Japanese Stock Market Indices
Nikkei 225, TOPIX, and Financial Fragility

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Introduction
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• Part I: Review
• Part II: Nikkei 225
• Part III: Tokyo Stock Price Index (TOPIX)
• Part IV: Nick Leeson and Barings Bank (January 1995)
• Part V: Index Volatility Trading and Correlation Trading
• Part VI: BOJ
Part I: Review (Open-End Funds and Closed-End Funds)

• Open-end funds: a type of mutual fund
• Can issue and redeem shares at any time
• No shares limit
• Not traded on open market
• Funds reprice based on the number of shares bought and sold
• Price based on NAV
Part I: Review  (Open-End Funds and Closed-End Funds)

• Closed-End Funds ≈ ETFs
• Launched through IPO
• Limited shares
• Trade on open market
• Price affected by supply and demand, allowing to trade at prices below or above its real value

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Part I: Review (Exchange-Traded Fund)

- Combination of open-end funds and closed-end funds
- Mutual fund can be traded on an exchange (like a stock)
- Oldest and largest ETF – SPDR S&P 500
- Owns underlying asset and divides ownership of assets into shares
- Based off index that tracks stocks, commodities, bonds, or a basket of assets
- Subject to Investment Company Act of 1940

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Part I: Review

• The Japanese economy today
  • Third largest in the world by nominal GDP
  • -0.1% short term interest rate and 0% 10-years Japanese government bond

• Tokyo Stock Exchange (TSE) is the 4\textsuperscript{th} largest stock exchange globally
  • First Section
  • Second Section
  • Mothers = Market of the High-Growth and Emerging Stocks

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Part II: Nikkei 225

Price-Weighted Indices

NKY

DJIA

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Part II: Nikkei 225 – Introduction

• Price-weighted index (similar to Dow Jones Industrial Average)
• Yen-denominated
• 225 stocks listed on the Tokyo Stock Exchange First Section

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Part II: Nikkei 225 – Change in Constituents

• Add or delete by “liquidity in the market” and “sector balance”

• Liquidity: “trading value” and “magnitude of price fluctuation by volume” = \( \frac{\text{High price/Low price}}{\text{Volume}} \)

• Top 450 stocks in terms of the liquidity are selected to form the “high liquidity group”

• Non-constituent stocks which are in the top 75 of the high liquidity group are added

• Among the 450 stocks, half number of those that belong to a sector is designated as the “Appropriate number of stocks” for such a sector

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Part II: Nikkei 225 – Calculation

• Calculated every 15 seconds during the Tokyo Stock Exchange's trading hours

• **Adjusted Stock Price** = \( \frac{\text{Stock Price} \times ¥50}{\text{Presumed Par Value} (¥)} \)

• **Nikkei Stock Average** = \( \sum \frac{\text{Adjusted Stock Price}}{\text{Divisor}} \)

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Part II: Nikkei 225 – Example

• Three stocks, A, B, and C, the presumed par value of them are ¥50
• Prices are A= ¥400, B= ¥500, and C= ¥900, divisor is 3
• Index = (400+500+900)*50/50/3 = 600
• If A is deleted and D (stock price ¥1000, presumed par value ¥50) is added
  • Adjusted Stock Price = \( \frac{\text{Stock Price} \times ¥50}{\text{Presumed Par Value (¥)}} \)
  • Nikkei Stock Average = \( \sum \frac{\text{Adjusted Stock Price}}{\text{Divisor}} \)
• New aggregate price of B, C, and D is 500 + 900 + 1000 = ¥ 2400
• New divisor = 2400/600 = 4

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Part III: TOPIX

• Free-float adjusted market capitalization weighted index
• All 2113 listed companies from the TSE 1st Section
• Top 10: Toyota, MUFG, SoftBank, Nippon Telegraph and Telephone Corporation, SONY, Sumimoto Mitsui, Honda, Keyence, Nintendo, Mizuho
• Assumes market capitalization on the base date (4 January 1968) is 100 points

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Part III: TOPIX

TOPIX (annual data from TSE)

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Part III: TOPIX

Free-Float Adjusted Market Cap Indices

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Part III: TOPIX

• Calculated to the nearest hundredth

\[ \text{Index} = \frac{\text{Current Market Value}}{\text{Base Market Value}} \times \text{Base Point} \]

• \text{Current Market Value} = \sum_{\text{Companies}} \text{Shares} \times \text{Price} \\
• \text{Shares} = \text{Total Number of Listed Shares} \times \text{FFW Ratio} \\
• If a newly listed company’s market cap exceeds 1% of total adjusted market value of TOPIX, company is included in the index in phases

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Part III: TOPIX

• Example of an adjustment

1. Old base market value is ¥20trn and previous day’s market value is ¥400trn, TOPIX is 2,000.00

2. Stock A listed shares increase by 100m. If previous day close was at ¥2,000, the adjustment amount is 100m shares x ¥2,000 = ¥200bn.

3. Base mkt val is ¥20trn x (¥400trn + ¥200bn) / ¥400trn = ¥20.01trn

4. (¥400trn + ¥200bn) / ¥20.01trn = 2,000.00 (same as before)
Part IV: Nick Leeson and Barings Bank

• British derivatives trader in the Singapore branch of Barings Bank (oldest merchant bank in England, founded in 1762)

• Success in speculative trading

• Used secret trading account 88888

• Strategies:
  • Arbitrage baskets of stocks in the Japanese cash market against Nikkei futures
  • Arbitrage contracts on Nikkei futures between OSE and SIMEX

• Led directly to the collapse of Barings Bank, $1.4 billion losses

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Part V: Index Volatility and Correlation

• As mentioned in David’s presentation, people trade options to bet on volatility
  • If you think real < implied, bet premium on option is expensive and short gamma, long theta; long otherwise
• We can be more specific using a BSM framework

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Part V: Index Volatility and Correlation

• Suppose we can continuously delta-hedge

• Static portfolio at \( t \) is \( C - \Delta S_t \)

\[
(C(S_{t+1}) - \Delta S_{t+1}) - (C(S_t) - \Delta S_t) + r(C - \Delta S_t)
\]

\[
= C(S_{t+1}) - C(S_t) - \Delta(S_{t+1} - S_t) + r(C - \Delta S_t)
\]

• Use a Taylor expansion for the difference \( C(S_{t+1}) - C(S_t) \):

\[
C(S_{t+1}) - C(S_t) = \Delta(S_{t+1} - S_t) + \frac{\Gamma}{2}(S_{t+1} - S_t)^2
\]

• So the change is then \( \frac{\Gamma}{2}(S_{t+1} - S_t)^2 + r(C - \Delta S_t) + \theta \)

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Part V: Index Volatility and Correlation

• Given $\frac{\Gamma}{2} (S_{t+1} - S_t)^2 + r(C - \Delta S_t) + \theta$, express in terms of vol
  • Use identity $(S_{t+1} - S_t)^2 \approx \sigma^2 S_t^2$

• PnL is $\frac{1}{2} \sigma^2 S_t^2 \Gamma + r(C - \Delta S_t) + \theta = 0$ (no arb)

• So PnL is proportional to $\frac{1}{2} S_t^2 \Gamma (\sigma_{real}^2 - \sigma_{implied}^2)$
Part V: Index Volatility and Correlation

• Volatility of an index tends to trade richer than its constituents’ vol due to supply/demand

• But due to correlation, index vol realizes lower

• Dispersion trading: going short index implied vol and long single stock implied vol

• Compare with index arbitrage – here we are using options
Part V: Index Volatility and Correlation

• [Show derivation of dispersion trading formulae on board]
Part V: Index Volatility and Correlation

• [Show PCA model]

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Part VI: BOJ

• The Bank of Japan’s monetary policy includes more familiar things such as YCC but also asset purchases
• Top 10 shareholder in nearly 40% of listed companies, including 4% of first section
• Annually purchases ¥6trn of ETFs and ¥90bn of J-REITs
• In July, the BOJ announced that on 6 Aug 2018 they would change the amount of each ETF to be purchased
  • TOPIX purchases to increase annually from ¥2.7trn to ¥4.2trn
  • Nikkei 225 purchases to decrease from ¥3trn to less than ¥1.5trn

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Part VI: BOJ

• Process
  1. BOJ places order for an ETF
  2. ETF share is freshly created by an asset manager using a basket

• Consequences
  • Inflated equity prices
  • ETFs can be held indefinitely on the bank’s balance sheet
  • BOJ’s assets exceed GDP
  • Picking winners and losers?

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Sources

Review:

Nikkei 225:
• https://indexes.nikkei.co.jp/nkave/archives/file/nikkei_stock_average_guidebook_en.pdf

TOPIX:
• https://www.jpx.co.jp/english/markets/indices/topix/
• https://www.jpx.co.jp/english/markets/indices/topix/tvdivq00000030ne-att/e_fac_3_topix.pdf

Nick Leeson:
• http://pages.stern.nyu.edu/~sbrown/leeson.PDF

Bank of Japan:
• https://www.boj.or.jp/en/mopo/mpmsche_minu/index.htm/
• https://asia.nikkei.com/News/Markets/Bank-of-Japan-weighs-rebalancing-ETF-buys
• https://www.cumber.com/the-bojs-ett-purchasing-program/?print=pdf

Volatility and Correlation:

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