

# Synthetic Differences in Differences Simulations

Joshua Derenski

## Simulations

### Parameters

- Number of Ls: 1
- Draws per L: 100
- Number of Units: 100
- Number of Control Units: 98
- Number of Times: 200
- Number of pre-treatment Times: 198
- Rank of L: 10
- Autocorrelation Parameter: 0.6
- True Effect Size: 3
- Error Type: gaussian
- Error Variance (if Gaussian error): 1
- Degrees of freedom (if t-error): 5
- Exchangable: FALSE
- Penalized: TRUE
- Rank Estimation Method: threshold
- Scaling for  $L$ : 1

## Simulation Description

In this simulation we sample 1 signal matrices  $L \in \mathbb{R}^{100 \times 200}$  of rank 10, and for each  $L$  we sample 100  $Y$ s such that for each  $Y$   $E(Y_{ij}) = L_{ij} + \tau W_{ij}$  where  $W$  is known, and  $\tau = 3$  (in the case of the t-distribution, we ensure the median of each cell is  $L_{ij} + \tau W_{ij}$ ). We generate  $L$  so that the rows and columns are not exchangable, and we estimate the weights in SDID using penalized regressions. For estimating the rank of  $L$  we are using a threshold method. From each corresponding pair of  $(L, Y)$  an estimate of  $\tau$  is generated via method  $i$ , which we call  $\hat{\tau}_{(L,Y),i}$ . To evaluate the performance of method  $i$  we calculate the following RMSE:

$$RMSE_i = \sqrt{\frac{1}{100} \sum_{(L,Y)} (\hat{\tau}_{(L,Y),i} - \tau)^2}$$

# Our Method vs Competitors, Fixed Parameters

## Results

### Signal to Noise Ratio

## [1] 17.44909

### Rmse for DID

## [1] 6.832237

### Se for Rmse for DID

## [1] 0

### Rmse for SC

## [1] 2.876962

### Se for Rmse for SC

## [1] 0

### Rmse for our Method (Explicit Tau)

## [1] 0.7457445

### Se for Rmse for our Method (Explicit Tau)

## [1] 0

### Rmse for SDID

## [1] 1.553544

### Se for Rmse for SDID

## [1] 0

### RMSE For Our Method (Not Explicit Tau)

## [1] 0.8281835

### Se for Rmse for Our Method (Not Explicit Tau)

## [1] 0

RMSE For Oracle (Perfect L)

## [1] 0.5660541

RMSE For Oracle (Perfect L)

## [1] 0

## Matrix Bias vs Reduction in Variance due to Averaging

For more general designs of  $W$  (like the block design scheme considered here) we allow a block in the bottom right hand corner of  $W$  to be non-zero. When implementing our method, we have two competing effects on estimation:

- The bias that's introduced by making more of the  $Y_{ij}$ s zero.
- The help we get with estimating  $\tau$  by being able to average over cells (because we assume  $\tau$  is the same for all units and times).

It would appear that accuracy increases for estimating  $\tau$  to a point, and then decreases when the bias introduced by replacement of cells with 0 in  $Y$  becomes too great.

## Influence of $N_0$ on Performance

## Influence of $\rho$ on Performance

## Influence of $\tau$ on Performance

## Influence of Rank Error on Performance