Lecture 5: Market Anomalies

In this lecture, we will discuss three apparent market anomalies that seem to defy market efficiency:

- Size effect
- Value effect
- Momentum

We will discuss the implications of these anomalies for portfolio managers and for market efficiency.

The Capital Asset Pricing Model (CAPM)

- In an efficient market, an investment strategy can earn high average returns only if it takes on high risk
- The backbone model of risk in finance has been the CAPM, which says that risk is measured by beta
  - Beta of a given stock is proportional to the covariance of the stock's returns with the market:

$$\beta_i = \frac{\mathrm{Cov}(R_i, R_M)}{\mathrm{Var}(R_M)}$$

  - The market model regression:

$$R_{i,t} - R_f = \alpha_i + \beta_i(R_{M,t} - R_f) + \epsilon_{i,t}$$

    * To estimate beta, we may work with total or excess returns (it makes very little difference)
    * To estimate alpha, we need excess returns

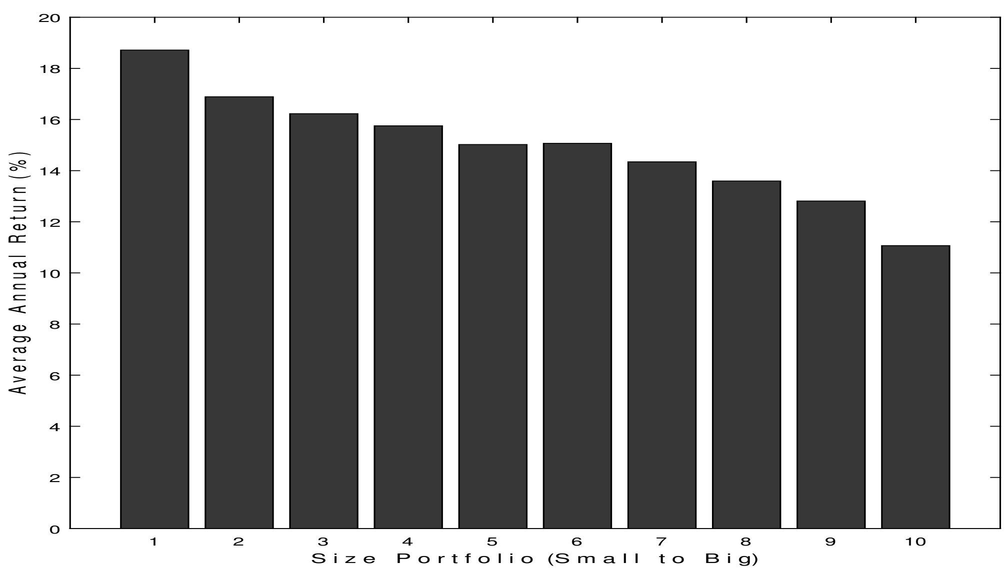
- In the CAPM, expected returns are driven by beta:

$$\mathrm{E}(R_{i,t}) \ = \ R_{f,t} + \beta_i \left[\mathrm{E}(R_{M,t}) - R_{f,t}\right]$$

  - According to the CAPM, all stocks should have zero alphas (i.e., zero risk-adjusted average returns)

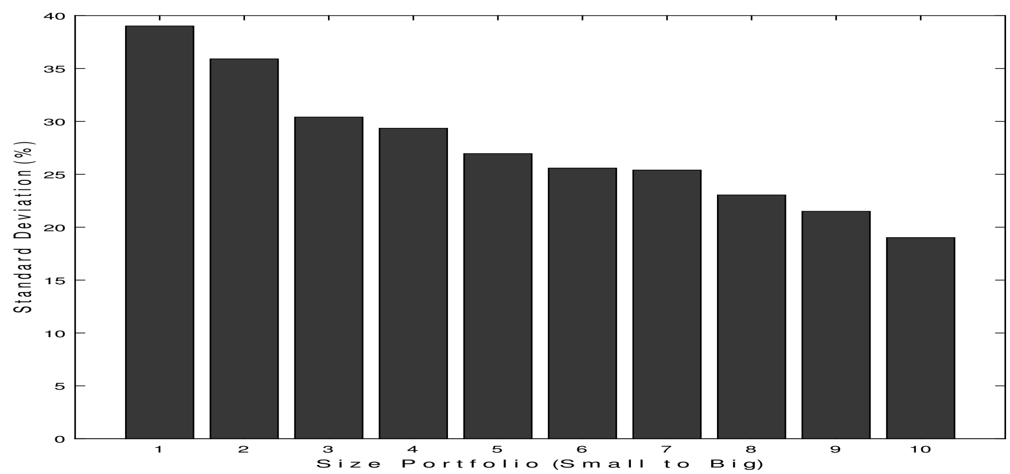
The Size Effect

- Small stocks have outperformed large stocks.
  - Size is measured by market capitalization (share price times number of shares outstanding)
- How do we compute returns on size-sorted portfolios?
  - At the end of each year, sort stocks into ten portfolios according to size (1: smallest, 10: biggest)
  - Record the value-weighted returns on these portfolios over the following year, and rebalance again
- **Average returns** over 1927–2016 (*size_a.m*):



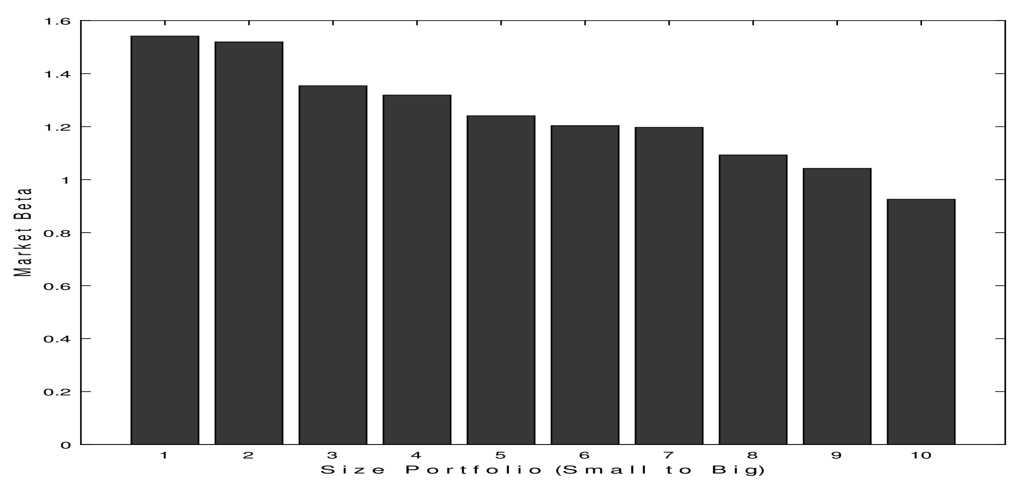
- Is the effect statistically significant?
  - Yes. The average 1-10 portfolio return (long smallest stocks, short largest stocks) is 18.7-11.1=7.6% per year, with a t-statistic of 2.5

- Why do smaller stocks have higher average returns? Are they riskier? How do we measure risk?
- **Return volatilities** over 1927–2016:



  - Smaller stocks have more volatile returns
  - Does that mean they are riskier?
  - Not necessarily; only systematic volatility (that driven by betas) should matter for pricing

- Market **betas** from annual returns over 1927–2016:

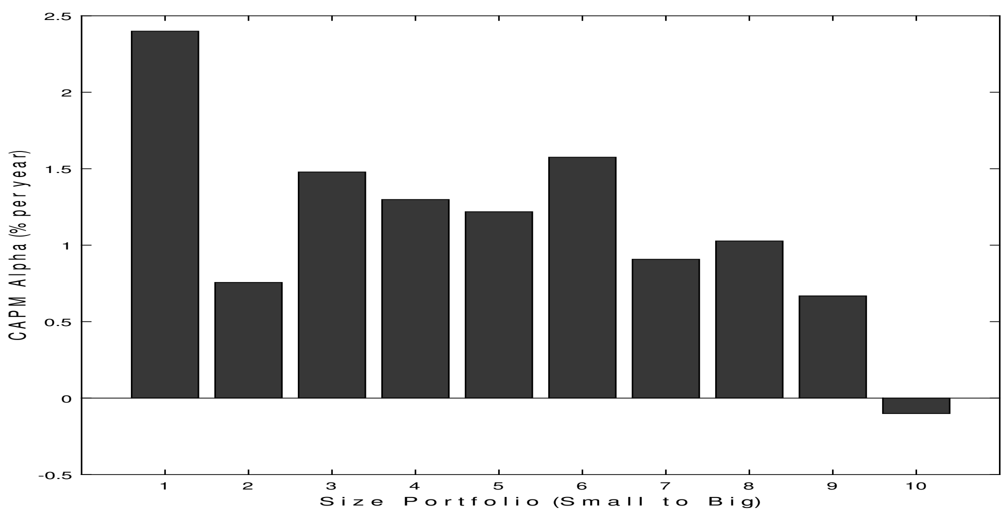


– Smaller stocks also have higher betas!

– Does that mean the CAPM explains the size effect?

– Not necessarily; the difference in βs may be too small to explain the difference in average returns

- CAPM **alphas** from annual returns over 1927–2016:



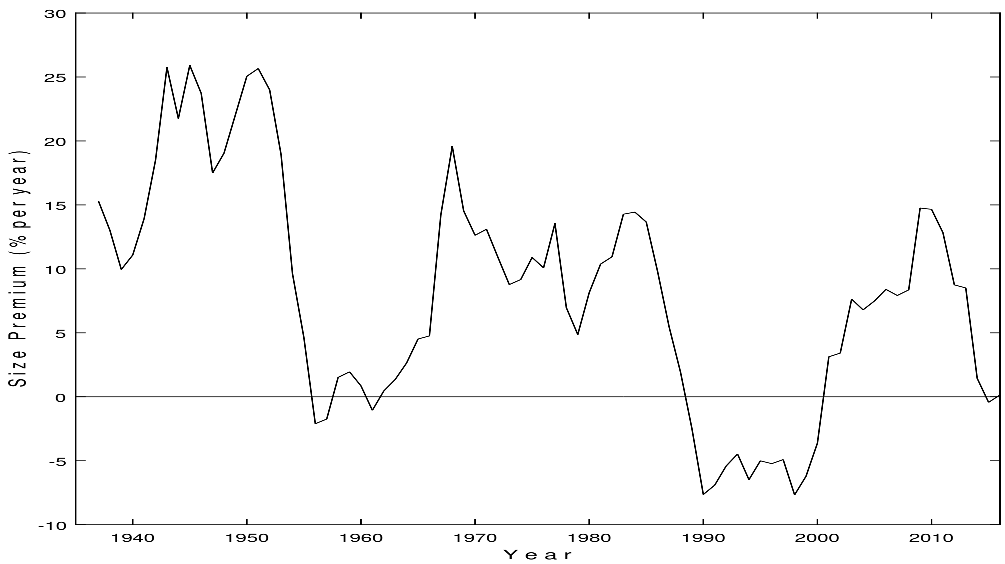
– Smaller stocks have higher CAPM alphas!

  ∗ That is, even after adjusting for risk via the CAPM, small stocks have earned higher average returns than large stocks

– So is the size effect is an anomaly that defies market efficiency? What does DFA think?

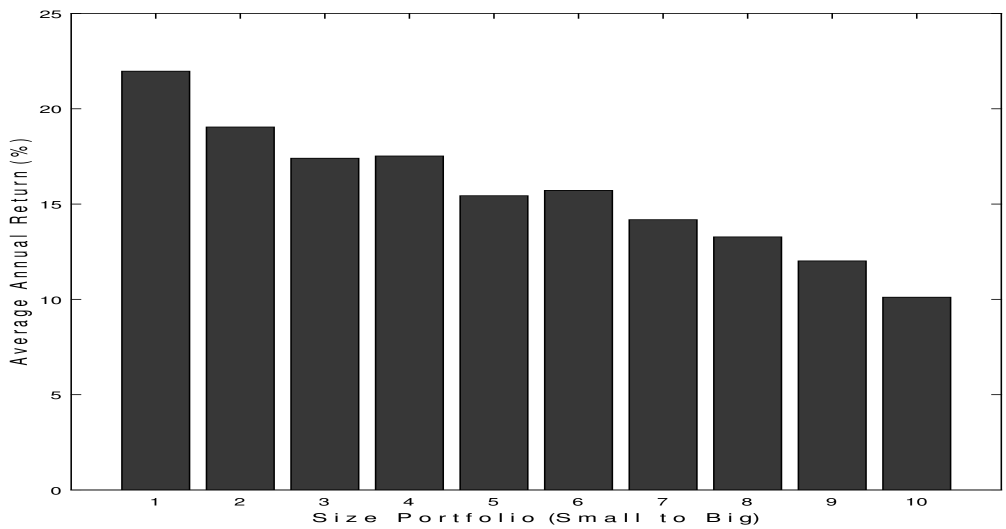
- DFA, along with Fama and French, would say no. They argue that the CAPM is not the right model of risk, and that small stocks are riskier because they have higher betas in the Fama-French 3-factor model.

- Does the size premium **vary over time**?
  - 10-year moving averages of the returns on the 1-10 portfolio (smallest minus biggest stocks):

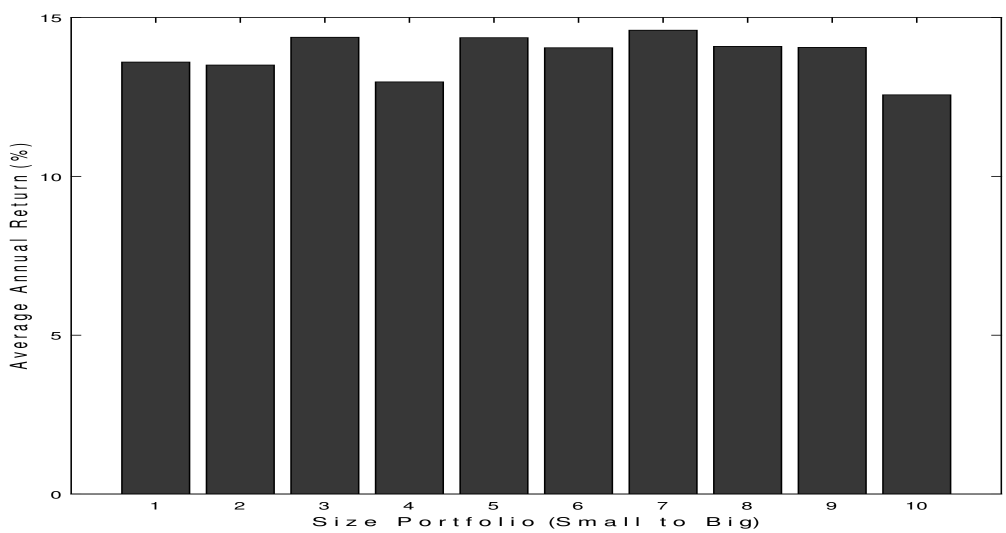


  - Small stocks underperformed large stocks in the 1980s as well as 1990s! (Each year, the average is computed over the previous 10 years.)
  - When was the size effect first identified?
  - When did DFA begin offering its first small-stock fund?
  - Has there been a size effect since 1981?

– Average returns over **1927–1981**:



– Average returns over **1982–2016**:



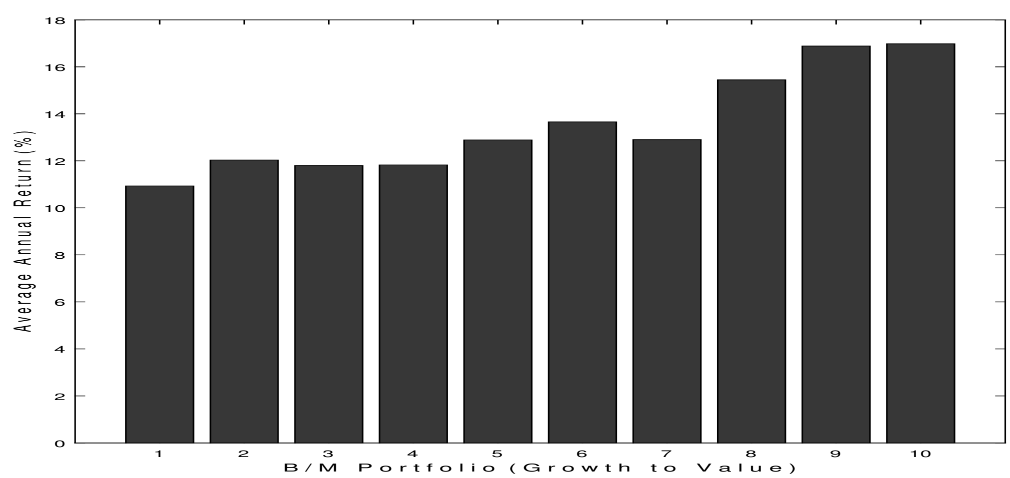
∗ The size effect disappeared after 1981!

· But it seems to be back in the 21st century

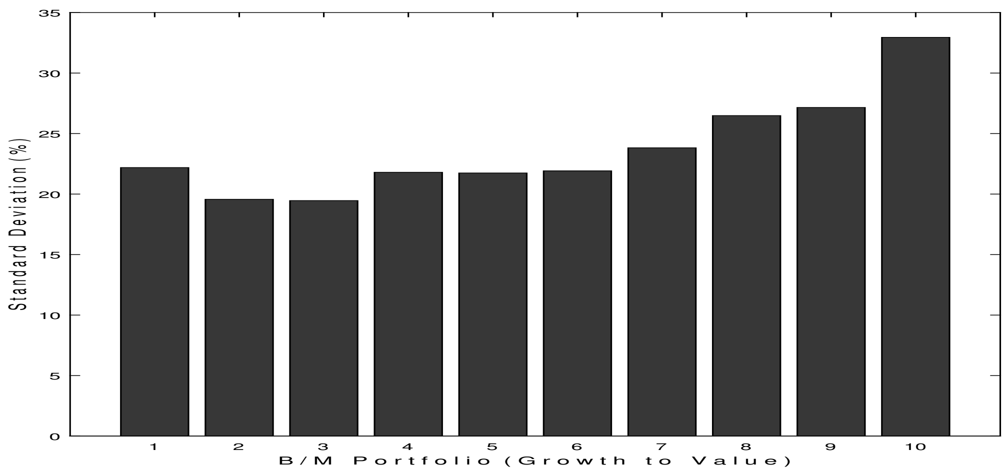
– Is the size effect a market anomaly?

The Value Effect

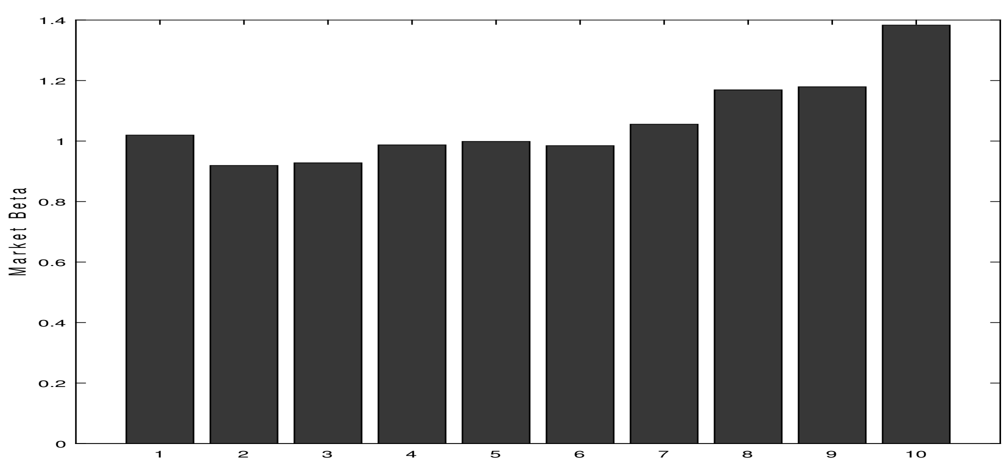
- Value stocks have outperformed growth stocks
  - We measure value by the ratio of the market value of equity to some measure of the fundamentals, such as book equity, cash flow, earnings, sales, etc.
  - Most common ratio: book-to-market, or B/M
    - **'Growth'** stocks: low B/M
    - **'Value'** stocks: high B/M
  - Other ways of measuring growth?
    - Example: CRSP Indexes
- To compute returns on B/M portfolios, at each year-end, sort stocks into ten portfolios according to B/M (1: lowest, 10: highest), and record the value-weighted returns on these portfolios over the following year
- **Average returns** over 1927–2016 (*value_a.m*):



- Is the effect statistically significant?
  - Yes. The average 10-1 portfolio return (long value stocks, short growth stocks) is 17.0-10.9=6.0% per year, with a t-statistic of 2.4
- **Return volatilities** over 1927–2016:

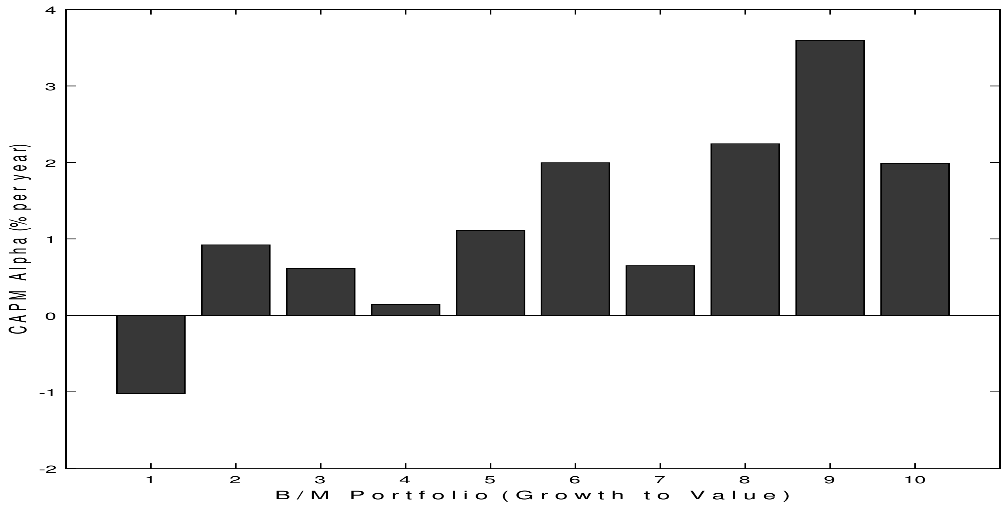


  - Value stocks have more volatile returns
- Market **betas** from annual returns over 1927–2016:



  - Value stocks also have higher betas!

- CAPM **alphas** from annual returns over 1927–2016:

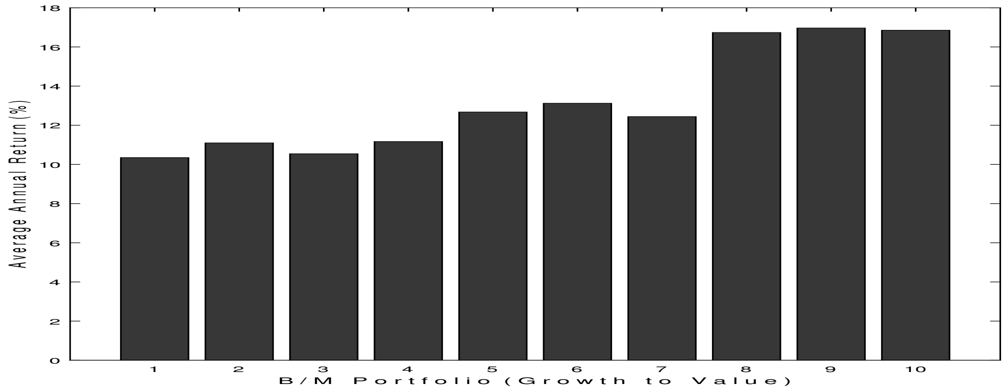


  - Value stocks have higher CAPM alphas!
    - That is, even after adjusting for risk via the CAPM, value stocks have earned higher average returns than growth stocks
  - So is the value effect an anomaly that defies market efficiency? What does DFA think?

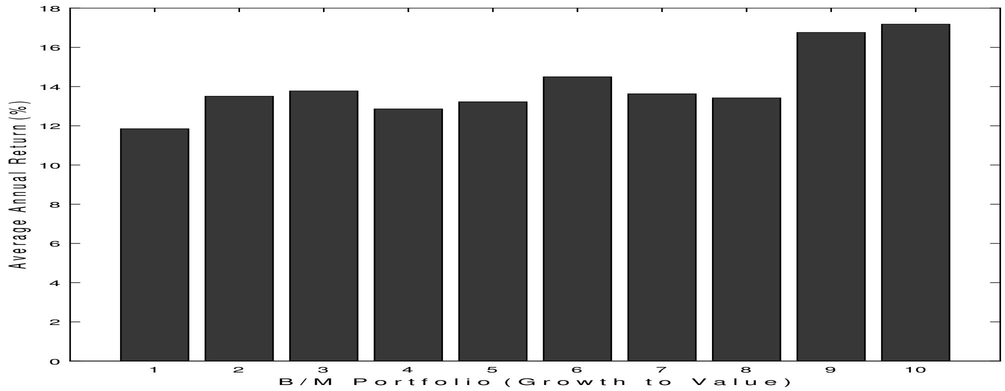
- DFA, along with Fama and French, would say no. They argue that the CAPM is not the right model of risk, and that value stocks are riskier because they have higher betas in the Fama-French 3-factor model.

  - This is a good example of Fama's *joint hypothesis problem*. When testing market efficiency, we are also simultaneously testing a model of the risk-return tradeoff (such as the CAPM).

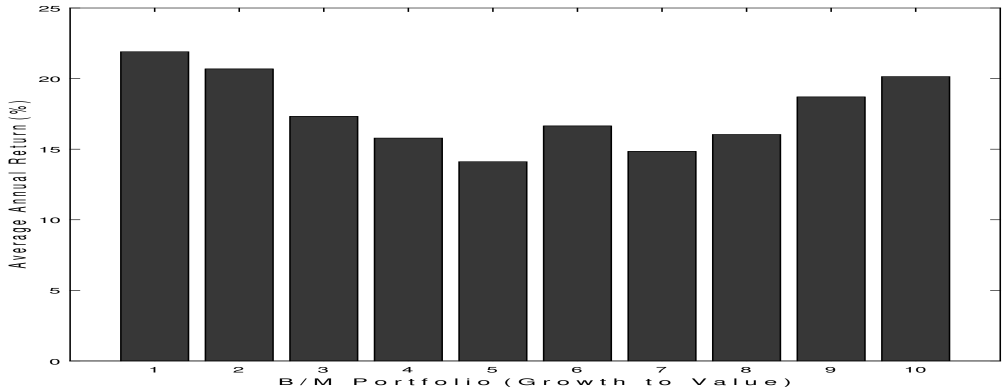
• Average returns over **1927–1981**:



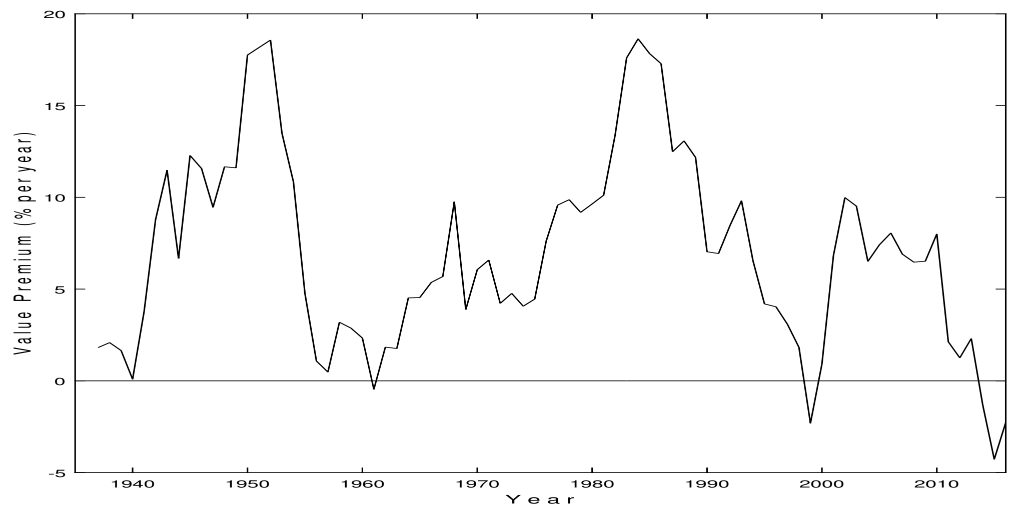
• Average returns over **1982–2016**:



• Average returns over **1990–1999**:



- How does the value premium **vary over time**?
  - 10-year moving averages of the returns on the 10-1 portfolio (value minus growth):



  - Value underperformed growth in the 1990s and 1930s, but outperformed it in all other decades

- The value effect made a comeback in the 21st century; what does it mean?

- Is there a value effect outside the U.S.?
  - Judge for yourself in Assignment 5!

Double-Sorting on Size and B/M

- Each year, sort stocks into 5 portfolios by size, and also sort them independently into 5 portfolios by B/M. Take the intersection $\Rightarrow$ 25 portfolios.

- Average returns over 1927-2016 (*size_value_a.m*):

	Small				Big	Small-Big
Growth	9.2	12.2	12.6	12.6	11.3	-2.1
	13.7	15.7	15.4	13.2	11.1	2.6
	16.6	16.6	15.7	14.8	12.6	4.0
	19.8	18.1	16.8	16.3	11.9	7.9*
Value	22.0	19.6	18.3	16.6	15.3	6.7*
Value-Growth	12.8*	7.4*	5.7*	4.0	4.0	

Numbers are % per year. * denotes statistically significant differences at 5% level.

  - The value effect is strongest among small stocks
  - The size effect is strongest among value stocks
  - Small growth stocks have performed the worst

- CAPM alphas over 1927-2016:

	Small				Big	Small-Big
Growth	−6.4*	-3.2	-1.3	-0.1	-0.1	−6.3*
	-3.0	1.5	2.4	0.7	0.2	-3.3
	1.6	2.7	2.8*	2.0	1.3	0.3
	4.5	4.0*	3.6*	3.2*	-0.4	4.9*
Value	5.8*	5.1*	4.4*	1.8	3.0	2.8
Value-Growth	12.2*	8.3*	5.6*	1.9	3.2	

- We can also formally test the CAPM
  - The so-called Gibbons-Ross-Shanken test examines the hypothesis that all 25 alphas are zero
  - The CAPM fails this test

The Fama-French Model

- Fama and French (1993) develop a 3-factor model in which small stocks and value stocks are riskier
  - Factor 1: Excess market return, MKT
  - Factor 2: Size factor, SMB ("Small Minus Big")
  - Factor 3: B/M factor, HML ("High Minus Low")
- How are SMB and HML constructed?
  - Each year, sort stocks by size into Small and Big (50% cutoff), and by B/M into Growth, Neutral, and Value (30%, 70% cutoffs); intersection $\Rightarrow$ 6 value-weight portfolios: SG, BG, SN, BN, SV, BV

$$\begin{aligned} SMB &= \frac{1}{3}(SV + SN + SG) - \frac{1}{3}(BV + BN + BG) \\ HML &= \frac{1}{2}(SV + BV) - \frac{1}{2}(SG + BG) \end{aligned}$$

  - SMB gives you size exposure, controlling for B/M
  - HML gives you B/M exposure, controlling for size
  - This makes SMB and HML almost uncorrelated
- Average annual returns over 1927-2016 – MKT: 8.4% ($t = 3.9$), SMB: 3.3% ($t = 2.3$), HML: 5.1% ($t = 3.4$)
- How do we use the Fama-French (FF) model?
  - Like any other multifactor model:

- Estimate asset i's three betas:

$$R_{i,t} - R_f \;=\; \alpha_i + \beta_i^M MKT + \beta_i^S SMB + \beta_i^H HML + \epsilon_{i,t}$$

  – According to the FF model, all stocks should have zero alphas in this regression

- Expected excess returns are then given by the sum of the products of the betas and the factor premia

$$\mathrm{E}(R_{i,t}) \;=\; R_f + \beta_i^M \lambda_{MKT} + \beta_i^S \lambda_{SMB} + \beta_i^H \lambda_{HML}$$

  – The three factor premia (λ) are expected returns on MKT, SMB, and HML; these are typically estimated by the sample averages given above

- Does the FF model explain the size and value effects?

  – FF alphas of the 25 portfolios over 1927-2016:

	Small				Big	Small-Big
Growth	-5.8^*	-3.0^*	-0.2	1.4^*	1.4^*	-7.2^*
	-5.2^*	0.2	1.7	-0.2	0.1	-5.3^*
	-1.1	0.5	0.8	-0.0	0.1	-1.1
	0.6	0.5	0.7	0.3	-2.9^*	3.5^*
Value	1.1	0.7	-0.2	-1.9	0.2	0.9
Value-Growth	6.9^*	3.7^*	0.0	-3.3^*	-1.2	

  – These alphas are smaller than the CAPM alphas, but the model still does not capture everything

Is the Fama-French Model Right?

- What is FF's economic story behind the model?
  - SMB and HML capture distress; small and value firms are more likely to fail in times of trouble
- Do SMB and HML capture non-diversifiable risks ("good times" and "bad times") that we care about?
  - Yes: HML did very poorly in the Great Depression, also in the recent crisis (2007Q3, 10/2008-2/2009)
  - No: HML performed well in many other recessions (Lakonishok, Shleifer, and Vishny, 1994)
    - In Japan's depression in the 1990s, value outperformed growth by about 9% per year
  - Yes: SMB and HML can predict future GDP growth in the US and abroad (Liew and Vassalou, 2000)
  - Recent HML returns (% per year):

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
8.2	8.3	14.0	-14.7	1.0	-9.1	-5.2	-8.4	9.9	1.5	-1.7	-9.5	23.33

    - Has the value effect disappeared? Yes $\Rightarrow$ anomaly. No $\Rightarrow$ either investors continue to be fooled despite strong evidence, or there is a good (risk-related) reason for the value effect
  - No: SMB and HML betas do not help explain the cross-section of average returns after controlling for the size and B/M characteristics (? see below)

- Risk vs characteristics
  - According to FF, small stocks and value stocks are riskier because they have higher FF *betas*
  - Daniel and Titman (1997) find that firm *characteristics* (size, B/M) are more closely related to average returns than FF betas are in 1973-93
    - Double-sort stocks on size snd SMB beta
    - Find bigger return differences across different sizes than across different SMB betas
    - Same for value and HML
  - Davis, Fama, and French (2000) find that betas work better than characteristics in 1929-97
  - Daniel, Titman, and Wei (2001) find that characteristics work better than betas in Japan
  - This debate is not easy to resolve. Characteristics are highly correlated with betas. While characteristics are known, betas must be estimated.
- Ball, Gerakos, Linnainmaa, and Nikolaev (2017) find that the only part of book value that matters for the predictive power of B/M is accumulated past earnings
  - B = retained earnings + contributed capital
  - Retained earnings-to-market subsumes B/M's predictive power in the cross section of stock returns

- People agree that SMB and HML are factors, but disagree over whether these factors are priced
  - A *factor* (f_t) is a variable that explains why returns on groups of stocks move together

    $$R_{i,t} - R_f \;=\; \alpha_i + \beta_i f_t + \text{ other factors} + \epsilon_{i,t}$$

    * Value (small) stock prices tend to move together, and comove with HML (SMB)
    * Hence, all of their risk cannot be diversified away
  - A *priced factor* is a factor that explains differences in average returns across stocks

    $$\mathrm{E}(R_{i,t}) \;=\; R_f + \beta_i \lambda_f + \text{ other factors}$$

    * A factor whose risk premium $\lambda_f \neq 0$
    * Only priced factors affect expected returns and thereby also stock prices

Multifactor Models: Intuition

"A banker is a fellow who lends you his umbrella when the sun is shining and wants it back the minute it begins to rain." Mark Twain

Example: A hypothetical "crime factor"

- When crime goes up, firms involved in alarms, locks, guns, and security guards see their prices go up (good news for future cash flow). These are high-crime-beta firms. Companies making BMW's, non-lockable doors, and gold jewelry see their prices go down, in relative terms. These are low/negative-crime-beta firms.
- Investors don't like crime, so they would like to buy insurance from it. Buying the crime factor (buying gun stocks and shorting BMW) gives such insurance, so the crime factor is attractive, and it commands a high price. Gun stocks are expensive (low expected return), BMW stock is cheap (high expected return).
- In general, factors that are positively correlated with good things have positive risk premium (example, the overall market). Factors that are positively correlated with bad things have negative risk premium (example, gold, which is correlated with turmoil and inflation).
- Here, gun stocks have high betas with respect to a factor with a negative risk premium ($\lambda_{crime} < 0$), so they have low expected returns ($\beta\lambda_{crime} < 0$).

Why Has Value Investing Been Profitable?

- Two fundamentally different explanations:
  - Behavioral
  - Rational/Risk-based
- **Behavioral** explanation:
  - Value stocks are *underpriced*, growth *overpriced*
  - Value stocks are dull, out of favor
    - Stocks are cheap because something about them makes investors uncomfortable
  - Growth stocks are cool, investors love them
    - Investors get too excited about the firm's new product or technology
    - Investors overreact to initial good news
  - So value investing is *contrarian*
  - Leading proponent: Warren Buffett
- **Rational** explanation:
  - Value stocks are *riskier* than growth stocks
  - Their higher average return represents fair compensation for the extra risk
- Recent research provides evidence that value stocks are riskier in some previously unexplored dimensions:

- Value stocks have high market betas when the market premium is high (Petkova and Zhang, 2005)
- Value stocks have higher "cash flow betas" than growth stocks (Cohen, Polk, and Vuolteenaho, 2003, Bansal, Dittmar, and Lundblad, 2005)
- Value stocks have higher "consumption betas" than growth stocks when consumption is cleverly measured (Parker and Julliard, 2005, Yogo, 2006, Jagannathan and Wang, 2007)
- Value stocks have higher "bad" market betas than growth stocks (Campbell and Vuolteenaho, 2004)
- Value firms find it more costly to reduce their capital stock in bad times (Zhang, 2005)

• If you don't believe that value stocks are riskier, buy a lot of value stocks (and short growth stocks)!

Good vs Bad Growth

• Good growth: sustainable growth in profits
  - Bad: growth in other numbers hurts profits

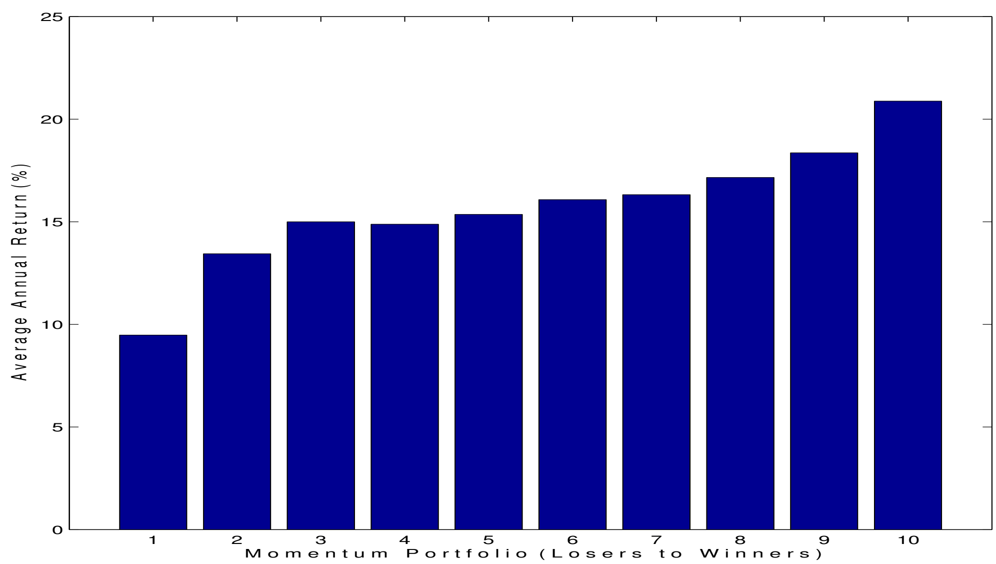
• **Example**: Two retail chains with strong sales growth
  - Good growth: Same-store sales growth
  - Bad growth: Buying more stores at premium prices

Beyond Value and Size

- Fama and French (2015) propose a five-factor model
  - Adding two factors to their three-factor model:
    - RMW: high minus low **profitability** ("robust minus weak")
    - CMA: low minus high **investment** ("conservative minus aggressive")
- Firms that invest more have lower average returns
  - Firms with cheaper capital want to invest more
  - Similarly, high asset growth predicts low returns
- More profitable firms have higher average returns
  - Sort on *gross profitability*: revenues minus costs, divided by book equity (Novy-Marx, 2013)
  - To improve the performance of the value strategy, combine it with a screen on profitability
  - Can also combine value with momentum (see next)
- The five-factor model prices stocks well, but it cannot explain the low average returns of small stocks that invest a lot despite low profitability
  - True also internationally (Fama and French, 2017)

Momentum

- Recent "winners" outperform recent "losers"
  - Winning and losing is measured by the stock price performance over the past 3-12 months
- At each year-end, sort stocks into ten portfolios according to past returns over 3-12 months (1: lowest, 10: highest), and record the value-weighted returns on these portfolios over the following year
- Effect first identified by Jegadeesh and Titman (1993), who formed portfolios based on past 6-month returns and held them for 6 months (Jan 1965 – Dec 1989):



- The 10-1 portfolio earned 11.40% per year, on average (highly statistically significant)

- We define the Winner-Minus-Loser portfolio (WML) as the top 30% minus the bottom 30% of stocks sorted by their returns in months -12 to -2
  - E.g., on Dec 31, 2000, we sort stocks on their returns between Jan 1, 2000 through Nov 30, 2000
  - We also control for size in the same way as when constructing HML
    * Each month, sort stocks by size into Small and Big (50% cutoff), and by past -12 to -2 returns into Winners, Neutral, and Losers (30%, 70% cutoffs); intersection $\Rightarrow$ 6 value-weight portfolios: SW, BW, SN, BN, SL, BL

$$WML = \frac{1}{2}(SW + BW) - \frac{1}{2}(SL + BL)$$

- **Average return** on WML over **1927–2016:** 9.3% per year ($t = 5.5$) (*momentum_a.m*)
- We skip month -1 because there are short-term reversals in returns related to liquidity effects
- The **horizon** (3-12 months) is very important
  - When we sort stocks on their performance over the past 3-5 years, we find reversals, not continuation (DeBondt and Thaler, 1985)
  - When we sort stocks on their performance over the past few weeks, we find reversals again

- Are recent winners **riskier** than recent losers?
  - If they are, we do not yet understand why
  - They do not have higher market betas

$$\begin{aligned} R_{WML,t} &= \alpha + \beta(R_{M,t} - R_f) + \epsilon_t \\ \hat{\beta} &= -0.07 \\ \hat{\alpha} &= 9.8\% \ (t = 5.5) \end{aligned}$$

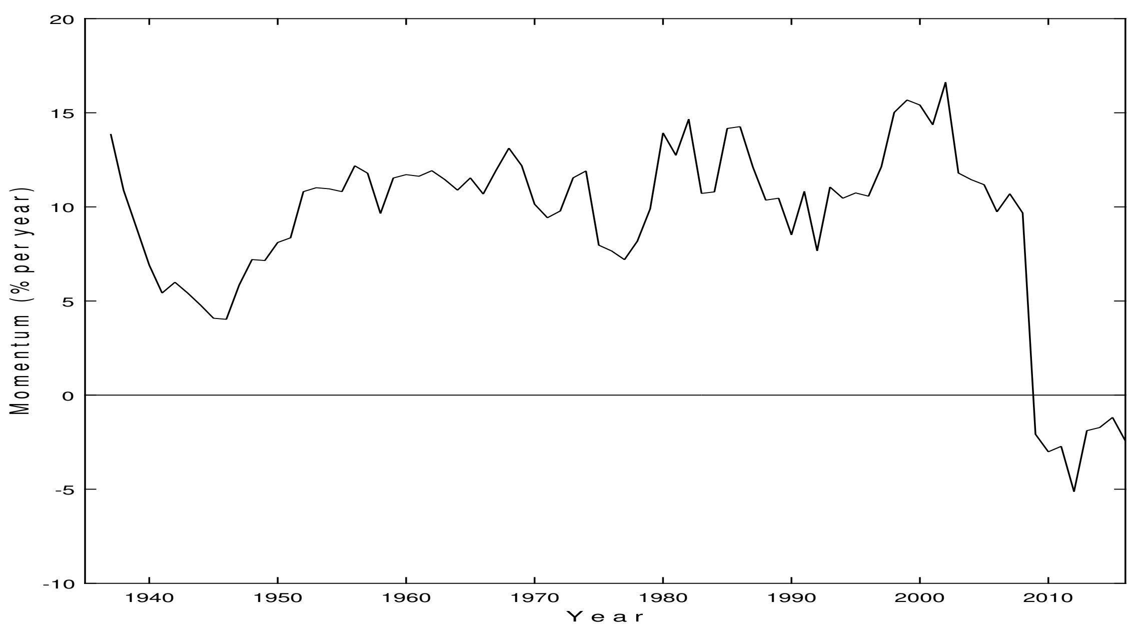
  - They do not have higher SMB and HML betas

$$\begin{aligned} R_{WML,t} &= \alpha + \beta^M MKT + \beta^S SMB + \beta^H HML + \epsilon_t \\ \hat{\beta}^M &= -0.04, \ \hat{\beta}^S = -0.06, \ \hat{\beta}^H = -0.18 \\ \hat{\alpha} &= 10.7\% \ (t = 5.8) \end{aligned}$$

    - The Fama-French risk adjustment makes momentum profits even larger!
  - Grundy and Martin (2001) find that factor models can explain 95% of winner and loser return variability, but cannot explain their average returns
- What causes momentum?
  - Chan, Jegadeesh, and Lakonishok (1996) argue that investor *underreaction* to news causes momentum
  - Lou (2012) and Vayanos and Woolley (2013) argue that *fund flows* cause momentum
    - Alas, both explanations seem unsatisfactory

- Does momentum work in **international** markets?
  - Yes. Rouwenhorst (1998) finds momentum in all 12 European countries considered. He finds that
    * an internationally diversified WML portfolio earns more than 1% per month after risk adjustment
    * international momentum returns are correlated with U.S. returns ($\Rightarrow$ common factor?)
  - Yes. Griffin, Ji, and Martin (2005) find momentum in 33 of the 40 countries examined (statistically significant in 16 countries as well as globally)
  - Momentum doesn't seem to work in Japan

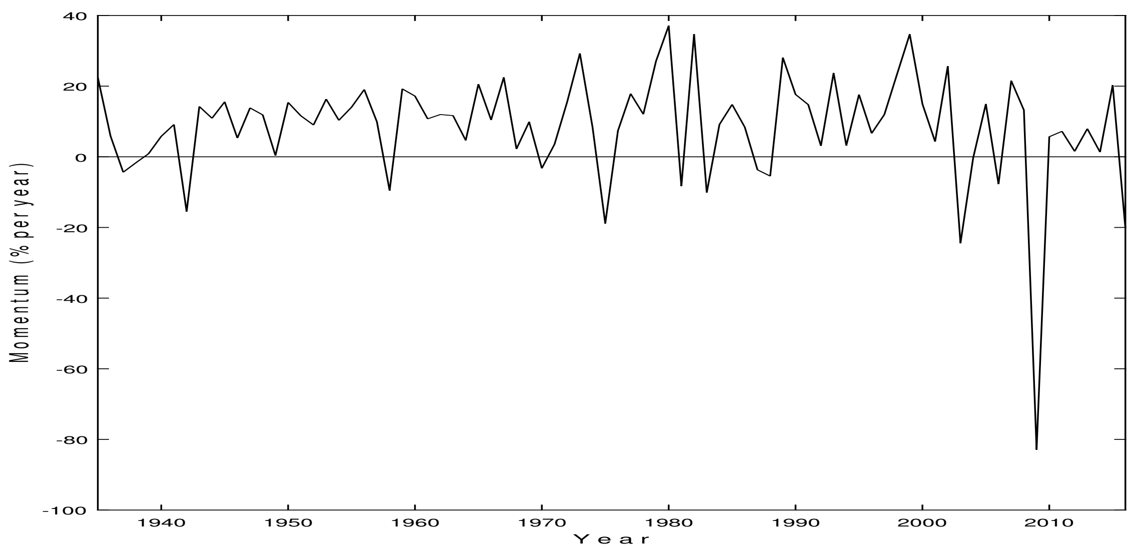
- How do momentum profits **vary over time**?
  - 10-year moving averages of WML returns:



- Has momentum disappeared since it was discovered?
  - Recent WML returns (% per year):

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
17.7	14.8	3.1	23.7	3.2	17.6	6.7	12.0	23.4	34.7	15.0	4.3	25.7	-24.5

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-0.3	14.9	-7.7	21.5	13.2	-82.9!	5.7	7.2	1.6	7.9	1.3	20.3	-20.2	?



- Momentum sometimes crashes during market rebounds (e.g., Daniel and Moskowitz, 2016)
- Momentum is sometimes called *price momentum*, to differentiate it from *earnings momentum*
  - Earnings momentum = post-earnings announcement drift (Ball and Brown, 1968) :

    Firms reporting unexpectedly high earnings outperform firms reporting unexpectedly low earnings, for 9 months after the earnings announcement
- Price momentum and earnings momentum are related

  - Winners (losers) tend to be stocks with good (bad) recent earnings surprises

- Chan, Jegadeesh, Lakonishok (1996) argue both types of momentum exist after controlling for each other

- But recent evidence suggests that earnings momentum subsumes price momentum (Novy-Marx, 2015)
  - In regressions of stock returns on past returns and earnings surprises, the latter drive out the former
  - The evidence of Chan et al is weaker, based on a coarse 3x3 sort and less data

- Asness, Moskowitz, and Pedersen (2013) show that
  - value and momentum effects are pervasive globally across various countries and asset classes
  - both value and momentum are positively correlated across asset classes
  - value is negatively correlated with momentum within and across asset classes (well known to GMO!)

- McLean and Pontiff (2016) study post-publication returns of 97 market anomalies; find that returns decline by 58% after academic publication, on average