

2018 AoM PDW “Natural Experiments in Management
Research: A Hands-on Introduction”


An Illustration of the Regression Discontinuity Design

Caroline Flammer
Boston University

August 10, 2018

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.**

Three Methods of Causal Inference

- 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 a Long-Term Orientation Create Value: Evidence from a Regression Discontinuity”
(*Strategic Management Journal*, 2017)

Agenda

1. Discontinuity
2. Randomization Tests
3. Estimation
4. External Validity
5. Recap—RDD “Etiquette”

Context

- Do companies benefit from a longer-term orientation?
- “Naïve” OLS Regression:

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


← →
Omitted Variables?

- **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.
- ...



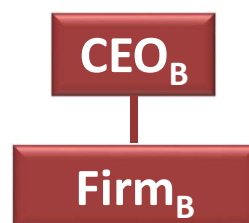

Ideal Experiment

**Long-term orientation
(random)**



- Shareholder value
- Operating performance

**Short-term orientation
(random)**



- Shareholder value
- Operating performance

RDD Approach

- 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).

Shareholder Proposals on LT Executive Compensation

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.

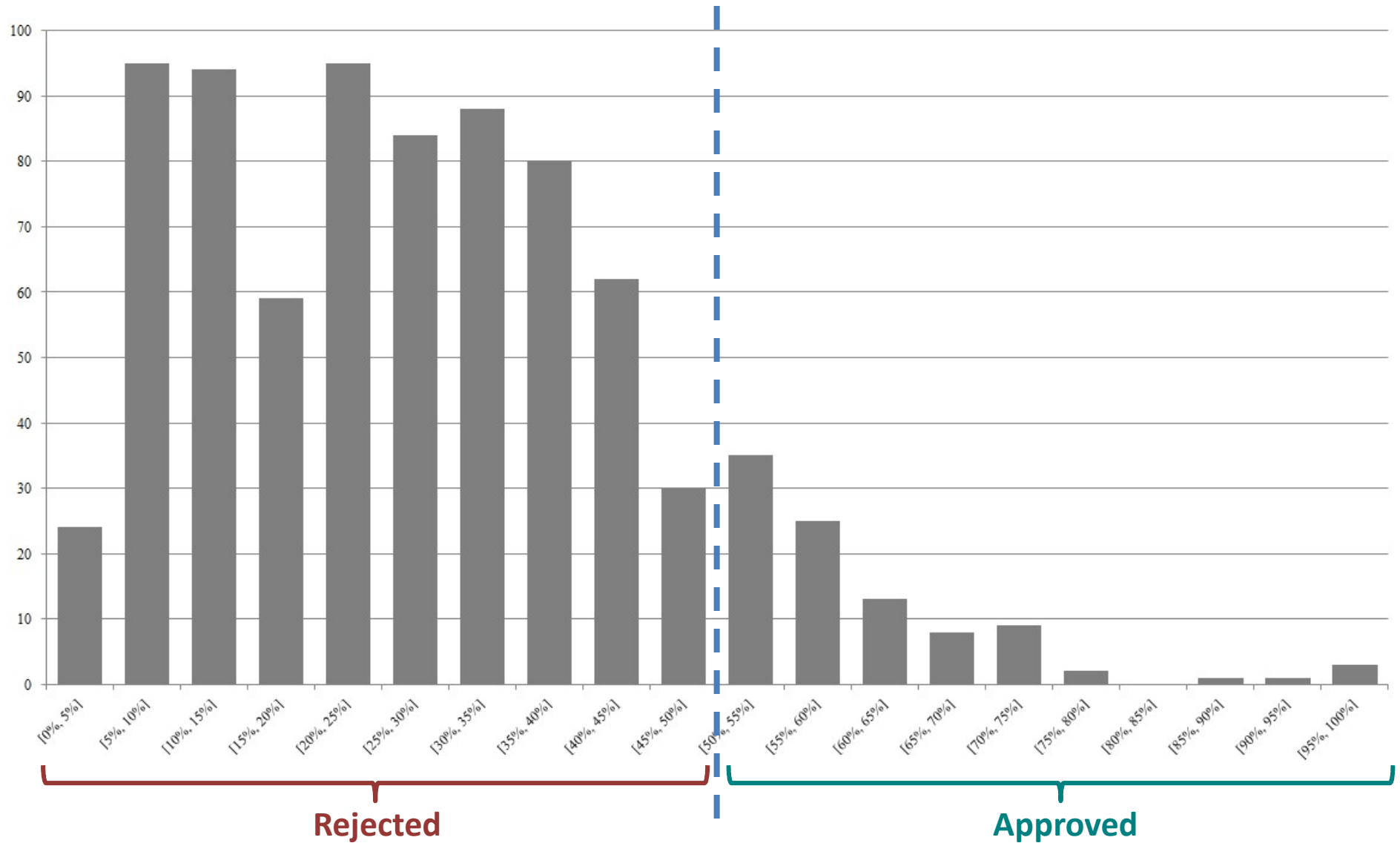
Voting result: Passed (50.1% Yes versus 49.9% No)

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



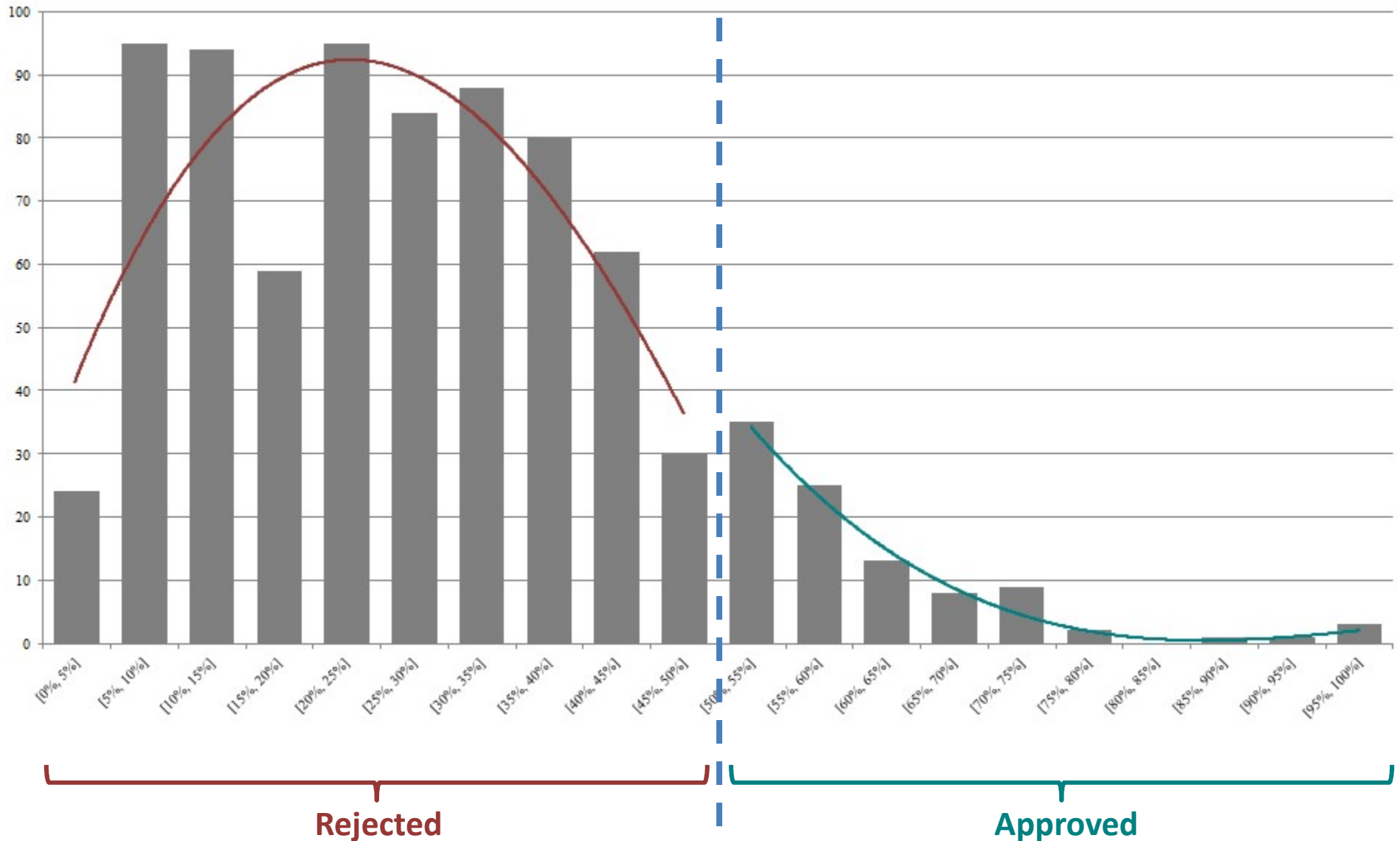
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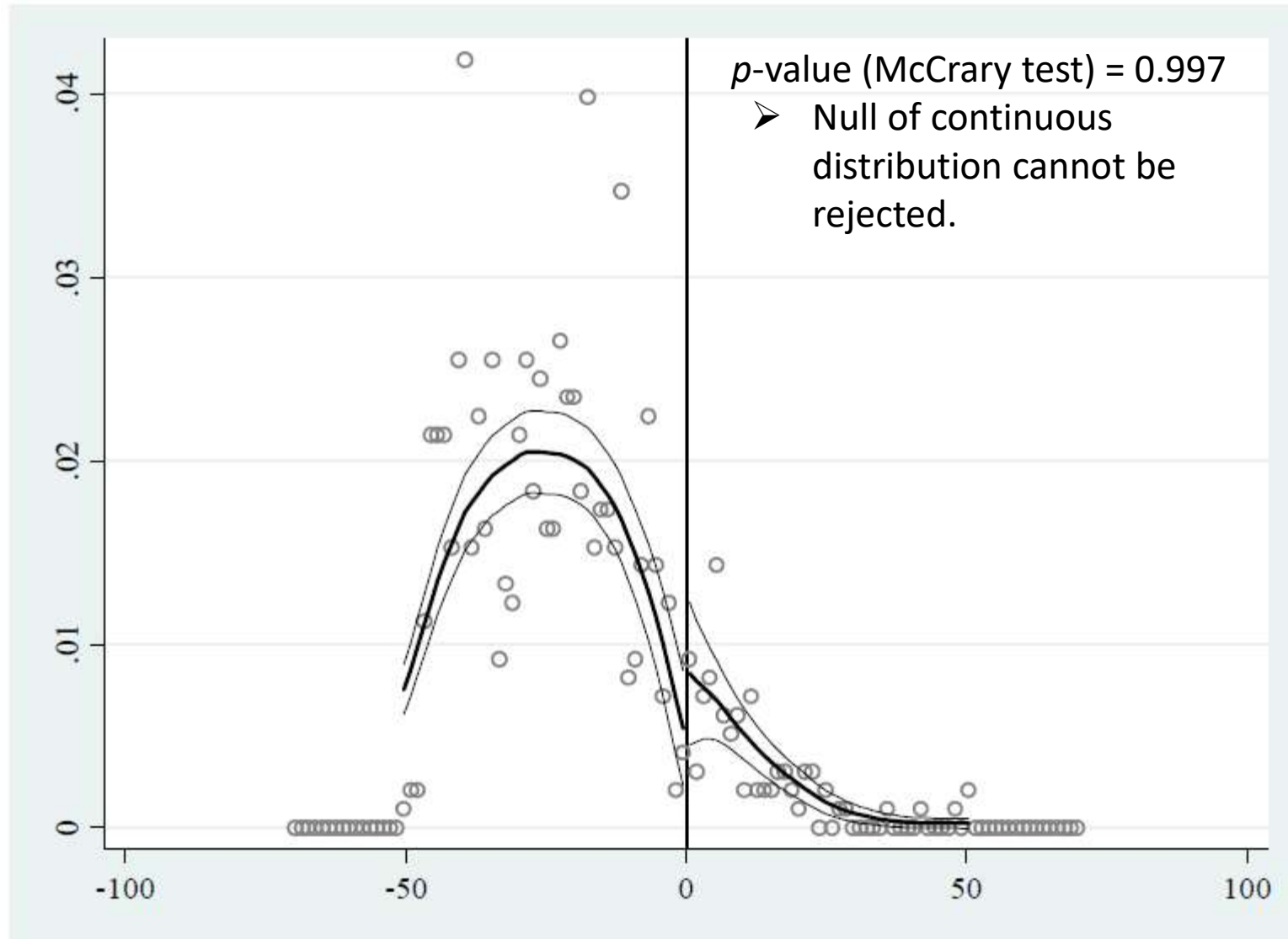
Randomization Tests

- **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



McCrary Test



No Pre-Existing Differences around Majority Threshold

	Before meeting ($t - 1$)		Change from ($t - 2$) to ($t - 1$)	
	(1)	(2)	(3)	(4)
Abnormal return	0.000 (0.002)	0.003 (0.005)	-0.001 (0.003)	0.003 (0.007)
Market value	-0.533*** (0.183)	-0.207 (0.356)	-0.043 (0.055)	0.044 (0.107)
Total assets	-0.491** (0.192)	0.087 (0.374)	-0.026 (0.024)	0.012 (0.046)
Total CEO compensation	0.220 (0.192)	0.254 (0.374)	0.128 (0.181)	0.529 (0.352)
Long-term CEO compensation	0.282 (0.850)	0.459 (1.623)	0.195 (0.761)	0.249 (1.474)
LT-index	-0.016 (0.016)	0.047 (0.031)	-0.000 (0.011)	0.010 (0.022)
Capital expenditures	-0.004 (0.005)	0.004 (0.008)	-0.001 (0.002)	-0.001 (0.004)
R&D expenditures	0.005 (0.007)	-0.001 (0.014)	-0.003 (0.002)	-0.001 (0.005)
ROA	-0.007 (0.010)	-0.001 (0.018)	-0.000 (0.006)	-0.006 (0.011)

No Pre-Existing Differences around Majority Threshold

	Before meeting ($t - 1$)		Change from ($t - 2$) to ($t - 1$)	
	(1)	(2)	(3)	(4)
NPM	-0.002 (0.021)	0.002 (0.040)	-0.005 (0.016)	-0.001 (0.032)
Sales growth	0.007 (0.022)	-0.004 (0.043)	0.022 (0.030)	0.028 (0.058)
Tobin's Q	-0.199* (0.107)	-0.176 (0.213)	-0.002 (0.051)	0.088 (0.102)
Leverage	-0.008 (0.018)	0.007 (0.034)	-0.004 (0.006)	-0.001 (0.012)
KZ-index	0.022 (0.087)	0.211 (0.174)	-0.057 (0.039)	-0.053 (0.079)
KLD-index	-0.949** (0.428)	0.122 (0.843)	0.010 (0.180)	-0.172 (0.357)
G-index	0.675** (0.262)	0.661 (0.507)	-0.025 (0.056)	-0.019 (0.109)

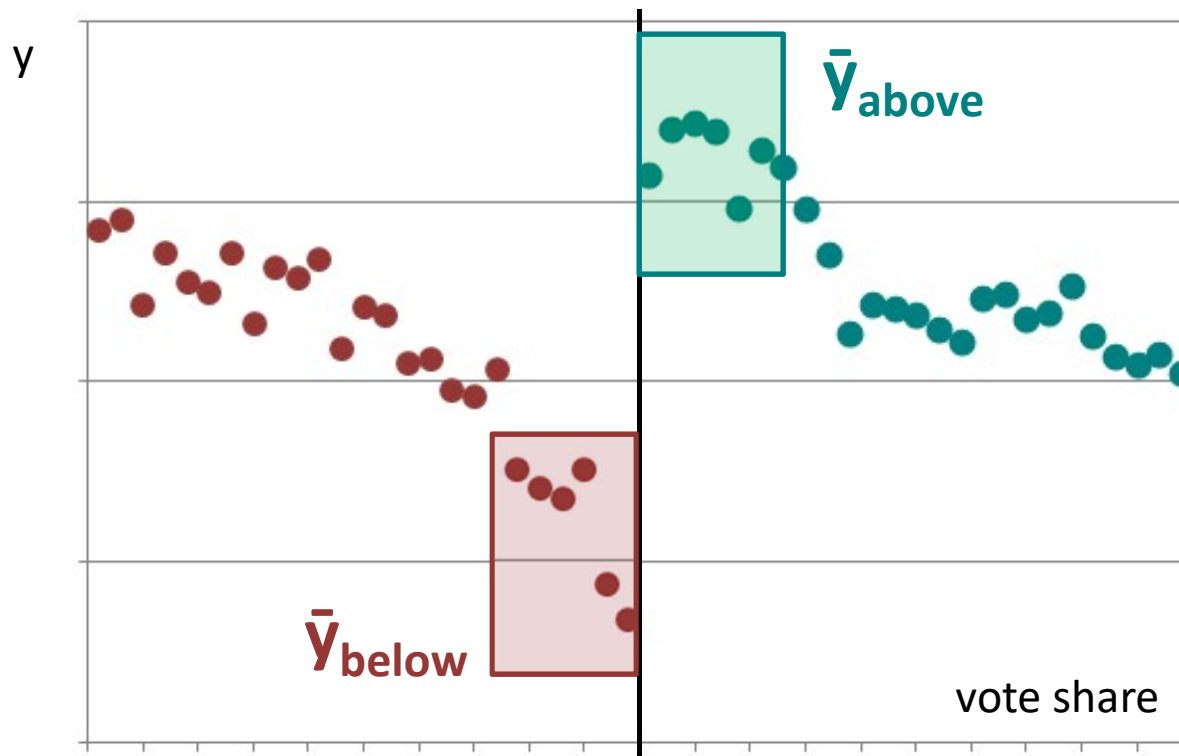
- Firms that marginally rejected proposals are **very similar** to firms that marginally accepted proposals, which **supports** the **randomization assumption**.

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Regression Discontinuity Design (RDD)

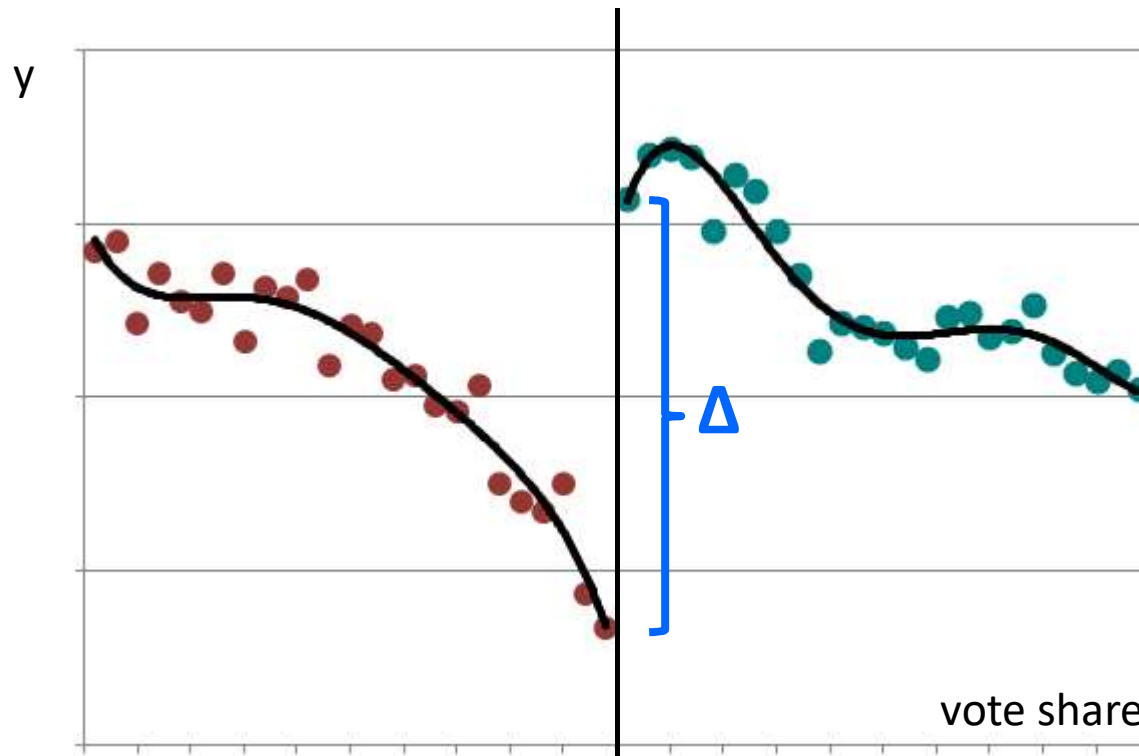
Objective: measure difference in outcome variable y around threshold.



$$\Delta = \bar{y}_{\text{above}} - \bar{y}_{\text{below}}$$

Regression Discontinuity Design (RDD)

Objective: measure difference in outcome variable y around threshold.

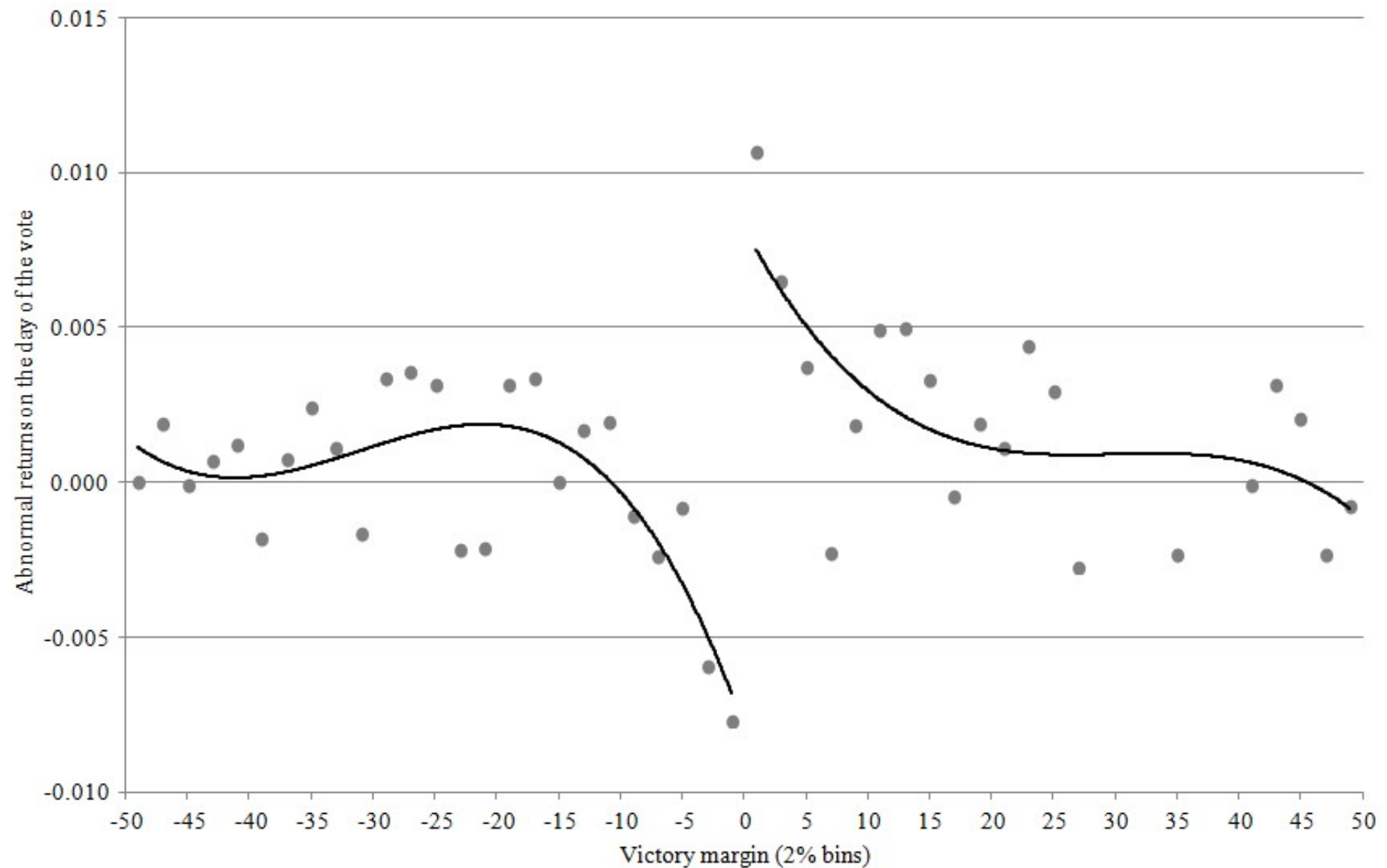


Regression Discontinuity Design

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

- 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).
- 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.
- ε_{it} : error term (standard errors clustered at firm level).

Abnormal Returns on Day of Vote



Effect of LT Incentives on Firm Performance

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

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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

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

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

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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:
 - Imbens GW, Lemieux T. 2008. Regression discontinuity designs: A guide to practice. *Journal of Econometrics* 142(2): 615–635.
 - Lee DS, Lemieux T. 2010. Regression discontinuity designs in economics. *Journal of Economic Literature* 48(2): 281–355.
- Applications of RDD:
 - Flammer C. 2015. Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. *Management Science* 61(11): 2549-2568.
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Thank You!

Contact: cflammer@bu.edu

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