

1. Market Efficiency, Behavioral Finance, Asset Management

Johan Hombert

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This Course

Investment strategies that beat the market...

...common prediction errors in financial markets...

...bubbles

Why arbitrage can fail?

How CAPM fails. What to do about it?

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How CAPM fails. What to do about it?

1. Market efficiency, behavioral finance, asset management

Rest of the course:

2. Information and trading in financial markets

3. Data in credit and insurance markets

4. Banking

5. Sustainability and finance

This Course

- Weekly problem sets (not graded)
- Group work (50% of total grade)
 - ▶ Guidelines during class 4
 - ▶ First round due for class 6
 - ▶ Second round due on TBD
- Final exam (50% of total grade)
 - ▶ May 21st, 45 minutes
 - ▶ Practice exam after class 4

Road Map

Market (In)Efficiency

CAPM (and its limits)

Multi-Factor Models

Limits to Arbitrage

Asset Pricing

Refresher from *Financial Markets*

Consider stock ABC

- D_1 : dividend per share paid in one year
- P_1 : stock price in one year after dividend payment
- D_1 and P_1 are uncertain. Based on currently available information, best forecasts are $E[D_1] = 3$ and $E[P_1] = 52$. $E[.]$ means expected value

Q1. Can you calculate the fair value of ABC today?



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Q1. Can you calculate the fair value of ABC today? discount rate is missing

- Suppose the discount rate for ABC is $k = 10\%$

Q2. Calculate the fair value (present value) of ABC



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$$\text{present value} = \frac{E[D_1] + E[P_1]}{1+k} = \frac{3+52}{1.1} = 50$$

Asset Pricing

Q3. Suppose ABC trades at $P_0 = 50$ today. What is the one-year expected return on the stock (i.e., buy today and re-sell next year after the dividend payment)?



Asset Pricing

Q3. Suppose ABC trades at $P_0 = 50$ today. What is the one-year expected return on the stock (i.e., buy today and re-sell next year after the dividend payment)?

$$\text{expected return } E[R] = \frac{E[D_1] + E[P_1] - P_0}{P_0} = \frac{3 + 52 - 50}{50} = 10\%$$

⇒ If the stock is fairly priced, the expected return is equal to the discount rate

Information Arrival

- Suppose good news arrives about ABC. The best forecasts are now $E[D_1] = 6$ and $E[P_1] = 60$

Q4. What happens to the stock price today? What is the new expected return?



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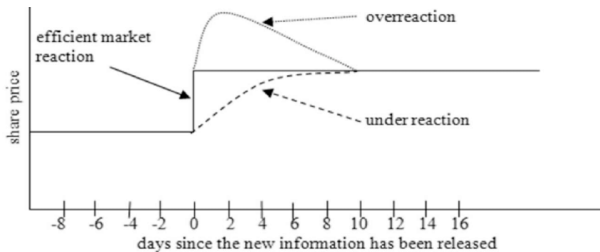
price increases to $\frac{6+60}{1.1} = 60$

expected return = $\frac{6+60-60}{60} = 10\%$

⇒ If the stock price incorporates the new information, the expected return remains equal to the discount rate

Market Efficiency

- *Definition:* In an **efficient market**, asset prices reflect all available information (Fama, 1970)



Market Efficiency Quiz

- Yesterday, tech company BigBrother released groundbreaking generative AI algorithm. This represents very good news for future earnings of BigBrother

Q1. If markets are efficient, it is a good idea to buy BigBrother's stock

- a. True b. False

Q2. If markets are inefficient, it is a good idea to buy BigBrother's stock

- a. True b. False

Market Efficiency Quiz 🤔

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- E-commerce company Mekong announces that its sales are up 25% compared to last year. Upon the announcement, Mekong's stock price drops 5%

Q3. The price reaction shows that the stock market is inefficient

- a. True b. False

Market Efficiency and the *Challenger* Disaster

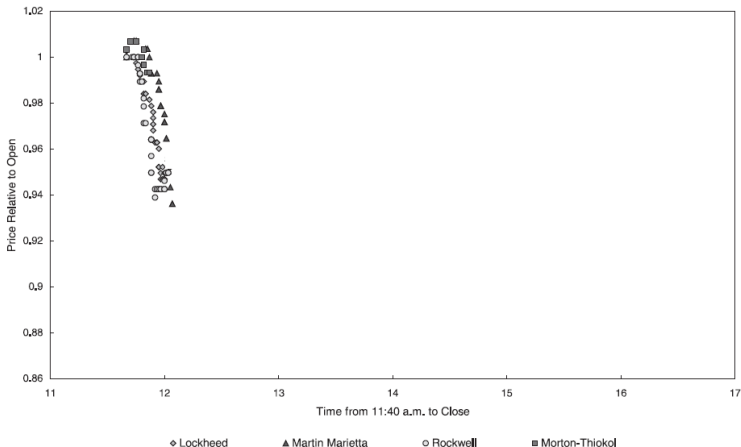
- On January 28, 1986, space shuttle Challenger explodes 73 seconds into its flight



- After 5 months of investigation, the Rogers Commission determines the failure of joints manufactured by Morton-Thiokol caused the explosion

Market Efficiency and the *Challenger* Disaster

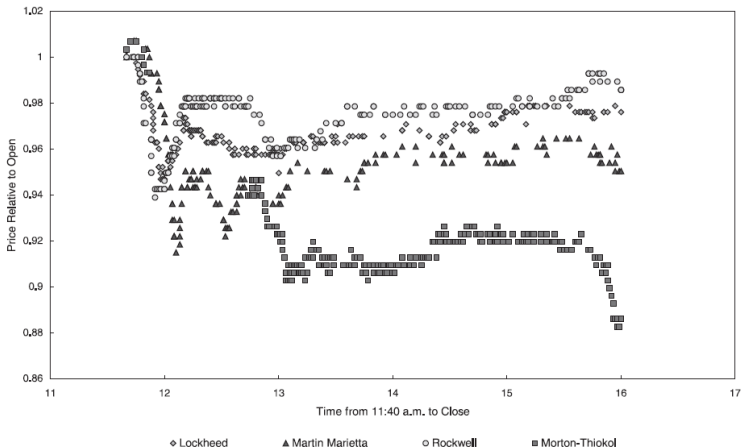
- Intraday stock price movement of the four main shuttle contractors following explosion at 11:40 am¹



¹Maloney and Mulherin, 2003, The Complexity of Price Discovery in an Efficient Market: The Stock Market Reaction to the Challenger Crash, *Journal of Corporate Finance* [\[pdf\]](#)

Market Efficiency and the *Challenger* Disaster

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Q. What is your interpretation?

¹Maloney and Mulherin, 2003, The Complexity of Price Discovery in an Efficient Market: The Stock Market Reaction to the Challenger Crash, *Journal of Corporate Finance* [\[pdf\]](#)

Market Efficiency

- If markets are efficient, it is impossible to generate superior returns on a risk-adjusted basis



Eugene Fama
Nobel Prize in
Economics 2013

"I'd compare stock pickers to astrologers but I don't want to bad mouth astrologers."

"What I like to remind people is that active management is a zero-sum game before costs."

Performance of Fund Managers

- Mutual funds do not outperform before fees, and underperform after fees on average²
- ⇒ Argument for **passive investing**: invest in the market portfolio (low management cost)
- Hedge funds outperform before fees, and perhaps after fees too (but sensitive to risk adjustment, more on this later)³

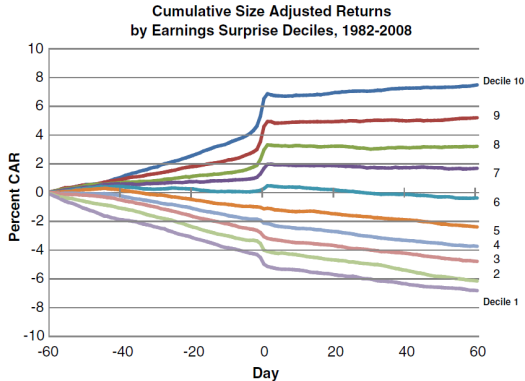
	Average risk-adjusted return (annualized)	
	before fees	after fees
Mutual Funds (active, US equity)	-0.2%	-1.1%
Hedge Funds (HFRI composite index)	7.3%	3.6%

²Fama and French, 2010, Luck versus Skill in the Cross-Section of Mutual Fund Returns, *Journal of Finance* [\[pdf\]](#)

³Jurek and Stafford, 2015, "The Cost of Capital for Alternative Investments," *Journal of Finance* [\[pdf\]](#)

Stock Price Reaction to Earnings Announcements

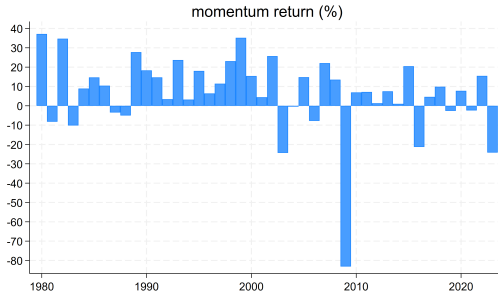
by decile of earnings surprise (actual earnings minus analysts' earnings forecast)



- Prices react to public news → consistent with market efficiency
- Prices drift before the announcement → consistent with market efficiency?
- Prices drift after the announcement → consistent with market efficiency?
→ **post-earnings announcement drift (PEAD)**

Momentum

- **Momentum** portfolio: buy past winners (stocks with high return in prior year) and short-sell past losers (low return in prior year)
- If markets are efficient, past return should not predict future return
- Yearly return of momentum portfolio (US stocks, 1980-2023)



Average: 8.7%
Std.Dev: 15.9%



How do you interpret the high average return of momentum?

A Classic Experiment

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations

Which is more probable?

1. Linda is a bank teller
2. Linda is a bank teller and is active in the feminist movement

Cognitive Mistakes

- Human brain is poorly equipped for probabilities
- Additional complexity in finance: information is abundant

Cognitive Mistakes



Daniel Kahneman and Amos Tversky
Nobel Prize in Economics 2002

Attention

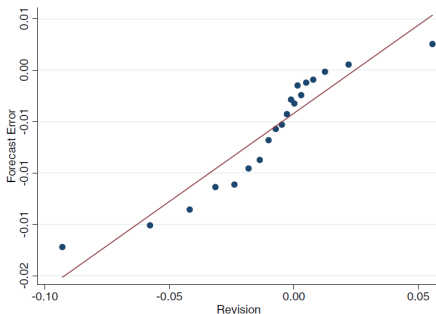
- Watch this [video](#) and answer the questions

Under-Reaction Among Professional Forecasters

- Analysts issue forecasts of companies' earnings, and sometimes revise their forecast
- A rational forecast is not always right (the future is not perfectly predictable)
- ...but the forecast error should not be predictable, otherwise the forecast could have been improved

Under-Reaction Among Professional Forecasters

- Forecast revisions predict forecast errors⁴



revision: new forecast minus
old forecast

forecast error: actual earnings
minus new forecast

⇒ Inconsistent with rational forecasting

- Under-reaction:** when bad news prompts analysts to revise their forecast downwards, analysts under-react → the forecast error is negative on average, i.e., the new forecast is still too high

⁴Bouchaud, Krüger, Landier and Thesmar, 2019, Sticky Expectations and the Profitability Anomaly, *Journal of Finance* [\[pdf\]](#)

Implications of Under-Reaction

- Under-reaction to information is a potential explanation for market anomalies such as momentum and PEAD

Over-Reaction Among Professional Forecasters

- Previously: under-reaction at 6-12 months horizon
- **Over-reaction** at longer horizons: following strong earnings growth, analysts forecast higher future long-term (3-5 years) growth than will materialize⁵
- Tendency to (incorrectly) extrapolate past trends into the future

⁵Bordalo, Gennaioli, La Porta and Shleifer, 2019, Diagnostic Expectations and Stock Returns, *Journal of Finance* [\[pdf\]](#)

Implications of Over-Reaction

- Over-reaction at long horizon is a potential explanation for **long-term reversal**: stocks with high return in the past 3-5 years have lower future return than stocks with low return in the past 3-5 years on average

Value

- Long-term reversal is related to the **value effect**: value stocks (high book equity/market equity ratio) have higher future return than growth stocks on average (low BE/ME)
- Because high return in past 3-5 years \Rightarrow high stock price, i.e., low BE/ME today

Behavioral Finance and Bubbles

- Over-reaction is a potential explanation for bubbles



Robert Shiller

Nobel Prize in Economics 2013



Richard Thaler

Nobel Prize in Economics 2017

Performance Evaluation

- Evaluating the performance of an investment strategy requires to separate the compensation for risk from the extra-performance
- There exist several risk models that accomplish this risk adjustment. The most widely used is the CAPM

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Multi-Factor Models

Limits to Arbitrage

Capital Asset Pricing Model (CAPM)

Refresher from *Financial Economics*

- CAPM in words: the risk exposure of an asset can be decomposed into
 - a) exposure to market risk, that is, the comovement of its return with the market return
 - b) exposure to all other risks, independent from the market
- CAPM says that
 - a) exposure to market risk commands a risk premium
 - b) exposure to other risks doesn't

CAPM

- CAPM in equations: the expected return of asset i is given by

$$E(r_i) = r_f + \underbrace{\beta_i \times (E(r_m) - r_f)}_{\text{asset } i\text{'s risk premium}}$$

r_f : risk-free rate

r_m : return on the market portfolio (all traded assets)

- $\beta_i = \text{Cov}(r_i - r_f, r_m - r_f) / \text{Var}(r_m - r_f)$: asset i 's **market beta** measures asset i 's exposure to **market risk**

Example

- Past returns of the market portfolio and assets A, B and C:



What are expectations of future average return of assets A, B and C according to the CAPM?

CAPM in Data

- CAPM in data: each observation is a month, three variables

r_{it} : return on stock i in month t

r_{mt} : market return in month t

r_{ft} : one-month risk-free rate (known at beginning of month t)

- Estimate the following linear regression

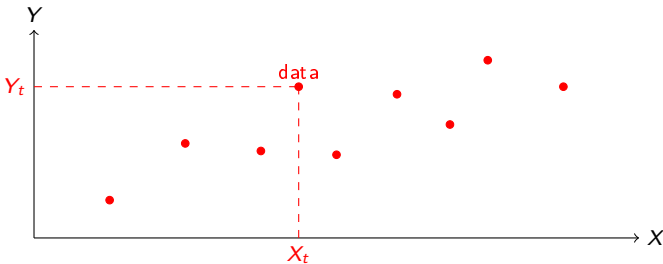
$$\underbrace{r_{it} - r_{ft}}_{\text{stock } i\text{'s excess return}} = \alpha_i + \beta_i \times \underbrace{(r_{mt} - r_{ft})}_{\text{market excess return}} + \epsilon_{it}$$

Refresher on Linear Regression

- The linear regression

$$Y_t = \alpha + \beta X_t + \epsilon_t$$

estimates parameters α and β to minimize the (squared) distance between observed values Y_t and predicted values $\alpha + \beta X_t$

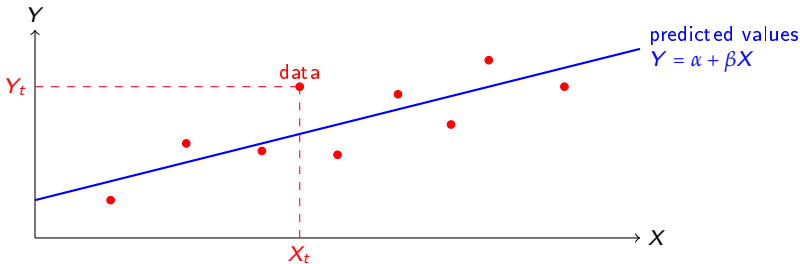


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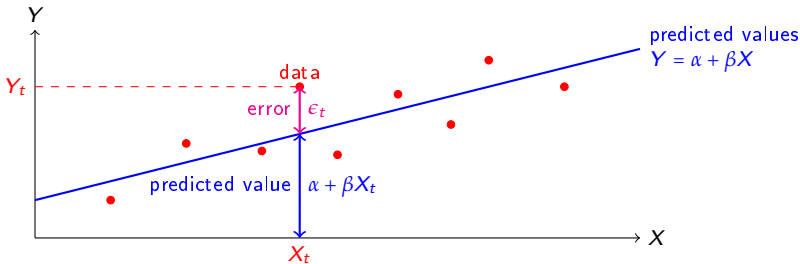


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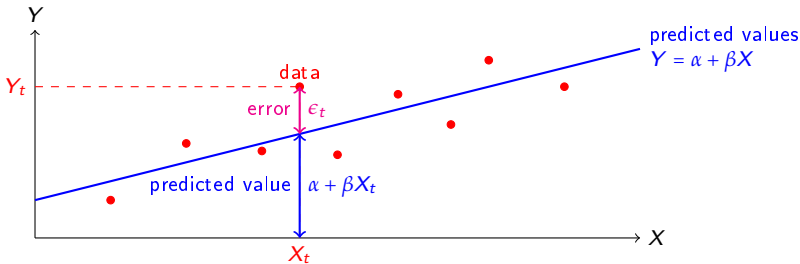


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- Intercept: α
- Slope: $\beta = \frac{\text{Cov}(X, Y)}{\text{Var}(X)}$

Estimating Alpha

- Estimate the CAPM regression

$$\underbrace{r_{it} - r_{ft}}_{\text{stock } i\text{'s excess return}} = \alpha_i + \beta_i \times \underbrace{(r_{mt} - r_{ft})}_{\text{market excess return}} + \epsilon_{it}$$

- $\beta_i = \frac{\text{Cov}(r_{it} - r_{ft}, r_{mt} - r_{ft})}{\text{Var}(r_{mt} - r_{ft})}$ is equal to the market beta
- Take expectations (average) on both sides of the CAPM regression

$$\underbrace{E(r_{it} - r_{ft})}_{\text{asset } i\text{'s risk premium}} = \underbrace{\alpha_i}_{\text{"abnormal" compensation}} + \underbrace{\beta_i E(r_{mt} - r_{ft})}_{\text{compensation for market risk}}$$

- α_i is the **CAPM alpha**
- $\alpha_i = 0$ if the CAPM is the correct risk model and the market is efficient

Example 1: Automotive Industry Portfolio

- US automotive industry portfolio [\[data\]](#)
- Estimate CAPM regression
- $\hat{\beta} = 1.34$ (s.e. = .06)

$\beta > 1$ means that the autos industry portfolio is quite procyclical:
when market goes up 1%, the autos industry portfolio goes up 1.3%
on average

- $\hat{\alpha} = -0.0006$ (s.e. = .0026)

alpha is not statistically different from zero, as predicted by market efficiency with CAPM risk adjustment

Example 1: Automotive Industry Portfolio

Q1. Autos stocks have higher expected return than the market portfolio

- a. True
- b. False

Q2. Autos stocks have a more favorable risk-return tradeoff than the market portfolio

- a. True
- b. False

Example 2: Momentum

- Momentum portfolio [data]
 - ▶ Long \$1 past winners (prior 2-12 monthly return in top 30%)
 - ▶ Short \$1 past losers (prior 2-12 monthly return in bottom 30%)
- Estimate CAPM regression
- $\hat{\beta} = -0.18$ (s.e. = .04)

Past winners have slightly lower beta than past losers \Rightarrow momentum portfolio has slightly negative beta

- $\hat{\alpha} = 0.0063$ (s.e. = .0019)

$\alpha = 0.0063 \times 12 = 7.6\%$ per year statistically different from zero, inconsistent with market efficiency and CAPM risk adjustment

Construction of Long-Short Portfolios

- A “zero-cost” long-short portfolio requires no financing
 - ▶ Long \$1 portfolio L (long leg)
 - ▶ Short \$1 portfolio S (short leg)
 - ▶ We refer to $r_L - r_S$ as the portfolio return even though it is an abuse of language because the initial investment is zero
- The corresponding long-short portfolio is
 - ▶ Long \$1 risk-free asset
 - ▶ Long \$1 portfolio L
 - ▶ Short \$1 portfolio S
 - ▶ The portfolio return is $r_f + r_L - r_S$
- The CAPM regression on the previous slide is

$$\underbrace{r_{mom,L} - r_{mom,S}}_{=r_{mom}} = \beta_{mom} \times (r_m - r_f) + \epsilon$$

Three Reasons for Finding Alpha

1. **p-hacking** (statistical fluke)

- ▶ Sample may have been too small/unrepresentative
- ▶ alpha disappears if sample is extended

⇒ Always test out-of-sample any trading idea

2. **Wrong risk model**

- ▶ CAPM only has one risk factor: the market factor
- ▶ Other risk factors may be priced (see later)

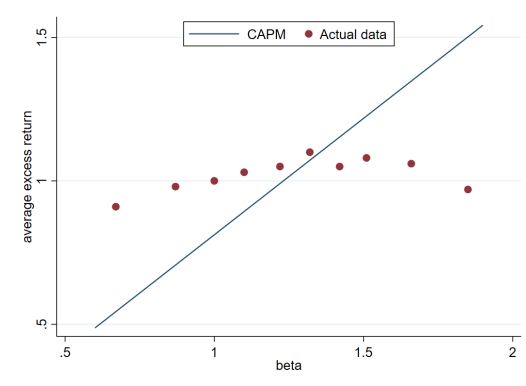
⇒ What looks like α may in fact be compensation for risk

3. **Mispricing** (market inefficiency)

- ▶ When not 1 and 2, there is a genuine trading opportunity
- ▶ $\alpha > 0$: asset is *undervalued* ⇒ should buy
- ▶ $\alpha < 0$: asset is *overvalued* ⇒ should short-sell
- ▶ Alpha goes away as investors trade on the mispricing

CAPM in Data: Oops...

- Security market line (SML) for 10 beta-sorted portfolios of US stocks⁶



- Read more at <https://johanhombert.github.io/blog/20201010-capm-fake-news>

⁶Frazzini and Pedersen, 2014, Betting Against Beta, *Journal of Financial Economics* [pdf]

Fixing CAPM

- Three explanations for lousy performance of CAPM, each one calling for a different solution

Fixing CAPM #1

Explanation #1: CAPM is a good model but betas are measured with error

- Backward-looking estimation
- Possible fix: improve statistical model
 - ▶ Shrinkage estimator
(e.g., Bloomberg's adjusted beta: $\frac{2}{3} \times \text{estimated beta} + \frac{1}{3} \times 1$)
 - ▶ Proprietary quant models (e.g., Barra beta)

Fixing CAPM #2

Explanation #2: CAPM is a good *normative* model (i.e., of what asset prices *should be*) but markets do not price assets correctly

- Behavioral finance: many anomalies
- Should we use the CAPM or market-implied valuations?

⇒ It depends on the problem at hand:

- ▶ Asset management: exploit anomalies
- ▶ M&A: do not ignore market valuations

Application of Flat SML to Asset Management



Construct a long-short portfolio with zero beta and positive alpha

Application of Flat SML to Asset Management



Construct a long-short portfolio with zero beta and positive alpha

- Buy low-beta stocks / short-sell high-beta stocks
- For instance, zero-cost portfolio
 - ▶ Long \$... stock portfolio $\beta = 0.75$ (has positive alpha $\alpha_L > 0$)
 - ▶ Short \$... stock portfolio $\beta = 1.5$ (has negative alpha $\alpha_S < 0$)
 - ▶ Short \$... risk-free asset

Application of Flat SML to Asset Management



Construct a long-short portfolio with zero beta and positive alpha

- Buy low-beta stocks / short-sell high-beta stocks
- For instance, zero-cost portfolio
 - ▶ Long \$2 stock portfolio $\beta = 0.75$ (has positive alpha $\alpha_L > 0$)
 - ▶ Short \$1 stock portfolio $\beta = 1.5$ (has negative alpha $\alpha_S < 0$)
 - ▶ Short \$1 risk-free asset

⇒ Portfolio's beta: $2 \times 0.75 - 1 \times 1.5 = 0$

Portfolio's alpha: $2 \times \alpha_L - 1 \times \alpha_S > 0$

- So-called **betting against beta**

Application of Flat SML to M&A

- In an M&A deal, both sides are advised by investment bankers, who use CAPM to value the target



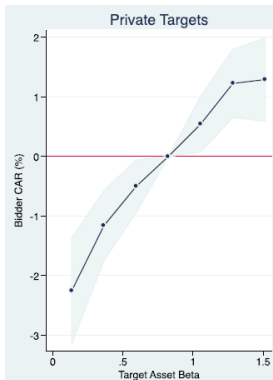
A low-beta target will be **over-valued** or **under-valued** relative to the market price?

Application of Flat SML to M&A

- In an M&A deal, both sides are advised by investment bankers, who use CAPM to value the target
 - ▶ A low-beta target will be over-valued relative to the market price
 - ▶ A high-beta target will be under-valued relative to the market price
- ⇒ CAPM-based offer price will be too high for low-beta targets / too low for high-beta targets, relative to market valuation
- What is the impact for the acquirer?

Stock Market Reaction to M&A

- Acquirer's stock price reaction to M&A announcement⁷



- Valuation mistakes ~20% of deal values



How come CAPM is still being used so widely?

- Read more at <https://johanhombert.github.io/blog/20201025-capm-mna>

⁷Dessaint, Olivier, Otto and Thesmar, 2021, CAPM-Based Company (Mis)valuations, *Review of Financial Studies* [pdf]

Fixing CAPM #3

Explanation #3: CAPM is not a good model

- Possible fix 1: use comparables
 - ▶ Corporate valuation/M&A: use comparable transaction multiples
 - ▶ Capital budgeting: implied cost of capital from comparable firms⁸
- Possible fix 2 (asset management): multi-factor models

⁸Hommel, Landier and Thesmar, 2023, Corporate Valuation: An Empirical Comparison of Discounting Methods, *Working Paper* [\[pdf\]](#)

To be continued...

Until next week: practice problem on BB

See you next week!

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