Fama and French (1993)

Junyong Kim

181008

Abstract

- 5 common risk factors
  - 3 stock market factors
    - Market ($RM - RF$)
    - Size (SMB)
    - Book-to-market (HML)
  - 2 bond market factors
    - Maturity ($TERM$)
    - Default (DEF)

1. Introduction

- βs don't work
  - CAPM (Sharpe (1964), Lintner(1965))
  - CCAPM or ICAPM (Breeden (1979), Reinganum (1981), Breeden et al. (1989))
- Other variables do
  - ME, leverage, E/P, B/M (Banz(1981), Bhandari (1988), Basu (1983), Rosenberg et al. (1985))
  - ME, B/M among others (Fama and French (1992))
- In this paper, the authors (i) introduce bond returns as dependent and independent variables, and (ii) employ time-series regressions rather than rolling regressions
  - Zero investment factor mimicking portfolios (SMB and HML)

Contents

1. Introduction
2. The inputs to the time-series regressions
3. The playing field
4. Common variation in returns
5. The cross-section of average returns
6. Diagnostics
7. Interpretation and applications

2. The Inputs to the Time-Series Regressions

1. The explanatory returns
   - Bond-market factors
     - $TERM = r_{\text{long-term government bond}} - r_{\text{one-month T-bill}}$
     - $DEF = r_{\text{portfolio of long-term corporate bonds}} - r_{\text{long-term government bond}}$
   - Stock-market factors
     - 6 VW portfolios (July t–June $t+1$) based on ME (June t, 5:5) and B/M (December $t-1$, 3:4:3) (NYSE breakpoints)
     - Book common equity (BE)=COMPUSTAT book value of stockholders' equity+balance sheet deferred taxes and investment tax credit-book value of preferred stock
     - Exclude $BE < 0$, include firms with ordinary common equity, two years after appeared on COMPUSTAT
     - $SMB = (r_{S/H} + r_{S/M} + r_{S/L})/3 - (r_{B/H} + r_{B/M} + r_{B/L})/3$
     - $HML = (r_{S/H} + r_{B/H})/2 + (r_{S/L} + r_{B/L})/2$
     - $RM - RF = r_{\text{value-weighted stock portfolio}} - r_{\text{one-month bill}}$
2. The returns to be explained
   - Bonds: Governments (1–5, 6–10) and corporate (Aaa, Aa, A, Baa, LG) bond portfolios
   - Stocks: 25 VW portfolios based on ME and B/M

Table 1: *ME* Vertically, *B/M* Horizontally

Size quintile	Book-to-market equity (*BE*/*ME*) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	Average of annual averages of firm size					Average of annual *B*/*E* ratios for portfolio				
Small	20.6	20.8	20.2	19.4	15.1	0.30	0.62	0.84	1.09	1.80
2	89.7	89.3	89.3	89.9	88.5	0.31	0.60	0.83	1.09	1.71
3	209.3	211.9	210.8	214.8	210.7	0.31	0.60	0.84	1.08	1.66
4	535.1	537.4	545.4	551.6	538.7	0.31	0.61	0.84	1.09	1.67
Big	3583.7	2885.8	2819.5	2700.5	2337.9	0.29	0.59	0.83	1.08	1.56
	Average of annual percent of market value in portfolio					Average of annual number of firms in portfolio				
Small	0.69	0.49	0.46	0.48	0.64	428.0	276.6	263.8	291.5	512.7
2	0.92	0.71	0.65	0.61	0.55	121.6	94.0	86.7	79.8	71.3
3	1.78	1.36	1.26	1.14	0.82	102.7	78.3	73.0	64.5	45.9
4	3.95	3.01	2.71	2.41	1.50	90.1	68.9	60.7	53.1	33.4
Big	30.13	15.87	12.85	10.44	4.61	93.6	63.7	52.7	44.0	23.6
	Average of annual *E*/*P* ratios (in percent) for portfolio					Average of annual *D*/*P* ratios (in percent) for portfolio				
Small	2.42	7.24	8.26	9.06	2.66	1.00	1.94	2.60	3.13	2.82
2	5.20	8.61	10.16	10.95	9.28	1.59	2.45	3.45	4.25	4.53
3	5.91	8.72	10.43	11.62	10.78	1.56	3.03	4.04	4.68	4.64
4	5.85	8.94	10.45	11.64	11.39	1.80	3.09	4.22	5.01	4.94
Big	6.00	9.07	10.90	12.45	13.92	2.34	3.69	4.68	5.49	5.90

Table 2: Factors, Assets (Time-Series)

Name	Mean	Std.	$t(mn)$	Autocorr. for lag 1	2	12	Correlations				
Explanatory returns											
RM	0.97	4.52	3.97	0.05	−0.05	0.03					
TB	0.54	0.22	45.97	0.94	0.90	0.65					
LTG	0.60	3.03	3.66	0.05	−0.00	0.00					
CB	0.62	2.24	5.10	0.20	−0.04	0.04					
RM-RF	0.43	4.54	1.76	0.05	−0.04	0.03	*RM-RF*	*RMO*	*SMB*	*HML*	*TERM*
RMO	0.50	3.55	2.61	−0.10	−0.05	0.02	0.78	1.00			
SMB	0.27	2.89	1.73	0.19	0.07	0.23	0.32	−0.00	1.00		
HML	0.40	2.54	2.91	0.18	0.06	0.07	−0.38	−0.00	−0.08	1.00	
TERM	0.06	3.02	0.38	0.05	−0.00	−0.00	0.34	0.00	−0.07	−0.05	1.00
DEF	0.02	1.60	0.21	−0.20	−0.04	−0.00	−0.07	−0.00	0.17	0.08	−0.69
Dependent variables: Excess returns on government and corporate bonds											
1-5G	0.12	1.25	1.71	0.15	−0.08	0.01					
6-10G	0.14	2.03	1.24	0.12	−0.05	0.02					
AAA	0.06	2.34	0.44	0.16	−0.04	0.02					
AA	0.07	2.23	0.58	0.19	−0.04	0.03					
A	0.08	2.25	0.63	0.21	−0.03	0.04					
BAA	0.14	2.35	1.09	0.21	0.00	0.03					
LG	0.13	2.52	0.98	0.23	0.05	0.08					

Dependent variables: Excess returns on 25 stock portfolios formed on *ME* and *BE/ME*

Size quintile	Book-to-market equity (*BE/ME*) quintiles: Low	2	3	4	High	Low	2	3	4	High
	Means					**Standard deviations**				
Small	0.39	0.70	0.79	0.88	1.01	7.76	6.84	6.29	5.99	6.27
2	0.44	0.71	0.85	0.84	1.02	7.28	6.42	5.85	5.33	6.06
3	0.43	0.66	0.68	0.81	0.97	6.71	5.71	5.27	4.92	5.69
4	0.48	0.35	0.57	0.77	1.05	5.97	5.44	5.03	4.95	5.75
Big	0.40	0.36	0.32	0.56	0.59	4.95	4.70	4.38	4.27	4.85
	***t*-statistics for means**									
Small	0.93	1.88	2.33	2.73	2.97					
2	1.11	2.05	2.69	2.91	3.11					
3	1.18	2.12	2.39	3.04	3.15					
4	1.49	1.19	2.08	2.88	3.36					
Big	1.50	1.42	1.34	2.43	2.26					

Table 3: *TERM*, *DEF*

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity

Size quintile	Book-to-market equity (BE/ME) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	m					$t(m)$				
Small	0.93	0.90	0.89	0.86	0.89	5.02	5.50	5.95	6.08	6.01
2	0.99	0.96	0.99	1.01	0.98	5.71	6.32	7.29	8.34	6.92
3	0.99	0.94	0.94	0.95	0.99	6.25	7.10	7.80	8.50	7.60
4	0.92	0.95	0.97	1.05	1.03	6.58	7.57	8.53	9.64	7.83
Big	0.82	0.82	0.80	0.80	0.77	7.14	7.60	8.09	8.26	6.84
	d					$t(d)$				
Small	1.39	1.31	1.33	1.45	1.52	3.96	4.27	4.73	5.45	5.45
2	1.26	1.28	1.35	1.38	1.41	3.84	4.47	5.28	6.05	5.29
3	1.21	1.19	1.25	1.24	1.21	4.05	4.74	5.49	5.89	4.88
4	0.96	1.01	1.13	1.21	1.22	3.65	4.28	5.25	5.89	4.92
Big	0.78	0.73	0.78	0.83	0.89	3.59	3.60	4.18	4.56	4.15
	R^2					$s(e)$				
Small	0.06	0.08	0.09	0.10	0.10	7.50	6.57	6.00	5.68	5.95
2	0.08	0.10	0.13	0.17	0.12	6.97	6.09	5.45	4.87	5.69
3	0.10	0.12	0.15	0.17	0.14	6.38	5.35	4.86	4.48	5.28
4	0.11	0.14	0.17	0.21	0.15	5.63	5.04	4.57	4.39	5.31
Big	0.13	0.15	0.16	0.17	0.12	4.61	4.33	4.00	3.89	4.55

Dependent variable: Excess returns on government and corporate bonds

	1–5G	6–10G	Aaa	Aa	A	Baa	LG
m	0.45	0.72	1.02	0.99	1.00	1.01	0.81
$t(m)$	31.73	38.80	99.94	130.44	139.80	56.24	18.05
d	0.25	0.27	0.94	0.96	1.02	1.10	1.01
$t(d)$	9.51	7.85	48.95	67.54	75.74	32.33	11.95
R^2	0.79	0.87	0.97	0.98	0.98	0.90	0.49
$s(e)$	0.57	0.75	0.41	0.30	0.29	0.72	1.80

Table 4: $RM - RF$

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity

Size quintile	Book-to-market equity (BE/ME) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	b					$t(b)$				
Small	1.40	1.26	1.14	1.06	1.08	26.33	28.12	27.01	25.03	23.01
2	1.42	1.25	1.12	1.02	1.13	35.76	35.56	33.12	33.14	29.04
3	1.36	1.15	1.04	0.96	1.08	42.98	42.52	37.50	35.81	31.16
4	1.24	1.14	1.03	0.98	1.10	51.67	55.12	46.96	37.00	32.76
Big	1.03	0.99	0.89	0.84	0.89	51.92	61.51	43.03	35.96	27.75
	R^2					$s(e)$				
Small	0.67	0.70	0.68	0.65	0.61	4.46	3.76	3.55	3.56	3.92
2	0.79	0.79	0.76	0.76	0.71	3.34	2.96	2.85	2.59	3.25
3	0.84	0.84	0.80	0.79	0.74	2.65	2.28	2.33	2.26	2.90
4	0.89	0.90	0.87	0.80	0.76	2.01	1.73	1.84	2.21	2.83
Big	0.89	0.92	0.84	0.79	0.69	1.66	1.35	1.73	1.95	2.69

Dependent variable: Excess returns on government and corporate bonds

	1–5G	6–10G	Aaa	Aa	A	Baa	LG
b	0.08	0.13	0.19	0.20	0.21	0.22	0.30
$t(b)$	5.24	5.57	7.53	8.14	8.42	8.73	11.90
R^2	0.07	0.08	0.14	0.16	0.17	0.18	0.29
$s(e)$	1.21	1.95	2.17	2.05	2.05	2.12	2.12

Table 5: *SMB*, *HML*

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity

Size quintile	Book-to-market equity (BE/ME) quintiles: Low	2	3	4	High	Low	2	3	4	High
	s					$t(s)$				
Small	1.93	1.73	1.63	1.59	1.67	22.52	21.38	21.88	22.30	22.16
2	1.52	1.46	1.35	1.18	1.40	17.23	17.68	17.08	15.47	16.42
3	1.28	1.12	1.05	0.93	1.16	14.43	13.89	13.42	12.13	13.45
4	0.86	0.82	0.77	0.72	0.95	10.16	9.64	9.29	8.57	10.02
Big	0.28	0.35	0.22	0.29	0.44	3.70	4.39	2.79	3.69	5.02
	h					$t(h)$				
Small	0.95	0.57	− 0.35	− 0.18	0.01	− 9.72	− 6.19	− 4.10	− 2.20	0.16
2	− 1.23	− 0.66	− 0.38	− 0.16	0.00	− 12.25	− 7.02	− 4.20	− 1.82	0.05
3	− 1.09	− 0.65	− 0.31	− 0.11	− 0.01	− 10.84	− 7.07	− 3.43	− 1.23	− 0.12
4	− 1.11	− 0.65	− 0.36	− 0.11	− 0.01	− 11.43	− 6.69	− 3.80	− 1.12	− 0.09
Big	− 1.07	− 0.65	− 0.42	− 0.06	0.08	− 12.46	− 7.07	− 4.64	− 0.66	0.81
	R^2					$s(e)$				
Small	0.65	0.60	0.60	0.60	0.59	4.57	4.31	3.98	3.79	4.01
2	0.59	0.53	0.49	0.42	0.44	4.68	4.41	4.20	4.06	4.53
3	0.51	0.43	0.37	0.31	0.35	4.71	4.31	4.19	4.10	4.60
4	0.43	0.30	0.24	0.18	0.23	4.53	4.55	4.40	4.48	5.06
Big	0.34	0.18	0.08	0.04	0.06	4.02	4.27	4.20	4.19	4.69

Dependent variable: Excess returns on government and corporate bonds

	1–5G	6–10G	Aaa	Aa	A	Baa	LG
s	− 0.02	− 0.06	− 0.00	0.00	0.03	0.09	0.19
$t(s)$	− 0.66	− 1.50	− 0.15	0.22	0.77	1.99	4.19
h	0.00	− 0.03	− 0.02	− 0.01	− 0.00	0.02	0.00
$t(h)$	0.24	− 0.71	− 0.45	− 0.22	− 0.05	0.46	0.15
R^2	− 0.00	0.00	− 0.00	− 0.00	− 0.00	0.00	0.04
$s(e)$	1.26	2.03	2.34	2.24	2.25	2.34	2.46

Table 6: *RM − RF*, *SMB*, *HML*

Dependent variable: Excess returns on 25 stock portfolios formed on size and book-to-market equity

Size quintile	Book-to-market equity (*BE/ME*) quintiles: Low	2	3	4	High	Low	2	3	4	High
	b					*t*(*b*)				
Small	1.04	1.02	0.95	0.91	0.96	39.37	51.80	60.44	59.73	57.89
2	1.11	1.06	1.00	0.97	1.09	52.49	61.18	55.88	61.54	65.52
3	1.12	1.02	0.98	0.97	1.09	56.88	53.17	50.78	54.38	52.52
4	1.07	1.08	1.04	1.05	1.18	53.94	53.51	51.21	47.09	46.10
Big	0.96	1.02	0.98	0.99	1.06	60.93	56.76	46.57	53.87	38.61
	s					*t*(*s*)				
Small	1.46	1.26	1.19	1.17	1.23	37.92	44.11	52.03	52.85	50.97
2	1.00	0.98	0.88	0.73	0.89	32.73	38.79	34.03	31.66	36.78
3	0.76	0.65	0.60	0.48	0.66	26.40	23.39	21.23	18.62	21.91
4	0.37	0.33	0.29	0.24	0.41	12.73	11.11	9.81	7.38	11.01
Big	− 0.17	− 0.12	− 0.23	− 0.17	− 0.05	− 7.18	− 4.51	− 7.58	− 6.27	− 1.18
	h					*t*(*h*)				
Small	− 0.29	0.08	0.26	0.40	0.62	− 6.47	2.35	9.66	15.53	22.24
2	− 0.52	0.01	0.26	0.46	0.70	− 14.57	0.41	8.56	17.24	24.80
3	− 0.38	− 0.00	0.32	0.51	0.68	− 11.26	− 0.05	9.75	16.88	19.39
4	− 0.42	0.04	0.30	0.56	0.74	− 12.51	1.04	8.83	14.84	17.09
Big	− 0.46	0.00	0.21	0.57	0.76	− 17.03	0.09	5.80	18.34	16.24
	R^2					*s*(*e*)				
Small	0.94	0.96	0.97	0.97	0.96	1.94	1.44	1.16	1.12	1.22
2	0.95	0.96	0.95	0.95	0.96	1.55	1.27	1.31	1.16	1.23
3	0.95	0.94	0.93	0.93	0.93	1.45	1.41	1.43	1.32	1.52
4	0.94	0.93	0.91	0.89	0.89	1.46	1.48	1.49	1.63	1.88
Big	0.94	0.92	0.88	0.90	0.83	1.16	1.32	1.55	1.36	2.02

Dependent variable: Excess returns on government and corporate bonds

	1–5G	6–10G	Aaa	Aa	A	Baa	LG
b	0.10	0.18	0.25	0.25	0.26	0.27	0.34
t(*b*)	6.45	6.75	8.60	9.30	9.46	9.58	12.22
s	− 0.06	− 0.14	0.12	− 0.11	− 0.09	− 0.04	0.04
t(*s*)	− 2.70	− 3.65	− 2.89	− 2.72	− 2.18	− 0.91	0.89
h	0.07	0.08	0.14	0.15	0.16	0.20	0.23
t(*h*)	2.66	1.83	2.77	3.26	3.51	4.08	4.75
R^2	0.10	0.12	0.17	0.20	0.20	0.22	0.33
s(*e*)	1.19	1.91	2.13	2.00	2.01	2.08	2.06

Table 7a: *RM − RF*, *SMB*, *HML*, *TERM*, *DEF* on Stocks

Size quintile	Book-to-market equity (*BE/ME*) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	b					*t*(*b*)				
Small	1.06	1.04	0.96	0.92	0.98	35.97	47.65	54.48	54.51	53.15
2	1.12	1.06	0.98	0.94	1.10	47.19	54.95	49.01	54.19	59.00
3	1.13	1.01	0.97	0.95	1.08	50.93	46.95	44.57	47.59	46.92
4	1.07	1.07	1.01	1.00	1.17	48.18	47.55	44.83	41.02	41.02
Big	0.96	1.02	0.98	1.00	1.10	53.87	51.01	41.35	48.29	35.96
	s					*t*(*s*)				
Small	1.45	1.26	1.20	1.15	1.21	37.02	43.42	50.89	51.36	49.55
2	1.01	0.98	0.89	0.74	0.89	32.06	38.10	33.68	32.12	35.79
3	0.76	0.66	0.60	0.49	0.68	25.82	22.97	20.83	18.54	22.32
4	0.38	0.34	0.30	0.26	0.42	12.71	11.36	9.99	8.05	11.07
Big	− 0.17	− 0.11	− 0.23	− 0.17	− 0.06	− 7.03	− 4.07	− 7.31	− 6.07	− 1.44
	h					*t*(*h*)				
Small	0.27	0.10	0.27	0.40	0.63	− 5.95	2.90	9.82	15.47	22.27
2	− 0.51	0.02	0.25	0.44	0.71	− 14.01	0.69	8.11	16.50	24.61
3	− 0.37	− 0.00	0.31	0.50	0.69	− 10.81	− 0.11	9.28	16.18	19.34
4	− 0.42	0.04	0.29	0.53	0.75	− 12.09	1.10	8.37	14.20	16.88
Big	− 0.46	0.01	0.21	0.58	0.78	− 16.85	0.38	5.70	18.16	16.59
	m					*t*(*m*)				
Small	− 0.10	− 0.11	− 0.05	− 0.04	− 0.06	− 1.93	− 2.70	− 1.49	− 1.19	− 1.87
2	− 0.05	− 0.04	0.07	0.14	− 0.05	− 1.16	− 1.12	1.90	4.33	− 1.48
3	− 0.04	0.02	0.06	0.09	0.01	− 0.91	0.53	1.48	2.48	0.25
4	− 0.02	0.00	0.08	0.18	− 0.01	− 0.55	0.19	1.92	3.98	− 0.19
Big	0.03	− 0.04	− 0.00	− 0.04	− 0.16	0.82	− 0.98	− 0.06	− 0.98	− 2.82
	d					*t*(*d*)				
Small	− 0.17	− 0.19	− 0.10	0.06	0.02	− 1.74	− 2.70	− 1.76	1.06	0.34
2	− 0.12	− 0.11	0.04	0.15	− 0.07	− 1.59	− 1.83	0.61	2.64	− 1.24
3	− 0.09	− 0.01	0.07	0.10	− 0.16	− 1.25	− 0.17	1.00	1.51	− 2.11
4	− 0.11	− 0.10	0.04	0.13	− 0.12	− 1.51	− 1.44	0.59	1.64	− 1.30
Big	0.06	− 0.14	− 0.02	− 0.07	− 0.18	0.97	− 2.15	− 0.25	− 1.08	− 1.84
	R^2					*s*(*e*)				
Small	0.94	0.96	0.97	0.97	0.96	1.93	1.43	1.16	1.11	1.20
2	0.95	0.96	0.95	0.95	0.96	1.55	1.27	1.31	1.13	1.23
3	0.95	0.94	0.93	0.93	0.93	1.45	1.41	1.43	1.31	1.50
4	0.94	0.93	0.91	0.90	0.89	1.46	1.47	1.48	1.59	1.88
Big	0.94	0.92	0.87	0.90	0.83	1.17	1.31	1.55	1.36	2.00

Table 7b: *RM − RF*, *SMB*, *HML*, *TERM*, *DEF* on Bonds

	Bond portfolio						
	1–5G	6–10G	Aaa	Aa	A	Baa	LG
b	− 0.02	− 0.04	− 0.02	0.00	0.00	0.02	0.18
$t(b)$	− 2.84	− 3.14	− 2.96	0.06	1.05	1.99	7.39
s	0.00	− 0.02	− 0.02	− 0.01	0.00	0.05	0.08
$t(s)$	0.30	− 1.12	− 2.28	− 2.42	0.40	3.20	2.34
h	0.00	− 0.02	− 0.02	− 0.00	0.00	0.04	0.12
$t(h)$	0.44	− 1.29	− 2.46	− 0.40	0.90	2.39	3.13
m	0.47	0.75	1.03	0.99	1.00	0.99	0.64
$t(m)$	30.01	36.84	93.30	117.30	124.19	50.50	14.25
d	0.27	0.32	0.97	0.97	1.02	1.05	0.80
$t(d)$	9.87	8.77	49.25	65.04	71.51	30.33	9.92
R^2	0.80	0.87	0.97	0.98	0.98	0.91	0.58
$s(e)$	0.56	0.73	0.40	0.30	0.29	0.70	1.63

Table 8a: *RMO* as Orthogonalized *RM* − *RF* on Stocks

Size quintile	Book-to-market equity (*BE*/*ME*) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	b					*t*(*b*)				
Small	1.06	1.04	0.96	0.92	0.98	35.97	47.65	54.48	54.51	53.15
2	1.12	1.06	0.98	0.94	1.10	47.19	54.95	49.01	54.19	59.00
3	1.13	1.01	0.97	0.95	1.08	50.93	46.95	44.57	47.59	46.92
4	1.07	1.07	1.01	1.00	1.17	48.18	47.55	44.83	41.02	41.02
Big	0.96	1.02	0.98	1.00	1.10	53.87	51.01	41.35	48.29	35.96
	s					*t*(*s*)				
Small	1.92	1.72	1.62	1.56	1.64	51.96	62.88	73.21	73.72	71.32
2	1.50	1.45	1.33	1.16	1.38	50.66	59.80	53.02	53.20	58.79
3	1.26	1.11	1.03	0.91	1.16	45.37	40.94	37.83	36.47	40.24
4	0.85	0.81	0.75	0.70	0.94	30.49	28.84	26.42	23.02	26.22
Big	0.26	0.34	0.20	0.28	0.43	11.56	13.69	6.85	10.62	11.17
	h					*t*(*h*)				
Small	− 0.94	− 0.56	− 0.34	− 0.18	0.01	− 22.65	− 18.19	− 13.67	− 7.49	0.57
2	− 1.22	− 0.65	− 0.37	− 0.15	0.01	− 36.52	− 23.89	− 13.09	− 6.22	0.51
3	− 1.08	− 0.64	− 0.30	− 0.10	0.00	− 34.68	− 21.18	− 9.82	− 3.61	0.16
4	− 1.09	− 0.64	− 0.35	− 0.10	0.00	− 34.85	− 20.12	− 10.93	− 2.83	0.10
Big	− 1.07	− 0.63	− 0.41	− 0.05	0.09	− 42.62	− 22.46	− 12.30	− 1.75	2.06
	m					*t*(*m*)				
Small	0.75	0.73	0.73	0.71	0.73	15.66	20.60	25.32	25.67	24.24
2	0.85	0.82	0.86	0.89	0.84	22.08	25.96	26.40	31.68	27.57
3	0.88	0.84	0.84	0.86	0.88	24.21	23.85	23.73	26.34	23.52
4	0.85	0.87	0.90	0.98	0.94	23.24	23.77	24.35	24.76	20.11
Big	0.80	0.79	0.79	0.77	0.73	27.60	24.17	20.42	22.83	14.66
	d					*t*(*d*)				
Small	0.67	0.63	0.66	0.78	0.79	7.25	9.20	11.90	14.81	13.73
2	0.76	0.72	0.81	0.89	0.79	10.23	11.94	12.96	16.36	13.57
3	0.80	0.78	0.83	0.84	0.69	11.53	11.64	12.25	13.53	9.63
4	0.74	0.74	0.84	0.91	0.80	10.56	10.48	11.88	12.01	8.98
Big	0.81	0.66	0.75	0.72	0.68	14.56	10.62	10.15	11.04	7.15
	R^2					*s*(*e*)				
Small	0.94	0.96	0.97	0.97	0.96	1.93	1.43	1.16	1.11	1.20
2	0.95	0.96	0.95	0.95	0.96	1.55	1.27	1.31	1.13	1.23
3	0.95	0.94	0.93	0.93	0.93	1.45	1.41	1.43	1.31	1.50
4	0.94	0.93	0.91	0.90	0.89	1.46	1.47	1.48	1.59	1.88
Big	0.94	0.92	0.87	0.90	0.83	1.17	1.31	1.55	1.36	2.00

Table 8b: *RMO* as Orthogonalized *RM* − *RF* on Bonds

	Bond portfolio						
	1–5G	6–10G	Aaa	Aa	A	Baa	LG
b	− 0.02	− 0.04	− 0.02	0.00	0.00	0.02	0.18
$t(b)$	− 2.84	− 3.14	− 2.96	0.06	1.05	1.99	7.39
s	− 0.00	− 0.03	− 0.03	− 0.01	0.00	0.06	0.16
$t(s)$	− 0.68	− 2.30	− 3.47	− 2.55	0.80	4.09	5.09
h	0.02	− 0.00	− 0.01	− 0.00	0.00	0.03	0.00
$t(h)$	1.76	− 0.00	− 1.36	− 0.47	0.52	1.72	0.12
m	0.45	0.72	1.02	0.99	1.00	1.01	0.79
$t(m)$	32.09	39.55	102.65	130.93	139.11	57.34	19.56
d	0.25	0.29	0.95	0.97	1.02	1.07	0.94
$t(d)$	9.46	8.25	50.04	67.08	74.00	31.77	12.09
R^2	0.80	0.87	0.97	0.98	0.98	0.91	0.58
$s(e)$	0.56	0.73	0.40	0.30	0.29	0.70	1.63

Table 9a: Intercepts on Stocks

Size quintile	Book-to-market equity (*BE/ME*) quintiles: a Low	2	3	4	High	$t(a)$ Low	2	3	4	High
				(i) $R(t) - RF(t) = a + mTERM(t) + dDEF(t) + e(t)$						
Small	0.31	0.62	0.71	0.80	0.92	0.75	1.73	2.20	2.61	2.87
2	0.35	0.63	0.77	0.75	0.93	0.93	1.91	2.60	2.85	3.03
3	0.34	0.58	0.60	0.73	0.89	1.00	1.99	2.28	3.01	3.11
4	0.41	0.27	0.49	0.69	0.96	1.34	1.01	1.96	2.88	3.35
Big	0.34	0.30	0.25	0.50	0.53	1.35	1.27	1.17	2.36	2.14
				(ii) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + e(t)$						
Small	− 0.22	0.15	0.30	0.42	0.54	− 0.90	0.73	1.54	2.19	2.53
2	− 0.18	0.17	0.36	0.39	0.53	− 1.00	1.05	2.35	2.79	3.01
3	− 0.16	0.15	0.23	0.39	0.50	− 1.12	1.25	1.82	3.20	3.19
4	− 0.05	− 0.14	0.12	0.35	0.57	− 0.50	− 1.50	1.20	2.91	3.71
Big	− 0.04	− 0.07	− 0.07	0.20	0.21	− 0.49	− 0.95	− 0.70	1.89	1.41
				(iii) $R(t) - RF(t) = a + sSMB(t) + hHML(t) + e(t)$						
Small	0.24	0.46	0.49	0.53	0.55	0.97	1.92	2.24	2.52	2.49
2	0.52	0.58	0.64	0.58	0.64	2.00	2.40	2.76	2.61	2.56
3	0.52	0.61	0.52	0.60	0.66	2.00	2.58	2.25	2.66	2.61
4	0.69	0.39	0.50	0.62	0.79	2.78	1.55	2.07	2.51	2.85
Big	0.76	0.52	0.43	0.51	0.44	3.41	2.23	1.84	2.20	1.70
				(iv) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + e(t)$						
Small	− 0.34	− 0.12	− 0.05	0.01	0.00	− 3.16	− 1.47	− 0.73	0.22	0.14
2	− 0.11	− 0.01	0.08	0.03	0.02	− 1.24	− 0.20	1.04	0.51	0.34
3	− 0.11	0.04	− 0.04	0.05	0.05	− 1.42	0.47	− 0.47	0.71	0.56
4	0.09	− 0.22	− 0.08	0.03	0.13	1.07	− 2.65	− 0.99	0.33	1.24
Big	0.21	− 0.05	− 0.13	− 0.05	− 0.16	3.27	− 0.67	− 1.46	− 0.69	− 1.41
				(v) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + mTERM(t) + dDEF(t) + e(t)$						
Small	− 0.35	− 0.13	− 0.05	0.01	0.00	− 3.24	− 1.58	− 0.79	0.20	0.09
2	− 0.11	− 0.02	0.08	0.04	0.02	− 1.29	− 0.24	1.10	0.67	0.29
3	− 0.12	0.04	− 0.03	0.06	0.05	− 1.45	0.48	− 0.42	0.79	0.56
4	0.08	− 0.22	− 0.08	0.04	0.13	1.04	− 2.67	− 0.94	0.47	1.23
Big	0.21	− 0.05	− 0.13	− 0.06	− 0.17	3.29	− 0.72	− 1.46	− 0.73	− 1.51

Tables 9b, 9c: Intercepts on Bonds, GRS Tests

	Bond portfolio						
	1–5G	6–10G	Aaa	Aa	A	Baa	LG
	(ii) $R(t) - RF(t) = a + mTERM(t) + dDEF(t) + e(t)$						
a	0.08	0.09	− 0.02	− 0.00	− 0.00	0.06	0.06
$t(a)$	2.70	2.16	− 1.10	− 0.55	− 0.29	1.42	0.67
	(iii) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + e(t)$						
a	0.08	0.08	− 0.03	− 0.02	− 0.01	0.04	0.00
$t(a)$	1.27	0.76	− 0.24	− 0.15	− 0.11	0.37	0.03
	(iii) $R(t) - RF(t) = a + sSMB(t) + hHML(t) + e(t)$						
a	0.12	0.16	0.07	0.07	0.07	0.11	0.08
$t(a)$	1.70	1.47	0.52	0.58	0.55	0.82	0.58
	(iv) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + e(t)$						
a	0.06	0.07	− 0.07	− 0.07	− 0.08	− 0.05	− 0.11
$t(a)$	0.89	0.62	− 0.62	− 0.64	− 0.69	− 0.41	− 1.00
	(v) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + mTERM(t) + dDEF(t) + e(t)$						
a	0.09	0.11	− 0.00	− 0.00	− 0.00	0.02	− 0.07
$t(a)$	2.84	2.77	− 0.17	− 0.25	− 0.57	0.52	− 0.77

	Regression (from tables 9a and 9b)				
	(i)	(ii)	(iii)	(iv)	(v)
F-statistic	2.09	1.91	1.78	1.56	1.66
Probability level					
Bootstrap	0.998	0.996	0.985	0.951	0.971
F-distribution	0.999	0.996	0.990	0.961	0.975

Table 10: January Effects

	a	b	$t(a)$	$t(b)$	R^2	a	b	$t(a)$	$t(b)$	R^2
Factor		Five-factor explanatory returns								
RM–RF	0.31	1.49	1.22	1.67	0.00					
RMO	0.40	1.19	2.03	1.70	0.00					
SMB	0.05	2.74	0.30	4.96	0.06					
HML	0.21	2.29	1.53	4.70	0.06					
TERM	0.10	−0.41	0.56	−0.69	−0.00					
DEF	−0.07	1.10	−0.81	3.56	0.03					
Stock portfolio		Excess stock returns					Five-factor regression residuals			
				Smallest-size quintile						
BE/ME Low	−0.13	6.31	−0.30	4.23	0.05	−0.12	1.51	−1.17	4.09	0.04
BE/ME 2	0.24	5.62	0.63	4.27	0.05	−0.05	0.56	−0.57	2.01	0.00
BE/ME 3	0.31	5.91	0.90	4.93	0.06	−0.06	0.69	−0.88	3.06	0.02
BE/ME 4	0.37	6.29	1.14	5.55	0.08	−0.06	0.76	−1.02	3.57	0.03
BE/ME High	0.40	7.39	1.20	6.31	0.10	−0.09	1.13	−1.41	4.94	0.06
				Size quintile 2						
BE/ME Low	0.20	2.92	0.48	2.04	0.00	0.02	−0.23	0.21	−0.74	−0.00
BE/ME 2	0.37	4.17	1.04	3.34	0.03	0.00	−0.04	0.04	−0.15	−0.00
BE/ME 3	0.53	3.95	1.63	3.48	0.03	0.04	−0.55	0.62	−2.16	0.01
BE/ME 4	0.48	4.32	1.65	4.22	0.05	0.02	−0.22	0.28	−0.97	−0.00
BE/ME High	0.55	5.76	1.66	4.99	0.07	−0.01	0.12	−0.14	0.49	−0.00
				Size quintile 3						
BE/ME Low	0.24	2.35	0.62	1.78	0.00	0.04	−0.49	0.50	−1.74	0.00
BE/ME 2	0.42	2.87	1.31	2.57	0.02	0.03	−0.41	0.42	−1.48	0.00
BE/ME 3	0.43	3.06	1.47	2.99	0.02	0.07	−0.80	0.83	−2.90	0.02
BE/ME 4	0.52	3.51	1.92	3.68	0.04	0.04	−0.46	0.52	−1.80	0.00
BE/ME High	0.60	4.53	1.91	4.12	0.04	0.03	−0.34	0.33	−1.15	0.00
				Size quintile 4						
BE/ME Low	0.39	1.12	1.16	0.95	−0.00	0.04	−0.46	0.46	−1.60	0.00
BE/ME 2	0.21	1.77	0.68	1.65	0.00	0.06	−0.73	0.73	−2.54	0.02
BE/ME 3	0.40	2.08	1.40	2.11	0.01	0.08	−0.93	0.93	−3.27	0.03
BE/ME 4	0.52	3.12	1.88	3.24	0.03	0.03	−0.37	0.34	−1.17	0.00
BE/ME High	0.68	4.45	2.15	4.00	0.04	0.00	−0.03	0.03	−0.09	−0.00
				Biggest-size quintile						
BE/ME Low	0.37	0.34	1.34	0.35	−0.00	−0.03	0.38	−0.48	1.67	0.00
BE/ME 2	0.27	1.11	1.02	1.19	0.00	0.00	−0.00	0.00	−0.02	−0.00
BE/ME 3	0.23	1.11	0.92	1.28	0.00	0.01	−0.17	0.16	−0.57	−0.00
BE/ME 4	0.37	2.38	1.54	2.85	0.02	−0.00	0.08	−0.09	0.31	−0.00
BE/ME High	0.32	3.38	1.17	3.59	0.03	−0.02	0.25	−0.18	0.63	−0.00
Bond portfolio		Excess bond returns					Five-factor regression residuals			
1–5G	0.11	0.05	1.58	0.20	−0.00	0.00	−0.04	0.12	−0.40	−0.00
6–10G	0.16	−0.22	1.35	−0.56	−0.00	0.00	−0.11	0.23	−0.79	−0.00
Aaa	0.03	0.34	0.21	0.74	−0.00	0.01	−0.17	0.62	−2.17	0.01
Aa	0.03	0.51	0.23	1.15	0.00	0.00	−0.11	0.53	−1.85	0.00
A	0.00	0.86	0.05	1.94	0.00	−0.01	0.12	−0.60	2.08	0.01
Baa	0.05	1.14	0.35	2.48	0.01	−0.01	0.14	−0.29	1.01	0.00
LG	0.00	1.56	0.05	3.17	0.03	−0.02	0.19	−0.17	0.58	−0.00

Table 11: Intercepts on Stocks (D/P, E/P)

	Portfolios formed on E/P			Portfolios formed on D/P		
Portfolio	Mean	Std.	$t(mn)$	Mean	Std.	$t(mn)$
$\leqslant 0$	0.72	7.77	1.72	0.48	7.36	1.20
Low	0.27	5.23	0.96	0.39	5.48	1.30
2	0.47	4.76	1.82	0.44	4.83	1.68
3	0.46	4.68	1.83	0.47	4.65	1.87
4	0.55	4.48	2.27	0.57	4.32	2.42
High	0.86	4.84	3.30	0.56	3.86	2.67

Portfolios formed on E/P

	Regression (i)			Regression (ii)				
Portfolio	a	b	R^2	a	b	s	h	R^2
$E/P \leqslant 0$	0.13 (0.50)	1.37 (24.70)	0.64	−0.30 (−1.68)	1.24 (27.82)	1.13 (17.42)	0.46 (6.10)	0.82
Low	−0.20 (−2.35)	1.10 (57.42)	0.91	0.04 (0.70)	0.99 (66.78)	−0.01 (−0.55)	−0.50 (−19.73)	0.96
2	0.03 (0.46)	1.01 (70.24)	0.94	0.03 (0.40)	1.01 (61.17)	0.02 (1.01)	−0.00 (−0.08)	0.94
3	0.04 (0.50)	0.99 (61.62)	0.92	−0.00 (−0.12)	1.00 (55.46)	0.01 (0.40)	0.09 (2.86)	0.92
4	0.15 (1.76)	0.93 (49.78)	0.88	−0.02 (−0.28)	0.98 (53.57)	0.05 (1.95)	0.33 (10.44)	0.91
High	0.46 (3.69)	0.94 (34.73)	0.78	0.08 (1.01)	1.03 (51.56)	0.24 (8.34)	0.67 (19.62)	0.91

Portfolios formed on D/P

	Regression (i)			Regression (ii)				
Portfolio	a	b	R^2	a	b	s	h	R^2
$D/P \leqslant 0$	−0.15 (−0.86)	1.45 (37.18)	0.80	−0.23 (−2.30)	1.20 (49.45)	0.99 (28.09)	−0.21 (−5.17)	0.94
Low	−0.11 (−1.29)	1.15 (59.15)	0.91	0.11 (1.64)	1.03 (65.09)	0.09 (3.92)	−0.48 (−17.92)	0.95
2	−0.01 (−0.19)	1.04 (85.34)	0.96	0.06 (1.17)	1.01 (77.07)	−0.01 (−0.66)	−0.14 (−6.49)	0.96
3	0.04 (0.64)	0.99 (69.14)	0.93	−0.03 (−0.44)	1.02 (64.43)	0.02 (0.72)	0.14 (5.09)	0.94
4	0.17 (2.45)	0.91 (58.42)	0.91	0.04 (0.59)	0.98 (66.51)	−0.06 (−2.80)	0.30 (12.00)	0.94
High	0.24 (2.22)	0.72 (30.16)	0.73	−0.01 (0.16)	0.85 (40.08)	−0.05 (−1.77)	0.54 (15.04)	0.84

7. Interpretation and Applications

- *RMO* (orthogonalized $RM - RF$) has a 0.50% premium with a 3.55% SD (stocks)
- *TERM*, *DEF* have 3.02% and 1.60% SDs, but 0.06% and 0.02% premia (stocks and bonds)
- *SMB* has a 0.27% premium with a 2.89% SD (stocks, cross-sectional dispersion)
- *HML* has a 0.40% premium with a 2.54% SD (stocks, cross-sectional dispersion)
- Why *SMB* and *HML*? Not theoretical, but empirical