Potential Pilot Problems

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The popular view about equity markets
Trading certainly looks different today...

20\textsuperscript{th} century

Automation has driven out costs.
Is it increasing liquidity and helping firms raise capital?

21\textsuperscript{st} century
Two liquidity measures defined

- Effective bid-ask spreads
  - \( ES_{it} = |P_{it} - M_{it}| \)
  - Distance from prevailing midpoint \( M_{it} \) to trade price \( P_{it} \)
  - Actually a half-spread or one-way cost
  - Defined for a single (child) transaction

- Implementation shortfall
  - More relevant for a parent order (e.g., buy 1mm shares of IBM)
  - For buys, \( IS_{it} = \bar{P} - M_{it} \)
  - Distance (usually in bps) from decision-time price \( M_{it} \) to average trade price \( \bar{P} \)
  - Captures effect of driving prices up with sequences of buy orders
US large-cap trading costs have trended down

Source: Jun 2014 ITG Global Cost
...all during the rise of the machines
What caused the improvements?

- There is a straightforward Econ 101 story
  - More competition within and across exchanges
  - Scalable technology drives down costs

- But we can’t be sure: correlation is not causality!

- Many other things have changed over the past 20 years
  - Various regulatory changes
  - Perhaps less private information now

- Can use market structure changes as instruments:
  - Example: Hendershott, Jones and Menkveld (2010 JF)

- But the gold standard for determining causal effects is randomized controlled trials
An example: 2007 repeal of short sale uptick rule

- Before 2005, NYSE short sales could only happen:
  - On an uptick (at a price higher than the last sale price)
  - Or on a zero-plus tick (at the same price as the previous transaction if the most recent price change was positive)

- Regulation SHO:
  - Adopted by the SEC in 2005.
  - Initiated a pilot program suspending the NYSE’s uptick rule and the Nasdaq’s analogous bid test.

- All Russell 3000 stocks ranked by market value; every third stock assigned to the pilot.

- Pilot continued into 2007.

- SEC decided to repeal all price tests
  - Announced June 13, 2007
  - Effective July 6, 2007
Empirical design

- Takes advantage of virtually random assignment

- Econometric approach: look before and after repeal

- Initial approach: treatment vs. control
  - Treatment group (non-pilot stocks) experiences the repeal
  - Control group (pilot stocks) free of the uptick rule throughout

- Implemented via a differences-in-differences regression:
  \[ Y_{it} = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 T_i A_t + \epsilon_{it} \]
  where
  - \( Y_{it} \) is the outcome variable for stock \( i \) at time \( t \),
  - \( T_i = 1 \) if stock \( i \) is in the treatment group, \( T_i = 0 \) otherwise
  - \( A_t = 1 \) if date \( t \) is after treatment (after repeal), else \( A_t = 0 \)

- The interaction term \( \beta_3 \) measures the average treatment effect.
Why the name?

\[ Y_{it} = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 T_i A_t + \varepsilon_{it} \]

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<thead>
<tr>
<th></th>
<th>Average Before Change</th>
<th>Average After Change</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Treatment Group</td>
<td>( \beta_0 + \beta_1 )</td>
<td>( \beta_0 + \beta_1 + \beta_2 + \beta_3 )</td>
<td>( \Delta Y_{\text{treatment}} = \beta_2 + \beta_3 )</td>
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<tr>
<td>Control Group</td>
<td>( \beta_0 )</td>
<td>( \beta_0 + \beta_2 )</td>
<td>( \Delta Y_{\text{control}} = \beta_2 )</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td></td>
<td>( \Delta \Delta Y = \beta_3 )</td>
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More shorting since tick test repealed

Shorting prevalence during 2007 in NYSE stocks

Shorting as a fraction of trading volume

Jan | Feb | Mar | Apr | May | Jun | Jul | Aug

Tick test repealed

- Pink line: non-pilot (treatment)
- Blue line: pilot (control)
Short-sale orders become more aggressive

Passive short-sale orders are those placed at or above the prevailing ask price.
Repeal widens effective bid-ask spreads

Effective Spread

Jan Feb Mar Apr May Jun Jul Aug

Uptick rule repealed

non-pilot pilot
The problem with this empirical design

- Doesn’t work if there are treatment spillover effects.
- Spillovers mean control stocks are affected by the treatment too.
- Controls aren’t actually controls.
- Not clear what the difference-in-difference approach measures.

- Seminal paper in econ: “Worms” (Miguel and Kremer, 2004)
  - Study randomized deworming treatments on Kenyan village children
  - But children in the control group also benefit via less transmission
  - So can’t do simple treatment vs. control

- These spillovers are called interference in the statistics literature.
What’s the problem with uptick repeal?

- Many short sale strategies are portfolio strategies

- Example: index arbitrage. If the index is cheap:
  - Buy futures or an index ETF
  - Simultaneously short all of the underlying stocks

- During the Reg SHO pilot, this strategy was hard to execute:
  - Only about 1/3 of S&P500 stocks exempt from the uptick rule
  - For all the rest, can’t short without complying with the uptick rule
  - Introduced substantial risk into this strategy.

- After repeal, could short all stocks without this constraint
  - Would expect more shorting of lists of stocks
  - More shorting of pilot (control) stocks
  - Voila! Treatment spillover.

- Same is true for any list-based strategy (e.g., factors)
Revisiting the evidence

Shorting prevalence during 2007 in NYSE stocks

Shorting as a fraction of trading volume

- Non-pilot (treatment)
- Pilot (control)

Tick test repealed
This is not always a problem: no evidence of spillovers during 2008 shorting ban

Cross-sectional mean of short sales as a percentage of trading volume (RELSS) for stocks on the original Sep 2008 SEC ban list with matched non-banned stocks.
Tackling spillovers methodologically

- Using notation from causal effects literature, $Y_i(z_i, \psi)$ is the potential outcome for firm $i$ given:
  - its own treatment $z_i = \{0, 1\}$
  - $\psi$ is the fraction of firms treated at random
  - We only observe one of these outcomes; the other is the unobserved counterfactual

- Overall treatment effect moving from treatment strategy $\psi$ to strategy $\varphi$:
  \[
  TE(\psi, \varphi) = \sum E[Y_i(1, \psi) - Y_i(0, \varphi)]
  \]

- This can be rewritten as:
  \[
  TE(\psi, \varphi) = \sum E[Y_i(1, \psi) - Y_i(0, \psi) + Y_i(0, \psi) - Y_i(0, \varphi)]
  \]
  direct treatment effect indirect treatment effect
Tackling spillovers (cont’d.)

- A treatment strategy $\psi$ is often compared to no treatment ($\varphi = 0$).
  - corresponds to the beginning of a regulatory pilot program.

- If the pilot is extended to all firms, treatment strategy changes from the original pilot fraction $\varphi$ to $\psi = 1$.

- In biostatistics, other fractions make sense:
  - Vaccinating 75% vs. 50% of the population

- Statistical inference is easier if you have many different groups with only within-group spillovers.
  - Most stats papers discuss this case.
  - Example: “Worms” studies randomized trials in many villages.
But most regulatory pilots are one village

- Solution: identify off of differences-in-differences regression with controls:
\[ Y_{it} = \beta_0 + \beta_1 T_i + \beta_2 A_t + \beta_3 T_i A_t + \gamma X_{it} + \varepsilon_{it} \]
where
- \( Y_{it} \) is the outcome variable for stock \( i \) at time \( t \),
- \( T_i = 1 \) if stock \( i \) is in the treatment group, \( T_i = 0 \) otherwise
- \( A_t = 1 \) if date \( t \) is after treatment (after repeal), else \( A_t = 0 \)
- \( X_{it} \) is a vector of control variables

- The interaction term \( \beta_3 \) measures the direct treatment effect.

- \( \beta_2 \) measures the indirect treatment effect (the average change in control firm outcome from moving to new treatment strategy).

- Controls become quite important here.
Indirect effect non-trivial for uptick repeal

Shorting prevalence during 2007 in NYSE stocks

- Direct treatment effect: +5.8%
- Indirect treatment effect: +6.0%

Tick test repealed
What’s HFT got to do with all this?

- Pilot designers need to think about potential spillovers.
- Currently in the U.S.: concern that current market structure is not ideal for small-cap firms.
But small-cap trading costs remain high

Source: Jun 2014 ITG Global Cost
SEC plans a new pilot program for smaller-caps

- To be a pilot stock, must satisfy all of the following:
  - Market cap of $5 billion or less
  - Average daily volume (ADV) of 1 million shares or less
  - Share price of $2 or more.

- Pilot design: 1 control group and 3 test groups
  - Approximately 300 securities in each of the four buckets

- Test group 1:
  - Quoted in nickels ($0.05), no other restrictions

- Test group 2:
  - Quoted & traded in nickels OR at the mid-point of the NBBO.
  - Retail orders internalized only with price improvement of at least $0.005.
  - No price improvement required for trades off-exchange (e.g., dark pool).

- Test group 3 same as group 2 plus:
  - Trade-at requirement: off-exchange trades require significant price or size improvement.
  - Otherwise, must first execute against the full size of on-exchange, protected quotations at the NBBO before executing off-exchange.
Overall conclusions

- Equity market liquidity in large caps is clearly better than it was 10 years ago.
  - Competition and cost reduction are *probably* the cause

- Regulatory experiments have the potential to clearly identify causal effects.
  - Would be great if Europe could start to do them
  - Must think carefully about spillovers
  - Must design the experiment carefully to maximize info gained

- My predictions and pleas:
  - Due to the nature of information about small firms, small cap liquidity will always be lousy regardless of market structure
  - Tick size and trade-at will have close to zero effect
  - Trade-at should dramatically increase liquidity in large-cap stocks; let’s try the pilot there!
For further reading

This talk incorporates elements from the following papers:


