Lecture I: Efficient Market Hypothesis

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Introduction

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- **Answer**: Liquid market and "correct" price
- E.g. convenient stores
- **Efficient Market Hypothesis** (EMH): Asset prices reflect all available information
- Idea behind the EMH: People are smart
- 2013 Nobel Prize in Economic Sciences
- Finance researchers view EMH as evolution
- **Question**: Does EMH sounds too idealistic?

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- **Efficient Market Hypothesis** (EMH): Asset prices reflect all available information
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- **Question**: Does EMH sounds too idealistic?
- For the most of time, **on average**, it is very plausible
- Analogy, particles
- E.g. price of a bottle of water

Efficient market hypothesis - more details

- **Central question**: Whether asset prices reflect all available information
  - No arbitrage (no free lunch): Price only adjusted to news, not predictable (in the deterministic sense), adjust quickly
  - The price is right: asset prices are equal to intrinsic value
- Motivation: Investors are very smart
- Implication to math:

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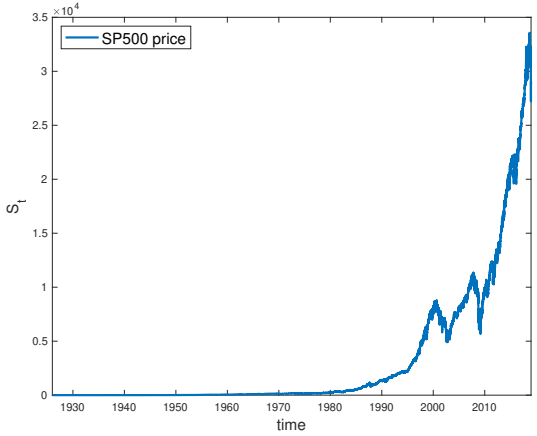
- Motivation: Investors are very smart
- Implication to math:
  - Stochastic process (change of prices come from news, which are unpredictable)
  - Markovian
  - Dimensional reduction
- **Challenge:** How to test it?

Security return

- Consider a security price S_t
- E.g. S&P 500



- **Question**: What is the trend of increasement?

Security return

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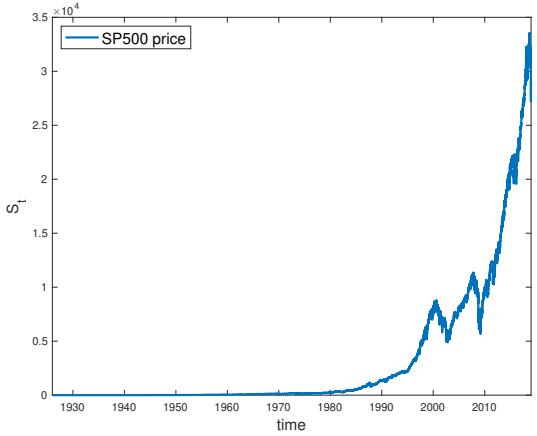

- **Question**: What is the trend of increasement? exponentially
- **Question**: Why would price increases exponentially?

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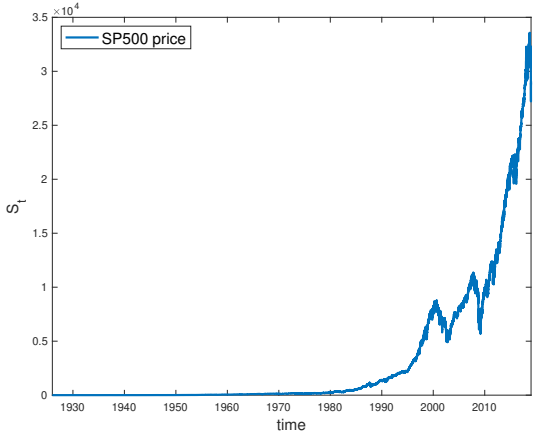
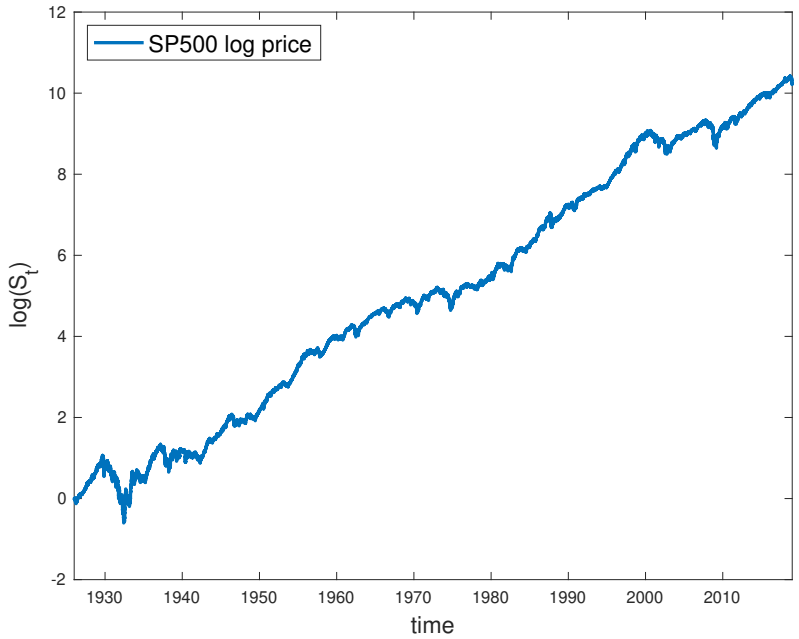


- **Question**: What is the trend of increasement? exponentially
- **Question**: Why would price increases exponentially?
- One intuition: continuous compounding
- Exponentially increasing is very rapid, faster than any polynomials!

$$\lim_{t\to\infty} \frac{t^n}{e^t} = 0.$$

Log return

- **Simple return**: $\frac{S_t - S_0}{S_0}$
- Convenient to work with log price $\ln(S_t)$



- Randomness are observed
- **Log return**: $R_t = \ln(S_t) - \ln(S_0) = \ln\left(\frac{S_t}{S_0}\right)$
- For $S_t \sim S_0$, $\ln(S_t) - \ln(S_0) = \ln\left(1 + \frac{S_t - S_0}{S_0}\right) \sim \frac{S_t - S_0}{S_0}$

Thought experiment

- Wish to test Markovian
- Consider a simple data generating process

$$y_t = r + y_{t-1} + c_0\epsilon_t + c_{-1}\epsilon_{t-1} + \dots$$

- Use this to mimic the stock market
- y_t - log-price
- r - expected return
- $\epsilon_t \sim \mathcal{N}(0, \sigma^2)$: impact from the news
- **Question**: if it is Markovian, how would the model looks like?

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- **Question**: if it is Markovian, how would the model looks like?
- $y_t = r + y_{t-1} + c_0\epsilon_t$
- **Question**: how to test if it is Markovian?

Challenge

- Find events that company keeps receive good news
- E.g., $y_\tau - y_0 \geq \eta$
- Check the impact of news: $\mathbb{E}[y_\tau | y_{\tau-1}, \ldots, y_0] = \mathbb{E}[y_\tau | y_{\tau-1}]$?
- **Q**: Challenge in practice?

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- Check the impact of news: $\mathbb{E}[y_\tau | y_{\tau-1}, \ldots, y_0] = \mathbb{E}[y_\tau | y_{\tau-1}]$?
- **Q**: Challenge in practice? Might not have enough data to test for a single company
- Use all companies in the market to calculate the expectation
- **Remark:** Test of EMH is in the sense of average

Event study

Event Studies:

Eugene Fama, Lawrence Fisher, Michael Jensen, Richard Roll

International Economic Review 1969

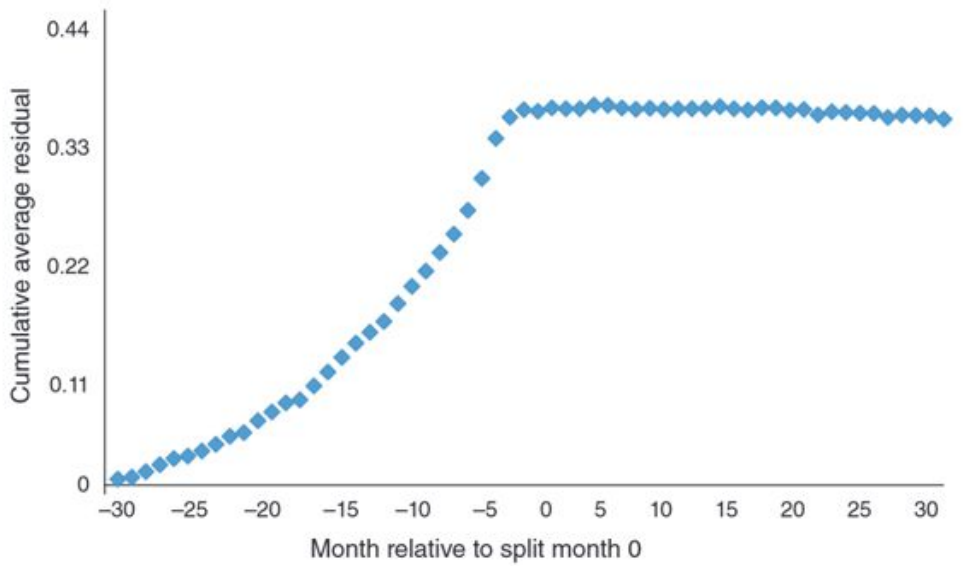
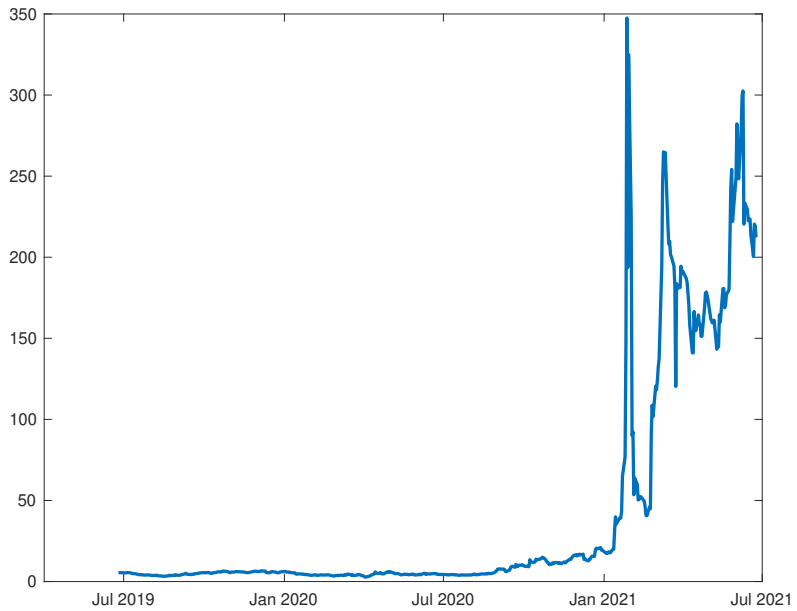


FIGURE 1. CUMULATIVE AVERAGE RESIDUALS IN THE MONTHS SURROUNDING A SPLIT

Source: Fama et al. (1969).

GameStop

- GameStop: An American video game, consumer electronics, and gaming merchandise retailer
- Decline since 2016, one of major reasons: Market conditions change (online)
- Jan 2021, GameStop's share price has a 1500% increase over two weeks
- Cause: Reddit community
- GME stock prices:



Summary

- **Efficient Market Hypothesis** (EMH): Asset prices reflect all available information
- Not necessarily always true, but very powerful
- Even if it is wrong, it provides a framework to think
- Regions that probably cannot be applied: high-frequency or illiquid market
- My thoughts: Heliocentric theory
- When it is wrong, it also serves as a "correction" direction

Some references

- 2013 Nobel lecture: https://www.youtube.com/watch?v=WzxZGvrpFu4&t=257s
- Debate between Fama and Thaler about EMH: https://www.youtube.com/watch?v=bM9bYOBuKF4&t=1673s
- https://www.nobelprize.org/prizes/economic-sciences/2013/summary/