自然實驗與因果推論
在社會科學和商學的應用

管理學院 財務金融系暨研究所

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April 26, 2023

Overview

- 自我介紹
- 為什麼要學習因果推論？
  - 相關性 ≠ 因果推論
- 簡介自然實驗
  - 自然實驗的方法
- 設計自然實驗
  - Example from Nobel Laureates
- 自然實驗在商學領域的應用
  - Example from my research

自我介紹

- 教育背景
  - National Chiao Tung University
    - BS in EE
  - National Taiwan University
    - Master in Finance
  - Kellogg Northwestern
    - Ph.D. in Finance

- 經驗
  - University of Kansas
    - Assistant Professor of Finance
  - Federal Reserve Bank of Richmond
    - Financial Economist
  - National Taiwan University
    - Associate Professor of Finance

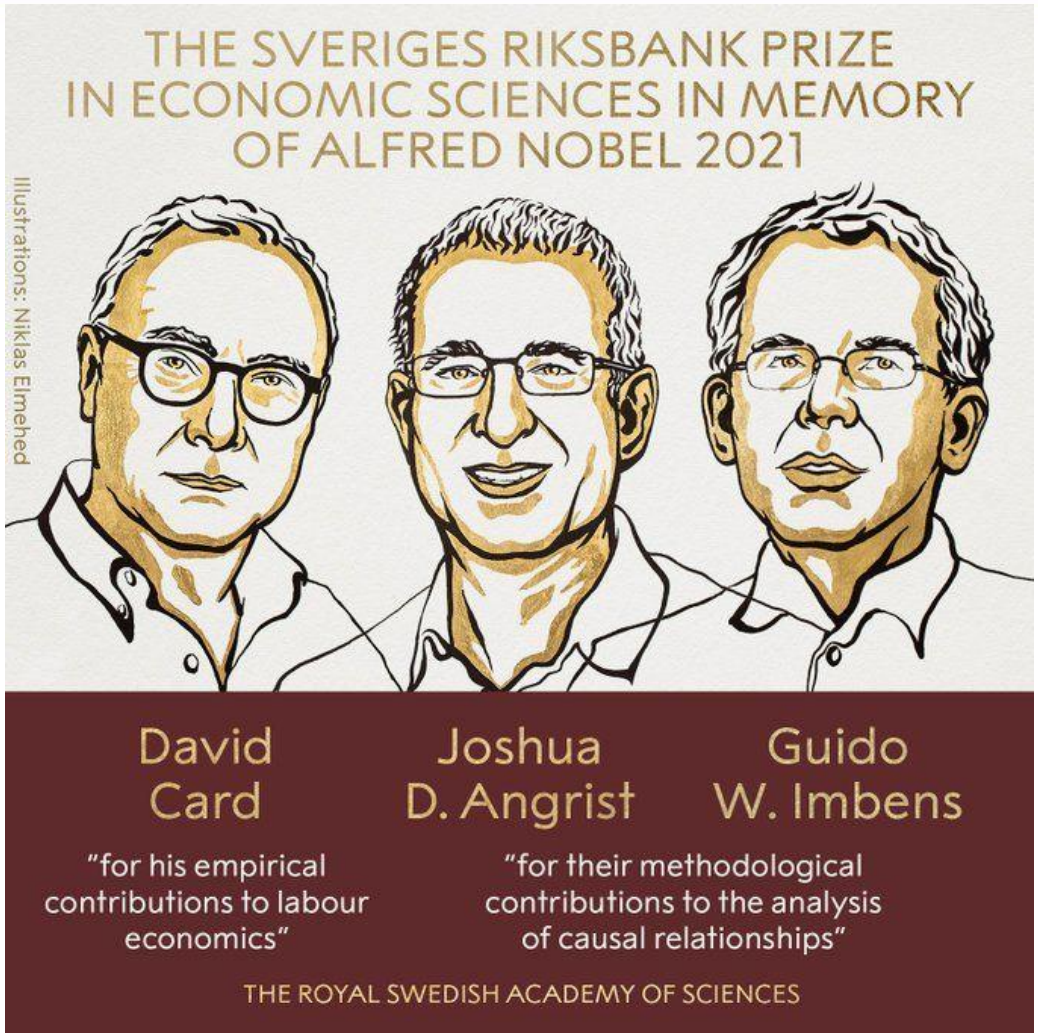
Why Causal Inference?

Why causal inference?

- Policy implication
- Academic research
  - economics, business, sociology, education, political science
- Personal life
  - weight loss, health, education

Correlation ≠ Causality (因果推論)

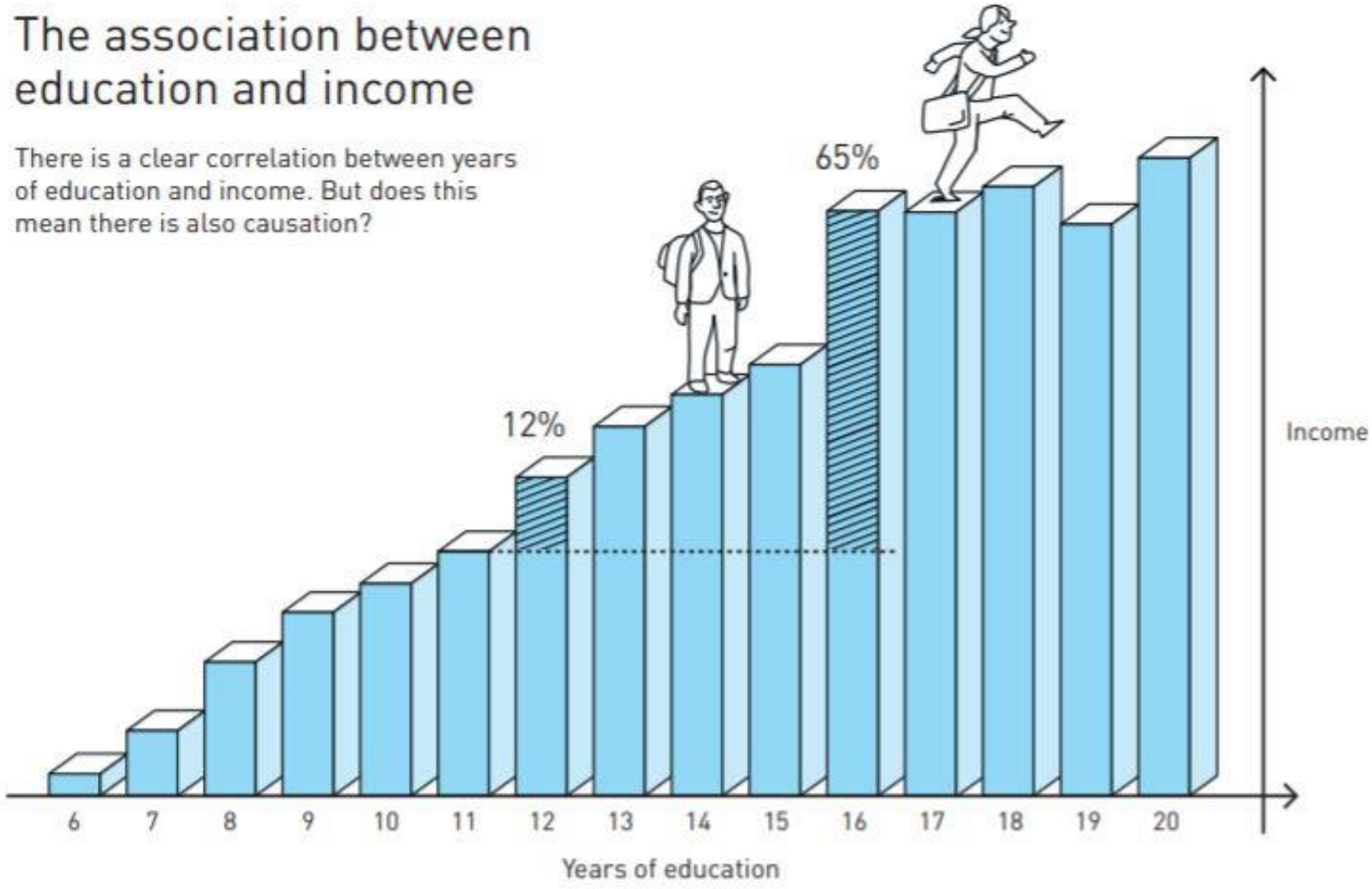
自然實驗提供了因果推論的好幫手！



資料來源： https://www.nobelprize.org/prizes/economic-sciences/2021

Natural Experiment

自然實驗在教育的應用



資料來源： https://www.nobelprize.org/prizes/economic-sciences/2021

理想很豐滿，現實很骨感

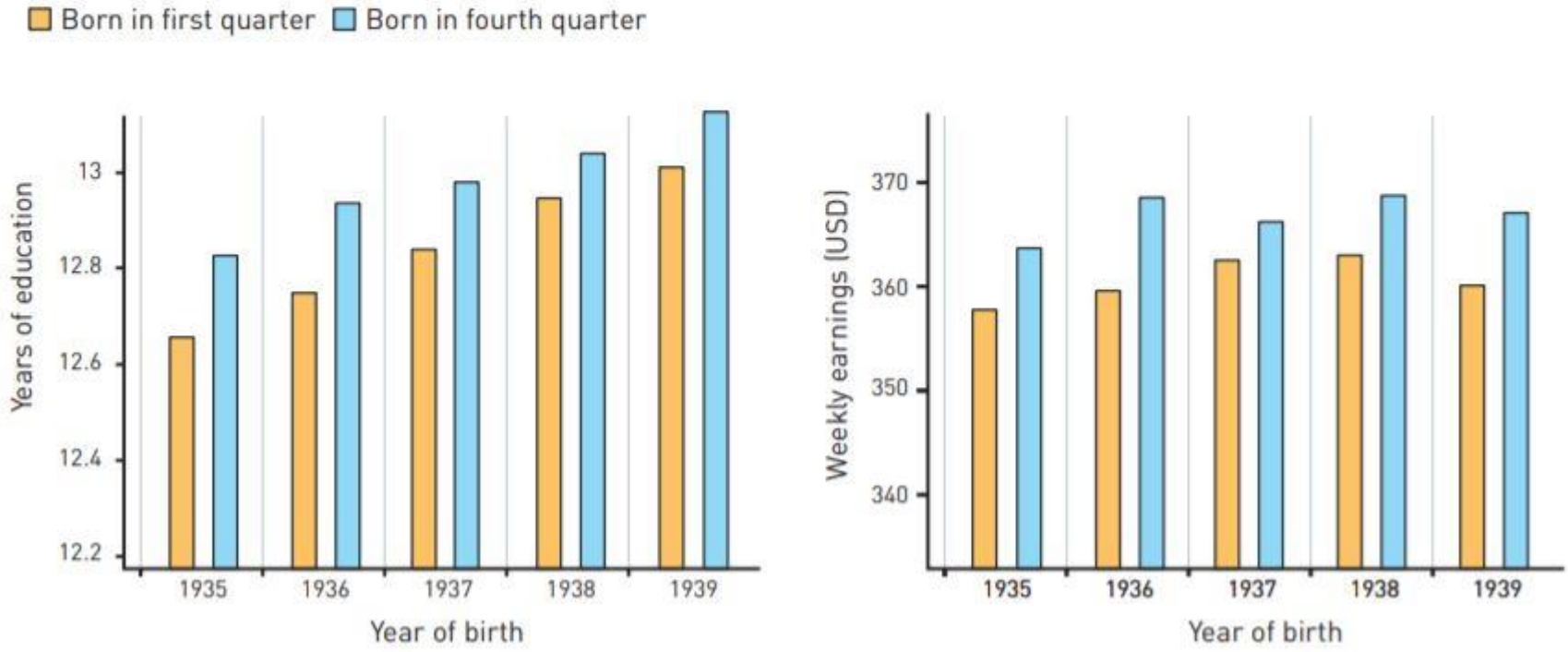
- Ideal randomized controlled experiment
- In practice,
  - nonexperimental data, ONLY “observational” data
- No ideal experiment…
- Second best choice
  - Quasi-nature experiment (自然實驗)

Example from Nobel Laureates

自然實驗在教育的應用

People born late in the year have more years of education and higher incomes

Additional years of education have a positive effect on income. The figure uses data from Angrist and Krueger (1991).



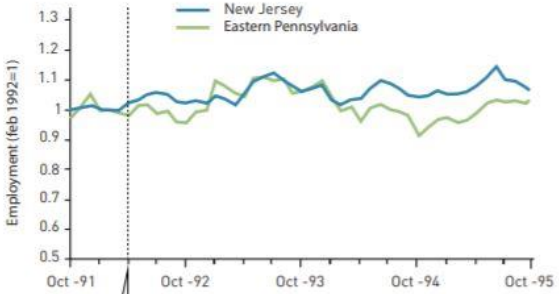
資料來源： https://www.nobelprize.org/prizes/economic-sciences/2021

自然實驗在勞動市場的應用

The effect of increasing the minimum wage

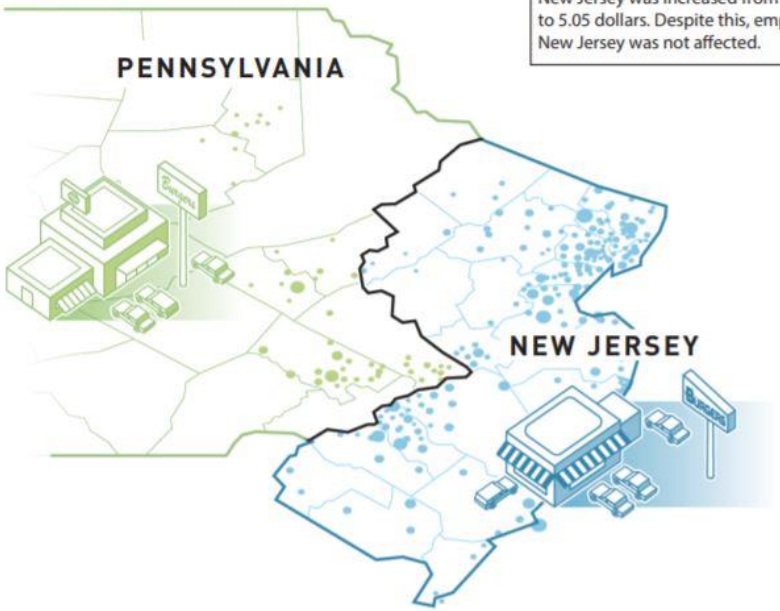
Card and Krueger used a natural experiment to study how increasing the minimum wage affects employment.

The researchers identified a treatment group (restaurants in New Jersey) and a control group (restaurants in eastern Pennsylvania) to measure the effect of increasing the minimum wage.



1 April 1992: The hourly minimum wage in New Jersey was increased from 4.25 dollars to 5.05 dollars. Despite this, employment in New Jersey was not affected.

CONTROL GROUP TREATMENT GROUP



資料來源： https://www.nobelprize.org/prizes/economic-sciences/2021

Examples from my research

Publication since joining NTU

七篇期刊論文

- 五篇科技部管理類學門A＋級期刊（財金*2，會計＊2，管理＊1）
  - (Jan, 2022) Learning from the Joneses: Technology Spillover, Innovation Externality, and Stock Returns, ***Journal of Accounting and Economics*** (單一作者）
  - (July, 2021) Testing Disagreement Models, ***The Journal of Finance***, (with Yen-Cheng Chang, Pei-Jie Hsiao, and Alexander Ljungqvist)
  - (Feb 2021) Valuation of New Trademarks, ***Management Science***, (with Po-Hsuan Hsu, Dongmei Li, Qin Li, and Siew Hong Teoh)
  - (Feb 2021) More Cash, Less Innovation: The Effect of the American Jobs Creation Act on Patent Value, ***Journal of Financial and Quantitative Analysis*** （領銜文章）(with Heitor Almeida, Po-Hsuan Hsu, and Dongmei Li) (Jan, 2021)
  - Short-Termist CEO Compensation in Speculative Markets: A Controlled Experiment, ***Contemporary Accounting Research***, forthcoming (with Yen-Cheng Chang, Minjie Huang, and Yu-Siang Su)

- 兩篇A級期刊（經濟＊1, 財金＊1).
  - (Sep, 2021) Supply Chain Technology Spillover, Customer Concentration, and Product Invention, ***Journal of Economics & Management Strategy***, forthcoming (with Po-Hsuan Hsu, Hai-Ping Hui, and Hsiao-Hui Lee)
  - (June, 2021) Technology Spillovers and the Duration of Executive Compensation, ***Journal of Banking and Finance***, 2021; 106209 (with Minjie Huang and Thomas Kubick)

自然實驗在財務領域的應用1

Establishing Causality in Investor Disagreement Models, Research Forthcoming in *The Journal of Finance*

Testing Disagreement Models, new research by Associate Prof. Yen-Cheng Chang, Associate Prof. Kevin Tseng, doctoral student Pei-Jie Hsiao of the NTU Department of Finance, and Chair Prof. Alexander Ljungqivst of the Stockholm School of Economics, is forthcoming in *The Journal of Finance*, marking the journal's first acceptance of a submission by NTU scholars since 1999.

Asset pricing is a core field in financial economics. One of the major challenges of asset pricing is to propose models that explain the behavior of asset prices. To this end, models that incorporate investor disagreement can be enlisted to explain empirical regularities, such as investor overtrading, asset bubbles, and stock price crashes. These are all issues of great interest to academics, practitioners, and policy makers. While models of investor disagreement are appealing on theoretical grounds, prior empirical studies do not demonstrate solid causal evidence for the role of disagreement in asset prices.

Photo of Research Team Pei-Jie Hsiao, Yen-Cheng Chang, Kevin Tseng (Left to Right).

To meet this empirical challenge, the research team exploited a

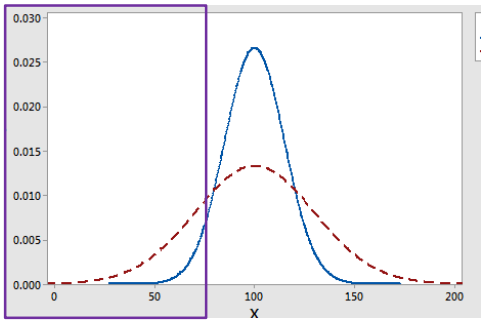
資料來源： NTU Highlights

驗證意見分歧模型（JF 2022）

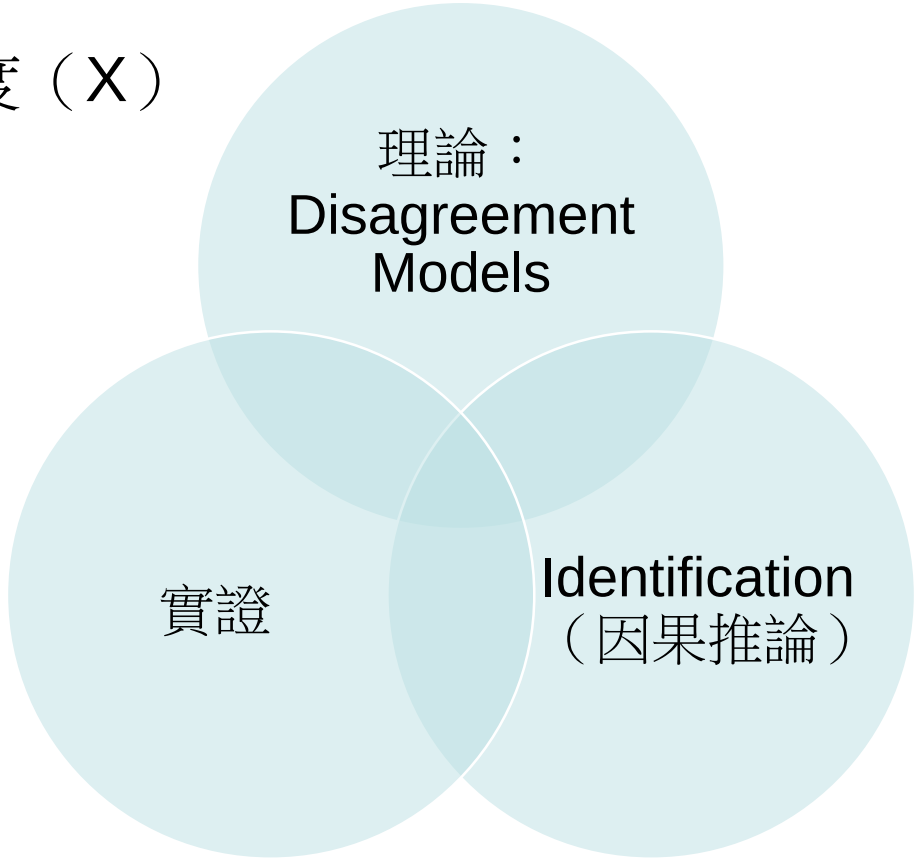
研究主題：使用嚴謹的因果推論方法來驗證意見分歧模型理論

理論： 投資人意見分歧程度（X）

賣空限制



=> 股價泡沫程度（Y）



資料來源： NTU Highlights

投資人意見分歧理論

- Miller 1977
- Contemporaneous effect

- 投資人意見分歧程度↓
- 估值↓

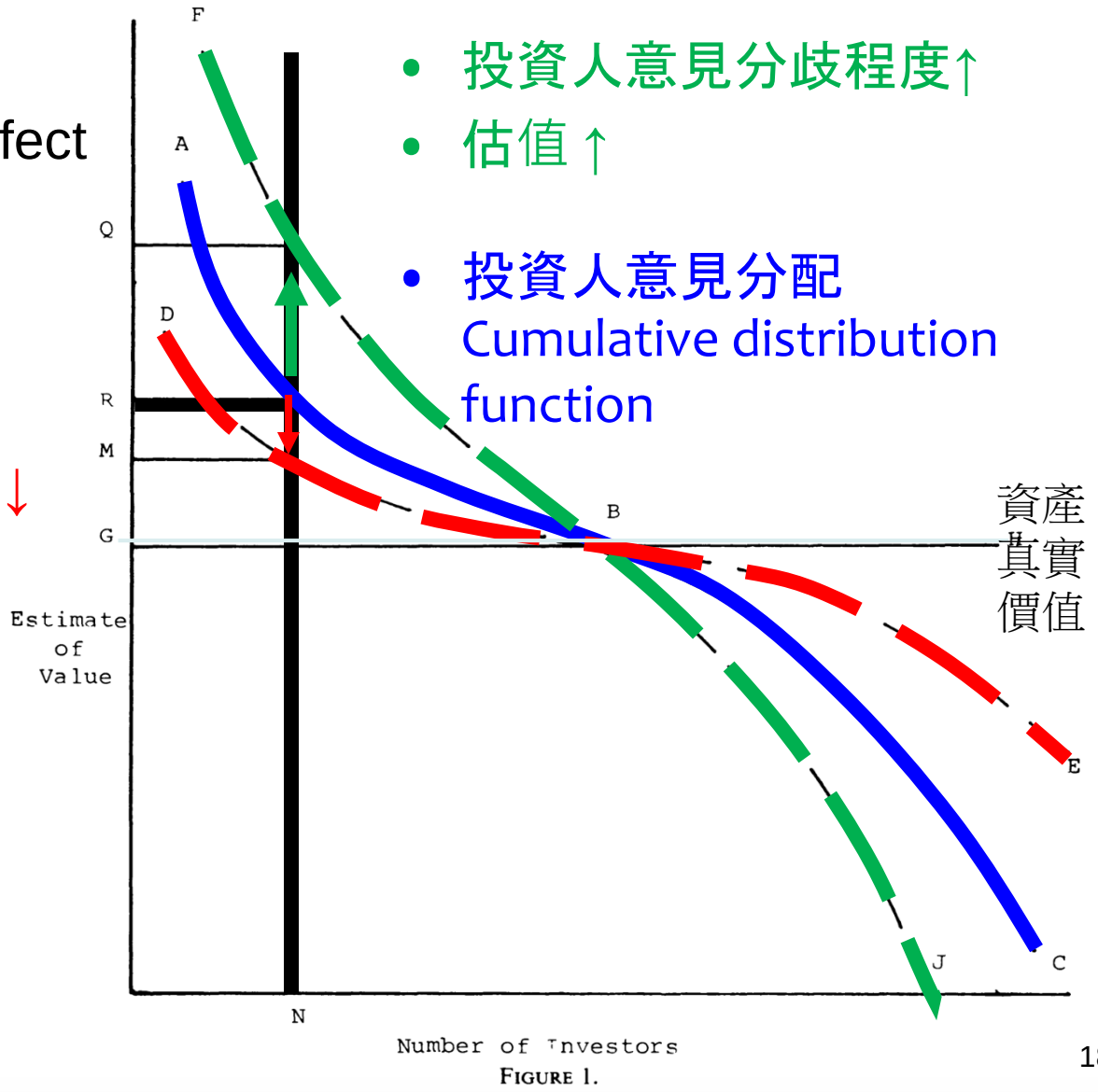


FIGURE 1.

- 投資人意見分歧程度↑
- 估值↑

- 投資人意見分配 Cumulative distribution function

驗證意見分歧模型（JF 2022）

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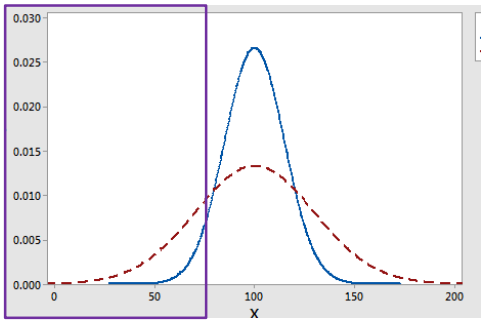
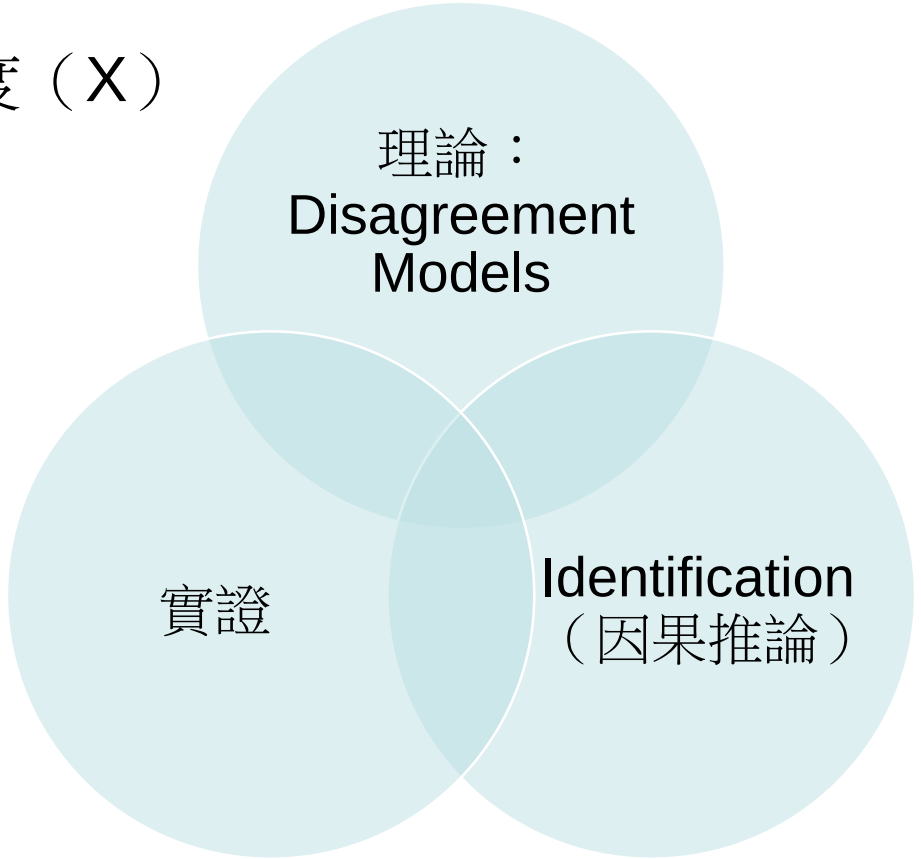


=> 股價泡沫程度（Y）

實證：Regress Y on X



資料來源： NTU Highlights

驗證意見分歧模型 (JF 2022）

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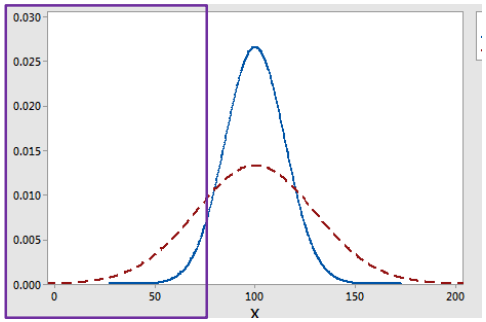
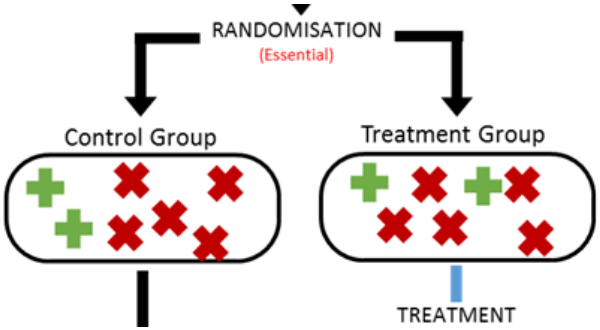
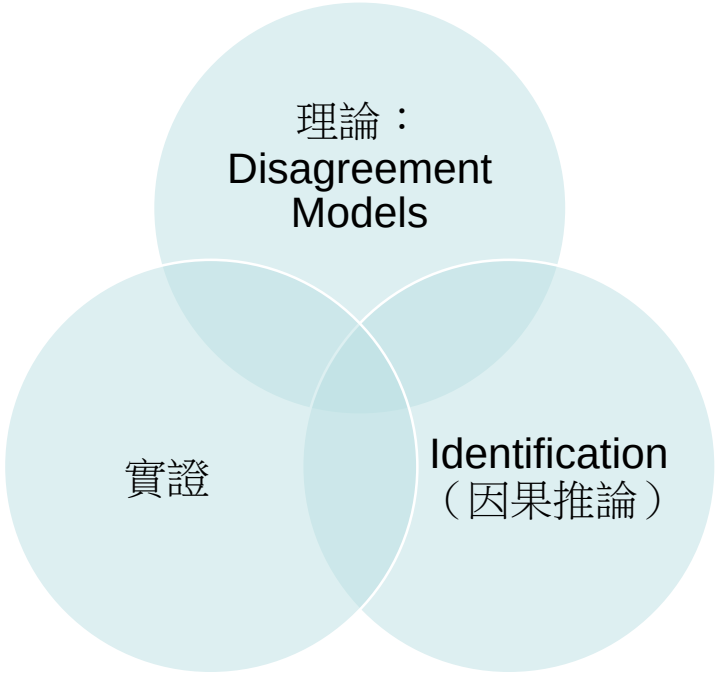


=> 股價泡沫程度（Y）

自然實驗



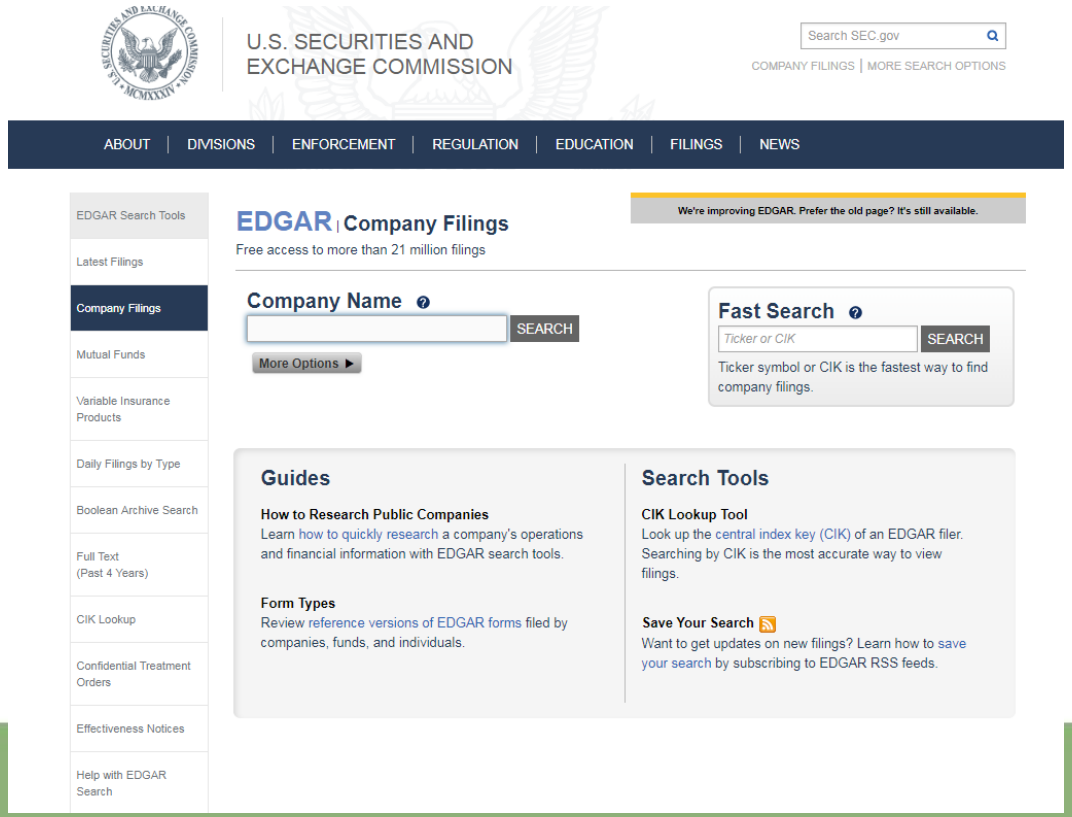


資料來源： NTU Highlights

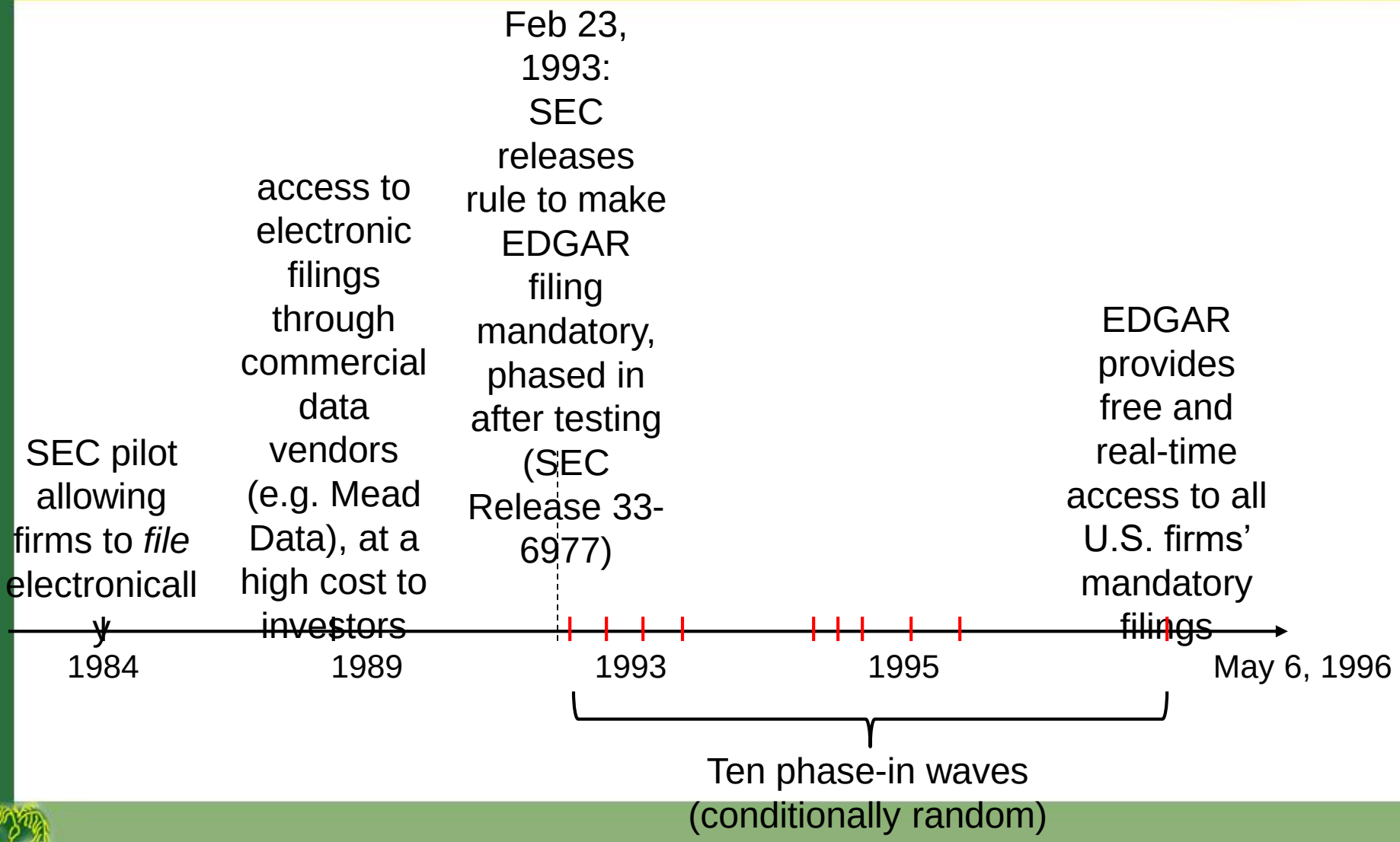
EDGAR (美國公開觀測站）的建立

Staggered introduction of online access to the Securities and Exchange Commission's EDGAR system

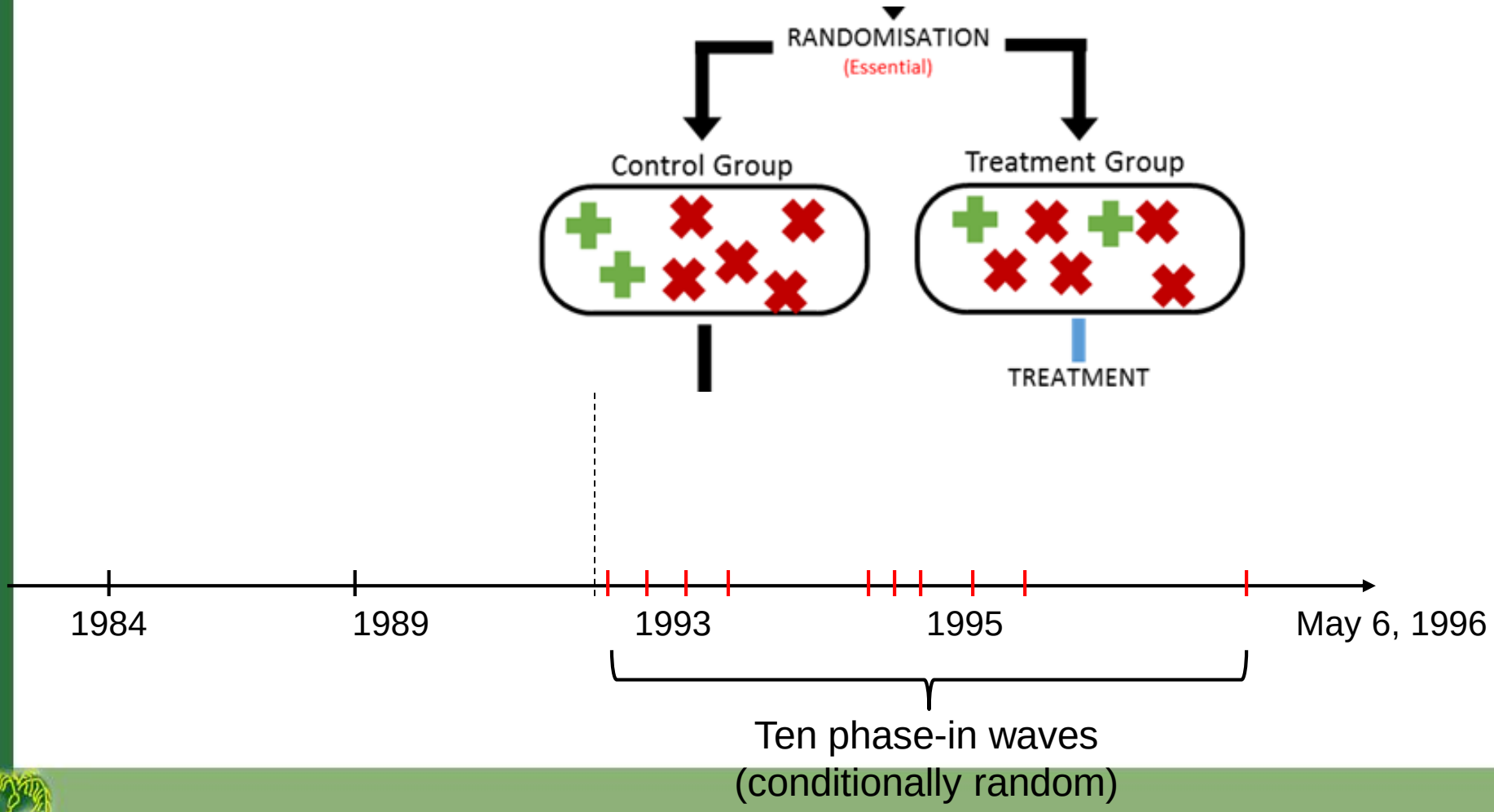
- Today, EDGAR provides free and real-time access to all U.S. firms' mandatory filings



EDGAR自然實驗

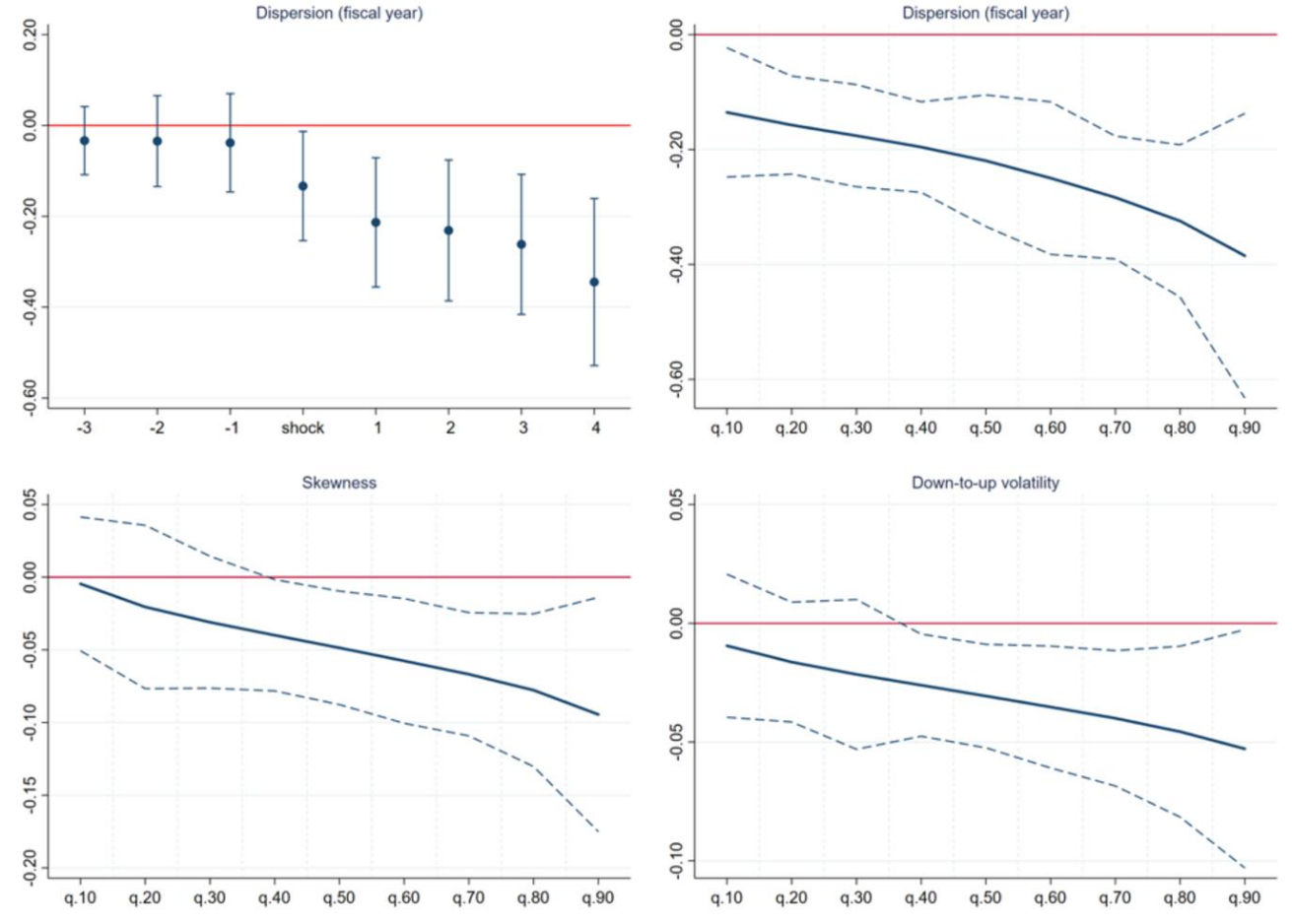

SEC pilot allowing firms to *file* electronically
access to electronic filings through commercial data vendors (e.g. Mead Data), at a high cost to investors
Feb 23, 1993: SEC releases rule to make EDGAR filing mandatory, phased in after testing (SEC Release 33-6977)
EDGAR provides free and real-time access to all U.S. firms' mandatory filings
1984
1989
1993
1995
May 6, 1996
Ten phase-in waves (conditionally random)

EDGAR自然實驗


RANDOMISATION
(Essential)
Control Group
Treatment Group
TREATMENT
1984
1989
1993
1995
May 6, 1996
Ten phase-in waves
(conditionally random)

自然實驗的發現

- 實驗組（相對於控制組）意見分歧程度大幅下降
- 股票估值高估情況大幅下降 （Miller 1977)
- 股票崩盤風險大幅下降 (Hong and Stein 2003)



JF2022-Contribution

- 本研究為財務經濟領域近40年來，第一篇以單一的研究設定驗證意見分歧模型所有核心預測，並且提供因果證據研究的論文。
  - 改寫教科書

21

Heterogeneous Beliefs

CONTENTS

This part of the book provides brief introductions to several important extensions of the theory. There is a large literature on each of the topics covered. Rather than trying to survey the literatures, we try to provide careful treatments of some foundational issues and models within each literature. The goal is to provide enough background to make the literatures accessible.

This chapter relaxes the assumption made in most previous chapters that investors have identical beliefs. We assume in this chapter that investors hold their beliefs dogmatically, in the sense that they are not persuaded to revise their beliefs when they realize that others hold different beliefs. It is very natural to assume different individuals have different beliefs and hold them dogmatically if we take the subjectivist view of probability (Ramsey, 1931; Savage, 1954). Chapter 22 examines differences in beliefs arising from differences in information. In that case, each investor learns something about other investors' information from the terms of trade they are willing to accept, and they regard this information

- Policy implication
  - **他山之石可以攻錯**
    - **房地產**
      - Difficult to short sell
      - **實價登錄**
    - **賣空限制**

Establishing Causality in Investor Disagreement Models, Research Forthcoming in *The Journal of Finance*

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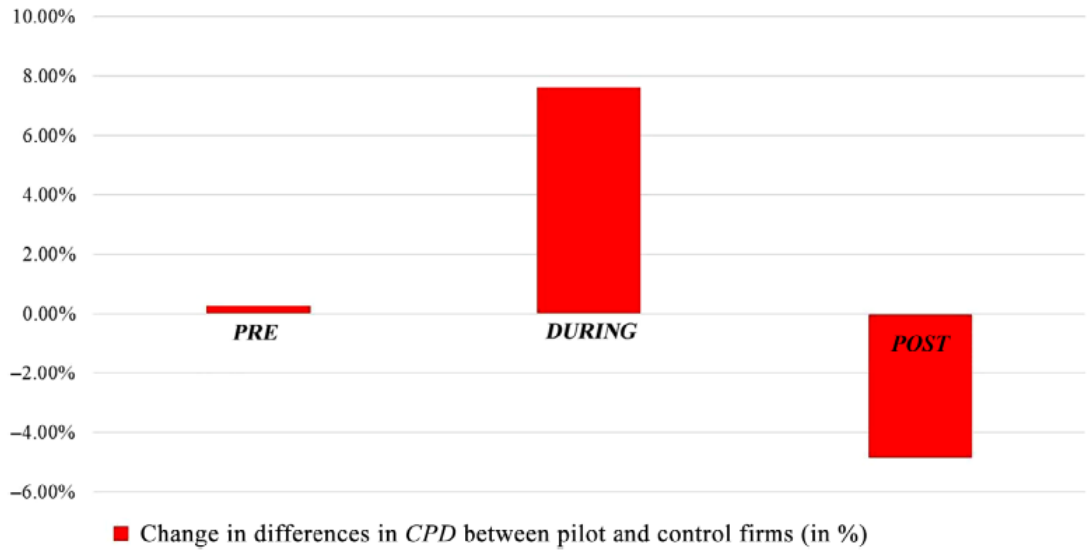
Photo of Research Team Pei-Jie Hsiao, Yen-Cheng Chang, Kevin Tseng (Left to Right).

To meet this empirical challenge, the research team exploited a

自然實驗在財務的應用2

- 股票市場賣空限制與公司深謀遠慮

Figure 2 Change in CEO compensation duration: Pilot versus control groups



Notes: We plot the evolution of the difference in CEO compensation duration (*CPD*) between the Regulation SHO experiment pilot and control firms. We first compute the average difference in *CPD* between the pilot and control firms during four three-year periods: 1998–2000, *PRE* (2001–2003), *DURING* (2005–2007), and *POST* (2009–2011). We graph the period-to-period changes in these differences for the *PRE*, *DURING*, and *POST* periods (i.e., from the three-year period 1998–2000 to *PRE*; from *PRE* to *DURING*; from *DURING* to *POST*).

CAR2021- SHO

- Natural experiment (SHO)
  - Regulation SHO: a randomized experiment by the SEC. Relaxed short-sale constraints for a group of pilot stocks from 2005 to 2007.
  - Program lifted short-sale price tests for every third stock in the Russell 3000 sorted by trading volume.

- Pilot stocks show large increase in short-selling activities and decrease in stock prices during the program (Diether, Lee, and Werner, 2009; Grullon et al., 2015).

- Program has beginning and ending dates, allowing us to do DiD tests both during and after the pilot program (Fang, Huang, and Karpo, 2016).

自然實驗在財務的應用3 (JFQA 2021)

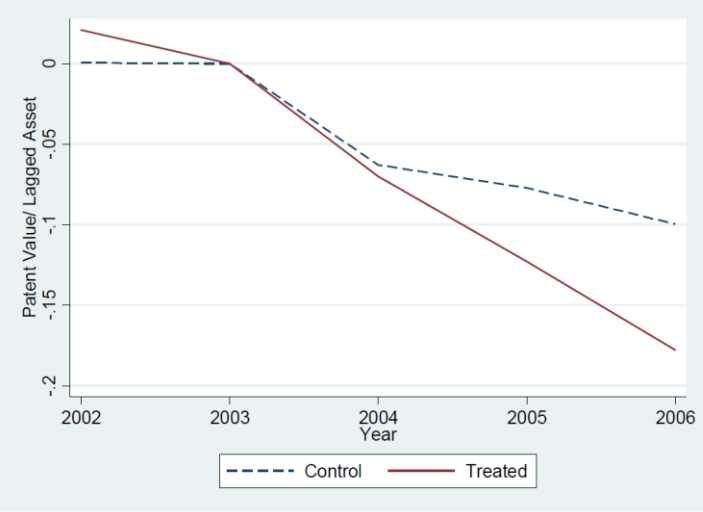
- 財務資源與科技創新成果

Figure 1

Patent Value around the AJCA

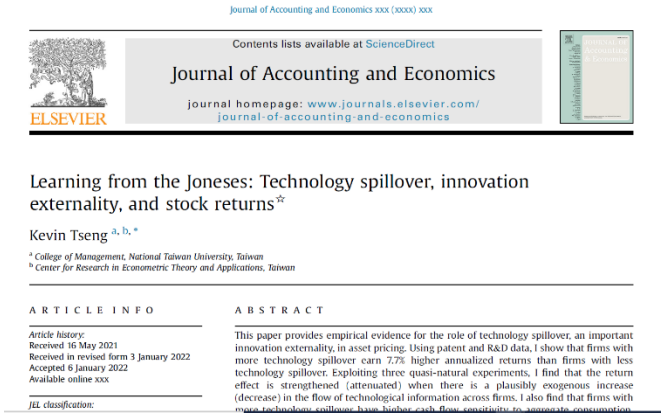
This upper panel (Panel A) shows the evolution of average patent value of the treated and control groups around the AJCA. Patent value is the annual patent market value to lagged assets. For post-shock variables, we scale patent value by total assets in 2003. Treated and control groups are defined as in Table 1. The lower panel (Panel B) is based on Equation (2), which includes year dummies, and then replace Residual[Firm Repatriates] (i.e., AJCA-Pr[Firm Repatriates]) with a set of year dummies times the residual.

Panel A: The CW method



自然實驗在財務的應用4 (JAE 2022)

科技外溢性增加公司所承擔的系統性風險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ELSEVIER

Learning from the Joneses: Technology spillover, innovation externality, and stock returns☆

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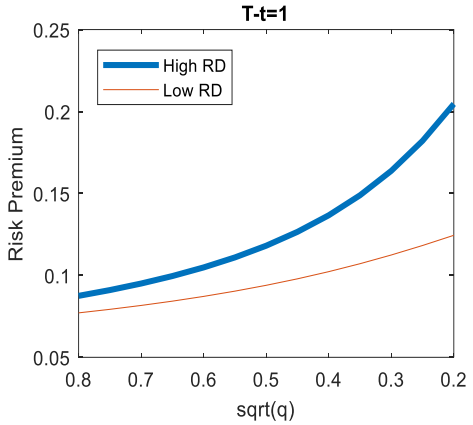
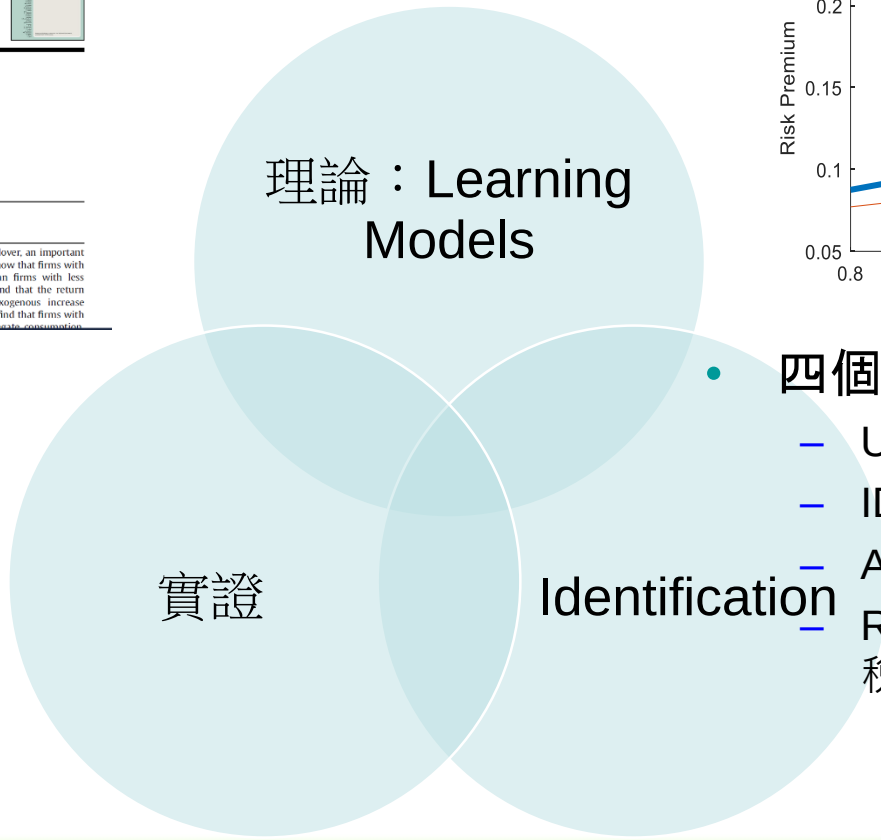
ABSTRACT

This paper provides empirical evidence for the role of technology spillover, an important innovation externality, in asset pricing. Using patent and R&D data, I show that firms with more technology spillover earn 7.7% higher annualized returns than firms with less technology spillover. Exploiting three quasi-natural experiments, I find that the return effect is strengthened (attenuated) when there is a plausibly exogenous increase (decrease) in the flow of technological information across firms. I also find that firms with





- 四個自然實驗
  - UTSA(商業機密)
  - IDD(傑出人才移動)
  - AIPA(專利資訊揭露)
  - R&D tax credit (研發稅盾)

Closing remark

Looking forward

- 因果推論
  - 必要條件
    - 好的自然實驗可以增進因果推論的嚴謹度
  - 結合自身領域的理論,故事,想法

- 跨領域的研究
  - 運用自然實驗
    - 所有社會科學都可以適用（經濟,財務,會計,教育,策略管理,社會學,政治經濟,人類學,歷史…）
  - 進一步設計“實驗”
    - 醫學（MRI）及其他自然科學