13) Difference-in-Differences

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Reference

Tables, Graphics, and Figures from:

1) Angrist & Pischke (2014). **Mastering 'Metrics: The Path from Cause to Effect.** Chapter 5.1.

2) Gertler et al. (2016). **Impact Evaluation in Practice**. Chapter 7.

Holzer et al (1993)

"Are Training Subsidies Effective? The Michigan Experience," Industrial and Labor Relations Review 46, 625-636.

$$log(scrap)_{it} = \beta_0 + \beta_1 grant_{it} + \alpha_i + u_{it}$$

$scrap_{it}$: scrap rate of firm i during year t

$grant_{it}$: 1 if received a job training in 1988

First-Difference Estimator

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + \alpha_i + u_{it}$$

$$y_{i2} = (\beta_0 + \delta_0) + \beta_1 x_{i2} + \alpha_i + u_{i2} \quad [\text{t=2}]$$

$$y_{i1} = \beta_0 + \beta_1 x_{i1} + \alpha_i + u_{i1} \quad [\text{t=1}]$$

$$y_{i2} - y_{i1} = \delta_0 + \beta_1 (x_{i2} - x_{i1}) + u_{i2} - u_{i1}$$

$$\Delta y_i = \delta_0 + \beta_1 \Delta x_i + \Delta u_i$$

Load Data

```
import pandas as pd
import statsmodels.api as sm
file="https://github.com/VitorKamada/ECO5100/raw/master/Data/JTRAIN.DTA"
df = pd.read_stata(file)
df['const'] = 1
df = df[df['d88'] == 1]
```

OLS vs First-Difference

```
reg1 = sm.OLS(df['lscrap'], df[['const', 'grant']],
              missing='drop').fit()
print(reg1.summary())
```

	coef	std err	t	P>|t|
const	0.4085	0.241	1.698	0.095
grant	0.0566	0.406	0.140	0.890

```
reg2 = sm.OLS(df['clscrap'], df[['const', 'cgrant']],
              missing='drop').fit()
print(reg2.summary())
```

	coef	std err	t	P>|t|
const	-0.0574	0.097	-0.591	0.557
cgrant	-0.3171	0.164	-1.935	0.058

Great Depression

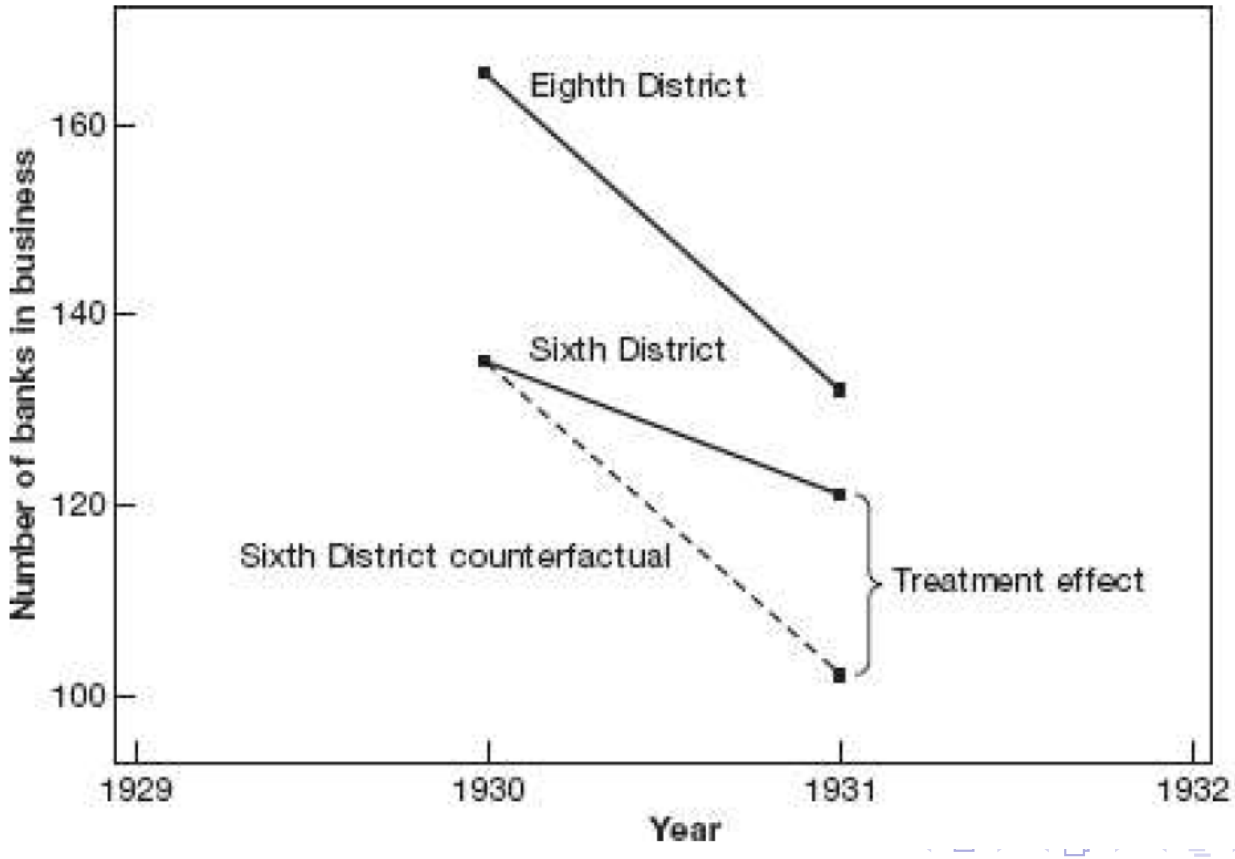
Crisis	Period	Worldwide GDP Fell
Great Depression	1929-1932	15%
Great Recession	2008-2009	1%

Fed	District	Lending (1929-1931)
Atlanta	Sixth	40%
St. Louis	Eighth	-10%

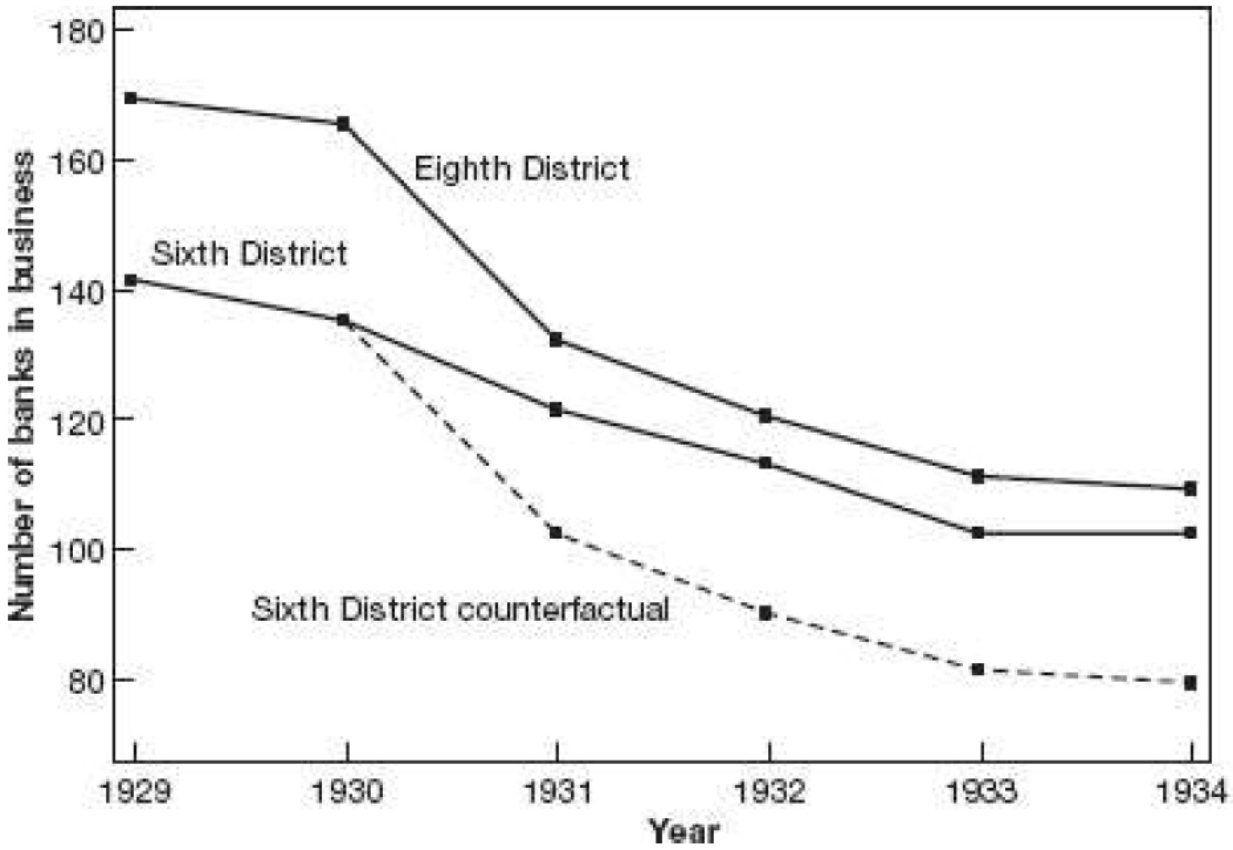
Confidence Crisis vs Real Crisis

Richardson and Troost (2009)

Monetary Intervention Mitigated Banking Panics during the Great Depression: Quasi- Experimental Evidence from a Federal Reserve District Border, 1929–1933. Journal of Political Economy, 2009, Vol. 117(6)



Manual Differences-in-Differences Estimator



$$\delta_{DD} = (Y_{6,1931} - Y_{6,1930}) - (Y_{8,1931} - Y_{8,1930})$$

$$(121 - 135) - (132 - 165) = -14 - (-33) = 19$$

Difference-in-Differences Estimator

$$y = \beta_0 + \delta_0 d2 + \beta_1 dT + \delta_1 d2 \cdot dT + u$$

$$\hat{\delta}_1 = (\overline{y}_{2,T} - \overline{y}_{2,C}) - (\overline{y}_{1,T} - \overline{y}_{1,C})$$

$$\hat{\delta}_1 = (\overline{y}_{2,T} - \overline{y}_{1,T}) - (\overline{y}_{2,C} - \overline{y}_{1,C})$$

	Before	After	After-Before
Control	β_0	$\beta_0 + \delta_0$	δ_0
Treatment	$\beta_0 + \beta_1$	$\beta_0 + \delta_0 + \beta_1 + \delta_1$	$\delta_0 + \delta_1$
Treatment-Control	β_1	$\beta_1 + \delta_1$	δ_1

$$\hat{y} = 167 - \underset{(7.6)}{49}\, d2 + \underset{(8.8)}{29}\, dT + \underset{(10.7)}{20.5} d2 \cdot dT$$

Wholesale Firm Failures and Sales in 1929 and 1933

	1929	1933	Difference (1933–1929)
Panel A. Number of wholesale firms			
Sixth Federal Reserve District (Atlanta)	783	641	−142
Eighth Federal Reserve District (St. Louis)	930	607	−323
Difference (Sixth–Eighth)	−147	34	181
Panel B. Net wholesale sales ($ million)			
Sixth District Federal Reserve (Atlanta)	141	60	−81
Eighth District Federal Reserve (St. Louis)	245	83	−162
Difference (Sixth–Eighth)	−104	−23	81

Kiel and McClain (1995)

House Prices during Siting Decision Stages: The Case of an Incinerator from Rumor through Operation. Journal of Environmental Economics and Management, Vol 28(2), 241-255

```
import pandas as pd

import statsmodels.api as sm

file="https://github.com/VitorKamada/ECO5100/raw/master/Data/KIELMC.DTA"

df = pd.read_stata(file)

df['const'] = 1

df['rprice'] = df['rprice']/1000
```

$\hat{\delta}_1 = -30,688 - (-18,824) = -11,863$

```
df81 = df[df['year'] == 1981]
reg1 = sm.OLS(df81['rprice'], df81[['const', 'nearinc']],
                    missing='drop').fit()
print(reg1.summary())
```

	coef	std err	t	P>|t|
const	101.3075	3.093	32.754	0.000
nearinc	-30.6883	5.828	-5.266	0.000

```
df78 = df[df['year'] == 1978]
reg2 = sm.OLS(df78['rprice'], df78[['const', 'nearinc']],
                    missing='drop').fit()
print(reg2.summary())
```

	coef	std err	t	P>|t|
const	82.5172	2.654	31.094	0.000
nearinc	-18.8244	4.745	-3.968	0.000

$rprice = \beta_0 + \delta_0 y81 + \beta_1 nearinc + \delta_1 y81 \times nearinc + u$

```
reg3 = sm.OLS(df['rprice'], df[['const', 'y81', 'nearinc',
                'y81nrinc']], missing='drop').fit()
print(reg3.summary())
```

	coef	std err	t	P>|t|
const	82.5172	2.727	30.260	0.000
y81	18.7903	4.050	4.640	0.000
nearinc	-18.8244	4.875	-3.861	0.000
y81nrinc	-11.8639	7.457	-1.591	0.113