Asset Management: Advanced Investments

Equities

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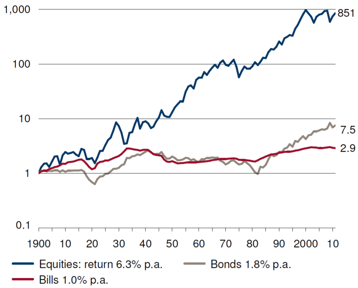
Overview

Risk Premium: Overview

1. The Equity Risk Premium
   - Definition
   - Economic Rationale for the ERP
   - Estimating the Historical ERP
   - Estimating the Expected ERP
2. Equity Return Predictability
3. The Cross-Section of Expected Returns

Equity Risk Premium: Definition

- The equity risk premium (ERP) is the excess return of the equity market over that of a low-risk asset.
- It is usually measured against Treasury bill or Treasury bond returns.



Source: Figure 1 in Dimson et al. [2011].

Key Questions:

1. How large is the ERP?
2. Does the ERP vary over time and why?

Historical versus Expected Equity Risk Premium

- One distinguishes **historical** and **expected** ERP:
  - **Historical/Realized:** The ERP is the extra return earned in the **past** from investing in the equity market rather than in T-bills:

$$\text{ERP}_t = R_{M,t} - R_{f,t} \ . \tag{1}$$

  - **Expected/Ex ante:** The ERP is the average extra return from investing in equities rather than in T-Bills over the **next** h months, quarters, or years:

$$\mathbb{E}_t \left[\text{ERP}_{t \to t+h} \right] = \mathbb{E}_t \left[R_{M,t \to t+h} \right] - R_{f,t \to t+h} \ . \tag{2}$$

- If you borrow capital and invest it in the equity market, the return on this long-short portfolio will be the ERP.
- Note that we can write the optimal portfolio formula for a mean-variance investor with risk aversion a as:

$$w = \frac{1}{a} \frac{\mathbb{E}_t[R_{M,t+1}] - R_{f,t+1}}{\text{var}_t[R_{M,t+1}]} = \frac{1}{a} \frac{\mathbb{E}_t[ERP_{t+1}]}{\text{var}_t[R_{M,t+1}]} \ . \tag{3}$$

- Hence, in order to make portfolio decisions, we need to estimate the **expected** ERP.

Overview

Economic Rationale

- The ex ante ERP is the compensation required by investors to allocate capital to the risky asset (equities) rather than to the risk-free asset.
- Equilibrium reasoning predicts a positive ex ante ERP because stocks do poorly in bad times:

		Real Rate of Return (%) over the Period						
Period	**Description**	**U.S.**	**U.K.**	**France**	**Germany**	**Japan**	**World**	**World ex-US**
Selected Episodes								
1914–18:	World War I	-18	-36	-50	-66	66	-20	-21
1919–28	Post-WWI recovery	372	234	171	18	30	209	107
1929–31	Wall Street Crash	-60	-31	-44	-59	11	-54	-47
1939–48	World War II	24	34	-41	-88	-96	-13	-47
1949–59	Post-WWII recovery	426	212	269	4094	1565	517	670
1973–74	Oil shock/recession	-52	-71	-35	-26	-49	-47	-37
1980–89	Expansionary 80s	184	319	318	272	431	255	326
1990–99	90s tech boom	279	188	226	157	-42	113	40
2000–02	Internet 'bust'	-42	-40	-46	-57	-49	-44	-46

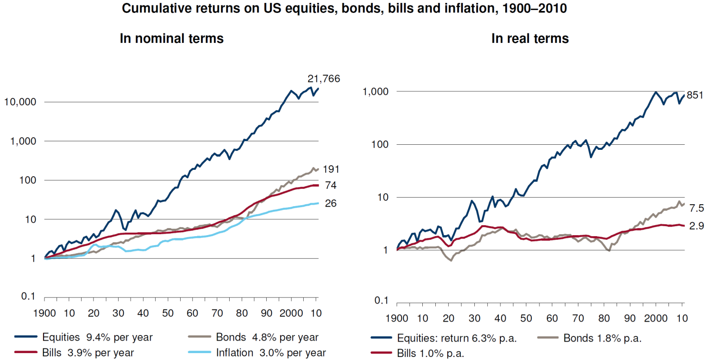
Source: Table 2 in Dimson et al. [2008].

- However, if investors' required ex ante ERP increases, realized equity returns will be negatively affected and might become negative.

Overview

Estimating the Historical ERP

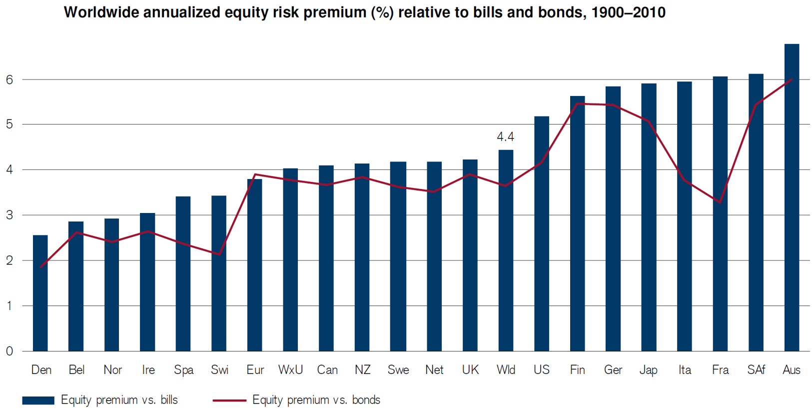
- One estimates the **historical** ERP by comparing historical average returns on the stock market and on the riskless asset.
- Since stock returns are volatile, it is important to use a **long sample period**.
- Estimation can be performed in nominal terms or in real terms:



Source: Figure 1 in Dimson et al. [2008].

Historical ERP Estimates by Country

- The historical ERP is positive in all countries considered:



Source: Figure 4 in Dimson et al. [2008].

Historical ERP Estimates by Subperiod

- The historical ERP varies over time:

Table 8.1. Compound average U.S. equity returns and equity premia over 200+ years

	Nominal equity market return GM (and AM) (%)		*Real equity market return GM* (%)	*Equity premium vs. cash (ERPC) GM* (%)	*Equity premium vs. bond (ERPB) GM (and AM)* (%)	
1802–2009	7.90	(9.42)	6.33	NA	2.68	(4.17)
1802–1899	6.00	(7.01)	6.21	NA	0.50	(1.42)
1900–1999	10.75	(12.68)	7.47	6.37	5.93	(7.79)
2000–2009	0.95	(0.28)	−3.38	−3.65	−7.21	(−5.23)
1926–2009	9.94	(12.22)	6.70	5.99	4.54	(6.87)
1960–2009	9.52	(10.70)	5.22	3.90	2.38	(3.51)

Sources: Arnott–Bernstein (2002), Bloomberg.
Note: GM = Geometric mean, AM = Arithmetic mean.

Source: Ilmanen [2011]

Historical ERP: Rolling Windows

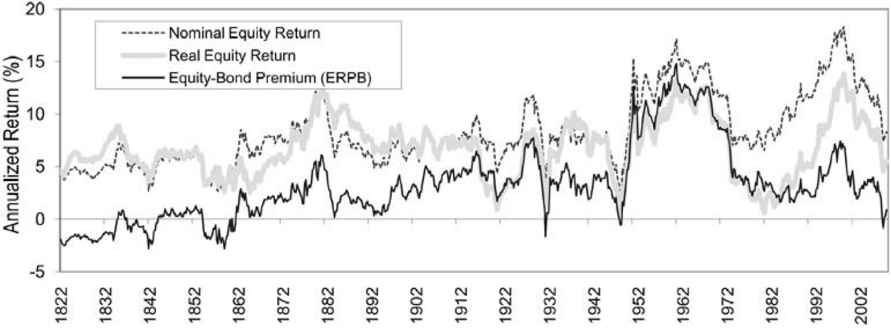
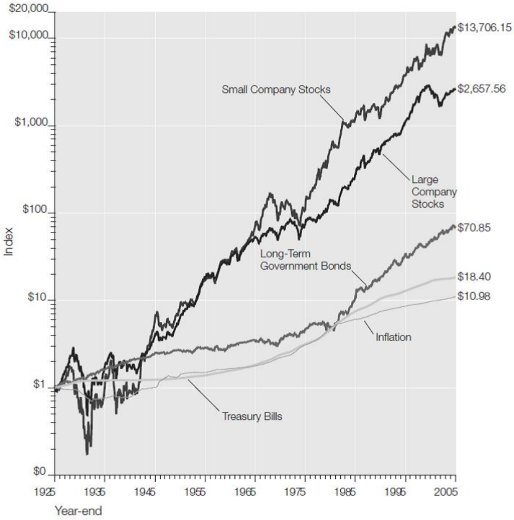


Figure 8.2. Rolling average 20-year returns and premia of U.S. equities.
Sources: Arnott–Bernstein (2002), Bloomberg.

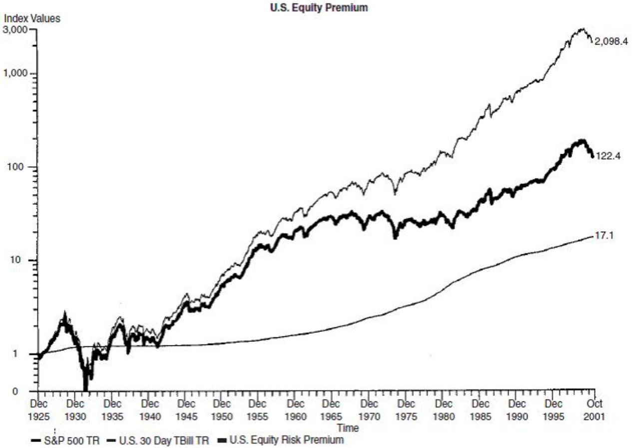
Source: Ilmanen [2011]

Historical ERP: Cumulative Returns



Source: Goetzmann and Ibbotson [2006]

Historical ERP: Cumulative Returns



Source: Goetzmann and Ibbotson [2006]

Overview

Estimating the Expected ERP

- Estimating the **expected ERP** is much more difficult.
- One cannot simply use the historical ERP because there is a negative relation between the historical ERP and the future ERP.
- Intuition: If investors' required ex ante ERP decreases, realized equity returns will be positive, driving up the historical ERP.

Source: Robert Shiller Online Data.

Decomposition of the ERP: Sources of Equity Returns

- To understand the relation between historical and expected ERP and estimate the future ERP, it is useful to decompose stock returns.
- Start from the definition of the one-period (gross) return:

$$R_t = \frac{P_t + D_t}{P_{t-1}} \ , \tag{4}$$

where P_t denotes the equity price and D_t the dividend at time t.

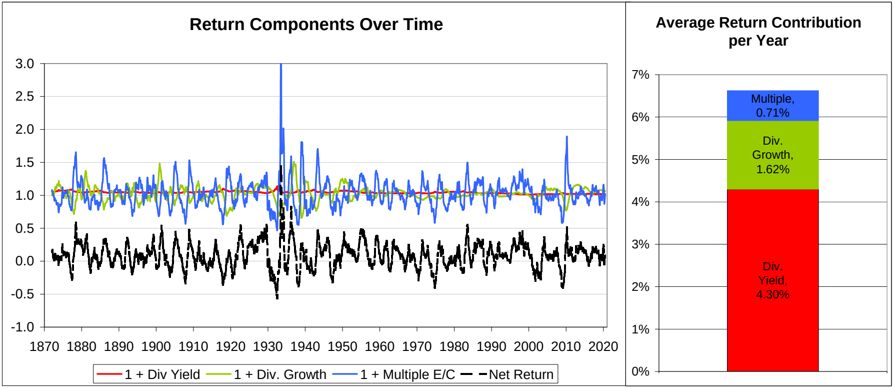
- The return can be decomposed in three components:

$$R_t = \underbrace{\left(1 + \frac{D_t}{P_t}\right)}_{\text{(1+Div. yield)}} \times \underbrace{\frac{D_t}{D_{t-1}}}_{\text{(1+Div. growth)}} \times \underbrace{\frac{P_t/D_t}{P_{t-1}/D_{t-1}}}_{\text{(1+Multiple expansion)}} \ . \tag{5}$$

- Changes in the expected ERP will affect the historical ERP through the multiple expansion/contraction.

Multiple Expansion/Contraction and US Equity Returns

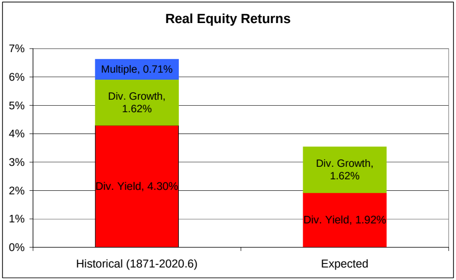
- Multiple expansion/contraction is the main driver of short- and medium-term returns.
- Over the long run, it accounts for a small part of the ERP.



Source: Robert Shiller online data.

Using the Decomposition to Estimate the Expected ERP

- We can use the decomposition to get a rough estimate of the expected ERP.
- To do so, we assess each of the components of real equity returns and then subtract the real riskless rate (which is currently -1.2%).
- The dividend yield is currently 1.92%. For dividend growth, we assume the average of the last 149 years. Finally, we don't count on any further multiple expansion. That gives us an estimate of expected real returns of about 3.5%:

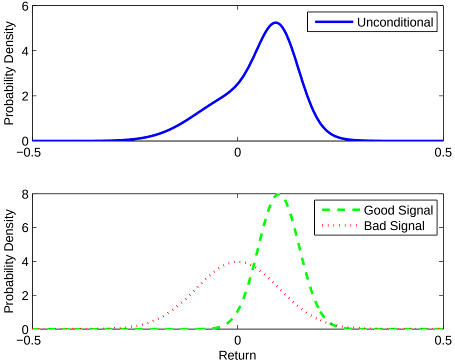


- Subtracting the real riskless rate yields an expected ERP of about 4.7%.

Equity Return Predictability: Overview

Review of the General Idea

- Recall that timing models are based on **predictability**.
- Predictability studies patterns in the return distribution over time. The goal is to identify a set of variables that forecast the future return distribution.
- We saw that predictability is about finding indicators for which the assets' **conditional** return distribution differs from the **unconditional** one.



Predictability: Approaches

We also saw that in order to assess whether a variable x_t has predictive ability, the following methods can be used:

1. **Split the sample** based on the values of x_t (e.g. positive versus negative values, values above or below the sample median,...). Compute the summary statistics of R_{t+h} for the subsamples and run a test for identical distributions.
2. Estimate the **predictive regressions**

$$R_{t+h} = \alpha_h + \beta_h x_t + \varepsilon_{t+h} \ , \tag{6}$$

$$R^2_{t+h} = \alpha_h + \beta_h x_t + \varepsilon_{t+h} \ , \tag{7}$$

   and assess the significance of the betas. The first regression tells you something about expected returns, the second about the variance. You can also investigate higher moments if you see some nonnormality.

3. Run **predictive regressions using dummy variables** $D_{x_t > \tilde{x}_t}$ instead of x_t:

$$R_{t+h} = \alpha_h + \beta_h D_{x_t > \tilde{x}_t} + \varepsilon_{t+h} \ , \tag{8}$$

$$R^2_{t+h} = \alpha_h + \beta_h D_{x_t > \tilde{x}_t} + \varepsilon_{t+h} \ . \tag{9}$$

Commonly Used Predictors

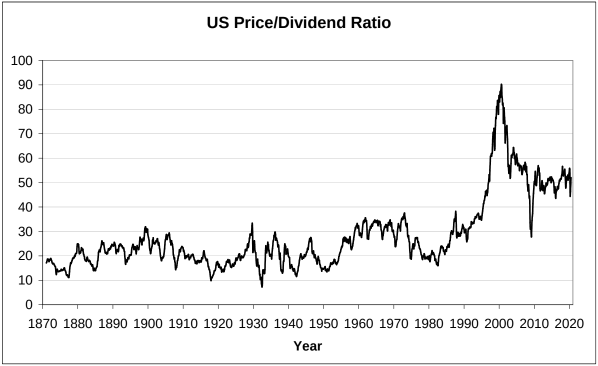
Finally, we had seen that the most common predictive variables investigated in the Finance literature are:

- Valuation ratios:
  - Dividend/Price ratio (D/P).
  - Earnings/Price ratio (E/P and E10/P).
  - Book-to-Market ratio (B/M).
  - Consumption/Wealth ratio (C/W or CAY).
- Interest rate variables:
  - T-bill rate and T-bill minus its 12-month moving average.
  - Term spread, i.e. long term yield minus short-term rate (TS).
  - Credit spread, e.g. BBB yield minus AAA yield (CS).
- Volatility variables:
  - Realized volatility.
  - Implied volatility, e.g. VIX.
- Macroeconomic variables:
  - GDP Growth (GDP).
  - Inflation (π).
- News sentiment.

Overview

Does the Price/Dividend Ratio Contain Information?

- We have seen that the dividend yield is a key component of long-term equity returns and that shifts in its inverse – the price/dividend (P/D) ratio – drive short-term returns.
- The P/D ratio varies strongly over time. Can we use it to estimate the expected ERP?



Source: Robert Shiller online data.

Price/Dividend Ratio: One-Period Present Value Model

- Consider a firm that pays dividends D_t. Suppose we are at time t and that the firm lasts one more period, i.e. it will pay out a terminal dividend D_{t+1}.

- Letting P_t denote the current price, the gross return on an investment in the firm is

$$R_{t+1} = \frac{D_{t+1}}{P_t} \; . \tag{10}$$

- Taking expectations:

$$\mathbb{E}_t \left[R_{t+1} \right] = \frac{\mathbb{E}_t \left[D_{t+1} \right]}{P_t} \; . \tag{11}$$

- Solving for P_t and dividing by today's dividend yields:

$$\frac{P_t}{D_t} = \frac{\mathbb{E}_t \left[D_{t+1}/D_t \right]}{\mathbb{E}_t \left[R_{t+1} \right]} \; . \tag{12}$$

- The P/D ratio moves due to changes in **expected dividend growth** or changes in **expected returns**.

Two Views on the Price/Dividend Ratio

There are two views on the information content of the P/D ratio:

1. **Traditional view:**
   Expected returns are more or less constant, and P/D is driven by changes in **expected dividend growth**.
   $\Rightarrow$ A high P/D ratio should predict **high future dividend growth**.
   For a forecasting horizon k, this can be tested by estimating the regression:

$$\frac{D_{t+k}}{D_t} = a_k + b_k \frac{D_t}{P_t} + \varepsilon_{t+k} \ . \tag{13}$$

2. **Modern view:**
   P/D is driven by changes in **expected returns**.
   $\Rightarrow$ A high P/D ratio should predict **low future returns**.
   This can be tested by estimating the regression:

$$\underbrace{R_{M,t\to t+k} - R_{f,t\to t+k}}_{\text{Excess return } R^e_{t\to t+k}} = a_k + b_k \frac{D_t}{P_t} + \varepsilon_{t+k} \ . \tag{14}$$

Formal Analysis of the Two Views

Write (10) as $\frac{P_t}{D_t} = R_{t+1}^{-1} \frac{D_{t+1}}{D_t}$, take logs to make things linear, and take expectations to obtain:

$$p_t - d_t = \mathbb{E}_t \left[\Delta d_{t+1}\right] - \mathbb{E}_t \left[r_{t+1}\right] \ , \tag{15}$$

where lowercase letters denote the log of uppercase variables and $\Delta d_{t+1} = \ln(D_{t+1}/D_t)$.

1. Suppose that **expected returns are constant**, $\mathbb{E}_t \left[r_{t+1}\right] = \overline{r}$.
   If expectations are rational (unbiased), one has $\Delta d_{t+1} = \mathbb{E}_t \left[\Delta d_{t+1}\right] + \varepsilon_{t+1}$ with $\mathbb{E}_t \left[\varepsilon_{t+1}\right] = 0$ so

$$\Delta d_{t+1} = \overline{r} + (p_t - d_t) + \varepsilon_{t+1} \ . \tag{16}$$

2. Suppose instead that **expected dividend growth is constant**, $\mathbb{E}_t \left[\Delta d_{t+1}\right] = \overline{d}$.
   With rational expectations, one has $r_{t+1} = \mathbb{E}_t \left[r_{t+1}\right] + \varepsilon_{t+1}$ with $\mathbb{E}_t \left[\varepsilon_{t+1}\right] = 0$ so

$$r_{t+1} = \overline{d} - (p_t - d_t) + \varepsilon_{t+1} \ . \tag{17}$$

Empirical Findings for the US Market

- For 1927-2005, D/P **predicts future returns** rather than dividend growth:

OLS Regressions of Excess Returns (value-weighted NYSE—Treasury bill) and Real Dividend Growth on the Value-Weighted NYSE Dividend-Price Ratio

Horizon k (years)	$R^e_{t\to t+k} = a + b\frac{D_t}{P_t} + \varepsilon_{t+k}$			$\frac{D_{t+k}}{D_t} = a + b\frac{D_t}{P_t} + \varepsilon_{t+k}$		
	b	$t(b)$	R^2	b	$t(b)$	R^2
1	4.0	2.7	0.08	0.07	0.06	0.0001
2	7.9	3.0	0.12	–0.42	–0.22	0.0010
3	12.6	3.0	0.20	0.16	0.13	0.0001
5	20.6	2.6	0.22	2.42	1.11	0.0200

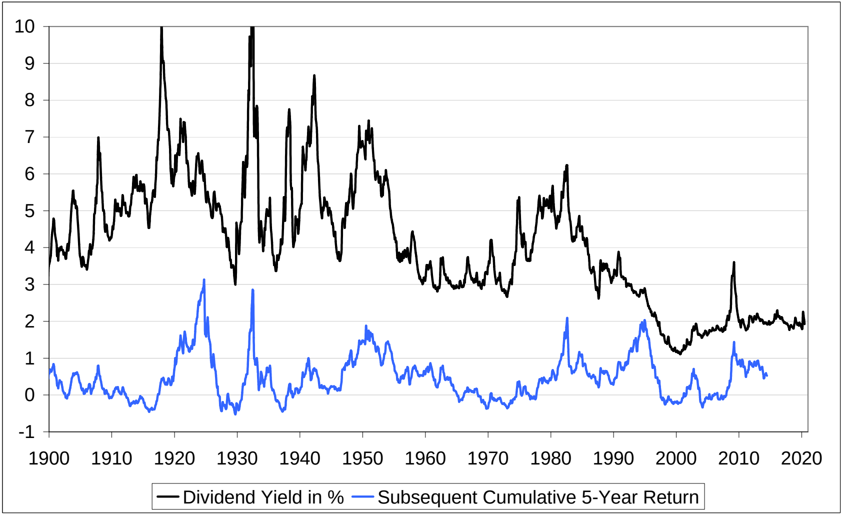
Sample 1927–2005, annual data. $R^e_{t\to t+k}$ denotes the total excess return from time t to time $t+k$. Standard errors use GMM (Hansen–Hodrick) to correct for heteroskedasticity and serial correlation.

Source: Table 1 in Cochrane [2008].

- Note that return predictability does not imply that markets are irrational or inefficient. It arises naturally if there is time variation in the ERP.

Dividend/Price Ratio

Graphically:



Source: Robert Shiller online data.

Dividend/Price Ratio: Multi-Period Present Value Model

- The one-period model we just considered can be extended to multiple periods (Campbell and Shiller [1988]). Start from the one-period return definition:

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} \, . \tag{18}$$

- Rewrite this expression as:

$$\frac{P_t}{D_t} = \frac{1}{R_{t+1}} \frac{P_{t+1} + D_{t+1}}{D_t} = R_{t+1}^{-1} \frac{D_{t+1}}{D_t} \left(1 + \frac{P_{t+1}}{D_{t+1}} \right) \, . \tag{19}$$

- Substituting forward one period yields:

$$\frac{P_t}{D_t} = R_{t+1}^{-1} \frac{D_{t+1}}{D_t} + R_{t+1}^{-1} \frac{D_{t+1}}{D_t} R_{t+2}^{-1} \frac{D_{t+2}}{D_{t+1}} \left(1 + \frac{P_{t+2}}{D_{t+2}} \right) \, . \tag{20}$$

- Iterate forward, impose a limiting condition, and take expectations:

$$\frac{P_t}{D_t} = \mathbb{E}_t \left[\sum_{i=1}^{\infty} \left(\prod_{j=1}^{i} R_{t+j}^{-1} \frac{D_{t+j}}{D_{t+j-1}} \right) \right] \, . \tag{21}$$

- Today's P/D ratio is high if people expect **high future dividend growth** or **low future returns**.

Dividend/Price Ratio: Multi-Period Present Value Model

- This expression is hard to work with so one usually uses the approximation suggested by Campbell and Shiller [1988]. Take logs of the expression

$$\frac{P_t}{D_t} = R_{t+1}^{-1} \frac{D_{t+1}}{D_t} \left(1 + \frac{P_{t+1}}{D_{t+1}}\right) \quad (22)$$

to obtain

$$p_t - d_t = -r_{t+1} + \Delta d_{t+1} + \ln\left(1 + \exp(p_{t+1} - d_{t+1})\right) \ . \quad (23)$$

- Perform a first-order Taylor approximation of the log to obtain

$$p_t - d_t = -r_{t+1} + \Delta d_{t+1} + c + \rho\left(p_{t+1} - d_{t+1}\right) \ , \quad (24)$$

where c is a constant and ρ is less than but close to one.
- Iterate forward, impose a limiting condition, and take expectations to obtain

$$p_t - d_t = \text{const} + \mathbb{E}_t\left[\sum_{i=1}^{\infty} \rho^{i-1}(\Delta d_{t+i} - r_{t+i})\right] \ . \quad (25)$$

- Again, high P/D reflects high future dividend growth or low expected returns.

Dividend/Price Ratio: Volatility

- Equity prices are quite volatile. Shiller [1981] notes that the variation in prices is not justified by changes in dividends or cash flows.

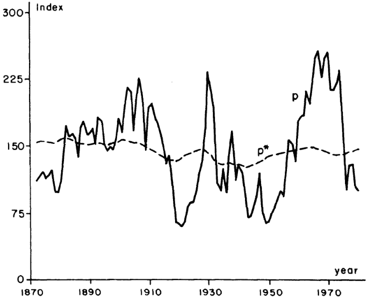


FIGURE 1

Note: Real Standard and Poor's Composite Stock Price Index (solid line p) and *ex post* rational price (dotted line p^*), 1871–1979, both detrended by dividing a long-run exponential growth factor. The variable p^* is the present value of actual subsequent real detrended dividends, subject to an assumption about the present value in 1979 of dividends thereafter.

- Does this excess volatility puzzle mean that markets are irrational or inefficient?

Dividend/Price Ratio: Volatility

- It turns out that **excess volatility is the same as return predictability**.
- From the multi-period price-dividend equation, one can compute the **variance of the P/D ratio** as

$$\text{Var}(p_t - d_t) = \text{Cov}\left(p_t - d_t, \sum_{i=1}^{\infty} \rho^{i-1} \Delta d_{t+i}\right) - \text{Cov}\left(p_t - d_t, \sum_{i=1}^{\infty} \rho^{i-1} r_{t+i}\right) . \tag{26}$$

- Thus, the dividend yield can only vary if it forecasts changes in future dividend growth or returns.
- We saw that empirically P/D predicts returns and not dividend growth. This means that the variation in the P/D ratio comes from movements in expected returns.

Market vs. Single Stock Returns

- The analysis we conducted so far was at the aggregate level, i.e. considered indices or diversified portfolios.
- Vuolteenaho [2002] shows that most of the variation in **single stock returns** comes from **cash-flow news** rather than expected return news.
- At the single stock level, D/P is driven by changes in cash flows, while at the aggregate level it is driven by changes in expected returns.
- Cash flow news about single stocks are highly idiosyncratic and are diversified away when stocks are combined into portfolios. As a result, movements in aggregate portfolio/index returns mostly reflect changes in expected returns which are driven by macroeconomic components.

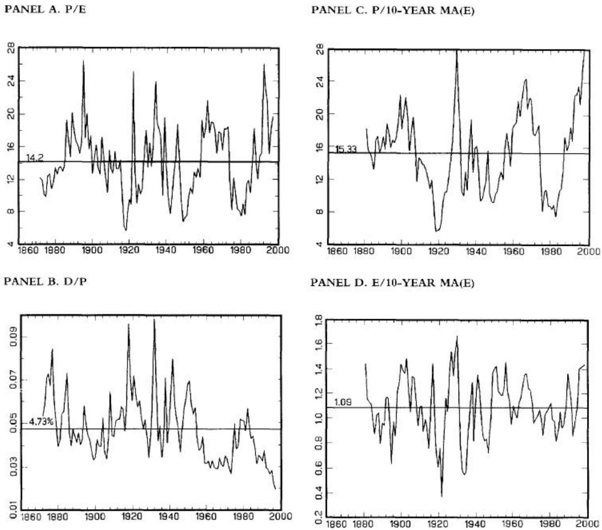
Overview

Other Profitability Ratios (E/P, E10/P)

- The earnings/price ratio (E/P) and the ratio of the 10-year moving average of earnings to price (E10/P or CAPE for cyclically adjusted P/E) are also good predictors.
- E10/P is more stable than E/P as it is less affected by single-year events.
- E10/P is reasonably good at catching periods of low expected returns (or periods of discrepancies between fundamentals and valuations), such as the dot com bubble in 2000.
- Campbell and Shiller [1998] compare different predictors. Their analysis was conducted before the bursting of the dot com bubble.

Other Profitability Ratios (P/E, P/E10, D/P, E/E10)

EXHIBIT 4
S&P COMPOSITE STOCK DATA JANUARY VALUES 1872-1997



Overview

D/P and Term Premium

- Fama and French [1988] predict returns on stock and long-term corporate bond portfolios using D/P and the **Term Premium** (TP = Aaa bond yield − 1-month T-bill yield).
- They find that D/P and TP predict returns in both markets. This suggests that there is **common variation in expected returns across markets**.
- In Fama and French [1989], they find that expected returns on stock and bonds are linked and share a common counter-cyclical component.
- D/P and TP are both **large in bad times** and **predict high expected returns in both stock and bond markets**. This is the typical constellation during recession periods. So expected returns are lower when economic conditions are strong and higher when they are weak.
- The variation through time in the risk premium related to D/P is stronger for low-grade bonds than for high-grade bonds and stronger for stocks than for bonds.

D/P and Term Premium

Table 3

Slopes, t-statistics, and R^2 from multiple regressions of excess returns on the term spread ($TERM$) and the value-weighted dividend yield (D/P) or the default spread (DEF); 1941–1987.[a]

T	Aaa	Aa	A	Baa	LG	VW	EW	Aaa	Aa	A	Baa	LG	VW	EW
	Portfolios													
	$r(t,t+T) = a + bD(t)/P(t) + cTERM(t) + e(t,t+T)$													
	Slopes for D/P							t-statistics for D/P slopes						
M	0.13	0.11	0.11	0.13	0.30	0.40	0.53	2.75	2.58	2.54	2.81	3.82	2.88	2.99
Q	0.36	0.34	0.36	0.42	0.94	1.31	1.78	1.91	1.89	1.97	2.42	3.28	2.93	3.03
1	0.40	0.27	0.74	1.23	3.33	5.49	7.96	0.75	0.47	1.31	2.14	3.91	3.45	3.67
2	1.00	0.62	2.05	3.15	7.67	11.84	16.70	0.87	0.49	1.58	2.56	3.97	4.18	3.87
3	1.41	0.91	2.93	4.34	10.88	15.65	21.22	1.37	0.78	2.27	3.11	3.65	4.94	3.31
4	2.41	1.76	3.87	5.29	12.66	18.48	23.43	3.78	1.94	3.65	3.83	4.21	5.26	3.18
	Slopes for $TERM$							t-statistics for $TERM$ slopes						
M	0.25	0.28	0.31	0.32	0.31	0.48	0.51	2.77	3.55	4.35	4.81	3.32	3.29	2.97
Q	0.62	0.60	0.73	0.75	0.77	1.13	1.17	1.51	1.52	2.07	2.43	1.89	2.17	1.82
1	3.64	3.56	3.87	3.57	3.27	1.64	1.33	4.74	5.07	5.68	5.57	4.10	0.94	0.66
2	4.29	4.18	4.25	4.16	3.71	−1.34	−2.90	3.25	3.48	3.64	4.06	3.04	−0.63	−0.89
3	4.41	3.81	3.83	3.62	2.71	−3.95	−6.35	2.13	2.09	1.95	2.31	2.01	−1.23	−1.27
4	3.73	3.07	3.27	3.51	3.27	−2.40	−2.67	1.11	0.97	1.02	1.40	1.45	−0.75	−0.64
	Regression R^2													
M	0.04	0.06	0.08	0.08	0.05	0.03	0.03							
Q	0.06	0.05	0.08	0.10	0.10	0.06	0.06							
1	0.39	0.37	0.44	0.41	0.35	0.16	0.18							
2	0.21	0.18	0.24	0.30	0.44	0.36	0.37							
3	0.13	0.08	0.15	0.24	0.46	0.53	0.48							
4	0.09	0.04	0.13	0.25	0.51	0.60	0.50							

Source: Fama and French [1989]. Aaa-LG denote bond portfolios formed on the corresponding Moody's ratings groups. VW and EW are the value- and equal-weighted NYSE portfolios.

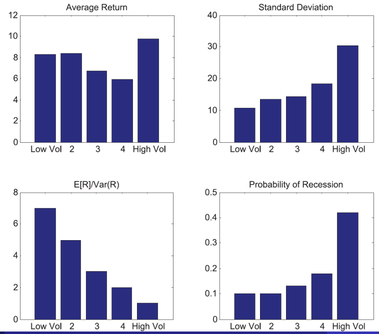
Overview

Volatility: Intuition

- The optimal exposure to stocks depends on the risk-return tradeoff, not just on the ERP:

$$w = \frac{1}{a}\frac{\mathbb{E}_t[R_{t+1}] - R_{f,t+1}}{\text{var}_t[R_{t+1}]} = \frac{1}{a}\frac{\mathbb{E}_t[ERP_{t+1}]}{\text{var}_t[R_{t+1}]} \,. \tag{27}$$

- Moreira and Muir [2017] show that return **variance is highly forecastable** at short horizons, but variance forecasts are only weakly related to future returns at these horizons. Building quintiles based on return variance in the previous month, for 1926-2015 one gets:



Volatility: Portfolio Strategy

- Since the optimal investment in the risky asset for a mean-variance investor is proportional to the mean-variance tradeoff,

$$w = \frac{1}{a}\frac{\mathbb{E}_t[R_{t+1}] - R_{f,t+1}}{\text{var}_t[R_{t+1}]}\ , \tag{28}$$

one can **scale the equity exposure** going into each month by the realized variance in the previous month RV_t, i.e. at the end of each month, set

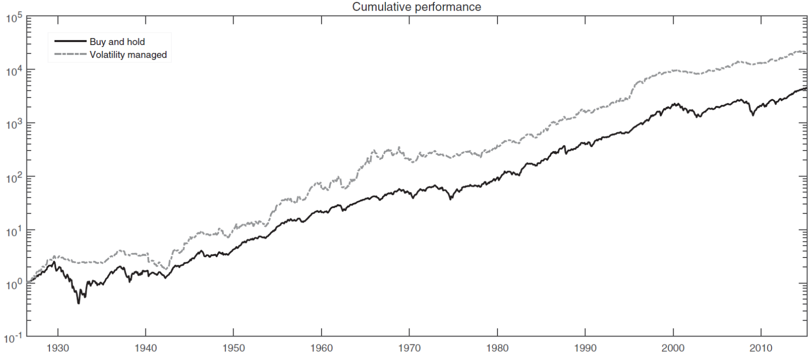
$$w_t = \frac{c}{RV_t}\ , \tag{29}$$

where c controls the average exposure of the strategy (chosen to match the unconditional standard deviation of the buy-and-hold portfolio in the paper).

- Managing exposure in this way improves the Sharpe ratio from investing in the US equity market from 0.42 to 0.51.

Volatility: Strategy Returns

- At equal volatility, the timed strategy earns much higher returns than the buy-and-hold strategy:



- Note that while it is true that the Sharpe ratio can be improved, whether the claimed improvement in returns can be achieved is not obvious because the scaling factor c is chosen in-sample.

Overview

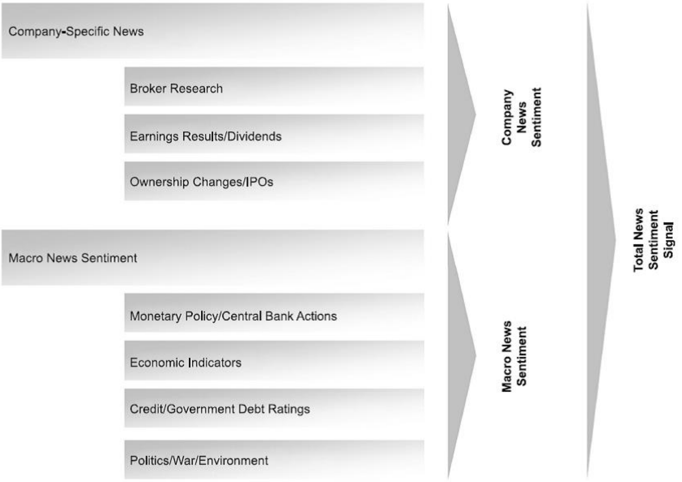
News Sentiment

- **Sentiment analysis** uses computers to determine the tone of news stories. Sentiment is then used to time exposure to the equity market.
- An example is Uhl et al. [2015], who conduct the analysis as follows:
  1. Obtain news sentiment data from Thomson Reuters News Analytics. Sentiment for each news story is positive, neutral, or negative (1, 0, -1).
  2. Aggregate these news either at the company or macro level to obtain a measure of the daily or weekly overall sentiment of the equity market.
  3. Filter the aggregate news with a smoothing procedure (CUSUM) to make the signal less noisy.
  4. Invest in the MSCI world equity index if aggregate equity sentiment is positive and in the investment grade 3-5 year bond index otherwise.
- This strategy achieves a Sharpe ratio of 1.47.
- The selection of the smoothing parameter affects performance.

News Sentiment: Data

EXHIBIT 2

Overview of Topic Codes for Company- and Macro-Specific Indicators

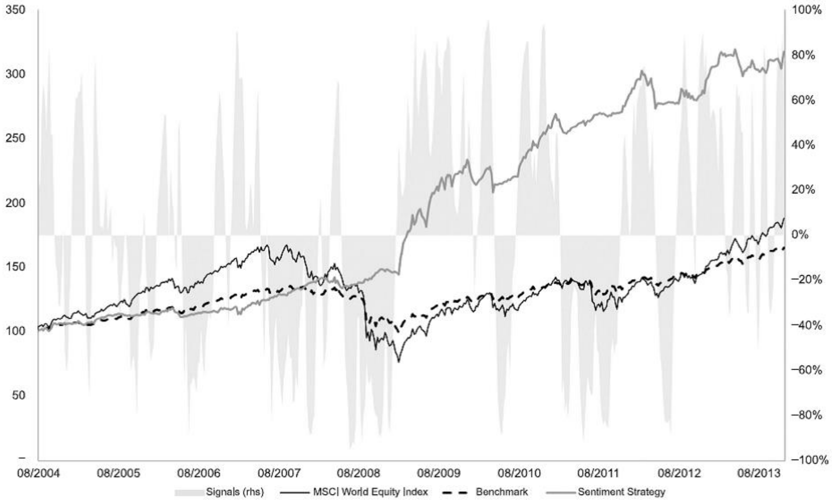


Source: Thomson Reuters NewsAnalytics.

News Sentiment: Signals and Strategy Returns

EXHIBIT 7

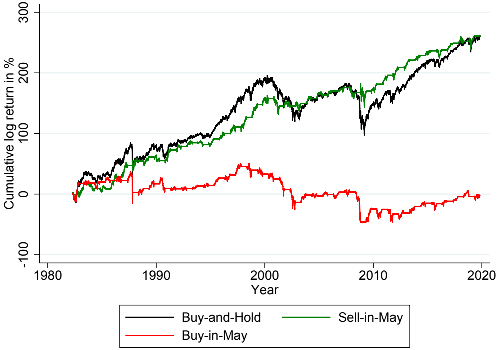
Tactical Asset Allocation Strategy Based on News-Sentiment Momentum



Overview

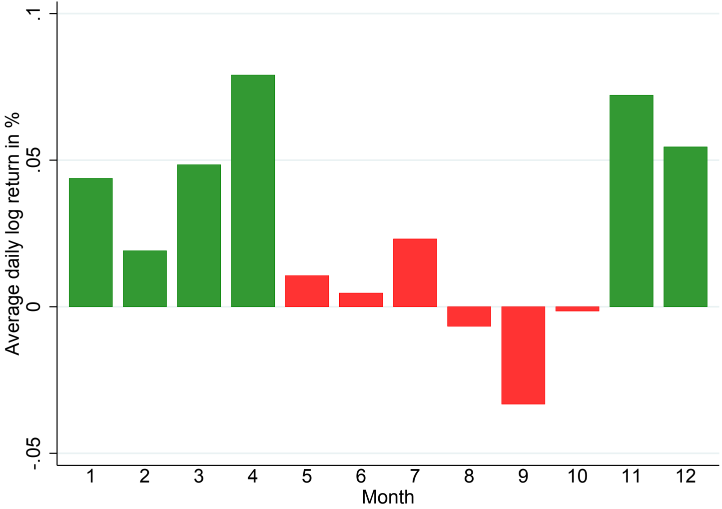
“Sell in May and Go Away”

- “Sell in May and Go Away” is an old market adage. It says to invest in the stock market from late October to early May and in cash from early May to late October.
- To investigate whether the effect is present, it is easiest to use futures contracts since their returns are excess returns.
- During 1982-2019, the entire US equity premium accrued during the winter months:



"Sell in May" – Average Returns by Month

- There is a striking seasonality in S&P 500 returns across months of the year:



"Sell in May" Around the World

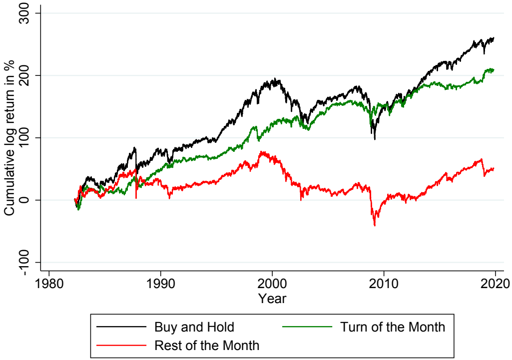
- The effect is present in almost all countries.
- Since the winter months also have (slightly) lower volatility, the Sharpe ratio from investing in stock markets in winter is quite attractive.

Country	Daily average return (bps)		Daily standard deviation (%)		Annualized Sharpe Ratio	
	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.	Nov.-Apr.	May-Oct.
Australia	3.01	0.05	0.93	1.02	0.51	0.01
Brazil	6.28	−5.04	2.03	2.03	0.49	−0.39
Canada	4.12	−0.62	1.17	1.13	0.56	−0.09
China	5.32	−1.50	1.42	1.62	0.60	−0.15
Eurozone	4.54	−3.03	1.43	1.55	0.50	−0.31
France	5.53	−2.52	1.30	1.42	0.68	−0.28
Germany	6.71	−2.91	1.36	1.43	0.78	−0.32
Hong Kong	4.18	1.79	1.83	1.62	0.36	0.18
India	4.69	2.81	1.39	1.53	0.54	0.29
Italy	3.44	−2.48	1.41	1.50	0.39	−0.26
Japan	2.90	−3.79	1.52	1.49	0.30	−0.40
Mexico	5.07	−1.84	1.31	1.30	0.61	−0.22
Netherlands	6.27	−2.01	1.25	1.35	0.80	−0.24
Norway	6.51	−1.09	1.45	1.59	0.71	−0.11
Russia	8.43	−2.96	2.39	2.54	0.56	−0.18
South Africa	3.48	−1.35	1.40	1.34	0.39	−0.16
South Korea	7.47	−5.05	1.92	1.87	0.62	−0.43
Spain	5.58	−0.99	1.39	1.52	0.64	−0.10
Sweden	7.68	−1.47	1.36	1.40	0.90	−0.17
Switzerland	4.47	−1.58	1.12	1.28	0.63	−0.20
Taiwan	6.04	−2.13	1.52	1.53	0.63	−0.22
Thailand	5.97	−0.52	1.47	1.57	0.65	−0.05
Turkey	2.54	0.52	1.71	1.77	0.24	0.05
UK	3.70	−1.08	1.06	1.15	0.55	−0.15
US	5.41	−0.04	1.13	1.26	0.76	−0.01

Source: Dzhabarov et al. [2020]

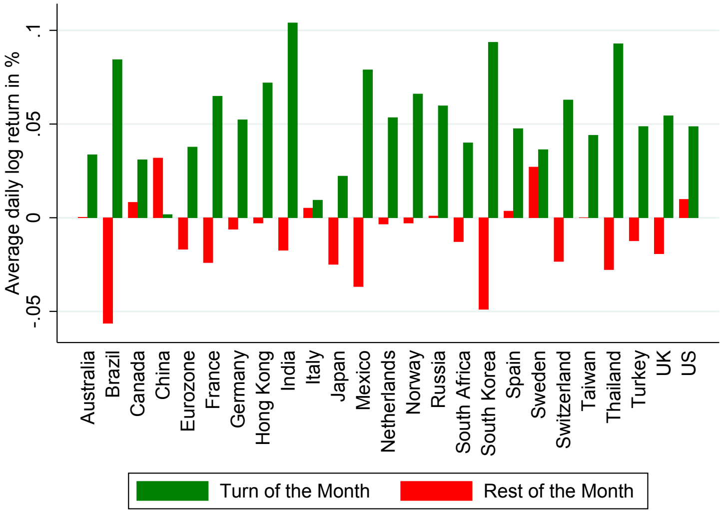
The "Turn-of-the-Month" Effect

- Another seasonality is the "Turn-of-the-Month" effect. It says that returns are much higher at the turn of the month than during the rest of the month.
- It is again easiest to use futures contracts to investigate this effect.
- During 1982-2019, most of the US equity premium accrued during the first five and last five trading days of the month:



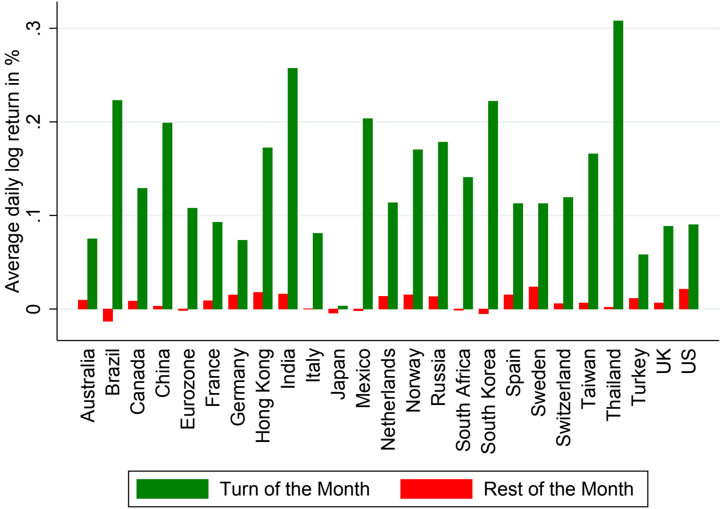
The "Turn-of-the-Month" Effect Around the World

- The effect that returns are higher during the **first five and last five trading days** of the month is present in almost all countries:



The "Turn-of-the-Month" Effect Around the World

- The effect is even stronger if the "turn-of-the-month" period only includes the **first and last trading day** of each month:



The Cross-Section of Expected Returns: Overview

General Idea

- Analyses of the cross-section of expected returns aim to identify variables that help explain **differences in expected returns across stocks**.
- Typically, new factors are identified by comparing the returns on assets or portfolios built using some variable. For instance, how do returns differ between small and large capitalization stocks?
- The **CAPM** predicts that **market beta** should explain the cross-sectional variation of expected returns, i.e. expected returns should be driven by exposure to a **single factor**, the return on the market portfolio.

CAPM Tests

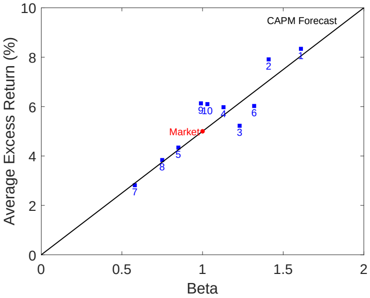
Regression tests of the CAPM consider the hypothesis that market model regression **alphas are jointly zero**:

1. For all assets or portfolios j, estimate the **market model**:

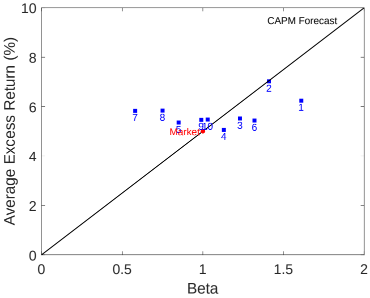
$$R_{j,t} - R_{f,t} = \alpha_j + \beta_j(R_{M,t} - R_{f,t}) + \varepsilon_{j,t} \ . \tag{30}$$

2. Test the null hypothesis predicted by the CAPM: $H_0 : \alpha_j = 0$ for all j.

CAPM holds:



CAPM doesn't hold:



Overview

Risk Premium Versus Mispricing

- Once an effect has been documented, the key question is whether differences in returns reflect a risk premium or mispricing. The latter could be caused by slow processing of information by investors, institutional frictions, or behavioral anomalies.

- To take a few examples:
  - Do **distressed firms** earn higher returns because they are highly pro-cyclical or because investors make errors in pricing them?
  - Do **past winners** tend to outperform past losers because investors incorporate good news too slowly, because of tax-induced trading behavior, or because of differences in the skewness of returns that command a crash premium?
  - Do **low-beta assets** outperform high-beta ones because of institutional frictions or because of an additional risk?

- We now consider a number of factors that have been documented to affect expected returns.

Overview

Size and Value

- Banz [1981] documented differences in average returns between stocks with large and small **market capitalization**.
- Stattman [1980] and Rosenberg et al. [1985] found that average returns on US stocks are positively related to the ratio of a firm's **book value of common equity to its market value**, B/M.
- Fama and French [1992], [1993], and [1996] **combine size and value** factors to explain the cross-section of expected stock returns.
  1. At a given point in time, sort stocks according to their B/M ratio. Call stocks with high B/M Value stocks and those with low B/M Growth stocks. Thus, Value and Growth are defined relative to other stocks in the cross-section.
  2. Similarly, sort stocks based on their market capitalization and divide them into Small stocks and Big stocks.

Size and Value: Results

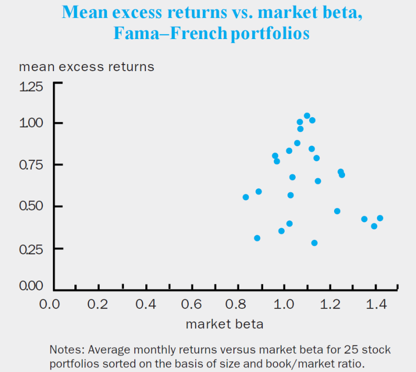
- Sorting along both dimensions, one can construct $m \times n$ portfolios and investigate their expected returns.
- For instance, the average returns if one builds $5 \times 5 = 25$ portfolios are:

	Book-to-Market Equity (BE/ME) Quintiles									
Size	Low	2	3	4	High	Low	2	3	4	High
	Panel A: Summary Statistics									
	Means					Standard Deviations				
Small	0.31	0.70	0.82	0.95	1.08	7.67	6.74	6.14	5.85	6.14
2	0.48	0.71	0.91	0.93	1.09	7.13	6.25	5.71	5.23	5.94
3	0.44	0.68	0.75	0.86	1.05	6.52	5.53	5.11	4.79	5.48
4	0.51	0.39	0.64	0.80	1.04	5.86	5.28	4.97	4.81	5.67
Big	0.37	0.39	0.36	0.58	0.71	4.84	4.61	4.28	4.18	4.89

Table 1 in Fama and French 1996

Size and Value as Evidence Against the CAPM

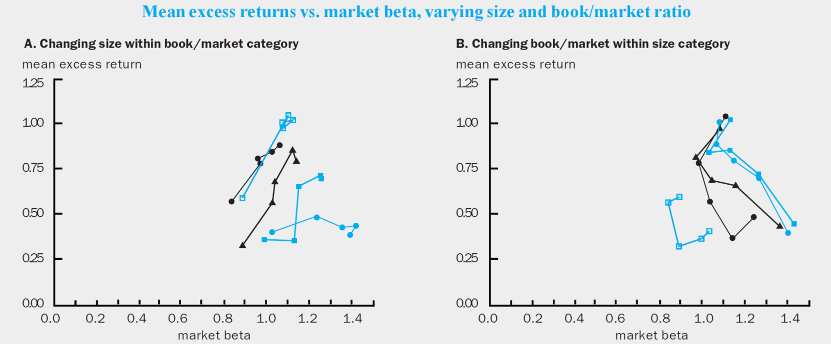
- In the data, Value stocks have higher average returns than Growth stocks and Small stocks have higher returns than Big stocks.
- However, these sizable differences in returns do not reflect differences in market β. Recall that CAPM predicts that all portfolios should lie on a straight line going through the origin.



Source: Cochrane [1999]

Size and Value as Evidence Against the CAPM

- The linear relation predicted by the CAPM does not hold even if one varies size within B/M categories (left panel) or if one varies B/M within size categories (right panel).



Notes: Average returns versus market beta for 25 stock portfolios sorted on the basis of size and book/market ratio. The points are the same as figure 3. In panel A, lines connect portfolios as size varies within book/market categories; in panel B, lines connect portfolios as book/market ratio varies within size categories.

Source: Cochrane [1999]

Size and Value: Factor Construction

In order to explain the cross-sectional variation in returns, the authors construct size and value **factors** as follows:

1. Double sort stocks (independently) by market cap and B/M in $2 \times 3 = 6$ portfolios and compute their returns (each portfolio is value-weighted).

2. **Size factor: SMB (Small Minus Big)**

$$\text{SMB} = \frac{(\text{Small Value} + \text{Small Neutral} + \text{Small Growth})}{3} - \frac{(\text{Big Value} + \text{Big Neutral} + \text{Big Growth})}{3}.$$

3. **Value factor: HML (High Minus Low)**

$$\text{HML} = \frac{(\text{Small Value} + \text{Big Value})}{2} - \frac{(\text{Small Growth} + \text{Big Growth})}{2}.$$

Size and Value: Factor Construction

- Note that the factors are **self-financing ("zero-cost")** portfolios. The long part is financed by the short part.
  1. **Size factor:** You are investing in small caps and financing this position with a short-sale of large caps.
  2. **Value factor:** You are investing in Value stocks and financing this position by shorting Growth stocks.
- Hence, the **factor returns are already excess returns**, i.e. there is no need to subtract the riskless asset return.
- French's web-page provides many different factors and a detailed description of their construction: `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`.

Size and Value: Factor Model

Based on these factors, the authors define a 3-Factor model to explain expected stock returns:

$$R^e_{i,t} = \alpha_i + b_i MKT_t + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \ , \tag{32}$$

where

- $R^e_{i,t} \equiv R_{i,t} - R_{f,t}$ is the excess return of asset i,
- $MKT_t \equiv R_{M,t} - R_{f,t}$ is the excess return of the market,
- SMB_t and HML_t are the size and value factor returns, respectively,
- α_i represents the model's mispricing, and
- $\varepsilon_{i,t}$ is a mean zero error term.

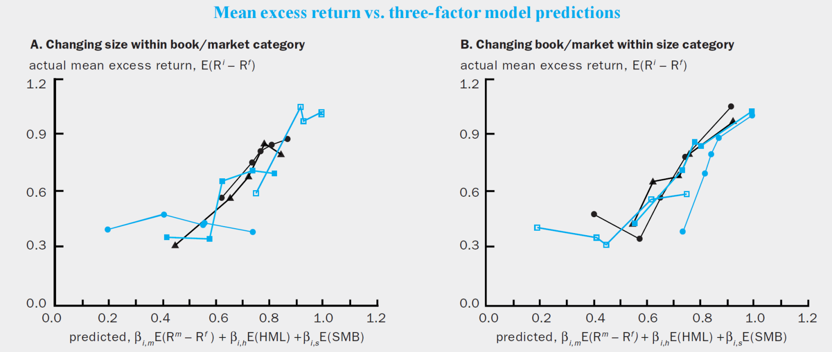
Size and Value: Factor Model Pricing Errors

Empirically, the pricing errors are small on the test assets, with an average value of $\alpha_i \approx 0.093\%$ per month:

	Book-to-Market Equity (BE/ME) Quintiles									
Size	Low	2	3	4	High	Low	2	3	4	High
Panel B: Regressions: $R_i - R_f = a_i + b_i(R_M - R_f) + s_i SMB + h_i HML + e_i$										
	a					t(a)				
Small	−0.45	−0.16	−0.05	0.04	0.02	−4.19	−2.04	−0.82	0.69	0.29
2	−0.07	−0.04	0.09	0.07	0.03	−0.80	−0.59	1.33	1.13	0.51
3	−0.08	0.04	−0.00	0.06	0.07	−1.07	0.47	−0.06	0.88	0.89
4	0.14	−0.19	−0.06	0.02	0.06	1.74	−2.43	−0.73	0.27	0.59
Big	0.20	−0.04	−0.10	−0.08	−0.14	3.14	−0.52	−1.23	−1.07	−1.17

Size and Value: Factor Model Pricing Errors

Graphically, small pricing errors mean that predicted and realized returns line up:



Notes: Average returns versus market beta for 25 stock portfolios sorted on the basis of size and book/market ratio versus predictions of Fama–French three-factor model. The predictions are derived by regressing each of the 25 portfolio returns, R_t^i, on the market portfolio, R_t^m, and the two Fama–French factor portfolios, SMB_t (small minus big) and HML_t (high minus low book/market).

Source: Cochrane [1999]

Size and Value: Factor Exposures

The test assets' market betas b are quite similar, but their exposures to the size and value factors, s and h, vary a lot:

	b					t(b)				
Small	1.03	1.01	0.94	0.89	0.94	39.10	50.89	59.93	58.47	57.71
2	1.10	1.04	0.99	0.97	1.08	52.94	61.14	58.17	62.97	65.58
3	1.10	1.02	0.98	0.97	1.07	57.08	55.49	53.11	55.96	52.37
4	1.07	1.07	1.05	1.03	1.18	54.77	54.48	51.79	45.76	46.27
Big	0.96	1.02	0.98	0.99	1.07	60.25	57.77	47.03	53.25	37.18
	s					t(s)				
Small	1.47	1.27	1.18	1.17	1.23	39.01	44.48	52.26	53.82	52.65
2	1.01	0.97	0.88	0.73	0.90	34.10	39.94	36.19	32.92	38.17
3	0.75	0.63	0.59	0.47	0.64	27.09	24.13	22.37	18.97	22.01
4	0.36	0.30	0.29	0.22	0.41	12.87	10.64	10.17	6.82	11.26
Big	−0.16	−0.13	−0.25	−0.16	−0.03	−6.97	−5.12	−8.45	−6.21	−0.77
	h					t(h)				
Small	−0.27	0.10	0.25	0.37	0.63	−6.28	3.03	9.74	15.16	23.62
2	−0.49	0.00	0.26	0.46	0.69	−14.66	0.34	9.21	18.14	25.59
3	−0.39	0.03	0.32	0.49	0.68	−12.56	0.89	10.73	17.45	20.43
4	−0.44	0.03	0.31	0.54	0.72	−13.98	0.97	9.45	14.70	17.34
Big	−0.47	0.00	0.20	0.56	0.82	−18.23	0.18	6.04	18.71	17.57

Size and Value: Mispricing or Risk Premium?

- The profitability of factors can represent a risk premium (compensation for risk) or mispricing by investors.
- The positive average returns on the value factor could be due to a recession premium reflecting the pro-cyclical nature of value stocks.
- These returns could also arise from undervaluation of value firms by investor due to behavioral reasons.
- Empirically, returns on the HML factor forecast changes in the Chicago Fed national activity index, consistent with a risk-based explanation (Cooper and Maio [2016]).

Overview

E/P, C/P, and Sales Growth

- Fama and French [1996] further investigated sorting on:
  1. the earnings/price ratio (E/P),
  2. the cash-flow/price ratio (C/P), and
  3. the five-year sales rank (5-Yr SR), computed as the time weighted average of the annual sales growth ranks of the prior five years.
- **High E/P and high C/P** decile portfolios have **higher returns** than lower decile portfolios. This is similar to B/M sorting.
- This is not surprising. B/M, E/P, and C/P are fairly similar variables; all three are ratios of a fundamental variable and a market valuation.
- On the other hand, low sales rank decile portfolios have higher returns than high decile portfolios, i.e. **past sales growth is negatively related to future returns**.
- *Intuition:* Firms that have performed poorly in sales terms in the last 5 years are relatively distressed and load positively on HML. They tend to rebound in the following period.

E/P, C/P, and Sales Growth

A summary of these results is reported below:

	Deciles									
	1	2	3	4	5	6	7	8	9	10
BE/ME	**Low**									**High**
Mean	0.42	0.50	0.53	0.58	0.65	0.72	0.81	0.84	1.03	1.22
Std. Dev.	5.81	5.56	5.57	5.52	5.23	5.03	4.96	5.06	5.52	6.82
t(Mean)	1.39	1.72	1.82	2.02	2.38	2.74	3.10	3.17	3.55	3.43
Ave. ME	2256	1390	1125	1037	1001	864	838	730	572	362
E/P	**Low**									**High**
Mean	0.55	0.45	0.54	0.63	0.67	0.77	0.82	0.90	0.99	1.03
Std. Dev.	6.09	5.62	5.51	5.35	5.14	5.18	4.94	4.88	5.05	5.87
t(Mean)	1.72	1.52	1.89	2.24	2.49	2.84	3.16	3.51	3.74	3.37
Ave. ME	1294	1367	1211	1209	1411	1029	1022	909	862	661
C/P	**Low**									**High**
Mean	0.43	0.45	0.60	0.67	0.70	0.76	0.77	0.86	0.97	1.16
Std. Dev.	5.80	5.67	5.57	5.39	5.39	5.19	5.00	4.88	4.96	6.36
t (Mean)	1.41	1.52	2.06	2.37	2.47	2.78	2.93	3.36	3.75	3.47
Ave. ME	1491	1266	1112	1198	990	994	974	951	990	652
5-Yr SR	**High**									**Low**
Mean	0.47	0.63	0.70	0.68	0.67	0.74	0.70	0.78	0.89	1.03
Std. Dev.	6.39	5.66	5.46	5.15	5.22	5.10	5.00	5.10	5.25	6.13
t (Mean)	1.42	2.14	2.45	2.52	2.46	2.78	2.68	2.91	3.23	3.21
Ave. ME	937	1233	1075	1182	1265	1186	1075	884	744	434

E/P, C/P, and Sales Growth

The 3-factor model still performs well when applied to decile portfolios constructed based on these additional variables:

	Deciles											
	1	2	3	4	5	6	7	8	9	10	GRS	$p(GRS)$
BE/ME	**Low**									**High**		
a	0.08	−0.02	−0.09	−0.11	−0.08	−0.03	0.01	−0.04	0.03	−0.00		
$t(a)$	1.19	−0.26	−1.25	−1.39	−1.16	−0.40	0.15	−0.61	0.43	−0.02	0.57	0.841
R^2	0.95	0.95	0.94	0.93	0.94	0.94	0.94	0.94	0.95	0.89		
E/P	**Low**									**High**		
a	−0.00	−0.07	−0.07	−0.04	−0.03	0.02	0.06	0.09	0.12	0.00		
$t(a)$	−0.07	−1.07	−0.94	−0.52	−0.43	0.24	1.01	1.46	1.49	0.05	0.84	0.592
R^2	0.91	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.92	0.92		
C/P	**Low**									**High**		
a	0.02	−0.08	−0.07	−0.00	−0.04	0.00	0.00	0.05	0.06	0.01		
b	1.04	1.06	1.08	1.06	1.05	1.04	0.99	1.00	0.98	1.14		
s	0.45	0.50	0.54	0.51	0.55	0.50	0.53	0.48	0.57	0.92		
h	−0.39	−0.18	0.07	0.11	0.23	0.31	0.36	0.50	0.67	0.79		
$t(a)$	0.22	−1.14	−1.00	−0.04	−0.51	0.00	0.06	0.72	0.92	0.14	0.49	0.898
$t(b)$	51.45	61.16	62.49	64.15	59.04	61.28	60.02	63.36	58.92	46.49		
$t(s)$	15.56	20.32	22.11	21.57	21.49	20.72	22.19	21.17	24.13	26.18		
$t(h)$	−12.03	−6.52	2.56	4.28	7.85	11.40	13.52	19.46	24.88	19.74		
R^2	0.93	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.92		
5-Yr SR	**High**									**Low**		
a	−0.21	−0.06	−0.03	−0.01	−0.04	−0.02	−0.04	0.00	0.04	0.07		
b	1.16	1.10	1.09	1.03	1.03	1.03	1.00	0.99	0.99	1.02		
s	0.72	0.56	0.52	0.49	0.52	0.51	0.50	0.57	0.67	0.95		
h	−0.09	0.09	0.21	0.20	0.24	0.33	0.33	0.36	0.47	0.50		
$t(a)$	−2.60	−0.97	−0.49	−0.20	−0.61	−0.25	−0.66	0.07	0.47	0.60	0.87	0.563
$t(b)$	59.01	70.59	67.65	65.34	56.68	68.89	62.49	54.12	50.08	34.54		
$t(s)$	25.69	25.11	22.59	21.65	20.15	23.64	21.89	21.65	23.65	22.34		
$t(h)$	−2.88	3.55	8.05	7.98	8.07	13.63	12.80	12.13	14.78	10.32		
R^2	0.95	0.96	0.95	0.95	0.93	0.95	0.94	0.93	0.92	0.87		

Overview

Profitability and Investment

- Fama and French [2015] extend their 3-factor model to a 5-factor model by adding profitability and investment factors:

$$R^e_{i,t} = \alpha_i + b_i MKT_t + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{i,t} \ , \quad (33)$$

  where RMW_t and CMA_t are the returns on the profitability and investment factors, respectively. Their construction is similar to that of HML and SMB.

- **Profitability Factor: RMW (Robust Minus Weak profitability)**
  - Sorting is performed based on $\frac{\text{Revenue} - \text{COGS} - \text{SGA} - \text{Interest}}{\text{Book value of equity}}$.

- **Investment: CMA (Conservative Minus Aggressive portfolios)**
  - Sorting is performed based on the percentage growth in total assets.

Profitability and Investment

There is large variation in average returns across portfolios:

Table 2
Averages of monthly percent excess returns for value-weight (VW) portfolios formed on (i) *Size*, *B*/*M*, and *OP*, (ii) *Size*, *B*/*M*, and *Inv*, and (iii) *Size*, *OP*, and *Inv*; July 1963–December 2013, 606 months.

At the end of June each year *t*, stocks are allocated to two *Size* groups (Small and Big) using the NYSE median market cap as breakpoint. Stocks in each *Size* group are allocated independently to four *B*/*M* groups (Low *B*/*M* to High *B*/*M* for fiscal year $t-1$), four *OP* groups (Low *OP* to High *OP* for fiscal year $t-1$), and four *Inv* groups (Low *Inv* to High *Inv* for fiscal year $t-1$) using NYSE breakpoints specific to the *Size* group. The table shows averages of monthly returns in excess of the one-month Treasury bill rate on the 32 portfolios formed from each of the three sorts.

	Small				Big			
Panel A: Portfolios formed on Size, B/M, and OP								
B/*M*→	Low	2	3	High	Low	2	3	High
Low *OP*	0.03	0.72	0.84	0.93	0.24	0.23	0.37	0.60
2	0.67	0.76	0.88	1.08	0.41	0.50	0.47	0.69
3	0.66	0.88	1.07	1.30	0.40	0.59	0.68	0.91
High *OP*	0.81	1.13	1.22	1.63	0.53	0.64	0.79	0.71
Panel B: Portfolios formed on Size, B/M and Inv								
B/*M* →	Low	2	3	High	Low	2	3	High
Low *Inv*	0.69	0.99	1.18	1.23	0.58	0.70	0.62	0.77
2	0.87	0.92	0.93	1.08	0.49	0.54	0.54	0.60
3	0.84	0.95	1.01	0.97	0.49	0.54	0.56	0.72
High *Inv*	0.39	0.75	0.87	1.01	0.49	0.44	0.39	0.64
Panel C: Portfolios formed on Size, OP, and Inv								
OP →	Low	2	3	High	Low	2	3	High
Low *Inv*	0.85	1.01	1.19	1.27	0.63	0.66	0.79	0.70
2	0.94	0.90	0.92	1.04	0.32	0.43	0.64	0.64
3	0.61	0.93	0.94	1.06	0.52	0.57	0.48	0.53
High *Inv*	−0.09	0.58	0.76	0.76	0.29	0.25	0.38	0.65

Profitability and Investment

Intercepts are much smaller when using five factors than when using three factors:

$$R(t)-R_F(t)=a+b[R_M(t)-R_F(t)]+sSMB(t)+hHMLO(t)+rRMW(t)+cCMA(t)+e(t)$$

$OP \rightarrow$	Low	2	3	4	High	Low	2	3	4	High
Panel A: Three-factor intercepts: R_M-R_F, SMB, and HML										
			a					*t(a)*		
Small	−0.30	0.10	0.05	0.09	−0.02	−3.25	1.54	0.85	1.30	−0.30
2	−0.24	−0.03	0.05	0.04	0.16	−3.16	−0.55	0.94	0.58	2.08
3	−0.21	0.07	0.01	0.05	0.20	−2.27	1.04	0.14	0.79	2.51
4	−0.11	−0.02	−0.05	0.06	0.18	−1.15	−0.24	−0.73	0.96	2.43
Big	−0.17	−0.20	−0.03	0.05	0.22	−1.90	−2.94	−0.58	1.20	4.03
Panel B: Five-factor coefficients: R_M-R_F, SMB, HMLO, RMW, and CMA										
			a					t(a)		
Small	−0.10	0.04	−0.05	−0.05	−0.15	−1.28	0.64	−0.80	−0.80	−2.05
2	−0.05	−0.11	−0.03	−0.11	0.00	−0.83	−1.86	−0.64	−1.92	0.02
3	0.08	0.04	−0.06	−0.07	0.03	1.15	0.67	−1.05	−1.23	0.43
4	0.16	0.02	−0.12	−0.09	0.05	1.91	0.26	−1.97	−1.52	0.76
Big	0.14	−0.11	−0.03	0.02	0.08	2.08	−1.67	−0.57	0.42	1.85
			h					*t(h)*		
Small	−0.14	0.24	0.26	0.28	0.21	−3.82	8.05	9.32	9.31	6.17
2	−0.12	0.17	0.23	0.18	0.15	−3.96	5.84	9.51	6.38	5.08
3	0.00	0.14	0.21	0.19	0.09	0.11	4.36	7.68	6.74	2.93
4	0.03	0.15	0.21	0.10	0.02	0.72	4.80	7.19	3.60	0.69
Big	0.22	0.16	0.04	−0.00	−0.13	6.70	5.33	1.42	−0.19	−6.13
			r					*t(r)*		
Small	−0.67	0.21	0.30	0.47	0.45	−17.70	6.98	10.59	15.08	12.95
2	−0.60	0.21	0.29	0.45	0.55	−19.94	6.90	11.32	15.76	17.91
3	−0.76	0.03	0.24	0.38	0.57	−21.06	0.93	8.33	13.12	17.19
4	−0.75	−0.15	0.23	0.39	0.37	−18.94	−4.54	7.49	12.95	11.09
Big	−0.71	−0.26	−0.08	0.12	0.35	−21.05	−8.41	−2.82	5.66	15.54
			c					t(c)		
Small	−0.06	0.25	0.34	0.31	0.14	−1.42	7.58	10.89	9.08	3.76
2	−0.09	0.29	0.26	0.23	0.05	−2.65	8.94	9.52	7.44	1.56
3	−0.17	0.26	0.24	0.23	0.02	−4.41	7.31	7.89	7.49	0.65
4	−0.02	0.30	0.30	0.26	0.02	−0.41	8.56	9.08	8.12	0.48
Big	−0.03	0.23	0.19	−0.04	−0.12	−0.83	6.82	6.16	−1.82	−5.22

Profitability and Investment

- The profitability factor shows that firms with **high operating profitability** have **higher average returns**.
- The investment factor shows that firms that **invest little** have **higher average returns** than firms that invest a lot.
- The 5-factor model performs better than the 3-factor model in terms of mispricing, i.e. αs become negligible.
- The profitability and investment factors overlap with the value factor to some extent. One can explain the premium on the value factor by its exposure to the other factors, making the **value factor redundant**.

Overview

Momentum

- Jegadeesh and Titman [1993] investigate a simple strategy that buys winners in the last 3-12 months and sells losers in the last 3-12 months.
- Firms that have performed well in the previous 3 to 12 months are found to keep performing well for as much as 12 months in the future. Underperforming firms also keep underperforming.
- The long-short portfolio of **buying winners and selling losers** is called **momentum** and its returns cannot be explained by MKT, SMB, and HML.
- This momentum effect lasts for about 12 months and is followed by a reversal.
- Momentum is particularly strong in December and January due to tax-loss selling.

Momentum: Returns

Table I

Momentum Portfolio Returns

This table reports the monthly returns for momentum portfolios formed based on past six-month returns and held for six months. P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest returns over the previous six months, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest returns, and so on. The "All stocks" sample includes all stocks traded on the NYSE, AMEX, or Nasdaq excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). The "Small Cap" and "Large Cap" subsamples comprise stocks in the "All Stocks" sample that are smaller and larger than the median market cap NYSE stock respectively. "EWI" is the returns on the equal-weighted index of stocks in each sample.

	All Stocks			Small Cap			Large Cap		
	1965–1998	1965–1989	1990–1998	1965–1998	1965–1989	1990–1998	1965–1998	1965–1989	1990–1998
P1 (Past winners)	1.65	1.63	1.69	1.70	1.69	1.73	1.56	1.52	1.66
P2	1.39	1.41	1.32	1.45	1.50	1.33	1.25	1.24	1.27
P3	1.28	1.30	1.21	1.37	1.42	1.23	1.12	1.10	1.19
P4	1.19	1.21	1.13	1.26	1.34	1.05	1.10	1.07	1.20
P5	1.17	1.18	1.12	1.26	1.33	1.06	1.05	1.00	1.19
P6	1.13	1.15	1.09	1.19	1.26	1.01	1.09	1.05	1.20
P7	1.11	1.12	1.09	1.14	1.20	0.99	1.09	1.04	1.23
P8	1.05	1.05	1.03	1.09	1.17	0.89	1.04	1.00	1.17
P9	0.90	0.94	0.77	0.84	0.95	0.54	1.00	0.96	1.09
P10 (Past losers)	0.42	0.46	0.30	0.28	0.35	0.08	0.70	0.68	0.78
P1–P10	1.23	1.17	1.39	1.42	1.34	1.65	0.86	0.85	0.88
t statistic	6.46	4.96	4.71	7.41	5.60	5.74	4.34	3.55	2.59
EWI	1.09	1.10	1.04	1.13	1.19	0.98	1.03	1.00	1.12

Momentum: Portfolio Characteristics

Table III

Portfolio Characteristics

This table reports the characteristics of momentum portfolios. The sample includes all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size cutoff). P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest past six-month returns, and so on. Average size decile rank is the average rank of the market capitalization of equity (based on NYSE size decile cutoffs) of the stocks in each portfolio at the beginning of the holding period. FF factor sensitivities are the slope coefficients in the Fama-French three-factor model time-series regressions. "Market" is the market factor (the value-weighted index minus the risk-free rate), "SMB" is the size factor (small stocks minus big stocks) and "HML" is the book-to-market factor (high minus low book-to-market stocks). The sample period is January 1965 to December 1998.

	Average Size Decile Rank	FF Factor Sensitivities		
		Market	SMB	HML
P1	4.81	1.08	0.41	−0.24
P2	5.32	1.03	0.23	0.00
P3	5.49	1.00	0.19	0.08
P4	5.51	0.99	0.17	0.14
P5	5.49	0.99	0.17	0.17
P6	5.41	0.99	0.19	0.19
P7	5.36	0.99	0.22	0.19
P8	5.26	1.01	0.24	0.16
P9	5.09	1.04	0.30	0.11
P10	4.56	1.12	0.55	−0.02
P1–P10	0.25	−0.04	−0.13	−0.22

Table IV

CAPM and Fama-French Alphas

This table reports the risk-adjusted returns of momentum portfolios. The sample comprises all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest past six-month returns, and so on. This table reports the intercepts from the market model regression (CAPM Alpha) and Fama-French three-factor regression (FF Alpha). The sample period is January 1965 to December 1998. The t statistics are reported in parentheses.

	CAPM Alpha	FF Alpha
P1	0.46	0.50
	(3.03)	(4.68)
P2	0.29	0.22
	(2.86)	(3.51)
P3	0.21	0.10
	(2.53)	(2.31)
P4	0.15	0.02
	(1.92)	(0.41)
P5	0.13	−0.02
	(1.70)	(−.43)
P6	0.10	−0.06
	(1.22)	(−1.37)
P7	0.07	−0.09
	(0.75)	(−1.70)
P8	−0.02	−0.16
	(−0.19)	(−2.50)
P9	−0.21	−0.33
	(−1.69)	(−4.01)
P10	−0.79	−0.85
	(−4.59)	(−7.54)
P1–P10	1.24	1.36
	(6.50)	(−7.04)

Momentum: Characteristics

- Momentum is mainly driven by:
  - Under-reaction to firm-specific information, which is only processed slowly by investors.
  - Investors' riding recent trends in asset prices.
- Momentum has good performance but its returns are negatively skewed, i.e. it is subject to **infrequent but large crashes**. Another issue is that its **turnover is high**, implying large transaction costs.
- Momentum is **negatively correlated with the Value factor**.
- Asness et al. [2013] investigate the presence of Value and Momentum factors across asset classes and countries. They find that Momentum (Value) in an asset class is positively related to Momentum (Value) in other asset classes.
- Value and Momentum are related to illiquidity factors but when combined they are neutral to illiquidity (which makes the returns even more puzzling).

Momentum and Value: US Stocks

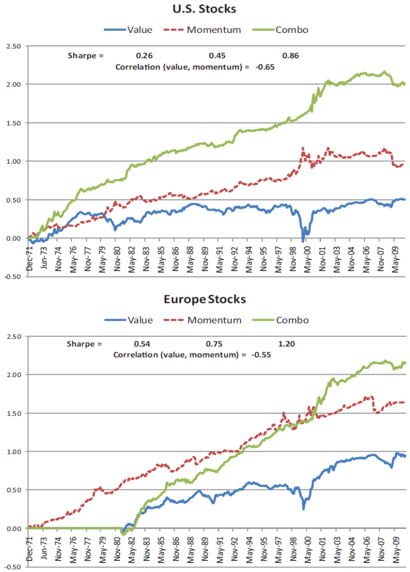
Panel A: Individual Stock Portfolios												
	Value Portfolios					Momentum Portfolios					50/50 Combination	
	P1	P2	P3	P3–P1	Factor	P1	P2	P3	P3–P1	Factor	P3–P1	Factor
Mean	9.5%	10.6%	13.2%	3.7%	3.9%	8.8%	9.7%	14.2%	5.4%	7.7%	4.6%	5.8%
(t-stat)	(3.31)	(4.33)	(5.19)	(1.83)	(1.66)	(2.96)	(4.14)	(4.82)	(2.08)	(2.84)	(3.98)	(5.40)
Stdev	17.9%	15.4%	15.9%	12.8%	14.8%	18.6%	14.8%	18.5%	16.4%	17.0%	7.2%	6.8%
Sharpe	0.53	0.69	0.83	0.29	0.26	0.47	0.66	0.77	0.33	0.45	0.63	0.86
Alpha	– 1.7%	0.8%	3.6%	5.3%	5.8%	– 2.3%	0.2%	3.7%	6.0%	8.7%	5.7%	7.2%
(t-stat)	(– 1.59)	(1.02)	(3.17)	(2.66)	(2.49)	(– 1.68)	(0.29)	(2.34)	(2.30)	(3.22)	(5.05)	(7.06)
										Correlation (Val, Mom) =	– 0.53	– 0.65

Momentum and Value: Non-US Stocks

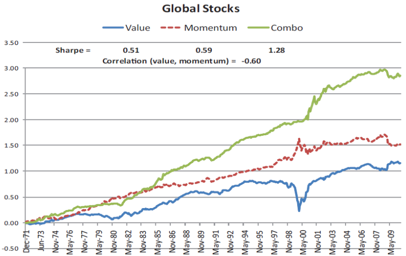
Panel A: Individual Stock Portfolios

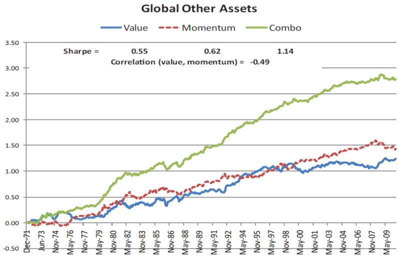
	Value Portfolios					Momentum Portfolios					50/50 Combination	
	P1	P2	P3	P3–P1	Factor	P1	P2	P3	P3–P1	Factor	P3–P1	Factor
Mean	8.1%	11.0%	14.6%	6.2%	5.8%	8.5%	11.1%	14.1%	5.6%	7.1%	6.3%	6.8%
(*t*-stat)	(3.17)	(4.54)	(5.84)	(3.60)	(3.18)	(3.10)	(4.82)	(5.46)	(2.94)	(3.73)	(6.52)	(8.04)
Stdev	16.6%	15.2%	15.7%	10.9%	11.4%	17.1%	14.5%	16.2%	12.0%	12.0%	6.1%	5.3%
Sharpe	0.50	0.72	0.93	0.57	0.51	0.49	0.77	0.87	0.47	0.59	1.04	1.28
Alpha	– 2.3%	0.7%	4.2%	6.6%	6.1%	– 3.3%	0.5%	3.1%	6.4%	8.1%	6.8%	7.5%
(*t*-stat)	(– 1.70)	(0.69)	(3.49)	(3.79)	(3.37)	(– 3.00)	(1.00)	(2.78)	(3.37)	(4.31)	(7.09)	(8.98)
								Correlation (Val, Mom) =			– 0.52	– 0.60

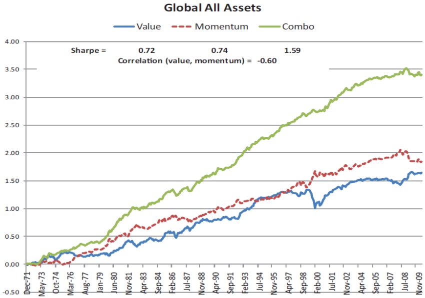
Momentum and Value: Returns for Stocks



Momentum and Value: Returns for Other Assets







Momentum: Timing Considerations

- Momentum has remarkable performance in terms of Sharpe ratio. Nonetheless, momentum is negatively skewed and exhibits sudden crashes.
- Daniel and Moskowitz [2016] investigate a **dynamic momentum strategy** to avoid crashes.
- Regressions reveal that momentum returns are particularly poor during bear markets with high volatility, specifically when:
  - There has been a steady market decline (a bear market defined as a negative cumulative market return during the previous 24 months).
  - Risk (measured as the variance of daily market returns during the previous 126 days) is high.
- The dynamic momentum strategy weights the investment in the momentum portfolio according to its conditional expected return and its conditional variance,

$$w \propto \frac{\mathbb{E}_{t-1}[R_{Mom}]}{\mathbb{E}_{t-1}[(R_{Mom} - \mathbb{E}_{t-1}[R_{Mom}])^2]} \,. \tag{34}$$

- The dynamic momentum strategy has a Sharpe ratio that is twice as high as the static momentum strategy.

Momentum: Timing Considerations

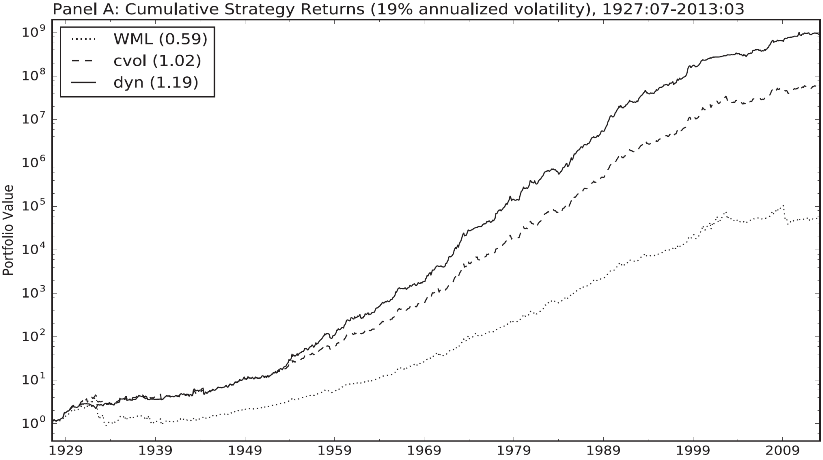
Table 1

Momentum portfolio characteristics, 1927:01–2013:03.

This table presents characteristics of the monthly momentum decile portfolio excess returns over the 87-year full sample period from 1927:01 through 2013:03. The decile 1 portfolio—the loser portfolio—contains the 10% of stocks with the worst losses, and decile 10—the winner portfolio—contains the 10% of the stocks with the largest gains. WML is the zero-investment winner-minus-loser portfolio which is long the Decile 1 and short the Decile 10 portfolio. The mean excess return, standard deviation, and alpha are in percent, and annualized. SR denotes the annualized Sharpe Ratio. The α, $t(\alpha)$, and β are estimated from a full-period regression of each decile portfolio's excess return on the excess Center for Research in Securities Prices value-weighted index. For all portfolios except WML, sk(m) denotes the full-period realized skewness of the monthly log returns (not excess) to the portfolios and sk(d) denotes the full-period realized skewness of the daily log returns. For WML, sk is the realized skewness of $\log(1+r_{WML}+r_f)$.

Return statistic	Momentum decile portfolios										WML	Market
	1	2	3	4	5	6	7	8	9	10		
$\overline{r-r_f}$	−2.5	2.9	2.9	6.4	7.1	7.1	9.2	10.4	11.3	15.3	17.9	7.7
σ	36.5	30.5	25.9	23.2	21.3	20.2	19.5	19.0	20.3	23.7	30.0	18.8
α	−14.7	−7.8	−6.4	−2.1	−0.9	−0.6	1.8	3.2	3.8	7.5	22.2	0
$t(\alpha)$	(−6.7)	(−4.7)	(−5.3)	(−2.1)	(−1.1)	(−1.0)	(2.8)	(4.5)	(4.3)	(5.1)	(7.3)	(0)
β	1.61	1.41	1.23	1.13	1.05	1.02	0.98	0.95	0.99	1.03	−0.58	1
SR	−0.07	0.09	0.11	0.28	0.33	0.35	0.47	0.54	0.56	0.65	0.60	0.41
sk(m)	0.09	−0.05	−0.19	0.21	−0.13	−0.30	−0.55	−0.54	−0.76	−0.82	−4.70	−0.57
sk(d)	0.12	0.29	0.22	0.27	0.10	−0.10	−0.44	−0.66	−0.67	−0.61	−1.18	−0.44

Momentum: Timing Considerations



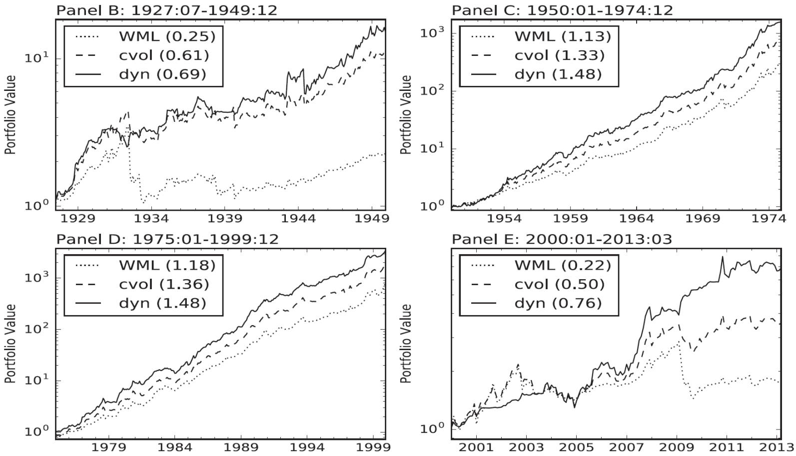
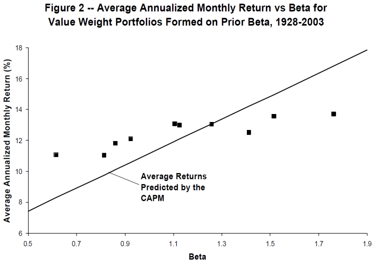


Fig. 6. Dynamic momentum strategy performance. These plots show the cumulative returns to the dynamic strategy, (dyn), from Eqn. (6), in which λ is chosen so that the in-sample annualized volatility of the strategy is 19%, the same as that of the Center for Research in Security Prices (CRSP) value-weighted index over the full sample. For comparison, we also plot the cumulative log returns of the static winner-minus-lower (WML) strategy and a constant volatility strategy (cvol), similar to that of Barroso and Santa-Clara (2015), also scaled to an annualized volatility of 19%. Panel A plots the cumulative returns over the full sample period from 1927:07 to 2013:03. Panels B–E plot the returns over four roughly quarter-century subsamples: 1927–1949, 1950–1974, 1975–1999, and 2000–2013. The annualized Sharpe ratios of each strategy in each period are reported in parentheses in the corresponding legend.

Overview

Low Beta

- Empirically, the SML is **flatter than predicted by the CAPM**:



Source: Fama and French [2004].

- One explanation for this effect is that many investors face **leverage constraints**. For example, US regulations constrain leverage at 2:1, and brokers generally do not allow more than 4:1 intraday leverage.
- In order to achieve high returns, **constrained** investors must purchase **high-beta assets**, causing them to be overpriced.
- **Unconstrained** investors can achieve good returns by taking **leveraged positions in underpriced low-beta assets**.

Low Beta

- A **betting against beta (BAB) factor** that goes long low-beta assets and short high-beta assets generates high returns and Sharpe ratios.
- The BAB factor is constructed to be **market-neutral** by leveraging up low-beta assets to a beta of one and de-leveraging high-beta assets to a beta of one (Frazzini and Pedersen [2014]). The factor returns are given by

$$R_{t+1}^{BAB} = \frac{1}{\beta_t^L}(R_{t+1}^L - R_{f,t+1}) - \frac{1}{\beta_t^H}(R_{t+1}^H - R_{f,t+1}) \ . \tag{35}$$

- Note that the underlying portfolio is **not self-financed**. Hence, the riskless rate must be subtracted from the returns of the long and short legs to obtain excess returns.
- The factor's returns cannot be explained by other commonly used factors (i.e. the others we considered).
- The profitability of the BAB factor holds across different asset classes and countries.

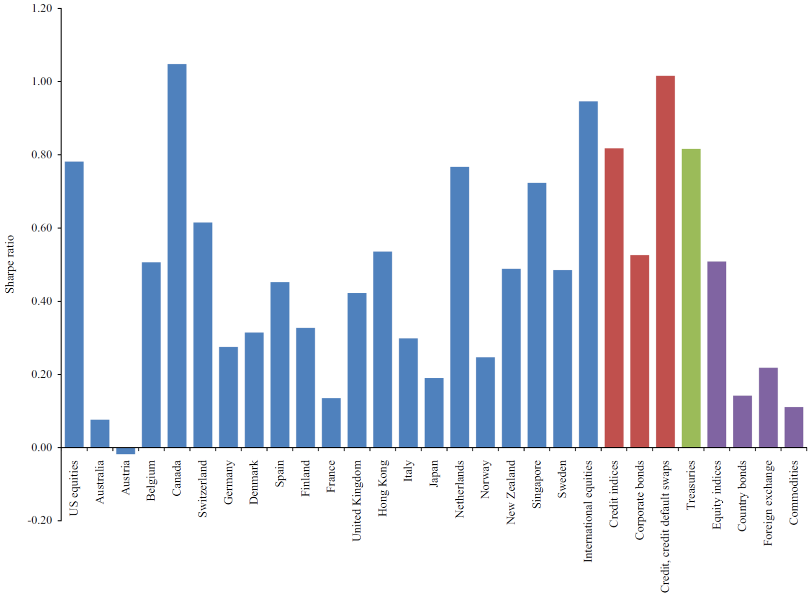
Low Beta: Decile and Long-Short Returns for US Stocks

Table 3
US equities: returns, 1926–2012.

This table shows beta-sorted calendar-time portfolio returns. At the beginning of each calendar month, stocks are ranked in ascending order on the basis of their estimated beta at the end of the previous month. The ranked stocks are assigned to one of ten deciles portfolios based on NYSE breakpoints. All stocks are equally weighted within a given portfolio, and the portfolios are rebalanced every month to maintain equal weights. The right-most column reports returns of the zero-beta betting against beta (BAB) factor. To construct the BAB factor, all stocks are assigned to one of two portfolios: low beta and high beta. Stocks are weighted by the ranked betas (lower beta security have larger weight in the low-beta portfolio and higher beta securities have larger weights in the high-beta portfolio), and the portfolios are rebalanced every calendar month. Both portfolios are rescaled to have a beta of one at portfolio formation. The betting against beta factor is a self-financing portfolio that is long the low-beta portfolio and short the high-beta portfolio. This table includes all available common stocks on the Center for Research in Security Prices database between January 1926 and March 2012. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and Pastor and Stambaugh (2003) liquidity factor. CAPM = Capital Asset Pricing Model. Regarding the five-factor alphas the Pastor and Stambaugh (2003) liquidity factor is available only between 1968 and 2011. Returns and alphas are in monthly percent, *t*-statistics are shown below the coefficient estimates, and 5% statistical significance is indicated in bold. Beta (ex ante) is the average estimated beta at portfolio formation. Beta (realized) is the realized loading on the market portfolio. Volatilities and Sharpe ratios are annualized.

Portfolio	P1 (low beta)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (high beta)	BAB
Excess return	**0.91**	**0.98**	**1.00**	**1.03**	**1.05**	**1.10**	**1.05**	**1.08**	**1.06**	**0.97**	**0.70**
	(6.37)	(5.73)	(5.16)	(4.88)	(4.49)	(4.37)	(3.84)	(3.74)	(3.27)	(2.55)	(7.12)
CAPM alpha	**0.52**	**0.48**	**0.42**	**0.39**	**0.34**	**0.34**	0.22	0.21	0.10	−0.10	**0.73**
	(6.30)	(5.99)	(4.91)	(4.43)	(3.51)	(3.20)	(1.94)	(1.72)	(0.67)	(−0.48)	(7.44)
Three-factor alpha	**0.40**	**0.35**	**0.26**	**0.21**	**0.13**	0.11	−0.03	−0.06	**−0.22**	**−0.49**	**0.73**
	(6.25)	(5.95)	(4.76)	(4.13)	(2.49)	(1.94)	(−0.59)	(−1.02)	(−2.81)	(−3.68)	(7.39)
Four-factor alpha	**0.40**	**0.37**	**0.30**	**0.25**	**0.18**	**0.20**	0.09	0.11	0.01	−0.13	**0.55**
	(6.05)	(6.13)	(5.36)	(4.92)	(3.27)	(3.63)	(1.63)	(1.94)	(0.12)	(−1.01)	(5.59)
Five-factor alpha	**0.37**	**0.37**	**0.33**	**0.30**	**0.17**	**0.20**	0.11	0.14	0.02	0.00	**0.55**
	(4.54)	(4.66)	(4.50)	(4.40)	(2.44)	(2.71)	(1.40)	(1.65)	(0.21)	(−0.01)	(4.09)
Beta (ex ante)	0.64	0.79	0.88	0.97	1.05	1.12	1.21	1.31	1.44	1.70	0.00
Beta (realized)	0.67	0.87	1.00	1.10	1.22	1.32	1.42	1.51	1.66	1.85	−0.06
Volatility	15.70	18.70	21.11	23.10	25.56	27.58	29.81	31.58	35.52	41.68	10.75
Sharpe ratio	0.70	0.63	0.57	0.54	0.49	0.48	0.42	0.41	0.36	0.28	0.78

Low Beta: Profitability across Countries and Asset Classes



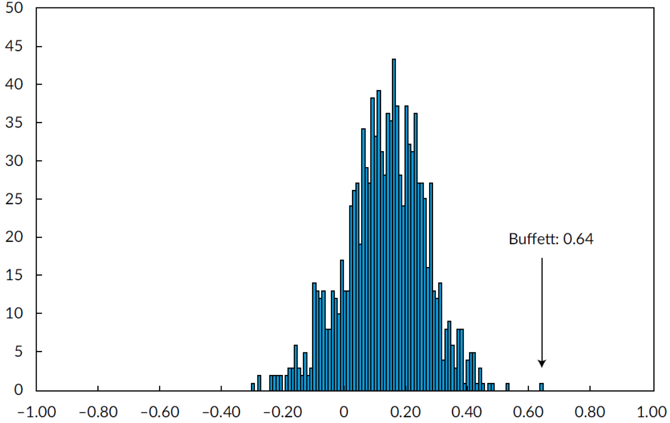
Overview

Buffett's Factor Exposures

- How does Warren Buffett invest?
- Frazzini et al. [2018] investigate Warren Buffett's factor exposures.
- They find that Buffett loads positively on: **market, value stocks, low-beta assets, and quality stocks**. All this is done with a leverage of approximately 1.6.
- The quality factor is constructed in Asness et al. [2019], who build on Piotroski [2000]:
  - Piotroski [2000] creates an indicator to distinguish high-quality stocks from low-quality stocks based on accounting information.
  - Asness et al. [2019] create the QMJ (Quality minus Junk) factor that goes long high-quality firms (those with strong profitability, high growth, and low risk) and short junk firms (those with the opposite characteristics).

Buffett: Historical Performance

Distribution of annualized information ratios for US common stocks



Source: Frazzini et al. [2018]. The sample comprises all common stocks in the CRSP database with at least 40 years of return history. The information ratio is defined as the intercept in a regression of monthly excess returns on the excess return of the value-weighted market portfolio, divided by the standard deviation of the residuals.

Buffett: Factor Exposures and Alpha

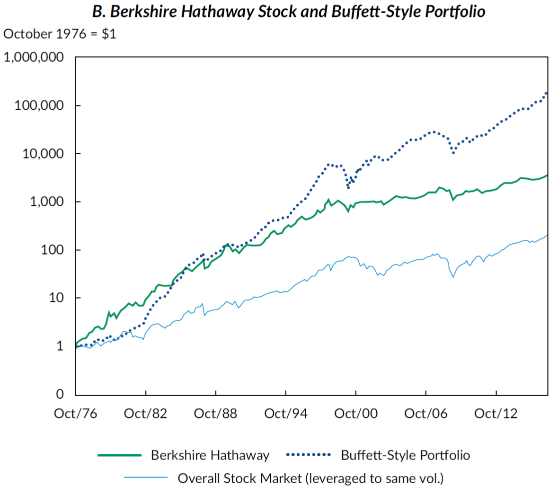
Table 4. What Kinds of Companies Does Berkshire Hathaway Own? (*t*-statistics in parentheses)

	Berkshire Stock, 10/1976–3/2017				13F Portfolio, 4/1980–3/2017				Private Holdings, 4/1980–3/2017			
Alpha	**13.4%**	**11.0%**	**8.5%**	5.4%	**5.8%**	**4.5%**	3.0%	0.3%	**7.0%**	4.9%	3.9%	3.5%
	(4.01)	(3.30)	(2.55)	(1.55)	(3.09)	(2.46)	(1.62)	(0.16)	(1.98)	(1.40)	(1.10)	(0.91)
MKT	**0.69**	**0.83**	**0.83**	**0.95**	**0.77**	**0.85**	**0.86**	**0.95**	**0.30**	**0.39**	**0.40**	**0.42**
	(11.00)	(12.74)	(12.99)	(12.77)	(22.06)	(23.81)	(24.36)	(23.52)	(4.46)	(5.63)	(5.72)	(5.03)
SMB		**−0.29**	**−0.30**	−0.13		**−0.19**	**−0.19**	−0.05		**−0.26**	**−0.25**	−0.23
		(−3.11)	(−3.19)	(−1.17)		(−3.73)	(−3.79)	(−0.95)		(−2.65)	(−2.56)	(−1.95)
HML		**0.47**	**0.31**	**0.40**		**0.28**	**0.19**	**0.25**		**0.28**	0.21	0.22
		(4.68)	(2.82)	(3.55)		(5.20)	(3.25)	(4.32)		(2.63)	(1.80)	(1.85)
UMD		0.06	−0.02	−0.05		−0.01	−0.06	**−0.09**		0.08	0.04	0.04
		(1.00)	(−0.25)	(−0.80)		(−0.36)	(−1.66)	(−2.58)		(1.24)	(0.62)	(0.51)
BAB			**0.33**	**0.27**			**0.19**	**0.15**			0.15	0.14
			(3.79)	(3.04)			(4.08)	(3.18)			(1.61)	(1.53)
QMJ				**0.47**				**0.37**				0.07
				(3.06)				(4.55)				(0.43)
$\bar{R}^2$	0.20	0.25	0.27	0.29	0.52	0.58	0.59	0.61	0.05	0.08	0.08	0.08
Obs.	486	486	486	486	444	444	444	444	399	399	399	399

Notes: This table shows calendar-time portfolio returns. Alphas are annualized. Boldface indicates statistical significance at the 5% level.

Buffett: Simulated Returns on Mimicking Portfolio

- Frazzini et al. [2018] reproduce Buffett's investment style by loading on academic factors. The portfolio is then rescaled to have the same volatility as the Berkshire stock returns.

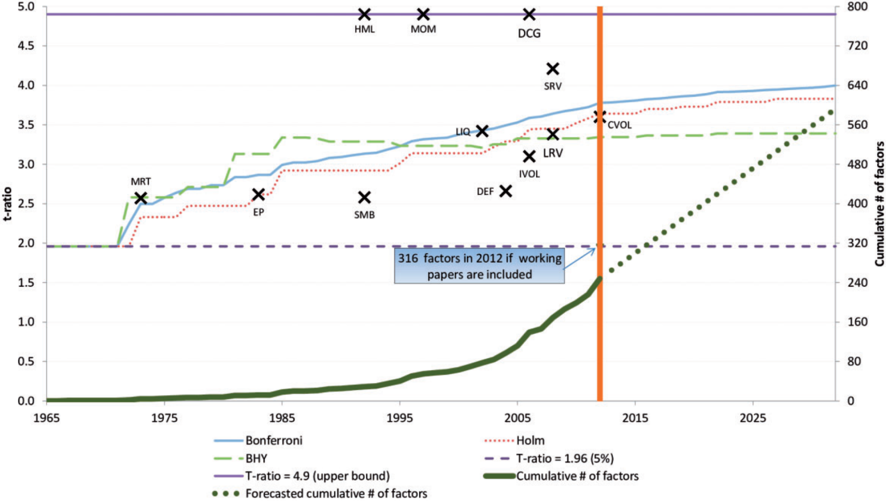


Overview

Statistical Significance Issues

- Harvey et al. [2016] investigate the large number of factors that the literature has identified so far.
- **There are over 300 factors nowadays.**
- They claim that the repetitive data-mining of the academic finance community requires t-stats much higher than 2 to consider a factor relevant (they suggest values of 3 or more).
- Accordingly, they claim that many of the factors found in the financial economics literature are most likely false.
- Nevertheless, the following factors are widely considered relevant and statistically significant:
  - MKT
  - SMB
  - HML
  - UMD
  - BAB

Statistical Significance: Required t-stats over Time



References I

Clifford S Asness, Tobias J Moskowitz, and Lasse H Pedersen. Value and momentum everywhere. *The Journal of Finance*, 68(3):929–985, 2013.

Clifford S Asness, Andrea Frazzini, and Lasse H Pedersen. Quality minus junk. *Review of Accounting Studies*, 24:34–112, 2019.

Rolf W. Banz. The relationship between return and market value of common stocks. *Journal of Financial Economics*, 9:3–18, 1981.

John Y Campbell and Robert J Shiller. The dividend-price ratio and expectations of future dividends and discount factors. *Review of Financial Studies*, 1(3): 195–228, 1988.

John Y Campbell and Robert J Shiller. Valuation ratios and the long-run stock market outlook. *The Journal of Portfolio Management*, 24(2):11–26, 1998.

John H. Cochrane. New facts in finance. *Federal Reserve Bank of Chicago Economic Perspectives*, 23(3):36–58, 1999.

John H Cochrane. Financial markets and the real economy. In Mehra Rajnish, editor, *Handbook of the equity premium*, chapter 7, pages 237–325. Elsevier, 2008.

References II

Ilan Cooper and Paulo Maio. Equity risk factors and the intertemporal capm. *Working Paper*, 2016.

Kent D Daniel and Tobias J Moskowitz. Momentum crashes. *Journal of Financial Economics*, 122:221–247, 2016.

Elroy Dimson, Paul Marsh, and Mike Staunton. The worldwide equity premium: A smaller puzzle. In Rajnish Mehra, editor, *Handbook of the equity risk premium*, pages 467–514. Elsevier, 2008.

Elroy Dimson, Paul Marsh, and Mike Staunton. Risk premia around the world. Technical report, London Business School, 2011.

Constantine Dzhabarov, William T Ziemba, and Alexandre Ziegler. Sell-in-may-and-go-away: The international evidence. In John Guerard and William T Ziemba, editors, *Handbook of Applied Investment Research*, chapter 12. World Scientific, 2020.

Eugene F Fama and Kenneth R French. Dividend yields and expected stock returns. *Journal of Financial Economics*, 22(1):3–25, 1988.

Eugene F Fama and Kenneth R French. Business conditions and expected returns on stocks and bonds. *Journal of Financial Economics*, 25(1):23–49, 1989.

References III

Eugene F Fama and Kenneth R French. The cross-section of expected stock returns. *The Journal of Finance*, 47(2):427–465, 1992.

Eugene F Fama and Kenneth R French. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1):3–56, 1993.

Eugene F Fama and Kenneth R French. Multifactor explanations of asset pricing anomalies. *The Journal of Finance*, 51(1):55–84, 1996.

Eugene F Fama and Kenneth R French. The capital asset pricing model: Theory and evidence. *The Journal of Economic Perspectives*, 18(3):24–46, 2004.

Eugene F Fama and Kenneth R French. A five-factor asset pricing model. *Journal of Financial Economics*, 116(1):1–22, 2015.

Andrea Frazzini and Lasse H Pedersen. Betting against beta. *Journal of Financial Economics*, 111(1):1–25, 2014.

Andrea Frazzini, David Kabiller, and Lasse H Pedersen. Buffett's alpha. *Financial Analysts Journal*, 74:35–55, 2018.

William N Goetzmann and Roger G Ibbotson. *The equity risk premium: essays and explorations*. Oxford University Press, 2006.

References IV

Campbell R Harvey, Yan Liu, and Heqing Zhu. ... and the cross-section of expected returns. *Review of Financial Studies*, 29:5–68, 2016.

Antti Ilmanen. *Expected returns: An investor's guide to harvesting market rewards*. John Wiley & Sons, 2011.

Narasimhan Jegadeesh and Sheridan Titman. Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, 48(1):65–91, 1993.

Alan Moreira and Tyler Muir. Volatility-managed portfolios. *The Journal of Finance*, 72:1611–1643, 2017.

Joseph D Piotroski. Value investing: The use of historical financial statement information to separate winners from losers. *Journal of Accounting Research*, 58, Supplement:1–41, 2000.

Barr Rosenberg, Kenneth Reid, and Ronald Lanstein. Persuasive evidence of market inefficiency. *The Journal of Portfolio Management*, 11:9–17, 1985.

Robert J Shiller. Do stock prices move too much to be justified by subsequent changes in dividends? *The American Economic Review*, 71(3):421–436, 1981.

References V

Dennis Stattman. Book values and stock returns. *The Chicago MBA: A Journal of Selected Papers*, 4:25–45, 1980.

Matthias W Uhl, Mads Pedersen, and Oliver Malitius. Whats in the news? using news sentiment momentum for tactical asset allocation. *The Journal of Portfolio Management*, 41(2):100–112, 2015.

Tuomo Vuolteenaho. What drives firm-level stock returns? *The Journal of Finance*, 57(1):233–264, 2002.