

STATES WITHOUT MINIMUM WAGE INCREASE IN 2021

STATES THAT WILL INCREASE MINIMUM WAGE IN 2021

Washington
\$13.69

Oregon
\$12.75
(effective July 1, 2021)

Nevada
(effective July 1, 2021)
Employees who aren't offered health insurance: \$9.50
Employees who are offered health insurance: \$8.50

California
For small employers: \$13
For large employers: \$14

Arizona
\$12.15

New Mexico
\$10.50

Alaska
\$10.34

Hawaii
\$10.10

Montana
\$8.75

Idaho
\$7.25

Wyoming
\$5.15
(Employers subject to FLSA must pay the federal minimum wage)

North Dakota
\$7.25

South Dakota
\$9.45

Kansas
\$7.25

Oklahoma
\$7.25

Texas
\$7.25

Minnesota
For small employers: \$8.21
For large employers: \$10.08

Wisconsin
\$7.25

Michigan
\$9.87

Illinois
\$11
(effective July 1, 2021)

Indiana
\$7.25

Missouri
\$10.30

Arkansas
\$11

Mississippi
\$7.25

Louisiana
\$7.25

Georgia
\$5.15
(Employers subject to the FLSA must pay federal minimum wage)

South Carolina
\$7.25

North Carolina
\$7.25

Tennessee
\$7.25

Alabama
\$7.25

New Hampshire
\$7.25

Vermont
\$11.75

New York State
(effective July 1, 2021)
\$12.50
Fast food workers: \$15.00

Pennsylvania
\$7.25

Ohio
\$8.80 for employers with over \$323,000 in annual gross receipts

Maine
\$12.15

Massachusetts
\$13.50

Rhode Island
\$10.50

Connecticut
\$13
(effective August 1, 2021)

New Jersey
For most employers: \$12
Seasonal and/or small employers: \$11.10
Agricultural employers: \$10.44

Delaware
\$10.25
(effective October 21, 2021)

Maryland
\$11.75
For small employers: \$11.60
For large employers: \$11.75

District of Columbia
(increase to be announced effective July 1, 2021, pursuant to Consumer Price Index)

Difference in Differences

Today:

- ▶ Extend linear regression to make the most of natural experiment type data;
- ▶ Work through a case study applying difference in differences.

So far, we've used linear regression to:

1. Model a linear relationship between dependent variable y and independent variable x :

$$y = \beta_0 + \beta_1 x + \varepsilon;$$

2. Model a linear relationship between dependent variable y and many independent variables x_1, x_2, x_3, \dots :

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \varepsilon;$$

3. Model a NON-linear relationship between dependent variable y and many independent variables x :

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_1^2 + \dots + \varepsilon;$$

4. Model relationships between independent variables:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + \varepsilon;$$

Does increasing the minimum wage decrease employment?

Motivation...

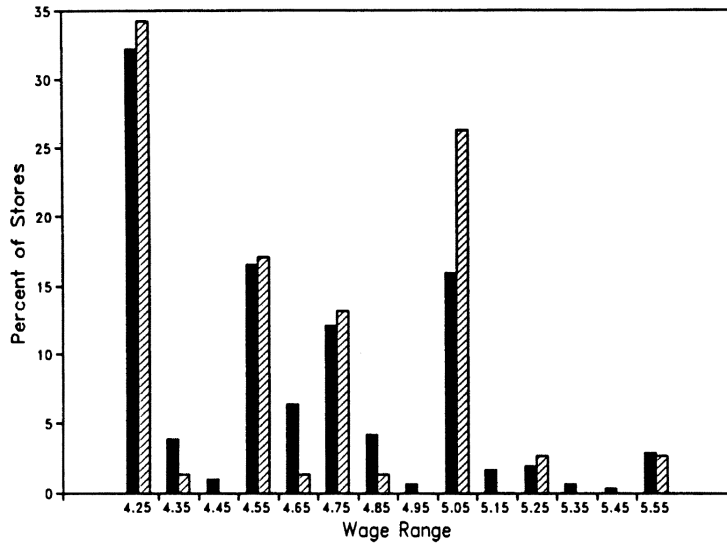
- ▶ In early 1990 NJ raised the minimum wage from \$4.25 to \$5.05 effective 1 April 1992 – highest minimum wage in the country;
- ▶ Notably, nearby eastern PA maintained a lower minimum wage;
- ▶ A **natural** within-subjects experiment;
 - ▶ NJ employers before/after;
 - ▶ PA employers before/after;
- ▶ Card and Krueger surveyed 473 fast food restaurants before and after law;
 - ▶ Low wage workers;
 - ▶ High response survey response rate.



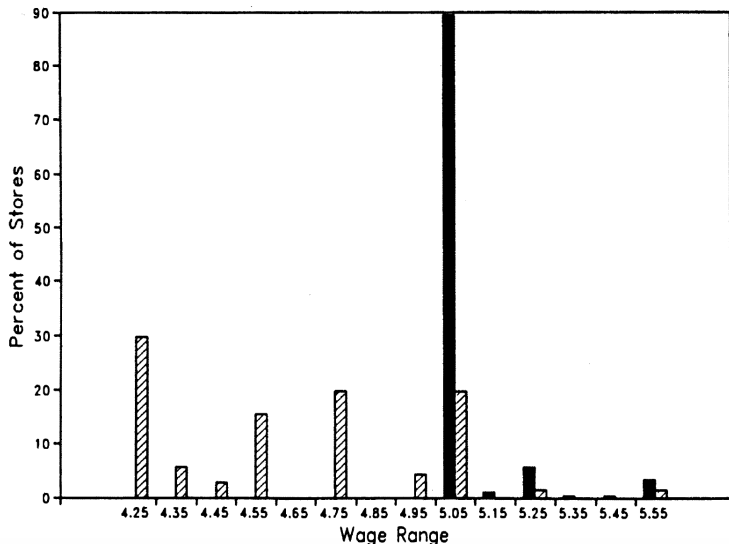
TABLE 1—SAMPLE DESIGN AND RESPONSE RATES

		Stores in:	
	All	NJ	PA
<i>Wave 1, February 15–March 4, 1992:</i>			
Number of stores in sample frame: ^a	473	364	109
Number of refusals:	63	33	30
Number interviewed:	410	331	79
Response rate (percentage):	86.7	90.9	72.5
<i>Wave 2, November 5–December 31, 1992:</i>			
Number of stores in sample frame:	410	331	79
Number closed:	6	5	1
Number under renovation:	2	2	0
Number temporarily closed: ^b	2	2	0
Number of refusals:	1	1	0
Number interviewed: ^c	399	321	78

February 1992



November 1992



Recall...

- ▶ If the researcher controls assignment of independent variables to observations (e.g. selection of treatment and control groups) then the data is experimental;
- ▶ A natural experiment is a situation in which:
 - ▶ The researcher does NOT control assignment of independent variables to observations...
 - ▶ ...but whatever does ends up creating a pseudo-randomly assigned treatment and control group anyway.
- ▶ So, can we extend linear regression to deal with observational data that has the characteristics of an experiment?

Difference in Differences

- ▶ Say we have data in which we measure the dependent variable for four groups:
 1. ...a 'treatment' group before treatment
 2. ...a 'treatment' group after treatment
 3. ...a 'control' group before no treatment
 4. ...a 'control' group after no treatment

Difference in Differences

- ▶ Say we have data in which we measure the dependent variable for four groups:
 1. ...a 'treatment' group before treatment (fast food restaurants NJ early 1992);
 2. ...a 'treatment' group after treatment (fast food restaurants NJ late 1992);
 3. ...a 'control' group before no treatment (fast food restaurants PA early 1992);
 4. ...a 'control' group after no treatment (fast food restaurants PA late 1992);

Difference in Differences

- Say we have data in which we measure the dependent variable for four groups:
 1. ...a 'treatment' group before treatment (fast food restaurants NJ early 1992);
 2. ...a 'treatment' group after treatment (fast food restaurants NJ late 1992);
 3. ...a 'control' group before no treatment (fast food restaurants PA early 1992);
 4. ...a 'control' group after no treatment (fast food restaurants PA late 1992);
- This data could look something like:

Unit ID	T (time)	G (state)	y (# of employees)
fast food restaurant 1	0 (early 1992)	1 (NJ)	10
fast food restaurant 1	1 (late 1992)	1 (NJ)	11
fast food restaurant 2	0 (early 1992)	0 (PA)	15
fast food restaurant 2	1 (late 1992)	0 (PA)	12
\vdots	\vdots	\vdots	\vdots
fast food restaurant 473	0 (early 1992)	1 (NJ)	25
fast food restaurant 473	1 (late 1992)	1 (NJ)	32

Difference in Differences

- ▶ Let's run a simple linear regression to analyze this data:

$$y = \beta_0 + \beta_1 T + \beta_2 G + \beta_{12}(TG) + \varepsilon$$

- ▶ As usual, in this linear regression equation:
 - ▶ y is the dependent variable – it comes from data;
 - ▶ T is an indicator that is a 1 for after treatment and 0 for before treatment;
 - ▶ G is an indicator that is 1 for treatment group and 0 for control group;
 - ▶ the β 's are the effects – linear regression will learn these from data;
 - ▶ ε is noise – we don't get to observe this;

Difference in Differences

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- ▶ As usual, in this linear regression equation:
 - ▶ y is the dependent variable – it comes from data;
 - ▶ T is an indicator that is a 1 for late 1992 and 0 for early 1992;
 - ▶ G is an indicator that is 1 for NJ and 0 for PA;
 - ▶ the β 's are the effects – linear regression will learn these from data;
 - ▶ ε is noise – we don't get to observe this;

Difference in Differences

- ▶ Let's run a simple linear regression to analyze this data:

$$y = \beta_0 + \beta_1 T + \beta_2 G + \beta_{12}(TG) + \varepsilon$$

- ▶ Check out β_{12} – it can be shown (though we won't) that:

$$\beta_{12} = (\bar{y}_{11} - \bar{y}_{01}) - (\bar{y}_{10} - \bar{y}_{00})$$

- ▶ \bar{y}_{TG} = average dependent variable for group G at time T ;

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- ▶ \bar{y}_{TG} = average dependent variable for group G at time T ;
- ▶ \bar{y}_{11} = average dependent variable for the treatment group after treatment;
- ▶ \bar{y}_{01} = average dependent variable for the treatment group before treatment;
- ▶ \bar{y}_{10} = average dependent variable for the control group after treatment;
- ▶ \bar{y}_{00} = average dependent variable for the control group before treatment;

Difference in Differences

- ▶ Let's run a simple linear regression to analyze this data:

$$y = \beta_0 + \beta_1 T + \beta_2 G + \beta_{12}(TG) + \varepsilon$$

- ▶ Check out β_{12} – it can be shown (though we won't) that:

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- ▶ \bar{y}_{TG} = average dependent variable for group G at time T ;
- ▶ \bar{y}_{11} = average employment for the NJ restaurants, late 92;
- ▶ \bar{y}_{01} = average employment for the NJ restaurants, early 92;
- ▶ \bar{y}_{10} = average employment for the eastern PA restaurants, late 92;
- ▶ \bar{y}_{00} = average employment for the eastern PA restaurants, early 92;

Difference in Differences

$$\beta_{12} = \left(\overbrace{\bar{y}_{11}}^{\text{NJ, late 92}} - \overbrace{\bar{y}_{01}}^{\text{NJ, early 92}} \right) - \left(\overbrace{\bar{y}_{10}}^{\text{PA, late 92}} - \overbrace{\bar{y}_{00}}^{\text{PA, early 92}} \right)$$

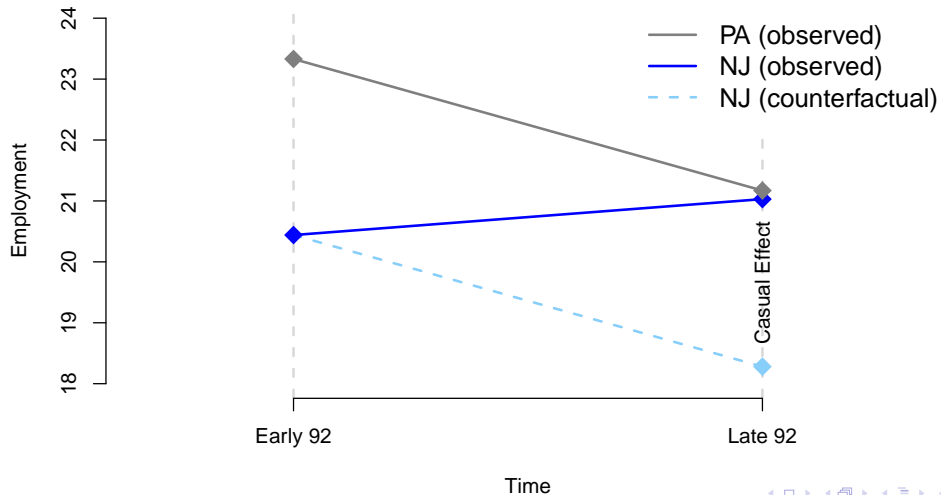
Difference in Differences

$$\beta_{12} = \underbrace{\left(\overbrace{\bar{y}_{11}}^{\text{NJ, late 92}} - \overbrace{\bar{y}_{01}}^{\text{NJ, early 92}} \right)}_{\text{Difference w/i Treatment}} - \underbrace{\left(\overbrace{\bar{y}_{10}}^{\text{PA, late 92}} - \overbrace{\bar{y}_{00}}^{\text{PA, early 92}} \right)}_{\text{Difference w/i Control}}$$

Difference in Differences

$$\beta_{12} = \underbrace{\left(\overbrace{\widehat{y}_{11}}^{\text{NJ, late 92}} - \overbrace{\widehat{y}_{01}}^{\text{NJ, early 92}} \right) - \left(\overbrace{\widehat{y}_{10}}^{\text{PA, late 92}} - \overbrace{\widehat{y}_{00}}^{\text{PA, early 92}} \right)}_{\text{Difference in Differences}}$$

Parallel Trend Assumption



So, does increasing minimum wage decrease employment?

	NJ	PA	Difference
Early 92	20.44	23.33	-2.89
Late 92	21.03	21.17	-0.14
Change	0.59	-2.16	2.75

$$\beta_{12} = (\bar{y}_{11} - \bar{y}_{01}) - (\bar{y}_{10} - \bar{y}_{00})$$

So, does increasing minimum wage decrease employment? Nope!

	NJ	PA	Difference
Early 92	20.44	23.33	-2.89
Late 92	21.03	21.17	-0.14
Change	0.59	-2.16	2.75

$$\beta_{12} = (\bar{y}_{11} - \bar{y}_{01}) - (\bar{y}_{10} - \bar{y}_{00})$$

$$\beta_{12} = (21.03 - 20.44) - (21.17 - 23.33) = 2.75.$$

Why should we care?

Experiments are the gold standard in establishing causality and we can use linear regression to model the data they generate.