Bakke & Whited [JF 2012]
Threshold Events and Identification: A Study of Cash Shortfalls
Discussion by Fabian Brunner & Nicolas Boob
Background and Motivation

- Rauh (2006): Financial constraints and real investment
  - Endogeneity: Investment opportunities are not observed
  - Idea: Use threshold event, i.e. mandatory pension contributions, to infer the causal relation (using kinks in the calculation function)
  - Result: firms cut investment by 70 ct. for each dollar of mandatory pension contribution!

- This paper (Bakke and Whited, 2012):
  - Explains how to properly use threshold events for identification in terms of Regression Discontinuity Design (see also Imbens and Lemieux, 2008)
  - Shows that Rauh’s results are due to an improper identification strategy: a small number of financially distressed firms drive the results
  - Shows that (affected!) firms rather manage receivables or the number of employees by using proper RDD
Regression Discontinuity Design

- First description: 1960 in social science literature, since the late 1990s numerous applications in economics (see Lee and Lemieux, 2010)
- Goal: Causal estimation of treatment effect: \( y_{i,1} - y_{i,0} = \alpha \)
  - The counterfactual remains unobserved however...
- Threshold events as quasi-natural experiments, given objects can not manipulate the assignment variable
  - Or only to a limited extent (McCrary, 2008)
  - Plausible for mandatory pension contributions: interest rates, market values
- Intuition: Objects just above and below the threshold are quasi-randomly assigned
- Examples: Scholarships and earnings, Test scores and class size
Regression Discontinuity Design – “Theory”

- Assumption I (Sharp RDD): Assignment to treatment is based on single, continuous measure $x$
- Assumption II: Measure $x$ has positive density in a neighborhood of the threshold $c$

$$y_i = \beta + \alpha D \{ x_i > c \} + u_i$$

$$\lim_{x_i \downarrow c} E [y_i | x_i] - \lim_{x_i \uparrow c} E [y_i | x_i] = \alpha \left( \lim_{x_i \downarrow c} E [D \{ x_i > c \} | x_i] - \lim_{x_i \uparrow c} E [D \{ x_i > c \} | x_i] \right)$$

$$+ \left( \lim_{x_i \downarrow c} E [u_i | x_i] - \lim_{x_i \uparrow c} E [u_i | x_i] \right)$$

$$\alpha = \lim_{x_i \downarrow c} E [y_i | x_i] - \lim_{x_i \uparrow c} E [y_i | x_i]$$

- Hence, the treatment effect can be estimated by the difference in (conditional) means in observations just above and below the threshold
- Then we don’t need to model $E [y_i | x_i]$ explicitly to estimate the local treatment
- Also, we don’t need to include all other influential variables (quasi-experiment)
Regression Discontinuity Design - Illustration

- Using the whole population, we need to get the functional form of $E[y_i|x_i]$ right

- By restricting to a subpopulation within a small bandwidth of the threshold, a local linear regression will do the job

- Trade-off: Power vs accuracy

Source: Angrist and Pischke (2008)
Internal vs. External Validity of RDD

- RDD has high internal validity, only weak assumptions needed
  - We can plausibly estimate the causal effect for firms close to the cut-off

- At best, however, we are estimating the local average treatment effect

- Strong assumptions are required to extrapolate the results to other observations or populations, i.e. homogenous (!) treatment effects.
  - E.g. a firm that might expect very bad effects could position themselves prohibitively far away from the threshold (or use other means to avoid it entirely)

- Hence, RDD provides only very limited external validity
### Global Investment Regression

<table>
<thead>
<tr>
<th></th>
<th>0.019</th>
<th>0.019</th>
<th>0.019</th>
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</thead>
<tbody>
<tr>
<td>Market-to-Book</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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<tr>
<td>Nonpension</td>
<td>0.113</td>
<td>0.113</td>
<td>0.112</td>
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<td>0.111</td>
<td>0.112</td>
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<tr>
<td>Cash Flow</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.011)</td>
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<tr>
<td>MPCs</td>
<td>-0.638</td>
<td>-0.624</td>
<td>(0.267)</td>
<td>(0.268)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding</td>
<td>0.024</td>
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<td></td>
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<tr>
<td>Status</td>
<td>(0.011)</td>
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<td></td>
<td></td>
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<tr>
<td>Funding Gap</td>
<td>0.038</td>
<td>0.048</td>
<td>(0.020)</td>
<td>(0.020)</td>
<td></td>
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<tr>
<td>Violation Indicator (×10)</td>
<td>-0.020</td>
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<td></td>
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<tr>
<td>Distance from 90% Underfunding</td>
<td>0.053</td>
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<td></td>
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</tr>
<tr>
<td>Distance from 80% Underfunding</td>
<td></td>
<td></td>
<td></td>
<td>0.058</td>
<td>(0.021)</td>
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<tr>
<td>Distance from the Kink</td>
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<td></td>
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<td></td>
<td>0.030</td>
<td>(0.030)</td>
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<tr>
<td>Kink Indicator (×10)</td>
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<td></td>
<td>0.020</td>
<td>(0.014)</td>
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<tr>
<td>R² (within)</td>
<td>0.101</td>
<td>0.101</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
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<tr>
<td>R²</td>
<td>0.684</td>
<td>0.684</td>
<td>0.684</td>
<td>0.684</td>
<td>0.684</td>
<td>0.691</td>
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</table>
### Split Samples

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>At Least 90% Funded</th>
<th>At Least 80% Funded</th>
<th>&gt;90% or &lt;80% Funded</th>
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</thead>
<tbody>
<tr>
<td>Market-to-Book</td>
<td>0.019</td>
<td>0.019</td>
<td>0.019</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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<tr>
<td>Nonpension</td>
<td>0.113</td>
<td>0.113</td>
<td>0.120</td>
<td>0.117</td>
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<tr>
<td></td>
<td>(0.011)</td>
<td>(0.013)</td>
<td>(0.011)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Cash Flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPCs</td>
<td>-0.624 ***</td>
<td>-0.586</td>
<td>-0.746 ***</td>
<td>-0.498</td>
</tr>
<tr>
<td></td>
<td>(0.268)</td>
<td>(0.434)</td>
<td>(0.317)</td>
<td>(0.317)</td>
</tr>
<tr>
<td>Funding</td>
<td>0.038</td>
<td>0.034</td>
<td>0.037</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.021)</td>
<td>(0.020)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Gap</td>
<td>0.101</td>
<td>0.106</td>
<td>0.105</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
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<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>R² (within)</td>
<td>0.684</td>
<td>0.693</td>
<td>0.690</td>
<td>0.686</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>7889</td>
<td>6932</td>
<td>7461</td>
<td>7360</td>
</tr>
</tbody>
</table>

- 12% of the sample is less than 90% founded
- 6% of the sample is less than 80% funded
### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>In Violation</th>
<th>Not in Violation</th>
<th>&lt;90% Funded</th>
<th>&lt;80% Funded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total assets</td>
<td>3,418</td>
<td>3,435</td>
<td>3,409</td>
<td>2,362</td>
<td>2,152</td>
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<tr>
<td>Employment % Change</td>
<td>0.808</td>
<td>0.520</td>
<td>0.965</td>
<td>-1.691</td>
<td>-2.853</td>
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<tr>
<td>Earnings</td>
<td>0.042</td>
<td>0.034</td>
<td>0.046</td>
<td>0.014</td>
<td>0.006</td>
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<tr>
<td>Z-Score</td>
<td>2.780</td>
<td>2.280</td>
<td>3.052</td>
<td>1.667</td>
<td>1.599</td>
</tr>
</tbody>
</table>

- Firms with pension plans are larger than the average Compustat firm
- Size of investment 40 times larger than mandatory contributions
- Comparability of treatment and control group questionable
Do firms manipulate the funding gap?

Continuous density necessary for identification with RDD

Clustering but no bunching observable
Local responses to funding violations

- Regression on a dummy for negative funding status
- Increasing sample size: sensitivity to window with
  - Gap of 0.002 = sample size of 406
  - Gap of 0.04 = sample size of 2,180
Local response: 90% Underfunding Point

- Magnitude of changes in receivables and employment larger than rise in mandatory contributions
- Pension contributions may capture expectations about the future
- Falsification test with interaction of before 1995-dummy
Summary

- Results of Rauh are driven by a small group of firms
- No causal evidence that financing impacts investment

Limitations and Criticism

- Noisy measure of the underfunding variable
- RDD has a high internal but limited external validity
- Overall treatment effect only under strong assumptions estimable
- More recent evidence on extrapolation from the discontinuity cut-off
  - Angrist and Rokkanen (2015)
References


