Problem Set 2 - Labour Economics

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1 a) Average wages

state	second interview wage_st2	first interview wage_st	difference (in between) dw
NJ	5.08	4.61	0.469
PA	4.62	4.65	-0.0348
diff (across)	0.463	-0.0407	0.504

Table 1: Average wages

Interpretation

In table 1 we can see the average wages before and after the minimum wage was increased from 4.25$ to 5.05$ in New Jersey (NJ). The first survey wave was in February/ March 1992. In NJ, the wage was around 4.61$ and in the second wave (around November/ December 1992) it increased to 5.08$. In comparison, we can obtain that in the first wave in Pennsylvania (PA) the wage was around 4.65$ while it decreased slightly to 4.62$ after the second wave.
On the one hand, we can see an increase in NJ from around 0.469$ per hour. On the other hand, we see a minimal decrease in the control group of around -0.0348$ per hour. As we compare the wages in the first wave of NJ and PA, we obtain a difference of around -0.0407. Interestingly, the wage was minimally higher in PA than in NJ before the reform. While after the second wave, we see a difference of 0.463 between the two states. Finally the difference of the time differences between NJ and PA is 0.504.
If we assume that the parallel trends assumption holds (meaning that there would be parallel trends in NJ and PA in the absence of the minimum wage policy) the results indicate that the minimum wage increase substantially raised starting wages in NJ relative to PA. But as we can see, the minimum wage increased by approx 19% (from 4.25$ to 5.05$) while the observed average starting wage in NJ increased by only about 10% (from 4.61$ to 5.08$). This difference shows that the increase in the legal minimum wage does not translate one-to-one into increases in the average starting wage. A likely explanation is that many restaurants were already paying above the minimum wage before the policy change, so only part of the wage distribution was directly affected by the new minimum.

2 b) Average employment

state	second interview fte2	first interview fte	difference (in between) dfte
NJ	17.6	17.3	0.287
PA	18.1	20.1	-2.02
diff (across)	-0.536	-2.84	2.30

Table 2: Average employment

Interpretation

Looking at table 2, you can see that the average employment in NJ, where the minimum wage was introduced, did not change that much between the first and second survey waves. The difference is

around 0.287. While having a look at PA shows a different picture. The difference between the first and second wave is around -2.02, implying that the average employment decreases.
Lets first discuss the first survey wave. We notice that in PA (20.1) we have on average a higher employment rate than in NJ (17.3). The difference, before the minimum wage was introduced in NJ, was around -2.84. After the second wave the difference shrinks to -0.536. Which is quite a lot, keeping in mind that between the first and the second survey only were around approx. 9 months. This descriptive analysis implies that in the short run, the average employment rate in NJ was not significantly affected by the introduction of the minimum wage. The number of jobs increased although the wage was higher and therefore it seems that worries about axing jobs because of a higher minimum wage might be unfounded. The result contradicts the classic prediction of a competitive labor market model, according to which a minimum wage should lead to lower demand for labor.

3 c) Difference-in-difference regression

3.1 Regression $Y_{ist} = \beta\ TREAT_{is} + \gamma\ POST_t + \delta_{rDD}(TREAT_{is} \cdot POST_t) + e_{ist}$

Equation for March and Nov/Dec

$$\begin{aligned}
For March(t=1,\, POST_1=0)\text{: } \mathrm{Y}_{is1} &= \beta\ TREAT_{is} + e_{is1} \\
For Nov/Dec(t=2,\, POST_2=1)\text{: } \mathrm{Y}_{is2} &= \beta\ TREAT_{is} + \gamma + \delta_{rDD}\ TREAT_{is} + e_{is2} \\
\Rightarrow Y_{is2} - Y_{is1} &= \beta\ TREAT_{is} + \gamma + \delta_{rDD}\ TREAT_{is} + e_{is2} - (\beta\ TREAT_{is} + e_{is1}) \\
&= \gamma + \delta_{rDD}\ TREAT_{is} + e_{is2} - e_{is1}
\end{aligned}$$

In the last equation the coefficient of interest is δ_{rDD} which reflects the differential changes in NJ . γ is the regression constant reflecting general changes of wages or employment. The new regression residual is $e_{is2} - e_{is1}$.

3.2 Diff-in-Diff Regression estimates on wage

	Estimate	Std. Error	t value	Pr(> |t|)
(Intercept)	-0.03485	0.04287	-0.813	0.417
state	0.50401	0.04757	10.595	$< 2 \times 10^{-16}$ ***

Residual standard error: 0.3483 on 349 degrees of freedom
Multiple R-squared: 0.2434, Adjusted R-squared: 0.2412
F-statistic: 112.2 on 1 and 349 DF, p-value: $< 2 \times 10^{-16}$

Table 3: Regression results for model $dw \sim state$

Interpretation

In this regression we can obtain a Diff-in-Diff regression to estimate the wage changes, after the introduction of the minimum wage. As we can see the estimated coefficient is around 0.50401, with a significant p-value (<0.000). The coefficient is exactly the same as in the result of 1 a). This implies that the wage rate in the Fast-Food-Sector in NJ increases on average more than in PA.

3.3 Diff-in-Diff Regression estimates on employment

	Estimate	Std. Error	t value	Pr(> |t|)
(Intercept)	-2.015	1.052	-1.916	0.0562
state	2.302	1.167	1.972	0.0494*

Residual standard error: 8.546 on 349 degrees of freedom
Multiple R-squared: 0.01102, Adjusted R-squared: 0.008184
F-statistic: 3.888 on 1 and 349 DF, p-value: 0.04942

Table 4: Regression results for model $dfte \sim state$

Interpretation

In this regression we can obtain again a Diff-in-Diff regression to estimate the effect of the introduction of the minimum wage to the employment rate. As we look at the output we obtain that the coefficient is estimated with 2.302 and a p-value of 0.0494. The coefficient is exactly the same as in the result of 2 b). As we interpret this result, we can conclude that the introduction of the minimum wage in the Fast-Food-Sector did not lead to losses in employment in NJ.

3.4 Regression with dummy on employment

	Estimate	Std. Error	t value	$\Pr(>\|t\|)$
(Intercept)	-1.6073	1.1867	-1.354	0.1765
state	2.2973	1.1741	1.957	0.0512 .
co_owned	0.3394	1.0777	0.315	0.7530
as.factor(chain)2	0.2949	1.2719	0.235	0.8143
as.factor(chain)3	-1.9637	1.2960	-1.515	0.1306
as.factor(chain)4	-0.7816	1.4626	-0.534	0.5934

Residual standard error: 8.554 on 345 degrees of freedom
Multiple R-squared: 0.0207, Adjusted R-squared: 0.006506
F-statistic: 1.458 on 5 and 345 DF, p-value: 0.2029

Table 5: Regression results for model $dfte \sim state + co\_owned + as.factor(chain)$

Interpretation

Here we see the regression output (5) while we have dummy variables on employment. For example we control for co-owned (compared to franchised) and chain (i.e. Burger King, KFC, Roy Rogers, and Wendy's). To give a brief overview of the results: We obtain that the employment effect of 2.2973 stays as well similar and is still positive and significant. This shows that the main results cannot be explained by systematic differences in the composition of restaurants between New Jersey and Pennsylvania. The results thus prove to be robust when additional control variables are taken into account.
Already answering question iv) We had assumed that including these covariates should not substantially change the difference–in–difference estimate.
Result: The covariates do not meaningfully affect the Diff-in-Diff estimate because they are constant over time and Diff-in-Diff already accounts for fixed differences across restaurants.

3.5 Regression with dummy on wages

	Estimate	Std. Error	t value	$\Pr(>\|t\|)$
(Intercept)	0.04497	0.04744	0.948	0.34379
state	0.50366	0.04693	10.731	$< 2 \times 10^{-16}$ ***
co_owned	-0.03676	0.04308	-0.853	0.39413
as.factor(chain)2	-0.04665	0.05084	-0.918	0.35945
as.factor(chain)3	-0.15112	0.05180	-2.917	0.00376 **
as.factor(chain)4	-0.15024	0.05846	-2.570	0.01060 *

Residual standard error: 0.3419 on 345 degrees of freedom
Multiple R-squared: 0.279, Adjusted R-squared: 0.2685
F-statistic: 26.7 on 5 and 345 DF, p-value: $< 2 \times 10^{-16}$

Table 6: Regression results for model $dw \sim state + co\_owned + as.factor(chain)$

Interpretation

Last but not least we have the same setup as above but with dummy variables on wages (6). As we can see the coefficient of 0.50366 changes just very little and is still positive and statistically significant. Even after we control for restaurant characteristics, wages in New Jersey rise significantly more than in Pennsylvania. The control variables are largely insignificant, meaning that the observed wage increase

cannot be explained by systematic differences between the restaurants.
Already answering question iv) Also here we expect that by adding the covariates the results does not substantially change the regression.
The minimum wage increase in New Jersey affects all restaurants in the treatment group in the same way. Also here we have consistency with the Diff-in-Diff theory, which is that time-invariant restaurant characteristics do not affect the estimated treatment effect.

4 d) High wage and low wage restaurants in NJ

4.1 Within NJ comparison vs NJ-PA comparison

We could think that the DD assumptions would be satisfied more easily for the within NJ comparison than for the NJ-PA comparison. Restaurants within NJ face similar regional economic conditions. Hence, comparing low-wage and high-wage restaurants may satisfy the parallel trends assumption more easily than comparing NJ to PA. Also there might be different time trends in NJ and PA. If we only look at restaurants in one of the states, this problem does not remain.

4.2 New Regression Diff-in-Diff estimates on employment

	Estimate	Std. Error	t value	Pr(> $\|t\|$)
(Intercept)	-2.2500	0.9472	-2.375	0.01820 *
low_wage	3.3014	1.0806	3.055	0.00246 **

Residual standard error: 7.695 on 283 degrees of freedom
Multiple R-squared: 0.03193, Adjusted R-squared: 0.02851
F-statistic: 9.334 on 1 and 283 DF, p-value: 0.002464

Table 7: Regression results for model $dfte \sim low\_wage$ (Data: NJ)

Interpretation

The estimated coefficient is 3.3014 and it is statistically significant (p-value: 0.00246). Hence the theory implies that as the minimum wages arises the employment rate should decrease. In this case the employment rate (on average) even rises in low-wage earning restaurants in NJ.

4.3 New Regression DD estimates on wages

	Estimate	Std. Error	t value	Pr(> $\|t\|$)
(Intercept)	-0.00409	0.02672	-0.153	0.878
low_wage	0.61587	0.03048	20.206	$< 2 \times 10^{-16}$ ***

Residual standard error: 0.2171 on 283 degrees of freedom
Multiple R-squared: 0.5906, Adjusted R-squared: 0.5892
F-statistic: 408.3 on 1 and 283 DF, p-value: $< 2 \times 10^{-16}$

Table 8: Regression results for model $dw \sim low\_wage$ (Data: NJ)

Interpretation

Looking at this regression output (8) we want to analyze how the starting wage changes after the reform in comparison to the low-wage employees and the high-wage employees. The result is that, following the reform, starting wages of employees in low-wage earning restaurants in NJ have risen more than in high-wage earning restaurants in NJ. The Within-NJ estimator shows the same pattern as the NJ vs. PA comparison: Wages rise significantly where they must be raised by the reform. Employment does not decline. The results are stable across different identification strategies.

Comparison: within-NJ vs NJ–PA Diff-in-Diff estimates

The larger within-NJ estimates are consistent with heterogeneous treatment effects. Hence restaurants starting from lower wages needed to raise wages by more after the reform, so a low vs high comparison within NJ reveals a stronger treatment contrast than the NJ vs PA comparison. Moreover, the within-NJ comparison may better satisfy the parallel trends assumption because restaurants face more similar local conditions, but it also risks selection.

5 e)

5.1 New Regression Diff-in-Diff estimates on employment just for PA

	Estimate	Std. Error	t value	Pr(> |t|)
(Intercept)	-3.848	2.340	-1.644	0.105
low_wage	2.813	2.899	0.970	0.336

Residual standard error: 11.22 on 64 degrees of freedom
Multiple R-squared: 0.01449, Adjusted R-squared: -0.0009036
F-statistic: 0.9413 on 1 and 64 DF, p-value: 0.3356

Table 9: Regression results for model $dfte \sim low\_wage$ (Data: PA)

Interpretation

Looking at the output (9) we see that the coefficient for low-wage is around 2.813 but is not statistically significant (p-value: 0.336). Furthermore the R^2 is nearly zero, which implies that the statistically explanatory value of that regression is nearly zero. As well the F-statistic is around 0.9413, which is very low. Hence we can conclude that the indicator low-wage can not explain any variation in the employment rate. The positive coefficient indicates purely descriptively that low-wage restaurants tended to have higher employment growth, but the effect is not statistically distinguishable from zero. As an instrument, low-wage would not be suitable for $dfte$ because it does not fulfill the necessary relevance condition.

5.2 New Regression Diff-in-Diff estimates on wages just for PA

	Estimate	Std. Error	t value	Pr(> |t|)
(Intercept)	-0.26522	0.07318	-3.624	0.000575 ***
low_wage	0.35359	0.09066	3.900	0.000233 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3509 on 64 degrees of freedom
Multiple R-squared: 0.192, Adjusted R-squared: 0.1794
F-statistic: 15.21 on 1 and 64 DF, p-value: 0.0002331

Table 10: Regression results for model $dw \sim low\_wage$ (Data: PA)

Interpretation

In this analysis we see a different picture (10), the coefficient is around 0.35359 and statistical significant (p-value: <0.0001). Restaurants that paid less than $5 before the minimum wage was introduced show an average wage increase of $0.35. The R^2 is around 0.192 which is better than in the model before. Looking at the F-statistic we see that its around 15.21, which implies that its a good and relevant instrument for wage change (keeping in mind the rule for the F-statistic). To conclude both outputs: The minimum wage has a direct impact on wages, but not directly on employment.
Solutions for i): For Pennsylvania (PA), the regression of changes in employment and wages using the low-wage indicator shows a clear pattern. For employment, the coefficient on low_wage is positive (around 2.81) but statistically insignificant, with a large standard error. Thus, low-wage status does not systematically predict employment changes in PA. For wages, however, the coefficient is positive (about

0.35) and highly significant. Low-wage restaurants in PA experience stronger wage growth than high-wage restaurants, even though PA did not experience a minimum wage increase. This reflects normal wage growth rather than a policy effect. Compared to New Jersey (NJ), the qualitative pattern is very similar: wage growth is much stronger in low-wage restaurants, while employment effects are small and insignificant. The key difference is that NJ restaurants faced a binding minimum wage increase, while PA restaurants did not. The similarity of patterns indicates that wage growth for low-wage restaurants is partly driven by general trends, not solely by the minimum wage reform.

5.3 Statistical test for wages

We estimate the model

$$dw = \beta_0 + \beta_1 NJ + \beta_2 low\_wage + \beta_3 (NJ \times low\_wage),$$

where β_2 measures the low-wage effect in PA and $\beta_2 + \beta_3$ the low-wage effect in NJ.

	Estimate	Std. Error	t value	$\Pr(>\|t\|)$
(Intercept)	-0.26522	0.05156	-5.144	4.51e-07 ***
NJ	0.26113	0.05987	4.361	1.71e-05 ***
low_wage	0.35359	0.06388	5.536	6.13e-08 ***
NJ:low_wage	0.26228	0.07270	3.608	0.000354 ***

Residual standard error: 0.2473 on 347 degrees of freedom
Multiple R-squared: 0.6207, Adjusted R-squared: 0.6174
F-statistic: 189.3 on 3 and 347 DF, p-value: $< 2.2 \times 10^{-16}$

Table 11: Regression results for model $dw \sim NJ + low\_wage + NJ\ low\_wage$

Interpretation

Starting with the Interception, we get the value -0.265 (11). This is in PA, high-wage Restaurants (wages above 5$ even before the reform). The negative estimated value implies that this group had slightly falling wages after the first and second survey wave. Moving on to the variable NJ, we see an estimated value of 0.26 and a statistically significant p-value (< 0.000). High-wage restaurants in NJ (which are not affected by the law) have wage changes that are \$0.26 higher than the baseline. This small effect is consistent with the fact that they were not forced to raise wages. The next variable is low-wage with an estimated value of 0.35359 and a statistical significant p-value (< 0.000). Low-wage restaurants in PA (under \$5 before the reform) have wage changes that are 0.35 dollars higher than high-wage restaurants in PA. The last variable is NJ: low-wage. This is the additional effect of the minimum wage increase for restaurants in NJ and below \$5 before the reform. \$0.262 additional wage increase due to the Minimum Wage Law.

5.4 Statistical test for employment

	Estimate	Std. Error	t value	$\Pr(>\|t\|)$
(Intercept)	-3.8478	1.7635	-2.182	0.0298 *
NJ	1.5978	2.0478	0.780	0.4358
low_wage	2.8129	2.1848	1.288	0.1988
NJ:low_wage	0.4884	2.4867	0.196	0.8444

Residual standard error: 8.457 on 347 degrees of freedom
Multiple R-squared: 0.03706, Adjusted R-squared: 0.02874
F-statistic: 4.452 on 3 and 347 DF, p-value: 0.004376

Table 12: Regression results for model $dftw \sim NJ + low\_wage + NJ\ low\_wage$

Interpretation

This model is basically doing the same as before but for effects of the employment rate. Starting again with the Intercept, which has the value –3.848 and is significant (12). Hence, High-wage restaurants in PA lose on average 3.85 FTE. Moving on to the variable NJ. Here we get the value 1.598 and a p-value which is not significant. High-wage restaurants in NJ have 1.6 FTE more employment change than the baseline, but this effect is not significant. We conclude that we do not have a specific employment trend for high-wage restaurants in NJ. The next variable is low-wage, with the value 2.813. It is not significant. Hence, low-wage restaurants in PA gain 2.8 FTE, but we have to keep in mind that we have large standard errors. We assume that in this specific sector is kinda normal to have a large "natural variation", which has no clear trend even after the reform (and in this specific case). Last but not least, we regress NJ × low-wage. The estimation shows 0.488 as a result. Additionally we do not see any significance. The most important employment coefficient is close to zero, with no significance and has large standard errors. We conclude that there is no employment effect in fast-food restaurants affected by the minimum wage in NJ. Furthermore, the minimum wage did not lead to more or less employment, in a statistically measurable way.

5.5 Check on methodology and what we can conclude

The test should evaluate whether the diff-in-diff methodology successfully isolates the causal effect of the minimum wage increase. In PA, where there was no policy change, low-wage restaurants should not exhibit an additional wage increase attributable to the minimum wage reform. In NJ it should be the other way around.

The difference between the low-wage effects in NJ and PA, which is estimated by β_3, should therefore be positive if the methodology is working properly. Coming back to our results, we have that low-wage restaurants in NJ show an additional wage increase of about $0.26 relative to PA. Thus, the methodology correctly identifies the causal impact of the minimum wage increase. We conclude that the Diff-in-Diff approach performs well in uncovering the true policy effect.