Statistical Inference in Accounting Research

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An Overview

• Sources of Knowledge: How do we know what we know?
• Induction, statistical; strengths, weaknesses
• Potential Pitfalls
  – Misspecification
  – Robustness
  – Causation and correlation
  – Mutual causation
  – Significance—substantive and statistical
  – Power of the test
  – Missing data
  – Present participle slip
• Where do we go from here?
How Do We Know What We Know?

- Direct observation
- Deduction
- Induction
- Belief/Intuition
- Most often, all of the above in some combination
  - Awareness of each element in supporting what we think we know
Direct Observation

• This apple is red
• Google reported increased EPS for 2014

• Earth is getting warmer?
• Google is an attractive investment?
Deduction

• From one or more broad premises, arriving at a certain specific conclusion through logic/reasoning
  – All apples are round; this is an apple; therefore it must be round
  – All public corporations publish financial reports; Google is a public corporation; therefore Google must publish financial reports

• Validity of deductions depends on validity of the premises
Statistical Induction or Inference

• Starting from some data/observations,
• **Assume** that the data at hand is not the whole population, but only a sample drawn by some **assumed** laws of chance from a larger population, and
• Arrive at some conclusions about the properties of the whole population
• Descriptive statistics: applicable to the sample only, not the population
• Inference: about the whole population
• Inference depends on: the sample data, the assumptions or the statistical model, and is only probabilistic (not certain)
  – There are apples and oranges in the basket in 60/40 ratio; 80 percent of apples are red, and 80 percent of oranges are yellow; this randomly picked fruit is red; therefore it is an apple with probability 6/7.
  – 5% of all firms go bankrupt each year; average current ratio of bankrupt firms is 1.0 and the average for non-bankrupt firms is 2.0 in the year preceding bankruptcy; a randomly chosen firm has current ratio of 1.5; what is the chance that it will go bankrupt in one year?
Belief/Intuition

- Important parts of our knowledge is *a priori*, or derived from intuition
- Examples?
Advantages of Statistical Inference

- All observations are specific instances
- We wish to generalize to the observed characteristics to a population to which the specific instances may be presumed to belong
- Generalized statements are far more powerful and useful
- Generalizations always involve an intuitive leap
- The question is: when is the leap believable or convincing?
  E.g.,
  - Earnings of X grew 5% in each of past five years ➔ earnings of X grow at 5% p.a.?
  - Earnings and advertising outlays of X over past 15 years have 0.7 correlation ➔ increased (decreased) advertising causes increase (decrease) in earnings
Pitfalls of Statistical Inference

- Misspecification
- Robustness
- Causation and correlation
- Mutual causation
- Significance—substantive and statistical
- Power of the test
- Missing data
- Present participle slip
Misspecification

• We **assume** that the data at hand is drawn from the relevant population
  – Could be the wrong population
    • Selection: a sample of LIFO firms may be drawn from the population of firms with brighter prospects
    • Survival: a sample of firms with 25 years of data may exclude firms that performed poorly and went out of business

• We **assume** that the sample is drawn following a given law of chance from population
  – May not be random: voluntary participation
  – May not be drawn by the assumed law of chance
Robustness

• What is the chance that the inferred relationship will hold in another
  – Sample
  – Time
  – Place
  – Industry
  – Subjects (for experiments, surveys)

• Have we used up all available data
  – Hold out sample

• Is the statistical regularity we identify robust to its own discovery?
Causation and Correlation

• Sine (x) and Cosine (x) have zero correlation but perfect causal relationship in both directions

• Identical twins have high correlation in their physical features, but one does cause the other (common cause in parental genes)

• If increase in price of gold raises expectation of future prices increases and leads to increased demand, higher prices will appear to cause increased demand

• Gender and length of hair are correlated. Causation?
Mutual Causation

- Mutual causation: OK in mathematics (sine $x$ and cosine $x$); =sign means $\leftarrow$ and $\rightarrow$
- In empirical data:
  - If we know that adoption of LIFO under inflation increases value of a firm, and we observe that the stock prices increase immediately after adoption, then we can infer that markets are efficient.
  - If we know that the stock market is efficient, and we observe that the stock price goes up immediately after adoption, then we can infer that LIFO adoption increases the value of the firm.
  - We cannot make both inferences from the same dataset.
  - Open loop and closed loop systems: power of efficient markets also is a monkey wrench in statistical inference in closed loop systems (impossibility result)
Significance—Substantive and Statistical

- Need a null and an alternative hypothesis
- What determines which hypothesis is null?
- Can we select them after looking at the data? How do we know?
- What is the distribution of the test statistic under the null hypothesis?
- Less dispersed the test statistic, smaller substantive differences become statistically significant
- Is the question of interest qualitative or quantitative (yes/no or how much?)
Power of the Test

- Within hypothesis testing (qualitative framework):
  - Type I error: reject null when it is, in fact, true
  - Type II error: fail to reject null when in fact it is not true
- Decreasing one error increases the other
- Increase in sample size decreases both
- Possible inferences?
Missing Data

• What do we do when some of the relevant data is not available? Example:
  - This paper aims at determining the value relevance of financial reporting. ...This study aims at explaining likely impact of financial reporting by listed companies on the market prices of their shares. Our study reveals that value relevance of published financial statements, per se, is negligible. ... The results of our investigation depict negligible value being added by cash flow reporting.
Two Problems with the Argument

• Could stock market be the sole or dominant criterion for choosing financial reporting?
• If it were, does statistical covariation deliver on its promise?
The Status Quo is System A

Financial Reporting System A ➔ Price System A
Estimate the Covariation of Accounting and Stock Market Data under the Status Quo

Financial Reporting System A → Price System A

R(A)
Consider Hypothetical Alternative B

Financial Reporting System A \(\Rightarrow\) Price System A

Financial Reporting System A \(\Rightarrow\) Price System A

Financial Reporting System B \(\Rightarrow\) Price System B
Estimate Covariation $R(B)$

- Financial Reporting System A $\Rightarrow$ Price System A
- Financial Reporting System A $\Rightarrow$ Price System A
  \[ R(A) \]
- Financial Reporting System B $\Rightarrow$ Price System B
- Financial Reporting System B $\Rightarrow$ Price System B
  \[ R(B) \]
Inference?

Financial Reporting System A ➔ Price System A
R(A)

Financial Reporting System B ➔ Price System B
R(B)

What can we learn about the relative desirability of A versus B from comparing R(A) against R(B)?
“Information Content” Criterion

• If statistically proximity of accounting and stock market data is to be maximized, it is trivial to achieve nirvana
• Fire the accountants and report change in market capitalization as income!
• Accounting from the markets, instead of accounting for the markets
• Violates the maintained hypothesis that accounting may be relevant for stock markets
But Things are Much Worse!

- We do not have stock price data under financial reporting regime B (because it is still being considered).
- We have no way of estimating $R(B)$ for comparison with $R(A)$ even if that comparison was of any use.
- What do we do?
- Here is the trick.
Correlate Accounting B to Price A

Financial Reporting System A  \( R(A) \)  Price System A

Financial Reporting System B  \( R^*(B) \)  Price System B

What can comparison of \( R(A) \) to \( R^*(B) \) tell us about the relative desirability of financial reporting systems A and B?
Accounting-Stock Market Covariation Studies

• It is hard enough to derive a logical inference from comparison of R(A) vs. R(B)
• Comparison of R(A) to R*(B) might make sense if stock prices were the identical under A and B
• That is, if financial reporting were irrelevant to stock markets
• In which case, why bother with these covariation studies
Two Inferential Slips

• Present participle: your broker calls on Jan 15, ‘04 to say: Starbucks shares are “going” up
• What does it mean?
• What can you infer from the data?
• “The data is consistent with my hypothesis”
Exercise

• Open a recent issue of your favorite accounting research journal
• Identify papers that depend on statistical inference
• Classify each paper: descriptive/substantive, or hypothesis testing framework
  – Null and alternative hypotheses stated?
  – Statistical or substantive significance?
  – Balance of Type I and II errors
  – Causation analyzed and/or inferred?
  – Conclusion: reject/fail to reject the null, or accept the null/data is consistent with my theory?
SSRN Papers on “Effect”

- The Subprime Crisis: Cause, Effect and Consequences
- The 'IKEA Effect': When Labor Leads to Love
- Goodbye Pareto Principle, Hello Long Tail: The Effect of Search Costs on the Concentration of Product Sales
- The Effect of Internet Piracy on CD Sales: Cross-Section Evidence
- Reel Piracy: The Effect of Online Film Piracy on International Box Office Sales
- Empirical Evidence on Corporate Governance in Europe. The Effect on Stock Returns, Firm Value and Performance
  - The Volatility Effect: Lower Risk Without Lower Return
- The Effect of International Institutional Factors on Properties of Accounting Earnings
- The Effect of ERP System Implementations on the Usefulness of Accounting Information
- The Legal Effect of Directives: Policy, Rules and Exceptions

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