Threshold Events and Identification: A Study of Cash Shortfalls

Tor-Erik Bakke and Toni M. Whited
Journal of Finance, 2012

Discussion by Fabian Gamm
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Provide guidance how one can and cannot use threshold events to identify causal relationships (resolving endogeneity issues)

Looking at a prominent paper that uses threshold events:

Rauh (2006), Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans

Rough overview of Rauh’s motivation:

- No financing constraints → internal cash shortfalls should not lead to a reduction of (profitable) investments since external capital markets can be used

- Problem when empirically testing this relation: investment opportunities can drive both investment and cash flows but are not directly observable → endogeneity
Motivation

- **Idea:** Use exogeneous variation in cash flows for identification
  - mandatory contributions (MC) to defined benefit pension plans
    - depend on degree of pension funding = pension assets - pension liabilities
    - discontinuities at 100% funding, 90% funding, 80% funding and an additional kink
      → 4 potential threshold events
    - Ass: investment opportunities do not have the same jumps

- **Approach:**
  \[
  \frac{I_{it}}{A_{i,t-1}} = a_i + a_t + b_1 Q_{i,t-1} + b_2 \frac{CF_{it}}{A_{i,t-1}} + b_3 \frac{FS_{it}}{A_{i,t-1}} + b_4 \frac{MC_{it}}{A_{i,t-1}} + u_{it},
  \]
  → controlling for Tobin’s Q / operating CFs / funding status FS (pension assets – pension liabilities)

- **Result:** Firms cut investment by 70 ct. for each dollar of mandatory pension contribution

- **Claim:** This effect is causal!
Motivation

- Bakke and Whited (2012) show that this result comes from an improper identification strategy:
  - small number of potentially financially distressed firms drive the result
  - comparability between treatment and control group questionable

- Intuition to use threshold events for identification comes from regression discontinuity design (RDD) – econometric method introduced in the 1960s
  - crucial to understand when it is valid to extend the intuition behind RDD to more general regression settings
Background: Regression Discontinuity Design (RDD)

- Threshold event = discrete event/treatment when an observable continuous variable passes a known threshold
  - here: jumps in mandatory pension contributions when funding status passes a certain threshold

- Assumption: Firms have imperfect control over their exact location near the threshold (quasi-random assignment of the treatment)
  - plausible: funding status depends on market values of assets, interest rates, ...

  → Thus: observations immediately to one side of the threshold are unlikely to differ systematically from observations immediately to the other side
  → valid control and treatment groups

- Local effect of treatment = average differences between variable of interest (here: investment) between treatment and non-treatment group
  → causal interpretation
Regression Discontinuity Design (RDD)

- RDD has strong local validity (firms close to the threshold) but weak external validity (firms far away from the threshold)
  → resolves endogeneity problem only for observations close to the threshold

- Extrapolating results to the whole sample
  - assume homogeneous treatment effect
  - control for the systematic differences (unobservable?)

→ Thus: including discontinuous variables in normal regressions using the whole sample as done by Rauh (2006) does not guarantee identification (not a strict application of RDD)
  → carefully examine whether this is valid or not
Two kernel regressions (nonparametric) of investment on funding status

- 100% funding: → lots of observations
  → but jump is not significant and has a small economic magnitude
- Other thresholds: → very few observations (external validity issue)
  → no significant discontinuities
Which threshold is most relevant for identification?

<table>
<thead>
<tr>
<th>Dependent variable: Investment</th>
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</thead>
<tbody>
<tr>
<td>Market-to-Book</td>
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<tr>
<td>Nonpension</td>
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<td></td>
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<tr>
<td>Cash Flow</td>
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<td></td>
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<td>MPCs</td>
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<tr>
<td>Funding</td>
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<tr>
<td>Gap</td>
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<td>Violation</td>
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<tr>
<td>Indicator</td>
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<tr>
<td>Distance from</td>
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<tr>
<td>90% Underfunding</td>
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<td>90% Underfunding Indicator</td>
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<tr>
<td>Distance from</td>
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<td>80% Underfunding</td>
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<tr>
<td>80% Underfunding Indicator</td>
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<tr>
<td>Distance from the Kink</td>
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<tr>
<td>Kink Indicator</td>
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</tbody>
</table>

Results

- Similar regression setup as in Rauh (2006) → variables scaled by total assets
- 4 thresholds tested (with dummy)
- Only significant decrease in investment at the 90% underfunding threshold
Dropping 12% of sample that is less than 90% funded: all significance gone

Dropping 6% of the sample that is less than 80% funded: significant again

Identification seems to come from the 80%-90% funded firms

But: These 529 firms are only ~6% of the total sample

Can one really extrapolate this result to the rest of the sample?
Treated firms are on average 33% smaller, have less cash-flows and earnings, pay lower dividends, and have lower bond-ratings and Z-scores → some are indicators of financial distress/financing constraints → comparability violated

Mandatory pension contributions are tiny relative to investment

<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>
</tr>
<tr>
<td>Mandatory Contributions</td>
<td>0.001</td>
<td>0.003</td>
<td>0.000</td>
<td>0.005</td>
<td>0.006</td>
</tr>
<tr>
<td>Investment</td>
<td>0.069</td>
<td>0.066</td>
<td>0.071</td>
<td>0.057</td>
<td>0.055</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.096</td>
<td>0.089</td>
<td>0.100</td>
<td>0.068</td>
<td>0.057</td>
</tr>
<tr>
<td>Bond Rating</td>
<td>0.411</td>
<td>0.400</td>
<td>0.417</td>
<td>0.271</td>
<td>0.193</td>
</tr>
<tr>
<td>Dividends</td>
<td>0.019</td>
<td>0.015</td>
<td>0.021</td>
<td>0.010</td>
<td>0.011</td>
</tr>
<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>
</tr>
<tr>
<td>Earnings</td>
<td>0.042</td>
<td>0.034</td>
<td>0.046</td>
<td>0.014</td>
<td>0.006</td>
</tr>
<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>

Problem 2 with this identification

Large systematic differences in characteristics between observations that provide identification (<90% funding) and rest of the sample
Analysis using RDD (local sample analysis)

1. Check whether firms seem to ‘manipulate’ funding gap

- Assignment measure of treatment should be not perfectly controllable by managers
- No clustering right after thresholds $\rightarrow$ no evidence of systematic active manipulation $\rightarrow$ valid assignment measure
- Kind of plausible given the small economic magnitude of the mandatory pension contributions (losing tax benefits if plan is overfunded)
Analysis using RDD (local sample analysis)

2. Local responses (Threshold = 100% funding)

- dependent variable = label of graph
  
  y-axis: coefficient on dummy that = 1 when funding < 100% (estimate of treatment effect)
  
  x-axis: gap-width = absolute value of distance from the threshold points
  → increasing sample size → trade-off: statistical power vs. unbiasedness

- Investment not significantly different from zero
Analysis using RDD (local sample analysis)

2. Local responses (Threshold = 100% funding)

- Significant negative treatment effects for R&D, inventories, receivables and changes in employees
- Similar results when using 90% threshold
Strong sensitivity of investment to mandatory pension contributions found in Rauh (2006) stems from heavily underfunded firms that:
- constitute a small fraction (~6.7%) of the sample
- are systematically different from the rest of the sample with respect to firm characteristics that are related to financial distress and financing constraints

→ cannot directly extrapolate the results to the whole sample
→ cannot rule out the possibility that unobservable characteristics cause both the pension underfunding and the investment declines

Firms that are affected by a mandatory pension contribution shock actually seem to manage receivables or the number of employees instead of reducing investments (but: local sample analysis)