

Fama and French (1993)

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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

- ▶ β s don't work
 - ▶ CAPM (Sharpe (1964), Lintner(1965))
 - ▶ CCAPM or ICAPM (Breedon (1979), Reinganum (1981), Breedon 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)

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1. Introduction
2. The inputs to the time-series regressions
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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 (<i>BE</i> , <i>ME</i>) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
Average of annual averages of firm size					Average of annual <i>BE</i> 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 <i>E/P</i> ratios (in percent) for portfolio					Average of annual <i>D/P</i> 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.	<i>t</i> (nn)	Autocorr. for lag			Correlations				
				1	2	12					
				Explanatory returns							
<i>RM</i>	0.97	4.52	3.97	0.05	− 0.05	0.03					
<i>TB</i>	0.54	0.22	45.97	0.94	0.90	0.65					
<i>LTG</i>	0.60	3.03	3.66	0.05	− 0.00	0.00					
<i>CB</i>	0.62	2.24	5.10	0.20	− 0.04	0.04					
<i>RM - RF</i>	0.43	4.54	1.76	0.05	− 0.04	0.03	<i>RM - RF</i>	<i>RMO</i>	<i>SMB</i>	<i>HML</i>	<i>TERM</i>
<i>RMO</i>	0.50	3.55	2.61	− 0.10	− 0.05	0.02	0.78	1.00			
<i>SMB</i>	0.27	2.89	1.73	0.19	0.07	0.23	0.32	− 0.00	1.00		
<i>HML</i>	0.40	2.54	2.91	0.18	0.06	0.07	− 0.38	− 0.00	− 0.08	1.00	
<i>TERM</i>	0.06	3.02	0.38	0.05	− 0.00	− 0.00	0.34	0.00	− 0.07	− 0.05	1.00
<i>DEF</i>	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 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 (<i>BE/ME</i>) 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
<i>t</i> -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 (<i>BE, ME</i>) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	<i>m</i>					<i>t(m)</i>				
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
	<i>d</i>					<i>t(d)</i>				
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
	<i>R</i> ²					<i>s(e)</i>				
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
<i>m</i>	0.45	0.72	1.02	0.99	1.00	1.01	0.81
<i>t(m)</i>	31.73	38.80	99.94	130.44	139.80	56.24	18.05
<i>d</i>	0.25	0.27	0.94	0.96	1.02	1.10	1.01
<i>t(d)</i>	9.51	7.85	48.95	67.54	75.74	32.33	11.95
<i>R</i> ²	0.79	0.87	0.97	0.98	0.98	0.90	0.49
<i>s(e)</i>	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 (<i>BE/ME</i>) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	<i>b</i>					<i>r(b)</i>				
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
	<i>R</i> ²					<i>s(e)</i>				
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
<i>b</i>	0.08	0.13	0.19	0.20	0.21	0.22	0.30
<i>r(b)</i>	5.24	5.57	7.53	8.14	8.42	8.73	11.90
<i>R</i> ²	0.07	0.08	0.14	0.16	0.17	0.18	0.29
<i>s(e)</i>	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 (<i>BE/ME</i>) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
	<i>s</i>					<i>t(s)</i>				
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
	<i>h</i>					<i>t(h)</i>				
Small	0.95	0.57	-0.35	-0.18	0.01	-9.72	-6.19	-4.10	-2.70	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
	<i>R</i> ²					<i>s(e)</i>				
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
<i>s</i>	-0.02	-0.06	-0.00	0.00	0.03	0.09	0.19
<i>t(s)</i>	-0.66	-1.50	-0.15	0.22	0.77	1.99	4.19
<i>h</i>	0.00	-0.03	-0.02	-0.01	-0.00	0.02	0.00
<i>t(h)</i>	0.24	-0.71	-0.45	-0.22	-0.05	0.46	0.15
<i>R</i> ²	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.04
<i>s(e)</i>	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

Book-to-market equity (*BE/ME*) quintiles

Size quintile	Low	2	3	4	High	Low	2	3	4	High
<i>h</i>					<i>t(h)</i>					
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
<i>s</i>					<i>t(s)</i>					
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
<i>h</i>					<i>t(h)</i>					
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
<i>R</i> ²					<i>s(e)</i>					
Small	0.94	0.96	0.97	0.97	0.96	1.94	1.44	1.16	1.17	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
<i>h</i>	0.10	0.18	0.25	0.25	0.26	0.27	0.34
<i>t(h)</i>	6.45	6.75	8.60	9.30	9.46	9.58	12.22
<i>s</i>	-0.06	-0.14	0.12	-0.11	-0.09	-0.04	0.04
<i>t(s)</i>	-2.70	-3.65	-2.89	-2.72	-2.18	-0.91	0.89
<i>h</i>	0.07	0.08	0.14	0.15	0.16	0.20	0.23
<i>t(h)</i>	2.66	1.83	2.77	3.26	3.51	4.08	4.75
<i>R</i> ²	0.10	0.12	0.17	0.20	0.20	0.22	0.33
<i>s(e)</i>	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
<i>b</i>						<i>t(b)</i>				
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
<i>s</i>						<i>t(s)</i>				
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
<i>h</i>						<i>t(h)</i>				
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
<i>m</i>						<i>t(m)</i>				
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
<i>d</i>						<i>t(d)</i>				
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
<i>R</i> ²						<i>s(e)</i>				
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
<i>b</i>	-0.02	-0.04	-0.02	0.00	0.00	0.02	0.18
<i>t(b)</i>	-2.84	-3.14	-2.96	0.06	1.05	1.99	7.39
<i>s</i>	0.00	-0.02	-0.02	-0.01	0.00	0.05	0.08
<i>t(s)</i>	0.30	-1.12	-2.28	-2.42	0.40	3.20	2.34
<i>h</i>	0.00	-0.02	-0.02	-0.00	0.00	0.04	0.12
<i>t(h)</i>	0.44	-1.29	-2.46	-0.40	0.90	2.39	3.13
<i>m</i>	0.47	0.75	1.03	0.99	1.00	0.99	0.64
<i>t(m)</i>	30.01	36.84	93.30	117.30	124.19	50.50	14.25
<i>d</i>	0.27	0.32	0.97	0.97	1.02	1.05	0.80
<i>t(d)</i>	9.87	8.77	49.25	65.04	71.51	30.33	9.92
<i>R</i> ²	0.80	0.87	0.97	0.98	0.98	0.91	0.58
<i>ste</i>	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 (<i>BE/ME</i>) quintiles									
	Low	2	3	4	High	Low	2	3	4	High
<i>b</i>					<i>t(b)</i>					
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
<i>s</i>					<i>t(s)</i>					
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
<i>h</i>					<i>t(h)</i>					
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
<i>m</i>					<i>t(m)</i>					
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
<i>d</i>					<i>t(d)</i>					
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
<i>R</i> ²					<i>s(e)</i>					
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
<i>b</i>	-0.02	-0.04	-0.02	0.00	0.00	0.02	0.18
<i>t(b)</i>	-2.84	-3.14	-2.96	0.06	1.05	1.99	7.39
<i>s</i>	-0.00	-0.03	-0.03	-0.01	0.00	0.06	0.16
<i>t(s)</i>	-0.68	-2.30	-3.47	-2.55	0.80	4.09	5.09
<i>h</i>	0.02	-0.00	-0.01	-0.00	0.00	0.03	0.00
<i>t(h)</i>	1.76	-0.00	-1.36	-0.47	0.52	1.72	0.12
<i>m</i>	0.45	0.72	1.02	0.99	1.00	1.01	0.79
<i>t(m)</i>	32.09	39.55	102.65	130.93	139.11	57.34	19.56
<i>d</i>	0.25	0.29	0.95	0.97	1.02	1.07	0.94
<i>t(d)</i>	9.46	8.25	50.04	67.08	74.00	31.77	12.09
<i>R</i> ²	0.80	0.87	0.97	0.98	0.98	0.91	0.58
<i>st(e)</i>	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					$t(a)$				
	Low	2	3	4	High	Low	2	3	4	High
(i) $R(t) - RF(t) = a + mTERM(t) + dDEF(t) + \epsilon(t)$										
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) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + \epsilon(t)$										
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) $R(t) - RF(t) = a + sSMB(t) + hHML(t) + \epsilon(t)$										
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) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + \epsilon(t)$										
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) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB(t) + hHML(t) + mTERM(t) + dDEF(t) + \epsilon(t)$										
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
(i) $R(t) - RF(t) = a + mTERM(t) + dDEF(t) + e(t)$								
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	
(ii) $R(t) - RF(t) = a + b[RM(t) - RF(t)] + e(t)$								
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

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

Portfolio	Portfolios formed on E/P			Portfolios formed on D/P		
	Mean	Std.	$t(mn)$	Mean	Std.	$t(mn)$
≤ 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

Portfolio	Portfolios formed on E/P			Portfolios formed on D/P				
	Regression (i)			Regression (ii)				
	a	b	R^2	a	b	s	h	R^2
$E/P \leq 0$	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

Portfolio	Portfolios formed on D/P			Portfolios formed on E/P				
	Regression (i)			Regression (ii)				
	a	b	R^2	a	b	s	h	R^2
$D/P \approx 0$	-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