# *Corporate Financial Management 2*

*Event Study*

*Summer term 2023*

*<u>Instructor</u>:*
*Univ.-Prof. Dr. A. Schertler*

# This course has two parts



## Event study

*Content*

-Empirically evaluate corporate decisions

-Statistical tests

Helps formulating expectations on how company news affect firm value

MacKinlay, C. 1997, Event studies in economics and finance, *Journal of Economic Literature*, 35, 13-39.

## Theoretical Corporate Finance

*Content*

-Tax effects

-Conflicts between debt and equity holders

-Managerial incentives

**Asynchronous learning**

**→ CF1 Taxes**

**→ CF2 Agency problems**

**→ CF3 Management**

**Assignment 2**
trains theoretical thinking

Berk and DeMarzo, Corporate Finance, Global Edition. Especially part V.

# DELIVERIES AND GRADING



| | Assignment 1 | Assignment 2 |
|---|---|---|
| Deliveries via Moodle | a. Dates & prices<br>b. Excel file<br>c. Report with your research results (1500 words)<br>d. Oral contributions | a. Hand-written solutions to exercises<br>b. Oral contributions to theory discussions |
| Hand-in dates | Deliveries a: **June 4, 2023**<br>Deliveries b+c: **July 1, 2023** | See next slide |
| Grade weight | 60% | 40% |

Important hints:

- Students can work in teams of two students (select a team mate from today's exercises)!
- You are not allowed to use installed program packages. I want to see how you calculate abnormal returns, variances and test statistics.

# TIME TABLE AND DELIVERY DATES



| Date | Event Study | Theory (upload solution on …) |
|---|---|---|
| May 8 | The big picture | |
| May 15 | How to calculate normal returns<br>Ass1: Select event type<br>Read MacKinlay (1997) | CF1 |
| May 22 | How to test<br>Ass1: Collect 50 events<br>Summarize relevant research papers | CF2<br>Ass2: Ex A (May 20) |
| June 5 | Questions<br>Ass1: Complete dataset (stock & market prices) | Ass2: Ex B (June 3) |
| June 12 | How to structure<br>Ass1: Calculate CAAR | CF3<br>Ass2: Ex C (June 10) |
| June 26 | Questions | Ass2: Ex D (June 24) |
| June 28 | Questions | Ass2: Ex E (June 26) |

Important hints:

- Every student will be graded according to the same criteria. There will be no special rules or exemptions for incoming (exchange) or local students.
- There will be no chance for extra work at the end of the course to make up for a lack of participation in class.

## Content

1. The big picture: How to carry out an event study
2. Return calculation and data sources
3. AR, CAR and models to predict normal returns
4. Statistical tests
5. How to structure your report
6. Extensions

# Consider the following company news….

TECH

## Amazon announces 20-for-1 stock split, $10 billion buyback

PUBLISHED WED, MAR 9 2022•4:42 PM EST | UPDATED THU, MAR 10 2022•6:59 AM EST

C.E.O. Fired Over a Relationship ...
nytimes.com

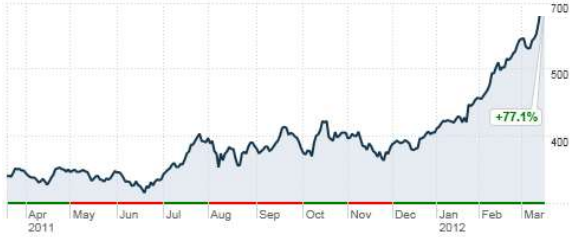

TECHNOLOGY NEWS FEBRUARY 14, 2020 / 3:58 AM / 2 MONTHS AGO

## Tesla to recall 3,183 Model X vehicles in China: market regulator

## Apple announces dividend and stock buyback

By David Goldman @CNNMoneyTech March 19, 2012: 4:23 PM ET

Apple Inc.




https://www.capital.de/wirtschaft-politik/fusion-von-deutscher-bank-und-commerzbank-ist-gescheitert

## … and answer the following questions



- **How** will shareholders value the new information?
- **What** do you expect to happen to the stock price of the company and to its competitors? Explain your answer!
- **Why** is it relevant to know how the stock price responds to these company news?

# 1. The big picture: How to carry out an event study



## What is an event study?

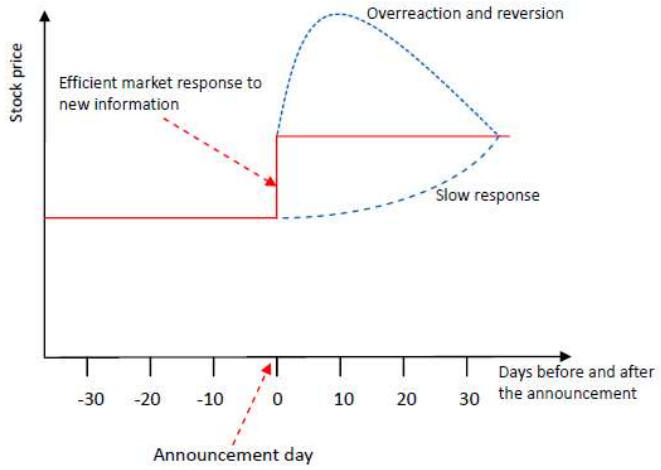


- A test that attempts to measure the price response around the announcement day when company news are released
- Price response can be studied for stock prices, bond prices, CDS spreads, trading volume, …
- Effects of company news on firm value can only be measured if the stock market is **informationally efficient**.
- An event study has the purpose to determine how a proposed company policy (dividend change, acquisition, …) is valued by the investors (shareholders, bondholders, ...).

# Informationally efficient capital markets (1)



- Assume that a company develops a major innovation to one of its products. The company believes that this innovation has positive NPV
- How does its stock price react to the public announcement?




Idea of informationally efficient capital markets:

- the price instantaneously adjusts to and fully reflects new information
- there is no tendency for subsequent increases or decreases (due to this specific new information)

# Informationally efficient capital markets (2)



- Definition (Market Efficiency):

  A market is efficient if all available information is reflected in stock prices

- General argument
  - If information could be used to predict a future price change, then this information should lead to a price change today
  - In case of favorable information, investors want to buy the stock to profit from future gains, which increases the price today to the fair level

# Informationally efficient capital markets (3)



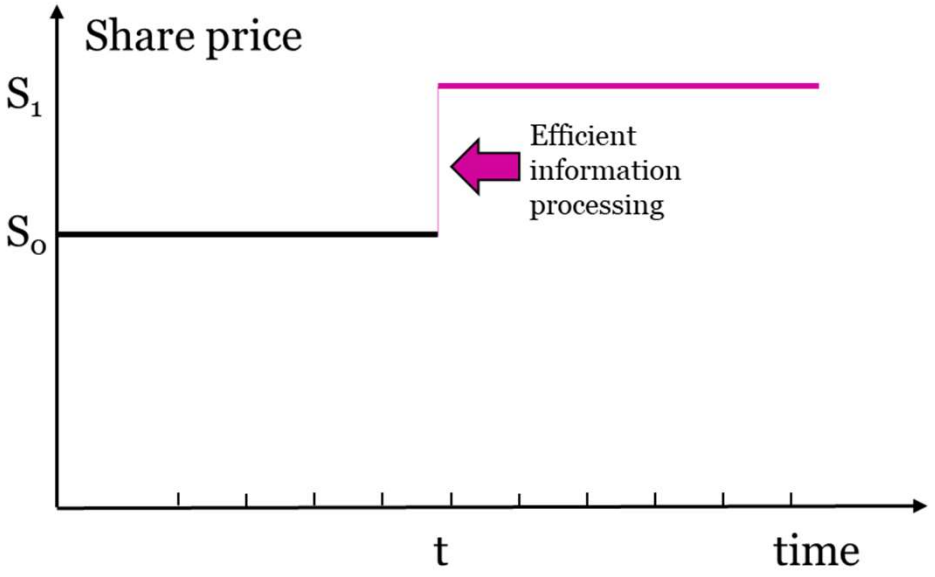
Forms of efficiency

- Weak market efficiency: Stock prices reflect all information from past market trading data (prices, trading volume,. . . )
- Semi-strong market efficiency: Stock prices reflect all **publicly available information** about a firm (also fundamental data like quality of management, balance sheet composition, earnings forecasts, . . . )
- Strong market efficiency: Stock prices reflect all **public and private information** relevant to the firm (including information only available to company insiders

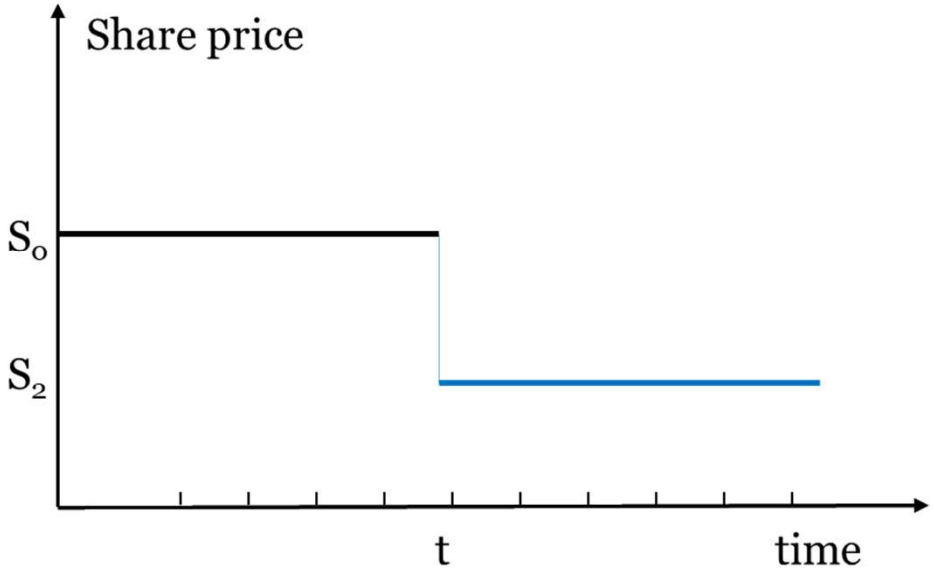
# Informationally efficient capital markets (4)



Positive information




Negative information



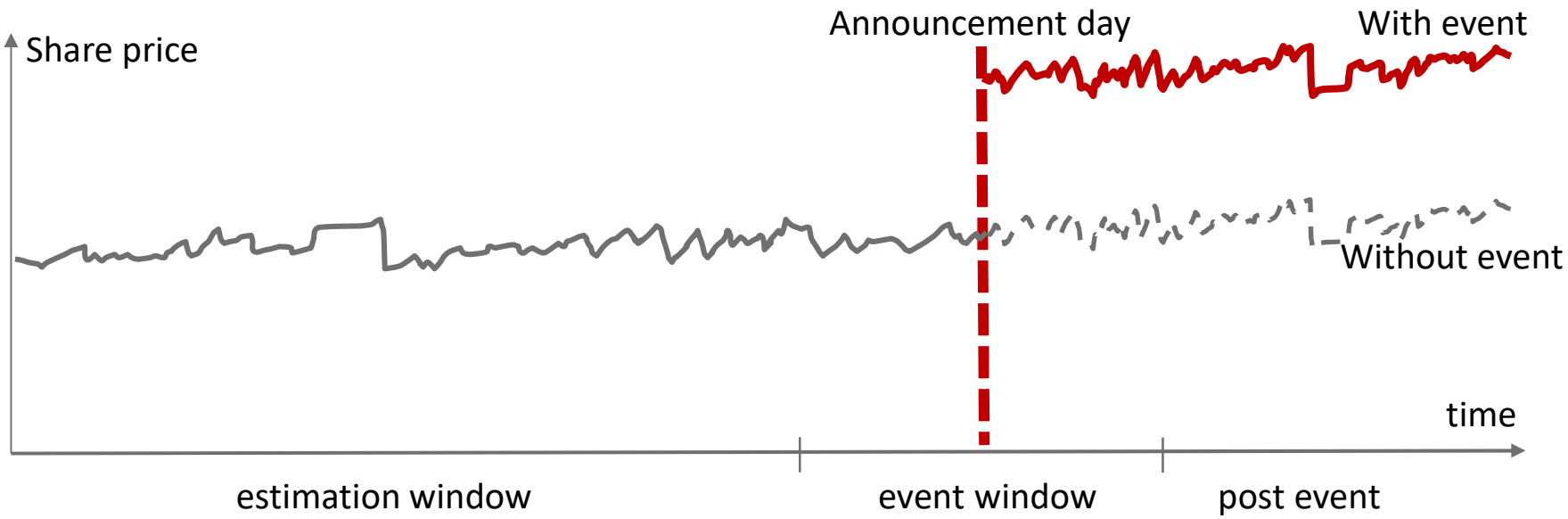
# Informationally efficient capital markets (5)



- Is the announcement of AC wellness positive or negative information for Apple's shareholders?
- Positive information
  - Apple's investment reduces shortage in health care and therefore increases productivity of Apple's employees (it is a project with positive Net Present Value - NPV).
- Negative information
  - Apple could collect, store and use data in an inappropriate way, which may destroy firm value.
  - It could be a prestige project (NPV<0)

# How to measure the effect (1)






Abnormal return $AR_{APPLE} = R_{APPLE} - E(R_{APPLE})$

Normal return $E(R_{APPLE}) = \alpha_{APPLE} + \beta_{APPLE} \cdot R^{Markt}$

We discuss models to predict normal returns in Section 3.

# How to measure the effect (2)



- A simple linear regression model performed on return data from the estimation window gives $\hat{\alpha}_{APPLE} = -0.024$ and $\hat{\beta}_{APPLE} = 1.42$

| Event day | Calculation | Result |
|---|---|---|
| *Apple* return | | -0.15 % |
| *Market* return | | -1.11 % |
| *Normal Apple* return | $E(R_{APPLE}) = \hat{\alpha}_{APPLE} + \hat{\beta}_{APPLE} R^{Markt}$ | -1.60 % |
| *Abnormal Apple* return | $AR_{APPLE} = R_{APPLE} - E(R_{APPLE})$ | 1.45 % |

**Can you claim this effect comes from announcing AC wellness?**

**No,**

**…**

**…**

# How to measure the effect (3)



- Event studies combine ARs of **several companies** that experience the **same type of event** at **different points in time**

| | Abnormal return |
|---|---|
| *Apple* | 1.45 % |
| *Amazon* | 2.75 % |
| *JP Morgan Chase* | 0.67 % |
| ... | ... |
| $\overline{AR}$ | 1.39 % |

Please select 50 events of the same event type for your event study

**Can you claim this effect to be different from zero?**

**No,**

**...**

**...**

## Hypothesis testing



- Is the average abnormal return different from zero?
- H0 Event has a non-postive abnormal return
  Ha Event has a positive abnormal return
- Perform a statistical test

We discuss tests in Section 4.

- In our example, we get $\theta$=1.72

# Sources to find events



- Google
- Finance yahoo
- Twitter
- Financial Newspapers (e.g. Financial Times, WSJ)
- Commercial databases (e.g. Refinitiv, Bloomberg, …)
- REFINITIV

  Access: Fakultätsbibliothek RESOWI
  https://rzblx10.uni-regensburg.de/dbinfo/detail.php?bib_id=ubg&colors=&ocolors=&lett=fs&tid=0&titel_id=11397
- …

# Tasks for next week



- Select an **event type** in which you are interested in:
  - Dividend change OR repurchase announcement, OR product recall, OR disasters OR CEO dismissal OR new sustainable strategy OR M&A OR …
- Start to collect 50 events

  (date, ISIN or other company identifier)
- Produce a sheet containing information on your event firms

| Name | ISIN | Date | Market | Y | X |
|---|---|---|---|---|---|
| Deutsche Bank | DE0005140008 | | DE | | |
| ABN | NL0011540547 | | NL | | |
| ….. | | | | | |
| | | | | | |

## Second exercise in groups



- Consider the following examples and decide on whether an event-study set up is a good choice

1. Covid-19 workplace closure in Austria
2. Anti-money laundering infractions of banks
3. Election of Trump
4. Announcement that vaccine has passed development stage
5. Monetary policy change by central banks
6. Fraud detection in manufacturing firms

# 2. Return calculation and sources



- Consider Allianz

**Allianz SE (ALV.DE)**
XETRA - XETRA Delayed Price. Currency in EUR

Add to watchlist

**218.45** +2.10 (+0.97%)
As of 10:13AM CEST. Market open.

Plus500 76.4%

Summary | Chart | Conversations | Statistics | Historical Data

| | | | |
|---|---|---|---|
| Previous Close | 216.35 | Market Cap | 90.032B |
| Open | 217.70 | Beta (5Y Monthly) | 1.34 |
| Bid | 218.45 x 214900 | PE Ratio (TTM) | 13.40 |
| Ask | 218.45 x 10000 | EPS (TTM) | 16.32 |
| Day's Range | 217.50 - 219.20 | Earnings Date | May 11, 2021 |
| 52 Week Range | 139.78 - 221.10 | Forward Dividend & Yield | 9.60 (4.44%) |
| Volume | 149,307 | Ex-Dividend Date | May 05, 2021 |
| Avg. Volume | 1,004,059 | 1y Target Est | 213.69 |

https://finance.yahoo.com/

Currency in EUR

| Date | Open | High | Low | Close* | Adj Close** |
|---|---|---|---|---|---|
| May 11, 2020 | 159.00 | 159.24 | 154.64 | 156.32 | 156.32 |
| May 08, 2020 | 159.02 | 159.52 | 156.62 | 157.68 | 157.68 |
| May 07, 2020 | 154.48 | 158.32 | 153.50 | 157.00 | 157.00 |
| May 07, 2020 | | | **9.6** Dividend | | |
| May 06, 2020 | 164.80 | 167.84 | 161.42 | 161.42 | 151.82 |
| May 05, 2020 | 165.40 | 166.60 | 162.32 | 163.36 | 153.64 |
| May 04, 2020 | 165.00 | 165.62 | 162.16 | 162.76 | 153.08 |
| Apr 30, 2020 | 176.20 | 177.40 | 168.88 | 168.88 | 158.84 |

*Close price adjusted for splits. **Adjusted close price adjusted for both dividends and splits.

- How to calculate the stock return?

## Return calculation



- Discrete return of a dividend paying stock:

$$r = \frac{Div_1 + P_1}{P_0} - 1 = \underbrace{\frac{Div_1}{P_0}}_{\substack{dividend \\ yield}} + \frac{P_1 - P_0}{P_0},$$

where $P_0$ is the stock price today, $P_1$ is the stock price in one year from now, $Div_1$ is the dividend paid within the next year.

- The price series of a single stock (and index) have to be adjusted for dividends and stock splits!

## Databases for stock prices (1)



- Finance yahoo
- Adjusted close is reported in “Historical data”
- Keep a eye on the currency and avoid mismatches in this respect!

# Databases for stock prices (2)



- Finance professionals use commercial databases, such as

  REFINITIV

- Two possibilities to get stock prices
  - EIKON
    time series with split-adjusted stock prices PLUS
    another series with the dividend
  - DATASTREAM
    possibility to download split- and dividend-adjusted stock prices (select the type RI)
- Access: Fakultätsbibliothek RESOWI
  https://rzblx10.uni-regensburg.de/dbinfo/detail.php?bib_id=ubg&colors=&ocolors=&lett=fs&tid=0&titel_id=11397

# 3. AR, CAR and models to predict normal returns



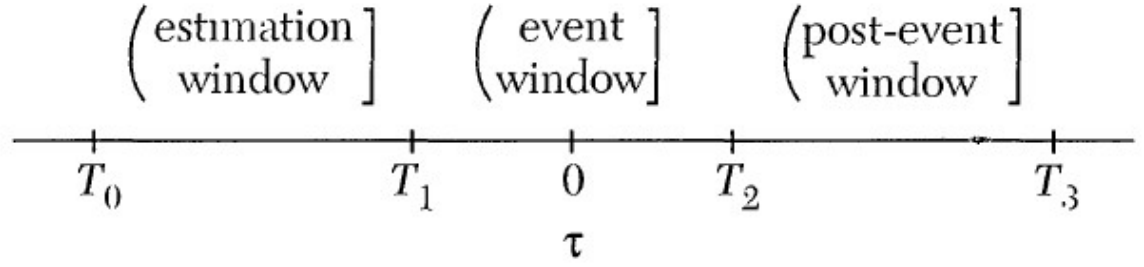



*Figure* 1. Time line for an event study.

- τ=0 is the announcement date in **event time**.
- The interval T0 to T1 is the **estimation window**. It contains **L1** return observations.
- The interval T1 to T2 is the **event window**. It may start 10 days before and may end 10 days after the announcement.

## Abnormal returns



- Abnormal returns are the difference between a company's actual return and the predicted return on the announcement day (or on another day in the event window)
- How to predict normal returns?
  - Factor models
  - Constant mean return model
  - Capital Asset Pricing Model

# 1-factor model (1)



- A 1-factor model considers only one factor to explain a company's returns: $R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it}$
- $\alpha_i$ and $\beta_i$ are determined on return data from the estimation window
- A **simple** ordinary least square (OLS) regression delivers explicit solutions:

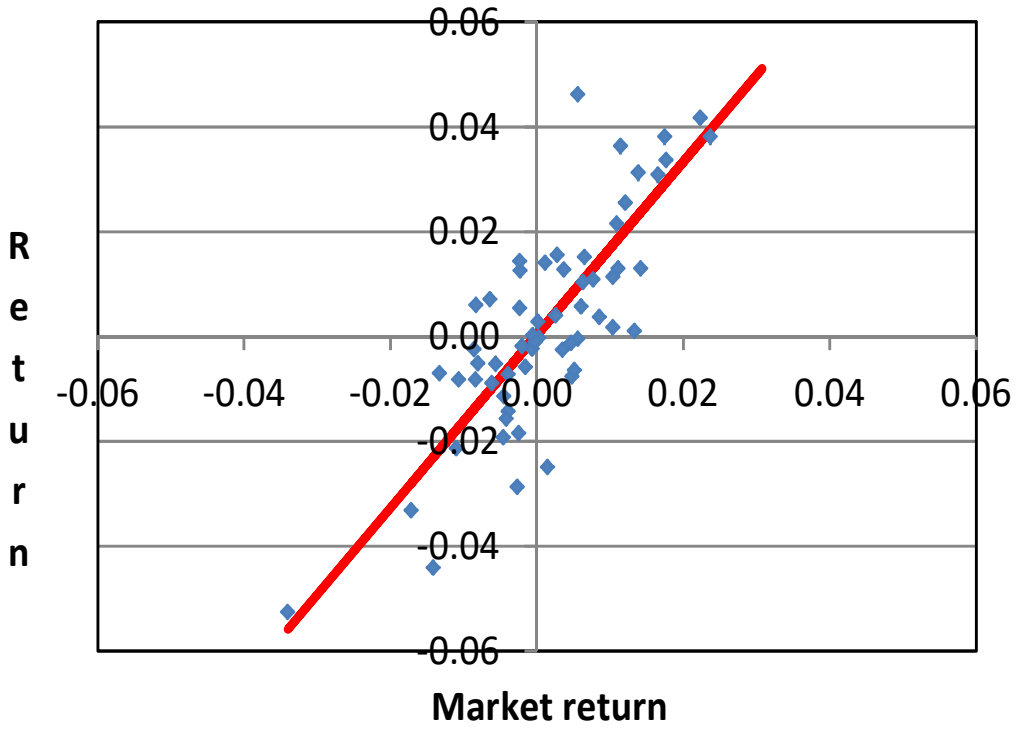
$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1} (R_{i\tau} - \hat{\mu}_i)(R_{m\tau} - \hat{\mu}_m)}{\sum_{\tau=T_0+1}^{T_1} (R_{m\tau} - \hat{\mu}_m)^2}$$

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i \hat{\mu}_m$$

# 1-factor model (2)



- Using OLS we get:




$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1} (R_{i\tau} - \hat{\mu}_i)(R_{m\tau} - \hat{\mu}_m)}{\sum_{\tau=T_0+1}^{T_1} (R_{m\tau} - \hat{\mu}_m)^2}$$

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i \hat{\mu}_m$$

# 1-factor model (3)



- The abnormal return on the event day $\tau$ is then:

$$AR_{i\tau} = R_{i\tau} - (\hat{\alpha}_i + \hat{\beta}_i R_{M\tau})$$

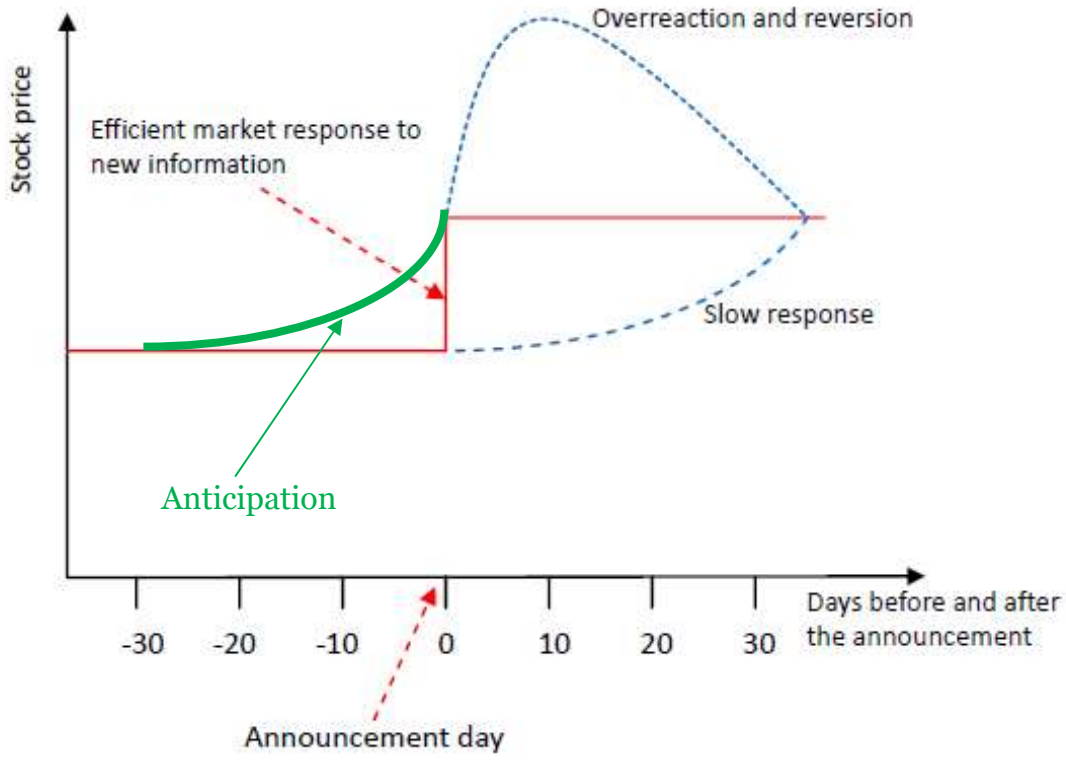
- Hints:
  - the actual return of the company ($R_{i\tau}$) and the return of the market ($R_{M\tau}$) are measured on the same day in the **event window**
  - The parameters $\hat{\alpha}_i$ and $\hat{\beta}_i$ are determined with return data from the **estimation window**

# Cumulative abnormal returns (CARs)



- Does the stock price react only on the announcement day?
- Cumulative abnormal return (CAR) cumulates AR over several days:

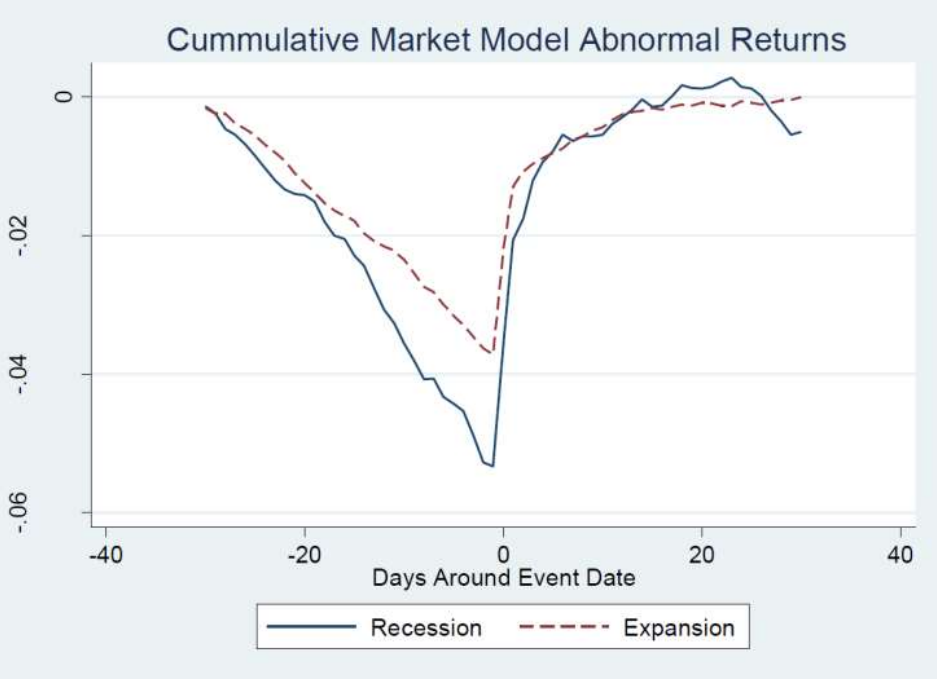
$$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau}.$$



# Cumulative abnormal returns (CARs) (2)

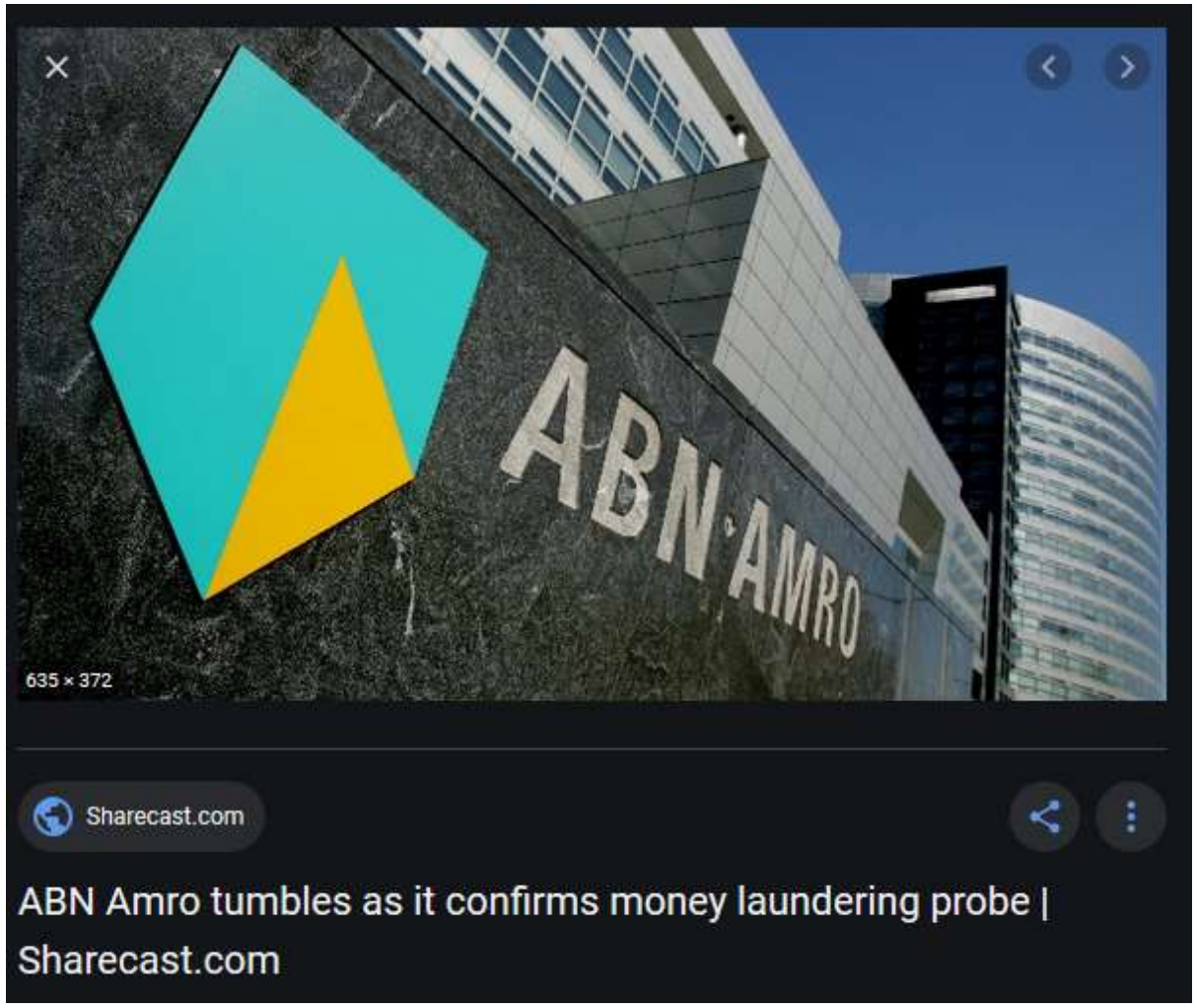


- A CAR plot allows us to see anticipation, slow response and reversion in the abnormal returns



# Students' example (1)






**Let's study ABN's money laundering event**

**Use StudentData and**

1) **determine $\alpha$ and $\beta$**
2) **calculate the AR**
3) **calcuate CAR from -10 to +10**
4) **interpret your CAR graph**

26-Sep-19

# Students' example (2)



- Align ABN returns with market returns in calendar time!

| Code | NL0011540547(RI)~U$ |
|---|---|
| 1/1/2018 | 199.67 |
| 1/2/2018 | 199.84 |
| 1/3/2018 | 199.26 |
| 1/4/2018 | 201.99 |

| Code | TOTMKNL(RI)~U$ |
|---|---|
| 1/7/2020 | 11558.4 |
| 1/6/2020 | 11535.34 |
| 1/3/2020 | 11572.37 |
| 1/2/2020 | 11682.89 |

- Excel's **index function** may help:

  INDEX(array, MATCH(lookup_value,lookup_array, type))

  **array:** the values that you want to match, i.e. *market returns*,

  **lookup_value:** the information used for matching, i.e. *the date*

  **lookup_array**: the information used for matching, i.e., *dates*

  **type**: approximate or exact matching

- Press F4 to fix a cell (the $ sign will be inserted)

# Students' example (3)



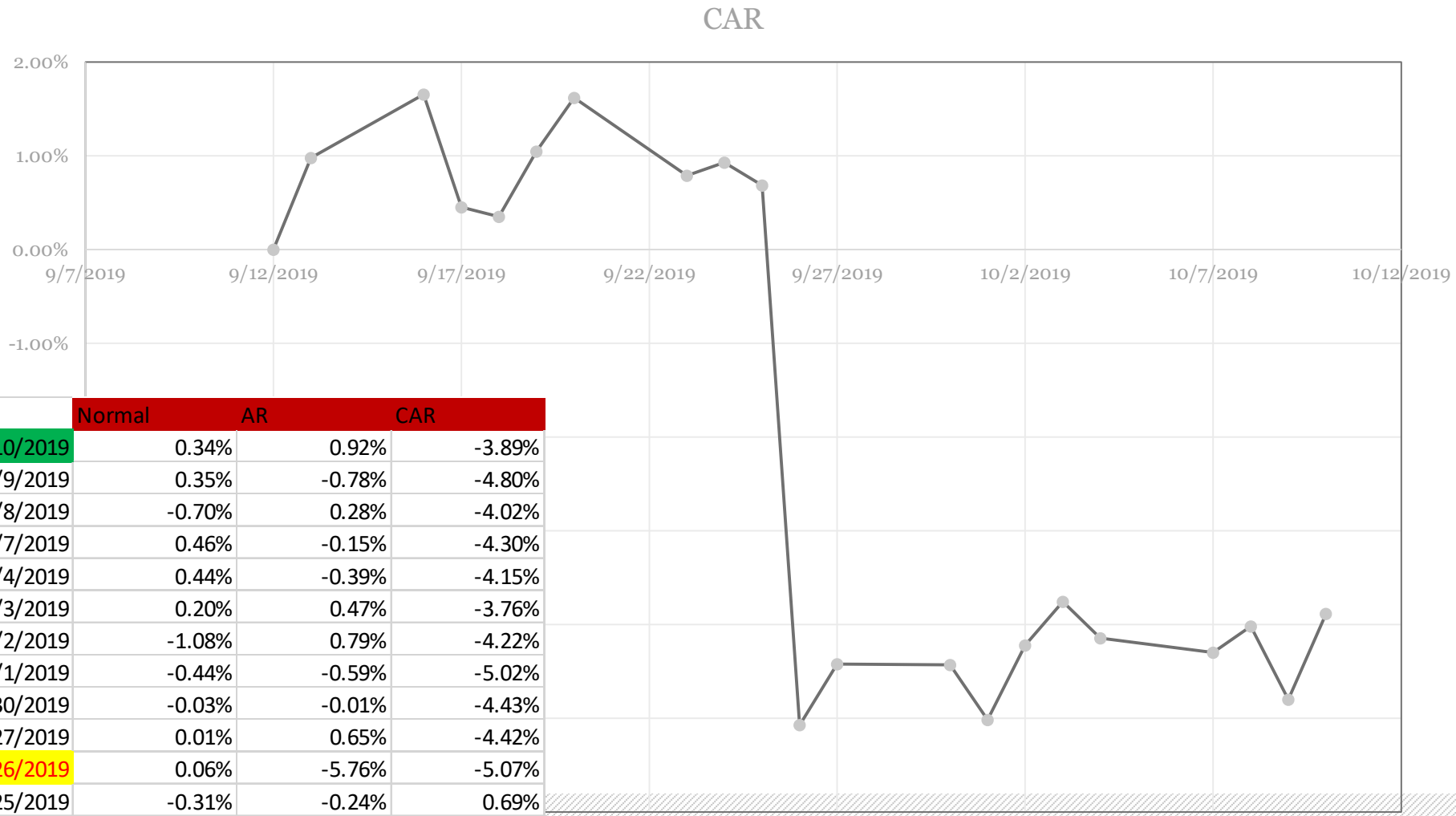
- Use the estimation window to calculate parameters

| CALCULATE PARAMETERS | | Excel function |
|---|---|---|
| alpha | -0.0003 | =INTERCEPT |
| beta | 1.0312 | =SLOPE |
| r2 | 0.3513 | =Rsq |
| Standard dev | 0.0054 | =STEYX |

- **Please check**:
  - (average) alpha has to be close to zero,
  - beta will be between -0 and 2.

# Students' example (4)






| | Normal | AR | CAR |
|---|---|---|---|
| 10/10/2019 | 0.34% | 0.92% | -3.89% |
| 10/9/2019 | 0.35% | -0.78% | -4.80% |
| 10/8/2019 | -0.70% | 0.28% | -4.02% |
| 10/7/2019 | 0.46% | -0.15% | -4.30% |
| 10/4/2019 | 0.44% | -0.39% | -4.15% |
| 10/3/2019 | 0.20% | 0.47% | -3.76% |
| 10/2/2019 | -1.08% | 0.79% | -4.22% |
| 10/1/2019 | -0.44% | -0.59% | -5.02% |
| 9/30/2019 | -0.03% | -0.01% | -4.43% |
| 9/27/2019 | 0.01% | 0.65% | -4.42% |
| 9/26/2019 | 0.06% | -5.76% | -5.07% |
| 9/25/2019 | -0.31% | -0.24% | 0.69% |
| 9/24/2019 | 0.05% | 0.14% | 0.93% |
| 9/23/2019 | -0.42% | -0.83% | 0.79% |

## Constant Mean Return Model



- Very simple model with

  $R_{it} = \mu_i + \varphi_{it}$ where $\mu_i$ is the mean return of security i,

  with

  $\mathrm{E}(\varphi_{it}) = 0$ and $\mathrm{var}(\varphi_{it}) = \sigma^2_{\varphi_i}$

- It often produces similar results than more complex models

# Capital asset pricing model



- Starting point is the Capital Asset Pricing Model.
- What is this model about?
- The SML (security market line) can be applied to predict normal returns

  $R_{it} = R_f + \beta_i(R_{Mt} - R_f)$
- However, recent literature has shown that restrictions imposed by the CAPM are questionable.

# Cumulative average abnormal returns (CAARs)



- One single company is not enough …
- Why?
- **Average abnormal returns** of several events of the same event type:

$$AAR_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau}$$

- These average abnormal returns can be again cumulated

$$\text{CAAR}[\tau_1, \tau_2] = \frac{1}{N}\sum_{i=1}^{N} CAR_i\,[\tau_1, \tau_2]$$

# How to organize your excel file with many events



- Bring data in event time:

  0 is the announcement day

  +1/-1 on the day after/before the announcement day

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Company ID | 1 | 2 | ... | |
| 2 | Market | NETH | GER | ... | |
| 3 | INTERCEPT | | | | |
| 4 | SLOPE | | | | |
| 5 | SD | | | | |
| 6 | *Event time* | | | | |
| 7 | 10 | 0.00037 | 0.01347 | | |
| 16 | 1 | 0.00867 | -0.00154 | | |
| 17 | 0 | -0.00412 | 0.00563 | | |
| 18 | -1 | -0.00251 | -0.00230 | | |
| 19 | -2 | 0.00253 | -0.00595 | | |
| 20 | -3 | -0.00769 | 0.00145 | | |
| 21 | -4 | 0.00188 | -0.00468 | | |
| 22 | -5 | -0.00342 | 0.00268 | | |
| 268 | -251 | -0.00313 | -0.00429 | | |
| 269 | -252 | 0.00501 | 0.00335 | | |
| 270 | | | | | |
| 271 | **Market** | | | | |
| 272 | 10 | 0.00122 | 0.01204 | | |
| 281 | 1 | 0.00470 | -0.00006 | | |
| 282 | 0 | -0.00143 | 0.00721 | | |
| 283 | -1 | 0.00151 | 0.00042 | | |
| 284 | -2 | 0.00271 | -0.00215 | | |
| 285 | -3 | 0.00216 | 0.00256 | | |
| 286 | -4 | 0.00196 | 0.00202 | | |
| 287 | -5 | 0.00154 | 0.00651 | | |
| 533 | -251 | -0.00517 | -0.00139 | | |
| 534 | -252 | -0.00449 | 0.00087 | | |

## Tasks for next week



- Find relevant research articles (**discuss them in class!**) and explain the link between the corporate news and firm value

- Collect all relevant data (event information, stock returns, market returns):
  - Use stock prices adjusted for dividends and stock splits
  - Use performance (and not price) indices of markets

# Where to find research articles?



- Library
  https://unikat.uni-graz.at/primo-explore/search?vid=UGR

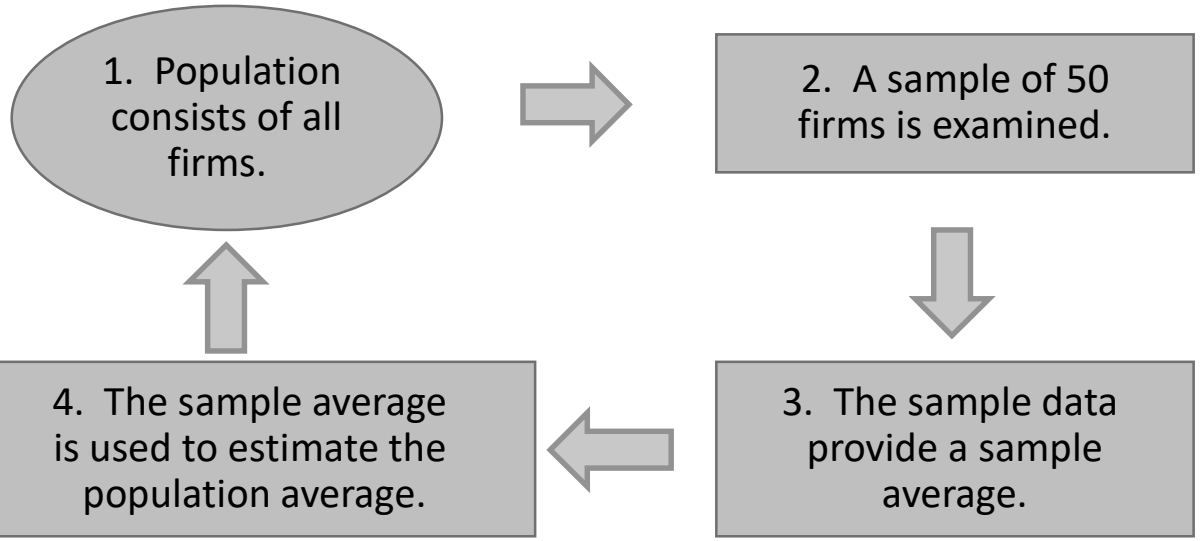
- Google scholar is an alternative


- Check the quality of the journal in which the article is published:
  https://vhbonline.org/fileadmin/user_upload/JQ3_BAFI.pdf
  Eg. von Eije and Megginson. Dividends and share repurchases in the European Union, Journal of Financial Economics, Volume 89, Issue 2, 2008.

## Hypothesis testing (1)

- Hypothesis testing can be used to determine whether a statement about the value of a population parameter should or should not be rejected

Population: the set of all elements of interest in a particular study




Sample: a subset of the population

With **proper sampling methods**, the sample results can provide "**good**" estimates of the population characteristics

# Hypothesis testing (2)



- $H_0$ (null hypothesis) is a tentative assumption
- $H_1$ (alternative hypothesis) is what the test is attempting to establish

| Lower-tail test | Upper-tail test | Two-tailed test |
|---|---|---|
| H0: AAR≥0<br>H1: AAR<0 | H0: AAR≤0<br>H1: AAR>0 | H0: AAR=0<br>H1: AAR≠0 |

- The null and alternative hypotheses are competing statements (only one is true)
- The test needs the **level of significance** a (usually 1% or 5%)

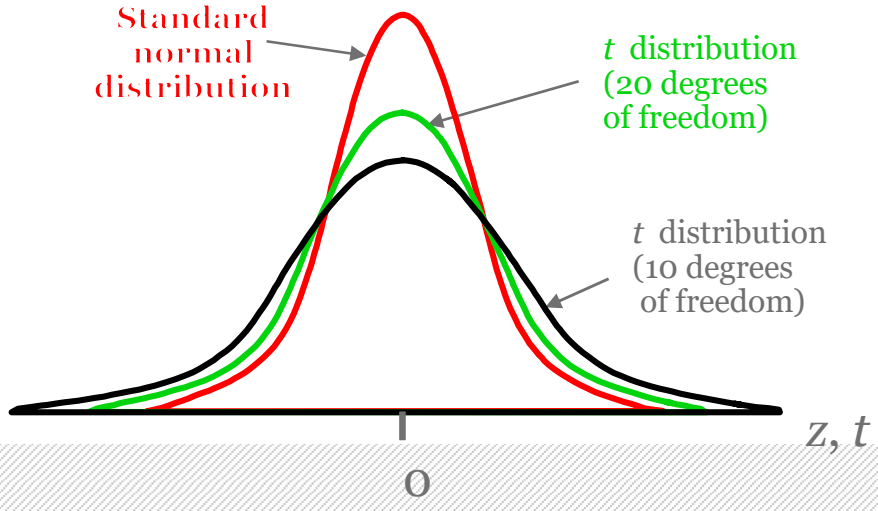
# Hypothesis testing (3)



- Compute the **test statistic** from sample data:

$$t = \frac{AAR}{var(AAR)^{0.5}}$$

- A specific *t* distribution depends on a parameter known as the degrees of freedom (*df*) that refers to the number of independent pieces of information that go into the computation of *s*

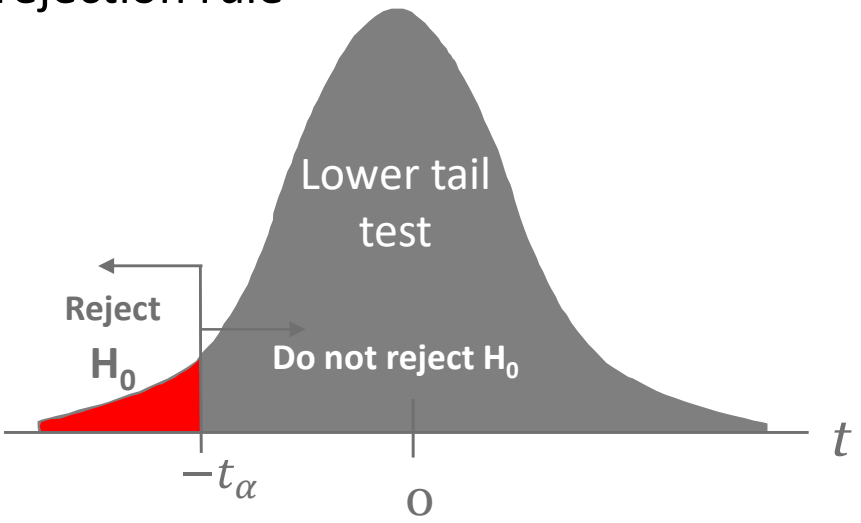


# Hypothesis testing (4)



- Determine the critical value and the rejection rule

| Critical t values (with large df) | | |
|---|---|---|
| a | Left/right | Two tails |
| 5% | -/+1.67 | -2.04,2.04 |
| 1% | -/+2.46 | -2.75,2.75 |




| | Lower tail | Upper tail | Two tails |
|---|---|---|---|
| Hypothesis | $H_0$: AAR≥0<br>$H_1$: AAR<0 | $H_0$: AAR≤0<br>$H_1$: AAR>0 | $H_0$: AAR=0<br>$H_1$: AAR≠0 |
| Reject $H_0$ if | $t \leq -t_a$ | $t \geq t_a$ | $t \leq -t_{a/2}$ or if $t \geq t_{a/2}$ |

# Type I and II errors (1)



- Because hypothesis tests are based on sample data, we must allow for the possibility of errors

| | Population Condition | |
|---|---|---|
| **Conclusion** | **$H_0$ True** | **$H_0$ False** |
| **Accept $H_0$** | Correct decision | Type II error |
| **Reject $H_0$** | Type I error | Correct decision |

- The probability of making a Type I error when the null hypothesis is true as an equality is called the **level of significance**

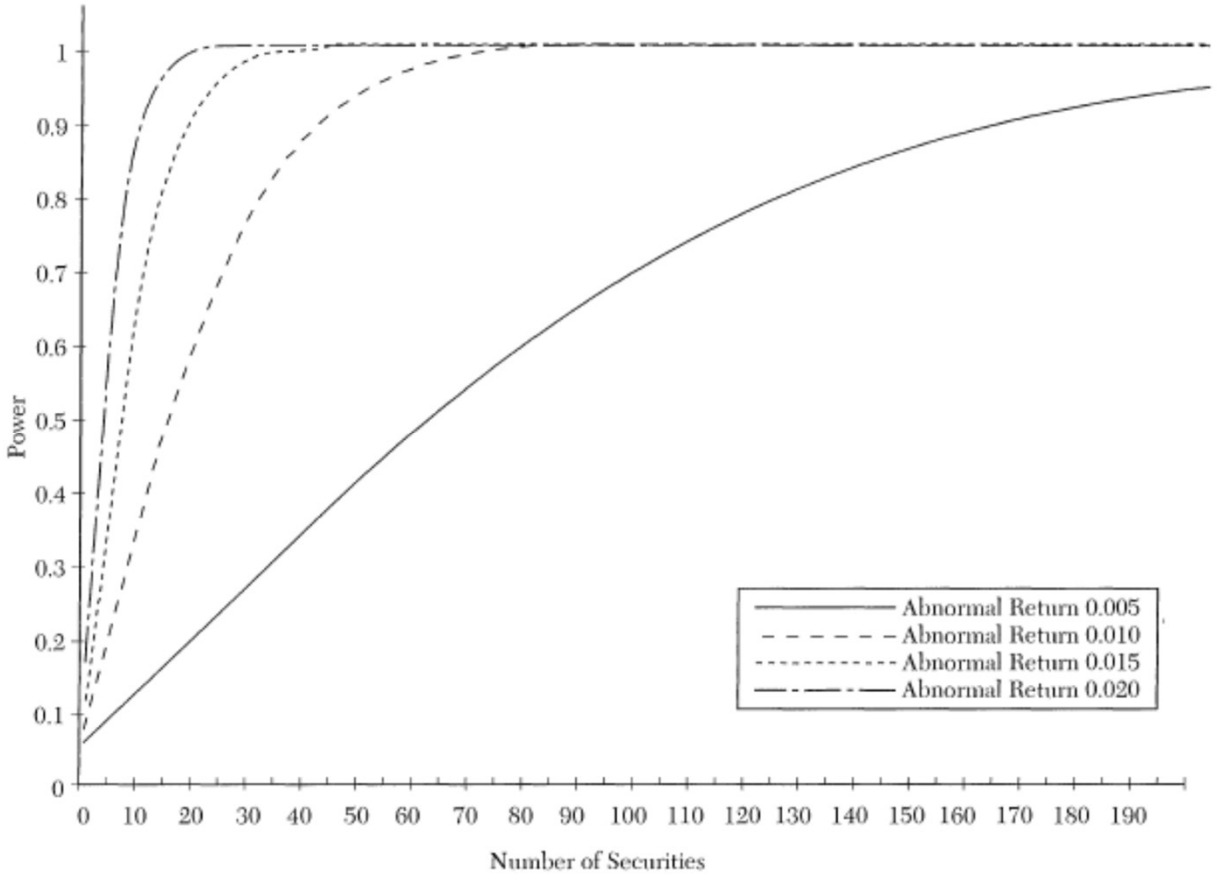
## Type I and II errors (2)



- What do we do with the Type II error?
- **Type II error:**
  Failing to reject the null hypothesis ($AAR = 0$) when the alternative ($AAR \neq 0$) is true
- Tests differ with respect to their ability to detect non-zero average abnormal returns (**power of the test**)

# Type I and II errors (3)

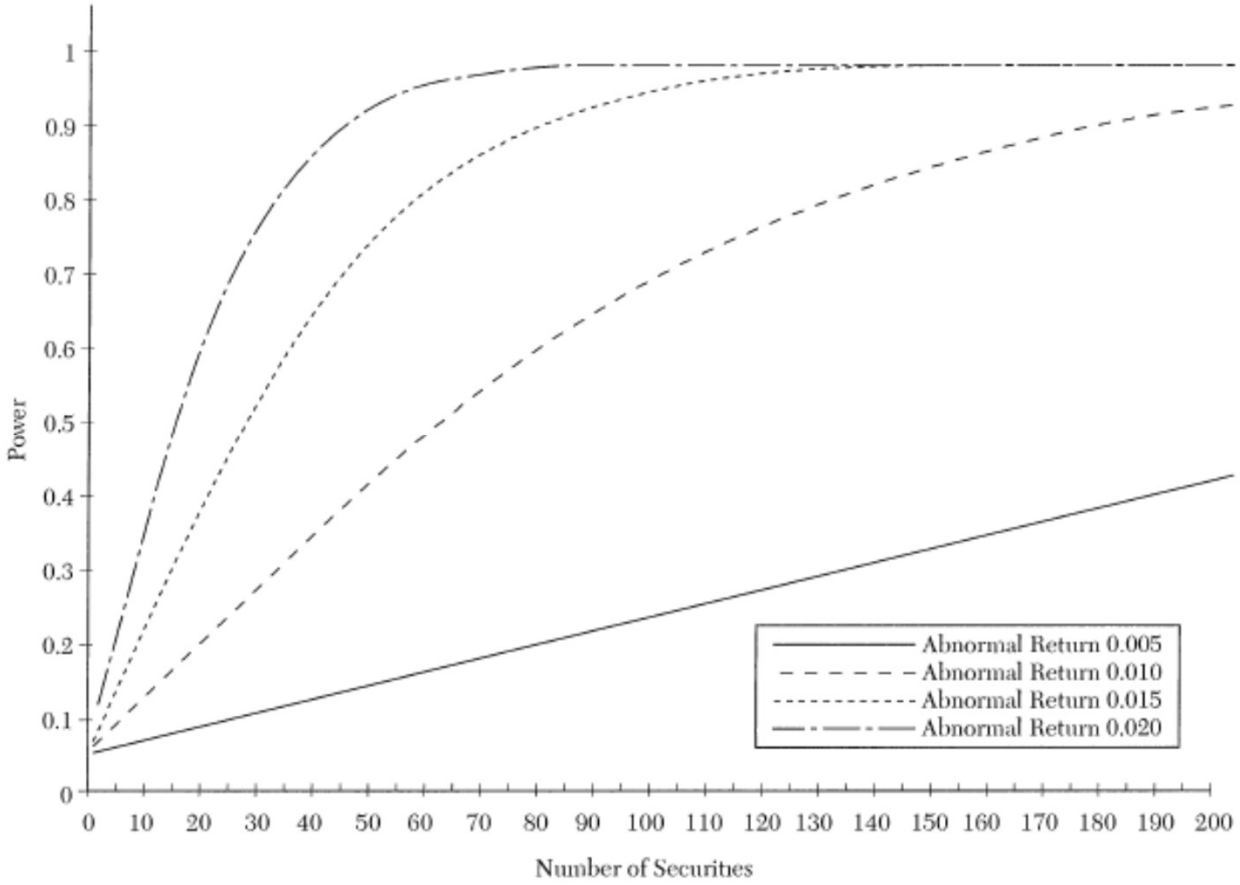





Power of the event study test statistics to reject the null (AAR=0), when the square root of the average variance of AR across firms is **2 percent**

# Type I and II errors (4)






Power of the event study test statistics $\theta 1$ to reject the null (AR=0), when the square root of the average variance of AR across firms is **4 percent**

**What does this mean for your work?**

# Inputs for the test statistics (1)



- Test whether average abnormal returns differ from zero:

$$t = \frac{AAR}{var(AAR)^{0.5}}$$

- AAR is given by $AAR_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau}$
- What about the denominator $var(AAR)^{0.5}$?
  - $var(AAR) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_i^2$
  - $\hat{\sigma}_i^2 = \frac{1}{L_1-2}\sum_{\tau=T_0+1}^{T_1}(R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau})^2$

| CALCULATE PARAMETERS | | Excel function |
|---|---|---|
| alpha | -0.0003 | =INTERCEPT |
| beta | 1.0312 | =SLOPE |
| r2 | 0.3513 | =Rsq |
| Standard dev | 0.0054 | =STEYX |

# Inputs for the test statistics (2)



- Test whether **cumulative average abnormal returns** differ from zero:

$$t = \frac{CAAR[\tau_1, \tau_2]}{var(CAAR[\tau_1, \tau_2])^{0.5}}$$

- Cumulative average abnormal returns are $\text{CAAR}[\tau_1, \tau_2] = \frac{1}{N}\sum_{i=1}^{N} CAR_i\,[\tau_1, \tau_2]$
- What about $var(CAAR[\tau_1, \tau_2])^{0.5}$?
  - $var(CAAR[\tau_1, \tau_2]) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_i^2[\tau_1, \tau_2]$
  - $\hat{\sigma}_i^2[\tau] = \frac{1}{L_1-2}\sum_{\tau=T_0+1}^{T_1}(R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau})^2$ measured for 1 day!
  - $\sigma_i^2[\tau_1, \tau_2] = (\tau_2 - \tau_1 + 1)\hat{\sigma}_i^2[\tau]$ adjusted to the length of your CAAR

- Parametric tests, such as a t-test are
  - more powerful to detect AAR than non-parametric tests
  - based on normal distribution, which the data may not meet.
- Test whether returns in the estimation window are normally distributed

  → Jarque–Bera test

$$JB = \frac{n}{6}\left(S^2 + \frac{K^2}{4}\right) \sim \chi^2_{\nu=2}()$$

| JB test | | Excel function |
|---|---|---|
| n | 443 | =COUNT |
| Skewness | -0.511 | =SKEW |
| Ex kurtosis | 0.851 | =KURT |
| JB test | 19.278 | |
| p-value of Chi2 | 0.00007 | =CHISQ.DIST.RT |

where S denotes the sample skewness,
K is the sample excess kurtosis, and
n is the number of non-missing return observations.

- If normality is in doubt, additionally use non-parametric tests

- Excel functions to get

| **a probability** | **z/t-value** |
|---|---|
| NORM.DIST | NORM.INV |
| T.DIST.2T(t,df) | T.INV.2T(prob;df) |
| T.DIST.RT(t,df) | T.INV(prob;df) |
| T.DIST(t, df, cum) | |

- Add significance level in Excel:

  =IF(ABS(t-value)>1.96, "**", "")

## Non-parametric event-study test



- Cowan generalized sign test: # of positive ARs in the event window equals the percentage of positive ARs in an estimation window
- Test statistic (when Ha >0)

$$Z_G = \frac{w - n\hat{p}}{\left[n\hat{p}\left(1-\hat{p}\right)\right]^{\frac{1}{2}}}$$

w is the # of stocks in the event window for which the CAR is positive; n is the # stocks

$$\hat{p} = \frac{1}{n}\sum_{j=1}^{n}\frac{1}{100}\sum_{t=E_1}^{E_{100}} S_{jt}, \quad \text{and} \quad S_{jt} = \begin{cases} 1 & \text{if } AR_{jt} > 0 \\ 0 & \text{otherwise} \end{cases}$$

E1 through E10 is the start and end date of the parameter estimation period (here 100!)

Cowan. 1992. Nonparametric event study tests. *Rev Quant Finan Acc* **2,** 343–358

# Tasks for next week



- Present your data
  - sample statistics of events,
  - returns,
  - time period,
  - industry
  - … whatever is relevant for your analysis)

# 5. How to structure your report



*Relevant Literature*

Theoretical foundation (motivation, hypotheses)

Statistical foundation (calculate AR, tests)

| Phase I | Phase II | Phase III | Phase IV | Phase V |
|---|---|---|---|---|
| **Research question** | **Collect data** | **Abnormal returns** | **Apply tests** | **„write it up“** |
| • Which event?<br>• What do you want to analyze?<br>• Results from other studies<br>• Theoretical idea | • Number events<br>• Time period<br>• Market, Index, | • $AR_{it} = R_{it} - E(R_{it})$<br>• How to determine $E(R_{it})$ | • parametric<br>• non parametric<br>⇓<br>• Test result delivers answer to the research question<br>• Result in line/not in line with literature | |

| STUDY | Motivation | Hypotheses/ literature | Data+ methodology | Results |
|---|---|---|---|---|

# Literature (1)



- Find research articles related to your project
- Read them!
  Knowing the title and abstract is not enough
- Recent literature on your topic defines what is “state of the art”.
- Compare literature to your
  - hypothesis formulation
  - test procedure (sample, event window, estimation window, tests, …)

# Literature (2)



- The literature determines your contribution
- Is finding positive AR when literature documents negative AR a contribution to the literature? **No**
- Is focusing on fewer events or types of events than the literature a contribution to the literature? **No**
- What is a contribution? **Something new that you add to the literature …**
  - an event never studied before, … country or region, time period, … new methodology, … alternative model,

# Statistical analysis (1)



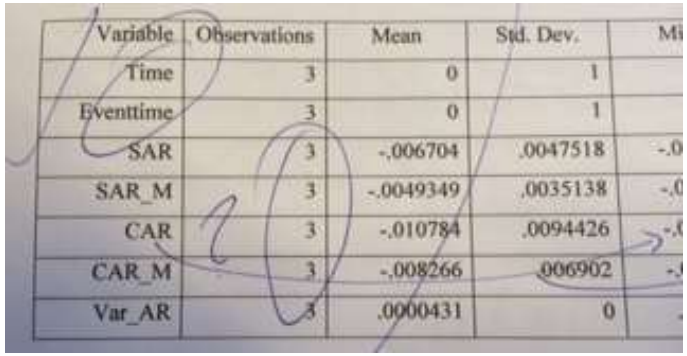
- **BASICS – must have**

  Data description and summary statistics complete?

**Table 1**
**Descriptive statistics of M&A announcements included in the event study**

| | Number of announcements | % of total | Deal Value | | |
|---|---|---|---|---|---|
| | | | Mean | Median | Minimum |
| Total | 43 | 100% | | | |
| $ bn | | | 23,934.05 | 16,098.30 | 4,628.80 |
| 2010 | 4 | 9% | | | |
| $ bn | | | 12,665.50 | 12,832.15 | 8,943.90 |
| 2011 | 6 | 14% | | | |
| $ bn | | | 24,020.63 | 23,361.85 | 8,875.90 |
| 2012 | 5 | 12% | | | |
| $ bn | | | 6,052.16 | 4,900.00 | 4,628.80 |

Good example, because time structure and deal value relevant to understand …
- bias
- limitations
- contributions



| Variable | Observations | Mean | Std. Dev. | Mi |
|---|---|---|---|---|
| Time | 3 | 0 | 1 | |
| Eventtime | 3 | 0 | 1 | |
| SAR | 3 | -.006704 | .0047518 | -.0 |
| SAR_M | 3 | -.0049349 | .0035138 | -.0 |
| CAR | 3 | -.010784 | .0094426 | -.0 |
| CAR_M | 3 | -.008266 | .006902 | -. |
| Var_AR | 3 | .0000431 | 0 | |

Bad example, because …
- variables shown not explained
- information not relevant

# Statistical analysis (2)



- **BASICS – must have**
  - Limitations and bias discussed?

6 Limitations and statistical bias
Event date uncertainty …
Event selection …
Company selection …
Nonsynchronous trading …
Clustering …
Normality constraint …
OLS estimator …

Bad example, because…

- Link between limitations and sample unclear
- Not all biases are relevant for the sample at hand
- No discussion of whether bias is positive or negative

# Statistical analysis (3)



- When and how do we use sensitivity tests?
- Sensitivity analysis (has to be motivated)
  - Different estimation window?
  - Subsamples?
  - Different tests?

# 6. Extensions



Alternative models to predict normal returns:

- 3-factor Fama-French model (often used for US companies):

$$R_{it} - R_f = \alpha_i + \beta_i(R_{Mt} - R_f) + \gamma_i SMB_t + \delta_i HML_t + \varepsilon_{it}$$

SMB = the outperformance of small versus big companies,

HML = the outperformance of high book-to-market versus small book-to-market companies

- Visit Kenneth French's web page to see which data are available

# Implementing n-factor models in Excel



- LINEST(y_values, x_values, const,stat)
  where const=TRUE if the model has a constant, else FALSE,
  stat=TRUE if additional statistics should be reported, else FALSE.
- LINEST must be entered as an array formula
- Hold down [Crtl] and [Shift] and press [Enter]

| | F1 | F2 | Intercept |
|---|---|---|---|
| Coefficient | 0.041 | 0.923 | 0.000 |
| Standard errors | 0.038 | 0.069 | 0.000 |
| R2 | 0.259 | 0.006 | #N/A |
| F statistic | 91.3 | 522.0 | #N/A |
| Ssxy | 0.006 | 0.017 | #N/A |

Standard error of y

# Matching approach



- Select for each company a similar company in terms of specified characteristics that had no event:

  $\mathrm{AR} = R_{it} - R_{Mat}$

  $R_{Mat}$ returns of the matched company (or portfolio of companies)

- Useful approach when investigating bonds

# Expected versus unexpected components



- Some events are expected from the capital market
- In a few cases, there is no need to think about (e.g. earthquakes)
- Need to distinguish:
  - Calculate expected component (e.g. earnings news, MacKinlay)

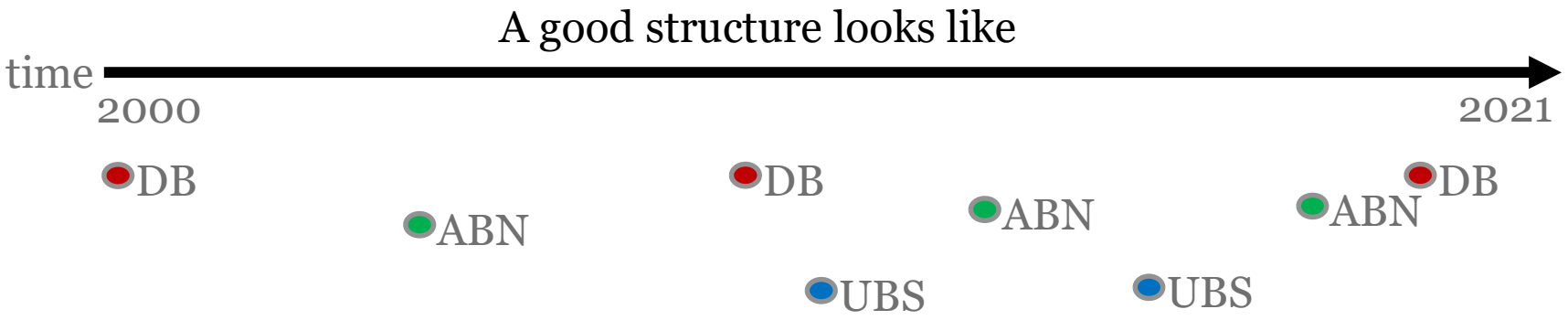
| | Earnings increase | Earnings decrease |
|---|---|---|
| Good news | Increase stronger than expected | Decrease less pronounced than expected |
| Bad news | Increase not as strong as expected | Decrease stronger than expected |

  - Subsample formation based on additional information:
    CEO retirement is more likely an expected event than CEO dismissal.
    AR retire < AR dismissal?
    What effect has the successor?

## How does a good data structure for an event study look like?



- How often do you observe the particular event type?
- At how many points in time do you observe the event type?




- Other structures require more data manipulation and modified test statistics.

## Clustering



- When aggregating ARs, we assumed that the event windows of the securities do not overlap
  → covariances across securities are zero.
- Suppose you consider several companies which are affected by the same event (such as earthquakes, monetary policy changes, regulation changes). → Covariances ≠0!
- Solution: Aggregate ARs to a portfolio and apply tests on these portfolios.

## Further tests



- Boehmer test: standardized AR corrected for **event-induced changes in volatility** (Boehmer et al., 1991).
- Kolari and Pynnönen: standardized AR corrected for event-induced changes in volatility and **cross-correlation** (Kolari and Pynnönen, 2010).
- …