PC2	0.12	-0.24	-0.14	-0.12	-0.16	0.17	-0.25	0.00	0.05	-0.24	0.09	0.05	0.20
PC3	0.19	0.06	-0.15	-0.07	-0.48	-0.06	0.01	-0.23	-0.42	-0.02	-0.18	-0.27	0.11
PC4	-0.14	0.28	0.21	0.50	0.00	-0.13	0.26	0.43	-0.22	0.12	0.03	0.17	-0.12
PC5	0.09	-0.10	0.01	-0.04	-0.09	0.35	-0.09	-0.07	0.13	0.09	0.17	-0.04	0.19
PC6	0.34	-0.14	-0.23	-0.29	-0.44	-0.17	-0.18	-0.26	-0.29	-0.27	-0.35	-0.48	-0.07

Panel C: Statistics of monthly mimicking productivity portfolios

	Mean	SD	SR
PC1	1.31	7.38	0.18
PC2	0.39	3.55	0.11
PC3	-0.95	5.67	-0.17
PC4	1.59	10.25	0.16
PC5	0.70	2.12	0.33
PC6	-0.99	4.85	-0.20

Using productivity factors to explain other pricing factors

α is insignificant.

Panel A: Full-sample estimation								
	MKT	SMB	HML	CMA	RMW	UMD	Q_{ME}	Q_{IA}
α	0.10	0.05	0.02	-0.06	0.10	-0.35	0.02	-0.03
t-stat	0.49	0.44	0.11	-0.97	1.48	-1.60	0.17	-0.64
Panel B: Extending-window estimation								
	MKT	SMB	HML	CMA	RMW	UMD	Q_{ME}	Q_{IA}
α	0.40	0.12	-0.09	0.10	0.21	-0.19	0.05	0.10
t-stat	1.33	0.73	-0.44	0.70	1.25	-0.56	0.31	0.76

Using productivity factors to explain other pricing factors

α is insignificant for all factors, except for EG (HMXZ, q^5) and PEAD (DHS).

Panel A: Full-sample estimation							
	Q_{ROE}	EG	MGMT	PERF	MIS	FIN	PEAD
α	0.08	0.32	0.08	-0.02	-0.11	0.15	0.46
t-stat	1.17	2.79	0.84	-0.11	-1.27	1.14	5.47
Panel B: Extending-window estimation							
	Q_{ROE}	EG	MGMT	PERF	MIS	FIN	PEAD
α	0.04	0.19	0.17	0.49	0.16	0.27	0.24
t-stat	0.19	1.26	0.93	1.43	0.64	1.23	1.98

Cross-sectional regressions of various factor models

155 test portfolios: 25 size-BM/OP/INV/Mom/IVOL + 30 Fama-French industry portfolios

	FF3		FF5		FF6		HXZ		HMXZ		SY		DHS		TFP	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
γ_0	0.51	5.35	0.01	0.29	-0.07	-2.24	0.00	-0.03	-0.06	-1.10	-0.03	-0.44	0.30	2.43	0.12	0.98
γ_{MKT}	0.06	0.29	0.47	2.30	0.59	2.91	0.49	2.32	0.57	2.73	0.57	2.70	0.42	1.81		
γ_{SMB}	0.09	0.70	0.22	1.65	0.21	1.55										
γ_{HML}	0.24	1.65	0.07	0.53	0.28	2.10										
γ_{CMA}			0.29	2.52	0.26	2.29										
γ_{RMW}			0.43	4.01	0.27	2.75										
γ_{UMD}					0.73	3.72										
$\gamma_{Q_{ME}}$							0.33	2.31	0.31	2.22						
$\gamma_{Q_{IA}}$							0.35	2.91	0.38	3.24						
$\gamma_{Q_{ROE}}$							0.56	3.98	0.52	3.63						
γ_{EG}									0.64	4.29						
$\gamma_{MIS_{ME}}$											0.32	2.39				
γ_{MGMT}											0.52	3.31				
γ_{PERF}											0.61	3.21				
γ_{FIN}													0.35	1.56		
γ_{PEAD}													0.38	2.25		
γ_{PC1}															1.13	3.31
γ_{PC2}															0.16	0.76
γ_{PC3}															-1.02	-3.61
γ_{PC4}															1.28	2.79
γ_{PC5}															0.67	5.09
γ_{PC6}															-0.84	-3.24
R^2	0.06		0.44		0.60		0.52		0.58		0.61		0.18		0.78	
$(5^{th}, 95^{th})$	(0.03, 0.49)		(0.27, 0.59)		(0.44, 0.70)		(0.32, 0.63)		(0.40, 0.66)		(0.40, 0.68)		(0.03, 0.49)		(0.59, 0.81)	

Comparing different models: Max squared Sharpe ratio

Rank competing models on the maximum squared Sharpe ratio (Barillas and Shanken, 2017; Fama and French, 2018).

	$Sh^2(f)$	$(5^{th}, 95^{th})$
FF3	0.04	(0.02, 0.08)
FF4	0.09	(0.06, 0.16)
FF5	0.10	(0.07, 0.17)
FF6	0.14	(0.10, 0.22)
HXZ	0.15	(0.10, 0.22)
HMXZ	0.26	(0.19, 0.36)
DHS	0.27	(0.20, 0.37)
TFP	0.32	(0.26, 0.44)

Explaining mispricing portfolios with productivity factors

11 mispricing portfolios from Stambaugh and Yuan (2017)

Panel A: Including mispricing factor in base assets

	MGMT						PERF				
	Acc	AG	CI	InvA	NOA	ISS	DIST	GP	Mom	OSCO	ROA
α	0.23	-0.14	0.08	0.04	0.18	0.05	-0.26	0.22	-0.27	0.31	0.18
t-stat	1.78	-1.06	0.55	0.29	1.34	0.45	-0.77	1.25	-0.76	1.67	1.04
R^2	0.22	0.50	0.38	0.27	0.07	0.37	0.31	0.25	0.31	0.20	0.46
s(e)	2.89	2.33	2.67	2.49	2.79	2.14	5.19	3.19	5.48	3.27	2.99

Panel B: Excluding mispricing factor from base assets

	MGMT						PERF				
	Acc	AG	CI	InvA	NOA	ISS	DIST	GP	Mom	OSCO	ROA
α	0.44	-0.01	0.12	0.14	0.21	0.11	-0.20	0.45	0.50	0.05	-0.03
t-stat	2.97	-0.08	0.94	1.18	1.41	0.92	-0.48	2.20	1.17	0.28	-0.22
R^2	0.18	0.46	0.37	0.29	0.08	0.27	0.24	0.20	0.18	0.16	0.49
s(e)	2.97	2.42	2.70	2.46	2.76	2.32	5.44	3.29	5.98	3.36	2.90

Explaining productivity factors with other pricing factors

Prevailing factors explain PC2 - PC6, but not PC1, a missing factor.

Panel A: Full-sample estimation						
	PC1	PC2	PC3	PC4	PC5	PC6
R^{EX}	1.31 (4.71)	0.39 (2.78)	-0.95 (-3.13)	1.59 (3.29)	0.70 (7.40)	-0.99 (-4.30)
α^{CAPM}	1.29 (4.41)	0.32 (2.26)	-1.17 (-3.94)	1.93 (4.18)	0.62 (6.87)	-1.20 (-5.53)
R^2	0.00	0.03	0.11	0.08	0.13	0.13
α^{FF3}	1.37 (4.82)	0.34 (2.89)	-0.96 (-3.28)	1.32 (3.28)	0.63 (7.15)	-1.05 (-5.52)
R^2	0.06	0.41	0.34	0.47	0.14	0.20
α^{FF4}	1.17 (3.79)	0.32 (2.82)	-1.00 (-4.08)	1.10 (2.60)	0.38 (4.53)	-0.57 (-3.11)
R^2	0.08	0.42	0.34	0.48	0.43	0.39
α^{FF5}	1.31 (4.27)	0.27 (2.08)	-0.59 (-2.03)	1.08 (3.67)	0.46 (4.15)	-0.40 (-2.49)
R^2	0.09	0.43	0.43	0.71	0.28	0.53
α^{FF6}	1.15 (3.53)	0.25 (2.09)	-0.67 (-2.56)	0.96 (3.26)	0.27 (3.26)	-0.09 (-0.65)
R^2	0.10	0.43	0.43	0.71	0.52	0.65
α^{SY}	0.91 (3.04)	0.15 (1.28)	-0.95 (-3.79)	0.28 (0.72)	0.06 (0.81)	0.26 (1.82)
R^2	0.12	0.39	0.27	0.50	0.63	0.66
α^{DHS}	1.27 (3.60)	-0.08 (-0.48)	-0.73 (-2.42)	2.09 (3.64)	0.15 (1.28)	-0.34 (-1.56)
R^2	0.02	0.16	0.28	0.09	0.33	0.28
α^{HXZ}	1.35 (4.20)	0.45 (3.59)	-0.11 (-0.37)	1.22 (3.41)	0.38 (3.29)	-0.15 (-0.94)
R^2	0.04	0.50	0.53	0.75	0.38	0.54
α^{HMXZ}	1.16 (3.90)	0.41 (3.34)	-0.42 (-2.01)	0.74 (2.68)	0.21 (1.95)	0.06 (0.34)
R^2	0.05	0.50	0.56	0.77	0.44	0.56

Interpreting PC1 as labor risk

- TFP includes both labor and capital productivity. Prevailing factors mainly capture the latter.
- Labor risk is priced.
  - Danthine and Donaldson (2002); Donangelo (2014); Donangelo et al. (2019); Marfè (2016, 2017); Hartman-Glaser et al. (2017); Lettau et al. (2018)
  - adjustment costs (Merz and Yashiv, 2007; Belo et al., 2014)
  - wage rigidity (Favilukis and Lin, 2016a,b)
  - search frictions (Petrosky-Nadeau et al., 2018)
- PC1 is highly correlated with labor risk.
- We construct the labor share factor, following Donangelo et al. (2019).

PC1 captures the labor risk

Panel A: Productivity and labor risk						
	PC1	R^{PC1}				
$\Delta Labor^{Agg}$	-0.20	-3.70				
	(-2.67)	(-3.39)				
$\Delta Capital^{Agg}$	0.18	2.34				
	(1.04)	(0.92)				
R^2	0.24	0.14				
Panel C: Correlation between the labor share factor and productivity factors						
	PC1	PC2	PC3	PC4	PC5	PC6
LS factor	0.43	-0.11	0.14	0.15	-0.11	0.09

TFP model explains LS.

Using LS+PC2-PC6 to explain other factors

LS performs similarly (weakly) to PC1.

Panel A: Regression of risk factors on TFP factor-mimicking portfolio augmented with the labor share factor

	MKT	SMB	HML	CMA	RMW	UMD	Q_{ME}	Q_{IA}	Q_{ROE}	EG	MGMT	PERF	MIS	FIN	PEAD
α	0.01	0.04	-0.13	-0.17	0.16	-0.10	0.00	-0.11	0.22	0.41	0.01	0.18	-0.02	0.07	0.51
t-stat	0.05	0.37	-0.81	-2.41	2.27	-0.54	-0.05	-2.16	2.94	4.05	0.14	1.14	-0.34	0.48	5.67
β_{LS}	0.50	0.42	-0.04	-0.08	-0.13	-0.29	0.44	-0.07	-0.12	-0.23	-0.27	-0.23	-0.28	-0.33	-0.03
t-stat	9.15	17.24	-0.80	-3.71	-5.39	-3.80	19.60	-4.09	-5.09	-9.43	-8.12	-4.94	-12.38	-5.33	-0.94
β_{PC2}	0.17	-0.32	0.08	0.04	0.01	-0.16	-0.42	0.03	-0.21	-0.03	0.12	-0.04	0.09	0.13	-0.04
t-stat	3.37	-13.73	1.61	1.63	0.35	-1.89	-19.64	1.62	-9.28	-1.22	3.60	-0.71	3.98	2.22	-1.12
β_{PC3}	0.02	0.11	-0.22	-0.15	-0.10	0.01	0.07	-0.23	-0.17	-0.08	-0.21	0.09	-0.05	-0.29	0.02
t-stat	0.74	5.43	-5.28	-9.45	-3.74	0.11	3.82	-17.55	-8.29	-3.52	-7.06	1.72	-2.71	-6.47	0.52
β_{PC4}	-0.02	0.06	0.12	0.14	-0.10	0.08	0.06	0.13	-0.13	0.03	0.16	-0.03	0.11	0.09	0.02
t-stat	-0.55	5.33	4.46	14.77	-7.54	1.82	5.47	13.92	-13.56	3.26	12.41	-1.21	10.76	3.17	0.96
β_{PC5}	1.13	0.04	0.09	0.19	-0.06	0.98	0.19	0.19	0.31	0.26	0.30	0.44	0.57	0.24	0.19
t-stat	9.37	0.61	0.65	3.51	-1.32	8.38	2.89	4.10	6.30	4.04	4.21	3.25	9.50	2.76	3.21
β_{PC6}	0.53	-0.08	-0.01	-0.01	-0.27	-0.21	-0.05	-0.02	-0.25	-0.13	-0.04	-0.46	-0.27	-0.23	-0.02
t-stat	10.21	-2.86	-0.15	-0.47	-9.91	-2.25	-1.92	-0.86	-12.21	-5.02	-1.09	-6.93	-10.40	-4.84	-0.83
R^2	0.57	0.70	0.30	0.57	0.61	0.38	0.75	0.72	0.74	0.45	0.53	0.52	0.80	0.52	0.07

Cross-sectional regressions of models augmented with PC1 or LS

PC1/LS improves the model performances, especially for FF6 and DHS.

	FF6+PC1		FF6+LS	
	Coeff	t-stat	Coeff	t-stat
γ_0	-0.05	-1.41	-0.06	-1.99
γ_{MKT}	0.57	2.79	0.57	2.80
γ_{SMB}	0.20	1.52	0.21	1.55
γ_{HML}	0.27	2.00	0.27	2.05
γ_{CMA}	0.29	2.56	0.24	2.12
γ_{RMW}	0.28	2.9	0.28	2.91
γ_{UMD}	0.73	3.72	0.73	3.74
$\gamma_{Q_{ME}}$				
$\gamma_{Q_{IA}}$				
$\gamma_{Q_{ROE}}$				
γ_{PC1}	1.10	3.36		
γ_{LS}			0.31	1.86
R^2	0.60		0.61	
$(5^{th}, 95^{th})$	(0.45, 0.71)		(0.50, 0.71)	

	DHS+PC1		DHS+LS	
	Coeff	t-stat	Coeff	t-stat
γ_0	0.19	1.78	0.00	-0.03
γ_{MKT}	0.50	2.14	0.56	2.51
$\gamma_{Q_{ME}}$				
$\gamma_{Q_{IA}}$				
$\gamma_{Q_{ROE}}$				
γ_{EG}				
$\gamma_{MIS_{ME}}$				
γ_{MGMT}				
γ_{PERF}				
γ_{FIN}	0.48	2.17	0.65	3.10
γ_{PEAD}	0.39	2.32	0.66	3.87
γ_{PC1}	1.12	3.28		
γ_{LS}			0.60	2.67
R^2	0.33		0.51	
$(5^{th}, 95^{th})$	(0.13, 0.58)		(0.27, 0.61)	

Conclusions

- Identify 6 principal productivity shocks underlying the economy.
- These 6 principal shocks explain 13 out of 15 pricing factors.
  - Fama-French factors and q-factors share the same set of fundamental risks.
  - Mispricing factors and long-horizon behavioral factor capture fundamental risks.
  - 2 Exceptions: EG and PEAD.
- The first principal component is missed in all models, which captures the labor risk.

Validating TFP decompositions

Panel A: Contemporaneous returns of TFP sorted portfolios						
	Low	2	3	4	High	H-L
ΔTFP	0.16	0.74	0.95	1.20	1.63	1.47
	(0.66)	(3.27)	(4.95)	(6.23)	(7.36)	(9.49)
ΔTFP_{sys}	0.65	0.79	0.84	1.14	1.48	0.83
	(2.58)	(3.86)	(4.35)	(5.78)	(6.27)	(4.88)
Panel B: Predicting excess returns with TFP and its components						
$\sigma_{\Delta TFP}$	0.22					
	(3.61)					
$\sigma_{\Delta TFP,sys}$		0.15	0.14			
		(2.44)	(2.35)			
$\sigma_{\Delta TFP,idio}$		0.09	0.08			
		(1.78)	(1.63)			
AG			-0.84			
			(-4.46)			
CF/K			-0.11			
			(-1.51)			
R^2	0.36	0.37	0.37			

Back

Estimating mimicking productivity factors

- Choosing the base assets
  - Choosing portfolios from Hou et al. (2015) and Stambaugh and Yuan (2017).
  - MKT + MIS + some size, investment, and profitability sorted portfolios
- 9 base assets
  - $X_{t,1}$ = [MKT, MIS, SSL, BLM, BLH, BMH, BSL, SMH, BSH]
  - $X_{t,2}$ = [MKT, MIS, SSL, BLM, BLH, BLL, BMH, BSL, SMH]
  - $X_{t,3}$ = [MKT, MIS, SSL, BLM, BLL, BSL, SMH, BSH, SSH]
  - $X_{t,4}$ = [MKT, MIS, SSL, BLM, BLH, BLL, BMH, BSL, SLM]
  - $X_{t,5}$ = [MKT, MIS, SSL, BLM, BLH, BLL, BSL, SLM, SMH]
  - $X_{t,6}$ = [MKT, MIS, SSL, BLM, SSM, BLH, BLL, BSL, SML].

Back

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