The Identification Challenge

• Does X cause Y?
• Tempting to regress Y on X ...

$$Y = a + b \times X + \text{controls} + e$$

Unobservables?

• ... but often X is **endogenous** with respect to Y
• Endogeneity is especially challenging in strategy research:
  ➢ By definition, firm strategies are endogenous decisions of companies.
How to Establish Causality?

• Ideally: need randomization of X.
• But: randomization is hard to get (except in controlled lab/field experiments).
• Second best: use *quasi-natural experiments*, i.e., look for an empirical setting in which X varies exogenously.
• Importantly: to establish causality, you need a source of exogenous variation in X.
Leaving aside controlled experiments, three main methods of causal inference:
1) IV (instrumental variables)
2) DID (difference-in-differences)
3) RDD (regression discontinuity design)

1) and 2) increasingly popular in strategy research.

3) is rarely used.
- Missed opportunity.
- RDD considered as the sharpest tool of causal inference since it is closest to ideal setting of randomized experiments (see, e.g., Lee and Lemieux, 2010).

This presentation: focus on 3) from applied perspective.
Regression Discontinuity Design (RDD)

Example:
Flammer and Bansal, “Does Long-Term Orientation Create Value? Evidence from a Regression Discontinuity”
## Agenda

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<td>2. Randomization Tests</td>
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<td>3. Estimation</td>
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<td>5. Recap—RDD “Etiquette”</td>
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</table>
Context

- Do companies benefit from long-term orientation?

- “Naïve” OLS Regression:

\[
\text{Performance} = \alpha + \beta \times \text{Long-term orientation} + \gamma'X + \varepsilon
\]

- Alternative story #1: “Deep pocket” story: Companies that perform better need to worry less about the short run and hence can more easily afford to be long-term oriented.

- Alternative story #2: More talented CEOs may take a longer time perspective and, at the same time, show better financial results given their managerial ability.

- ...

Omitted Variables?

- Do you have any form of identification?
Ideal Experiment

Long-term orientation (random)

- CEO_A
- Firm_A

➢ Shareholder value
➢ Operating performance

Short-term orientation (random)

- CEO_B
- Firm_B

➢ Shareholder value
➢ Operating performance
Shareholder proposals on long-term executive compensation.
  - Objective of long-term compensation: incentivize executives to create long-term value, thus fostering long-term orientation (e.g., Kole, 1997).

(Quasi-)random assignment of long-term incentives to companies:
  - Long-term executive compensation shareholder proposals that pass or fail by small margin of votes.
    - Intuition: no systematic difference between company that passes proposal with, e.g., 50.1% of votes and company that rejects proposal with 49.9% of votes.
  - Minor difference in vote shares leads to discrete change (i.e., a discontinuity) in adoption of long-term compensation policies.
    - Regression Discontinuity Design (RDD).
  - Passage of such “close-call” proposals akin to random assignment of long-term incentives to companies → provides clean causal estimate.
Shareholder Proposals on LT Executive Compensation

• Source:
  - RiskMetrics and SharkRepellent databases.

• Coverage:
  - U.S. publicly-traded companies from 1997–2012.
  - Information included:
    • Firm identifiers, proposal description, date of shareholder meeting, proposal’s sponsor, voting requirement, outcome of votes.

• Selection Criteria:
  - Shareholder-sponsored proposals.
  - Related to long-term executive compensation:
    • Restricted stocks (i.e., company shares that cannot be sold in short run);
    • Stock options with long-term vesting period;
    • Long-term incentive plans (LTIP).
Example of LT Compensation Proposal that was Closely Approved

Company: Lucent Technologies, Inc.
Meeting Date: February 16, 2005
Proposal Type: Restricted stocks
Support Statement: As long-term shareholders, we support compensation policies for senior executives that provide challenging performance objectives that motivate executives to achieve long-term shareholder value.
Voting result: Passed (50.1% Yes versus 49.9% No)
Source: SharkRepellent
Final Sample

• Final Sample:
  ➢ 808 long-term executive compensation proposals.
    • 65 proposals within 5% of majority threshold.
    • 152 proposals within 10% of majority threshold.

“close call”
Distribution of Vote Outcomes

The bar chart shows the distribution of vote outcomes across different percentage ranges. The chart is divided into two categories: Rejected and Approved. Each bar represents the number of votes in a specific percentage range.

- **Rejected**
  - 0% to 50%: Several bars are visible, indicating multiple vote outcomes.
  - Above 50%: Fewer bars, showing a decrease in vote outcomes.

- **Approved**
  - Above 50%: Several bars, indicating a significant number of approved votes.
  - 100%: A few bars, showing a small number of cases where the vote was 100% approved.

The chart effectively illustrates how vote outcomes are distributed across different percentage ranges, with a clear distinction between Rejected and Approved votes.
1. Discontinuity
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4. External Validity
5. Recap—RDD “Etiquette”
Randomization Tests

• **Regression discontinuity design (RDD):**
  - Compare shareholder proposals that pass or fail by small margin of votes.

• **Identifying assumption** of the RDD:
  - Around majority threshold, outcome of vote is as good as *random*.

• **Two standard tests** of this assumption (akin to tests of randomization in randomized experiments):
  1) Distribution of votes is *continuous around majority threshold*.
  2) *No pre-existing differences* between companies that marginally pass and reject long-term compensation proposals.
Continuity around Majority Threshold

Rejected

Approved
p-value (McCrary test) = 0.997

- Null of continuous distribution cannot be rejected.
### No Pre-Existing Differences around Majority Threshold

<table>
<thead>
<tr>
<th></th>
<th>Before meeting ((t - 1))</th>
<th>Change from ((t - 2)) to ((t - 1))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Abnormal return</td>
<td>0.000</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Market value</td>
<td>-0.533***</td>
<td>-0.207</td>
</tr>
<tr>
<td></td>
<td>(0.183)</td>
<td>(0.356)</td>
</tr>
<tr>
<td>Total assets</td>
<td>-0.491**</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>(0.192)</td>
<td>(0.374)</td>
</tr>
<tr>
<td>Total CEO compensation</td>
<td>0.220</td>
<td>0.254</td>
</tr>
<tr>
<td></td>
<td>(0.192)</td>
<td>(0.374)</td>
</tr>
<tr>
<td>Long-term CEO compensation</td>
<td>0.282</td>
<td>0.459</td>
</tr>
<tr>
<td></td>
<td>(0.850)</td>
<td>(1.623)</td>
</tr>
<tr>
<td>LT-index</td>
<td>-0.016</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Capital expenditures</td>
<td>-0.004</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>R&amp;D expenditures</td>
<td>0.005</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>ROA</td>
<td>-0.007</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.018)</td>
</tr>
</tbody>
</table>

Caroline Flammer  Regression Discontinuity Design
Firms that marginally rejected proposals are very similar to firms that marginally accepted proposals, which supports the randomization assumption.

<table>
<thead>
<tr>
<th></th>
<th>Before meeting ((t - 1))</th>
<th>Change from ((t - 2)) to ((t - 1))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>((1))</td>
<td>((2))</td>
</tr>
<tr>
<td>NPM</td>
<td>-0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Sales growth</td>
<td>0.007</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>-0.199*</td>
<td>-0.176</td>
</tr>
<tr>
<td></td>
<td>(0.107)</td>
<td>(0.213)</td>
</tr>
<tr>
<td>Leverage</td>
<td>-0.008</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>KZ-index</td>
<td>0.022</td>
<td>0.211</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.174)</td>
</tr>
<tr>
<td>KLD-index</td>
<td>-0.949**</td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td>(0.428)</td>
<td>(0.843)</td>
</tr>
<tr>
<td>G-index</td>
<td>0.675**</td>
<td>0.661</td>
</tr>
<tr>
<td></td>
<td>(0.262)</td>
<td>(0.507)</td>
</tr>
</tbody>
</table>
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Regression Discontinuity Design (RDD)

Objective: measure difference in outcome variable $y$ around threshold.

$$\Delta = \bar{y}_{\text{above}} - \bar{y}_{\text{below}}$$
Regression Discontinuity Design (RDD)

Objective: measure difference in outcome variable $y$ around threshold.

$\Delta$
Regression Discontinuity Design

\[ y_{it} = \beta \times \text{Pass}_{it} + P_l(v_{it}, \gamma_l) + P_r(v_{it}, \gamma_r) + \epsilon_{it} \]

- \( y_{it} \): dependent variable for firm \( i \) around proposal vote at time \( t \).
  - Abnormal return (AR) computed using the 4-factor model (i.e., stock return adjusted for market, size, book-to-market, and momentum).
- \( \text{Pass}_{it} \): dummy variable that equals
  - 1 for firms that pass proposal
  - 0 for firms that reject proposal.
- \( P_l(v_{it}, \gamma_l) \): polynomial in vote share on LHS of majority threshold.
- \( P_r(v_{it}, \gamma_r) \): polynomial in vote share on RHS of majority threshold.
- \( \epsilon_{it} \): error term (standard errors clustered at firm level).
Abnormal Returns on Day of Vote

The graph shows the abnormal returns on the day of the vote against the victory margin (in 2% bins). The x-axis represents the victory margin, while the y-axis shows the abnormal returns. The data points are scattered, with a notable trend indicating a peak in abnormal returns around a specific victory margin, followed by a drop.
## Effect of LT Incentives on Firm Performance

<table>
<thead>
<tr>
<th></th>
<th>Full model</th>
<th>[−10%, +10%]</th>
<th>[−5%, +5%]</th>
<th>[−2.5%, +2.5%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>0.0114***</td>
<td>0.0068*</td>
<td>0.0142**</td>
<td>0.0228*</td>
</tr>
<tr>
<td></td>
<td>(0.0039)</td>
<td>(0.0041)</td>
<td>(0.0066)</td>
<td>(0.0134)</td>
</tr>
<tr>
<td>Polynomial in vote share</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.013</td>
<td>0.019</td>
<td>0.064</td>
<td>0.055</td>
</tr>
<tr>
<td>Observations</td>
<td>808</td>
<td>152</td>
<td>65</td>
<td>19</td>
</tr>
</tbody>
</table>
Agenda

1. Discontinuity
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External Validity

• Benefit of RDD: **internal validity**.
  - Variation in long-term incentives is quasi-random.
  - RDD methodology often seen as the “sharpest tool of causal inference since it approximates very closely the ideal setting of randomized controlled experiments” (Lee and Lemieux, 2010).

• Potential concern of RDD: **external validity**.
  - Identification is obtained from firms close to discontinuity.
  - Are those firms representative of firms far from discontinuity?

• Assessment of external validity:
  - Contrast firms close to discontinuity with firms far from discontinuity.
## External Validity

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mean [–5%, +5%]</th>
<th>Mean [-10%, +10%]</th>
<th>Other Proposals</th>
<th>Mean [–5%, +5%]</th>
<th>Mean [-10%, +10%]</th>
<th>Other Proposals</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal return on meeting day</td>
<td>0.001</td>
<td>0.000</td>
<td>0.900</td>
<td>0.000</td>
<td>0.001</td>
<td>0.325</td>
<td></td>
</tr>
<tr>
<td>Market value ($ billion)</td>
<td>41.088</td>
<td>37.595</td>
<td>0.715</td>
<td>37.157</td>
<td>38.043</td>
<td>0.872</td>
<td></td>
</tr>
<tr>
<td>Total assets ($ billion)</td>
<td>115.722</td>
<td>108.582</td>
<td>0.808</td>
<td>112.359</td>
<td>108.414</td>
<td>0.814</td>
<td></td>
</tr>
<tr>
<td>Total CEO compensation ($ million)</td>
<td>13.139</td>
<td>13.223</td>
<td>0.962</td>
<td>13.995</td>
<td>13.034</td>
<td>0.513</td>
<td></td>
</tr>
<tr>
<td>Long-term CEO compensation ($ million)</td>
<td>5.851</td>
<td>4.197</td>
<td>0.227</td>
<td>5.178</td>
<td>4.127</td>
<td>0.175</td>
<td></td>
</tr>
<tr>
<td>LT-index</td>
<td>0.732</td>
<td>0.751</td>
<td>0.262</td>
<td>0.731</td>
<td>0.753</td>
<td>0.088*</td>
<td></td>
</tr>
<tr>
<td>Capital expenditures</td>
<td>0.045</td>
<td>0.046</td>
<td>0.906</td>
<td>0.043</td>
<td>0.046</td>
<td>0.371</td>
<td></td>
</tr>
<tr>
<td>R&amp;D expenditures</td>
<td>0.050</td>
<td>0.038</td>
<td>0.208</td>
<td>0.045</td>
<td>0.038</td>
<td>0.306</td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>0.095</td>
<td>0.114</td>
<td>0.064*</td>
<td>0.108</td>
<td>0.114</td>
<td>0.363</td>
<td></td>
</tr>
<tr>
<td>NPM</td>
<td>0.181</td>
<td>0.190</td>
<td>0.660</td>
<td>0.192</td>
<td>0.189</td>
<td>0.840</td>
<td></td>
</tr>
<tr>
<td>Sales growth</td>
<td>0.078</td>
<td>0.070</td>
<td>0.734</td>
<td>0.097</td>
<td>0.064</td>
<td>0.070*</td>
<td></td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>1.503</td>
<td>1.680</td>
<td>0.146</td>
<td>1.611</td>
<td>1.679</td>
<td>0.409</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>0.279</td>
<td>0.289</td>
<td>0.611</td>
<td>0.267</td>
<td>0.293</td>
<td>0.076*</td>
<td></td>
</tr>
<tr>
<td>KZ-index</td>
<td>0.153</td>
<td>0.165</td>
<td>0.901</td>
<td>0.195</td>
<td>0.157</td>
<td>0.510</td>
<td></td>
</tr>
</tbody>
</table>

Companies at the threshold are likely **representative** of other companies in our sample.
Agenda

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Recap—RDD “Etiquette”

- Steps to implement the RDD:
  - Starting point: a “discontinuity”:
    - E.g., majority threshold for election/vote, merit threshold for award, etc.
    - Importantly, being marginally above or below the discontinuity should be “as good as random”.
  - Randomization tests:
    - McCrary test.
    - Covariate balance.
  - Estimation:
    - Non-parametric: compare means right above vs. right below discontinuity.
    - Parametric: polynomials.
  - External validity:
    - Contrast firms close to discontinuity vs. firms far from discontinuity.
Literature

• Econometrics of RDD:

• Applications of RDD:
Thank You!