# Lecture 8 Differences-in-Differences

Filipa Sá

King's College London

Semester 1, 2019/20

# Readings

- Angrist and Pischke chapter 5
- 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*, vol. 117, no. 6, pages 1031-1073

# Bank runs

- During the Great Depression, more than 4,000 banks failed in the US
- Bank runs are caused by a *maturity mismatch* in banks' balance sheets — banks lend long term to businesses and households, and hold less cash than needed to pay all depositors
- If depositors lose confidence in the bank and start withdrawing their deposits, banks do not have enough cash to pay all depositors

# Bank runs

- The UK experienced a bank run on Northern Rock in 2007. The bank was eventually nationalised.

# Bank runs

- Central banks can deal with bank runs in two ways:
  - They can intervene to provide liquidity to troubled banks
  - They can let the bank fail
- One argument for no intervention is *moral hazard* — if banks know that the central bank will provide them with cheap liquidity, they do not need to take care to avoid crises in the first place
- We would like to evaluate the effect of different central bank responses

# Bank runs

- The US Federal Reserve System is organised into 12 districts, each run by a regional Federal Reserve Bank.
- During the Great Depression, the heads of the regional Feds had considerable policy independence.
  - The Atlanta Fed (in charge of the Sixth District) favoured lending to troubled banks
  - By contrast, the St Louis Fed (in charge of the Eighth District) believed that the central bank should restrict credit in a recession
- The border between the jurisdiction of the two regional Feds runs through the middle of the state of Mississippi

# Bank runs

- Richardson and Troost use this to construct an experiment
  - Control group: banks in the part of Mississippi covered by the St Louis Fed — no increase in liquidity provided to banks
  - Treatment group: banks in the part of Mississippi covered by the Atlanta Fed — increase in liquidity provided to banks
- We can measure the effect of the provision of liquidity by comparing the number of banks in the two groups before and after the Fed's intervention — **differences-in-differences (DD)**

# Bank runs

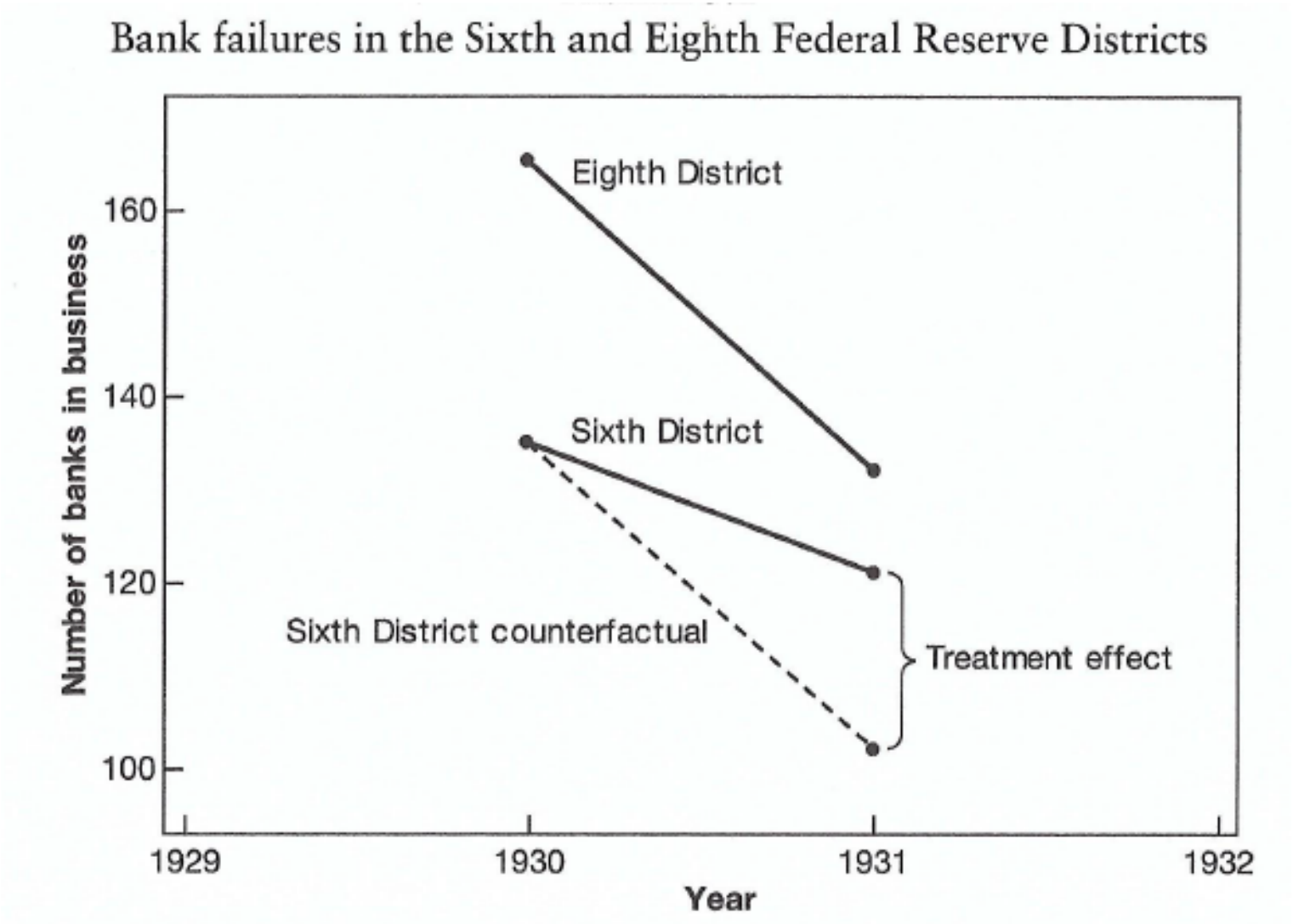
- Let $Y_{dt}$ denote the number of banks in district $d$ in year $t$. We look at the Sixth and Eighth districts and the years 1930 (before bank runs during the Great Depression started) and 1931 (after the bank run on Caldwell Company).
- The DD estimate of the effect of the provision of liquidity in the Sixth district is given by:

$$\begin{aligned}
\delta_{DD} &= (Y_{6,1931} - Y_{6,1930}) - (Y_{8,1931} - Y_{8,1930}) \\
&= (121 - 135) - (132 - 165) \\
&= -14 - (-33) = 19
\end{aligned}$$

# Bank runs

- If we compare the number of banks open in the Sixth and Eighth districts after Caldwell (121 versus 132), we might conclude that liquidity provision was counterproductive.
- But the Eighth district had more banks to start with (165 versus 135). DD contrasts the change in the number of banks operating in the two districts.
- DD estimates suggest that liquidity provision by the Fed helped save 19 banks.

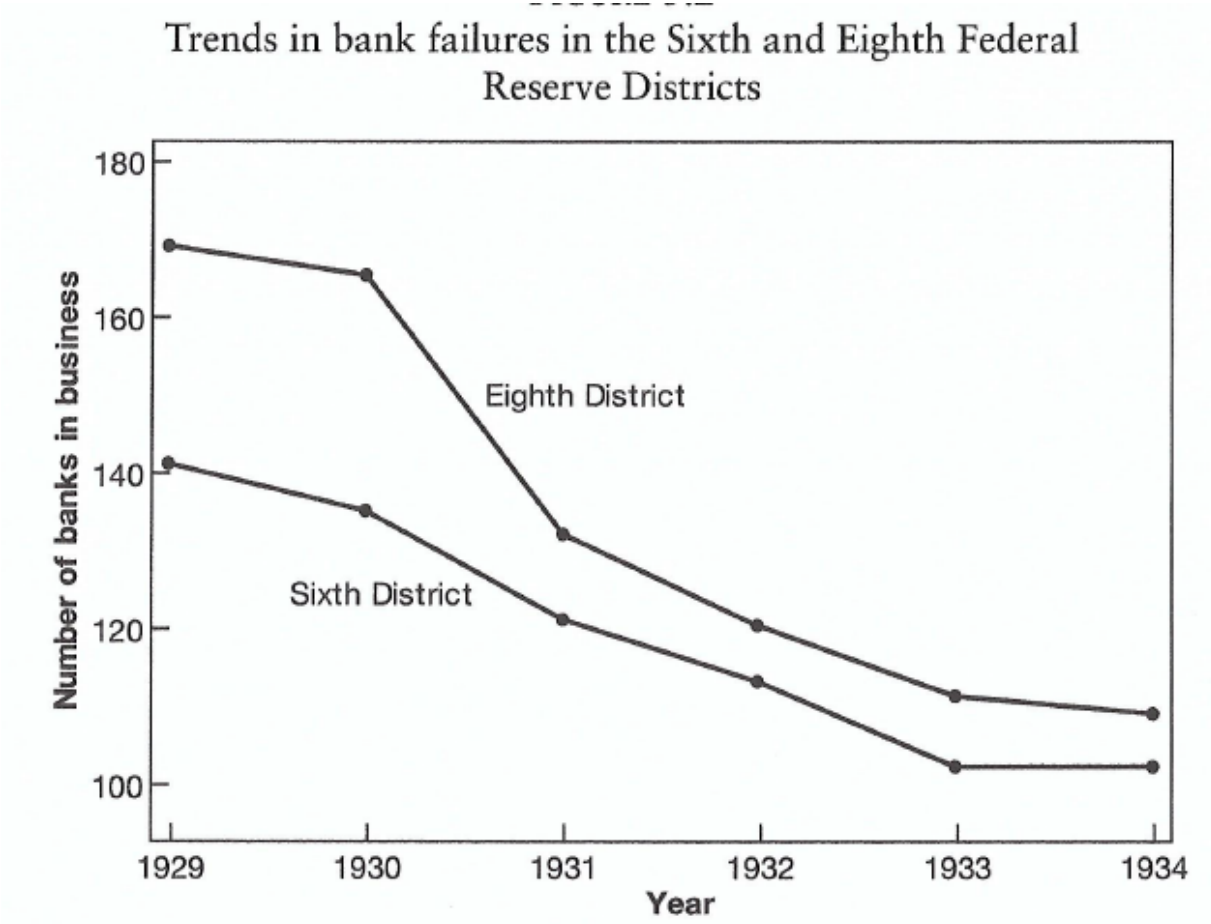
# Bank runs


Bank failures in the Sixth and Eighth Federal Reserve Districts
Number of banks in business
160
140
120
100
Eighth District
Sixth District
Sixth District counterfactual
Treatment effect
1929
1930
1931
1932
Year

# Bank runs

- DD estimation relies on a key identification assumption — **common trends**
- DD presumes that, absent any policy differences, the Eighth district trend is what we should have expected to see in the Sixth district.
- Figure 5.2 supports this assumption and shows that the number of banks moved in parallel in the two districts between 1929 and 1930.
- After 1931, the St Louis Fed abandoned the policy of tight money and started lending to troubled banks. Trends in bank activity in the two districts are similar after 1931.

# Bank runs


Trends in bank failures in the Sixth and Eighth Federal Reserve Districts
Number of banks in business
180
160
140
120
100
Eighth District
Sixth District
1929
1930
1931
1932
1933
1934
Year

# Bank runs

- The simplest DD calculation involves just four numbers. In practice, we can do better if we have data for more than two periods — six years of data in Figure 5.2
- The regression version of DD has three ingredients:
  - A dummy for the treatment district, which controls for fixed differences between districts ($Treat_d$)
  - A dummy for post-treatment period, which controls for the fact that conditions change over time for all districts, whether treated or not ($Post_t$)
  - The interaction of the two dummies ($Treat_d \times Post_t$). The coefficient on this term is the DD causal effect.

# Bank runs

- In the Richardson and Troost experiment:
  - $Treat_d$ equals 1 for data points in the Sixth District and 0 for data points in the Eighth District
  - $Post_t$ equals 1 for observations from 1931 onwards
  - The interaction term $Treat_d \times Post_t$ indicates observations from the Sixth District from 1931 onwards
  - The model is estimated in a sample of size 12 (2 districts, 6 years):

$$Y_{dt} = \alpha + \beta TREAT_d + \gamma POST_t + \delta_{DD}(TREAT_d \times POST_t) + e_{dt}$$

# Bank runs

- Regression-based DD should provide a more precise and reliable measure of policy effects than DD based on four numbers
- The results suggest that 21 banks were saved by the intervention of the regional Fed

$$Y_{dt} = 167 - \underset{(8.8)}{29}\, TREAT_d - \underset{(7.6)}{49}\, POST_t + \underset{(10.7)}{20.5}\,(TREAT_d \times POST_t) + \epsilon_{dt}.$$