

Minimum Wage Analysis

IDS 701: Final Report

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Intended Audience: Policy Maker

Introduction & Executive Summary

Minimum wages have a substantial impact on a state's economy. For instance, higher minimum wage would mean businesses must give workers higher pay and could make businesses feel reluctant to hire more workers. While on the other hand, low wages could demotivate workers. The true effect on how to set minimum wage is a controversial topic, and has long been debated by economists and policy makers. This sparked our interest in applying causal inference to study how increasing minimum wage would affect a state's economy. With our hope to quantify the impact of change in minimum wage, we want to help policy makers and economists to make better decisions.

In this analysis we use difference in difference analysis to study the effect of raising minimum wage policy on a state's economic status including unemployment rate and state's gross domestic product (GDP). The regression study unveils empirical evidence of causal effects on both unemployment rate and GDP. Specifically, the regression results show that there is a statistically significant effect of raising the minimum wage on unemployment rate in terms of differences-in-differences. We discovered the difference in difference has a +1.4092% effect on unemployment rate. Moreover, the effect of raising the minimum wage on GDP is also found to be significant, causing 8567.285 million dollars decrease on average to the GDP. In the end, the study is still preliminary. There are various confounding factors that are not included such as race, sex and age, but they are definitely exerting impacts on our dependent variables, which could shift our findings.

Experiment Design

I. Selecting States

We sought to design an experiment that isolated the causal effect of increasing minimum wage on a state's economy. Some states follow the federal minimum wage and some states have their own wage policies that pay more than the federal minimum wage. We considered states that switched from the federal minimum wage policy to their own policies for the treatment group and states that continued to adopt federal minimum wage for the control group.

We decided to use Iowa, Kansas, and Idaho as our control states. We chose South Dakota, West Virginia, and Nebraska as our treatment states. We chose these states as our treatment and control states because they are all relatively similar in size and location (Mid-West). Furthermore, all of our control states maintained the federal minimum wage from 2010 - 2019. All of our treatment states followed the federal minimum wage from 2010 - 2014 (inclusive), and then in 2015 began following their own, higher, state minimum wages.

We have reason to believe that our control and treatment states would experience similar fluctuations in unemployment rate and GDP if they all maintained the same minimum wage because of their similarities. Because we believe all of the states would have similar potential outcomes, they will function well as control and treatment groups for observing differences caused by the change in legislation. We began measuring the post-treatment effect for our treatment states in 2016.

II. Measuring Variables of Interest

After selecting our states and minimum wage policies of interest, we turn to our response variables. We sought ways to measure the impact of the minimum wage on a state's economy. We decided to use the state unemployment rate and the state's Gross Domestic Product (GDP) as measures of economic well-being. A lower unemployment rate and a higher GDP are desirable economic outcomes.

We decided to use a Difference-in-Difference analysis because we want to see if the minimum wage policy change altered economic outcomes for our treatment states when compared to our control states. We will be able to see if the trajectory of the unemployment rate or GDP changed after deviating from the federal minimum wage. We also conducted regressions that controlled for additional state characteristics via state fixed effects. We wanted to ensure we isolated the effect of minimum wage policy as much as possible by controlling for variation between states. We sought a technique that allowed us to control for similar working populations, age demographics, racial demographics, and sex demographics. By controlling for the fixed effects of each state, we can capture the invariant demographics of different state populations.

III. Combining Data

In order to conduct this analysis we needed the following data for each state from 2010 to 2019: unemployment rate, population, and gross domestic product (GDP). Using the Bureau of Labor Statistics we obtained unemployment rates for each state, by month, over our years of interest. From the United States Census website we obtained population estimates for each state over our years of interest. Lastly, we sourced annual and quarterly GDP data for each state from the Bureau of Economic Analysis.

The greatest task was to combine all of our datasets together into one large data table. We began by getting each table into the same form - such that one row represented a single state in a single year, possibly a single month, and the data of interest. We were then able to join our tables together using state names and year labels. The resulting data table contained each state's unemployment rate, GDP, and population.

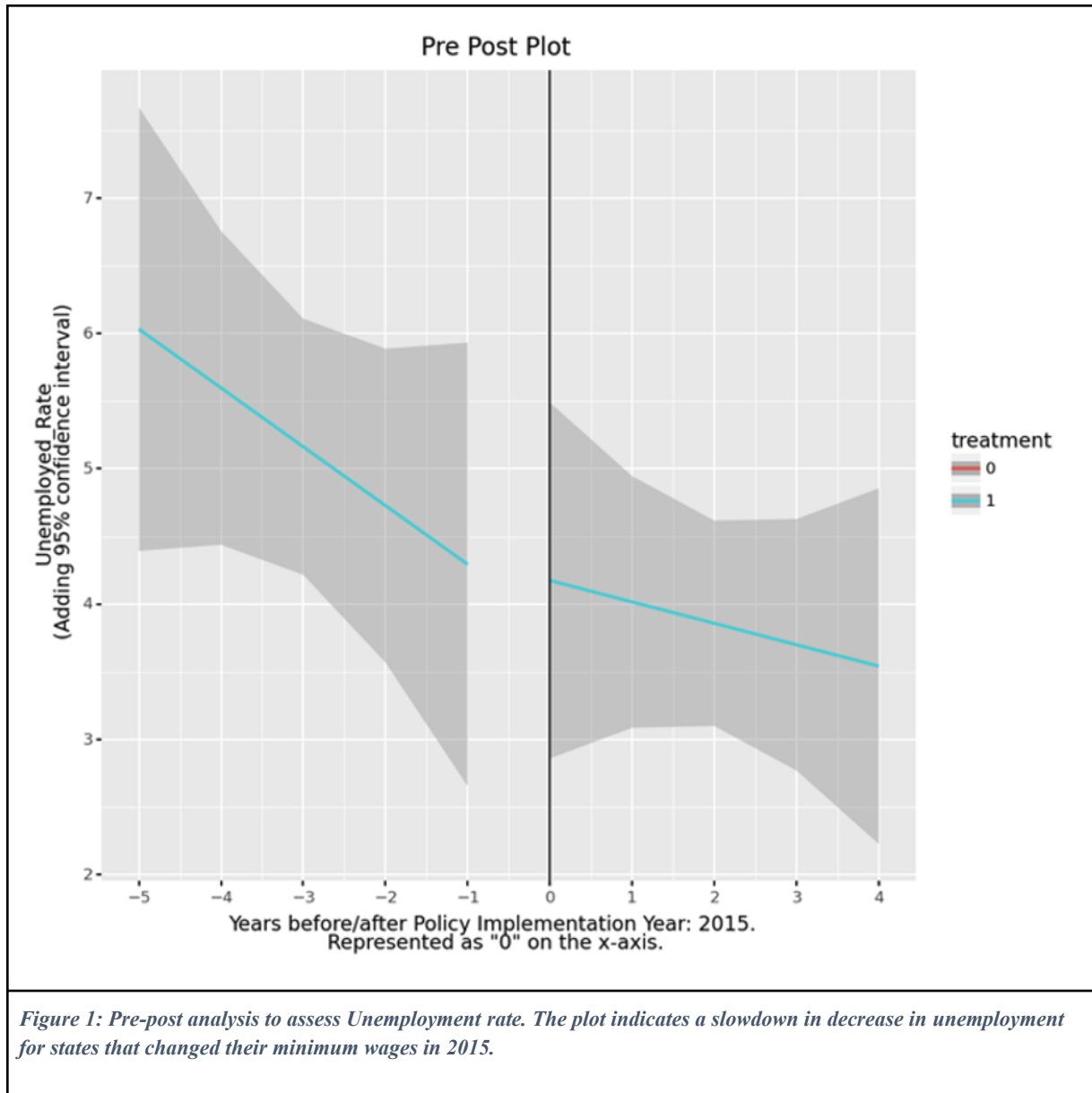
We will use the unemployment rates and GDP in our Difference-in-Difference analysis. We will also use state fixed effects in regressions to determine their effect on our treatment - increasing the state minimum wage above the federal minimum wage.

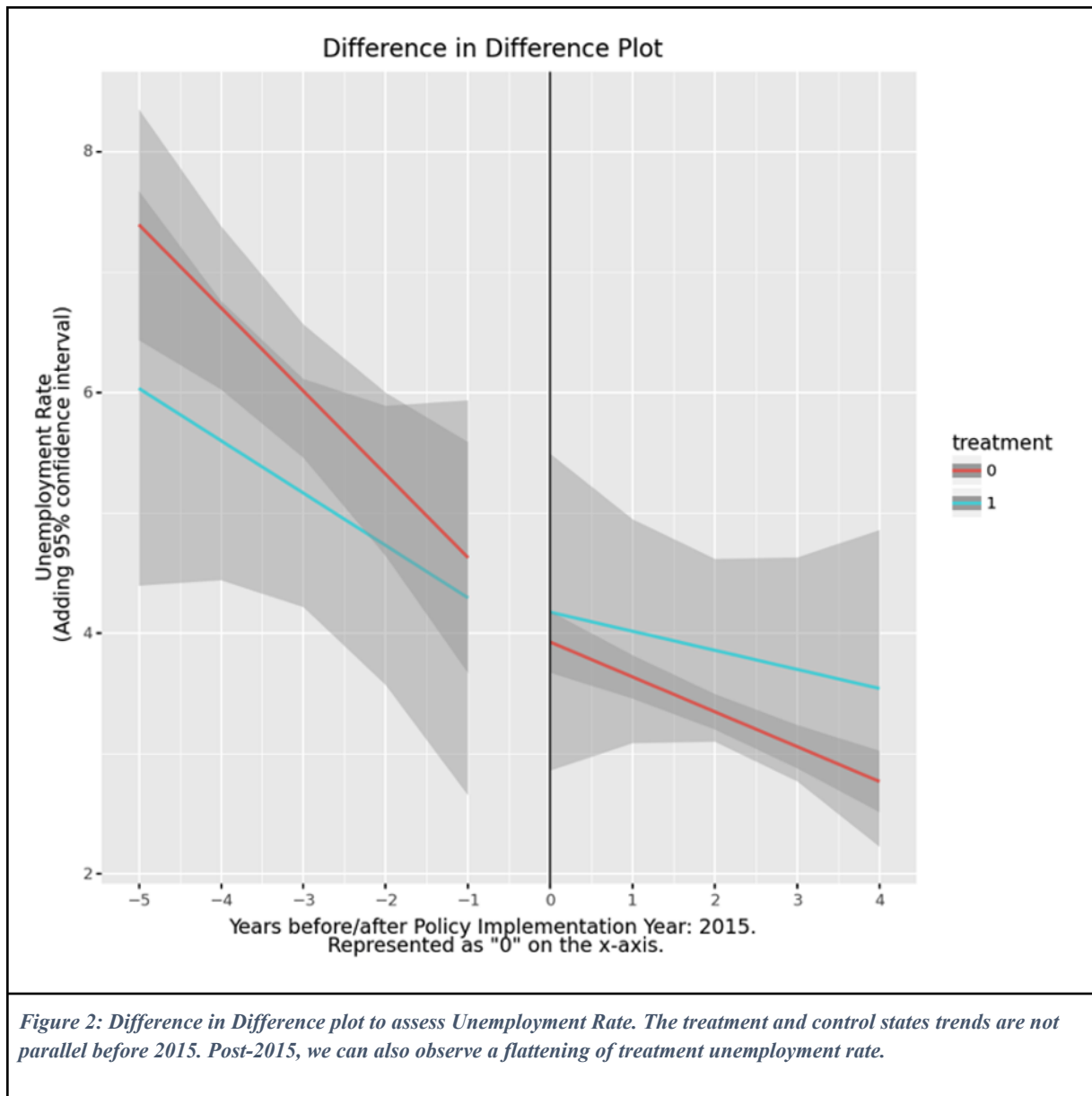
Results

By using pre-post and difference-in-difference analysis simultaneously on our treatment states, we can provide a visualization for the impact of key response variables such as unemployment rate and GDP for treatment states that changed their minimum wages in 2015. We also performed regression analysis to further interpret the observed differences.

I. Unemployment Rate Analysis

The pre-post graph in Figure-1 measures unemployment rate over time in years for the treatment states. It shows a gradual decrease in the unemployment rate after 2015 (year of minimum wage divergence). The unemployment rate was calculated by dividing the total unemployment by the total available labor force for a given state and year, and as can be observed was naturally decreasing at a steady rate before 2015. But after the treatment states increased their minimum wages, the unemployment rate showed a reduced rate of decrease. Since the pre-post only shows our treatment states before and after the policy change, this is not sufficient because we do not know how much of the trend is due to our policy change and how much of the trend is due to the natural/nation-wide trend changes in unemployment. In order to better understand the impact of minimum wages on the unemployment rate, we also need to look at the difference-in-difference analysis and compare the treatment state trends with reference states trends during the same time period, to have more confidence on what we can attribute as actual treatment effect versus a general natural/nationwide trend.





Through the difference-in-difference plot we observe that the trendline for both treatment and control states are not parallel pre-2015. We also observe that the treatment line has flattened post-2015 and moves from being below the control states line to above the control states line. More importantly, since the trendlines for treatment and control are not parallel pre-2015, we cannot make a reasonable comparison on the effects of increasing minimum wages having a direct impact on unemployment rate.

To better analyze the slight flattening of unemployment rate post-2015, we regressed Unemployment Rate on states that increased their minimum wages (treatment), years after 2015 (post), states that increased their minimum wages after 2015 (interaction between treatment:post), and added a fixed effect for the 6 states (3 control states and 3 treatment states).

We observed that the p-values of all features, except Kansas state, is below an alpha of 0.05. More specifically, the interaction term, representing all states that increased their minimum wages post-2015, also corresponds to the observed difference-in-difference change from the plot above. The coefficient of this interaction term is 1.4092 and is statistically significant. As a result, the previous observation where the treatment trendline post-2015 flattens and increases above the control trendline, can be attributed to a difference-in-difference value of 1.4092. We can interpret this result as, for a given treatment state that increased its minimum wages after 2015, the data showcases an increase in unemployment rate.

Please find the regression coefficients and corresponding p-values below:

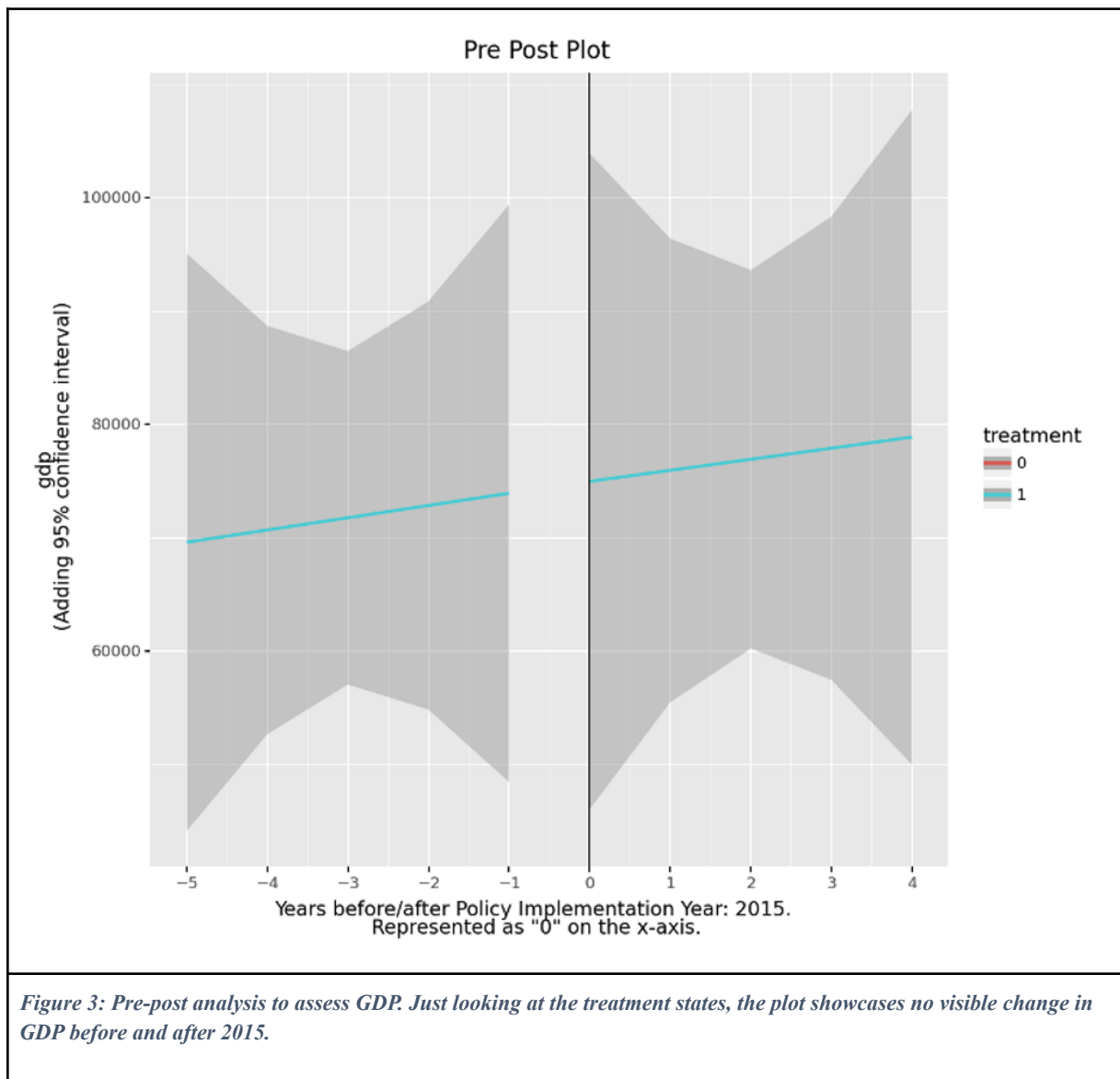
	coef	std err	t	P> t	[0.025	0.975]
Intercept	6.5712	0.312	21.075	0.000	5.944	7.199
C(treatment)[T.1]	-1.0563	0.284	-3.721	0.001	-1.628	-0.485
C(Post)[T.1]	-2.8018	0.322	-8.704	0.000	-3.450	-2.154
C(State)[T.Iowa]	-1.1278	0.392	-2.879	0.006	-1.916	-0.339
C(State)[T.Kansas]	-0.5574	0.392	-1.423	0.162	-1.346	0.231
C(State)[T.Nebraska]	-1.3691	0.245	-5.584	0.000	-1.863	-0.876
C(State)[T.South Dakota]	-1.2746	0.245	-5.198	0.000	-1.768	-0.781
C(State)[T.West Virginia]	1.5874	0.245	6.474	0.000	1.094	2.081
C(treatment)[T.1]:C(Post)[T.1]	1.4092	0.455	3.096	0.003	0.493	2.325

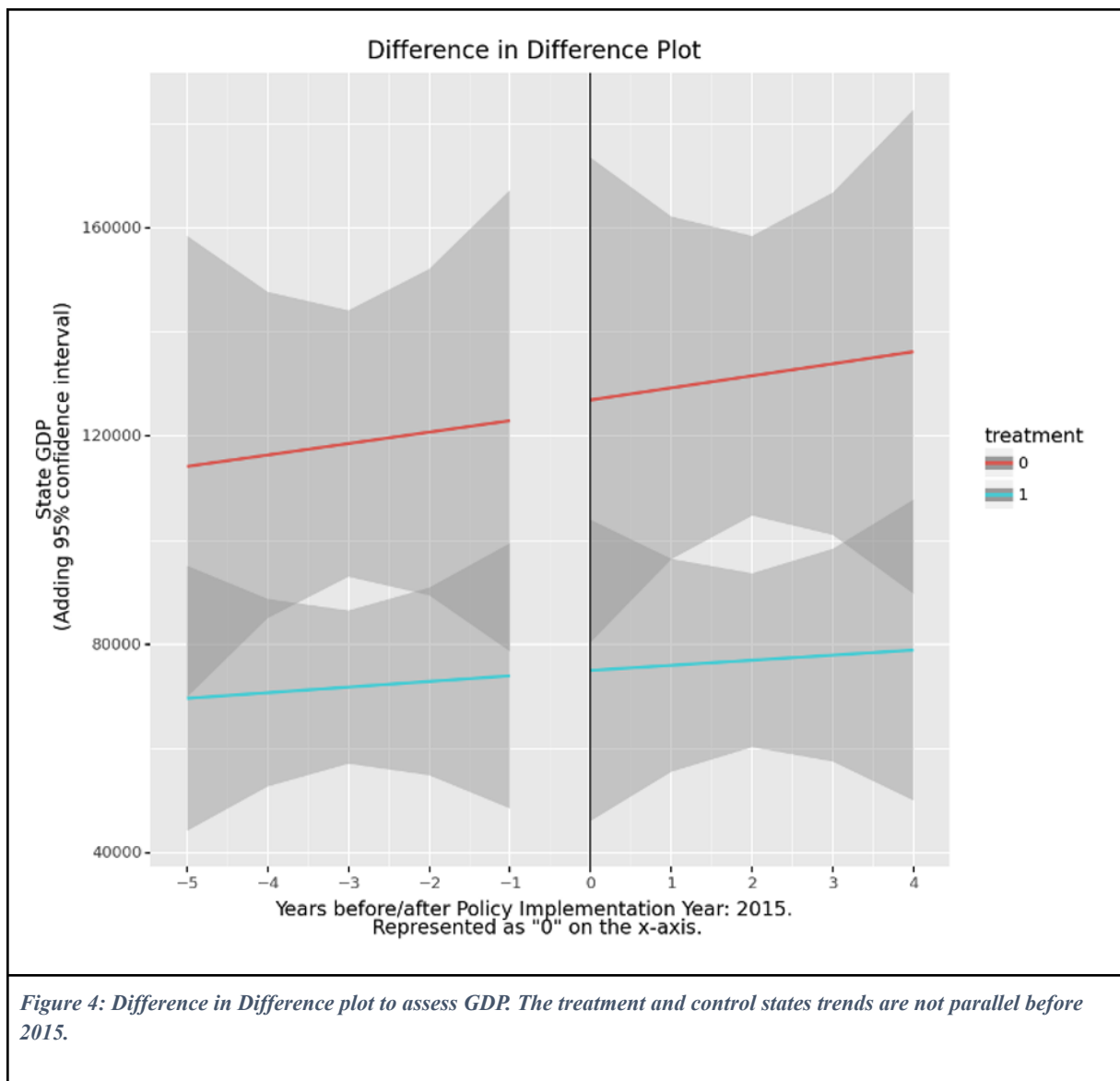
Table 1: Regressing Unemployment Rate on Treatment, Post, Treatment:Post and States. The interaction term of Treatment:Post is the feature of interest as it corresponds to the difference-in-difference analysis.

II. GDP Analysis

Figure 3 below showcases the change in GDP for states that increased their minimum wages in 2015. There is no clear observable difference in the pre-post plot before and after 2015. Before 2015, the GDP for the treatment states showcased a gradual increasing slope. After 2015, when there was a change in the minimum wages for the treatment states, it did not lead to any immediate growth/decline in GDP. In order to rule out potential confounders e.g, other events or movements that could have occurred in 2015 on a national level that could offset any potential GDP growth, we also implemented difference-in-difference analysis by comparing the trend in

the treatment states with that of the 3 reference states that did not change their minimum wages in 2015.





Looking at figure 4, we observe that the treatment and control trendlines are not exactly parallel pre-2015. The control states line has a slightly higher rate of increase in GDP compared to the treatment states line. Due to this, we cannot make a reasonable comparison to directly attribute changes from increasing minimum wages for treatment states.

To better analyze the above observations, we regressed GDP on states that increased their minimum wages (Treatment), years after 2015 (Post), states that increased their minimum wages after 2015 (interaction between Treatment:Post), and added a fixed effect for the 6 states (3 control states and 3 treatment states). We observed that the p-values of all features, except Virginia state, is below an alpha of 0.05. More importantly, the interaction term representing all states that increased their minimum wages post-2015, also corresponds to the observed difference-in-difference change from the plot above. The coefficient of this interaction term is

-8,567.285 million dollars and is statistically significant. We can interpret this result as, for a given treatment state that increased its minimum wages after 2015, the data showcases a decrease in GDP.

Please find the regression coefficients and corresponding p-values below:

	coef	std err	t	P> t	[0.025	0.975]
Intercept	5.781e+04	1293.676	44.686	0.000	5.52e+04	6.04e+04
C(treatment)[T.1]	1.048e+04	1177.847	8.899	0.000	8110.831	1.29e+04
C(Post)[T.1]	1.409e+04	1335.553	10.549	0.000	1.14e+04	1.68e+04
C(State)[T.Iowa]	9.909e+04	1625.584	60.958	0.000	9.58e+04	1.02e+05
C(State)[T.Kansas]	8.309e+04	1625.584	51.113	0.000	7.98e+04	8.64e+04
C(State)[T.Nebraska]	3.729e+04	1017.344	36.657	0.000	3.52e+04	3.93e+04
C(State)[T.South Dakota]	-2.612e+04	1017.344	-25.671	0.000	-2.82e+04	-2.41e+04
C(State)[T.West Virginia]	-695.0100	1017.344	-0.683	0.498	-2742.817	1352.797
C(treatment)[T.1]:C(Post)[T.1]	-8567.2850	1888.758	-4.536	0.000	-1.24e+04	-4765.413

Table 2: Regressing GDP on Treatment, Post, Treatment:Post and fixed effect on States. The interaction term of Treatment:Post is the feature of interest as it corresponds to the difference-in-difference analysis.

Conclusion

Utilizing pre-post and differences-in-differences methodology, this article examined the causal effect of raising minimum wage on macro-level indicators such as unemployment rate and GDP, measuring economic prosperity. It took advantage of the year 2015 as a threshold, distinguishing the federal minimum wage policy implementations in different states, by which we were able to identify the effect of the policy on state economies through quantifying the differences in indicators between the treatment states and the control states.

By visualizing the changes in trend for unemployment rate and GDP before and after the threshold year, the report was trying to reveal the effect of raising the minimum wage on them. However with the difference-in-difference plots, no clear evidence was observed which could support the causal relationship of minimum wages on both unemployment rate and GDP.

Meanwhile, the regression analysis unveiled empirical evidence of causal effects on both unemployment rate and GDP. Specifically, the results showed that there was a statistically significant effect of raising the minimum wage on unemployment rate in terms of differences-in-differences, meaning the minimum wage hike in the treatment states would increase 1.4092 units on average in unemployment rate relative to the control states, controlling for states' variations. Furthermore, the effect of minimum wage on GDP was also significant from the perspective of differences-in-differences, causing 8567.285 million dollars decrease on

average for the treatment states relative to the control states when controlling for states' variations.

However, we would admit that the above is just a preliminary study right now. There are various confounding factors that are not included such as population, race, sex and age, but they are definitely exerting impacts on our economic measurements, which could alter the current conclusions. Moreover, our experiment design is not perfect since we were limited to states that concurrently changed their minimum wage legislation. Many states have deviated from the Federal minimum wage by different amounts, but did so at different times - rendering them ineffective for our analysis. A more comprehensive analysis might look at all states that changed their minimum wage, regardless of year. Therefore, further study should be conducted focusing on the improving of experiment design and also considering more influential factors in our models.

Data Sources

1. Changes in Basic Minimum Wages by states

<https://www.dol.gov/agencies/whd/state/minimum-wage/history>

2. State Population Totals: 2010-2019

<https://www.census.gov/data/datasets/time-series/demo/popest/2010s-state-total.html>

3. Population demographic characteristics: age, sex, etc. by state

<https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html>

4. Employment data by county, including labor force, employment, unemployment

<https://www.bls.gov/lau/home.htm#tables>