Chapter 13 - Empirical Evidence on Security Returns

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The CAPM assumes that beta explains why different securities offer different expected rates of return

- It is difficult to definitively test the CAPM since we cannot observe the true market portfolio
- The most common tests use a two-pass approach
  1. Use time-series returns to estimate the systematic risk
  2. Use a cross-section of returns to test if riskier assets have higher returns on average

Testing the single-factor SML

- The CAPM proposes the following expected return-beta relation:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f]$$

- We can test this relation with a large sample of monthly stock returns for the same stocks over time:
  - r_{it} for 100 stocks over 60 months
  - r_{Mt} for the market index over 60 months
  - r_{ft} for the risk-free rate over 60 months

First pass: Estimate the SCLs

- We estimate the security characteristic line (SCL) for each security:

$$r_{it} - r_{ft} = a_i + b_i(r_{Mt} - r_{ft}) + e_{it}$$

- We collect the following statistics:
  - $\overline{r_i - r_f}$ is the sample average excess return for each of the 100 stocks
  - b_i is the estimate of β for each of the 100 stocks
  - $\overline{r_M - r_f}$ is the sample average excess return for the market index
  - $\sigma^2(e_i)$ is the variance of the residuals for each of the 100 stocks

Second pass: Estimate the SML

- We estimate the security market line (SML) for the market:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_i$$

- The CAPM predicts:
  - $\gamma_0 = 0$
  - $\gamma_1 = \overline{r_M - r_f}$
- We can also add $\sigma^2(e_i)$ and estimate:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_i + \gamma_2 \sigma^2(e_i)$$

- The CAPM predicts:
  - $\gamma_0 = 0$
  - $\gamma_1 = \overline{r_M - r_f}$
  - $\gamma_2 = 0$

These two-pass tests do not support the CAPM

- The SML is too flat (i.e., $\gamma_1 < \overline{r_M - r_f}$), and the intercept is too large (i.e., $\gamma_0 > 0$)
- There are several difficulties with these two-pass tests
  1. Stock returns are extremely volatile, reducing the precision of average return estimates
  2. We have fundamental concerns about the structure of these two-pass tests
     a. The market index is not the CAPM's market portfolio
     b. First-stage betas are estimated with sampling error
     c. Investors cannot borrow at the risk-free rate

Roll's critique of the CAPM

1. The CAPM has a single testable hypothesis: The market portfolio is mean-variance efficient
2. All other CAPM implications (e.g., a linear relation between expected return and beta) are not independently testable
3. If we estimate betas against mean-variance efficient portfolios, they will satisfy the SML relation exactly *ex post* regardless of whether the true market portfolio is mean-variance efficient *ex ante*
4. The CAPM is not testable unless we include *all assets* in the sample
5. Using a market index proxy is subject to two difficulties:
   a. The proxy may be mean-variance efficient even when the true market portfolio is not
   b. Most proxies are correlated, but different proxies can lead to different conclusions

Measurement error in beta

- Problem: If beta has measurement error and appears as a right-hand-side variable in the second-pass regression:
  - γ_1 will be biased downward
  - γ_0 will be biased upward
- Solution: Build portfolios on beta ranks
  - Fama and MacBeth (1973) estimate the following regression:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_i + \gamma_2 b_i^2 + \gamma_3 \sigma^2(e_i)$$

    where i indicates a diversified portfolio formed on first-pass betas
  - They find:
    - $\gamma_0 \approx 0$
    - $0 < \gamma_1 < \overline{r_M - r_f}$
    - $\gamma_2 \approx 0$
    - $\gamma_3 \approx 0$

However, recent years have not been kind to the CAPM

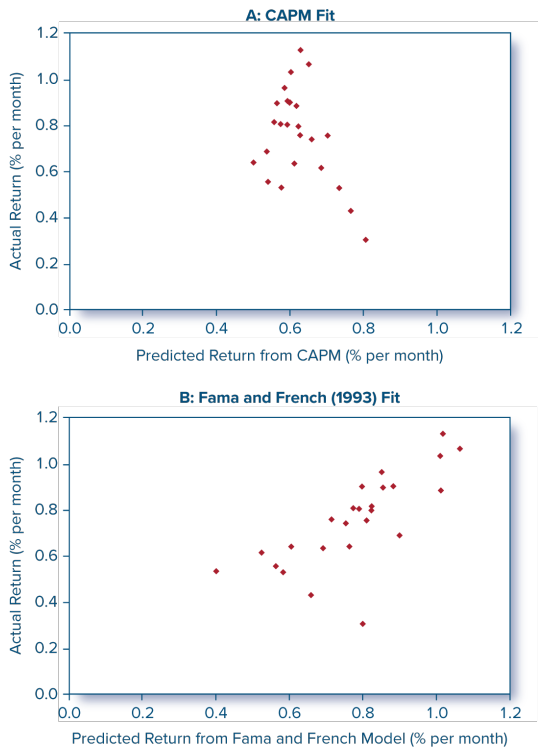
- The relation between average returns and beta has weakened
- Fama and French (1992) show $\gamma_1 \approx 15$ basis points per month instead of the observed excess return of ≈ 35 basis points
- *There is more to the risk-return relation than the CAPM captures*

Three types of factors are likely to augment the market risk factor in a multifactor SML

- These three types of factors are:
  1. Factors that hedge consumption against uncertainty in prices (e.g., housing or energy)
  2. Factors that hedge future investment opportunities (e.g., interest rates or market volatility)
  3. Factors that hedge assets missing from the market index (e.g., labor income or private business)
- Merton's ICAPM suggests that these extra-market sources of risk will command a risk premium if investors demand to hedge them

The Fama and French (1993) 3-factor model is state-of-the-art I

- Fama and French (1993) add two factors to the CAPM to explain:
  - Higher book-to-market firms experience higher returns (HML)
  - Smaller firms experience higher returns (SMB)
- They find that value and size are priced risk factors



The Fama and French (1993) 3-factor model is state-of-the-art II

Figure 1: CAPM versus the Fama and French model. The figure plots the average actual returns versus returns predicted by the CAPM and the FF model for the 25 size and book-to-market double-sorted portfolios. (BKM 2023, Figure 13.1)

Relations between fundamental sources of asset risk and SMB and HML strengthens their case

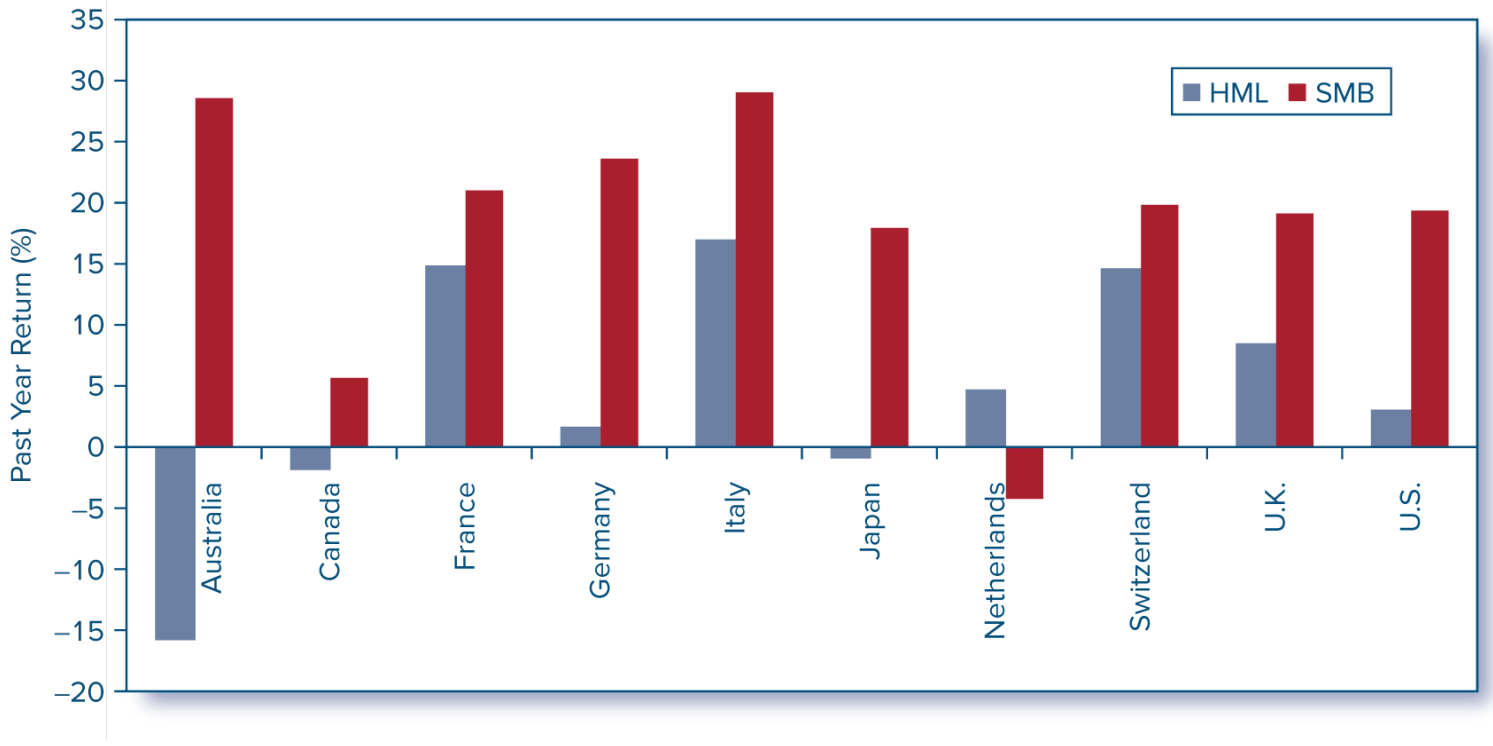


Figure 2: Difference in return to factor portfolios in year prior to above-average versus below-average GDP growth. Both SMB and HML portfolio returns tend to be higher in years preceding better GDP growth. (BKM 2023, Figure 13.2)

HML has behavioral explanations I

- Glamour firms
  - Recent good performance
  - High prices
  - Low book-to-market ratios
  - Therefore, they tend to underperform value firms
- Overreaction
  - High *past* growth is extrapolated and then impounded in price
- Extrapolation error
  - Investors ignore evidence that they cannot extrapolate past growth far into the future

HML has behavioral explanations II

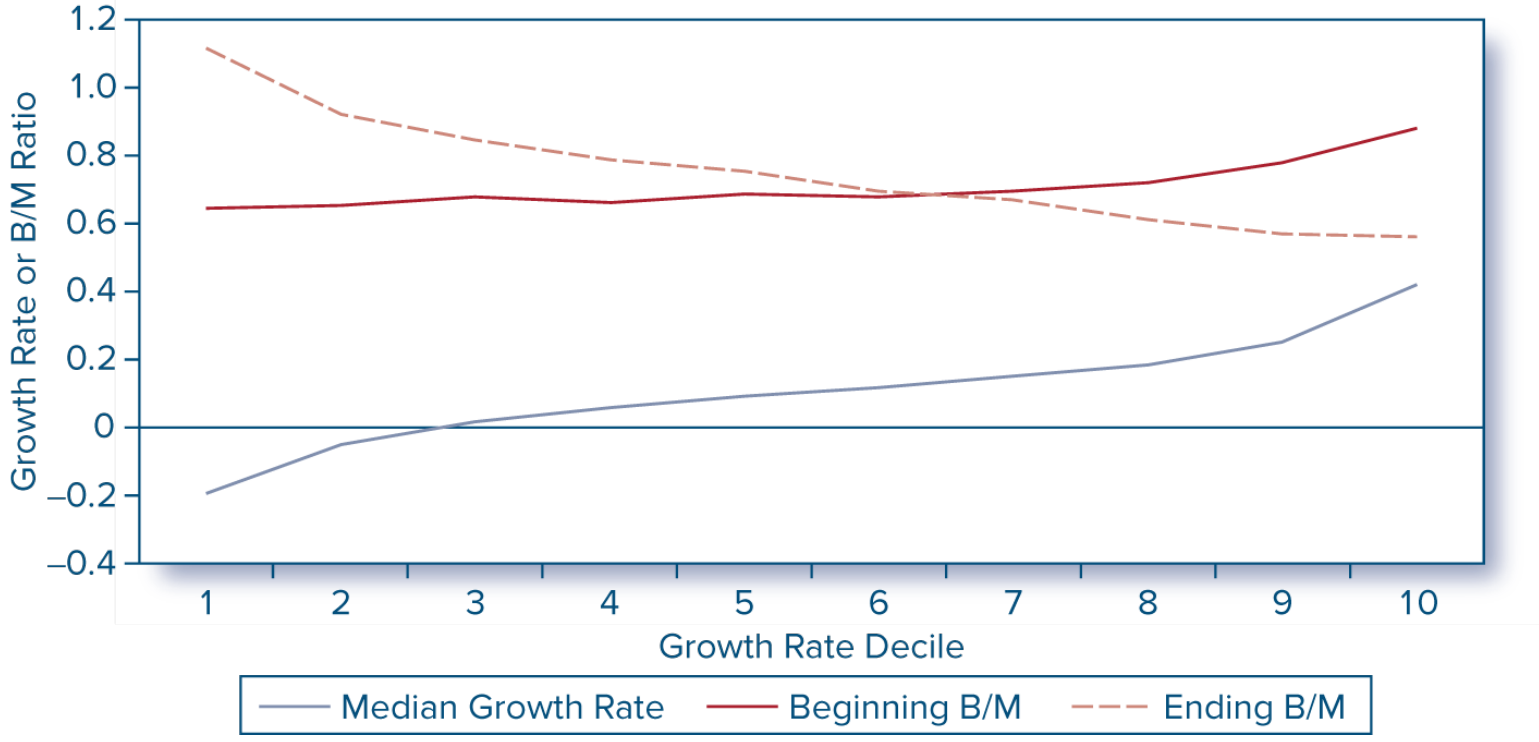


Figure 3: The book-to-market ratio reflects past growth, but not future growth prospects. B/M tends to fall with income growth experiences at the *end* of a five-year period, but actually increases slightly with future income growth rates. (BKM 2023, Figure 13.3)

HML has behavioral explanations III

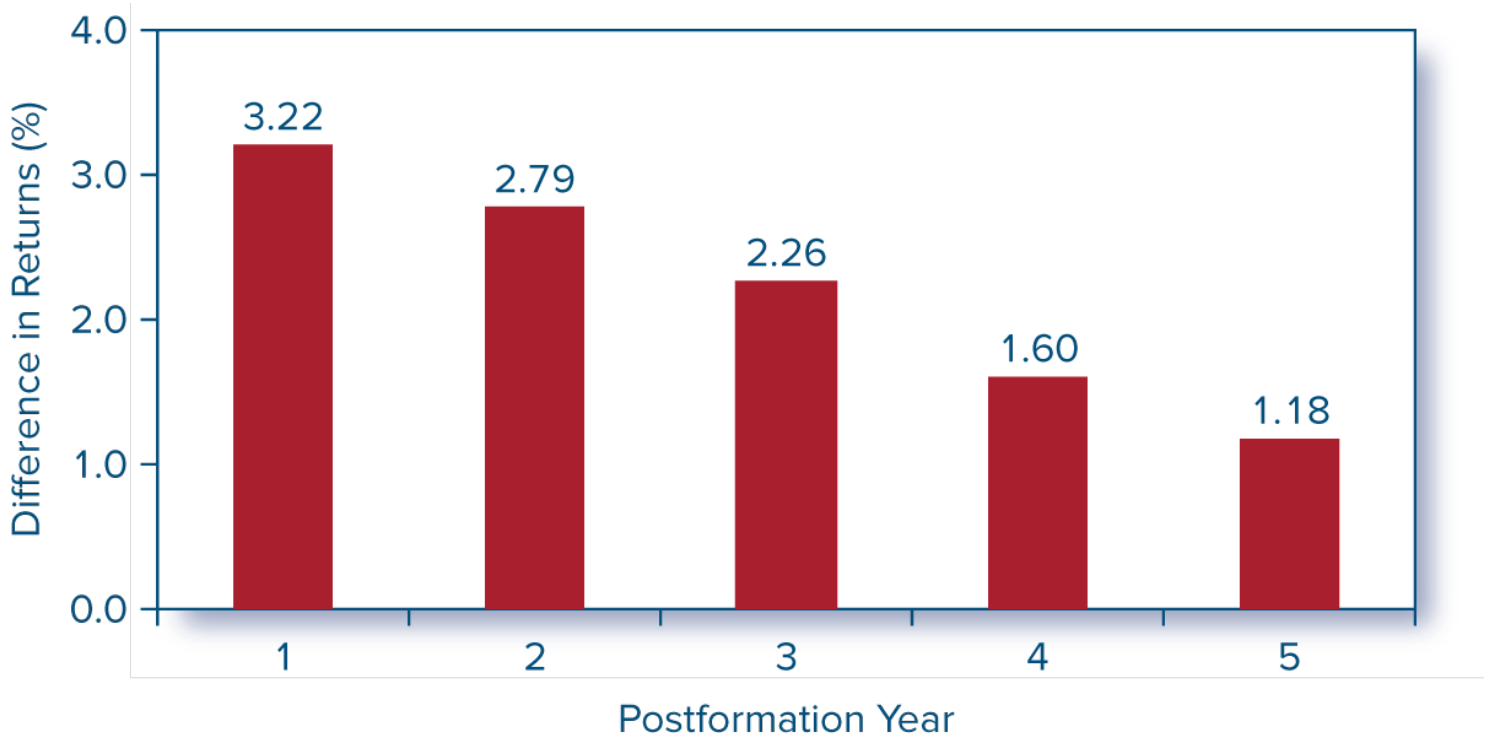


Figure 4: Value minus growth returns surrounding earnings announcements, 1971–1992. Announcement effects are measured for each of four years following classification as a value versus growth firm. (BKM 2023, Figure 13.4)

Momentum is the fourth factor

- Momentum is the fourth factor added to the Fama and French (1993) model
- The winners-minus-losers (WML) portfolios determine winners and losers based on the past 1 to 12 months of returns
- However, WML is hard to interpret as an obvious source of risk

A summary of the cross-section of expected stock returns

	Slope	*t*-Statistic
Size: Stock market capitalization	−.15	−5.01
Book-to-market ratio	.35	6.18
Momentum: Return in past year	.96	6.86
Stock issues: Growth in shares outstanding	−.35	−3.52
Accruals: Change in net working capital	−1.38	−5.69
Profitability: Return on assets	1.43	3.57
Asset growth: Growth in total assets	−.54	−4.49
Dividend yield	−.46	−.27
Beta: Single index model	.33	3.05
Volatility: Standard deviation of stock returns	−1.45	−1.40
Turnover: Shares traded as a fraction of outstanding shares	−4.49	−3.68
Sales: Total sales as multiple of market capitalization	.04	3.10

Figure 5: The Cross Section of Expected Stock Returns

Now we have a "factor zoo"!

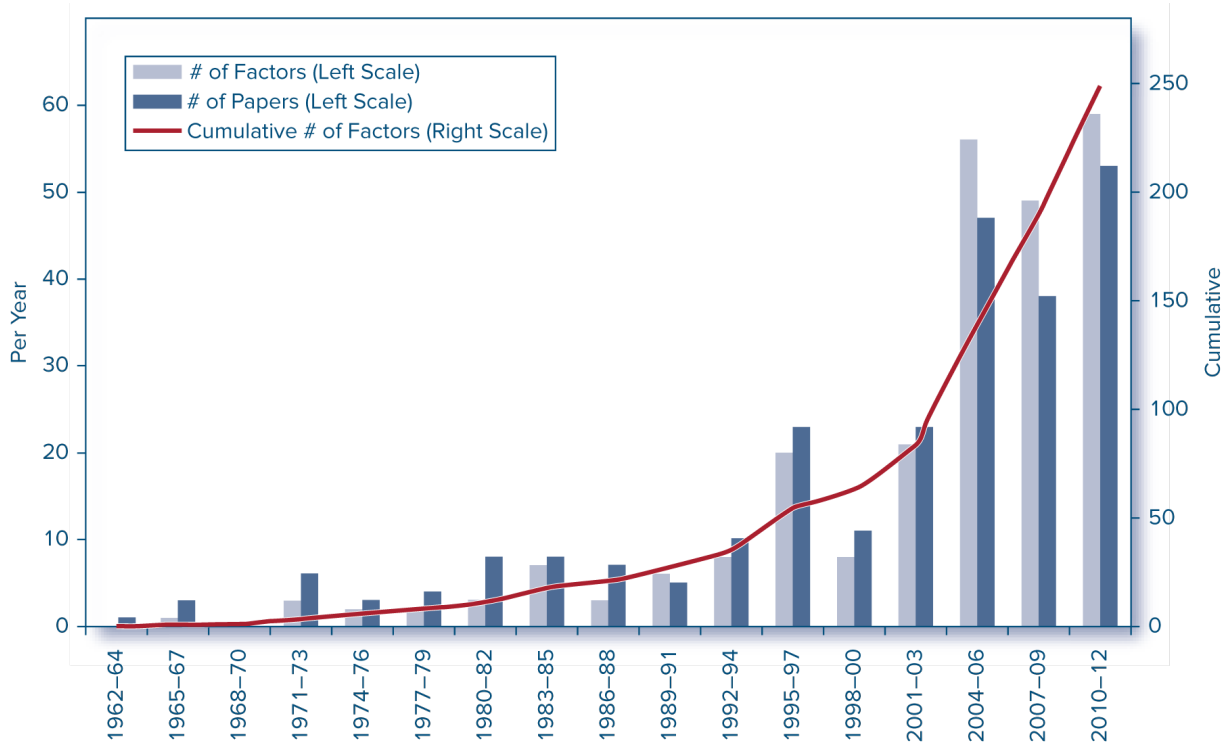


Figure 6: Published risk factors appear in the finance literature (BKM 2023, Figure 13.5)

Liquidity is difficult to measure with a single statistic

- Liquidity involves the following:
  - Trading costs
  - Ease of sale
  - Price concessions to effect a quick transaction
  - Market depth
  - Price predictability
- Popular measures of liquidity focus on price impact

Three popular measures of liquidity I

- Pastor and Stambaugh
  - Look for evidence of price reversals, especially following large trades
  - The original price change was a concession on the part of trade initiator who needed to offer (accept) a higher (lower) purchase price to complete their trade promptly
- Amihud
  - Focuses on large trades and price movements
  - Defined as:

$$\text{ILLIQ} = \text{Monthly average of daily} \left(\frac{|\text{Stock return}|}{\text{Dollar volume}} \right)$$

- Sadka
  - Uses trade-by-trade data
  - The liquidity of firms can vary as the prevalence of informationally motivated trades varies

Three popular measures of liquidity II

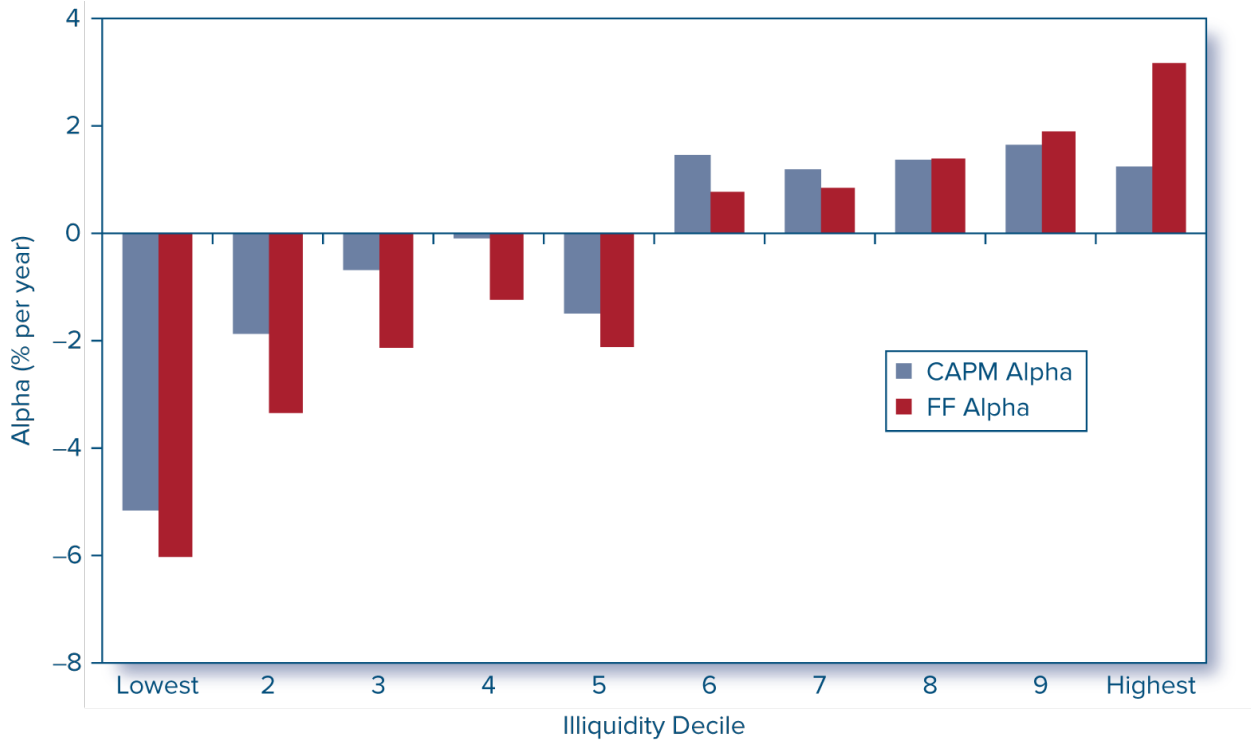


Figure 7: Alphas of value-weighted portfolios sorted on liquidity betas (BKM 2023, Figure 13.6)

Equity premium puzzle: Returns are too high given that consumption varies so little

- Systematic consumption risk is too low to justify the observed market excess returns
- Unless we assume implausibly high levels of risk aversion
- Recent research has improved estimation using consumption-tracking portfolios

The consumption CAPM (CCAPM) implies that investors care about their lifetime consumption flows instead of wealth

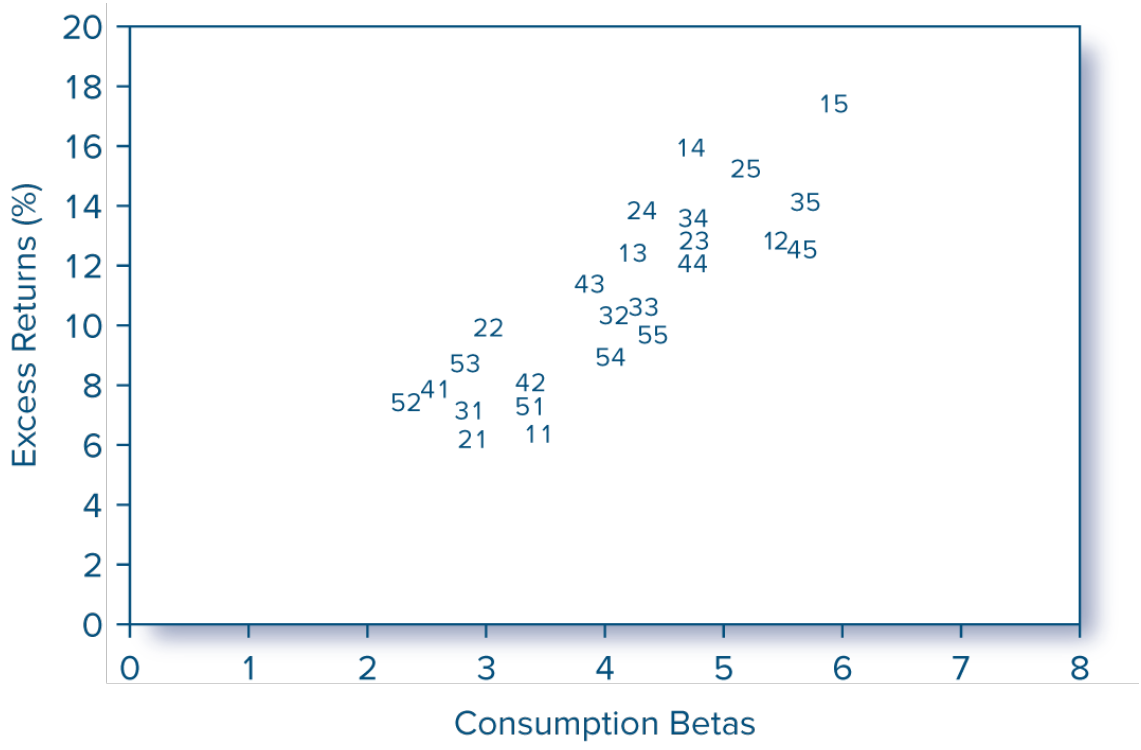


Figure 8: Cross section of stock returns: Fama-French 25 portfolios, 1954–2003 (BKM 2023, Figure 13.7)

Fama and French attribute the equity premium puzzle to unexpected capital gains after 1949

	Mean Return		Standard Error		*t*-Statistic		Sharpe Ratio	
Period	DDM	Realized	DDM	Realized	DDM	Realized	DDM	Realized
1872–1999	4.03	6.10	1.14	1.65	3.52	3.70	0.22	0.34
1872–1949	4.35	4.62	1.76	2.20	2.47	2.10	0.23	0.24
1950–1999	3.54	8.41	1.03	2.45	3.42	3.43	0.21	0.51

Survivorship bias may explain the equity premium puzzle

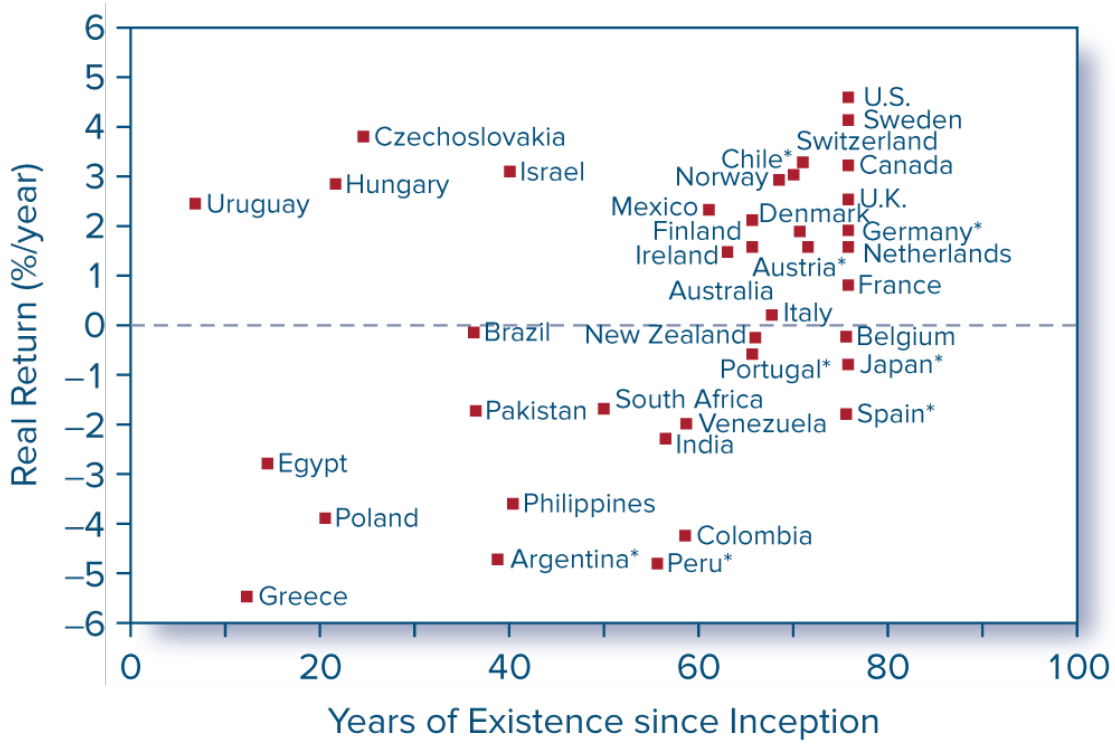


Figure 9: Real returns on global stock markets. The figure displays average real returns for 39 markets over the period 1921 to 1996. Markets are sorted by years of existence. An asterisk indicates that the market suffered a long break. (BKM 2023, Figure 13.8)

Liquidity may explain the equity premium puzzle

- The illiquidity premium may have the same order of magnitude as the market risk premium
- Part of the average excess return is likely compensation for *liquidity* risk rather than just systematic risk
- The equity premium puzzle may be less of a puzzle than it first appears

There are behavioral explanations for the equity premium puzzle

- Barberis and Huang explain the puzzle as an outcome of irrational investor behavior
- Premium results from two factors:
  - Narrow framing: Investors evaluate every risk in isolation
  - Loss aversion: Investors are more sensitive to losses than gains
- Investors focus on total volatility instead of the low correlation of a stock portfolio with other components of wealth
- Require higher risk premiums than rational models would predict

Summary from BKM (2023)

Page 436

1. Early tests of the single-factor CAPM were generally supportive of the model, but that support has long since evaporated. The positive relation between beta and average return has not characterized the data for decades.
2. Roll's critique implies that the usual CAPM test is a test only of the mean-variance efficiency of a prespecified market *proxy* and therefore that tests of the linearity of the expected return–beta relationship do not bear on the validity of the model.
3. Tests of the single-index model that account for human capital and cyclical variations in asset betas are more supportive of the single-index CAPM and APT. Moreover, anomalies such as the size and book-to-market effects are somewhat mitigated once these variables are accounted for.
4. The dominant multifactor models today are variants of the Fama-French model, incorporating market, size, value, momentum, and, sometimes, liquidity or other factors. However, the recent emergence of an ever-growing collection of discovered factors casts doubt on the validity of many of these findings. This has led to several suggestions that the criteria for widespread acceptance of a priced factor be tightened.
5. In some tests of consumption-based capital asset pricing models, consumption betas help to explain average portfolio returns and are associated with the Fama-French factors. These results support Fama and French's conjecture that their factors proxy for more fundamental sources of risk.
6. The equity premium puzzle originates from the observation that equity returns exceeded the risk-free rate to an extent that is inconsistent with the covariance of returns with consumption risk and reasonable levels of risk aversion—at least when average rates of return are taken to represent expectations. Some explanations for this puzzle focus on incomplete risk sharing or on habit formation. Other explanations are empirically based. For example, the puzzle emerges primarily from excess returns in the post–World War II period. It is plausible that the extent of the economic success of the United States in the post-war period was unexpected, making historical averages unrepresentative of prior expected values. Alternative estimates of expected returns using the dividend growth model instead of average returns suggest that excess returns on stocks were high largely because of unexpectedly large capital gains.

Key equations from BKM (2023)

First-pass regression equation: $r_{it} - r_{ft} = a_i + b_i \left(r_{Mt} - r_{ft}\right) + e_{it}$

Second-pass regression equation: $\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_i$

Fama-French three-factor model: $E\left(r_i\right) - r_f = a_i + b_i \left[E\left(r_M\right) - r_f\right] + s_i E\left[R_{SMB}\right] + h_i E\left[R_{HML}\right]$

References I

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