New Facts in Finance[1]

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[1] These slides are inspired by Cochrane (1999)'s "*New Facts in Finance.*"

What we once believed (I/II)

1. The CAPM is a good measure of **risk**
2. Returns are unpredictable, like coin flips (i.e., random walk theory of stock prices).
3. Bond returns are not predictable (i.e., expectation hypothesis of the term structure of interest rates).

What we once believed (II/II)

4. Foreign exchange bets are not predictable (i.e., interest rate parity).

5. Stock market volatility does not change much through time (i.e., returns are i.i.d.).

6. Professional managers do not reliably outperform simple indices and passive portfolios once one corrects for risk (i.e., *beta*).

Capital Asset Pricing Model (CAPM)

- The CAPM goes back to seminal work by Sharpe (1964); Treynor (1961); Lintner (1969).

- It is one of the first models to provide a comprehensive answer to the question of how the risk of an asset affects its expected return (e.g., see the review paper by Perold (2004)).

CAPM in two slides (I/II)

- The CAPM uses a time-series regression to measure β which quantifies an asset's (or portfolio) tendency **to move with the market as a whole**:

$$R_{it} - R_t^f = a_i + \beta_{i,m}(R_t^m - R_t^f) + \epsilon_{it}.$$

- Then the CAPM predicts that **expected excess returns** should be proportional to β (and $a_i = 0$):

$$E(R_{it} - R_t^f) = \beta_{i,m}\lambda_m,$$

where λ_m is called the **market price of risk** (or risk premium) and $\beta_{i,m}$ is called the **quantity of risk** (or asset exposure).

CAPM in two slides (II/II)

- Since the model applies to market returns as well (i.e., $\beta_{m,m} = 1$), a simple way to estimate the price of risk is:

$$\lambda_m = E(R_t^m - R_t^f),$$

where, operationally, $E()$ is the sample-mean (i.e., $(1/T)\sum_{t=1}^{T}$).

Outline

Fil rouge

Asset markets are **informationally efficient** Fama (1970, 1991)

- All information pertaining to a company's stock (or asset in general) has been incorporated into its current price.
- The only way to earn large returns is by taking on additional **risk**.

What we know now (I/II)

1. There are assets whose average returns **cannot be explained** by their market betas $\rightarrow$ multifactors extensions to the CAPM.

2. **Equity returns are predictable**: variables like the dividend/price ratio and the term premium can predict a substantial amount of stock return variation over business cycle and longer horizon. However, daily, weekly and monthly stock returns are still close to unpredictable.

3. **Bond returns are predictable**.

What we know now (II/II)

4. **Foreign exchange** returns are predictable.

5. **Volatility** does change through time: times of past volatility indicate future volatility.

6. Some **mutual funds** seem to outperform simple indexes, even after controlling for risk. Fund returns are also slightly predictable.

Outline

Stylized facts: US 1961-2024 sample (1/2)

- Average **real** return on holding the S&P 500 or similar broad index is 7.5% per year (about half is attributable to capital gains).

- Stock returns are very volatile: $\sigma(R) = 18.1\%$ per year. The average standard error is large: $\sigma(E(R)) = \sigma(R)/\sqrt{T}$ close to 2.3%.

- Serial correlation in stock returns is very small: -0.04 in annual data.

Stylized facts: US 1961-2024 sample (2/2)

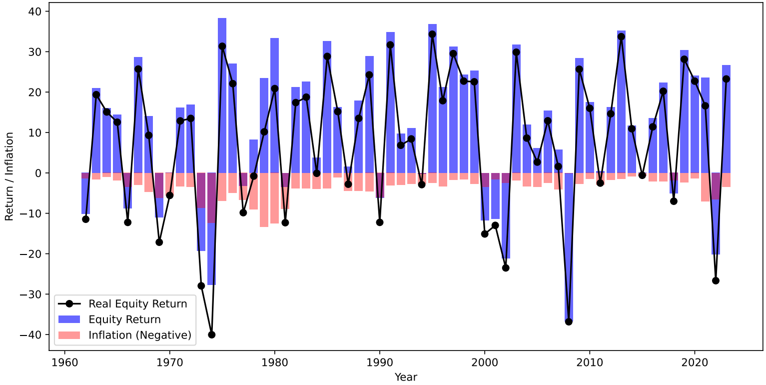
- The average real risk free rate is about 0.57% per year (US T-bill minus US CPI), and is not very volatile ($\sigma(R^f) = 2.6\%$ for annual data), but it is persistent ($\rho = 0.72$ in annual data).

- The **equity premium** (broad index minus US T-bill) is large and about 6.95% per year with a SD of 17.75%.

- Real long-term bond returns (10Y) are not much higher than short-term bond returns (2.2% vs. 0.35%). However, long-term bonds are more volatile (7.6% vs. 2% per year).[2]

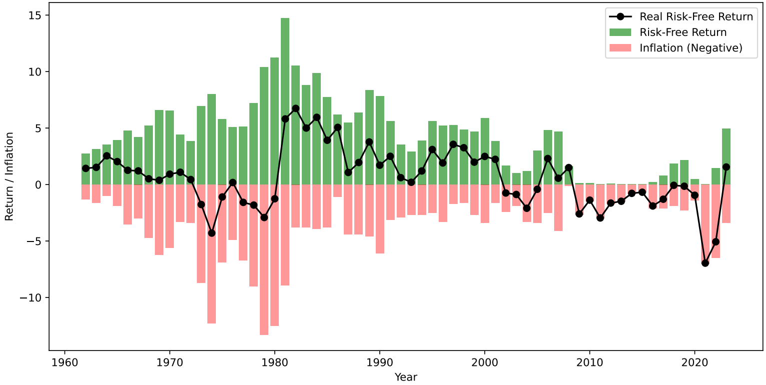
[2] For bonds, means and standard deviations of returns are monthly and annualized. The source is the Fama-Bond portfolios from CRSP.

US equity return and inflation



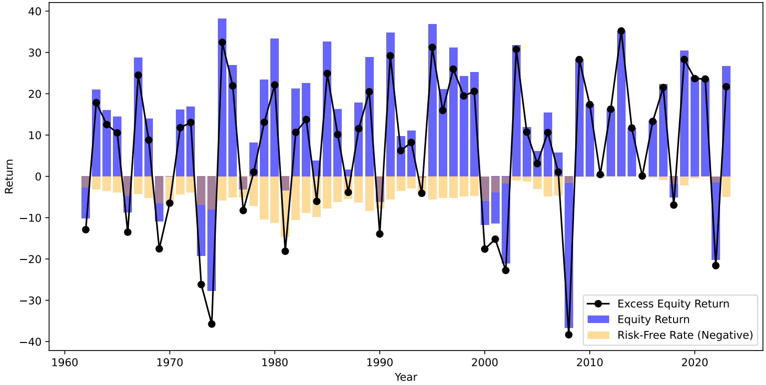
Note: annual data from 1961 to 2023

US risk-free rate and inflation



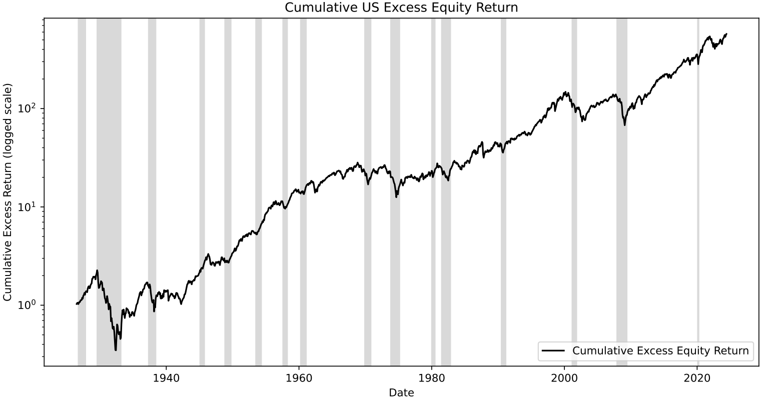
Note: annual data from 1961 to 2023

US equity return and risk-free rate



Note: annual data from 1961 to 2023

US cumulated equity excess return



Note: shaded regions are NBER recessions. Data is monthly 192607 to 202406.

The performance of the CAPM

- Despite the huge popularity and widespread use, the empirical performance of the CAPM is modest
    - In the **time-series**, the explanatory power of the market excess return is large.
    - However, in the **cross-section** the explanatory power of the market excess return is small and often not significant.

Small αs, close to unit βs, high R-squareds

$\hookrightarrow$ **Time-series regressions reveal the existence of a common factor**

Column	Intercept	SE Intercept	Slope	SE Slope	R-squared
Lo 10	0.054	0.127	1.095	0.029	0.605
Dec 2	-0.012	0.109	1.184	0.025	0.706
Dec 3	0.045	0.092	1.179	0.021	0.773
Dec 4	0.012	0.082	1.157	0.019	0.802
Dec 5	0.037	0.073	1.145	0.017	0.836
Dec 6	0.024	0.061	1.105	0.014	0.872
Dec 7	0.037	0.052	1.106	0.012	0.904
Dec 8	0.037	0.044	1.075	0.010	0.924
Dec 9	0.041	0.035	1.008	0.008	0.946
Hi 10	0.012	0.028	0.941	0.006	0.958

Table: Time-series regressions of the excess return of ten size-sorted portfolios on the market excess return. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Cross-sectional fit of CAPM (I/II)

$\hookrightarrow$ **For the size-sorted portfolios, the performance of the CAPM is not awful, but the estimate of "Slope" is not significantly different from zero!**

Statistic	Estimate	SE
Intercept	0.058958	0.476272
Slope	0.644372	0.502227
Avg. Market Excess Return	0.671935	0.141565
R-squared	0.862339	–

Table: Cross-sectional regression of the mean excess return of ten size-sorted portfolios on the time-series betas. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency. Standard errors on "Slope" using the repeated cross-section procedure.

Cross-sectional fit of CAPM (II/II)

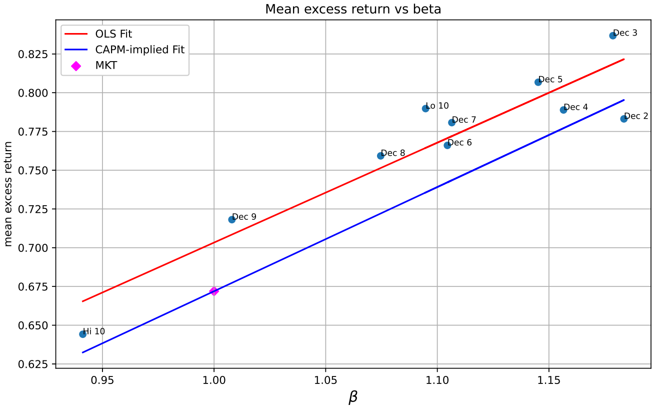


Figure: Cross-sectional regression of the mean excess return of ten size sorted portfolios on the time-series betas. CAPM-implied fit sets slope to the mean market excess return and intercept to zero. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Small firm effect: Small stocks outperform large stocks in the long-term

↪ **Performance of SMB is problematic for CAPM**

Figure: Cumulated SMB excess return. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Outline

Why multifactors models?

- The average investor has different sources of income (e.g., labor income and financial income), while the CAPM assumes that the average investor only cares about the performance of her investment portfolio.

- Note that while financial income depends on the stock of wealth, labor income depends on the stock of **human capital**.

- Events like recessions hurt the majority of investors (think at Covid-19 shock for extreme example, or at the GFC).

Why multifactors models

- Compare two stocks:
  - same market β,
  - one does well doing a recession, while the other does poorly (i.e., think about correlation in the tails of the distribution).
- Clearly, most investors would prefer the stock that does well during a recession, which provides insurance $\rightarrow$ they are willing to hold it at a lower (expected) average return (or pay a higher price).
- Therefore, we expect that an additional dimension of risk, **covariation with recessions**, should matter in determining average returns.

Multifactor extensions to CAPM

- **Multifactors models** use a time-series multiple regression to quantify an asset's tendency to move with multiple risk factors F:

$$R_{it} - R_t^f = a_i + \beta_{i,m}(R_{mt} - R_t^f) + \beta_{i,A}F_{At} + \beta_{i,B}F_{Bt} + \ldots + \epsilon_{it}.$$

- Expected excess returns are proportional to the factor betas:

$$E(R_{it} - R_t^f) = \beta_{i,m}\lambda_m + \beta_{i,A}\lambda_A + \beta_{i,B}\lambda_B + \ldots.$$

- What are the factors?
    - Factor zoo: see, e.g., Borri et al. (2024); Feng et al. (2020); Harvey and Liu (2019)

Good times and bad times

- Consumption (or marginal utility) should provide the purest measure of bad times.
- Empirical models that relate asset prices to consumption data not very successful.
- Empirical models look at more direct measures of good and bad times:
    1. the market return (CAPM),
    2. recessions/disasters,
    3. variables that forecast stock or bond returns (e.g., dividend/price ratio, term premium, etc.),
    4. returns on other well-diversified portfolios (factor-mimicking portfolios, see Huberman et al. (1987)).

Small and value/growth stocks

- The **size** and **book-to-market** factors by Fama and French (1996) are among the most popular additional risk factors.
  - Small-cap stocks have smaller market values than large-cap stocks.
  - Value (or high book-to-market) stocks have market values that are small relative to the value of assets on the company's books.
  - Both categories of stocks have high average returns not entirely accounted for by the CAPM.

Value stocks outperform growth stocks in the long-term

↪ **Performance of HML is problematic for CAPM**

Figure: Cumulated HML excess return. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Small αs, high R-squareds

↪ **Also for the 2x3 portfolios, the time-series regressions reveal the existence of a common factor**

Column	Intercept	SE Intercept	Slope	SE Slope	R-squared
SMALL LoBM	-0.147	0.100	1.247	0.019	0.792
ME1 BM2	0.152	0.086	1.185	0.016	0.824
SMALL HiBM	0.250	0.120	1.314	0.022	0.748
BIG LoBM	0.019	0.033	0.971	0.006	0.956
ME2 BM2	0.002	0.050	1.005	0.009	0.909
BIG HiBM	0.095	0.090	1.207	0.017	0.816

Table: Time-series regressions of the excess return of 6 portfolios sorted on size and book-to-market (2x3) on the market excess return. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Cross-sectional fit of CAPM (I/II)

$\hookrightarrow$ **For the 2x3 portfolios, the performance of the CAPM is mediocre considering we are trying to fit 6 points with a straight line**

Statistic	Estimate	SE
Intercept	-0.335597	0.347163
Slope	1.028109	0.376692
Avg. Market Excess Return	0.684039	0.155616
R-squared	0.544723	–

Table: Cross-sectional regression of the mean excess return of 6 portfolios sorted on size and book-to-market (2x3) on the time-series betas. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency. Standard errors on "Slope" using the repeated cross-section procedure.

Cross-sectional fit of CAPM (II/II)

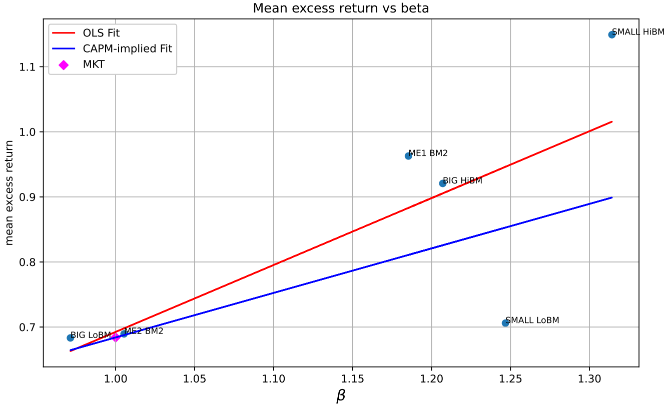
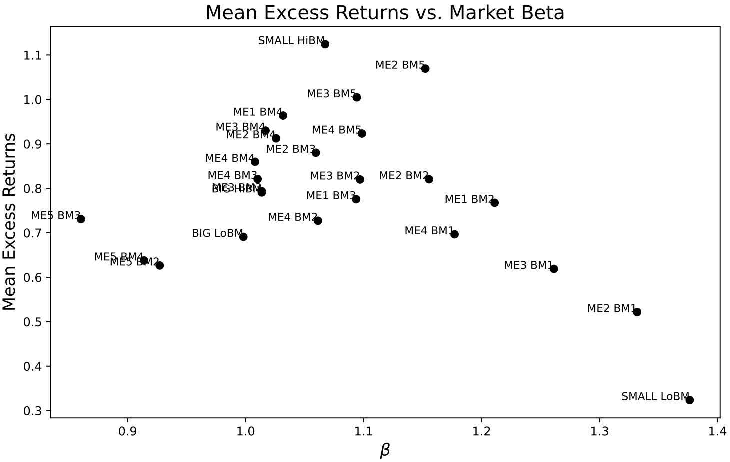


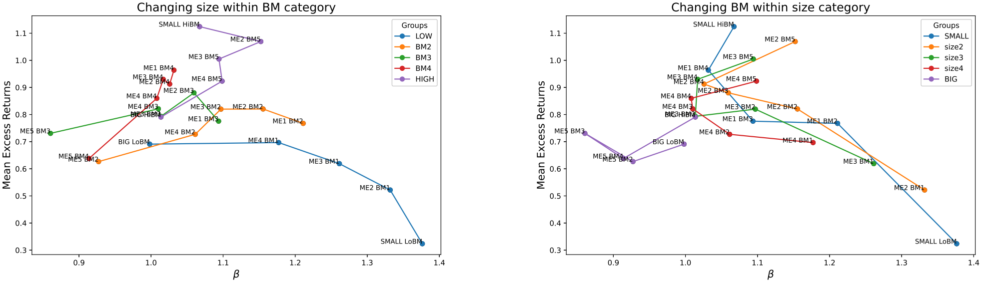
Figure: Cross-sectional regression of the mean excess return of 6 portfolios sorted on size and book-to-market (2x3) on the time-series betas. CAPM-implied fit sets slope to the mean market excess return and intercept to zero. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

5x5 small and value/growth stocks



Average monthly returns versus market beta for 25 stock portfolios sorted on the basis of size and book-to-market. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Fixing one dimension: Size or BM



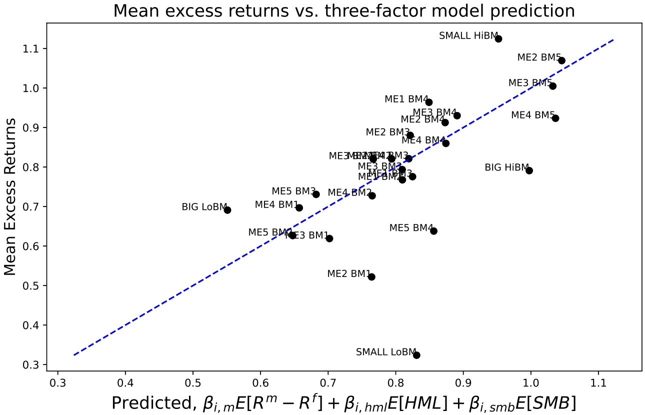
Average monthly returns versus market beta for 25 stock portfolios sorted on the basis of size and book-to-market. In the left panel, lines connect portfolios as size varies within book/market (BM) categories; in the right panel, lines connect portfolios as BM varies within size categories. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Small and value/growth stocks

- To explain the small and value/growth effect, Fama and French (1993, 1996) advocate a multifactor model with:

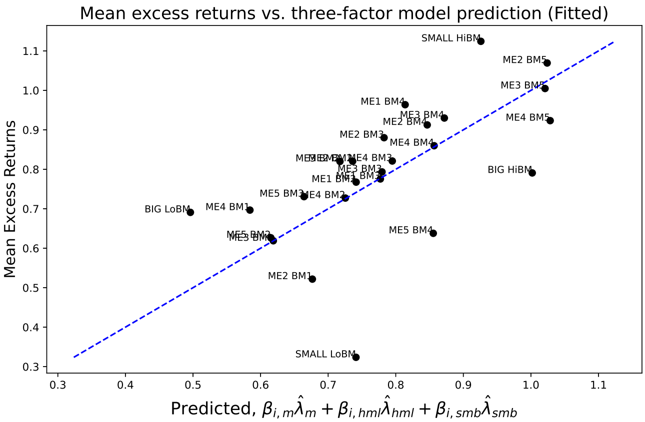
    1. market return,
    2. return of small less big stocks (SMB),
    3. the return of high book/market less low book/market stocks (HML).

Fit of FF3 model (1/2)



Fit of FF3 model when prices of risks are factor means. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

Fit of FF3 model (2/2)



Fit of FF3 model when prices of risks are estimated using cross-sectional regression. Data are from Kenneth French's data library for the period 194701 to 202406 at the monthly frequency.

What are the size and value factors?

- Fama and French (1995) note that the typical value stock has a price that has been driven down due to financial distress.
- In the event of credit crunch, liquidity crunch, flight to quality, etc., stocks in financial distress will do very badly.
- Note that the distress of the individual firm (i.e., idiosyncratic risk) is not a risk factor, since it can be diversified away.

What are the size and value factors?

- An alternative interpretation regards the model as an arbitrage pricing theory (APT) following Ross (1976).
- If the returns of the 25 size and book-to-market portfolios could be *perfectly* replicated by the returns of the three-factor portfolios (i.e., $R^2 = 100\%$), then the multi factor model would have to hold exactly in order to exclude arbitrage opportunities.

What are the size and value factors?

- The size and book-to-market premiums seem to have diminished substantially in recent years.
- Was it just an anomaly?

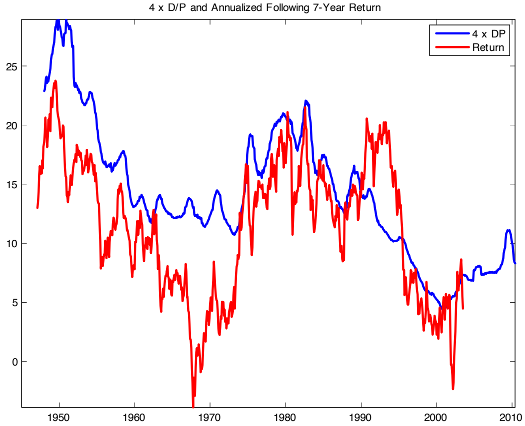
Outline

Predictable returns with DP

Horizon k	b	t(b)	R^2	$\sigma\left[E_t(R^e)\right]$	$\frac{\sigma[E_t(R^e)]}{E(R^e)}$
1 year	3.8	(2.6)	0.09	5.5	0.76
5 years	20.6	(3.4)	0.28	29.3	0.62

$$R^e_{t\rightarrow t+k} = a + b\frac{D_t}{P_t} + \varepsilon_{t+k}; \quad \sigma\left[E_t(R^e)\right] \equiv \sigma\left(\hat{b} \times \frac{D_t}{P_t}\right)$$

Predictable returns with DP



Predictable returns

- Annual returns are only slightly predictable,
- and month-to-month returns are still strikingly unpredictable,
- but returns at five-year horizons seem very predictable.

Predictable returns

- Interpretation? If daily returns are very slightly predictable by a slow-moving variable, then predictability adds up over long horizons.
- Example: temperature and temperature forecasts.

Predictable returns

- Persistence of the price-dividend ratio in long return regressions makes the regressions somewhat spurious $\rightarrow$ t-stats need to be adjusted, and the long-horizon forecasts are not more significant that the 1 year forecast (despite higher R^2).
- These regressions are unstable and have little out-of-sample forecasting power.
- Why investors do not time the market?

Momentum and reversal

Since a sequence of good returns gives a high price, it is not surprising that individual stocks that do well for a long time subsequently do poorly (think mean-reversion).

Strategy	Period	Port formation	Avg. Return	SE
Reversal	7/1963-6/2023	60-13	0.233000	0.099000
Momentum	7/1963-6/2023	12-2	0.607000	0.157000
Reversal	1/1931-2/1963	60-13	0.385000	0.235000
Momentum	1/1931-2/1963	12-2	0.538000	0.282000

Table: Momentum and (long-term) reversal factors. Data are from Kenneth French's data library for the period 194701 to 202306 at the monthly frequency.

Momentum and Reversal Cumulated Excess Returns

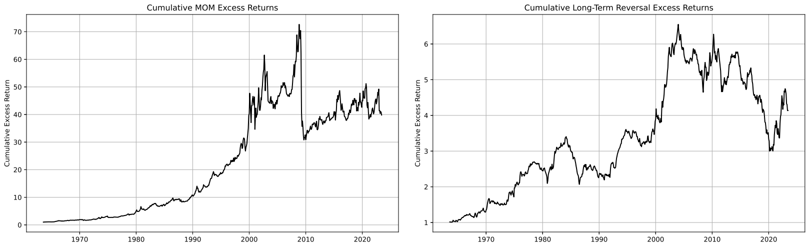


Figure: Cumulated momentum and long-term reversal excess return. Data are from Kenneth French's data library for the period 196301 to 202306 at the monthly frequency. Note the different range of the y-axis.

Momentum and reversal

- Fama and French (1996) show that portfolios built on a reversal strategy are explained by their three factors model.
- Momentum is not explained by the Fama and French (1996) three-factor model.
- Momentum stocks move together: *ad hoc* momentum risk factor (see also Asness et al. (2013) for an analysis of momentum in different asset classes).

Bonds and the expectation hypothesis (EH)

- Denote with $p_t^{(N)}$ the log of N-year discount (i.e., zero-coupon) bond price at t (see, e.g., wiki page).
- The N period continuously compounded yield is:

$$y_t^{(N)} = -\frac{1}{N} p_t^{(N)}.$$

- The continuously compounded holding period return (*hpr*) is equal to:

$$r_{t+1}^{(N)} = p_{t+1}^{(N-1)} - p_t^{(N)}.$$

e.g., buy a 10Y zero at t and sell a 9Y zero at $t-1$ (t corresponds to one year).

Bonds and forward rates

- The forward rate is the rate at which an investor can contract today to borrow \$1 $(N-1)$ years from now, and repay that money N years from now.
- As a result:

$$f_t^{(N)} = p_t^{(N-1)} - p_t^{(N)},$$

  e.g., we can replicate the forward rate with a portfolio of zeros.
- The yield is the average of intervening forward rates (i.e., replace the $f_t^{(i)}$):

$$y_t^{(N)} = \frac{1}{N}(f_t^{(1)} + f_t^{(2)} + \ldots + f_t^{(N)}),$$

  e.g., the two strategies to move forward \$1 must be equal by an arbitrage argument.

Bonds and the EH

- The EH states that bond returns should not be predictable. From this statement follows:

  1. The forward rate should equal the expected value of the future spot rate:

  $$f_t^{(N)} = E_t(y_{t+N-1}^{(1)})$$

  2. The expected holding period return should be the same on bonds of any maturity:

  $$E_t(hpr_{t+1}^{(N)}) = E_t(hpr_{t+1}^{(M)}) = y_t^{(1)}$$

  3. The long-term bond yield should equal the average of the expected future one-period rates

  $$y_t^{(N)} = \frac{1}{N} E_t(y_t^{(1)} + y_{t+1}^{(1)} + \ldots + y_{t+N-1}^{(1)}).$$

Bonds and the EH

Maturity N	Average HPR	Standard error	Standard deviation
1	5.83	0.42	2.83
2	6.15	0.54	3.65
3	6.40	0.69	4.66
4	6.40	0.85	5.71
5	6.36	0.98	6.58

- The expectation hypothesis seems to do pretty well.
- However, one might want to check if a forward rate that is unusually high forecasts an unusual increase in spot rates.

Fama and Bliss (1987) regressions

N	Intercept	S.E. intercept	Slope	S.E. slope	Adjusted R^2
1	0.10	0.3	-0.10	0.36	-0.02
2	-0.01	0.4	0.37	0.33	0.005
3	-0.04	0.5	0.41	0.33	0.013
4	-0.30	0.5	0.77	0.31	0.110

- The EH predicts a slope coefficient equal to 1.

Notes: OLS regressions, 1953-97 annual data. Estimated equation is: $y_{t+N}^{(1)} - y_t^{(1)} = a + b(f_t^{(N+1)} - y_t^{(1)}) + \epsilon_{t+N}$.

Foreign exchange

Interest rate parity

An interest rate differential across countries on bonds of similar credit risk should reveal an expectation of currency devaluation.

Foreign exchange

- Take two bonds with similar default risk, for example the German and the U.S. bonds.
- If German interest rates are 10% and U.S. interest rates are 5%, but the Euro falls 5% relative to the dollar during the year, you make no more money holding the German bonds despite the higher interest rate.

Forward discount puzzle

	DM	Pound	Yen	CHF
Mean USD appreciation	-1.8	3.6	-5.0	-3.0
Mean interest differential	-3.9	2.1	-3.7	-5.9
b, 1975-89	-3.1	-2.0	-2.1	-2.6
R^2	.026	.033	.034	.033
b, 1975-96	-0.7	-1.8	-2.4	-1.3
b, 10-year horizon	0.8	0.6	0.5	–

where interest rate differential is foreign minus domestic (i.e., US).

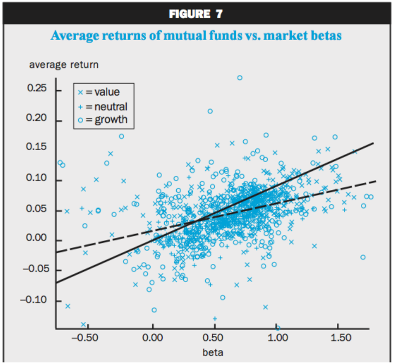
- According to interest parity condition first two rows should be equal (on average *apparently* ok).
- Coefficient b should be equal to 1 $\longrightarrow$ this is the forward discount puzzle.

Notes: OLS regressions: $s_{t+1} - s_t = a + b(r_t^f - r_t^d) + \epsilon_{t+1}$, where s is the log spot exchange rate, f denotes the foreign country and d the domestic country (e.g., the US).

Mutual funds

- Studying the returns of mutual funds is interesting because account for trading costs.
- Are skills in stock picking able to generate larger returns?

Mutual funds



Notes: Average returns of mutual funds over the Treasury bill rate versus their market betas. Sample: 1962-96. Source: Cochrane (1999).

- There exists correlation between beta and average returns.
- The wide dispersion in fund average returns is surprising.
- What about persistence in fund returns?

Mutual funds

- Long history of empirical work finds little persistence in mutual funds' returns.
- Active management does not generate superior performance, especially after transaction costs and fees.

Mutual funds

TABLE 7

Portfolios of mutual funds formed on previous year's return

Last year rank	Average return	CAPM alpha	4-factor alpha
	(------------------	*percent*	----------------)
1/30	0.75	0.27	–0.11
1/10	0.68	0.22	–0.12
5/10	0.38	–0.05	–0.14
9/10	0.23	–0.21	–0.20
10/10	0.01	–0.45	–0.40
30/30	–0.25	–0.74	–0.64

Notes: Each year, mutual funds are sorted into portfolios based on the previous year's return. The rank column gives the rank of the selected portfolio. For example, 1/30 is the best performing portfolio when funds are divided into 30 categories. Average return gives the average monthly return in excess of the T-bill rate of this portfolio of funds for the following year. Four-factor alpha gives the average return less the predictions of a multifactor model that uses the market, the Fama–French HML and SMB portfolios, and portfolio PR1YR which is long NYSE stocks that did well in the last year and short NYSE stocks that did poorly in the last year.

Source: Carhart (1997).

Outline

Implications: Price-based forecasts

- If expected returns rise, prices are driven down, since future dividends and other cash flows are discounted at a higher rate.
- Low price/dividend, price/earnings or price/book values signal times when the market as a whole will have higher average returns.
- Interpretation: the expected return (i.e., the risk premium) varies slowly over time. Therefore, we can track market expectations of returns by watching price/dividend, price/earnings, or book/market ratios.

Caveat

- Standard formula for the standard error of the mean $\sigma/\sqrt{T}$ implies we need at least 25 years of data to start measuring average returns:
  - $\sigma = 16\%$ (typical annual standard deviation of returns of an index),
  - $T = 25$ years,
  - standard error is $16/5 = 3\%$ per year.
  - average return we try to measure close to 6%!
- Rare events are ... rare: small probability makes measuring average returns harder.
- Few data points to evaluate predictability.
- Decline in *anomalous* risk premia over time.

Conclusions

- Returns are predictable and predictability is consistent with Fama (1970)'s notion of informationally efficient markets.

- Predictability is pervasive across markets (i.e., equity, bonds, etc.) and can be related to a time-varying risk-premium.

- These results have massive implications for investment and economic models.

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