IV and Difference-in-Differences Design

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May 28, 2023

Empirical Example: Fabian Waldinger (2010)
Combining DD and IV

Fabian Waldinger (2010) "**Quality Matters: The Expulsion of Professors and the Consequences for PhD Student Outcomes in Nazi Germany**" JPE

- The author estimates the effect of faculty quality on the outcomes of PhD students by combining IV and DID approach

- Sometimes combining DID and IV methods can be quite useful

Empirical Example: Fabian Waldinger (2010)
Motivation

- Estimating the effect of faculty quality on PhD student outcomes is challenging because of:
    1. Selection of good students into good universities
    2. Omitted variables affecting both faculty quality and student outcomes
    3. Measurement error in faculty quality
- He address these issues by using the dismissal of scientists in Nazi Germany as an exogenous shock to faculty quality
- The dismissal affected some departments very strongly, while other departments were not affected

Empirical Example: Fabian Waldinger (2010)

Historical Background

- Germany was the leading country for scientific research at the beginning of the 20th century

- Immediately after gaining power in 1933 the new Nazi government dismissed all Jewish and "politically unreliable" scholars from the German universities

Reichsgesetzblatt

Teil I

| 1933 | Ausgegeben zu Berlin, den 7. April 1933 | Nr. 34 |

Inhalt: Gesetz zur Wiederherstellung des Berufsbeamtentums. Vom 7. April 1933................. S. 175

Gesetz zur Wiederherstellung des Berufsbeamtentums.
Vom 7. April 1933.

Die Reichsregierung hat das folgende Gesetz beschlossen, das hiermit verkündet wird:

§ 1

(1) Zur Wiederherstellung eines nationalen Berufsbeamtentums und zur Vereinfachung der Verwaltung können Beamte nach Maßgabe der folgenden Bestimmungen aus dem Amt entlassen werden, auch wenn die nach dem geltenden Recht hierfür erforderlichen Voraussetzungen nicht vorliegen.

(2) Als Beamte im Sinne dieses Gesetzes gelten unmittelbare und mittelbare Beamte des Reichs,

des jeweiligen Grundgehalts der von ihnen zuletzt bekleideten Stelle bewilligt werden; eine Nachversicherung nach Maßgabe der reichsgesetzlichen Sozialversicherung findet nicht statt.

(4) Die Vorschriften der Abs. 2 und 3 finden auf Personen der im Abs. 1 bezeichneten Art, die bereits vor dem Inkrafttreten dieses Gesetzes in den Ruhestand getreten sind, entsprechende Anwendung.

§ 3

(1) Beamte, die nicht arischer Abstammung sind, sind in den Ruhestand (§§ 8 ff.) zu versetzen; soweit es sich um Ehrenbeamte handelt, sind sie aus dem Amtsverhältnis zu entlassen.

Empirical Example: Fabian Waldinger (2010)
Data

- A panel dataset of all mathematics PhD students graduating from all German universities between 1923 and 1938

- A panel dataset of faculty members from all German universities between 1923 and 1938

- Construct a measure of faculty quality

Empirical Example: Fabian Waldinger (2010)

Dismissed Professors Across German Universities

University	Number of Professors Beginning of 1933	Dismissed 1933–34		Dismissal-Induced Change to Department Quality
		Number	Percentage	
Aachen TU	7	3	42.9	+
Berlin	13	5	38.5	− −
Berlin TU	14	2	14.3	+
Bonn	7	1	14.3	+
Braunschweig TU	3	0	0	0
Breslau	6	3	50.0	− −
Breslau TU	5	2	40.0	− −
Darmstadt TU	9	1	11.1	+
Dresden TU	10	0	0	0
Erlangen	3	0	0	0
Frankfurt	8	1	12.5	+
Freiburg	9	1	11.1	−
Giessen	7	1	14.3	+
Göttingen	17	10	58.8	− −
Greifswald	3	0	0	0

Empirical Example: Fabian Waldinger (2010)

Dismissed Professors Across German Universities II

|				
Halle	7	1	14.3	+
Hamburg	8	0	0	0
Hannover TU	6	0	0	0
Heidelberg	5	1	20.0	+
Jena	5	0	0	0
Karlsruhe TU	6	1	16.7	0
Kiel	5	2	40.0	+
Köln	6	2	33.3	+
Königsberg	5	2	40.0	−
Leipzig	8	2	25.0	−
Marburg	8	0	0	0
München	9	0	0	0
München TU	5	0	0	0
Münster	5	0	0	0
Rostock	2	0	0	0
Stuttgart TU	6	0	0	0
Tübingen	6	0	0	0
Würzburg	4	0	0	0

Empirical Example: Fabian Waldinger (2010)

Effect of Dismissals on Department Size
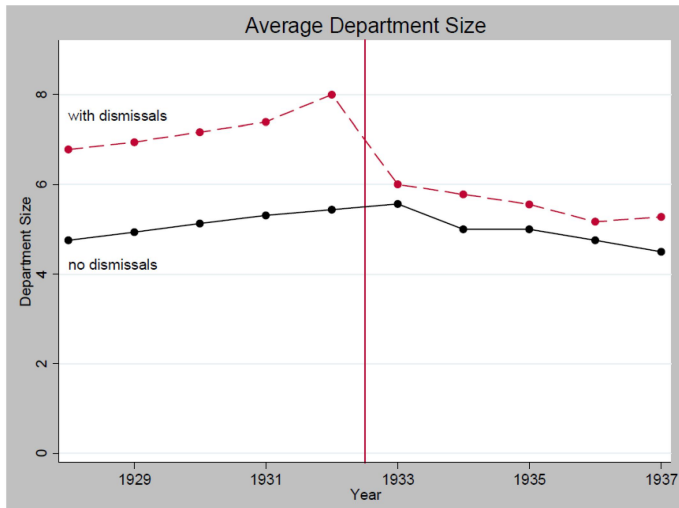
Empirical Example: Fabian Waldinger (2010)
Effect of Dismissals on Faculty Quality

Faculty Quality

with (above avg. quality) dismissals

no dismissals

Average Faculty Quality

Year
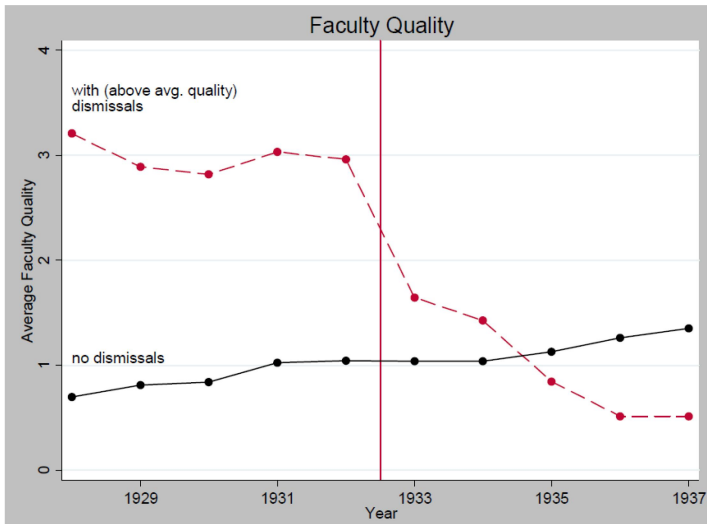
Empirical Example: Fabian Waldinger (2010)
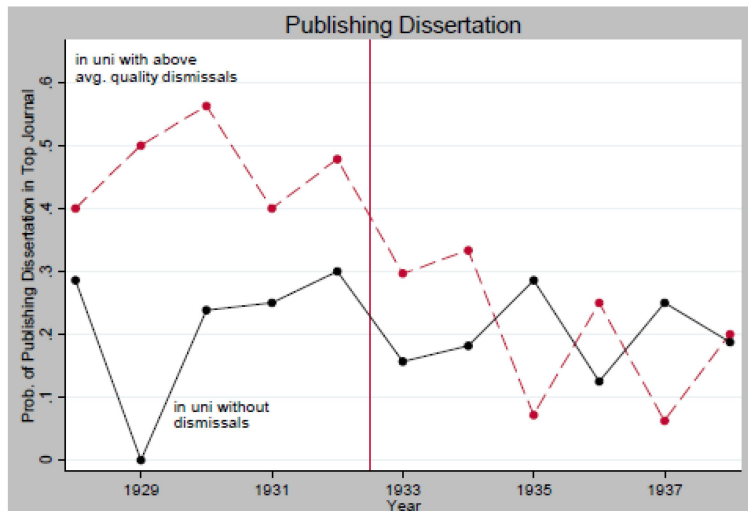Identification Strategy

- Use the dismissal as exogenous variation in faculty quality

- The empirical strategy essentially compares changes in outcomes of PhD students in affected department before and after 1933 to changes in outcomes in unaffected departments

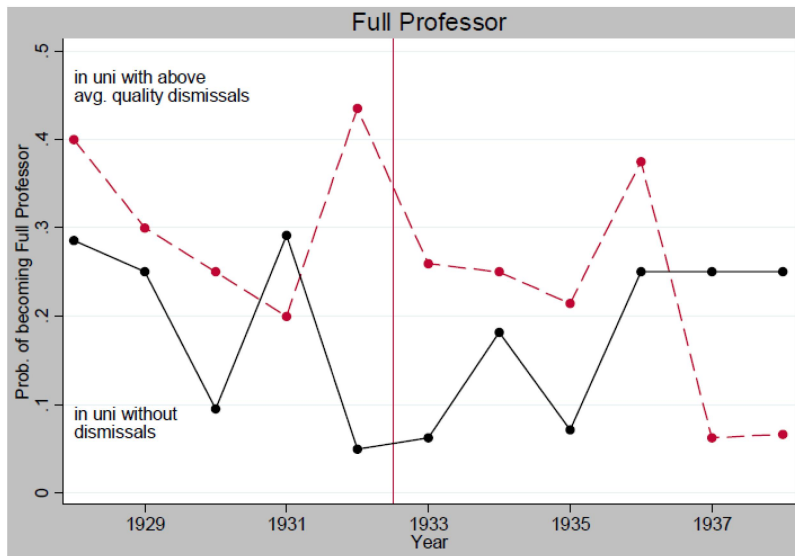# Empirical Example: Fabian Waldinger (2010)
Identification Strategy

- He investigates the following outcomes:
    1. Whether former PhD student publishes dissertation in a top journal
    2. Whether former PhD student ever becomes full professor
    3. # of lifetime citations
    4. Positive lifetime citations

Graphical Analysis - Publishing Dissertation

Publishing Dissertation

in uni with above avg. quality dismissals

in uni without dismissals

Prob. of Publishing Dissertation in Top Journal

Year

Graphical Analysis - Full Professor

Graphical Analysis - Lifetime Citations
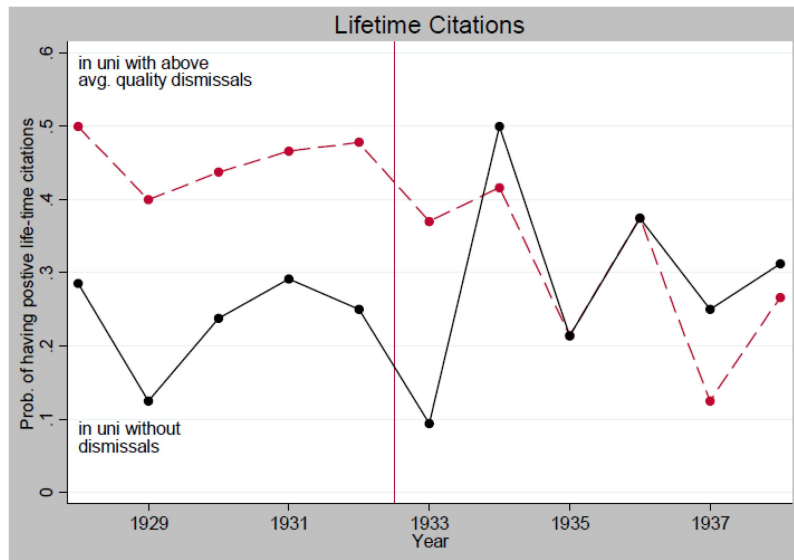
DID Estimation

- He estimates the following DID regression:

$$\text{Outcome}_{idt} = \beta_1 + \beta_2(\text{Dismissal induced Reduction in Faculty Quality}_{dt})$$
$$+ \beta_3(\text{Dismissal induced increase in Student/Faculty Ratio})_{dt}$$
$$+ \beta_4\text{Famale}_{idt} + \beta_5\text{Foreign}_{idt} + \beta_6\text{CohortFE}_t + \beta_7\text{DepFE}_d + \varepsilon_{idt}$$

DID Estimation

- **Dismissal induced Reduction in Faculty Quality** is 0 until 1933

    - It is equal to the dismissal induced fall in faculty quality after 1933 (and remains 0 in departments without dismissals)

- **Dismissal induced increase in Student/Faculty Ratio** is also 0 until 1933

    - It is equal to the dismissal induced increase in student/faculty ratio after 1933

- The above regression is essentially a differences-in-differences estimation but with different treatment intensities.

DID Estimation

Results

	Reduced Form			
	Published Top (1)	Full Professor (2)	No. of Lifetime Citations (3)	Positive Lifetime Citations (4)
Dismissal-induced fall in faculty quality	−.134**	−.090**	−6.137**	−.164**
	(.017)	(.021)	(2.218)	(.019)
Dismissal-induced increase in student/faculty ratio	.002	.000	−.042	.002
	(.001)	(.001)	(.114)	(.002)
Female	.004	−.119*	−10.723*	−.067
	(.048)	(.045)	(4.459)	(.058)
Foreigner	.031	−.147*	.942	−.033
	(.048)	(.065)	(6.151)	(.075)
Father's occupation	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes
Observations	690	690	690	690
R^2	.221	.208	.185	.208

Test Common Trend Assumption

Placebo Test

- He conducts a placebo test using a "treatment" in 1930

	Placebo Moving Dismissal to 1930 (Only Pre-1933 Observations)			
	Published Top (5)	Full Professor (6)	No. of Lifetime Citations (7)	Positive Lifetime Citations (8)
Dismissal-induced fall in faculty quality	−.023	.053	3.434	−.037
	(.031)	(.037)	(5.597)	(.030)
Dismissal-induced increase in student/faculty ratio	−.004	−.002	−.462	−.002
	(.004)	(.005)	(.431)	(.003)
Female	.009	−.167*	−12.114**	−.104
	(.066)	(.068)	(4.228)	(.071)
Foreigner	−.017	−.136	−7.169	−.050
	(.103)	(.102)	(6.479)	(.134)
Father's occupation	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes
Observations	403	403	403	403
R^2	.302	.291	.224	.260

DID Estimation

- If you want to know causal effect of **dismissal induced fall in faculty quality** on PhD student outcomes

    - DID estimation gives you answer

- However, this does not represent the causal effect of **faculty quality** on PhD student outcomes

- Use **dismissal induced fall in faculty quality** as an IV for **faculty quality**

Use Dismissal as IV

- OLS model to the effect of faculty quality on PhD student outcomes:

$$\text{Outcome}_{idt} = \beta_1 + \beta_2(\text{Avg. Faculty Quality})_{dt-1}$$
$$+ \beta_3(\text{Student/Faculty Ratio})_{dt-1}$$
$$+\beta_4\text{Female}_{idt}+\beta_5\text{Foreign}_{idt}+\beta_6\text{CohortFE}_t+\beta_7\text{DepFE}_d+\varepsilon_{idt}$$

- Faculty quality quality and student/faculty ratio are endogenous

    - Use dismissal as IV.

IV Estimation

- 2 Endogenous Variables $\rightarrow$ 2 First Stage Regressions:

  1. Avg. Faculty Quality$_{idt}$ = γ_1
     $+\gamma_2$(Dismissal induced Reduction in Faculty Quality)$_{dt}$
     $+\gamma_2$(Dismissal induced increase in Student/Faculty Ratio)$_{dt}$
     $+\gamma_4$Female$_{idt}$ + γ_5Foreign$_{idt}$ + γ_6CohortFE$_t$ + γ_7DepFE$_d$ + ε_{idt}

  2. Student/Faculty Ratio$_{idt}$ = δ_1
     $+\delta_2$(Dismissal induced Reduction in Faculty Quality)$_{dt}$
     $+\delta_2$(Dismissal induced increase in Student/Faculty Ratio)$_{dt}$
     $+\delta_4$Female$_{idt}$ + δ_5Foreign$_{idt}$ + δ_6CohortFE$_t$ + δ_7DepFE$_d$ + ε_{idt}

IV Estimation

First Stages

	DEPENDENT VARIABLE	
	Average Quality (1)	Student/Faculty Ratio (2)
Dismissal-induced fall in faculty quality	−1.236**	−4.195
	(.074)	(2.058)
Dismissal-induced increase in student/faculty ratio	.014	.439**
	(.008)	(.116)
Female	.142*	1.165
	(.060)	(.705)
Foreigner	.046	−1.971
	(.097)	(1.183)
Cohort dummies	Yes	Yes
University fixed effects	Yes	Yes
Observations	690	690
R^2	.795	.757
Cragg-Donald eigenvalue statistic	25.2	

IV Estimation
First Stages

- To test for weak instruments one cannot simply look at the first stage F-statistics because here we have 2 endogenous regressors and 2 IVs.

- Use Cragg-Donald EV statistic here critical value is 7.03

IV Estimation

Results

	Published Top		Full Professor	
	OLS (1)	IV (2)	OLS (3)	IV (4)
Average faculty quality	.056**	.102**	.037	.076**
	(.018)	(.015)	(.021)	(.015)
Student/faculty ratio	.000	.003	.000	−.001
	(.001)	(.002)	(.001)	(.003)
Female	−.015	−.022	−.099*	−.103**
	(.059)	(.055)	(.041)	(.036)
Foreigner	.014	.022	−.134*	−.135*
	(.048)	(.045)	(.053)	(.053)
Cohort dummies	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes
Observations	690	690	690	690
R^2	.163		.155	
Cragg-Donald eigenvalue statistic		25.2		25.2